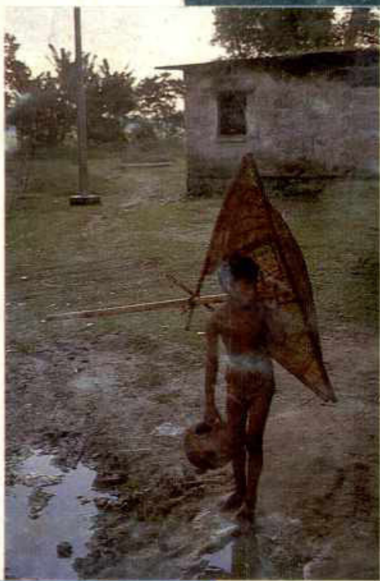
FAP 17

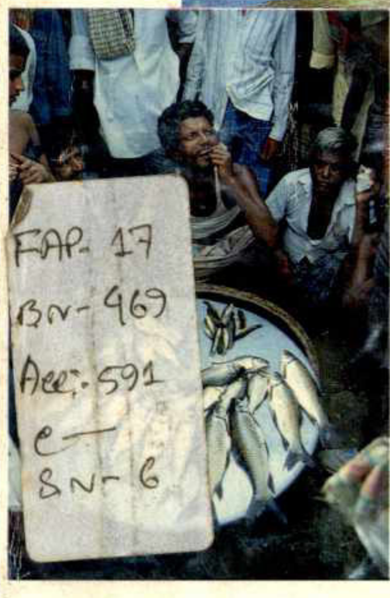
Fisheries Studies and Pilot Project



FINAL REPORT

(Draft)

JUNE 1994



MAIN VOLUME

Prepared for the Government of Bangladesh

FAP 17

FINAL REPORT

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**** Draft ****

FAP 17
FISHERIES STUDIES
AND PILOT PROJECT

June, 1994

Funded by ODA in conjunction with the Government of Bangladesh

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1. EXECUTIVE SUMMARY

1.1 FISHERIES STUDIES

1.1.1 Unregulated floodplains

The fisheries catch assessment surveys (including records of species composition), fishing effort surveys, and studies of hatchling drift, from the "control" sites in areas outside FCD/I embankments provide baseline data on the fishery against which the impacts of flood control can be measured.

Main rivers

The total fish catch per unit area recorded for the year March 1993 to February 1994 was approx. 24 kg/ha for the Jamuna north of its confluence with the Hurasager and 111 kg/ha south of this. The Padma yielded 44 kg/ha upstream of its confluence with the Jamuna, and 244 kg/ha downstream of it. Estimates of total catch from those parts of these rivers lying within Bangladesh for the year were almost the same: 5,044 tonnes from the Jamuna/ Brahmaputra and 4,925 tonnes from the Padma.

The most important species in the fishery of both rivers was *ilish (Hilsa ilisha)*, which contributed an estimated 1,407 tonnes to the total catch from the Jamuna and 1,853 tonnes to the Padma catch.

Between August 1992 and February 1994 a total of 120 fish species were recorded in catches from the main rivers, 107 occurring in the Padma and 90 in the Jamuna. Typically "riverine" and "migratory" species predominated, but significant numbers of "floodplain resident" species were also represented in catches from these rivers.

Secondary rivers

Annual catch per unit length of secondary rivers varied widely between regions, reaching a maximum during the year March 1993 to February 1994 of between 4 and 6 tonnes/km in the North West and North East. On the other hand annual catches from some rivers in the North Central and South West Regions were below 1 tonne/km.

The total number of fish species found in catches from secondary rivers was variable, from as few as 30 per year in some parts of the North Central and South West Regions, to almost 80 on the Atrai/Baral system of the North West. The average species composition was more or less evenly split between riverine, migratory and floodplain resident species, though there were some regional differences.

Canals

Annual catch per unit length of canals varied from less than 1 to almost 4 tonnes/km, with a less clearly distinguishable regional trend than was found for rivers. Peak catches occurred during the period of flood recession, when fish following the flood waters off the floodplain are concentrated in canals.

Total species number varied from around 40 to almost 100, again with no clear regional trend. In canals, however, floodplain resident species predominated in catches, reflecting their origins. Substantial numbers of migratory species were also found, but true riverine species were rare.

Floodplains/*beel*

Floodplain and *beel* fisheries were grouped together in analyses because fish caught in *beel* are in fact produced on the floodplain and merely become concentrated in *beel* as the flood waters recede. Annual floodplain yields varied from less than 50 kg/ha to over 400 kg/ha, with a national average of 107 kg/ha. Peak catches in all regions occurred during the flood recession, when fish are concentrated in residual water bodies and become more vulnerable to capture.

Total species number varied from less than 30 to over 70, with perhaps rather less species diversity being found in the South West than in other regions. As would be expected, floodplain resident species were by far the most numerous. Migratory species were less common, and truly riverine species rare.

The same 20 - 30 floodplain resident species dominated catches all over the country, forming the backbone of the national freshwater fish production. By comparison, major carps made up only a relatively small proportion of the catch nationwide, rarely contributing more than 5% to floodplain catches and in many places being insignificant. Other migratory species, including clupeids and catfishes, were most important in the North East and North West

Regions, where they contributed about 37% and 26% respectively to annual catch, and least important in the South West. Prawns (species unidentified) were very important in the fisheries of all regions, frequently comprising 15 - 20% of the annual catch by weight.

Annual variations

Where data were collected over the two consecutive flood seasons 1992/3 and 1993/4, substantially greater fish catches were recorded in the wetter (1993/4) year. This applied to all habitat types, but was most pronounced for floodplains/*beel* and canals, where catches during the drought year of 1992/3 were up to 70% lower than those of 1993/4.

1.1.2 Fisheries inside FCD/I schemes

The fisheries studies of FAP 17 were carried out on eight FCD or FCD/I schemes (plus the Charghat regulator on the Baral River) in four of the FAP regions of Bangladesh, as follows:

Tangail Compartmentalization Pilot Project (NC)

The Tangail CPP is only partially empoldered, and the embankment had no effect on flooding patterns in floodplain, *beel* and canal sites inside.

The annual catch per unit length of the Lohajang River flowing through the CPP was higher (784 kg/km) than those of two adjacent rivers, the Pungli (598 kg/km) and the Northern Dhaleswari (438 kg/km) lying immediately outside the CPP, but the difference could not be validated statistically because of the lack of consistency in catch rate trends.

There was no statistically significant difference between annual catches from canals inside (955 kg/km) and outside (1,042 kg/km) the CPP.

Floodplain catches were similar inside (57 kg/ha) and outside (60 kg/ha) the CPP. A *baor*-type beel inside the CPP produced a higher catch per unit area (550 kg/ha) than comparable *beel* outside it (404 kg/ha) but there was little difference between floodplain depression-type *beel* inside (123 kg/ha) and outside (108 kg/ha). Although fish productivity appeared slightly higher inside the CPP, the difference could not be tested statistically because of inconsistencies in catch rate trends of dominant gears.

Species richness, as measured by the total number of species recorded in the catch, was similar inside and outside the CPP and also between rivers, canals, floodplain and *beel*. Species numbers ranged from 79 to 92 between different habitats outside the CPP and from 84 to 90 between different habitats within it for the sampling period August 1992 to February 1994.

Species composition of floodplain and *beel* catches was almost identical inside and outside the CPP, while rivers and canals supported a higher proportion of migratory species outside the CPP than inside it. The majority of migratory species in canals comprised major carps which totalled 30% of the catch outside and 6% inside the embankment. 90-94% of species dominating floodplain/*beel* catches were floodplain resident.

Chalan Beel Polder B (NW)

Fish yields were considerably higher in floodplains/*beel* inside (189 kg/ha) than outside (68 kg/ha) the embankment.This was largely attributable to greater fishing effort inside, but insufficient comparable data from use of common gears were available to enable a statistical appraisal of actual fish densities in and out.

Peak catch occurred about a month later inside than out, and the main fishing period was extended by two to four weeks inside. This phenomenon was found in many of the schemes studied by FAP 17. It results from the delayed drainage of the polder caused by drainage congestion following construction of the embankments. Thus one reason why fish catches inside schemes are sometimes higher than out is simply that water is retained **longer** inside embankments, providing a longer growing season for fish.

Chalan provided evidence that floodplains inside and outside embankments may respond differently to hydrological variations between years. In the dry year 1992/3, catches within Chalan were 69% lower than in 1993/4, whereas at control sites outside the polder the yield was only 15% lower in the dry year. This may be partly explained by the fact that flooding inside was more influenced by levels of rainfall, rather than river flooding, so that inside areas may be subject to greater fluctuations in flood intensity between years. However, another factor of central importance in determining catches everywhere is the vulnerability of fish to capture. Thus in the dry year the lower water levels outside the polder rendered fish easily catchable in gears such as bag nets, reducing the difference in catch between wet and dry years despite the undoubted large differences in true fish abundance.

Total number of fish species found inside Chalan was 64 and outside 79, a reduction of about 19% inside the polder. As for all other schemes studied, migratory species were most affected.

Brahmaputra Right Embankment (NW)

The BRE functioned as intended during the period of the FAP 17 study. Floodplain fish yields inside the embankment were very much lower (8 kg/ha) than those of control areas outside (81 kg/ha). Canals showed the same trend, but in less extreme form, yielding 964 kg/km outside and 434 kg/km inside. The difference was reversed in secondary rivers, where outside sites averaged 489 kg/km compared to 1501 kg/km inside. Inside yields were actually slightly greater in the dry year of 1992/3 than in 1993/4, again stressing the importance of fish "catchability" in determining actual fishery yields. Total species number was 35% lower inside (31) than outside (48) the embankment.

Pabna Irrigation and Rural Development Project (PIRDP)(NW)

Though the PIRDP was considered as an FCD/I scheme which works fairly well, hydrological modelling nevertheless confirmed that for many flood cells within the embankment both depth and duration of flooding had been increased by construction of the scheme. This was perhaps one reason why floodplain fish yields were considerably greater (143 kg/ha) inside than outside (76 kg/ha), but the overwhelmingly more important cause was the very much higher fishing effort deployed inside the scheme. Statistical analysis suggested that true fish abundance was significantly lower inside, but this was masked by a fishing effort, expressed in standard gear hours, of 3694 inside compared with only 1923 outside. It is not known why such large differences should occur, but there is evidence of a trend away from expensive "professional" gears towards cheaper "subsistence" gears, affordable by a larger proportion of the population, inside embankments. The phenomenon raises questions about the ability of fish stocks to sustain such high levels of fishing pressure. Yields were 68% lower during the dry year of 1992/3 outside, and 31% lower inside.

Canal and secondary river yields inside the PIRDP were, however, lower than outside (canals 889 kg/km outside, 436 kg/km inside; rivers 4726 kg/km out, 3135 kg/km in).

Species number was 27% lower inside (55) than out (75), with migratory species being most affected by the embankment as usual.

The Charghat Regulator (NW)

Construction of the Charghat regulator on the Baral River reduced peak flows and prevented river flooding on adjacent floodplains. Considerably higher values of catch per unit area were recorded outside on the Padma River compared to those inside on the Baral but the difference could be attributed to differences in the size of the rivers.

The number of species caught inside and outside the regulator was about the same, but different species dominated the catch in and out. During the monsoon season when gates remained partially open, the regulator still formed an obstacle to the upstream migration of fish, notably *ilish*. At the same time, the regulator reduced the downstream drift of major carp hatchlings.

Shanghair Haor Project (NE)

The Shanghair Haor Project is a submersible embankment which, in the year of the FAP 17 study (1993) overtopped on May 19, very close to the "target" date specified in the project design. Floodplain fish yields were virtually identical inside (105 kg/ha) and outside (108 kg/ha). Species diversity was actually higher inside the submersible embankment (total 70 species) than outside (62).

Manu Irrigation Project (MIP)(NE)

The Manu embankment was designed to provide full protection against river flooding, but it was breached and deliberately cut in several places during June 1993. Floodplain fish yields were higher outside (145 kg/ha) than in (107 kg/ha). This occurred despite higher effort inside, and is a reflection of greater fish abundance outside. Conversely canal yields were higher inside (3434 kg/km) than out (2783 kg/km). The effects of breaching of the embankment on species diversity were clearly seen. Total number of species inside was 54% less (46) than that outside (69) before the breaches, but virtually the same (70) afterwards. However, the FAP 17 hatchling movement studies showed that the period of peak abundance of juvenile carps in the rivers outside Manu occurred in May, and had passed before the embankment was cut. Therefore the presence of the embankment certainly reduced the population of carp which might otherwise have been seeded onto the floodplains within the scheme.

Chatla-Fukurhati Project (SW)

The Chatla-Fukurhati scheme had breaches in it even before the 1993 rains began and regulators remained open due to inadequate maintenance and repair, so that flood waters were able to enter as soon as outside water levels reached the embankment. Free access was therefore available to fishes migrating onto the floodplain from outside. On the other hand, as flood waters receded, the restricted drainage and limited number of exit routes served both to delay and impede the escape of fish from the embanked area. Further, the vulnerability of fish to capture was increased as they were funnelled out through the canals leaving the scheme. As a consequence the embankment acted rather like a large fish trap, and higher floodplain and canal fish catches were recorded inside Chatla-Fukurhati than outside (floodplains 142 kg/ha in, 111 kg/ha out; canals 4124 kg/km in, 3022 kg/km out). Total species number was also 41% higher inside (72) than out (51) on floodplains, and 7% higher (63 in, 59 out) in canals.

Satla-Bagda Polder 1 (SW)

Satla-Bagda Polder 1 was subject to extensive rainfall flooding, but entry of river water via canal networks was prevented during June and July, therefore modifying the source of floodwaters compared to free-flooding areas of Bagihar beel.

The magnitude of the flood was reduced by 0.5m within the polder, but the area inundated was not significantly affected since most land inside the polder was inundated during 1993. Timing and duration of flooding were not altered by flood control structures.

Total annual catch per hectare from floodplain and *beel* sampling sites outside the polder (216 kg/ha) was 73% higher than that from inside (125 kg/ha).

Extrapolation of floodplain catch data to the total area of Polder 1 and the defined area of Bagihar *beel* together with the integration of these with canal catches resulted in an estimated total catch per unit area of 202 kg/ha from Bagihar *beel*, which was 54% higher than that in Satla-Bagda Polder 1 (131 kg/ha).

Catch rates of dominant gears were used as indicators of relative abundance of fish in statistical analysis of floodplain fisheries. Significantly ($p < 0.05$) lower densities of fish were recorded inside the polder compared with outside sites, indicating lower fish productivity within the polder.

Fishing effort was greater outside the polder and contributed to the recorded higher catches.

Generally, lower numbers of fish species per site were found within the polder, indicating a small reduction in biodiversity inside the FCD area compared with outside sites.

Flood control had little impact on the species composition of more than 90% of the annual catch. At both inside and outside sites the catch was dominated by floodplain resident (sedentary) species. Migratory species made little contribution to the total annual catch either within or outside the polder.

The flood control scheme prevented the entry of fish hatchlings, notably those of major carps, into the polder during June and July because sluice gates remained closed. This period coincided with the peak abundance of carp hatchlings in the Kumar River. Carp hatchlings appeared in the Kumar in mid-May, but were prevented from entering free-flooding floodplains by rainfall runoff until mid-June, when water currents reversed and river water entered the plains.

1.1.3 Conclusions

The effects of FCD/I schemes on fisheries were perhaps not as great as was initially anticipated, partly because the effects of flood control schemes on flooding were not as great as planned. When averaged out over all the schemes studied by FAP 17, floodplain fish catch per unit area was not substantially different between sites inside (116 kg/ha) and outside (107 kg/ha) FCD/I embankments during the flood year 1993/4, and this was also the case when an average was taken only using those schemes considered to be functioning fairly well. Catches from secondary rivers and canals were so variable as to make generalization difficult.

On the other hand, a clear impact of FCD/I was demonstrated on fish species diversity. Total numbers of species occurring in catches outside embankments were consistently higher than inside. Species composition was also different, with less migratory species being represented inside embankments. Over the whole country the contribution of major carps to the fisheries both in and outside FCD/I schemes was not great, with the exception of the North Central Region. The importance of other migratory species varied regionally, with migratory clupeids and catfishes being of most significance in the North East and least in the South West. However, the floodplain fisheries of Bangladesh were shown to depend largely on a limited number (20-30) of floodplain resident species.

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1.2 SOCIO-ECONOMIC STUDIES

1.2.1 Regional variation

There are significant variations between the fisheries of different regions in their social and economic features: the distribution of catch and benefits between different groups; the patterns of access to fisheries resources; and the values and attitudes associated with fishing as a livelihood. These variations are often linked to physical differences in landform and drainage patterns and to historical settlement patterns. Their result is that broad generalizations at the national level are to be avoided: similar flood control interventions could have very different social and economic impacts in different regions of the country. The principal regional findings are given below.

North Central

The role of subsistence and occasional fishermen is greater here than in any other region, particularly on the floodplains and *beel*, where they took around 80% of the total sampled catch. Professionals, who tend to be traditional Hindu *caste* fishermen with no other major source of income, take the majority of the catch only on the main rivers.

For all groups, fishing is an activity of some importance, with higher overall levels of participation than the NW and NE. For the landless it was of critical importance during the period July-September, when its contribution to total monthly income rose to around 25%. The significance of fishing within annual income should not however be overstressed: it is one of many sources, contributing less than 10% of the total landless income and 5% or less of village income in three out of the four main villages covered by socio-economic monitoring.

North East

In the NE the characteristics of the fishery are determined largely by hydrology and, linked to this, limitations on access. In the peak flood, the much deeper flooding limits subsistence fishing activity to a relatively smaller proportion of the total floodplain, around the homestead area; much of the catch goes to larger seine nets, such as *ber jal,* operating on open waters. As the floods recede fish may be caught by landowners dewatering their fields or, more usually, when they become concentrated in the *beel,* by professional fishermen working for the leaseholders. Both landowners and leaseholders attempt to limit fishing that could subtract from their ultimate catch, limiting the scope for the landless.

As a result most of the catch in all habitats was taken by professional fishermen, usually traditional Muslim *maimals*. Occasional fishing is rarer than elsewhere and in the agricultural communities monitored the limited amount of subsistence fishing that takes place is mainly undertaken by farmers, rather than the landless, despite the generally low levels of income of the latter. Fishing contributed less than 2% of total landless income in three of the four villages studied. Even at its seasonal peak in the village where it was most significant, fishing contributed less than 20% of landless monthly income.

North West

In the NW there seems to be strong residual taboo against fishing among the more traditional members of the agricultural community, particularly using gears involving immersion - the use of hooks or small lift nets (*dharma jal*) from the banks of *khal*, for instance, is less frowned upon. At the same time, the withdrawal of Hindu professionals from the floodplain fisheries seems to have created opportunities that many households in this generally poor region could not afford to ignore.

Most of the value of the catch on habitats except *khal* is taken by professional fishermen, most of whom are now Muslim - often non-traditional. A relatively small proportion of the catch of non-professionals is taken by subsistence fishermen. More than in any other region, those who fish do so for income: around two thirds of fishing households in agricultural communities earn between Tk.500 and Tk.5,000 per annum from this activity.

South West

In the SW, like the NE, hydrology is the principal factor determining the socio-economic characteristics of the fishery. Here, the difference between the elevation of ridge crests and basin centres is generally less than two metres and though there are areas that are extensively and deeply flooded, there are few permanent waterbodies on the floodplain. Drawdown is into a series of dispersed pools, rather than a single sump; and it occurs early enough for most of the area to be cultivated. As a result, there is little government (*khas*) land on the floodplain that is available for leasing and most of the benefits from the concentrations of fish that occur go to owners of the bottom lands, many of whom have fish pits (*kua*).

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The strong seasonality in opportunities reduces the scope for professional full-time fishing, though there are significant numbers of professionals with other sources of income. But professionals take the majority of the catch only on the secondary rivers - on the main rivers the very important *Hilsa* fishery attracts large numbers of part-timers, reducing the share of professionals to less than half. On the other habitats, subsistence and part-time fishermen dominate, taking around three fifths of the total catch.

Among non-professionals the fishery is an important seasonal source of income, though its importance varies for different groups through the year. The landless take the bulk of the catch during the peak flood season; farmers benefit more from the economically richer fishery in and after the drawdown, when their land ownership enables them to assert fishing rights.

1.2.2 Local variations

Within the context of these broad regional patterns, there are important local variations that significantly affect the importance of fishing in livelihood strategies. The value of local fisheries resources clearly is an important determinant of its **potential** significance, particularly for subsistence or part-time fishermen, who usually do not travel more than a mile or so to fish. But its actual value is also influenced by a range of other factors: the leasing or ownership status of waterbodies or floodlands; the attitudes of leaseholders to the community - willingness to accept subsistence fishing or employ professionals; the availability of alternative livelihood options; and the historical and cultural background of the communities themselves, which affects social attitudes to fishing.

As a result, neighbouring communities both located very close to rich fisheries resources may have completely different levels of involvement in fisheries.

1.2.3 Impacts of flood control on fisheries

The impacts of flood control structures on fisheries are not as marked as might be expected, principally because the impact of flood control structures on **flooding** was often limited. Many of the schemes studied did not function as planned, due either to failures in operation and maintainance or to breaching, which frequently occurs when flood control is most needed. Where embankments and water regulators are in place and "function", stopping flooding from rivers, they tend to obstruct the passage of hatchlings and/or brood-stock of migratory fish. However, non-migratory, floodplain resident fish are not affected as long as rainfall flooding maintains the duration and extent of flooding and a sufficiently large breeding stock survives the dry season.

These migratory species are mostly **high-value**, such as the major Indian carps (*ruhi*, *catla*, *mrigal* and *kalibaus*) and large migratory catfish such as *boal* (*Wallagonia attu*). While these fish contribute significantly to the **value** of catches, even in areas **not** affected by flood control they make up a relatively small proportion of the total. These higher value fish tend to be concentrated in the deeper parts of perennial *beel* which are normally leased out and harvested by those professional fishermen engaged in *beel* fisheries. Reductions in these species therefore primarily affect professional fishermen and leaseholders rather than seasonal or subsistence fishermen, though there may be some impact on the value of the catch of hooks and lines, which are often used by the landless.

These high-value migratory fisheries are in decline both inside and outside flood control schemes, partly as a result of the interruption of natural migration routes by flood control, but probably more seriously as a result of road and pathway construction and the conversion of wetland areas to agriculture.

1.2.4. Flood control and fisheries access

Access to the most important fisheries resources has long been controlled. But it is apparent that throughout Bangladesh the existing patterns of control are under pressure, sometimes through processes set in motion or accelerated by flood control.

Traditionally, large areas of *khas* land subject to deep flooding were fished almost exclusively by professional fishermen using large gears suited to the hydrological conditions found there. Often such waterbodies were subject to official leasing. Over the last two to three decades, these areas have dwindled as the frontier of cultivation has been pushed ever deeper into the wetlands by land hunger and new crop options made possible by reductions in flood depth (due to siltation or flood control) and the spread of mechanical irrigation.

Within such areas, professional fishermen have since found themselves increasingly in competition for the fisheries resource with local agricultural communities, newly enabled to fish (by changes in flood levels) and newly empowered by their tenurial claims to the land beneath the floodwaters. In this competition, unless backed by a powerful leaseholder, the professional fishermen are at a severe disadvantage.

The inital effect of such changes is often an opening up of the fishery. But this can be followed by increasing competition among members of the agricultural community. Owners of bottom land dig fish pits (*kua*) to simultaneously aggregate and privatise fish during the flood recession; they may accompany this by encouraging the local bureaucracy to enforce the ban on *current jal* on the surrounding floodplain during the peak flood season. Where mitigation measures such as *beel*-stocking have been carried out, this latter trend is dramatically illustrated.

These changes are neither unique to flood control schemes nor inevitable within them; they are, however, one of its possible outcomes.

1.2.5 Flood control and professional fishing communities

Traditional fishermen are the most likely losers from changes in floodplain fisheries that result from flood control, whether this be through a decline in the value of fish stocks or reduced fishing opportunities.

Different fishing communities pursue different strategies in dealing with these changes depending on their location, local circumstances and their historical and cultural traditions. Many have concentrated their fishing activity on main rivers such as the Padma and Meghna, reportedly leading to a very significant rise in numbers of fishing units operating. Others have sought to specialise in specific fisheries, including, in some areas, the management and harvesting of both cultured and naturally-stocked submersible ponds. Migration out to India and, where possible, changes of occupation are frequently pursued options for Hindu fishermen.

1.2.6 Flood control and part-time fishermen

As with other socio-economic impacts of flood control on fisheries - as is inevitable with so many interacting variables - the effect on part-time fishermen is contingent on circumstances.

When flood control significantly reduces the areas of *jalmahal* (and the associated control of fishing effort) but not the area flooded, part-time fishermen may find they have increased access to a still large stock of floodplain resident species. At the other end of the spectrum, if fish stocks are seriously affected in an area where part-time fishermen are already taking a significant proportion of the catch, they will be adversely affected.

1.2.7 Flood control and subsistence fishing

A large proportion of the population living in floodplain areas catch fish at some time or another during the year. Children in particular play an extremely active role in these fisheries. These subsistence fisheries are opportunistic and vary dramatically in intensity from year to year depending on flood levels. The degree to which they contribute to household livelihood is similarly variable.

Subsistence fisheries are concentrated on shallow flooded areas of the floodplain, when they are indundated, on residual waterbodies such as homestead borrow-pits and along the banks of rivers and *khal*. Flood control, as observed during the study, does not directly affect fisheries on these areas, unless it also has a significant impact on flooding.

A reduction in flood risk can encourage more intensive use of borrow-pits and ponds for fish culture. This leads to the steady reduction in access to subsistence fishing in areas close to homesteads. Some of these small, residual waterbodies are particularly important for extremely poor people, such as the very old or female-headed households, who are not able to leave the homestead area and for whom nearby, naturally-stocked ditches may be the only available source of fish.

1.2.8 Fish consumption

For the majority of people living on the floodplain, fish consumption is not greatly affected by flood control. The small floodplain resident species consumed by the majority of rural people are little affected - unless there is a large change in the area flooded - and access to them may actually improve. In spite of widespread occasional fishing in floodplain communities, for most households fish is bought significantly more often than it is caught.

Although fish is consumed frequently and is extremely important as a condiment, its nutritional significance is limited. Fish provides variety and some important micro-nutrients not provided in what is otherwise an extremely monotonous and rice-dependent diet. However, in terms of protein intake, it is of minor importance (19.2% in fishing communities, 13.3% in main villages) - rice is overwhelmingly the most important source. Catch for own consumption is significantly more common in the SW than in other regions.

1.2.9 Fisheries impacts and the economics of flood control

Fisheries production on the floodplain is considerably more valuable than previously assumed. It is also considerably more resilient. Most floodplain fish production comes from species that do not have to migrate to and from the rivers. Fisheries impacts will therefore be higher than previously thought when a significant area ceases to be flooded but lower when flooding largely continues.

As the value per hectare of agricultural production is still substantially higher than that of fisheries, the increased estimate of the value of fisheries losses on areas where flooding ceases does not necessarily imply that flood control cannot be economically justified. But it will tend to make schemes less viable at the margin.

Each scheme has to be evaluated on a case by case basis.

2. INTRODUCTION

2.1 BACKGROUND

FAP 17: Fisheries Studies and Pilot Project, is one of the supporting studies of the Flood Action Plan. It is the only FAP project entirely devoted to inland fisheries issues. FAP 17 was designed as a two-phase project. Phase I, the Fisheries Studies, is a biological and socio-economic research project which aims to provide much needed baseline data on fish stocks and catches, and to provide impact assessment of a range of different types of FCD/I schemes on fish production and the fishing communities dependent to varying degrees on this resource. Phase II, the Pilot Project, will demonstrate feasible strategies to reduce or partially compensate for the expected loss in benefits from capture fisheries caused by FCD, through the integration of fisheries into water management. This report is the Final Report of Phase I.

The project is funded by the British Overseas Development Administration (ODA) in conjuction with the Government of Bangladesh (GoB). The national Implementing Agency for Phase I is the Department of Fisheries (DoF) of the Ministry of Fisheries and Livestock, and the project also reports 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. To take account of the extension, the original budget of £1.933 million sterling was increased to £2.460 million.

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.

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 fisheries.

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 Socio-economic 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. They were:

A. The use of passes and water regulators to allow movements of fish through FCD/I structures.

B. Investigation of pesticide residue levels in floodplain fish in Bangladesh.

C. The nature and extent of NGO's participation in fishery resource development in Bangladesh.

D. An annotated bibliography (1940-1992) on the river and floodplain fisheries biology and production in Bangladesh and South Asia.

E. Review and annotated bibliography of nutrition in Bangladesh.

2.2 THE REPORT

This is the Final Report of FAP 17, Phase I. It presents the results of analyses of all the fisheries and socio-economic data collected by the project. The results are explained and interpreted to address the immediate objectives described above.

The report is structured into three levels of documents:

Level 3. The lowest, most basic level at which results are presented in this report is as Appendices. These summarize the key data collected by FAP 17 into tables. It should be noted, however, that the tables given provide only a brief, highly condensed picture of the vast quantities of data collected by the project. Readers wishing to delve into the raw data from which these summaries were drawn, for the purposes of further research, must consult the original database. Copies of this are held in Dhaka and London. Permission for access to the database should be sought in the first instance through the Overseas Development Administration, Aid Management Office, British High Commission, Dhaka, Bangladesh. Documentation and description of the database is also given in the Appendices, together with details of methodologies used for analysis and statistical testing of the data.

Level 2. Results are further condensed and interpreted to provide the material for a series of Supporting Volumes. These may be regarded as the definitive level at which FAP 17's results are presented, providing stand-alone accounts of findings from each component of the project's work. On the fisheries assessment side of the project, the Supporting Volumes comprise nine "inside/outside" comparisons, one for each of the FCD/I schemes studied. Additional reports cover fisheries in the major rivers and the movements of fish hatchlings. The socio-economic results are presented in seven Village Study reports, one for each FCD/I scheme around which village clusters were surveyed, plus a "Thematic Study" which draws out and discusses the major issues arising from the village surveys. In addition, "Special Studies" papers cover fish marketing and prices, the NGO target group approach to aquaculture development, and the issue of access to fisheries resources.

Level 1: The Main Volume. Here the major findings presented in the supporting volumes are drawn together, interpreted and explained to present in a summarized and manageable form the full picture of impacts of FCD/I on fisheries and the communities which are to some extent dependent on the fishery resource.

Section 3: Impacts on Fish, starts with a description of floodplain/*beel*, canal and river fisheries, based on the data collected by FAP 17 from sample sites "outside" flood control schemes. This provides the baseline against which data collected at "inside" sites are assessed. "In/out" differences in fishing effort, catch, gear use, species composition, patterns of fish movement etc. are interpreted in the light of the hydrology on either side of FCD/I embankments.

Section 4: Impacts on People provides a synthesis of the results of FAP 17's village surveys, presenting summarized results by region of the country. Implications of changes in fisheries and agricultural patterns for professional, part-time and subsistence fishermen are discussed. An economic analysis ties together the fisheries and sociological results of FAP 17 by calculating and tracking the distribution of incomes from fisheries through rural communities.

The final two chapters of the Main Volume present the project's recommendations for measures to mitigate any adverse effects of FCD/I developments on fisheries and communities, and guidelines for the assessment of impacts of future proposed schemes.

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3. IMPACTS ON FISH

3.1 OBJECTIVES

Of the seven immediate objectives of FAP 17 listed in Section 2, five directly concern the fisheries studies (Nos. 1, 4, 5, 6, 7). The training element of the study (objective No. 7) has been addressed by on-the-job training of six supervisors and approximately 100 fisheries biologists during the course of the field programme. 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 yields inside and outside FCD schemes, 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* , used by children, to the large-scale gears such as *ber jal*, used by teams of professional fishermen. To do this, enumerators had to meet and interview fishermen on the water, whether on the shallow floodplain or on the mighty Jamuna River. This approach was highly labour intensive, expensive 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. Another possibility was the detailed demographic household and market surveys which have been used in other fisheries studies in Bangladesh, e.g. the Third Fisheries Project. However, these approaches 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[1] 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.

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 schemes within FAP regions.
3. Aquatic habitats within each FCD 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 schemes were selected to ensure inclusion both of a range of different types nationally and of types which were of particular regional significance (Table 3.1). 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 FCD schemes, and therefore both these types of flood control were selected for study in this region.

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

Figure 3.1 FAP 17 study areas

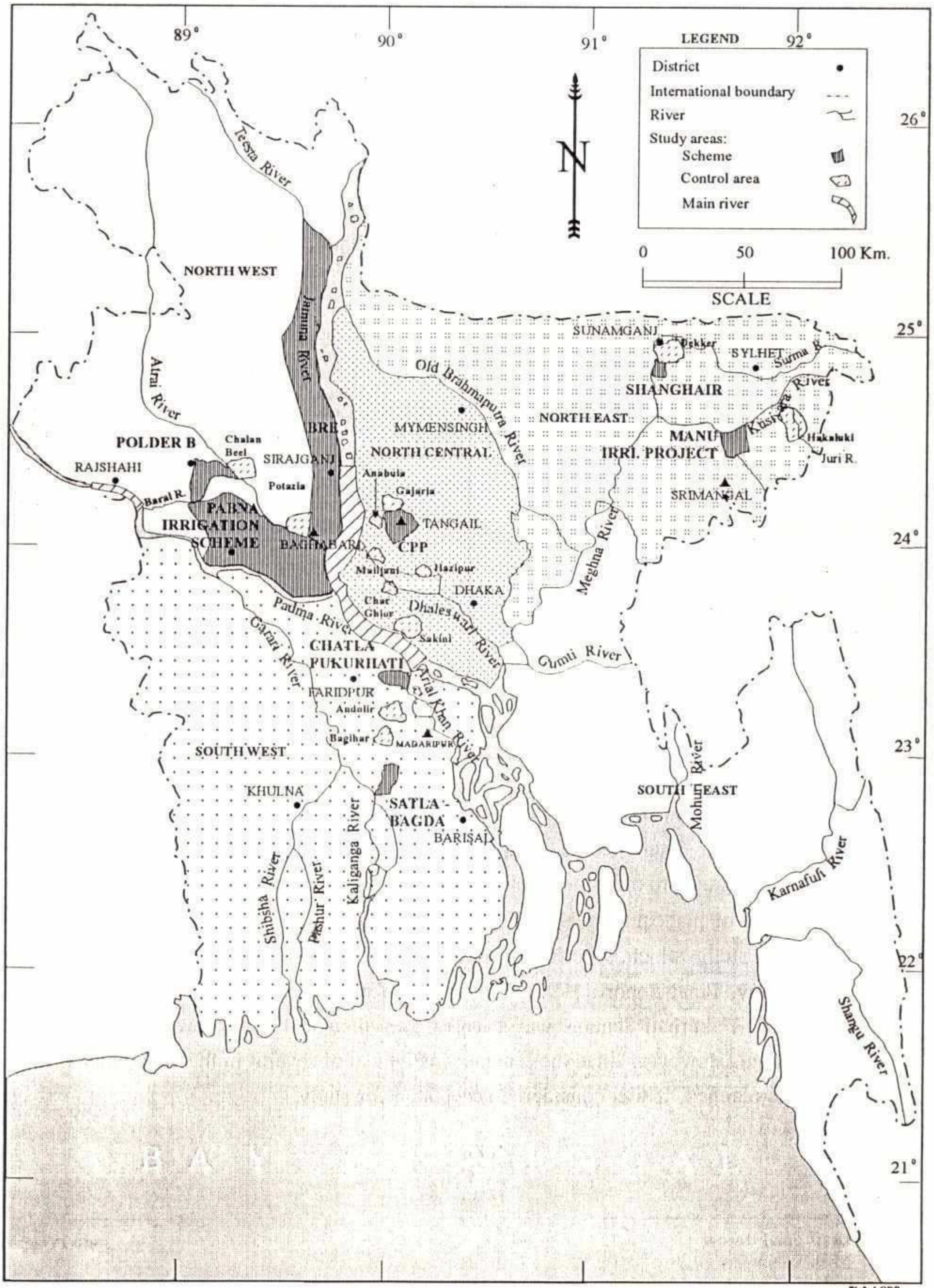

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Table 3.1 Flood Control Schemes studied by FAP 17

Name of flood control scheme	Type of scheme	Functioning
Compartmentalization Pilot Project (CPP) in Tangail (NC)	FCD	Not yet completed as a compartmentalization project, some flood protection, but no regulation of flooding or drainage.
Pabna Irrigation and Rural Development Project (PIRDP) (NW)	FCDI	Successful flood control and drainage. Until 1993, pumped drainage and irrigation through Bera was not available. Pumped drainage through Kaitola was sporadic.
Brahmaputra Right Embankment (BRE) (NW)	Full river embankment	Successful flood control in the study area.
Chalan Beel Polder B (NW)	FCD	Successful flood control and drainage.
Manu Irrigation Project (MIP) (NE)	FCDI	Irrigation resulting from closure of the barrage in winter. Several breaches since completion have affected the success.
Shanghair Hoar Project (SHP) (NE)	FCD - with submersible embankments	Variable reports of the success of submersible embankment delaying flooding until after 15 May.
Chatla-Fukurhati Project (CFP) (SW)	FCD	All regulators not working well, but some control of flooding.
Satla-Bagda Project Polder 1 (SBP) (SW)	FCD	Successful flood control.

The greatest constraint on the selection process at this geographical level was in finding FCD/I schemes which functioned as planned. The majority of schemes 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 another FAP study which specifically addressed this issue (FAP 13: Operation and Maintenance Study, Final Report, 1992). This meant, for example, that in the South West Region the Chatla-Fukurhati Scheme was selected even though it was known to be at best partially functional. However, since the scheme 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, as follows:

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 a dry season reservoir of fish which is 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 particular FCD schemes, whilst all other aquatic habitats, if they occurred within a selected FCD scheme and its outside control area, were sampled at the same time. The distinction between floodplain and *beel* was fairly arbitrary in 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. In the selection of floodplain and *beel* sites inside and outside FCD schemes, 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. A summary of sites selected by habitat type is given for each region in Table 3.2.

Table 3.2 Survey of the total number and size[1] of sampling sites by habitat and region

Habitat	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)	4	5,665.40	0	-	3	3,288.0	1	1,256.5	8	10,209.9
Secondary River	7	90.07	5	51.91	9	96.65	3	29.30	24	267.9
Canal	8	46.77	3	8.25	4	32.20	6	31.56	21	118.8
Floodplain/beel	12	1,562.70	13	2,457.10	14	3,572.6	12	1,710.10	51	9,302.5
Total	31		21		30		22		104	

Note: 1. Size of site refers to length in km for canals and secondary rivers and area in hectares for floodplains/*beel* and main rivers.

3.4 METHODS

Methods used in fisheries surveys were presented in detail in the Interim Report of FAP 17. Only a brief summary of these is given below.

3.4.1 Fish Production Study

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 of each gear type operating day and night. By applying the catch rates of each gear type to the total daily effort deployed on that gear, 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.

The values of catch per unit area (CPUA) could then be used to make comparisons between similar aquatic habitats inside and outside FCD schemes and to extrapolate estimates to larger areas of each habitat type.

3.4.2 Fish Movement Studies

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 would also assist mitigation measures by improvements in regulator design and operation to allow the passage of hatchlings onto their nursery grounds on the floodplains.

3.4.3 Water Quality and Hydrology Studies

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.

Baseline data were collected to describe flooding patterns inside and outside FCD schemes. Every two weeks sketch maps were made of the flood extent at each site and water depths were recorded at fixed points on the floodplain covering a range of land heights. This information was used to provide a quantitative description of the timing, duration, extent and magnitude of flooding which could then be related to fisheries data when undertaking assessments of the impact of various flood control schemes.

3.4.4 Statistical Analyses

A detailed description of the statistical analyses employed as part of the impact assessment procedure is presented in the Fisheries Appendices of this Final Report. To summarise briefly, the method is based on fisheries data collected using stratified random sampling from comparable sites inside and outside FCD/I schemes 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 schemes 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 schemes 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 SCHEMES

3.5.1 Background

The floodlands of Bangladesh represent the combined floodplain of the Padma, Jamuna and Meghna rivers and can cover some 5.5 million hectares of land during the monsoon season. There is, however, considerable variability in extent, duration and depth of flooding from year to year depending upon the amount of rainfall and the relative magnitude and timing of flood discharges from the three rivers. Some 13 million people are estimated to live on the active floodlands, of whom around 80% will fish at some time in the year. It is this intimate association between such large numbers of people and the fisheries on the floodplain which gives the fisheries their particular importance in Bangladesh. In addition, there is a progressive increasing trend in the number of landless people, and for them fishing in open areas is frequently the last resort for a livelihood.

In recent years areas of the floodplain have been modified and regulated for flood control and to improve water regulation for agriculture. Most often this has involved poldering areas into FCD and FCD/I systems for improvement in conditions for paddy cultivation. It would be anticipated that such empolderment of the floodplain with consequent modification of the flood pattern would impose considerable changes upon the fishery. The FAP will increase this compartmentalization process as part of its implementation. For this reason FAP 17 has centered its attention around existing schemes and conducted paired surveys to examine the modification of the fishery inside compared to that on the open floodplain outside. The results of these comparative fisheries surveys are presented as a series of Supporting Volumes to this Final Report of FAP 17. The following discussion draws together, compares and interprets the results to provide a summary of the projects' findings. In this section the riverine and floodplain fisheries of non-poldered, relatively free-flooding areas outside embankments are described to provide a background against which to place in context the various impacts of flood control.

The FAP 17 fisheries studies surveyed 104 sites on floodplains, *beel* and rivers in all FAP regions except the south east. During the 19 months of field surveys 389 tonnes of fish were sampled, representing 11% of the total estimated catch from all sites (Table 3.3).

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 3.2, 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 population and fisheries in areas outside FCD/I schemes 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. 3.2) but much of the variation was due to the distribution of the migratory *ilish (Hilsa ilisha)*, which 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 3.4).

Table 3.3 Summary Description of Catch Assessment Surveys

	Main Rivers	North Central	North West	North East	South West	All Region
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
% of sample weight to total weight	0.41	7.14	5.01	36.52	14.55	11.03
Number of gears observed	48	34	36	47	29	71
Number of species observed during whole study period	123	154	148	149	135	231
Number of species observed during 12 month period (March 1993 - February 1994)	116	127	147	136	134	218
Number of species tentatively identified in Hatchling study.		107	110	107		142

Table 3.4 **Annual Catch at 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 (kg/ha)	Without hilsa
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 both 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 3.5). This value lies within the range of published catch statistics (BFRSS) provided by the Department of Fisheries between 1983 (21,000 t) and 1989 (5,600 t). The published estimates show a marked progressive decline in catches during this period. The estimate from the present study is about double the most recent published estimates. However, this estimate is for one year only and reveals nothing about long-term trends.

Figure 3.2 Annual catch (kg/ha) from the Jamuna and Padma rivers, March 1993 - February 1994

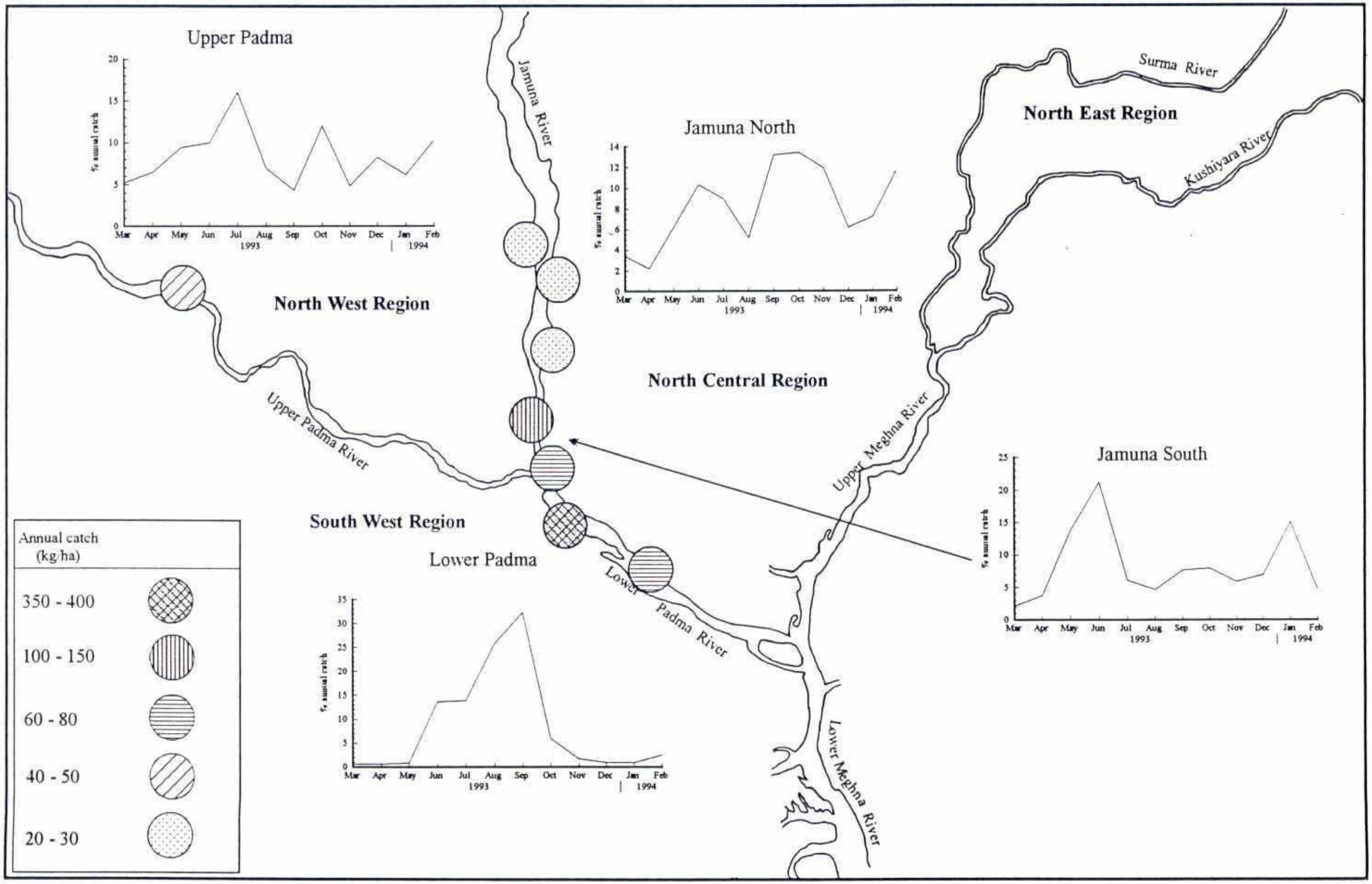

Table 3.5 Estimated total annual catch of Jamuna and Padma rivers, March 1993 - February 1994

River	Annual Catch (tonnes)			
	Hilsa ilisha	Other Species	Total	% Hilsa
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

Hilsa ilisha (ilish) dominated the catch of the lower Padma (49% of annual catch) and Jamuna (28%) but was relatively unimportant on the upper Padma (Table 3.5). 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 represents about 75% of the total combined catch of the three principal rivers Padma, Jamuna and Meghna (DoF Annual Statistics, 1988-1989). *Ilish* undertakes seasonal spawning migrations from sea to river, the most important of which historically was along the Padma into the Ganges of India. However, following the completion of the Farakka barrage across the Ganges for water diversion in India, the numbers of *ilish* using this migration route are believed to have declined drastically. Certainly, its habit of migrating upstream close to the river bed as recorded in the present study suggests that the barrage would present a considerable obstacle despite overtopping by floodwaters during the monsoon. 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 immune to the impacts of FCD developments. Of more concern to the long-term sustainability of this fishery is the general increase in fishing pressure inland and in the Bay of Bengal and the widespread use of illegal seine nets to capture juvenile fish in rivers such as the Atrai and lower Meghna.

The most important gears used on the Jamuna and Padma rivers are listed in Table 3.6 together with their percentage contribution to the total annual catch. Drifting gill nets predominated on both rivers, however on the Padma, 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 targets *ilish*, was omitted from the percentage compositions given in Table 3.6 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 3.6 Percentage contribution made by dominant gears to the total annual catch of Jamuna and Padma Rivers, March 1993 - February 1993

Gear Name	Jamuna	Padma
Ber jal	8.61	9.52
Moi jal	11.82	3.34
Satiber jal	2.15	-
Thella jal	5.84	-
Jhaki jal	3.92	2.14
Chandi jal	-	3.55
Current jal (Stationary)	5.76	-
Current jal (Drifting)	25.08	-
Par jal	1.05	27.49
Kajuli jal	1.92	2.00
Gai Dasem	-	33.84
Veshal	-	2.36
Sip	3.82	-
Tana Barsi	5.03	-
Daun	8.16	-
Doiar trap	7.35	5.87
Total	90.51	90.12

Note: Dominant gears are defined as those which between them capture at least 90% of the catch in each river.

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 rather 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. 3.3). Major seasonal changes in the number of species recorded were generally similar at all sites with two periods of increase, the first 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

CD

to seek the shelter of rivers.

Catch Composition

Species compositions (% by weight) of the annual catch of the Jamuna and Padma Rivers 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. Details of species composition at each sampling site can be found in Supporting Volume No.10. Species in Table 3.7 are divided into three categories which 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 dependence on the floodplain, although some species can occasionally be found on extensive floodplains, particularly in the North East.

b) Migratory

Species which move between river and floodplain during different stages of their life cycle.

c) Floodplain resident

Species which are generally sedentary and are capable of surviving in perennial waters on the floodplain throughout the year. Many of these species also inhabit a variety of freshwater habitats, including large rivers, as Table 3.7 shows.

The fish fauna of the Jamuna and Padma is dominated by riverine species, mainly comprising the clupeid, *ilish* and various types of catfish. Typical floodplain resident species, as a group, contributed about the same proportion as migratory species (13%) to the total annual catch of the Jamuna and somewhat less (6%) on the Padma (Table 3.7). Only a few floodplain residents, notably the goby, *Glossogobius giurus* (*bailla*) and the barbs *Puntius sophore* (*puti*) and *P. conchonius* (*canchan puti*) were amongst the dominant species comprising more than 1% of the total catch. Important migratory species included major carps, *Labeo rohita* (*rui*)

Figure 3.3 Biodiversity: Annual total number of fish species in the Jamuna and Padma rivers, March 1993 - February 1994

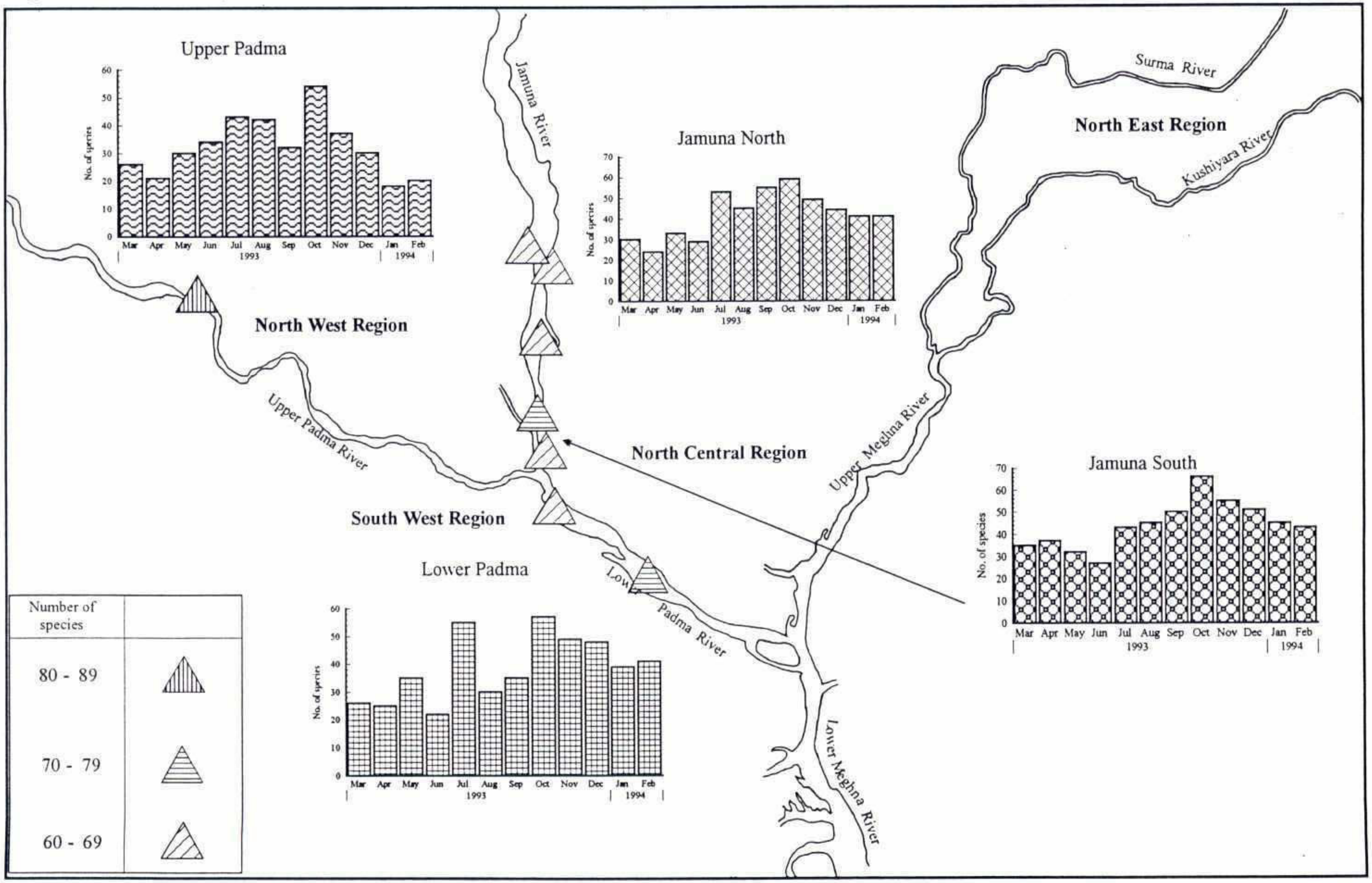

Table 3.7 Annual species composition (% of catch by wt) of the fish of the Jamuna and Padma rivers, March 1993 – February 1994

Habitat Preference	Species name Scientific	Bengali	Jamuna Annual	Jamuna Winter	Padma Annual	Padma Winter
Riverine	*Rita rita*	*Rita*	0.332	(0.147)	2.284	(6.047)
	Aspidoparia morar	*Piali*	3.244	(7.280)	0.986	(2.090)
	Raiamas bola	*Bhol*	–	–	0.010	–
	Barilius evezardi		–	–	0.001	–
	Crossocheilus latius	*Kalabata*	1.064	(1.654)	0.133	(0.593)
	Nemacheilus botia	*Balichata*	0.081	(0.083)	0.011	(0.004)
	Somileptes gongota	*Gharpoia*	0.001	(0.002)	–	–
	Botia dario	*Rani*	0.061	(0.088)	0.024	(0.098)
	Hilsa ilisha	*Ilish*	31.377	(7.752)	47.194	(4.140)
	Anodontostoma chacunda	*Koi puti*	0.00007	–	–	–
	Gonialosa manmina	*Goni chapila*	–	–	0.069	(0.042)
	Corica soborna	*Kachki*	0.023	(0.040)	1.880	(8.623)
	Setipinna phasa	*Phasa*	0.094	(0.073)	0.203	(0.386)
	Apocryptes bato	*Chiring*	0.095	(0.278)	0.698	(3.267)
	Awaous stamineus	*Bele*	–	–	0.010	–
	Brachygobius nunus	*Nunabailla*	0.292	(0.767)	0.180	(0.767)
	Liza parsia	*Bata*	–	–	0.005	–
	Rhinomugil corsula	*Khorsula*	2.571	(1.919)	3.677	(11.059)
	Sicamugil cascasia		0.084	(0.071)	0.006	(0.010)
	Pisodonophis boro	*Kharu*	–	–	0.016	–
	Plotosus canius	*Gang Magur*	0.0002	–	–	–
	Ailia coila	*Kajuli*	2.827	(3.858)	2.329	(7.842)
	Clupisoma garua	*Ghaura*	8.212	(5.929)	1.625	(2.692)
	Clupisoma naziri	*Muri Bacha*	–	–	0.011	–
	Silonia silondia	*Shillong*	0.482	(0.529)	0.432	(1.210)
	Bagarius bagarius	*Baghair*	1.171	(0.595)	4.097	(1.668)
	Gagata cenia	*Kauwa*	0.171	(0.196)	0.0001	(0.000)
	Gagata nangra	*Gang tengra*	0.623	(1.534)	0.015	(0.069)
	Gagata viridescens	*Gang tengra*	–	–	0.016	(0.073)
	Gagata youssoufi	*Gang tengra*	2.753	(6.526)	0.412	(1.626)
	Glyptothorax telchitta	*Telchitta*	–	–	0.0002	–
	Hara hara	*Kutakanti*	0.0003	–	–	–
	Sisor rhabdophorus	*Sisor*	0.002	(0.004)	–	–
	Pangasius pangasius	*Pangas*	–	–	8.706	(0.527)
	Johnius coitor	*Koitor*	–	–	0.125	(0.053)
	Pama pama	*Poa*	0.155	(0.220)	0.253	(0.619)
	Psilorhynchus balitora	*Balitora*	–	–	0.0001	–
	Taenioides buchanani	*Raja chewa*	–	–	0.011	(0.051)
	Amblyceps mangois	*Magur*	0.004	(0.003)	–	–
	Cynoglossus sp		–	–	0.0004	(0.002)
	Euryglossa pan	*Kathal pata*	–	–	0.0002	(0.001)
	Himantura sp	*Shangus*	4.153	(12.249)	–	–
Subtotal			59.873	(51.797)	75.420	(53.559)
Migratory	*Aorichthys aor*	*Ayre*	0.859	(0.383)	0.855	(1.986)
	Aorichthys seenghala	*Guizza*	2.777	(8.056)	0.034	–
	Mystus bleekeri	*Golsha tengra*	0.783	(1.088)	0.040	(0.023)
	Mystus cavasius	*Kabashi*	1.346	(1.103)	0.315	(0.631)
	Catla catla	*Catla*	0.110	–	3.921	(2.349)

(Cont.)

Table 3.7 Annual species composition (% of catch by wt) of the fish of the Jamuna and Padma rivers, March 1993 – February 1994

Habitat Preference	Species name		Jamuna		Padma	
	Scientific	Bengali	Annual	Winter	Annual	Winter
Migratory	*Cirrhinus mrigala*	*Mrigel*	0.310	(0.098)	0.019	–
	Cirrhinus reba	*Raik*	0.505	(0.239)	0.327	(0.870)
	Labeo bata	*Bata*	1.083	(0.222)	0.062	(0.213)
	Labeo boga	*Bhangan*	–	–	0.0004	–
	Labeo calbasu	*Kalbaus*	0.094	(0.005)	0.489	(1.860)
	Labeo gonius	*Goni*	–	–	0.010	–
	Labeo rohita	*Rui*	0.049	–	1.590	–
	Chela laubuca	*Kash Khaira*	0.006	(0.001)	0.005	(0.003)
	Securicula gora	*Chora chela*	0.105	(0.167)	0.024	(0.105)
	Salmostoma bacaila	*Katari*	1.387	(1.386)	0.444	(1.870)
	Salmostoma phulo	*Fulchela*	0.119	(0.068)	0.378	(1.668)
	Gudusia chapra	*Chapila*	0.327	(0.535)	0.939	(2.799)
	Eutropiichthys vacha	*Bacha*	0.244	(0.296)	0.073	(0.176)
	Pseudeutropius atherinoides	*Batasi*	0.118	(0.077)	0.015	(0.040)
	Ompok bimaculatus	*Kani pabda*	0.023	(0.004)	0.010	–
	Ompok pabda	*Madhu pabda*	0.003	–	0.001	–
	Ompok pabo	*Pabda*	0.001	–	–	–
	Wallagu attu	*Boal*	2.891	(4.092)	0.379	–
	Notopterus chitala	*Chital*	0.256	–	0.040	–
Subtotal			13.396	(17.820)	9.970	(14.593)
Floodplain Resident	*Anabas testudineus*	*Koi*	–	–	0.002	–
	Mystus tengara	*Bajari tengra*	0.004	(0.004)	0.001	(0.005)
	Mystus vittatus	*Tengra*	0.695	(1.524)	0.018	(0.065)
	Colisa fasciatus	*Khalisha*	0.031	–	0.007	–
	Colisa lalia	*Lal Khalisha*	0.0004	–	0.0001	–
	Colisa sota	*Khalisha*	0.002	–	–	–
	Colisa labiosus	*Khalisha*	–	–	0.003	–
	Xenentodon cancila	*Kaikka*	0.141	(0.153)	0.058	(0.088)
	Cyprinus carpio	*Karfu*	–	–	0.014	–
	Mylopharyngodon pisceus	*Kalo carp*	–	–	0.001	–
	Puntius chola	*Chala puti*	–	–	0.002	–
	Puntius conchonius	*Canchan puti*	1.519	(0.953)	0.638	(0.975)
	Puntius gelius	*Giliputi*	0.058	(0.043)	0.005	(0.007)
	Puntius guganio	*Mola puti*	–	–	0.001	–
	Puntius phutunio	*Phutani puti*	0.012	–	0.002	–
	Puntius sarana	*Sarputi*	0.010	–	–	–
	Puntius sophore	*Puti*	2.915	(3.367)	0.213	(0.204)
	Puntius terio	*Teri punti*	–	–	0.024	–
	Puntius ticto	*Tit puti*	0.043	(0.011)	0.015	(0.015)
	Osteobrama cotio cotio	*Keti*	0.051	(0.101)	0.011	(0.020)
	Amblypharygodon mola	*Mola*	0.062	–	0.005	(0.001)
	Danio devario	*Chebli*	0.007	(0.001)	0.015	(0.017)
	Brachydanio rerio	*Anju*	0.0002	–	–	–
	Esomus danricus	*Darkina*	0.222	(0.0004)	0.019	(0.005)
	Rasbora daniconius	*Darkina*	–	–	0.001	(0.004)
	Rasbora rasbora	*Leuzza darkina*	–	–	0.002	–
	Glossogobius giurus	*Bailla*	3.577	(6.172)	3.948	(11.930)
	Hypophthalmichthys molitrix	*Silver carp*	–	–	0.060	–
	Chela cachius	*Chep Chela*	0.102	(0.041)	0.005	(0.011)

(Cont.)

Table 3.7 Annual species composition (% of catch by wt) of the fish of the Jamuna and Padma rivers, March 1993 – February 1994

Habitat Preference	Species name		Jamuna		Padma	
	Scientific	Bengali	Annual	Winter	Annual	Winter
	Lepidocephalus guntea	*Gutum*	0.128	(0.032)	0.003	(0.001)
	Aplocheilus panchax	*Kanpona*	0.004	–	0.0003	–
	Channa marulius	*Gajar*	0.040	(0.034)	0.003	–
	Channa orientalis	*Cheng*	–	–	0.003	–
	Channa punctatus	*Taki*	0.812	(0.675)	0.270	(0.021)
	Channa striatus	*Shol*	0.041	–	0.027	–
	Clarias batrachus	*Magur*	0.001	–	0.001	–
	Oreochromis nilotica	*Nilotica*	–	–	0.003	–
	Heteropneustes fossilis	*Shingi*	0.006	–	0.006	–
	Macrognathus aculeatus	*Tara baim*	0.126	(0.004)	0.002	–
	Mastacembelus armatus	*Baral baim*	0.813	(0.437)	0.159	(0.154)
	Macrognathus pancalus	*Guchi*	0.620	(0.087)	0.046	(0.049)
	Badis badis	*Napit koi*	0.008	(0.001)	0.001	–
	Monopterus cuchia	*Kuchia*	–	–	0.001	–
	Notopterus notopterus	*Foli*	–	–	0.018	–
	Tetraodon cutcutia	*Potka*	0.022	(0.016)	0.001	–
	Chanda baculis	*Chanda*	0.176	(0.011)	0.010	(0.006)
	Chanda nama	*Nama Chanda*	0.232	(0.135)	0.058	(0.132)
	Chanda ranga	*Lal chanda*	0.135	(0.006)	0.019	(0.003)
Subtotal			12.616	(13.808)	5.701	(13.713)
	Prawn spp.	Chingri/icha	14.089	(16.502)	8.907	(18.136)
		Total	100	(100)	100	(100)

Notes: 1. Values in parentheses relate to catches made during the winter period, March, April and December 1993 and January – February 1994.

2. See text for definitions of habitat preference categories.

and *Catla catla* (*catla*), other smaller carps *Labeo calbasu* (*kalbaus*) and *L. bata* (*bata*), catfish *Aorichthys seenghala* (*guizza*), *A. aor* (*ayre*), *Mystus cavasius* (*kabashi*), *Gudusia chapra* (*chapila*) and a minnow *Salmostoma bacaila* (*katari*). Prawns were important in both rivers, forming 9 to 14% of the total annual catch which, after *ilish*, represented the highest single catch component.

Apart from differences in the catch of *ilish*, other differences between the Padma and Jamuna included the greater abundance of the catfish *pangas*, *rita* and *baghair* and the major carps *rui* and *catla* on the Padma and the lower catches of *piali*, *ghaura*, *guizza*, *boal* and *puti*.

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 in serving as both 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.

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 onto 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 the floodplain.

3.5.3 Secondary Rivers

Catch

Annual catches varied considerably between regions, with highest catches recorded in the North East and North West (Fig. 3.4). Tropical riverine catches are normally directly related to differences in the size of river systems, with larger rivers generally supporting greater catches (Welcomme, 1985)[2]. However, in the present study 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 appear to be related to differences in seasonal patterns of catch (Fig. 3.4). 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 3.8. *Ber jal* predominated in all regions, but were especially important in the North East where they captured 30% of the catch. *Veshal* were the most important gear in the North Central and South West, taking 21-22% of the catch, but captured only 2.5% of the catch in the North West. Other important, widely used gears

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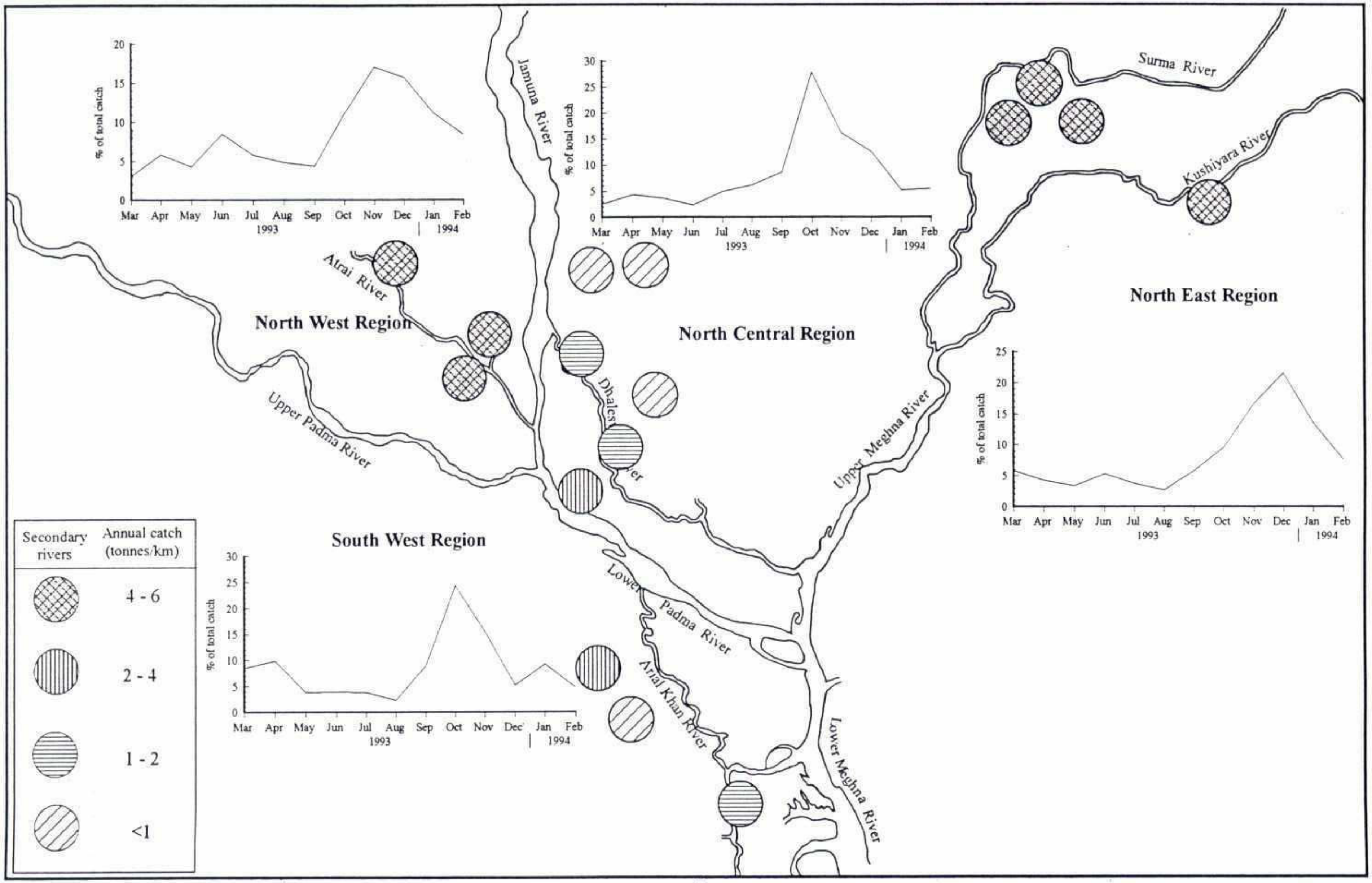
2 Welcomme, R. L. 1985. River Fisheries. FAO. Fish Tech. Pap., **262**: 330pp

Figure 3.4 Annual catch (tonnes/km) from secondary rivers, March 1993 - February 1994



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.

Biodiversity

The number of species found in rivers varied regionally, with highest numbers (90-109 per annum) recorded in the North East and North West (Fig. 3.5). This regional pattern follows that of fish production. It therefore appears that rivers of the North East and North West support 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 relatively higher diversity found in the Padma, which feeds these rivers, compared with 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.

Species Composition

Dominant species comprising the bulk (82-87%) of the riverine catch in each region are listed in Table 3.9. Each listed species individually comprised 1% or more of the total annual catch during the period March 1993 to February 1994. Clear differences in species compositions were apparent between regions. Riverine and migratory species predominated in the North East and North West, forming 70% and 54% respectively of the total catch of dominant species. These same regions supported greatest species diversity and highest annual catches.

It would appear that the impoverished fauna of the North Central and South West Regions is related to a substantially lower overall contribution made by riverine and migratory groups of fish. In these regions, between 50% and 57% of the catch of dominant species consisted of floodplain resident species and prawns. In the South West Region prawns contributed almost one quarter (23%) of the total annual catch and formed the single most important component in the catch. This compares with contributions made by prawns in other regions ranging from about 8% to 12%. The much greater significance of prawns in the South West may be attributed to the proximity of brackish waters to the south which possibly favoured some species.

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Table 3.8 Percentage contribution made by dominant gears to the total annual catch of secondary rivers, March 1993 – February 1994

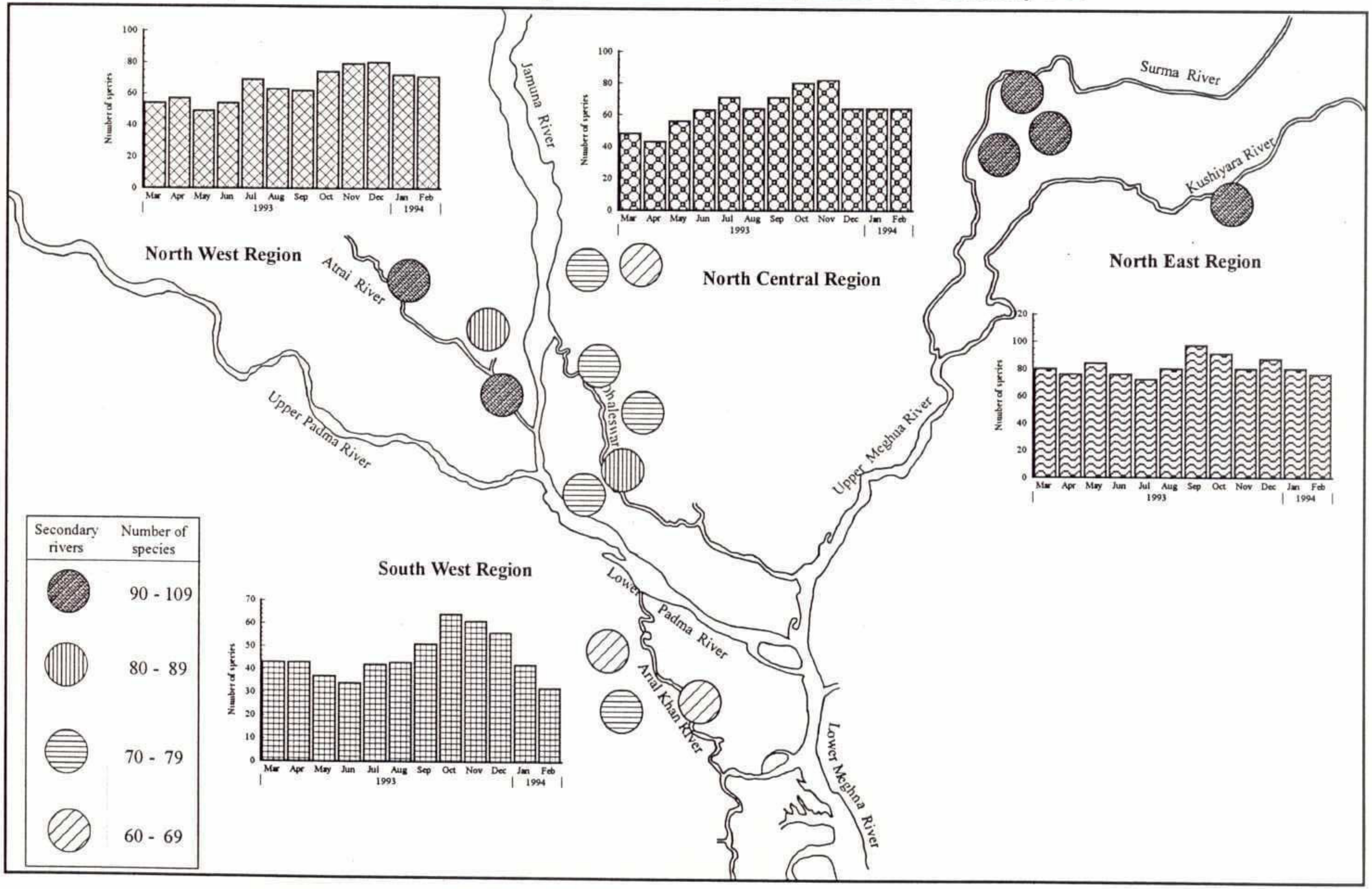
Gear Code	Gear name (Bengali)	Region			
		North East	South West	North West	North Central
45	*Ber jal*	29.6	14.5	11.5	16.0
202	*Moi jal*	–	7.3	6.1	2.7
304	*Satiber jal*	–	–	–	2.1
306	*Baoli jal*	–	–	5.5	–
325	*Dora jal*	4.2	–	–	–
297	*Horhori*	–	–	1.3	–
68	*Uttar jal*	6.6	–	–	–
321	*Afa/Hat bauli*	3.6	–	–	–
255	*Thella jal*	4.6	9.0	1.2	5.8
164	*Jhaki jal*	–	9.7	9.8	6.4
88	*Current jal (Stationary)*	–	–	–	3.3
282	*Current jal (drifting)*	3.0	–	12.0	–
324	*Awo jal*	2.3	–	–	–
266	*Veshal*	11.9	22.4	2.5	20.7
271	*Suti jal*	–	–	2.6	–
234	*Shangla jal*	–	4.7	–	–
30	*Sip*	9.1	3.1	6.1	3.6
152	*Tana Barsi*	6.1	–	1.5	6.9
272	*Daun*	4.0	5.7	1.4	–
95	*Doiar trap*	–	6.4	5.0	7.5
270	*Katha*	4.9	4.0	24.2	12.5
307	*Hand fishing*	–	5.8	–	3.9
	Total=	90.0	92.5	90.7	91.3

Note: Dominant gears are defined as those which between them capture at least 90% of the catch in each river.

LEGEND

(black)	>10%
(grey)	5–9.9%
(white)	<5%

Figure 3.5 Biodiversity: Annual total number of fish species in secondary rivers, March 1993 - February 1994



Of the riverine species, *ilish* predominated in all regions except the North Central where it rarely occurred. Another clupeid, *kachki*, was the second most important riverine species in the North East and South West but was unimportant in other areas. The rivers of the North Central supported a particularly impoverished riverine community with only three species, *piali*, *kajuli* and *ghaura* appearing in the list of dominant species. However, in terms of migratory species these rivers supported almost the same proportion (28%) as in the North West (31%), both of which were substantially higher than in the South West (10%) where only *ayre* and three major carps *rui*, *catla* and *raik* were listed as dominant species (Table 3.9).

The higher proportions of the catch made up by migratory, and to a lesser extent, riverine species in the North East and North West is probably related to the larger areas of open, deeply flooded land during the monsoon season. Certainly, many of these species also formed an important component of floodplain catches in these regions. The seasonal timing of movements of these species between river and floodplain varies between different groups.

The carps enter the floodplains as hatchlings carried by passive downstream drift of river floodwaters on to the floodplain. The timing of these movements varies regionally, on the Brahmaputra - Jamuna system the important period ranges from about early May to August, but there are inter-annual variations in peak periods of hatchling supply dependent on fluctuations in river flow. This system can potentially supply the floodplains of the North West Region, but mitigation measures are needed to assist the passage of the hatchlings through the Brahmaputra Right Embankment (BRE). The system already supplies the North Central Region and the South West, and although the South East Region was not studied it seems probable that the river also supplies carp hatchlings to this area.

A similar supply of wild carp hatchlings originates from the upper Padma and possibly from the Ganges upstream in India. However, timing of the supply is a little later than that on the Jamuna, starting around July and continuing until the end of August, again depending on inter-annual variations in river flows which stimulate the onset of spawning. This river could potentially supply the southern part of the North West region, but again mitigation measures are needed to improve the supply rate. The river already supplies hatchlings to the South West mainly via the two largest tributaries, the Madhumati and Arial Khan. The river probably supplies the South East region together with the Jamuna.

Table 3.9 Percentage contribution to the total annual catch made by dominant species in secondary rivers, 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	*Rita rita*	*Rita*	1.8	1.3	–	–
	Aspidoparia morar	*Piali*	–	–	–	1.4
	Botia dario	*Rani*	1.4	–	–	–
	Hilsa ilisha	*Hilsa*	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	2.3
	Eutropiichthys vacha	*Bacha*	1.1	–	1.0	–
	Gagata youssoufi	*Gang tengra*	1.4	–	1.4	–
	Johnius coitor	*Koitor*	–	–	1.1	–
	Pangasius pangasius	*Pangas*	–	1.4	–	–
Subtotal			20.5	18.3	22.3	4.9
Migratory	*Aorichthys aor*	*Ayre*	3.2	2.1	–	1.9
	Aorichthys seenghala	*Guizza*	9.8	–	–	–
	Mystus bleekeri	*Golsha tengra*	1.8	–	6.3	2.0
	Mystus cavasius	*Kabashi*	4.9	–	9.7	1.1
	Pseudeutropius atherinoides	*Batasi*	–	–	1.9	–
	Wallagu attu	*Boal*	4.2	–	7.3	7.5
	Catla catla	*Catla*	–	1.9	–	2.0
	Cirrhinus mrigala	*Mrigel*	–	–	–	2.4
	Cirrhinus reba	*Raik*	1.6	3.7	1.1	4.2
	Labeo calbasu	*Kalbaus*	6.5	–	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	–
	Notopterus chitala	*Chital*	3.1	–	–	–
Subtotal			49.7	9.7	31.2	27.7
Floodplain Resident	*Mystus vittatus*	*Tengra*	–	2.0	2.7	2.9
	Xenentodon cancila	*Kaikka*	–	4.3	1.3	2.8
	Puntius conchonius	*Canchan puti*	1.0	1.0	2.3	8.2
	Puntius sophore	*Puti*	–	3.6	2.6	7.1
	Puntius ticto	*Tit puti*	–	1.0	–	–
	Glossogobius giurus	*Bailla*	1.7	14.2	4.5	7.1
	Channa marulius	*Gajar*	–	1.4	–	–
	Channa punctatus	*Taki*	–	3.0	1.1	3.8
	Mastacembelus armatus	*Baral baim*	2.6	1.2	5.7	5.8
	Macrognathus pancalus	*Guchi*	–	2.2	1.6	2.7
	Chanda baculis	*Chanda*	1.7	–	–	–
Subtotal			6.9	33.8	21.8	40.4
	Prawn spp.	Chingri/icha	7.6	23.0	11.7	9.3
		Total	84.8	84.8	86.9	82.3

Notes: 1. Shaded values highlight the most important species (>4%).

2. See text for definitions of habitat preference categories.

3. Dominant species are those comprising 1% or more of the total annual catch in each region.

Other groups of important migratory fish include various catfish, some of which are large e.g. *boal*, *ayre* and *guizza*, while others are small species, e.g. *batasi*. The larger species such as *boal* and *ayre* were fairly widespread, but *batasi* formed an important component of the catch only in the North West (Table 3.9). The migratory clupeid, *Gudusia chapra (chapila)* was most important in the North East and to a lesser extent in the North West; however it did not appear in the list of dominant species in the North Central and South West. *Chital* was even more restricted in terms of geographical importance, occurring only in the North East as a dominant species.

In contrast to the major carps, all of these other migratory species move from river to floodplains as adults during the pre-monsoon or early monsoon. The requirements for moving across aquatic habitats must therefore be taken into account in terms of mitigation measures. Little is known at present about their specific swimming abilities or the water velocity requirements to stimulate upstream attraction on to the floodplain during pre-monsoon rainfall runoff, or the critical velocities against which they are unable to pass through existing flood control structures in embankments. Further research is urgently required in this field.

3.5.4 Canals

Catch

Values of catch per unit length of canals varied regionally (Fig. 3.6). 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 compared to 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 Fig. 3.7. 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

Figure 3.6 Annual catch (tonnes/km) from canals, March 1993 - February 1994

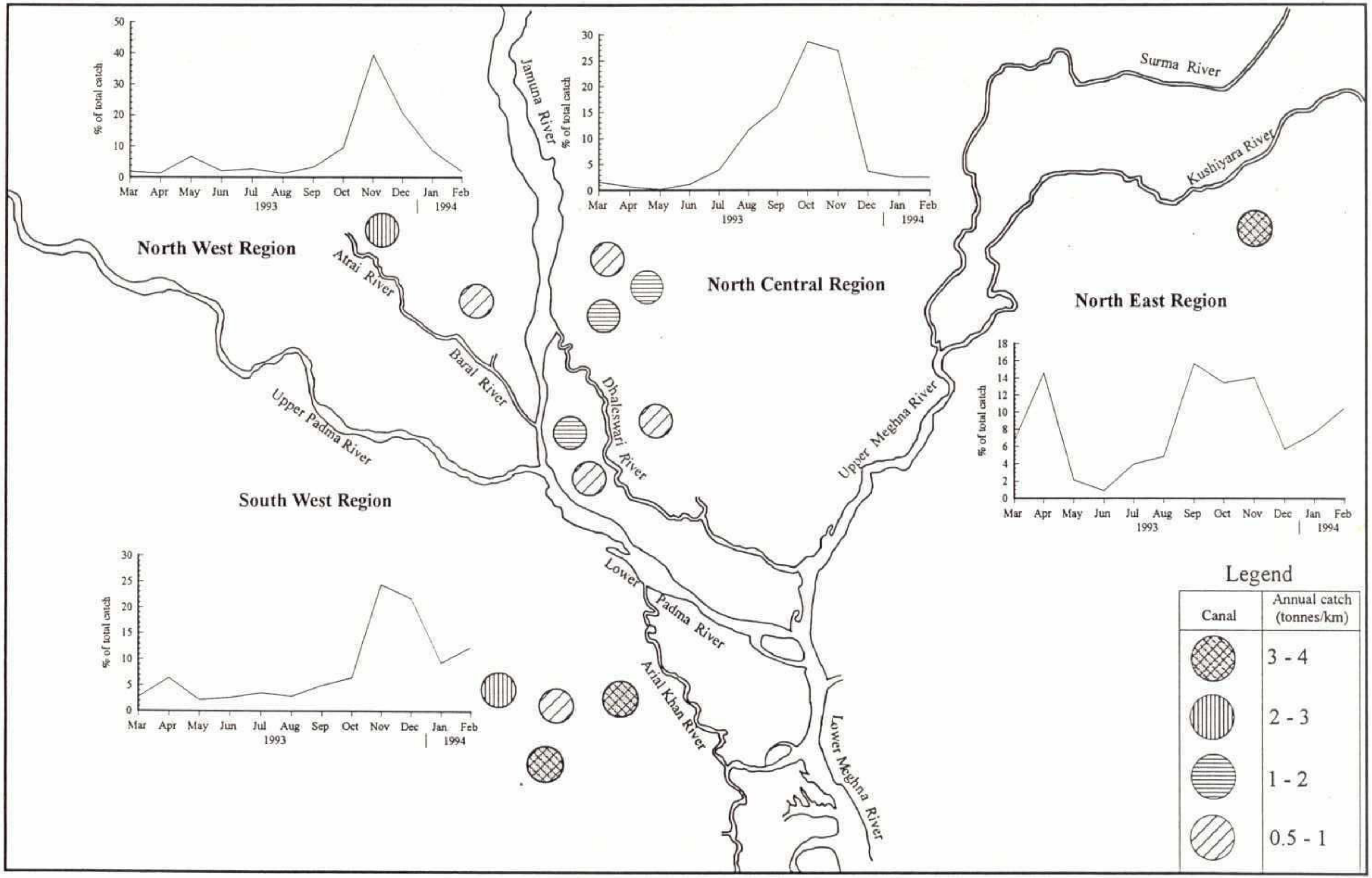
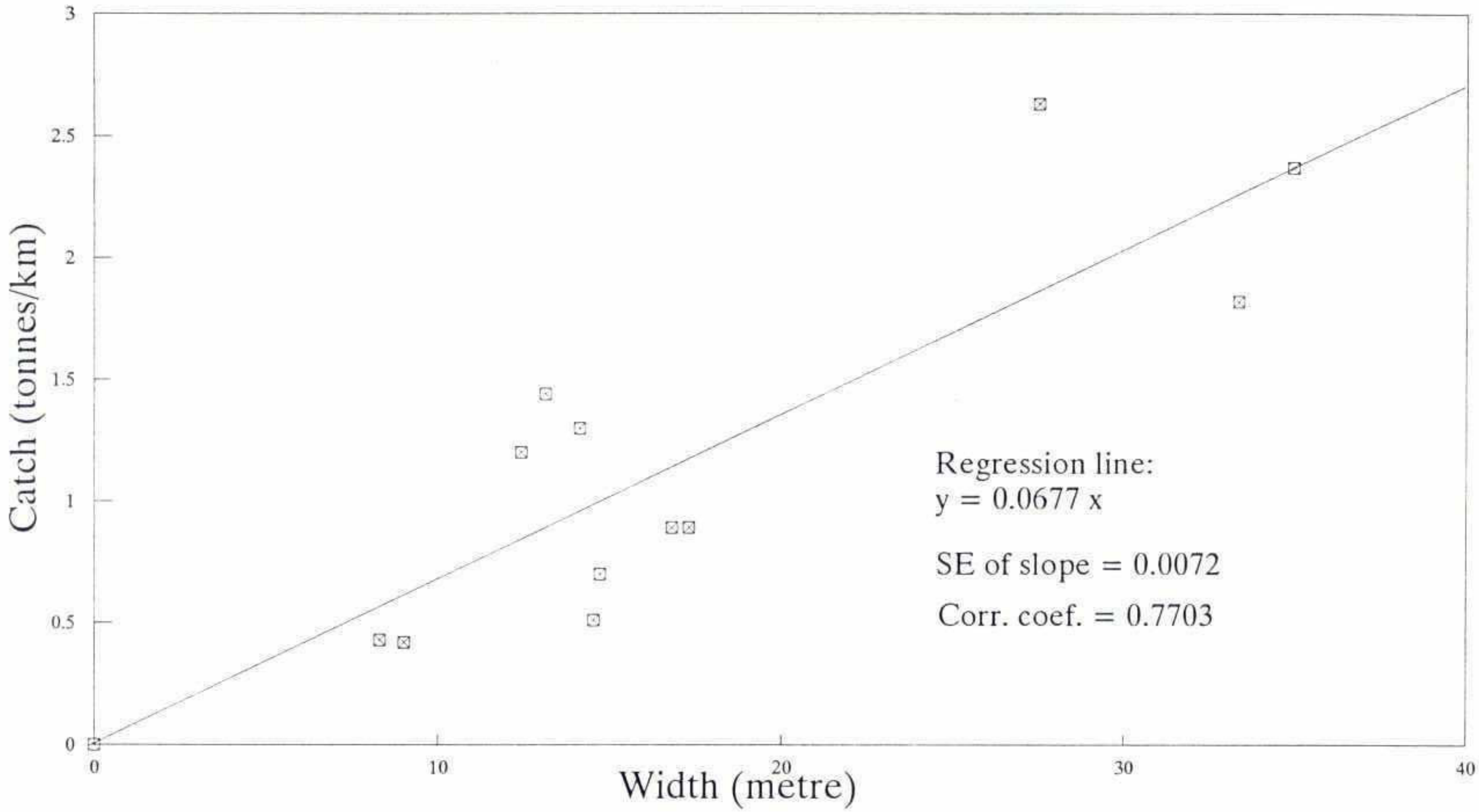


Figure 3.7 Relationship between total annual catch of canals and canal width in the North Central and North West Regions, March 1993 – February 1994



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, with peak catches taken during or immediately following the flood drawdown (Fig. 3.6). In the South West and North West a major part of the catch (56% and 60% respectively) was taken during November and December, while in the North Central 56% 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.

The most important gears used on canals in each region are listed in Table 3.10, together with the proportion of the total annual catch captured by each gear type during the period March 1993 to February 1994. The North East differed from other regions in that 50% 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 results from the more perennial nature of the sites monitored in these areas.

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. 3.8). 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, numbers increased to a single peak during August and September coinciding with the start of the flood

Table 3.10 Percentage contribution made by dominant gears to the total annual catch of canals, March 1993 – February 1994

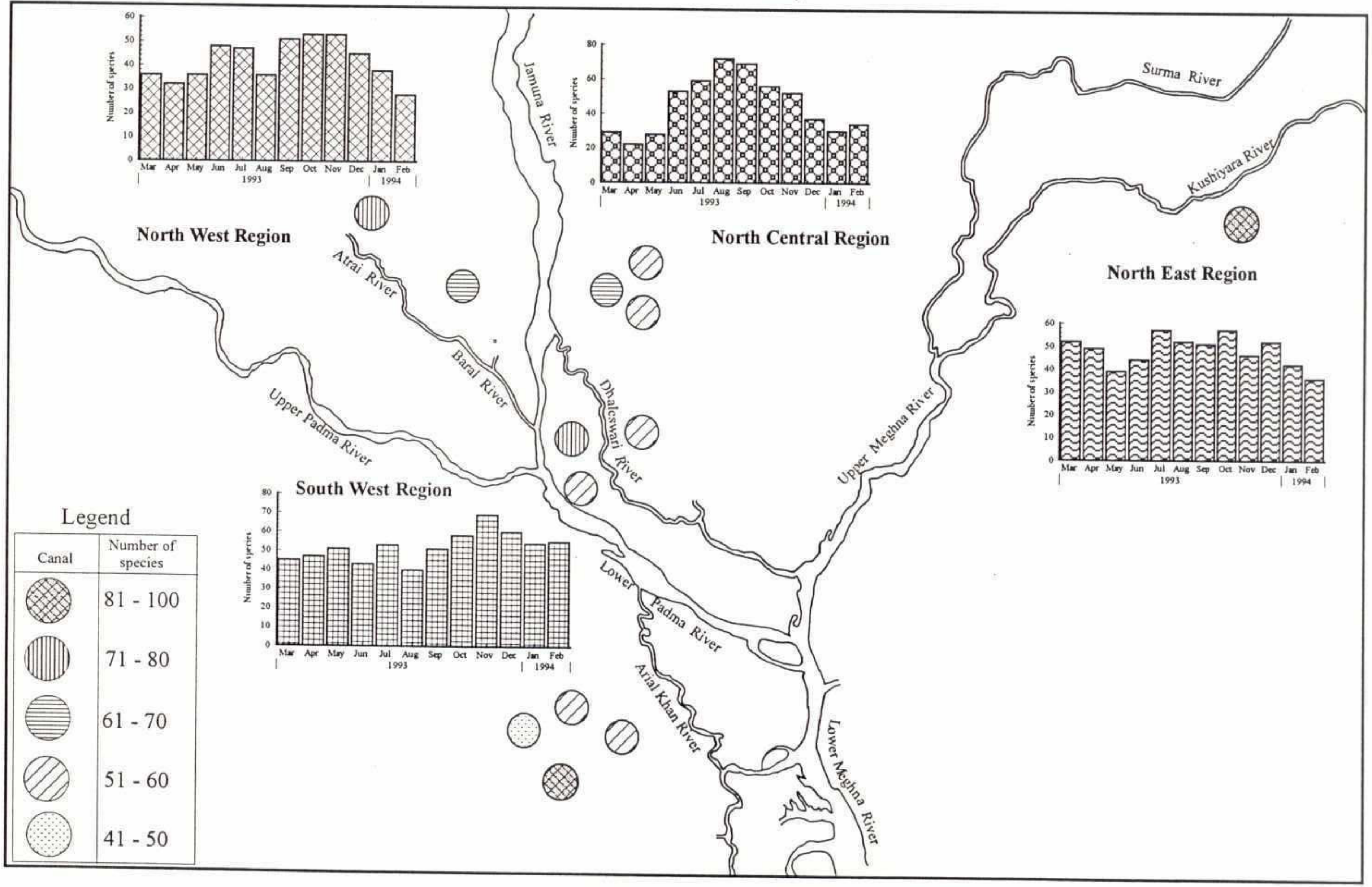
Gear Code	Gear name (Bengali)	Region			
		North East	South West	North West	North Central
45	*Ber jal*	22.5	4.0	–	3.7
89	*Dhor jal*	–	3.8	5.3	–
202	*Moi jal*	–	3.1	4.1	–
306	*Baoli jal*	–	–	9.3	–
68	*Uttar jal*	27.3	–	–	–
263	*Ucha*	–	–	–	3.4
296	*Tukri*	–	9.4	–	–
255	*Thella jal*	4.7	7.1	3.3	8.3
164	*Jhaki jal*	6.8	14.7	14.1	10.0
105	*Dharma jal*	–	–	–	13.7
266	*Veshal*	14.0	12.8	3.8	29.3
271	*Suti jal*	–	–	32.3	–
30	*Sip*	2.2	2.4	–	1.8
272	*Daun*	–	3.7	–	–
95	*Doiar trap*	–	9.1	7.9	5.5
270	*Katha*	14.4	16.0	4.2	6.3
302	*Kua*	–	–	–	3.4
170	*Juti*	–	2.5	–	–
291	*Urani*	–	–	–	2.0
298	*Akra*	–	–	3.4	–
307	*Hand fishing*	–	2.2	5.5	3.8
	Total=	92.0	90.7	93.2	91.2

Note: Dominant gears are defined as those which between them capture at least 90% of the catch in each river.

LEGEND

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

Figure 3.8 Annual total number of fish species in canals, March 1993 - February 1994



drawdown, when fish migrated from the adjacent floodplains and concentrated in canals. In the North West and South West highest number 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. 3.8). Seasonal patterns were less clear in the North East, possibly resulting from the influence of riverine waters mixing with water from the main drainage channel of Hakaluki *haor*.

Species Composition

The percentage contributions to the total annual catch by dominant species in canals of each region are presented in Table 3.11. Clearly, typical riverine species made very little contribution to canal catches in any region. Migratory species comprised 34-35% of the catch in the North East and North West but less in the North Central (19%) and South West (11%) where floodplain resident species predominated, forming between 54% and 59% of the catch. Prawns formed an important component of the catch in all regions, ranging from 9% in the North East to 21% in the South West. The most important migratory species included mainly catfish and carp. 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*, *mrigel* and *raik* formed 18% 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 the carp, *kalbaus* comprised about 5% of the catch and the major carp *mrigel*, about 2%, but *rui* and *catla* were uncommon and did not appear amongst dominant species from the one site sampled.

3.5.5 Floodplains and *beel*

Catch

In planning for the increased control of inundation on the floodplain, the first question to ask is what would be lost if some areas need to be excluded from this system altogether. The fisheries yield or production estimates from open, unregulated floodplain sites can provide planning estimates for this eventuality, which represents the ultimate impact on fisheries. Information from these sites therefore provides an indication of what might be lost if floodplain areas are totally excluded or reclaimed, for example as construction sites, embankments or for dry land agriculture.

Table 3.11 Percentage contribution to the total annual catch by dominant species in 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*	–	–	1.2	–
	Botia dario	*Rani*	1.2	–	–	–
	Hilsa ilisha	*Hilsa*	1.1	–	–	–
	Ailia coila	*Kajuli*	1.4	–	–	–
Subtotal			3.7	–	1.2	–
Migratory	*Aorichthys aor*	*Ayre*	2.0	3.4	–	–
	Aorichthys seenghala	*Guizza*	3.1	–	–	–
	Mystus bleekeri	*Golsha tengra*	3.1	–	10.8	–
	Mystus cavasius	*Kabashi*	10.9	–	4.6	–
	Pseudeutropius atherinoides	*Batasi*	–	–	3.0	1.0
	Wallagu attu	*Boal*	8.2	5.2	12.7	–
	Catla catla	*Catla*	–	–	–	5.9
	Cirrhinus mrigala	*Mrigel*	1.7	–	–	3.4
	Cirrhinus reba	*Raik*	–	–	2.0	1.5
	Labeo calbasu	*Kalbaus*	5.2	–	–	–
	Labeo rohita	*Rui*	–	1.5	–	7.5
	Salmostoma bacaila	*Katari*	–	–	1.0	–
	Gudusia chapra	*Chapila*	1.2	–	–	–
	Macrobrachium rosenbergii	*Golda*	–	1.2	–	–
Subtotal			35.4	11.3	34.1	19.3
Floodplain resident	*Anabas testudineus*	*Koi*	–	–	–	1.4
	Mystus tengara	*Bajari tengra*	–	1.1	–	1.0
	Mystus vittatus	*Tengra*	2.4	4.3	3.9	2.1
	Colisa fasciatus	*Khalisha*	–	1.8	1.6	3.1
	Colisa lalia	*Lal Khalisha*	–	1.0	–	–
	Xenentodon cancila	*Kaikka*	–	4.6	–	2.1
	Chanda ranga	*Lal chanda*	–	–	–	1.1
	Cyprinus carpio	*Karfu*	–	–	–	1.1
	Puntius chola	*Chala puti*	1.6	–	–	–
	Puntius conchonius	*Canchan puti*	2.3	2.0	3.5	3.0
	Puntius sophore	*Puti*	–	10.8	9.9	17.6
	Puntius ticto	*Tit puti*	–	3.4	–	2.5
	Rasbora daniconius	*Darkina*	–	1.7	–	–
	Glossogobius giurus	*Bailla*	4.2	4.2	3.8	3.2
	Hypophthalmichthys molitrix	*Silver carp*	5.1	–	–	–
	Lepidocephalus guntea	*Gutum*	–	2.1	2.6	2.3
	Channa marulius	*Gajar*	–	–	–	1.0
	Channa punctatus	*Taki*	–	2.9	4.9	9.2
	Channa striatus	*Shol*	–	1.2	–	2.4
	Heteropneustes fossilis	*Shingi*	–	1.0	–	1.0
	Macrognathus aculeatus	*Tara baim*	–	–	1.0	–
	Mastacembelus armatus	*Baral baim*	8.2	1.4	3.7	1.2
	Macrognathus pancalus	*Guchi*	2.8	5.7	6.3	3.4
	Nandus nandus	*Bheda*	–	2.8	–	–
	Notopterus notopterus	*Foli*	1.5	–	–	–
	Tetraodon cutcutia	*Potka*	–	1.7	–	–
	Chanda baculis	*Chanda*	2.4	–	–	–
Subtotal			30.3	53.8	41.2	58.5
	Prawn spp.	Chingri/icha	8.6	21.2	9.8	11.2
	Turtle	*Dur kasim*	4.8	–	–	–
		Total	82.7	86.3	86.3	89.0

Notes: 1. Shaded values highlight the most important species (>4%).

2. See text for definitions of habitat preference categories.

3. Dominant species are those comprising 1% or more of catch.

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The results of surveys of floodplain sites outside existing FCD/I schemes are summarised in Fig. 3.9. These suggest that there is some variation between regions, with generally highest catch per unit area values observed 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 scheme studied, the results from a number of unregulated floodplain and *beel* sites were integrated to give an estimate for flooded areas as a single floodland system (Table 3.12).

The mean fish yield per unit area of these floodplain systems in Bangladesh is 107 kg/ha (Table 3.12). Around this mean there is some evidence of regional variation, with higher yields in the South West and, to a lesser degree, in the North East.

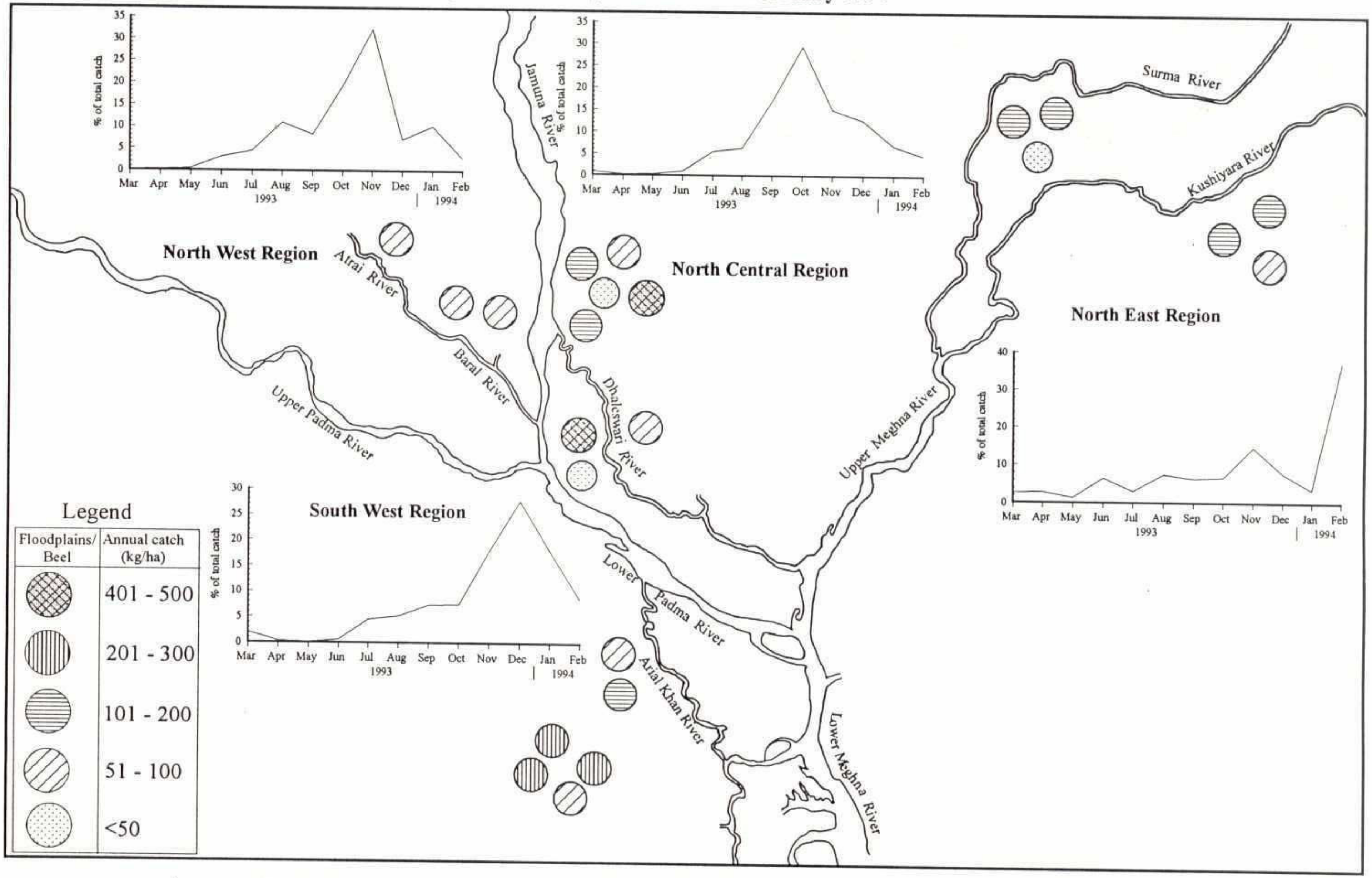
In terms of estimates from elsewhere, the yields from floodplains generally have been reported as lying between 40 and 80 kg/ha, although this is largely based upon African data. A correlation of fish production with floodplain areas for the whole of Asia has provided a mean estimate of 80 kg/ha, with estimates from the Ganges and Brahmaputra falling close to the upper range of the confidence limits. The average estimate for floodplain production given in Table 3.12 is therefore consistent with estimates obtained elsewhere, although it indicates that Bangladesh ranks amongst the more productive regions of the world.

Table 3.12 Mean annual yield from unregulated floodplain/beel sites outside existing schemes

Scheme	Yield ($kg.ha^{-1}$)
North West:	
Chalan Beel	68
BRE*	81
Pabna (PIRDP)	76
South West:	
Chatla Fukurhati	111
Satla-Bagda	215
North Central:	
Tangail (CPP) intermediate elevation	107
Manikganj (lower elevation)	51
North East:	
Manu (MIP)	145
Shanghair Haor	105
Mean	107

* Although BRE is a scheme in the north west, this 'outside' reference site was just across the Jamuna River in the North Central Region.

Figure 3.9 Annual catch (kg/ha) from floodplains and beel, March 1993 - February 1994



Seasonal changes in catch varied regionally. In the North East, dramatic increases in catch occurred at the end of the study in 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 3.13). In the North East *ber jal* captured more than half (52%) the annual catch. This gear was used widely 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* (bag nets) were, to a large extent all 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* to catch mainly prawns by subsistence and semi-commercial fishermen. 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 *ber jal* was again the most important gear contributing 23% 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*.

A survey period of 19 months from August 1992 to February 1994 in the North Central Region provided an opportunity to examine inter-annual changes in catch through two full flood recessions when the bulk of the annual catch was taken (Table 3.14). The 1992/93 year was a particularly dry year compared to 1993/94 when floods were greater and more prolonged. Comparison of the catches from floodplains, canals and rivers over the same seven month period (August-February) in both years revealed substantially higher catches in the wet year. Apart from the major hydrological differences between years, another factor which might have influenced catches was the occurrence of epizootic ulcerative fish disease which was much more serious in 1992 than 1993. However, the outbreak occurred in mid-November 1992, after most of the catches had already been taken, and it is therefore unlikely to have had a major influence on the comparisons of catches made in Table 3.14. The varying

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Table 3.13 Percentage contribution made by dominant gears to the total annual catch of floodplains and beel, March 1993 – February 1994

Gear Code	Gear name (Bengali)	Region			
		North East	South West	North West	North Central
45	*Ber jal*	52.2	–	23.2	8.6
325	*Dora jal*	4.4	–	–	–
89	*Dhor jal*	–	–	2.2	2.6
202	*Moi jal*	–	–	6.0	–
297	*Horhori*	–	–	5.2	–
306	*Baoli jal*	–	–	4.9	–
263	*Ucha*	–	–	–	3.9
255	*Thella jal*	17.1	–	–	32.6
164	*Jhaki jal*	–	–	2.6	9.0
88	*Current jal(Stationary)*	3.0	23.9	10.9	5.5
123	*Koi jal*	–	4.3	2.3	–
105	*Dharma jal*	–	–	–	4.3
266	*Veshal*	–	7.6	–	4.9
271	*Suti jal*	–	–	6.7	–
320	*Ghori jal*	3.4	–	–	–
30	*Sip*	–	5.4	2.2	–
272	*Daun*	–	–	4.3	–
278	*Nol barsi*	–	8.9	–	–
95	*Doiar trap*	–	6.8	6.8	–
222	*Polo*	–	2.9	–	–
332	*Patar savar*	–	6.3	–	–
270	*Katha*	6.5	–	9.2	2.3
302	*Kua*	–	23.9	2.6	13.0
97	*By hand/Dewatering*	2.6	–	–	–
307	*Hand fishing*	5.1	–	2.6	3.4
	Total=	94.3	90.1	91.8	90.1

Note: Dominant gears are defined as those which between them capture at least 90% of the catch in each river.

LEGEND

(dark)	>10%
(light shade)	5–9.9%
(white)	1–4.9%

9e

reductions in catches suggest that there may be a differential impact of inter-annual variation in flood extent and magnitude on fish communities in different habitats, with the greatest changes occurring on floodplains followed by canals then rivers. This agrees with expected direction of any differential impact due to changes in flooding.

Table 3.14 Comparison of the inter-annual variation in catch from different habitats in the North Central Region

Habitat	Aug 1992 - Feb 1993	Aug 1993 - Feb 1994	Percentage decrease in 92/93
Floodplain/Beel(kg/ha)	25	64	61
Canal (kg/km)	472	1137	58
River (kg/km)	1060	1554	32

Biodiversity

Highest species diversities from individual floodplain and *beel* sites were observed in the North West and North East Regions (Fig. 3.10). 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. Elimination of floodplains in the North West would reduce the habitat for an average of 70-79 species and in other regions somewhat fewer than this. However, this is the number recorded during one year only and at a limited number of sites. If the sampling effort had been increased or the survey period extended many more species would probably have be recorded on the floodplains, and it is these rarer species which would be more vulnerable to the adverse effects of habitat loss resulting from flood control.

Species composition

Examination of the composition of dominant species found on floodplains and *beel* revealed considerable differences between regions (Table 3.15). In the North West and North East, a major proportion of the catch comprised migratory species (26% and 36% respectively) whereas in the South West and North Central this group of fish was insignificant, forming only 1% to 5% of the total annual catch. Conversely, in the North East and North West

Figure 3.10 Biodiversity: Annual total number of fish species in floodplains and beel, March 1993 - February 1994

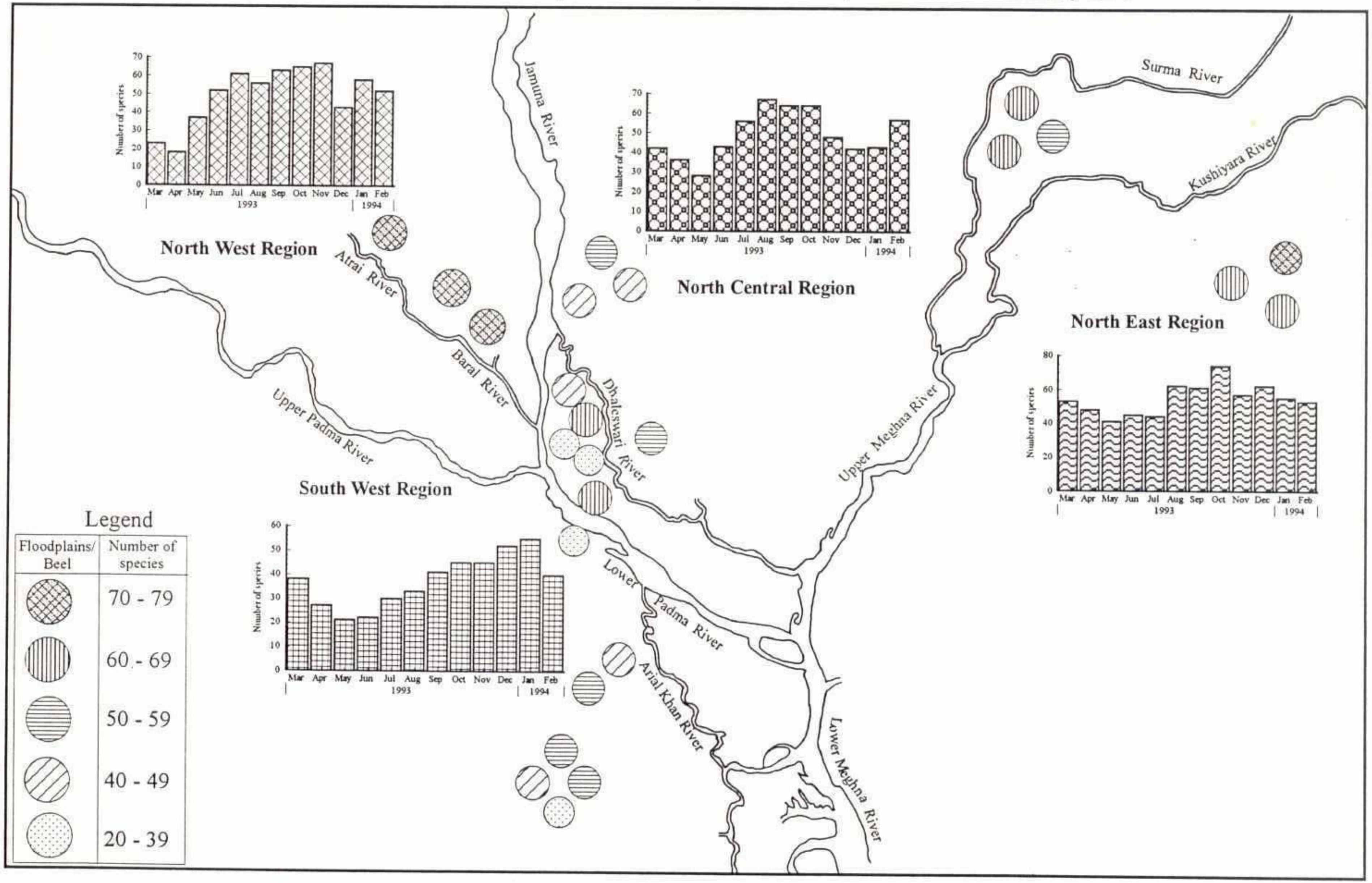

Table 3.15 Percentage contribution to the total annual catch by dominant species in floodplains/beel, March 1993 – February 1994

Habitat	Species name		Region			
Preference	Scientific	Bengali	North East	South Wes	North West	North Central
Floodplain	*Anabas testudineus*	*Koi*	–	13.6	–	2.8
Resident	*Mystus vittatus*	*Tengra*	2.0	1.3	4.0	1.4
	Colisa fasciatus	*Khalisha*	–	13.8	–	3.7
	Colisa lalia	*Lal Khalisha*	–	1.1	–	1.8
	Xenentodon cancila	*Kaikka*	2.5	1.4	–	3.1
	Cyprinus carpio	*Karfu*	–	–	2.4	–
	Puntius conchonius	*Canchan puti*	2.2	1.7	2.4	2.3
	Puntius sophore	*Puti*	1.0	16.8	11.4	12.6
	Puntius ticto	*Tit puti*	–	1.3	–	–
	Osteobrama cotio cotio	*Keti*	2.7	–	–	–
	Glossogobius giurus	*Bailla*	3.0	–	4.4	2.2
	Lepidocephalus guntea	*Gutum*	–	–	1.5	3.0
	Channa marulius	*Gajar*	1.9	–	–	–
	Channa punctatus	*Taki*	–	14.1	2.8	12.1
	Channa striatus	*Shol*	–	7.9	–	2.2
	Clarias batrachus	*Magur*	–	1.1	–	–
	Heteropneustes fossilis	*Shingi*	1.0	10.0	–	3.0
	Macrognathus aculeatus	*Tara baim*	–	–	3.0	1.9
	Mastacembelus armatus	*Baral baim*	2.4	–	3.2	1.3
	Macrognathus pancalus	*Guchi*	3.0	1.2	5.3	5.7
	Nandus nandus	*Bheda*	–	2.4	–	–
	Notopterus notopterus	*Foli*	2.8	2.2	–	–
	Chanda baculis	*Chanda*	2.6	–	1.2	–
	Chanda nama	*Nama Chanda*	1.0	–	2.8	–
	Chanda ranga	*Lal chanda*	–	–	1.1	2.2
Subtotal			27.9	89.7	45.5	61.2
Migratory	*Aorichthys aor*	*Ayre*	1.1	–	1.1	–
	Aorichthys seenghala	*Guizza*	13.9	–	–	–
	Mystus bleekeri	*Golsha tengra*		–	4.5	–
	Mystus cavasius	*Kabashi*	4.9	–	3.4	–
	Pseudeutropius atherinoides	*Batasi*	–	–	4.0	–
	Wallagu attu	*Boal*	1.0	1.2	7.8	–
	Catla catla	*Catla*	–	–	–	1.9
	Cirrhinus reba	*Raik*	–	–	1.0	–
	Cirrhinus mrigala	*Mrigel*	1.0	–	–	–
	Labeo calbasu	*Kalbaus*	1.1	–	–	–
	Labeo rohita	*Rui*	–	–	–	2.8
	Salmostoma phulo	*Fulchela*	1.3	–	1.3	–
	Gudusia chapra	*Chapila*	9.5	–	3.3	–
	Ompok bimaculatus	*Kani pabda*	2.6			
Subtotal			36.5	1.2	26.3	4.7
Riverine	*Hilsa ilisha*	*Ilish*	–	–	3.0	–
	Prawn spp.	Chingri/icha	22.0	2.0	13.0	21.8
		Total	86.4	92.9	87.8	87.7

Notes: 1. Shaded values highlight the most important species (>4%)

2. See text for definitions of habitat preference categories

3. Dominant species are those comprising 1% or more of the total annual catch in each region.

floodplain resident species comprised 28% and 46% of the catch whilst in the North Central and South West they comprised 61% and 90% of the catch respectively. 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 22% of the catch and in the North West region 13%. 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 the *haor* during rising and full flood seasons.

The most abundant migratory species found on the *haor* of the North East included the catfish, *guizza* and the schooling clupeid, *chapila*. Next in importance were *kabashi* and *kani pabda*. 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*, *batashi* 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 takes place.

In the North Central Region only two migratory species appeared as dominant species, 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.

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3.6 FISHERIES INSIDE FCD/I SCHEMES

3.6.1 Schemes for Consideration

A fully compartmentalized scheme has all major inlets and outlets regulated so that there is no free flooding from outside and the level of flooding within the compartment can be controlled by drainage. Most of the schemes selected for sampling fell into this category, but not all functioned in the way their designers intended over the sampling period.

Some were selected for the FAP 17 fisheries studies even though they were not fully compartmentalized. Tangail CPP is only partially poldered and free flooding occurred in the areas studied. The Shanghair Haor Project is an example of a project protected by submersible embankments which aim to protect rice from early floods but then are eventually over-topped as the floods rise. This, then, is an example of a particular type of flood control, although not completely compartmentalized.

There are, in addition, some schemes which should be fully compartmentalized but in which the banks were breached at some point during the flood cycle of 1993 or whose regulators did not function due to inadequate maintenance. These included Manu (MIP) in the North East and Chatla Fukurhati in the South West respectively. These, therefore, cannot be relied upon to provide a true picture of the effects of compartmentalization upon the fishery.

Those schemes which remained intact and fully functional over the sampling period included:

Satla-Bagda Polder 1: SWR
Brahmaputra Right Embankment (BRE): NWR
Chalan Beel Polder B : NWR
Pabna Irrigation and Rural Development Project (PIRDP): NWR

The BRE is a major flood control embankment running along the Brahmaputra/Jamuna River which protects land to the north of the PIRDP and also forms the eastern embankment of the PIRDP itself. The other three schemes are large FCD developments which, in the case of the PIRDP, possesses some pumped irrigation capability. An important feature of all these schemes was that despite embankments remaining intact and regulators and drainage sluices remaining operational, extensive rainfall flooding occurred in all areas up to depths of two metres or more. In the case of Satla-Bagda, the problem of rainfall flooding was recognised at the feasibility stage in planning when it was admitted that little could be done to alleviate serious rainfall flooding without pumped drainage facilities. The same is true for the other two schemes studied in the North West Region. With regard to fisheries, the important point is that extensive flooding still occurred within FCD/I areas but that the origin of floodwater changed, with proportionately more rainfall flooding rather than river flooding occurring as a result of the construction of protective embankments. It follows therefore that inter-annual variations in flood magnitude and extent inside FCD areas will be determined to a large extent by local rainfall patterns and therefore their floodplain fisheries will probably be exposed to greater annual fluctuations in flooding than those on unregulated floodplains which also receive flooding from large rivers.

In addition to the functioning FCD/I schemes studied in the North West Region, the Baral River was also monitored as an example of a regulated river, to examine its effects on the movement of both adult fish and hatchlings. This river is an offtake of the Padma which previously formed an important connection with the Jamuna system via the Atrai River. Construction of the Charghat Regulator at the junction of the river with the Padma has substantially decreased flows in this river and prevented flooding of adjacent lands.

The differences in fish production inside and outside of the Charghat Regulator on the Baral River are difficult to compare in a meaningful way because the outside site was essentially part of the main, expansive Padma River. However, qualitative differences in larval and adult distribution provided baseline data when judging the overall effect of regulation in a compartmentalized scheme. Hatchling surveys have also been conducted at other sites around the PIRDP, Tangail CPP, Manu Irrigation Project and the Shanghair Haor Project (Supporting Volume 11) to enable some indications to be gained on the influence of downstream hatchling drift and subsequent colonization of the floodplain.

In order to obtain the most categoric indications of the effect of compartmentalization a comparison of the results of surveys inside and outside the fully functional systems listed above is most appropriate. The remainder can be compared in the light of their alternative functions or their subsequent breaching.

3.6.2 Catch

Fully compartmentalized schemes

The yields from floodplain/*beel* systems within compartmentalized schemes can be quite considerable (Table 3.16), up to 189. kg/ha from Chalan Polder B, for example. It is clear, therefore, that compartmentalization does not eliminate the fishery. However in one case, that of the BRE, only very low fish yields were produced.

In two of the four "working" schemes studied, Satla-Bagda and BRE, the yield outside exceeded the yield inside to a marked degree. In the other two schemes, Chalan Polder B and

Table 3.16 Fish yields from four functional fully compartmentalized schemes, March 1993 - February 1994

Schemes	Yield Outside (kg. ha^{-1})	Yield Inside (kg. ha^{-1})	Yield Outside (kg. km^{-1})	Yield Inside (kg. km^{-1})	Standard Gear Hours	
					Outside	Inside
Floodplain/Beel:						
Chalan Polder B	68	189				
BRE	81	8				
Pabna (PIRDP)	76	143			1923	3694
Satla-Bagda	215	129			15831	11422
Mean	110	117				
Canals:						
BRE	-	-	964	434		
Pabna (PIRDP)	-	-	889	436	2920	1339
Satla-Bagda	-					
Kalabari/Ambola		-	3376	2182		
Rivers:						
BRE	-	-	445	1501		
Pabna (PIRDP)	-	-	4726	3135		
Baral (Regulated)	-	-	4417	856	16438	3561
Arial Khan	-		1667			
Bhubaneswar	-		2451			
Kumar	-		541			

PIRDP, the reverse was true and relative yields inside were greater than those outside. This perhaps controverts initial assumptions within the FAP, that compartmentalization might invariably cause reduction in fish yields.

It is unlikely, however, that these higher rates of yield were the result of any higher fish abundance or productivity. A statistical analysis, in which the effort of selected common gears operating inside and out were standardised to remove the effects of fishing effort and demonstrate differences due to fish abundance, indicated that in many cases there was no significant difference in the abundance of fish inside and out (Table 3.17). It must be understood, however, that conducting this or any similar statistical analysis in floodplains, where the types of gears used are so varied, presents some difficulties, and is one of the major problems in conducting comparative surveys of floodplain fisheries. In some circumstances, in fact, there were insufficient common gears operating both inside and out to allow any statistical comparison to be achieved, e.g. Chalan Polder B. However, in one large compartmentalized system, the Satla-Bagda Polder 1 of the South West Region, it was demonstrated that fish abundance was actually significantly greater outside compared to inside (Table 3.17). In a second large compartmentalized scheme, the PIRDP of the North West Region, statistical analyses suggested that fish abundance was higher outside, but this could not be demonstrated conclusively because of poor fit of the statistical model.

The PIRDP is one of the two schemes for which yield was greater inside than outside. The reason for the higher yield inside is to be found in the much higher fishing effort exerted inside the scheme. The statistical analysis allows a rescaling of gear effort to account for the differential catchability characteristics. Consequently, although the gears may be of a different nature, their effort can be standardised in terms of gear hours fished. In this way, with regard to the common gears, 3694 gear hours were fished inside at PIRDP compared with 1923 gear hours outside (Table 3.16). As a result, the lower fish abundance on the floodplains within the scheme is more than offset by the much greater fishing intensity. The question arises, therefore, as to the ability of the stocks inside to sustain this much higher fishing pressure.

In Satla-Bagda not only was the fish abundance higher in the floodplains outside, perhaps of the order of 10%, but the fishing effort was also higher, leading to one of the highest overall yields determined for open floodplains in any region.

Unfortunately there was an insufficient number of common gears inside and out in Chalan Polder B to allow a statistical comparison of abundance or to produce values for standardised effort. However, a comparison of gill nets, one of the commonest gears used inside and out, showed that over the year, hours fished were 1.6 times more inside than outside and catch rates were consistently lower inside. It would seem, therefore, that here also a much higher effort contributed to the higher catch inside the polder while fish abundance was probably lower than outside.

Table 3.17 Summary of statistical analysis using standardised gear effort inside and out to test differences in abundance of fish

Location	Observed Inside	Predicted Inside	Predicted from outside	Significance for fish abundance
North West:				
Chalan Polder B	NA	NA	NA	NA
BRE				
(a) Floodplain				NS
(b) Canal	479.4	517.6	517.6	NS
(c) Rivers	2002.9	2063.5	1611.4	I>0
Pabna (PIRDP)				
(a) Floodplain low land	94.0	89.7	144.6	0>I
(b) Floodplain high land	NA	NA	NA	NS
(c) Canals	300.0	275.9	275.9	NS
South West:				
Chatla Fukurhati Floodplain	132.7	141.6	141.6	NS
Canals	4148	3969.4	3969.4	NS
Satla-Bagda Floodplain	84.2	79.5	89.2	0>I
Canals	NA	NA	NA	NS
North Central:				
Tangail (CPP) Floodplain	NA	NA	NA	NS
Canals	848	914.4	849.8	NS
North East:				
Manu (MIP)	46.1	48.0	49.9	NS
Shanghair Haor	135	138.4	138.4	NS

Note: 1. This compares the predicted inside values from the statistical model with those predicted to be achieved outside with the same amount of effort.
2. Fish abundance measured as (a) Kg/ha for floodplain.
(b) Kg/km for rivers and canals.

Chalan Beel Polder B also demonstrates one further feature of these in/out comparisons. In 1992 there was something of a drought. Comparisons from those schemes for which data are available from the peak catch period of October 1992 to February 1993 and the same season in 1993-1994 shows that generally yields were much lower following the 1992 floods compared to the much higher floods of 1993 (Table 3.18). This demonstrates the tremendous effect year to year hydrological variation can have on fish production and yield. In the case of Chalan this effect was much more marked inside the compartment than outside, but the reverse was seen in the PIRDP. Since fisheries within these FCD schemes are more dependent on rainfall flooding than those outside, it would seem likely that they would be more adversely affected during drought years.

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Table 3.18 Comparison of the inter-annual variation in catches from inside and outside functioning FCD/I schemes in the North West Region

Scheme	October 1992 - February 1993 (kg. ha^{-1})	October 1993 - February 1994 (kg. ha^{-1})	Annual percentage difference 1993/4 to 1992/3
Chalan out	29	34	- 15
Chalan in	52	169	- 69
BRE out	28	42	-33
BRE in	4.5	4.2	+ 7
Pabna out	18	57	- 68
Pabna in	62	90	- 31

A comparison of monthly catch rates at Chalan inside and outside also illustrates two other general features of most schemes. The peak catch often occurs a month later inside compared to out and the main fishing period can be extended by two to four weeks inside. These are both functions of the delayed drainage of the polder.

Yields from canals were uniformerly greater at outside sites even in the PIRDP (Table 3.16). This is almost certainly due to the fact that the canals are the main points of fish aggregation as the waters recede. On open floodplains fish are at their most dispersed and difficult to catch at the height of the flood. The canals act as drainage channels and offer a much readier access. Even at the PIRDP more effort was expended on the canals outside than inside. The yield from canals is essentially derived from floodplain production.

For rivers it is not really possible to generalise since they vary so much in width, location and flood characteristics. Like canals, however, their overall contribution to the floodplain production inside and outside the scheme needs to be integrated into the final total.

To achieve final integrated totals requires the total area of floodplain together with a division into high elevation and low elevation sites. Those given in Table 3.16 are overall averages or weighted means where estimates of catch rates for different elevations are available. The integrated total also needs the total lengths or areas of rivers and canals within the schemes and on the floodplain locations outside. An example of the methodology used in combination of fish yields across habitats to provide an integrated value of yield per unit area of floodplain is provided by analysis of the Satla-Bagda scheme (Supporting Volume No. 2).

Partly functional compartments and other schemes

Amongst these schemes, Chatla Fukurhati in the South West and the Manu Irrigation Project in the North East breached during the 1993 monsoon to allow substantial interchange of water with the outside floodlands. Tangail CPP is only partially empoldered and Shanghair Haor is protected by submersible embankments. In the case of the Tangail CPP and Shanghair Haor, yields inside and out were very similar. In the case of MIP, despite breaching of its embankments in June 1993 yields inside remained lower than those outside in Hakaluki Haor, whereas in the Chatla Fukurhati scheme of the South West the reverse was found (Table 3.19).

Table 3.19 Annual fish yields and standardised effort for partially functioning compartmentalized schemes

Schemes	Yield Outside (kg. ha^{-1})	Yield Inside (kg. ha^{-1})	Yield Outside (kg. km^{-1})	Yield Inside (kg. km^{-1})	Standard Gear Hours	
					Outside	Inside
Floodplain/Beel:						
Chatla Fukurhati	111	142			3618	8148
Tangail (CPP)	108	109				
Manu (MIP)	145	107			35	51.4
Shanghair Haor	108	105			6.2	19.8
Canals:						
Chatla-Fukurhati			3022	4124	10408	8970
Tangail (CPP)			1042	955		
Manu (MIP)			2783	3434		
Rivers:						
Tangail (CPP)			518	784		

In each case the statistical model suggested that, overall, there was no significant difference in the abundance of fish inside and out (Table 3.17). However, a consideration of the seasonal analyses shows a consistent picture of rather lower densities inside than out in the early seasons, i.e. dry season and early monsoon, and higher densities in the later seasons. For example, at Chatla Fukurhati in season 2 (May - June) a significantly lower fish density was found inside than out, whilst in seasons 3-5 (July - February) slightly higher densities inside than out were indicated (although these were not significant). This would be consistent with fish entering the compartment through the 1992 erosion breaches as the flood rose. Similarly, the MIP showed inside densities lower in seasons 1-3 (March - September) and higher at 4-5 (October - February) although only 1 and 5 were significant. This would be consistent with a negation of the original deficit inside to out by immigration followed by concentration of the fishes as the floods recede, augmented by reproduction. Shanghair Haor showed a similar picture. By contrast the two functionally compartmentalized systems, PIRDP and Satla-Bagda, showed inside abundance to be consistently lower than outside all through the flood seasons.

The effects of effort and accessibility

There does appear to be something about a compartmentalization system which encourages a much higher effort to be deployed in the fishery. There is no increase in biological productivity, in fact this may be reduced, although this is offset when openings occur in the compartment. The effects of higher effort greatly exceed any effects on biological productivity and can result in much higher yields coming from inside some schemes. This effort may come from higher numbers of people being associated with the schemes, with the result of more people participating in the fishery. There is evidence from several of the schemes of a shift away from the larger, more expensive gears in use outside, to lower investment types such as traps and gill nets within the schemes. This may indicate a shift to people who are essentially farmers but who, since it is relatively easier to fish within the scheme, participate on an occasional or part-time basis.

One further feature of a compartmentalized system is the reduced number of outlets compared to a free flooding situation. This will make it relatively easy for fishermen to target the fish as they attempt to leave the compartment during the flood recession. A compartment such a Chatla Fukurhati, which allows fish in from the outside floodwater, will act as a large fish trap when the fish try to escape during the drainage period. The intimate relationship between farmers and the controlled floodwater in the scheme would facilitate their exploiting a wide range of fishing locations. The overall effect is that the chance of a fish being caught within the scheme is much greater than that of one outside the scheme, resulting in the probability that a larger proportion of the total population is removed each year from within the scheme than from outside.

The ability of the fish populations to sustain fishing with such high levels of effort is unknown, but the populations need to be very resilient. The situation also mitigates against the survival of species which cannot grow and mature within a year.

3.6.3 Biodiversity

Functionally compartmentalized schemes

A comparison of the numbers of species occurring in different habitats inside and outside the four fully functional compartmentalized schemes demonstrates that the predominant effect is negative (Table 3.20), with a general loss of species inside compared to outside. In four schemes, the floodplains lost between 6 and 35% of their species.

A similar picture is shown by the canals where losses range from 13 - 39% (Table 3.20). The exception this time is the Kalabari canal outside the Satla-Bagda scheme which yielded only 46 species, rather fewer than inside. By contrast, the Satla-Bagda *Khal*, also outside this scheme, possessed 81 species, which would give a species reduction of 35% compared to the Ambola canal inside. The true picture probably lies between these extremes.

Of the four schemes studied the highest diversity is to be found in the rivers outside the PIRDP scheme, where 93 species were recorded. These rivers are influenced by both the main Jamuna and Padma rivers. In this respect, although the Baral River connection with the Padma main river is controlled by the Charghat Regulator, the number of species found inside remained as high as out.

Table 3.20 Total species number recorded inside and outside functionally compartmentalized schemes

Scheme	No. of Species Outside	No. of Species Inside	Difference %
Floodplains/Beel:			
Chalan Polder B	79	64	- 19
BRE	48	31	- 35
Pabna (PIRDP)	75	55	- 27
Satla-Bagda	48	45	- 6
Canals:			
BRE	56	34	- 39
Pabna (PIRDP)	64	56	- 13
Satla-Bagda			
Kalabari/Ambola	46	52	+ 13
Satla-Bagda Khal	81		- 36
Mean	62		- 36
Rivers:			
BRE	73	60	- 18
Pabna	93	72	- 23
Padma/Baral (regulated)	81	85	+ 5

Partially compartmentalized schemes

In partly compartmentalized schemes there was either little difference between numbers of species inside and out, as in the Tangail CPP, or else the species count was higher inside (Table 3.21). The one exception was found in the Manu Irrigation Project where the number of species recorded inside before the breaches was 33% lower than outside.

On average inside sites show a 23% loss of species compared to outside in functionally compartmentalized schemes. In partially functional compartmentalized systems the balance is more equitable.

Table 3.21 Total species number recorded inside and outside partially functioning schemes

Scheme	No. of Species Outside	No. of Species Inside	Difference %
Floodplains/Beel:			
Chatla Fukurhati	51	72	+ 41
Tangail (CPP)	66	65	- 2
Manu (MIP)	69	70	+ 1
Manu before breach		46	- 33
Shanghair Haor	62	70	+ 13
Canals:			
Chatla Fukurhati	59	63	+ 7
Tangail	58	59	+ 2
Manu	97	71	- 27
Mean	66	65	+ 0.3
Rivers:			
Tangail	73	80	+ 10

3.6.4 Species Composition

From the viewpoint of operation and management of compartments, there are essentially two types of species, i.e. those which are floodplain resident and are able to complete their life cycle within the compartment and those which are migratory and, therefore, need to move into or out of the compartment at some point of their life history.

Those species dominating the catches from floodplains and *beel* inside functional schemes are presented in Table 3.22. Such schemes were found in only two regions, the North West and South West.

Species composition for the North West was derived from catch data pooled across three functional schemes, the PIRDP, Chalan Polder B and the BRE. When comparisons are made between the species composition of unregulated floodplains of the North West (Table 3.15) and that inside FCD/I schemes clear differences emerge. Migratory species comprised only 4% of the total annual catch inside FCD/I schemes compared with 26% outside. Species which were relatively less abundant inside schemes included catfish such as *boal*, *batashi*, *kabashi* and *golsha tengra*, the clupeid, *chapila* and the carp, *raik*. In contrast prawns increased in relative abundance inside these schemes, forming 25% of catch compared with 13% of that outside. In the South West, migratory species were insignificant both inside and outside the FCD scheme. Prawns however, again increased inside (7%) compared to outside (2%). The list of species comprising the floodplain resident community in both the North West and South West was similar inside and outside schemes.

In the partially functioning schemes of the North East there was little noticeable change in the proportion of migratory species inside (25%) compared to outside (28%) although three species, *guizza*, *kabashi* and *kani pabda* disappeared from the list of dominant species inside schemes (Table 3.23). In the South West, the proportion of migratory species increased inside a partly working scheme from 1% outside to 9% inside. The species which were responsible for this increase were the major carps *rui*, *catla*, the small carp *kalbaus* and the catfish, *ayre*. Prawns once again increased in relative abundance inside the scheme where they comprised 16% of the catch compared with only 2% outside. In the North Central Region, the Tangail CPP had almost no effect on species composition.

The sedentary group is particularly important. The 25 species of this group (Table 3.24) contribute almost 50% of all floodplain and beel catches, across regions and inside and outside of schemes. It is virtually certain, for example, that this small group of species provides an equally large proportion of the category of "miscellaneous" fishes often recorded in the national statistics as contributing the largest part of the 250,000 mt. of floodplain and *beel* catches. They are, therefore, of immense significance to the national fishery as a whole. They tend to be small species, maturing within a 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

Table 3.22 Percentage contribution to the annual catch by dominant species of floodplains and beel inside working schemes, March 1993 – February 1994

Habitat Preference	Species Name		Region	
	Scientific	Bengali	South West	North West
Floodplain Resident	*Anabas testudineus*	*Koi*	4.3	–
	Mystus tengara	*Bajari tengra*	–	1.8
	Mystus vittatus	*Tengra*	3.1	1.2
	Colisa fasciatus	*Khalisha*	3.6	2.0
	Colisa lalia	*Lal Khalisha*	3.0	–
	Xenentodon cancila	*Kaikka*	2.8	6.5
	Puntius conchonius	*Canchan puti*	1.3	4.3
	Puntius sophore	*Puti*	28.9	9.2
	Puntius ticto	*Tit puti*	1.6	–
	Glossogobius giurus	*Bailla*	1.1	3.9
	Lepidocephalus guntea	*Gutum*	–	1.5
	Channa marulius	*Gajar*	1.3	1.3
	Channa punctatus	*Taki*	10.9	11.9
	Channa striatus	*Shol*	3.8	2.7
	Heteropneustes fossilis	*Shingi*	10.1	–
	Macrognathus aculeatus	*Tara baim*	–	1.3
	Mastacembelus armatus	*Baral baim*	–	1.4
	Macrognathus pancalus	*Guchi*	1.8	5.0
	Nandus nandus	*Bheda*	4.1	–
	Notopterus notopterus	*Foli*	1.4	–
	Tetraodon cutcutia	*Potka*	1.2	1.1
	Chanda nama	*Nama Chanda*	–	2.2
	Chanda ranga	*Lal chanda*	–	3.4
Subtotal			84.2	60.5
Migratory	*Labeo rohita*	*Rui*	–	1.8
	Salmostoma phulo	*Fulchela*	–	2.3
Subtotal			–	4.1
	Prawn spp.	Chingri/Icha	7.3	24.9
		Total	91.5	89.5

Notes: 1. Shaded values highlight the most important species (>4%)
2. See text for definitions of habitat preference categories
3. Dominant species are those comprising 1% or more of catch.

Table 3.23 Percentage contribution to the total annual catch by dominant species of floodplains and beel inside partially working schemes, March 1993 – February 1994

Habitat Preference	Species Name		Region		
	Scientific	Bengali	North East	South West	North Central
Floodplain Resident	*Anabas testudineus*	*Koi*	–	3.1	1.3
	Mystus vittatus	*Tengra*	1.6	2.2	1.7
	Colisa fasciatus	*Khalisha*	–	1.3	5.5
	Colisa lalia	*Lal Khalisha*	–	–	1.6
	Xenentodon cancila	*Kaikka*	2.4	1.6	4.5
	Cyprinus carpio	*Karfu*	2.9	–	1.6
	Puntius chola	*Chala puti*	2.9	–	–
	Puntius conchonius	*Canchan puti*	–	2.6	–
	Puntius sophore	*Puti*	4.3	12.1	15.3
	Puntius ticto	*Tit puti*	–	1.1	–
	Osteobrama cotio cotio	*Keti*	–	1.1	–
	Glossogobius giurus	*Bailla*	2.2	1.6	1.2
	Lepidocephalus guntea	*Gutum*	–	1.7	2.6
	Channa marulius	*Gajar*	2.1	2.6	–
	Channa orientalis	*Cheng*	–	–	1.3
	Channa punctatus	*Taki*	4.2	12.0	11.2
	Channa striatus	*Shol*	–	4.8	1.4
	Heteropneustes fossilis	*Shingi*	3.7	3.2	3.1
	Macrognathus aculeatus	*Tara baim*	–	2.0	–
	Mastacembelus armatus	*Baral baim*	–	3.1	–
	Macrognathus pancalus	*Guchi*	1.6	3.2	4.5
	Nandus nandus	*Bheda*	4.1	–	–
	Notopterus notopterus	*Foli*	4.3	4.0	2.2
	Tetraodon cutcutia	*Potka*	–	1.2	–
	Chanda baculis	*Chanda*	2.9	–	–
	Chanda nama	*Nama Chanda*	1.4	–	–
	Chanda ranga	*Lal chanda*	–	–	1.7
Subtotal			40.6	64.3	60.8
Migratory	*Aorichthys aor*	*Ayre*	8.5	1.7	–
	Catla catla	*Catla*	–	2.9	1.1
	Cirrhinus mrigala	*Mrigel*	2.0	–	–
	Labeo calbasu	*Kalbaus*	–	1.0	–
	Labeo rohita	*Rui*	3.0	3.7	2.5
	Salmostoma phulo	*Fulchela*	3.2	–	–
	Gudusia chapra	*Chapila*	6.7	–	–
	Wallagu attu	*Boal*	1.7	–	–
Subtotal			25.1	9.3	3.5
	Prawn spp.	Chingri/Icha	20.9	15.9	24.1
		Total	86.6	89.5	88.4

Notes: 1. Shaded values highlight the most important species (>4%)
2. See text for definitions of habitat preference categories
3. Dominant species are those comprising 1% or more of catch.

species once their population dynamics are understood. At present there is insufficient information on the population dynamics of these species to allow this to be done.

A further common characteristic is the importance of prawns in the catch. Overall they constitute the single largest component, at 14.3% of the total catch. They are similarly prominent in most site catches.

Table 3.24 Dominant sedentary fish species found on the floodplains and *beel* of Bangladesh

Family	Scientific Name	Bengali Name
ANABANTIDAE	*Anabas testudineus*	*Koi*
BAGRIDAE	*Mystus tengara* *Mystus vittatus*	*Bajari tengra* *Tengra*
BELONTIIDAE	*Colisa fasciatus* *Colisa lalia*	*Khalisha* *Lal Khalisha*
BELONIDAE	*Xenentodon cancila*	*Kaikka*
CYPRINIDAE	*Puntius conchonius* *Puntius sophore* *Osteobrama cotio cotio* *Puntius ticto* *Glossogobius giurus*	*Canchan puti* *Puti* *Keti* *Tit puti* *Bailla*
COBITIDAE	*Lepidocephalus guntea*	*Gutum*
CHANNIDAE	*Channa marulius* *Channa punctatus* *Channa striatus*	*Gajar* *Taki* *Shol*
HETEROPNEUSTIDAE	*Heteropneustes fossilis*	*Shingi*
MASTACEMBELIDAE	*Macrognathus aculeatus* *Mastacembelus armatus* *Macrognathus pancalus*	*Tara baim* *Baral baim* *Guchi*
NANDIDAE	*Nandus nandus*	*Bheda*
NOTOPTERIDAE	*Notopterus notopterus*	*Foli*
TETRAODONTIDAE	*Tetraodon cutcutia*	*Potka*
AMBASSIDAE	*Chanda baculis* *Chanda nama* *Chanda ranga*	*Chanda* *Nama Chanda* *Lal chanda*

The basic migratory community contributes a much smaller proportion of the total catch at around 13%. Of these 7.3% were major carps. These are perceived to have constituted a much larger percentage of floodplain catches in earlier years. Certainly Indian catches of major carps on the Lower Ganges exceeded 40% in the late 1950's.

One significant aspect of the proportion of migratory species in the catch is the effect they have on its relative value. Generally they increase the value of the catch because of their higher relative price (see Section 4).

Looking at the proportion of migratory and sedentary communities inside and outside the individual schemes shown in Table 3.25, gives some indication of the impact of compartmentalization on the structure of the communities. For the four fully compartmentalized schemes, the proportion of migratory species occurring inside is extremely small, with a range of 0.001 - 5% of the catches. The proportion outside tends to be rather higher, considerably so in the case of Chalan Beel Polder B and the PIRDP. Major carps generally form only a tiny percentage of the catches, particularly at inside sites.

Table 3.25 The relative contribution of sedentary and migratory species inside and outside fully and partially compartmentalized schemes

Scheme	Migratory Outside (%)	Migratory Inside (%)	Sedentary Outside (%)	Sedentary Inside (%)
Chalan Polder B	29.7	2.6	45.0	72.3
BRE	4.1	<1	64.7	87.6
Pabna	25.7	4.7	46.3	58.1
Satla-Bagda	1.2	0.3	93.3	91.2
Tangail	9.4	6.0	58.5	63.0
Chatla Fukurhati	1.3	9.3	87.3	64.3
Manu	50.5	25.6	21.2	42.2
Shanghair Haor	5.4	22.8	56.7	46.3

Taken together with the general reduction in number of species (Table 3.21) the impact of compartmentalization is to simplify the fish communities supporting the fisheries inside the compartments. These fisheries become more reliant upon the basic community of around 25, mainly small, sedentary species. Particular casualties are the migratory species (Table 3.15) which consequently tends to reduce the value of the catch inside compared to out. The hatchling surveys (Supporting Volume 11) have demonstrated how closure of inlet sluices during the early monsoon prevents colonization by the main early peak of hatchlings. This specifically includes major carps and other migratory species. In reducing the species number inside the compartment those most likely to go are the rarer ones in that particular community. If the majority of the floodplain were to be compartmentalized then there would be every possibility for a large reduction in habitats for species in general and migratory species in particular.

The sedentary fish community is undoubtedly very resilient, as can be seen from its ability to bounce back with high yields in the floods of 1993 after having been depleted in the drought year of 1992. Nevertheless insufficient is known of the population dynamics of these species to be able estimate sustainable yields or the levels of fishing effort beyond which the fishery will be damaged. This will be particularly relevant in a drought year when combinations of high effort and low water level will exert mortalities beyond those which can be sustained by the populations. Whatever the regenerative capacity, every population has its limit. Increasing compartmentalization will narrow the species base of the fishery and thereby render it more vulnerable and less valuable in the longer term.

3.6.5 The special case of submersible embankments

The Shanghair Haor Project differs from all others covered in the FAP 17 surveys by being protected by submersible embankments. The intention is to protect the inner land from early flooding, after which the embankments would be overtopped. Assuming this scheme achieved its flood control objective, it appears to have had the least impact on fish of any of the schemes. The yields inside are high, with high levels of effort being deployed. This may be damaging in the longer term, although this remains to be seen. However, the number of species remains equally high inside and out and the proportion of migratory species is also high (Table 3.25). There was evidence from the hatchling survey that the intervention of the submersible embankments during the early flood denies access to the first peak of hatchlings. However, proportionately higher catches of *rui* were recorded inside the scheme compared with outside. Once the embankment is overtopped, the species number, fish abundance and number of migratory species equilibrates and then the compartment provides a feeding ground for all species.

A similar picture emerges for some of the compartments which have breached. This gives some indication that if the inflow and outflow from the compartments is managed with a view to the timing of events, the impact of compartmentalization can be reduced.

4. IMPACTS ON PEOPLE

4.1 CONCERNS AND FRAMEWORK

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.

While the initial thrust of the FAP was humanitarian and aimed at the protection of people and property from destructive flooding, the principal economic justification provided relates to the more secure environment created by flood control for agriculture and other productive activities. The exclusion or control of river flooding and, in some schemes, the improvement of drainage and irrigation facilities allow the intensification of cropping, the introduction of improved technology and the creation of new employment opportunities in agriculture, as well as the improvement of land-based communications and infrastructure.

Many concerns have been expressed regarding the environmental impact of such interventions, whether they constitute the best response to the problems of flooding in Bangladesh and, on a more basic level, whether they will actually work given the highly dynamic nature of river morphology and hydrology in the floodplains of Bangladesh. Many of the problems of existing schemes spring from their failure to properly consider many non-agricultural activities important in rural livelihood strategies, such as water-transport and fisheries.

In the past, the overwhelming concern of planners to raise grain production to satisfy the basic food requirements of the nation, arguably, justified this relative neglect of other sectors. Now that national food self-sufficiency has been achieved, such a position deserves reconsideration, particularly as it appears that surplus grain is not well suited to the international market and might serve only to depress prices internally.

In the past, the importance of fisheries tended to be under-estimated, in part because of the relative abundance of the resource, its extraordinary diffusion by the annual floods and the fact that it does not lend itself to control. But the steady drop in per capita fish consumption, despite the spread of intensive aquaculture, together with a sharpened interest in the contribution of common property resources have contributed to a growth in the awareness of the value of capture fisheries in rural Bangladesh and concern over its decline.

Much of this concern has been focussed on the effects of flood control. The negative impacts of flood control measures on the large numbers of traditional, full-time fishermen who exploit capture fisheries in *beel*, floodplains and rivers has always been accepted as an unfortunate side-effect of flood control. Mitigation measures have generally been directed towards the replacement of lost fisheries production rather than the compensation of minority groups who have lost their source of livelihood. But the numbers supposedly benefitting from agricultural improvements generally seemed to justify the negative impacts on a relatively small specialised group.

However, the potential implications of changes in the fisheries resource for the population at large have only been realised more recently and have given rise to greater concern. As an open-access resource, in an area where competition for all resources is acute, capture fisheries may provide an important source of supplementary food and income for those who have access to few other resources. Patterns of labour demand, and the agricultural activity on which that is largely assumed to depend in rural areas, are acutely seasonal in floodplain areas. The traditional lean season for the poorest, labour-dependent section of the rural community corresponds to the floods when fishing activity could provide an important stop-gap for households with few other livelihood options. During the *mora kartik*, or lean period in early October just before the harvest of broadcast *amon* crops, open-access fishing activity is generally at its peak as the flood recession commences and water and fish flow off the floodplains and can be easily caught by anyone with even the simplest of fishing gears.

The more obvious forms of mitigation for losses in capture fisheries, such as aquaculture development, might replace at least some of the lost **production**. But these measures can do little to replace the obvious distributional benefits of floodplain capture fisheries; in most years of "normal" flooding, the natural cycle of flood expansion brings the fish to the people making a valuable source of nutrition and income available to all.

Based on a purely subjective assessment, and given an acute lack of reliable data on fisheries in rural Bangladesh, these concerns are extremely important. Even the briefest of visits to floodplain areas in the country, particularly during the flood recession, will indicate that fishing activity involves an extremely wide and heterogeneous portion of the rural population. The tremendous concentrations of fishing effort which take place as residual waterbodies and *beel* are harvested during the dry season contributes to this sense that fisheries may constitute a resource whose importance for rural people is grossly underestimated.

But distinguishing the **real** importance of fishing in terms of livelihoods and survival strategies is more difficult. The impression obtained by superficial observations can be very deceptive: a large number of people out fishing in the water may seem a strange sight to urban-based observers and cause them to overestimate its relative significance; to fisheries specialists unused to floodplain fisheries the amount of fishing effort being applied seems extraordinary, masking the fact that methods are often inefficient; the very fact that so little is known about an activity which is taken so much for granted in rural areas can encourage an inflated impression of its importance.

The FAP 17 socio-economic 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.

During the course of the formulation of the study it became clear that floodplain fisheries in Bangladesh are undergoing considerable long-term changes. As many of these changes are **not** linked to flood control, it is clearly important to understand these historical processes in order to try to isolate the impacts which **are** the result of flood control interventions from those which are more general.

Originally, the FAP 17 study intended to isolate flood control impacts by looking at communities inside and outside flood control schemes. However, the difficulties encountered in identifying, on the one hand, fully functioning flood control schemes 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 the 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.

4.2 METHODOLOGY 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 socio-economic household monitoring surveys, conducted by the socio-economic 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 and summarised in section 3 above. The further processing of this data to allow socio-economic analysis is described below, as is the data collection process for the various surveys undertaken by the socio-economic team.

The analysis of both sets of data has placed considerable emphasis on distinguishing between catch or income accruing to different categories of fishermen, as this has a significant influence on the distributional consequences of flood control impacts. Before moving on to the methodology used for classification (and for other aspects of the quantification), a discussion is provided of the broader issue of who fishes in Bangladesh.

4.2.1 Definitions

Who fishes - Characterization of fishing groups

Concern over the possible social impacts of a significant reduction in floodplain fisheries is based on a widespread perception that fishing constitutes an important seasonal source of food and income for many of the poorest of the poor in rural areas. Subjectively, this concern would seem to be well-founded. Any experience of rural Bangladesh during the period of the annual floods and their recession cannot help but note the numbers of people involved in fishing, the bewildering variety of techniques employed and the apparent heterogeneity of the people involved.

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 by profession, religion, caste and social status. But, given the widespread diffusion of the fisheries resource which occurs during the floods, it would seem logical that most of the rest of the population would also have some degree of fisheries involvement, depending on distance from suitable waterbodies, availability of alternatives and seasonal or annual variations in flood extent. This would make any division between "seasonal" and "subsistence" fishermen extremely arbitrary.

As is so often the case, "logical" assumptions do not reflect reality very faithfully. Due to institutional and socio-economic structure of fisheries access and the social attitudes surrounding fisheries as an occupation, the degree to which the rural population at large is engaged in fishing is more circumscribed than is immediately apparent. The vast majority of families living on the floodplains of Bangladesh do catch fish at some time or another during the year, but the numbers depending on fishing for a **significant** contribution to their household's livelihood is considerably less.

Consequently, the commonly used categorisations of fishing households: professional, seasonal and subsistence, actually hold up quite well to more detailed analysis of relative levels of fisheries dependence. Given the degree of variation noted above between regions, areas and villages, and the degree of variation in the fisheries resource from year to year, there are obviously many groups and areas which will fall outside any attempt at categorisation at any given moment. But, in general terms, the three groups discussed below constitute sectors of the population with identifiably different levels of dependence on fishing.

Subsistence fishermen

Subsistence fishermen is a rather misleading term to use as a catch-all for everyone engaged in fishing who does not regard it as an "occupation". A better term would be "opportunistic" fishermen. Many of these fishermen may fish on a very regular basis through the flood season and drawdown, but at relatively low levels of intensity (a few hours at a time) using small, flexible gears on generally shallow and peripheral waterbodies which generally yield small amounts of fish. These opportunistic fisheries are dominated by children who 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).

Generally, there seems to be 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". Most "subsistence" fishermen would not even say that they fish, even if they do so frequently. They consider the activity as being, above all, "only for consumption" even if they may sometimes earn considerable income.

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 "normal" inundation, the commonly cited figure of 80% of floodplain people engaged in subsistence fisheries may well be close to the truth, but in a relatively dry year the figure might be dramatically less.

"Subsistence" fishing does **not** 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. This is not to say that a large proportion of subsistence catches do not end up in the family cooking pot, but as much of the catch of these "opportunistic" fishermen is probably sold as is consumed and there are very few species, even among the smallest of the floodplain resident *chhotto maach* which do not command a market value in the local *hat*.

Seasonal fishermen

One important group of people exploiting the fisheries resource actually seems to be benefitting from the types of changes in fisheries access which flood control encourages.

In the context of floodplain fisheries in Bangladesh, "part-time" means "seasonal", because access to fisheries resources for non-professionals is dictated, first of all, by the seasonal cycle of flood expansion and recession and the movement of fish which this stimulates.

This category presents the greatest problems in terms of definition. As discussed above, an enormous 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 during 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.

However, these 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 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.

In Ahmmedpur, a predominantly agricultural community on the shores of Gandahasti *beel*, in the Pabna Irrigation Project, the first involvement of a Muslim agriculturalist in fishing dates back to the 1960s. Even before the Hindu *rajbangshi* fishing community that used to live in the village moved out, a certain Aru Sarder started secretly catching fish in the *beel* and selling them at one of the local markets. When it was discovered, this person was so violently ostracised by the local *panchayat* that he ended up leaving the village and going to live elsewhere. Not long after his departure, however, other households in the village began to follow his example. This trend has steadily gathered pace as general levels of poverty and the pressure on agricultural employment has grown. The numbers of Muslim, seasonal fishermen took off when the *rajbangshi* community migrated out to India in the mid-1970s, partly in response to the construction of the Padma Irrigation Project.

Box 1: Muslims and fishing in Ahmmedpur

The appearance of this group seems to date from the 1970s. 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 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 (see Box 1).

Because of this social stigma, it seems that those people who have overcome the social barriers surrounding involvement in fisheries tend 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.

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 waterbodies such as the channels (*halot*), ditches (*maital*) and other areas not subject to traditional fishing rights. Where flood control has reduced the higher-value fisheries, the area fished by traditional fishermen and regulated by leasing has been reduced. Seasonal fishermen have generally benefitted by the opening up of wider areas to fishing.

However the benefits from the removal of access controls may, in the long run, be cancelled out by the increase in fishing effort and potential for overexploitation of the resource. The tendency for landowners to also become more involved in the exploitation of fish resources on their land when it is flooded may also, in the long run, restrict the opportunities for seasonal fishermen.

Professional fishermen

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. Professional fishermen (*jele*) are frequently thought of as being almost all Hindu, but 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 or poor Muslim communities which have been involved in fishing for so many generations that they have become fishermen.

Some of the major riverine fisheries, on the Padma and Meghna Rivers in particular, continue to be dominated by Hindu caste fishermen, but on the floodplain and *beel* fisheries in many areas the structure of the professional fishing community tends to be more complex with diverse groups exploiting distinct niches in the fishery.

These "traditional" fishermen are increasingly being joined by newcomers to the sector who are attracted by the increasing value of the fisheries resource and the avid demand for fish in the country. Particularly where low-status groups have nominal control over the fisheries tenure system, whether they are Hindu or Muslim traditional fishermen, these new-comers are able to either ignore access restrictions completely or influence the mechanisms for access distribution in their favour.

The numbers of these professional but non-traditional fishermen who are completely dependent on fishing are still limited. The acute seasonality in almost all fisheries in Bangladesh means that new entrants to fisheries tend to remain seasonal and exploit fisheries at the time of the year when returns are greatest, access is easiest or there are no other options available. But given the year-round competition for all sources of livelihood in rural Bangladesh, the numbers of people turning to fisheries full-time is steadily growing and, in some areas, they now outnumber the traditional fishermen.

There is no doubt that professional fishermen are the single group most negatively impacted by the changes in fisheries caused by flood control. It is precisely the most valuable fisheries located in the *beel* and along the *khal* connecting *beel* to rivers which are reduced by flood control, either by being cut off completely or regulated by sluices which are generally operated in response to the demands of agriculture rather than fisheries.

Floodplain resident species do not appear to be especially affected by the reduction of access to rivers, but traditional fishermen are highly reliant on formal control of fisheries access in order to maintain their own access to fisheries. The decline of the value of the fisheries has led to smaller areas under leasing and more open-access. In this context, the low-status of professional fishermen counts against them. It is extremely difficult for them to continue their fishing activities in the face of numerically superior non-traditional fishermen who are progressively pushing further and further into the areas normally reserved for traditional fishermen.

Seasonally as well, more and more non-traditional fishermen are continuing their fishing activity into the winter to take part in the harvesting of residual waterbodies. The options open to traditional fishermen in response to these changes are limited. Many Hindu fishermen have migrated out, usually primarily in response to political and social changes rather than changes in fisheries, but the increasing uncertainty over their access to fisheries resources certainly contributes. Shifts in occupation out of fishing into new sectors are not as rare as might be expected among Hindu caste fishermen. If anything, Muslim traditional fishermen, such as the *maimul* in the North-East, seem to have greater difficulty.

In areas where *kua* excavation and pond aquaculture have developed, many traditional fishermen have been able to establish a niche for themselves in the management and harvesting of ponds. However, the scope for large-scale replacement of capture fisheries opportunities for traditional fishermen through aquaculture development are limited. As the potential for fish culture is realised and techniques become more familiar on a wider scale, pond owners inevitably take on more and more of the activities in the culture cycle themselves.

Leaseholders and Landowners

As long as the limits of **any** categorisation are recognised, the three categories of fishing households discussed above offer an acceptable breakdown of relative involvement in fishing as an activity. However, if the interpretation of "fishing" is extended beyond the physical act of catching fish to the more general sense of extracting benefits from the fisheries resource, a fourth and extremely important category needs to be added.

The control of the more valuable fisheries resources in Bangladesh has **never** completely resided with fishermen. In the colonial period *zamindars* were responsible for revenue collection across wide estates that included the waterbodies that lay within them. On the more valuable water estates (*jalmahal*), fishing was restricted and a proportion of the catch had to be surrendered. When the *zamindari* estates were broken up at the time of Partition, these waterbodies became government (*khas*) land, and have since been subject to formal leasing arrangements.

Though nominal preference is given to 'genuine' fishermen in the allocation of these leases, those who catch fish directly are rarely able to muster the resources necessary to gain direct control of *jalmahal* 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 *mohajan* (moneylenders), fish traders or simply businessmen investing in fisheries. Their degree of personal involvement 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 floodplain and along the banks of *khal* to establish claims to fish. 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 extract a sizeable proportion of the benefits of the fishery without suffering the social stigma attached to professional fishing, as fishermen or labourers are engaged to undertake the harvest.

4.2.2 Methodology

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 *arotdars*) 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 *mrigal*, on which continuous price data were not collected, was that of *rohu*, its indicator species, multiplied by 0.69, its markup factor.

The value of catch was estimated by multiplying the 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 socio-economic village monitoring. The greater margin in the NE 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 subsistence, not income. The categories used by FAP17, which are broadly based on those used by FAO, are given in Table 4.1.

Table 4.1 Household Fishing Categories Used

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

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 FAP6.

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. This is important because it is thought that the primary beneficiaries of flood control are farmers: improved agricultural incomes would therefore automatically compensate them, in part at least, for losses in their income from fisheries.

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.

Socio-Economic Surveys

The procedures for the collection of socio-economic data were discussed in some detail in the FAP17 Interim Report. This section provides a brief review and update of the material contained there.

The principal focus of the socio-economic 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 schemes, 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 main 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 schemes

The only existing flood control scheme in the NCR was the Tangail CPP. As this small area had already been studied in very considerable detail by FAP20 and FAP16, it was felt that respondent fatigue would preclude any further monitoring there by FAP17. NCR was therefore taken as an outside area. Elsewhere the choice of schemes 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 I and Chatla-Fukurhati scheme.

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 fishing and 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 satellite communities 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.

Households were then classified. In the main villages this was on the basis of landholding category; in the satellite fishing communities 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).

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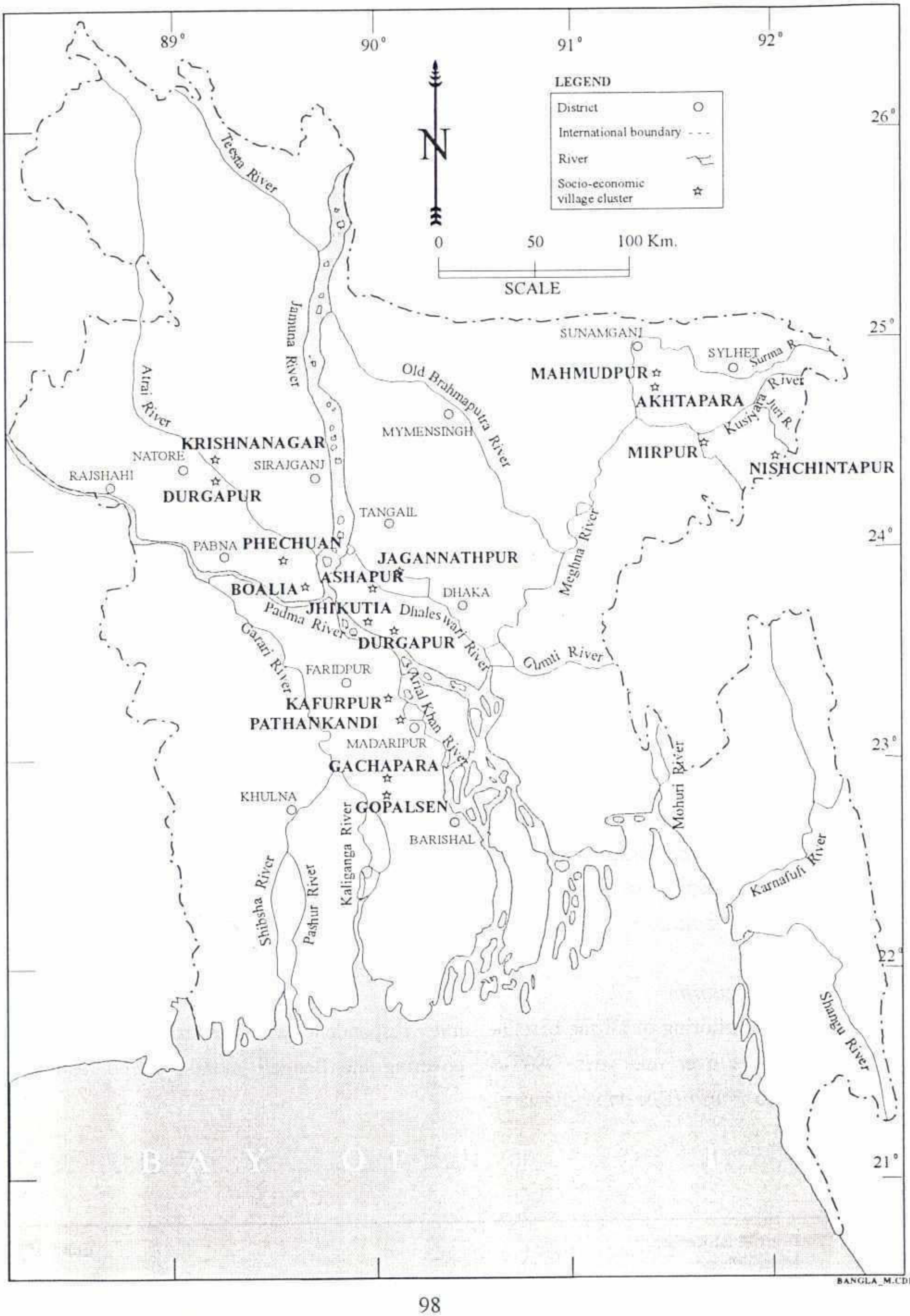
Figure 4.1
Location of main villages surveyed by the FAP 17 Socio-Economic Studies



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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 absorbtion 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.

Ad hoc surveys

In addition to the main 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 waterbody, a study of access was undertaken to supplement the information on this derived from the village studies.

4.3 FISHERIES ISSUES

A wide range of factors were encountered during the course of the FAP 17 study which influence the ways in which floodplain communities interact with the fisheries resource. Many of these factors are specific to particular regions, areas or even villages. But, right across the country a few issues were identified which are of general importance and need to be understood in order to put the impacts of flood control on fisheries in context.

4.3.1 Inter-Regional Differences

Patterns of fisheries in any area develop from the combination of fisheries resources, the configuration of local waterbodies, the social and cultural history of surrounding communities and the other economic activities carried out. While it would be easy to assume a homogeneous pattern for floodplain fisheries in Bangladesh, there are in fact very important regional differences which have a major influence on the kinds of impacts which flood control will have. These differences have been clearly distinguished in the four FAP regions studied by FAP 17: the North-Central (Manikganj District), the North-West (Pabna and Natore Districts), the North-East (Maulvi Bazar and Sunamganj Districts) and the South-West (Faridpur and Barisal Districts).

These regions have been defined by FAP planners based on primarily hydrological considerations. As a result, they often spread across important social and cultural boundaries which influence the way in which people are affected by changes in fisheries: e.g. within the South-West Region, patterns of fisheries exploitation are very different along the Arial Khan River in Faridpur and Madaripur compared with the brackishwater areas of Khulna and Patuakhali.

However, between the various regions studied there are clear differences which are extremely significant for planners. Flood control works which reduce access to fisheries resources will impact very different social groups in different regions because patterns of fisheries involvement have developed along very different lines. Often these differences are directly linked to hydrological features and the configuration of waterbodies.

In the North-East, for example, the remoteness of the *haor* coupled with its history of relatively sparse settlement has given rise to a unique social structure which strongly affects settlement patterns, control of water and land resources and access to fisheries. As a result, the impacts of any changes in floodplain and *beel* fisheries caused by flood control would affect very particular groups, particularly leaseholders and traditional fishing communities. Among other floodplain communities, some settler communities (*abadi*) would be impacted in remoter areas but the numbers of non-traditional fishermen in the *haor* is far more limited than in some other parts of the country. In the North-West, the numbers of non-traditional fishermen are greater, but fishing as an activity is circumscribed by considerable social stigma, so the benefits of fisheries are still generally limited to a relatively small part of the rural population.

By contrast, in many parts of the North-Central and South-West Region, any reduction in fisheries would be felt through a far wider portion of the rural community as widespread seasonal involvement in fisheries by non-fishermen is more accepted socially and easier because of the lack of access controls on waterbodies.

Flood control planners looking at impacts of schemes which will reduce fisheries therefore need to approach the problem in very different ways in different regions.

4.3.2 Intra-Regional Differences

Even within regions, patterns of fisheries exploitation can often vary considerably between one village and the next even though they have very similar sets of resources at their disposal and apparently similar access to fisheries. The reasons for such variation are complex and require an understanding of the history of settlement, cultural background and occupational and land ownership structure of each individual community.

But it needs to be clearly understood that, although certain regional patterns can be distinguished in fisheries dependence, there are usually as many communities which do **not** follow the trend as there are that fit.

For FAP planners, these variations clearly have important implications, as the lack of homogeneity in levels of fisheries dependence over large areas complicates the task of defining what forms of mitigation are appropriate.

4.3.3 Impact on Value of Fish

Flood control affects the average value of fish caught throught its impact on species composition. Species that are known to migrate to and from the rivers or which prefer the deeper waters in the *beel*, include many of those attracting the highest prices per kilogramme: *rohu, mrigal, boal, ayre* etc. Average prices would therefore tend to be lower where flood control had blocked their movement to and from the floodplain. Such an effect on values was identified, though the lower than anticipated significance of the migratory species in the unprotected areas ensured that it was was not dramatic.

Comparisons of Values

Values of catch were derived using the procedure outlined in Section 4.2.2 on methodology above. These data were used to perform two sets of inside/outside comparisons of average values: first, for each gear in each region, habitat and flood period; second, on a habitat by habitat basis.

In the course of the fish catch assessment surveys around 70 different gears were recorded. Of these, 41 occurred both inside and outside FCDs within the same region in the same flood period on the same habitat type at least once. In all there were just over 500 pairings. The results of the comparisons are shown in Table 4.2. There were 311 cases where the value of catch per kilogramme was higher for the gear outside than for the same gear inside; the reverse was true 196 times[3].

Taking a simple average across all gears, the mean value outside was Tk.37.2/kg; inside it was Tk.34.6/kg. (Note: this is not intended as an estimate of the average value of fish as it gives equal weight to all gears and the rarer, more specialised gears often target the higher value fish.)

The comparison of average value of the catch between habitats was also instructive. There were only 13 inside/outside pairings of habitats within the four regions: there were, of course, no main rivers inside in any region; no secondary rivers inside and no *khal* outside in the NE; and no secondary rivers inside in the SW.

[3] The non-random nature of this distribution was tested and found to be significant at the 99.99% level using a Chi-squared (X^2) test.

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Table 4.2 Differences in Average Value/Kg, by Gear, Inside and Outside FCDs

Gear Type	Gear Name	Code	Combinations of: Out>In	In>Out	Avg. Value/Kg (Tk.) Out	In	Difference Tk.	%
Gill Nets	*Current jal*	88	25	23	39.2	37.9	1.3	3.4
	Koi/Fashi jal	123	13	6	52.8	48.7	4.1	8.4
	Monofilament Net	282	2	2	51.8	54.0	−2.2	−4.1
	Kajuli jal	316	1	0	50.5	49.7	0.8	1.6
Seine Nets	*Ber jal*	45	14	13	31.2	28.8	2.4	8.3
	Deol	89	8	6	33.2	31.0	2.1	6.8
	Kathi jal	175	0	1	17.8	19.7	−1.9	−9.6
	Moi jal	202	9	4	27.0	26.8	0.2	0.7
	Hat panch	276	2	0	46.5	20.5	26.0	126.8
	Kachitana	277	0	1	35.0	60.6	−25.6	−42.2
	Horhori	297	1	1	49.6	46.9	2.7	5.8
	Baoli	306	4	0	42.7	30.9	11.9	38.5
Bag Nets	*Suti jal*	271	7	1	41.3	29.4	11.9	40.5
	Beon jal	285	1	1	54.7	49.0	5.7	11.6
	Ghori jal	320	1	0	26.7	20.6	6.1	29.6
Lift Nets	*Dharma jal*	105	11	6	37.6	34.3	3.3	9.6
	Veshal jal	266	15	9	31.0	29.3	1.8	6.1
Scoop Nets	*Ucha*	263	2	0	25.1	24.3	0.8	3.3
	Tukri	296	9	7	26.3	24.6	1.7	6.9
	Afa	321	1	0	51.4	43.0	8.4	19.5
Clap Net	*Shangla jal*	234	1	0	43.6	42.9	0.7	1.6
Katha/Kua	*Katha*	270	5	7	42.0	47.5	−5.5	−11.6
	Kua	302	4	5	38.0	38.5	−0.5	−1.3
	Boat Katha	314	1	3	30.3	36.1	−5.8	−16.1
Traps	*Doiar*	95	27	14	33.2	26.2	7.0	26.7
	Polo	222	3	2	27.8	20.0	9.4	47.0
	Deal	286	3	2	35.3	30.9	4.4	14.2
Hooks and Lines	*Sip*	30	22	12	52.9	42.2	10.7	25.4
	Tana Barsi	152	1	3	54.9	69.5	−14.6	−21.0
	Daun	272	18	8	40.5	36.7	4.0	10.9
	Nol barsi	278	7	7	37.4	35.2	2.2	6.3
Spear	*Koch*	170	12	7	38.7	31.2	7.9	25.3
Cast net	*Jhaki jal*	164	24	16	36.8	33.2	3.6	10.8
Push net	*Thella jal*	255	34	16	25.0	22.5	2.5	11.1
Other	*By hand/Dewatering*	97	3	0	43.6	24.5	19.1	78.0
	Net/Basket+Dewatering	98	1	0	29.3	28.4	0.9	3.2
	Hand fishing	307	15	7	29.6	27.9	1.7	6.1
	Urani	291	1	1	20.6	24.1	−3.5	−14.5
	Akra	298	4	3	32.2	31.2	1.2	3.8
	Chunga	301	0	2	28.6	29.9	−1.3	−4.3
	Thushi	317	1	1	31.6	30.4	1.2	3.9
Average *	–	–	7.6	4.8	37.2	34.6	2.6	7.5

Source: FAP 17

* Simple unweighted average

The results are shown in Table 4.3. In terms of the average prices the ranking of habitats in all regions is as would be expected: the value of fish caught is highest on the secondary rivers and lowest on the floodplains. The *khal* and *beel* are intermediate and their relative ranking varies.

Table 4.3 Average Fish Price by Habitat

Region	Habitat	Inside Tk/Kg	Outside Tk/Kg
NC	Secondary Rivers	38.8	43.1
	Khal	29.3	33.3
	Floodplains	38.3	30.7
	Beel	37.4	32.1
NE	Floodplains	22.5	22.8
	Beel	39.6	32.9
NW	Secondary Rivers	33.8	42.0
	Khal	26.4	36.9
	Floodplains	21.7	35.9
	Beel	26.7	25.6
SW	*Khal*	34.6	26.8
	Floodplains	28.5	31.5
	Beel	30.4	32.4

Values are higher outside than in for all the secondary rivers, *khal* and floodplains, with the exceptions of *khal* in the SW. Perplexingly, the *beel* in the NE, NW and NC regions had higher values inside than out, though the difference was only marginal in the NW.

Table 4.4 - 4.7 verify that, in nearly all cases, these differences are the product of the impact of flood control on the proportion of catch from migratory species. This is based on an analysis of the percentage contribution to annual value of production of the 29 most important floodplain species, summarised by their migratory categories: floodplain resident (FPR), river-floodplain migrators (R-F M) and miscellaneous (Misc.). The only cases where higher average values outside were not attributable to a greater proportion of migratory species was in the floodplains and *beel* of the SW, where a significantly higher proportion of the catch was made up of highly valued live fish *koi* (*Anabas testudineus*), *tengra* (*Mystus vittatus*), *shingi* (*Heteropneustes fossilis*), and *shol* (*Channa striatus*).

4.3.4 The Economic Implications for Flood Control

The mechanisms through which flood control affects fish production are complex. Stock composition is affected when the connections between rivers and the floodplain are blocked, chiefly affecting higher value migratory species. But floodplain resident species, which make

Table 4.4 Percentage Value by Species, Principal Species NC

Habitat	In/Out	Site	Floodplain Resident Species														River – Floodplain Migrators										Miscellaneous				
			41	55	122	121	6	42	137	88	75	37	35	132	36	110	209	107	175	86	89	32	189	58	48	102	931	180	83	210	All
Main River	Outside	NC01	0	0	0	0	0	0	1	0	0	0	0	1	0	0	5	0	2	0	34	0	0	0	0	0	4	2	11	0	64
		NC20	0	0	1	0	0	0	0	0	0	0	0	2	0	0	1	0	0	0	41	0	0	0	1	0	8	1	2	0	57
		NC32	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2	0	1	0	45	0	0	0	0	0	7	0	5	0	61
		NC33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	84	1	0	0	0	0	0	0	1	0	87
			0.0	0.0	0.3	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	1.0	0.0	0.0	2.0	0.3	0.8	0.0	51.0	0.3	0.0	0.0	0.3	0.0	4.8	0.8	4.8	0.0	67.3
Secondary River	Inside	NC12	1	0	20	3	0	0	8	0	1	1	0	1	0	1	7	3	3	0	0	1	0	0	1	0	5	6	4	1	70
	Outside	NC02	1	0	6	0	0	0	5	0	0	0	0	5	1	0	3	0	11	0	0	0	1	0	0	15	2	2	6	1	60
		NC06	3	1	7	0	1	0	3	0	0	0	0	2	0	1	23	0	5	0	0	0	1	0	1	0	5	6	6	1	68
		NC16	1	0	8	0	0	0	1	0	0	0	0	3	0	0	23	2	12	1	1	1	2	2	2	0	4	1	6	1	70
		NC21	2	1	7	0	0	0	10	0	1	0	0	2	0	2	6	4	6	0	0	0	2	0	2	1	4	6	8	1	64
		NC25	2	0	8	0	0	1	3	0	0	1	0	13	0	0	5	6	4	1	0	2	1	0	4	2	3	3	6	2	68
		NC29	2	1	2	0	0	1	7	0	0	1	0	2	1	1	6	7	3	0	0	4	1	1	6	1	6	5	6	1	66
			1.8	0.5	6.3	0.0	0.2	0.3	4.8	0.0	0.2	0.3	0.0	4.5	0.3	0.7	11.0	3.2	6.8	0.3	0.2	1.2	1.3	0.5	2.5	3.2	4.0	3.8	6.3	1.2	66.0
Khal	Inside	NC10	5	2	1	1	1	2	9	5	1	1	0	0	0	4	1	5	2	0	0	3	0	0	1	0	7	15	4	5	76
		NC13	12	3	0	1	2	0	5	0	1	1	0	0	1	1	0	6	4	0	0	2	0	0	0	1	5	32	7	3	87
			8.5	2.5	0.5	1.0	1.5	1.0	7.0	2.5	1.0	1.0	0.0	0.0	0.5	2.5	0.5	5.5	3.0	0.0	0.0	2.5	0.0	0.0	0.5	0.5	6.0	23.5	5.5	4.0	81.5
	Outside	NC03	5	3	2	1	1	0	8	1	1	1	0	0	1	2	0	4	5	0	0	1	3	0	6	0	18	12	3	2	79
		NC07	3	1	1	1	0	0	4	0	2	1	0	0	1	1	1	11	1	0	0	12	2	0	2	2	4	12	4	0	65
		NC17	2	1	1	0	2	0	2	1	0	0	0	1	0	1	0	30	1	1	0	21	1	0	1	0	4	3	4	0	78
		NC22	5	1	2	2	1	2	11	1	0	0	0	2	0	4	1	5	5	0	0	2	0	0	1	0	3	15	4	3	72
		NC26	5	2	1	0	3	4	3	2	0	1	0	0	1	2	1	13	1	0	0	12	0	0	2	0	5	14	3	2	77
		NC30	11	5	2	0	7	3	7	3	2	1	0	0	0	2	0	6	1	0	0	8	0	0	1	1	5	15	5	2	88
			5.2	2.2	1.5	0.7	2.3	1.5	5.8	1.3	0.8	0.7	0.0	0.5	0.5	2.0	0.5	11.5	2.3	0.2	0.0	9.3	1.0	0.0	2.2	0.5	6.5	11.8	3.8	1.5	76.5
Floodplain	Inside	NC11	7	4	1	1	2	3	5	4	0	1	0	0	1	2	3	4	1	0	0	1	0	0	0	0	11	19	2	5	78
		NC14	7	4	1	0	10	10	3	8	0	2	0	0	0	2	1	5	1	0	0	3	0	0	0	0	14	8	1	1	81
			7.0	4.0	1.0	0.5	6.0	6.5	4.0	6.0	0.0	1.5	0.0	0.0	0.5	2.0	2.0	4.5	1.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0	12.5	13.5	1.5	3.0	79.5
	Outside	NC04	7	3	1	6	3	0	2	2	1	6	0	0	1	4	0	1	1	0	0	0	1	0	1	0	23	9	4	2	77
		NC08	4	2	0	1	0	0	1	0	1	8	0	0	6	1	3	17	6	3	0	2	6	0	1	1	4	5	2	0	75
		NC18	13	5	1	2	11	5	2	8	1	1	0	0	0	5	1	0	0	0	0	0	0	0	0	0	18	5	1	0	79
		NC23	10	4	0	1	11	2	3	12	0	1	0	0	1	2	1	5	1	0	0	0	0	0	1	0	11	12	2	4	87
		NC27	11	3	0	0	17	1	4	15	0	2	0	0	0	1	0	0	1	1	0	0	0	0	0	0	13	16	3	0	89
		NC31	11	3	3	1	14	10	2	7	0	1	0	0	0	1	0	5	1	0	0	3	0	0	1	0	4	10	2	1	81
			9.3	3.3	0.8	1.8	9.3	3.0	2.3	7.3	0.5	3.2	0.0	0.0	1.3	2.3	0.8	4.7	1.7	0.7	0.0	0.8	1.2	0.0	0.7	0.2	12.2	9.5	2.3	1.2	81.3
Beel	Inside	NC15	5	4	1	0	5	3	3	7	0	2	0	0	0	2	6	8	0	0	0	4	0	0	0	0	9	8	1	2	71
			5.0	4.0	1.0	0.0	5.0	3.0	3.0	7.0	0.0	2.0	0.0	0.0	0.0	2.0	6.0	8.0	0.0	0.0	0.0	4.0	0.0	0.0	0.0	0.0	9.0	8.0	1.0	2.0	71.0
	Outside	NC05	6	3	1	4	1	2	11	4	0	2	0	0	1	5	1	2	3	0	0	1	1	0	0	0	7	23	3	2	83
		NC09	2	1	1	1	0	0	3	1	1	3	0	0	1	2	2	1	4	1	0	0	9	0	7	0	10	20	4	0	72
		NC19	2	2	5	0	2	0	2	1	0	1	0	3	1	2	9	10	0	0	0	11	0	0	1	1	7	6	5	1	74
		NC28	3	2	1	0	2	1	1	2	0	1	0	0	0	1	5	35	1	0	0	8	0	0	0	0	13	4	3	1	88
			3.3	2.0	2.0	1.3	1.3	0.8	4.3	2.0	0.3	1.8	0.0	0.8	0.8	2.5	4.3	12.0	2.0	0.3	0.0	5.0	2.5	.0.0	2.0	0.3	9.3	13.3	3.8	1.0	79.3

Source : FAP17

J2C

Table 4.5 Percentage Value by Species, Principal Species, NE

Habitat	In/Out	Site	Floodplain Resident Species														River-Floodplain Migrators										Miscellaneous				
			41	55	122	121	6	42	137	88	75	37	35	132	36	110	209	107	175	86	89	32	189	58	48	102	931	180	83	210	All
Secondary River	Outside	NE06	0	0	5	0	0	0	0	0	0	0	0	17	0	0	5	2	0	2	0	1	2	0	1	2	2	0	0	0	42
		NE07	0	0	9	0	0	0	3	0	0	0	1	14	0	0	12	1	2	1	0	0	1	0	1	5	4	0	2	0	58
		NE11	0	0	6	0	0	0	0	0	0	1	1	9	1	0	8	9	0	12	0	1	1	4	2	3	6	0	1	0	66
		NE16	0	0	1	0	0	0	0	0	0	0	0	1	0	0	9	6	0	3	0	0	1	3	2	14	1	0	0	0	42
		NE20	1	0	5	1	0	0	1	0	0	1	2	7	1	1	1	1	3	9	0	0	2	3	3	0	9	1	4	1	56
			0.2	0.0	5.2	0.2	0.0	0.0	0.8	0.0	0.0	0.4	0.8	9.6	0.4	0.2	7.0	3.8	1.0	5.4	0.0	0.4	1.4	2.0	1.8	4.8	4.4	0.2	1.4	0.2	52.8
Khal	Inside	NE01	2	0	2	0	0	0	2	0	0	1	1	3	4	0	13	14	0	11	0	1	1	0	0	4	7	1	0	0	69
		NE03	4	0	1	0	0	0	2	1	0	2	1	0	3	1	0	0	0	4	0	0	0	19	0	0	30	4	4	0	77
		NE15	1	0	2	1	1	1	1	9	0	0	3	0	1	1	0	11	0	11	0	0	15	0	2	2	4	2	1	13	81
			2.3	0.0	1.7	0.3	0.3	0.3	1.7	3.3	0.0	1.0	1.7	1.0	2.7	0.7	4.3	8.3	0.0	8.7	0.0	0.3	5.3	6.3	0.7	2.0	13.7	2.3	1.7	4.3	75.7
Floodplain	Inside	NE02	7	0	1	0	0	0	5	3	0	4	11	1	3	0	2	0	0	5	0	0	1	0	0	1	22	3	0	1	74
		NE05	5	2	0	0	0	0	1	2	0	1	6	0	9	0	0	0	0	4	0	3	1	0	0	0	34	3	5	0	79
		NE14	4	1	2	0	16	0	6	6	0	1	4	2	0	0	0	0	4	3	0	0	0	0	0	1	9	2	1	3	66
			5.3	1.0	1.0	0.0	5.3	0.0	4.0	3.7	0.0	2.0	7.0	1.0	4.0	0.0	0.7	0.0	1.3	4.0	0.0	1.0	0.7	0.0	0.0	0.7	21.7	2.7	2.0	1.3	73.0
	Outside	NE08	0	0	5	1	0	0	2	0	0	1	1	11	0	0	0	0	4	2	0	0	1	2	0	0	17	0	2	1	53
		NE10	2	0	0	0	0	0	2	1	0	1	4	0	2	0	0	0	2	2	0	0	0	0	0	3	57	2	2	0	83
		NE17	2	0	3	0	0	0	0	2	0	1	1	0	0	1	0	0	15	5	0	0	0	0	0	5	41	2	2	1	82
			1.3	0.0	2.7	0.3	0.0	0.0	1.3	1.0	0.0	1.0	2.0	3.7	0.7	0.3	0.0	0.0	7.0	3.0	0.0	0.0	0.3	0.7	0.0	2.7	38.3	1.3	2.0	0.7	72.7
Beel	Inside	NE04	2	0	0	0	1	0	2	8	0	0	1	0	0	0	3	1	0	7	0	2	0	0	0	1	7	3	1	0	41
		NE12	6	3	1	1	6	2	1	5	0	2	2	0	0	1	1	2	1	1	0	0	0	0	0	1	15	12	2	1	66
		NE13	1	1	0	0	3	1	1	2	0	2	2	0	1	0	1	29	1	1	0	0	1	0	0	0	16	7	2	6	79
			3.0	1.3	0.3	0.3	3.3	1.0	1.3	5.0	0.0	1.3	1.7	0.0	0.3	0.3	1.7	10.7	0.7	3.0	0.0	0.7	0.3	0.0	0.0	0.7	12.7	7.3	1.7	2.3	62.0
	Outside	NE09	1	0	12	0	0	1	12	0	0	0	1	7	1	0	4	0	1	6	0	0	1	0	2	4	5	0	1	0	59
		NE18	2	0	9	0	0	2	0	3	0	2	5	0	3	1	1	6	5	7	0	0	1	0	0	4	22	1	3	3	79
		NE19	1	0	2	2	0	6	1	2	0	0	3	1	0	2	1	0	4	7	0	0	2	0	0	1	7	0	5	12	60
			1.3	0.0	7.7	0.7	0.0	3.0	4.3	1.7	0.0	0.7	3.0	2.7	1.3	1.0	2.0	2.0	3.3	6.7	0.0	0.0	1.3	0.0	0.7	3.0	11.3	0.3	3.0	5.0	66.0

Source: FAP17

Table 4.6 Percentage Value by Species Type, Principal Species NW

Habitat	In/Out	Site	Floodplain Resident Species														River–Floodplain Migrators										Miscellaneous				
			41	55	122	121	6	42	137	88	75	37	35	132	36	110	209	107	175	86	89	32	189	58	48	102	931	180	83	210	All
Main River	Outside	NW01	0	0	1	0	0	0	0	0	0	0	0	1	0	0	3	0	3	0	15	0	0	0	1	0	6	0	1	0	33
		NW02	0	0	1	0	0	0	1	0	0	0	0	3	0	0	4	1	0	0	62	0	0	0	0	0	5	1	2	0	82
		NW24	1	0	1	0	0	0	0	0	0	0	0	3	0	0	0	0	1	4	7	0	0	0	0	4	10	0	7	0	40
			0.3	0.0	1.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	2.3	0.0	0.0	2.3	0.3	1.3	1.3	28.0	0.0	0.0	0.0	0.3	1.3	7.0	0.3	3.3	0.0	51.7
Secondary River	Inside	NW06	2	1	1	0	0	0	2	1	0	1	1	0	3	0	0	9	5	4	0	0	3	0	0	0	21	6	7	1	68
		NW07	5	0	5	2	0	0	15	2	0	1	0	1	2	2	1	3	4	1	3	1	0	0	9	1	4	13	4	6	84
		NW11	2	0	16	1	0	0	5	1	0	2	0	3	3	0	7	3	1	1	3	1	3	0	2	1	5	9	3	2	72
		NW14	0	0	5	0	0	0	3	0	0	0	0	19	1	0	6	1	1	1	16	0	0	1	2	1	4	1	3	0	68
		NW19	3	1	2	1	0	0	3	4	0	1	0	3	1	2	7	14	2	0	0	1	0	0	6	9	3	3	3	1	70
		NW25	0	0	6	0	0	0	0	0	0	0	0	1	0	0	2	8	2	1	34	5	0	0	2	1	2	0	2	0	68
			2.0	0.3	5.8	0.7	0.0	0.0	4.7	1.3	0.0	0.8	0.2	4.5	1.7	0.7	3.8	6.3	2.5	1.3	9.3	1.3	1.0	0.2	3.5	2.2	6.5	5.3	3.7	1.7	71.7
	Outside	NW15	1	0	7	0	0	0	3	0	0	1	0	14	1	1	9	0	2	1	4	1	1	1	2	5	7	2	4	1	66
		NW27	1	0	7	0	0	0	2	0	0	0	0	7	0	0	33	3	2	1	2	0	0	0	2	4	2	1	1	0	68
			1.0	0.0	7.0	0.0	0.0	0.0	2.5	0.0	0.0	0.5	0.0	10.5	0.5	0.5	21.0	1.5	2.0	1.0	3.0	0.5	0.5	0.5	2.0	4.5	4.5	1.5	2.5	0.5	67.0
Khal	Inside	NW08	16	2	1	5	1	0	4	3	1	3	0	0	2	2	1	9	1	3	0	1	0	0	1	0	4	17	9	1	87
		NW20	11	4	0	1	0	11	3	3	2	1	0	0	0	4	0	6	3	0	0	0	0	0	2	1	4	21	2	4	84
			13.5	3.0	0.5	3.0	0.5	5.5	3.5	3.0	1.5	2.0	0.0	0.0	1.0	3.0	0.5	7.5	2.0	1.5	0.0	0.5	0.0	0.0	1.5	0.5	4.0	19.0	5.5	2.5	85.5
	Outside	NW16	4	1	3	1	0	0	7	3	0	1	0	1	2	3	17	4	2	1	1	1	1	0	1	0	8	14	5	1	81
		NW29	2	1	5	1	0	0	2	2	0	0	1	5	1	5	20	0	2	1	0	0	0	0	5	1	2	6	1	0	62
			3.0	1.0	4.0	1.0	0.0	0.0	4.5	2.5	0.0	0.5	0.5	3.0	1.5	4.0	18.5	2.0	2.0	1.0	0.5	0.5	0.5	0.0	3.0	0.5	5.0	10.0	3.0	0.5	71.5
Floodplain	Inside	NW04	10	2	1	1	1	8	1	1	0	6	0	0	2	2	1	9	3	2	0	1	2	0	1	0	17	6	6	5	88
		NW09	7	4	9	2	0	3	1	4	0	8	0	0	3	1	0	11	0	6	0	2	0	0	0	0	4	7	3	2	80
		NW12	7	1	2	4	0	0	2	1	0	3	2	0	3	2	2	11	4	1	0	3	4	0	0	0	12	8	9	3	86
		NW22	24	1	0	1	1	35	0	1	1	0	0	0	0	1	0	0	2	0	0	0	0	0	0	0	3	4	1	1	74
		NW23	11	14	0	3	0	1	0	5	7	2	0	0	0	1	0	0	3	0	0	0	0	0	0	0	10	8	3	2	69
		NW26	2	0	0	3	19	34	4	0	17	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	2	1	3	0	87
		NW28	18	2	3	1	0	2	3	3	0	5	0	1	1	1	10	2	4	1	0	2	1	0	3	1	8	13	5	2	90
			11.3	3.4	2.1	2.1	3.0	11.9	1.6	2.1	3.6	3.4	0.3	0.3	1.3	1.1	1.9	4.7	2.4	1.4	0.0	1.1	1.0	0.0	0.6	0.1	8.0	6.7	4.3	2.1	82.0
	Outside	NW17	1	0	4	2	0	0	6	1	0	1	0	8	1	1	12	2	1	2	5	0	1	0	0	1	5	5	4	0	65
		NW30	2	0	2	4	0	1	4	4	0	0	1	3	0	2	32	0	1	0	0	0	0	0	3	1	3	4	1	0	69
			1.5	0.0	3.0	3.0	0.0	0.5	5.0	2.5	0.0	0.5	0.5	5.5	0.5	1.5	22.0	1.0	1.0	1.0	2.5	0.0	0.5	0.0	1.5	1.0	4.0	4.5	2.5	0.0	67.0
Beel	Inside	NW05	13	1	1	2	1	7	1	3	0	5	0	0	2	2	1	16	2	1	1	1	1	0	3	1	8	5	4	6	88
		NW10	4	1	4	1	1	1	6	1	0	1	0	3	1	1	2	11	2	2	0	3	0	0	1	1	8	6	3	1	63
		NW13	6	1	2	1	1	0	5	1	0	2	1	2	2	1	6	9	3	0	0	2	1	0	0	0	8	14	6	4	78
		NW21	17	18	0	0	4	3	2	16	1	1	0	0	0	2	0	0	0	0	0	0	0	1	0	0	4	11	0	0	80
			10.0	5.3	1.8	1.0	1.8	2.8	3.5	5.3	0.3	2.3	0.3	1.3	1.3	1.5	2.3	9.0	1.8	0.8	0.3	1.5	0.5	0.3	1.0	0.5	7.0	9.0	3.3	2.8	77.3
	Outside	NW18	2	0	2	1	0	0	4	1	0	2	0	4	5	1	6	2	3	8	5	1	2	0	1	0	9	12	6	1	78
			2.0	0.0	2.0	1.0	0.0	0.0	4.0	1.0	0.0	2.0	0.0	4.0	5.0	1.0	6.0	2.0	3.0	8.0	5.0	1.0	2.0	0.0	1.0	0.0	9.0	12.0	6.0	1.0	78.0

Source: FAP17

Table 4.7 Percentage Value by Species, Principal Species, SW

Habitat	In/Out	Site	Floodplain Resident Species														River–Floodplain Migrators										Miscellaneous				
			41	55	122	121	6	42	137	88	75	37	35	132	36	110	209	107	175	86	89	32	189	58	48	102	931	180	83	210	All
Main River	Outside	SW01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	60	0	1	2	0	0	4	0	4	0	73
			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	60.0	0.0	1.0	2.0	0.0	0.0	4.0	0.0	4.0	0.0	73.0
Secondary River	Outside	SW02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	1	17	0	0	7	1	0	15	1	13	0	61
		SW03	4	1	3	1	0	1	7	1	0	0	0	2	1	1	0	8	1	0	0	8	0	0	13	1	6	5	4	7	77
		SW07	0	0	1	0	0	0	1	0	0	0	0	1	0	0	0	5	1	2	7	0	0	16	3	0	18	1	14	0	72
			1.3	0.3	1.3	0.3	0.0	0.3	2.7	0.3	0.0	0.0	0.0	1.0	0.3	0.3	0.7	4.3	0.7	1.0	8.0	2.7	0.0	7.7	5.7	0.3	13.0	2.3	10.3	2.3	70.0
Khal	Inside	SW04	7	3	2	2	2	4	12	5	0	0	0	2	0	1	1	3	2	0	0	1	0	0	1	0	2	11	2	1	65
		SW17	0	0	1	0	0	0	2	1	0	1	0	1	0	0	10	3	0	0	1	1	0	0	0	0	21	2	4	1	53
		SW20	2	1	2	1	2	2	14	5	0	0	0	0	0	3	7	0	1	0	0	0	0	0	0	0	6	13	5	2	66
			3.0	1.3	1.7	1.0	1.3	2.0	9.3	3.7	0.0	0.3	0.0	1.0	0.0	1.3	6.0	2.0	1.0	0.0	0.3	0.7	0.0	0.0	0.3	0.0	9.7	8.7	3.7	1.3	61.3
	Outside	SW08	4	3	0	0	2	4	10	3	0	1	0	0	1	6	2	6	3	0	0	3	0	0	0	0	3	17	1	7	77
		SW11	1	1	1	0	1	2	6	0	0	1	0	8	0	0	26	0	3	0	0	1	0	0	1	0	8	11	5	1	76
		SW12	2	2	4	2	2	2	11	4	0	0	0	1	0	4	4	0	2	0	0	0	0	0	0	0	2	7	1	5	56
			2.3	2.0	1.7	0.7	1.7	2.7	9.0	2.3	0.0	0.7	0.0	3.0	0.3	3.3	10.7	2.0	2.7	0.0	0.0	1.3	0.0	0.0	0.3	0.0	4.3	11.7	2.3	4.3	69.7
Floodplain	Inside	SW05	4	1	4	3	7	5	2	7	0	1	0	1	1	1	1	8	2	0	0	4	0	0	1	1	16	8	2	1	79
		SW18	12	3	0	0	15	5	1	26	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2	16	0	1	83
		SW21	5	2	1	1	10	5	2	27	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	3	13	1	1	72
		SW22	4	2	0	0	8	5	7	17	0	0	0	0	0	1	1	0	1	0	0	2	0	0	0	0	4	24	1	3	83
			6.3	2.0	1.3	1.0	10.0	5.0	3.0	19.3	0.0	0.3	0.0	0.3	0.3	0.8	0.5	2.3	1.0	0.0	0.0	1.5	0.0	0.0	0.3	0.3	6.3	15.3	1.0	1.5	79.3
	Outside	SW09	11	4	1	2	23	6	4	11	0	0	0	0	0	3	1	1	2	0	0	0	0	0	0	0	3	13	0	0	85
		SW13	7	18	0	0	51	4	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	0	0	97
		SW15	4	9	0	0	36	5	2	16	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	15	0	1	91
			7.3	10.3	0.3	0.7	36.7	5.0	2.0	13.0	0.0	0.0	0.0	0.0	0.0	1.0	0.3	0.3	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7	10.3	0.0	0.3	91.0
Beel	Inside	SW06	7	1	3	1	7	5	3	6	0	0	0	0	0	2	1	9	1	0	0	6	0	0	1	2	6	6	1	1	70
		SW19	10	3	0	0	12	3	0	26	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	10	14	0	0	81
			8.5	2.0	1.5	0.5	9.5	4.0	1.5	16.0	0.0	0.0	0.0	0.0	0.0	1.5	0.5	4.5	1.0	0.0	0.0	3.0	0.0	0.0	0.5	1.0	8.0	10.0	0.5	0.5	75.5
	Outside	SW10	8	3	1	1	20	19	2	11	0	0	0	0	0	0	3	3	1	0	0	0	0	0	0	0	2	8	0	1	86
		SW14	4	9	0	0	17	6	1	32	0	0	0	0	0	1	4	1	0	0	0	0	0	0	0	0	1	4	0	1	82
		SW16	8	5	0	0	19	8	2	26	0	0	0	0	0	0	2	2	1	0	0	0	0	0	0	0	1	8	0	1	83
			6.7	5.7	0.3	0.3	18.7	11.0	1.7	23.0	0.0	0.0	0.0	0.0	0.0	0.3	3.0	2.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	6.7	0.0	1.0	83.7

Source : FAP17

up the bulk of the stock both inside and outside flood control schemes, still persist in surprising numbers wherever flooding continues.

Catch is determined by an interaction of stock densities and the level of effort. Flood control can encourage an increasing level of effort to be applied, either by stimulating a shift in cropping patterns away from the broadcast *aman* that previously occupied much of the floodplain, thereby reducing cover for fish or by changing access conditions. This can result in a greater proportion of the stock being taken.

Production on the floodplains that remain may therefore go up or down, depending on the balance of these forces. So the principal effect of flood control on fisheries that can be predicted with any certainty is of the loss that results from a loss of habitat - from the removal of floodplain from the system.

The most recent, wide ranging analysis of the economic viability of flood control was provided by FAP12. Their figures were based on a detailed analysis of the construction and operational costs and agricultural benefits of various schemes. On an avowedly provisional basis, the negative effects on fisheries were also included, using national level estimates of floodplain fisheries production of FRSS. With the revised estimates of the catch and catch value provided by FAP17 it is now possible to look again at the implications of fisheries losses for the economic viability of flood control schemes. (The social implications that stem from such changes are considered further below.)

The FAP12 methodology for calculating fisheries losses was based on a standard set of assumptions concerning different types of effect, as follows:

- One hectare of floodplain removed from the system was assumed to reduce fish production by 37 kg/ha.
- Production on the remaining floodplain was assumed to decline by 20 kg/ha.
- *Beel* drained resulted in a loss of 400 kg/ha.
- Loss on remaining *beel* was 150 kg/ha.
- Loss on internal *khal* and external rivers was assumed to be 15 kg/ha.

Increases in average pond productivity (from 1,000 kg/ha to 1,400 kg/ha) were also assumed.

The results of FAP17's studies do not support the view that fish production on remaining floodlands will necessarily be significantly affected in terms of catch per hectare, though a drop in average value per kilogramme could be anticipated. On a scheme by scheme basis there were significant inside/outside differences but no consistency in the pattern. These studies do however suggest that the average production per hectare is around 110 kg/ha, significantly higher than the 37 kg/ha assumed by FAP12. Part of the difference is due to methodology: the FAP17 results take a figure for the floodlands including floodplain and *beel* together, rather than treating the *beel* separately.

Allowing for these differences in methodology a sample of the FAP12 analyses were reworked to see how economic viability was affected. The FAP 12 figures on agricultural benefits, construction and maintenance costs etc. were taken as the starting point. The impact on fisheries was calculated as a direct function of the area of floodplain removed from the system, plus an additional decline (7%) in the value of production.

Not surprisingly the significance of such losses varied considerably from scheme to scheme. In all cases the costs of fisheries losses were greater using the FAP17 figures than those of FAP12. But though higher than previously assumed the value of fisheries production is still relatively low compared with that of agriculture. 110 kg of fish is worth around Tk.2,750. The gross margin on a hectare of irrigated HYV *boro* is of the order of Tk.12,000. Where scheme investment costs per hectare are at the lower end of their range, there is scope for incremental agricultural production to still exceed the value of fish production lost. The effects on the economics of flood control schemes therefore will be most telling on schemes that are already somewhat marginal.

4.3.5 Agricultural Change

In large areas of the floodplains of Bangladesh, the last 20-30 years have seen an important shift in cropping patterns. Up until the 1960s, cropping patterns in most areas were dominated by *kharif* or summer season rice crops, such as broadcast, deep-water *amon* or mixed *aus* and *amon*, followed by a variety of *rabi* or winter season crops. The introduction of irrigation technology coupled with high-yielding (HYV) varieties of rice have encouraged a well documented shift to cropping patterns dominated by winter *boro* rice.

These changes in cropping pattern have had several important impacts on floodplain fisheries, through their effects on labour demand, vegetative cover and dry season water use. These are described below. This shift has also had an indirect, but important, effect on land ownership of the wetlands and so on the tenurial claims on fisheries; this is covered in the section on Fisheries Access.

Labour demand

The traditional summer rice crops in low-lying areas require relatively limited labour inputs during their long growing period but give rise to two peaks of labour demand, one at the end of the *kharif I* season, in July and August, and again at the end of the *kharif II* season in October and November. The newer *boro*-based patterns have greatly reduced the intensity of these two peaks in labour demand, although they have generally created more labour opportunities during the winter *rabi* season. In rural areas already characterized by chronic under-employment and a rising population, these changes have diminished employment opportunities during the peak flood and the recession, freeing more labour to go into seasonal fishing.

Impacts on floodplain environment

The impact of these changes in cropping pattern on the fisheries environment in the *beel* and floodplain areas is also important. Under traditional cropping patterns, large areas of the floodplain were covered with vegetation during the flooding season, providing shelter for fish and restricting fishing to the use of a few gears, such as hooks and traps, that could be used without damaging the paddy. The shift to *boro* has meant that much of this previously "protected" area is now devoid of vegetation during the flooding season. More intensive fishing operations using other gears are therefore now easier.

Cultivation has also been extended into deeper parts of the *beel* and floodplain. The natural vegetation which persisted in these areas has therefore been cleared, leaving a far more impoverished environment for floodplain fish.

Water use

The spread in the use of low-lift pumps to irrigate *boro* has also created alternative demands on the management of water in the *beel* and *khal* - the principal overwintering habitats of the important floodplain resident species.

The interests of the fish are unequivocally in one direction: the more water the better. The interests of the fishermen are not: individually, they benefit from low levels, as this makes the fish easier to catch; but, collectively, it is better if all water levels do not drop too far, as they need enough of the stock to survive to guarantee an adequate breeding population. In the past, when there were no alternative demands, water levels in the *beel* and *khal* were managed to suit the fishery.

Farmers needs for water management, unsurprisingly, do not coincide with those of the fishermen. They need water levels to drop at the right speed to gradually plant their *boro* seedlings into the receding water margin. They then want enough water to be retained to guarantee irrigation through the dry season. Both requirements can generate complaints from fishermen that there is "too much water". Conversely, in a dry year, farmers may use all the water available, generating complaints that there is "too little water". Either way the fishermen lose out. This is particularly disturbing in the latter case, when the sustainability of the fishery can be threatened.

4.3.6 Fisheries Access

Everywhere in Bangladesh, the control of access to fisheries resources is a key factor in determining the way in which fisheries benefits are distributed. The importance of this cannot be overemphasised. Mere vicinity to waterbodies does **not** necessarily translate into fisheries dependence and, as often as not, this is because of access restrictions. For flood control planners trying to determine how changes in fisheries will affect different social groups in surrounding communities, understanding the nature of access arrangements and who controls them is essential.

Access restrictions vary from region to region in their form, strength and degree of coverage, as do their impact on the fisheries dependence of different social groups. As in most other features of the fisheries, there are also local variations. However, some features of floodplain fisheries access tend to cut across regional divisions; these need to be clearly understood.

Seasonality and fisheries access

Fishing activity on the floodplains and *beel* is dictated by the seasonal expansion and contraction of the flooded area. When the flood extent is at its maximum, generally from late June to early September, in many floodplain areas practically everything is under water except for homesteads and road embankments. The boundaries demarcating property rights and tenure in the floodplain are obscured and the fisheries resource is, generally, open to all. However, because of dispersal of the fishery resource, catch rates are low.

There is little in the way of regulation of fishing during this period of high flood, because controls would be both practically difficult to enforce and of limited value to an individual leaseholder while flooding connects all waterbodies.

Once the floods begin to recede, the picture changes radically. Fish become more concentrated in the receding waters and can be channeled and blocked, making catch easier. This is the period of the greatest fishing activity among the farming population. However, as the water recedes further, the bunds dividing the fields emerge and landowners can claim rights to any stranded fish. Whether they choose to do so is determined by the value of potential catch, local norms and individual attitudes.

The drawdown period is therefore flexible in terms of the degree of control which can be exerted over the fisheries resource. The dry season, by contrast, is the time when control is most easily exerted and when it pays to exert control because the remaining fisheries stock is concentrated in a relatively limited area, whether of perennial waterbody - *beel*, *baor* or *khal* - or of bottom land, where fish pits are often excavated. Catchability of fish is greatly increased and the returns on fishing activity are potentially very high. Controls of fisheries access therefore generally apply to this period, which can last from the end of November to the rise of flood waters at the beginning of the new flood cycle in May or June, though many areas will be fished out sooner.

Historical patterns of access control

Fisheries access has become an active issue only relatively recently on the floodplains of Bangladesh. Up until the 1960s, in most parts of the country, fishing as a livelihood was strictly limited to traditional fishing communities. For non-fishermen, fishing for income was surrounded by strong social stigma and farmers or labourers fished purely for consumption in areas near to homesteads. Traditional fishermen were thus left to exploit practically any waterbody with little interference. Most traditional Hindu fishing communities, and the Muslim *maimul* of the North-East, had relationships with local *zamindar* for the exploitation of particular waterbodies against payment of a relatively nominal tribute. In this situation, the question of enforcement of access restrictions was not an issue, as only fishermen were interested in the fishery. Disputes would occur between different *zamindar* over control of particular fisheries but subsistence fishing, the only form of fishing in which the majority of the population had any real interest, was generally tolerated on the floodplains and even the *beel* themselves.

After Partition in 1947, this situation changed radically. Ex-*zamindari* water estates became, at least in name, *khas* land and allocation of fishing rights became a means of revenue collection. At the same time many nominally *khas* areas were occupied by local people or subsequently set aside for distribution. In the 1970s and 1980s the diffusion of irrigation equipment, together with heavy siltation, made dry season cultivation possible in many areas that were previously uncultivable, creating opportunities which were eagerly seized by the rapidly increasing population. Consequently, with and without government sanction, the area of *khas* land has dwindled, reducing the areas available for fisheries.

This burgeoning population has created tremendous pressure, not just on land, but on all sources of livelihood. As rates of acute poverty in rural areas increased and the options open to poor households for survival narrowed, the taboos which had restrained Muslim farmers from fishing for sale started to break down. The 1970s seems to have been a key decade in terms of pushing many rural people into fishing first seasonally and then as an important source of income. Each episode of famine or serious flooding pushed more people into poverty and many took to fishing.

The effects of this expansion in the numbers of people fishing need to be fully appreciated. Many floodplains were probably only fished selectively prior to the 1970s. Fishing by traditional fishermen used to be **highly** concentrated on specific stretches of water at specific times of year: during the winter, the dry season, professional fishermen divided their time between large rivers and the harvesting of *beel*; with the onset of the floods, some fishing would take place on particular areas of floodplain and the *khal* connecting rivers and *beel*, and the *ilish* fishery on the main rivers; with the drawdown, residual waterbodies and smaller *beel* would be harvested as they dried up and the *khal* channeling fisheries resources off the floodplain into areas of perennial water were also heavily targeted; and so back to the dry season fishery on *beel* and rivers.

Over the last 25 years this relatively selective fisheries system has changed with a wider range of waterbodies being targeted much less selectively throughout the year. The number of households developing a seasonal interest in professional fishing seems to have overwhelmed the traditional fishermen whose hold on the fisheries resource has steadily weakened. Hindu fishermen have found themselves particularly vulnerable as a religious minority, but Muslim *maimul* fishermen in the North-East have suffered in exactly the same way. After initially targeting peripheral areas such as higher parts of the floodplain and small *khal* and using smaller gear such as traps and push nets, these new non-traditional fishermen are increasingly moving onto areas which have long been the preserve of the traditional fishing communities such as the *beel* and rivers.

In some areas this process can be characterised as an opening up of the fishery. But, where the fisheries are still valuable, alternative mechanisms for restricting access are increasingly employed. This is seen particularly in floodplain areas where changes in the ownership and use of land seem to be leading towards the establishment of private property rights over the fisheries resource. The process of distribution of *khas* land to farmers and labourers from the 1950s through to the 1970s means that the land in most lowland areas is now privately owned. Previously, the ownership of land did not, by itself, imply any right to the fisheries resource in floodwaters covering that land. During the flood recession, landowners might fish out their plots by bunding, but more often this would be done by others without interference from the actual owner.

As competition for resources has increased, it was only a matter of time before landowners sought to take advantage of, and augment, the concentrations of fish occurring on their lands after the recession. There has been a long tradition of excavating submersible ponds (variously called *kua*, *danga*, *pukur* or *pushkunni* depending on the region) where natural stocks of fish would remain isolated to be harvested during the course of the dry season. But, in recent years, the growth in the numbers of such pits has been dramatic. Likewise, in *khal* and rivers, owners of land on the banks are increasingly claiming rights to set brush-piles (*katha*) for the same purpose.

Moreover, it is now apparent that the owners of *katha* and *kua* are increasingly following the path of leaseholders in attempting to restrict fishing around their waterbodies in the hope of raising their ultimate catch; and doing so ever earlier. The mechanisms of restriction are varied, ranging from guards, to discreet social pressure to the enlistment of assistance from the authorities. In one village cluster in Madaripur District, owners of ponds in the local *beel* solicited the intervention of the fisheries authorities and the police to suppress use of the illegal *current jal* on the flooded *beel* around their ponds. While this was ostensibly an act of good citizenship there was little doubt that pond owners were more concerned about the potential returns from their *kua* that year than about the sustainability of the local fisheries resource.

Formal leasing arrangements

Given this general increase in competition for the resource, leasing arrangements become the only effective means of imposing limits on fishing effort. Fisheries regulations established by the government attempt to limit the use of certain gears thought to threaten the sustainability of fisheries, but enforcement on the ground is extremely difficult and seems to have a limited impact. The illegal *current jal* (monofilament gillnet) is one of the commonest fishing gears encountered in rural areas, even where special efforts have been made to limit its use.

Leasing of *khas*, or government owned, waterbodies (*jalmahal*) was introduced soon after Partition following the abolition of the *zamindari* system by the State Aquisition Act of 1950. Changes in the leasing system introduced following Independence in 1971 were primarily aimed at improving the coverage and efficiency of the mechanisms for revenue collection from government *jalmahal*. It is widely recognised that this system was subject to widespread abuse and, as often as not, a large share of the economic surplus that leasing was intended to capture in the form of revenue was dissipated in efforts, quite outside the formal bidding processes, to secure and maintain leaseholdings.

The system was revised to provide for competitive auctions of fisheries leases while at the same time notionally giving preference in the first round of bidding to fisheries *samity* or cooperatives, the first of many attempts to ensure that control of fisheries would reside with the primary producers.

Certain features built into this revised leasing system have made it practically impossible for it to achieve its overt distributional intentions. Notably, the automatic raising of base lease fees by 25% from one lease period to another has quickly led to fishing communities, and the *samity* which are supposed to represent them, being priced out of the market. Only by borrowing increasingly large sums from local *mohajan*, or moneylenders, and, in turn,

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surrendering effective control to the lender, have fishing communities been able to maintain even a nominal title to access rights.

In reality, the *mohajan* are usually the active movers in the relationship, approaching the heads of fisheries *samity* and acquiring the right to use their name in order to obtain leases while the fishermen are able to ensure at least the right to fish either as labourers, "licence"-holders or sub-lessees. Lack of institutional credit means that relatively few have been able to genuinely retain control of fishing rights as intended, particularly on the more valuable waterbodies, and the system and its outcome remains barely distinguishable from the one that it replaced.

> The intensification of seasonal fishing activity on the floodplain has changed both the economics of leaseholding and the climate within which the leases are managed. With an increasing share of the potential catch on their waterbodies vulnerable to fishing on the adjacent floodplains, many leaseholders have attempted, **illegally**, to restrict fishing there as well as on their *beel*. Enforcement costs have gone up , with two or three times as many guards employed now as 20 years ago. And, in an atmosphere of mounting bitterness, episodes of violence are on the increase. In one village in Hakaluki *Haor*, the former leaseholders were remembered as "lionhearts", now they are referred to as "cut-throats".

Box 2: Rising Conflict over Enforcement

Though fishing communities do not control fisheries access directly, they do at least benefit from the framework of order that the leaseholding system provides - a fully open resource would lead to competition and conflict from which they would be unlikely to gain. But this order is increasingly costly to maintain, see Box 2 above.

The introduction of the New Fisheries Management Policy (NFMP), or *nitimala* as it is commonly called, was intended to address the political and distributional problems inherent in the leasing system by granting fishing licences to "genuine" fishermen. On some of the waterbodies, it seems to have succeeded. However, experience suggests that fishing communities often cannot, by themselves, enforce the kind of regulation of fishing effort required to make NFMP work. On the Padma-Jamuna Barabant *jalmahal*, formally assigned to fishermen from Sivalaya and Harirampur *thana* in Manikganj District, traditional Hindu fishermen belonging to the controlling *samity* complain that the introduction of the NFMP has effectively resulted in the removal of all access controls and that many of the most valuable fisheries on the Padma, such as the *pangas* fishery, are suffering as a result. The case study in Box 3 illustrates what can happen when NFMP is introduced in the face of a deeply-rooted and politically influential leaseholding elite. Ironically, in this case, the *status* *quo* may actually provide better guarantees of continued access to the fishery for local fishermen than if they attempted to implement NFMP unaided.

On two sections of the Mahasingh River in Sunamganj District, the introduction of the New Fisheries Management Policy has had practically no impact on the *status quo*. The river has traditionally been controlled by a group of powerful, traditional leaseholders with close links to the local *maimul* fishing communities. Through their influence in the local bureaucracy responsible for identifying "genuine" fishermen and distributing fishing licences, these leaseholders have continued to treat the river as their own leaseholding; they auction off sites for gears, distribute licences and collect licence fees. No local fishermen have seen any documentation to prove that they really **do** have licences and when they ask the leaseholder they are told: "I am your licence".

Box 3: NFMP on the Mahasingh River

Fisheries access and flood control

Flood control can affect leased waterbodies and the professional fishermen that depend upon them in a number of ways, through:

- its impact on fish migration
- its impact on the flooded area and the supportable stock
- its expansion of the frontier of cultivation into *khas* land
- its modification of flooding regimes, to the advantage of gears not commonly used by the traditional fishing communities
- its effects on water use and water control

Though there are variations according to the hydrological impact of the individual scheme, the overall result is usually a decline in the incentives and feasibility of maintaining tight control over access to the fisheries resource. There are, however, circumstances where the balance of these effects is to the advantage of leaseholders, at least in the short-term.

The impacts of flood control on fisheries are concentrated on higher value, migratory species, which are often those targeted by the traditional fishermen. This can reduce the average value of the fish stock, reducing the incentives to maintain control over the fishery on the *beel*. It will also affect the value of *jalmahal* on the major *khal* that, before flood control, connected the rivers to the *beel*/floodplains. On *khal* where this connection is severed, major migrations will cease and they will maintain value only in so far as they assume the role of small *beel* - as waterbodies where floodplain resident species attempt to overwinter. On major *khal* that have regulators, the effects may even be positive: as more of the floodplain will be drained through them, a greater proportion of the migratory fish will attempt to use them. Here much depends on the management of the regulators. If they are not opened at the right time to allow in the hatchlings at the start of the flood, there may be few young fish attempting to get out during the recession. But regulator management is not the only issue, how these *khal* themselves are managed can also be critical: overintensive fishing of the hatchling influx at the beginning of the monsoon limits the potential catch at the end, both for the *khal* operators themselves and across the whole floodplain fishery. As seasonal fishermen in Gandahasti *beel* commented: "There's not much point in having better sluice gate operation if the fishermen catch everything that gets through within the first two hundred yards inside the scheme."

In a scheme which significantly reduced the extent of flooding, this would constitute a loss to the fisheries system, as it would result in a corresponding drop in the volume of nutrients available for recycling. Away from the main rivers - and, arguably, even on them - most fisheries production can be traced back to this uptake of nutrients that flooding allows. A *beel* which has its catchment reduced will, therefore, tend to have a smaller stock of fish concentrated within it after the drawdown.

The expansion of the frontier of cultivation into *khas* land is stimulated by the more predictable cropping environment that flood control creates. With this come tenurial counter claims on the fisheries above, particularly as the drawdown advances. Leaseholders/professional fishermen therefore find that their activities are increasingly contested and conflicts more common. This reduces the fish stock available and/or increases the costs of restricting fishing.

In addition to this, and with similar effects, a reduction in the level of flooding increases the area over which non-traditional fishermen can operate their, generally, shallower-water gears. Professional fishermen have traditionally used deep-water gears such as *ber jal*. Subsistence and part-time fishermen tend to use cheaper, smaller gears, such as *thella jal, current jal* and traps that are easier to manage in shallow water. Reductions in flood levels therefore increase the fishing opportunities for the latter. This may extend their range onto the leased areas themselves, or simply make a larger proportion of the stock on the surrounding floodplain vulnerable to them, reducing ultimate concentrations.

Most of the above effects move in the same direction. By reducing the fish stock and its average potential value, returns decline; by increasing the costs of enforcement, costs escalate: both result in a fall in the value of controlling a fishery. Only leaseholders of the *khal* connected to the main regulators might benefit.

There is one effect that can be to the advantage of leaseholders: the greater control of water levels that flood control regulators can allow. The profitability of controlling a fishery is closely linked to the catchability of the fish after the drawdown and hence to water levels. If managed with the interests of the leaseholder in mind - and this can usually be arranged - regulators can time the drop in water levels to ease harvesting.

While these trends are clear, it must be emphasised that there is no simple equation between flood control and the elimination of the incentives to maintain leases. Within many of the schemes studied, important leases continue to exist - the most valuable and most intensively managed lease investigated was on Patasinga *Beel,* inside Manu Irrigation Project. The effects outlined above do not occur in all schemes, too much depends on local hydrology and the extent to which it is modified. Valuable fisheries may be less valuable than they were but still worth controlling.

4.4 REGIONAL REVIEW

4.4.1 North Central

Research by the socio-economic component of FAP 17 in the North-Central Region concentrated on Manikganj District, an area unprotected by formal flood control works. The Tangail area to the north, covered by the FAP 20 Compartmentalization Pilot Project and which includes a number of the FAP17 FCA sites, has quite different hydrological and fisheries characteristics, making comparison with the low-lying, flood prone areas in Saturia, Ghior and Harirampur *thana* difficult.

It was therefore originally intended to compare the clusters in the Manikganj area with those inside the Pabna Irrigation and Rural Development Project (PIRDP) on the west bank of the Jamuna River. This comparison was to be based on similarities in the agro-ecological characteristics of the two areas. However, once work in the field began, major historical differences in fisheries and hydrological patterns were identified which would have invalidated the basis of such a comparison. As a result, data for the two areas was looked at seperately.

However, the very differences in fishing patterns which made direct comparisons difficult highlighted key regional differences which are of equal importance to flood control planners.

Several features distinguish fisheries in the area around Manikganj. First of all, even without formal flood control schemes, the area is experiencing many of the changes which are generally associated with flood control due to siltation of many of the principal waterways. Practically all *beel* and floodplain areas indundated by the Dhaleswari and Kaliganga Rivers seem to be growing steadily shallower and many local rivers have become seasonal. This is steadily reducing the areas under lease and restricting the control of waterbodies exerted by traditional fishing communities.

In spite of these changes, there are still a considerable number of small perennial waterbodies, particularly the many *baor*, or *rak* as they are locally called, which are old river courses which have been isolated from the main stream. These, and *jalmahal* on rivers such as the Kaliganga, the Dhaleswari and the Ichhamati are the principal focus for fishing activities by traditional fishing communities. However, though they retain nominal control of fisheries leases, traditional fishermen have difficulty in restricting fishing activity by members of the agricultural community; more and more traditional fishermen are concentrating their fishing on larger rivers such as the Padma and the Ganges.

Distribution of Catch Between Different Groups

The socio-economic characteristics of those fishing in NC have been determined using the data collected through the Fish Catch Assessment (FCA) surveys and the Socio-Economic Village (SEV) surveys. Their findings are consistent. The fisheries of NC are dominated by occasional and subsistence fishermen, mainly landless, fishing for both income and consumption.

Data on gear users collected during the catch assessment survey (CAO1) has been summarised in Table 4.8. This summary, which aggregates all respondents in the region, inevitably obscures important differences, to which we will return, between habitats and between the inside and outside of flood control schemes. It does however provide a useful starting point for a discussion of the NC fishery, as the differing patterns of gear use inside and outside FCDs both reflect and are reflected by shifts in the proportions of the catch taken by different groups.

Within this Table gears are ordered by gear type. The most important gill net is the *current jal*, a cheap monofilament net widely used in the floodplains and *beel*, where it is set. These are owned almost exclusively (94%) by Muslims engaged in subsistence or occasional fishing and, in this region, are particularly favoured by the landless. The same net, when drifted rather than set, has been classified separately as a monofilament net and is also largely Muslim owned (93%); but, being more a river gear, it is used mostly (78%) by professional fishermen and rarely (4%) by subsistence.

Seine nets are used primarily by professional fishermen. The various *ber jal* are used mostly/exclusively by Hindus; the others are more evenly split between Muslims and Hindus with the exception of the *deol,* a smaller net used primarily by Muslim farmers.

Lift nets include the small *dharma jal*, which is used by Muslim subsistence fishermen and the *veshal jal*, which is used by Hindu professionals.

Table 4.8 Characteristics of Gear Users, North Central Region

Gear Category	Gear Code	Bengali Gear Name	Obser-vations	Religion		Fisherman Category				First Ranked Source of Income (%)				
				Hindu	Moslem	1	2	3	4	Fishing	Farming	Labour	Trade	Other
Gill Nets	88	*Current jal*	970	6.0	94.0	12.2	7.0	40.5	40.4	19.1	16.8	50.6	8.0	5.5
	123	*Koi/Fashi jal*	60	11.7	88.3	14.7	15.5	48.6	21.3	30.1	12.9	48.0	7.1	1.9
	282	*Monofilament Net*	268	6.1	93.9	27.3	50.2	20.2	2.3	77.6	8.2	11.3	2.7	0.3
	315	*Pangas jal*	68	31.9	68.1	50.8	35.4	13.8	–	86.2	10.0	3.8	–	–
	316	*Kajuli jal*	80	57.2	42.8	52.3	40.7	7.0	–	93.0	–	5.1	1.9	–
Seine Nets	45	*Ber jal*	417	79.9	20.1	87.0	7.4	4.7	1.0	94.4	0.5	2.0	3.2	–
	89	*Deol*	278	1.7	98.3	0.5	2.1	7.6	89.8	2.6	49.0	28.5	7.5	12.4
	132	*Gai Dasem*	72	54.5	45.5	66.8	26.0	7.2	–	92.8	7.2	–	–	–
	175	*Kathi jal*	57	49.1	50.9	56.3	10.9	19.3	13.5	67.3	6.1	24.3	–	2.4
	202	*Moi jal*	281	42.1	57.9	52.2	27.2	11.2	9.4	79.4	4.9	10.0	3.9	1.8
	268	*Konaber jal*	49	97.7	2.3	100.0	–	–	–	100.0	–	–	–	–
	304	*Satiber jal*	71	88.7	11.3	91.0	6.9	–	2.1	97.9	–	2.1	–	–
Bag Nets	271	*Suti jal*	45	93.8	6.2	97.0	–	–	3.0	97.0	–	3.0	–	–
Lift Nets	105	*Dharma jal*	873	3.8	96.2	1.9	0.7	10.0	87.4	2.6	33.5	37.6	12.8	13.6
	266	*Veshal jal*	669	79.9	20.1	85.1	1.6	9.5	3.9	86.7	1.6	7.7	3.3	0.7
Scoop Nets	263	*Ucha*	139	2.9	97.1	0.7	0.8	2.3	96.2	1.5	34.3	45.3	14.0	5.0
	296	*Tukri*	99	–	100.0	–	–	1.0	99.0	–	34.2	41.7	15.5	8.7
Clap Nets	234	*Shangla jal*	201	14.7	85.3	10.4	23.8	51.5	14.3	34.1	22.4	33.8	9.7	–
Traps	95	*Doiar*	497	5.3	94.7	10.1	14.4	33.7	41.8	24.5	13.8	45.4	10.4	5.8
Hooks and Lines	30	*Sip*	779	12.7	87.3	2.0	1.1	9.8	87.2	3.1	24.7	40.2	16.3	15.7
	152	*Tana Barsi*	73	16.4	83.6	18.8	19.6	8.1	53.4	38.5	11.4	26.6	13.8	9.8
	272	*Daun*	279	8.3	91.7	12.6	20.4	44.7	22.3	33.1	10.7	49.0	4.7	2.5
	278	*Nol barsi*	120	5.0	95.0	7.5	3.0	42.6	46.8	10.5	6.3	76.6	5.6	1.0
Spear	170	*Koch*	75	8.4	91.6	17.8	–	2.7	79.5	17.8	34.2	23.4	18.9	5.8
Cast Net	164	*Jhaki jal*	1441	54.6	45.4	53.9	1.7	4.3	40.0	55.7	17.3	15.0	8.4	3.7
Push Net	255	*Thella jal*	1637	2.8	97.2	0.7	1.0	3.9	94.4	1.7	29.3	50.2	10.5	8.3
Misc.	307	*Hand fishing*	357	5.9	94.1	2.7	0.6	0.3	96.4	3.2	22.8	52.4	9.2	12.4
	298	*Akra*	42	2.4	97.6	6.8	2.4	21.0	69.8	9.1	25.6	65.3	–	–

Apart from the *jhaki jal* (cast net), all the remaining categories of gear - scoop nets, clap nets, traps, hooks, push net - are used largely or nearly exclusively by Muslims. And though some (*shangla jal, tana barshi* and *daun*) are used up to one third of the time by professionals, most are principally subsistence gears used by those giving their first ranked source of income as labour, trade or other, i.e. not farmers.

In the NC, as in other regions, labouring is the first ranked source of income for the majority of part-time fishermen. Unlike elsewhere though, it is also the single most cited source for those engaged in subsistence. On the same account, farming comes second in both categories.

The value of catch taken by each of the most important gears on the different sites covered by the FCA surveys is given in Table 4.9; sites are grouped by habitat type and by flood control status. Analysis of the characteristics of gear users, indicated the relative insignificance of professionals within the fisheries of NC, even on the flowing waterbodies. In the habitat progression from main river to *beel*, the share taken by non-professionals rose steadily, from 46% to 84%, (Table 4.10). Though the proportion of this taken by farmers also increased simultaneously, it never eclipsed that taken by the landless, who, as indicated above, are important beneficiaries of these fisheries.

On the main river the single most important gear is the monofilament net (code 282), which takes 34% of the total catch. The rest is distributed fairly widely, with just under 20% taken by seine nets, 13% by various hooks and lines; *jhaki jal* (push nets, code 164) take 3% and *thella jal* (push nets, code 255) take 6%. Through most of the year professional fishermen (HFC1 and HFC2) take around 75% of the value of catch, but the important *Hilsa* fishery in the peak flood period, which is dominated by seasonal fishermen using *shangla jal*, ensures that their share of the annual catch value is only 54%.

On the secondary rivers there was a marked difference between inside and outside sites. Inside the fishery was dominated by non-professionals - using *sip* (hand lines, code 30), *dharma jal* (small lift nets, code 105) and *thella jal,* who took nearly 80% of catch value. Outside professionals - using *ber jal* (seine net, code 45), *veshal* (large lift net, code 266) and *katha* (brush shelters, code 270) - were more active, but still only took less than half of total catch value.

Table 4.9 Value of Catch (%) by Gear Type, North Central Region

Habitat	In/ Out	Site Code	Gill Nets 88	Gill Nets 123	Gill Nets 282	Seine Nets 45	Seine Nets 306	Seine Nets 175	Seine Nets 297	Seine Nets 202	Seine Nets 89	Bag 271	Lift 266	Lift 105	Scoop 263	Scoop 296	Traps 95	Traps 286	Traps 222	Lines and Hooks 30	Lines and Hooks 278	Lines and Hooks 272	Lines and Hooks 152	Spear 170	Cast 164	Push 255	Dewatering 336	Dewatering 307	Misc. 298	Misc. 291	Katha 270	Kua 302	Total
Main River	O	NC01	1	1	21	12	–	1	11	6	–	–	–	1	–	–	–	–	–	6	–	3	–	–	2	15	–	2	–	–	–	–	84
	O	NC20	–	–	43	7	–	1	–	3	5	–	1	1	–	–	5	–	–	3	–	7	10	–	5	2	–	1	–	–	–	–	93
	O	NC32	1	–	39	5	–	1	–	3	2	–	5	–	–	–	5	–	–	1	–	3	8	–	1	–	–	–	–	–	–	–	75
		Average	1	0	34	8	–	1	4	4	2	–	2	1	–	–	3	–	–	3	–	4	6	–	3	6	–	1	–	–	–	–	84
Secondary River	I	NC12	–	–	–	5	–	–	–	–	–	7	1	13	–	–	8	–	–	35	–	–	4	–	14	7	–	2	–	–	4	–	100
		Average	–	–	–	5	–	–	–	–	–	7	1	13	–	–	8	–	–	35	–	–	4	–	14	7	–	2	–	–	4	–	100
	O	NC02	1	–	1	16	–	2	–	–	–	1	–	2	–	–	–	–	–	42	–	–	1	–	17	9	–	3	–	–	–	–	97
		NC06	1	–	–	9	–	2	–	11	1	1	–	5	–	–	6	–	–	20	–	6	2	–	12	14	–	3	–	–	8	–	100
		NC16	6	3	1	30	–	1	–	–	–	–	–	–	–	–	5	–	–	6	–	2	24	1	5	3	–	1	–	–	2	–	91
		NC21	–	–	1	13	–	–	–	1	15	1	15	–	–	–	–	–	–	7	–	–	–	–	12	2	–	2	–	–	32	–	100
		NC25	6	–	1	14	–	–	–	1	3	–	10	–	–	–	17	–	–	2	–	4	3	–	6	2	–	3	–	–	25	–	99
		NC29	1	–	–	13	–	–	–	2	–	–	46	–	–	–	2	–	–	5	–	2	–	–	3	1	–	–	–	–	24	–	100
		Average	3	1	1	16	–	1	–	3	3	1	12	1	–	–	5	–	–	14	–	2	5	0	9	5	–	2	–	–	15	–	98
Khal	I	NC10	–	–	–	9	–	–	–	–	–	–	25	18	–	–	7	–	–	3	–	–	–	–	18	6	–	1	–	–	11	–	100
		NC13	21	–	–	–	–	–	–	–	–	2	–	33	–	–	14	–	–	13	–	–	–	–	4	8	–	–	–	6	–	–	100
		Average	11	–	–	5	–	–	–	–	–	1	13	26	–	–	11	–	–	8	–	–	–	–	11	7	–	1	–	3	6	–	100
	O	NC03	–	–	–	5	–	–	–	–	–	–	2	34	–	–	3	–	–	3	–	–	–	–	17	29	–	4	–	–	2	–	100
		NC07	2	–	–	26	–	–	–	1	2	–	–	45	–	–	4	–	–	4	–	2	–	–	5	7	–	2	–	–	–	–	100
		NC17	4	–	–	15	–	–	–	2	1	1	8	37	–	–	–	–	–	3	–	–	–	–	22	7	–	–	–	–	–	–	100
		NC22	–	–	–	1	–	–	–	–	1	20	36	–	–	–	–	–	–	6	–	–	–	–	16	2	–	3	–	1	7	–	95
		NC26	1	–	–	3	–	–	–	1	–	–	50	–	2	1	8	–	–	1	1	–	–	–	7	3	–	2	–	2	12	8	100
		NC30	4	–	–	1	–	–	–	1	1	2	28	4	10	1	–	–	–	8	–	1	–	1	26	3	–	4	–	–	3	2	99
		Average	2	–	–	9	–	–	–	1	1	4	21	20	2	0	3	–	–	4	0	1	–	0	16	9	–	3	–	1	4	2	99
Floodplains	I	NC11	7	–	–	5	–	3	–	–	–	–	1	3	–	–	5	–	1	2	1	1	–	–	16	23	–	13	–	1	16	1	100
		NC14	12	1	–	1	–	–	–	–	–	–	–	13	–	–	1	–	–	15	–	–	–	1	8	31	–	1	–	–	13	2	100
		Average	10	1	–	3	–	2	–	–	–	–	1	8	–	–	3	–	1	9	1	1	–	1	12	27	–	7	–	1	15	2	100
	O	NC04	10	–	–	21	–	1	–	–	–	–	5	1	–	–	–	–	–	–	1	–	–	–	8	50	–	1	–	1	–	–	99
		NC08	2	–	–	62	–	2	–	–	–	–	–	10	–	–	–	–	–	–	–	2	–	–	–	16	–	5	–	–	–	–	100
		NC18	3	–	–	–	–	–	–	–	9	–	–	1	–	–	–	–	–	5	3	–	–	–	–	48	–	4	–	–	–	27	100
		NC23	6	–	–	9	–	–	–	–	3	–	7	–	–	2	–	–	–	1	–	–	–	2	7	21	–	4	–	–	3	34	100
		NC27	59	–	–	–	–	–	–	–	1	–	–	–	26	–	–	–	–	–	11	2	–	–	–	–	–	–	–	–	–	–	100
		NC31	13	–	–	11	–	–	–	–	–	–	5	1	4	–	2	–	1	5	2	6	–	–	4	14	–	2	–	–	–	30	100
		Average	16	–	–	17	–	1	–	–	2	–	3	2	5	0	0	–	0	2	3	2	–	0	3	25	–	3	–	0	1	15	100
Beel	I	NC15	9	4	–	6	–	–	–	–	1	–	–	11	–	–	–	–	–	1	–	2	–	–	4	24	–	1	–	–	36	–	100
		Average	9	4	–	6	–	–	–	–	1	–	–	11	–	–	–	–	–	1	–	2	–	–	4	24	–	1	–	–	36	–	100
	O	NC05	7	–	–	7	–	–	–	–	–	–	–	5	–	–	–	–	–	1	–	–	–	–	33	21	–	2	7	–	5	–	89
		NC09	–	–	–	56	–	2	–	–	–	–	–	13	–	–	–	–	–	2	–	–	–	–	2	20	1	4	–	–	–	–	100
		NC19	3	1	–	4	–	–	–	1	2	–	–	23	–	–	–	–	–	14	–	8	–	2	9	22	–	–	–	–	11	–	100
		NC28	5	–	–	39	–	–	–	–	4	–	–	–	15	–	3	–	–	1	2	–	–	–	13	3	–	–	–	–	4	11	100
		Average	4	0	–	27	–	1	–	0	2	–	–	10	4	–	1	–	–	5	1	2	–	1	14	17	0	2	2	–	5	3	97

Source: FAP17

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Table 4.10 Distribution of Value of Catch (%), NC

Habitat	Fishing Category				Non-Professionals	
	HFC1	HFC2	HFC3	HFC4	Farmers	Others
Main Rivers	28.3	25.4	34.5	11.7	17.5	28.8
Secondary Rivers	44.3	3.2	15.5	37.0	19.6	32.9
Khal	38.4	3.9	13.8	44.1	21.0	36.7
Floodplains	18.4	3.9	15.6	61.7	36.7	40.9
Beel	12.4	3.3	22.2	62.1	38.3	46.0

On the *khal* the share taken by professionals was lower (46%) than in the secondary rivers but differed less between inside and outside sites, despite distinct differences in patterns of gear use. Non-professional fishermen, principally using *dharma jal,* traps and *thella jal* took just over three fifths of catch value inside the partially protected area and just under this proportion in the outside areas.

The fisheries on the floodplains and *beel* are even more dominated by non-professionals. In this, there was some seasonal variation, with the shares taken by the landless highest in the peak flood and drawdown; farmers benefitted most in the dry season, when *katha* and *kua* were harvested. Most of the catch was classified as going for subsistence, possibly incorrectly. Farmers are often reluctant to admit that they gain income from fishing and often take some pains to dissociate themselves from the sale of fish, even when it comes from their pond or *kua*; when asked, they will still refer to themselves as subsistence fishermen.

Again, there were contrasts between the gears in different flood control regimes, with the share taken by *ber jal* considerably lower on the inside sites. These differences were also reflected in the lower share taken by Hindus, who, in this region, are traditional *caste* fishermen.

Significance of Fisheries Income to Different Groups

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; it says nothing, however, as to how the members of those groups that do fish might be affected. It is to this that we now turn.

Professional fishermen in the satellite communities

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.

Satellite communities were studied to ensure adequate coverage of professional fishermen, a group of principal importance to FAP17 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 NC, this involved three of the seven satellite communities covered.

The average income for all the communities monitored in NC is presented in Table 4.11 and Figure 4.2 below. The average annual household income was just under Tk.30,000, very similar to that of the main 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, (see Box 4), but the variation should be borne in mind when interpreting these results.

> The two principal determinants of household fishing income are the gear owned and the degree/terms of access to the more valuable fisheries resources, which are often correlated. Access to an important *beel* can, depending on leasing arrangements, yield economic benefits (in returns per man day) that are many times higher than access to its adjacent floodplain. The resource base of agricultural communities also varies, with average landholding and crop potential, but not to the same extent. In addition, a minority of fishing communities are moving into fish culture, which can also yield very significant returns - the reason why incomes in NC3-2 were so high.
>
> **Box 4: Reasons for Income Variability**

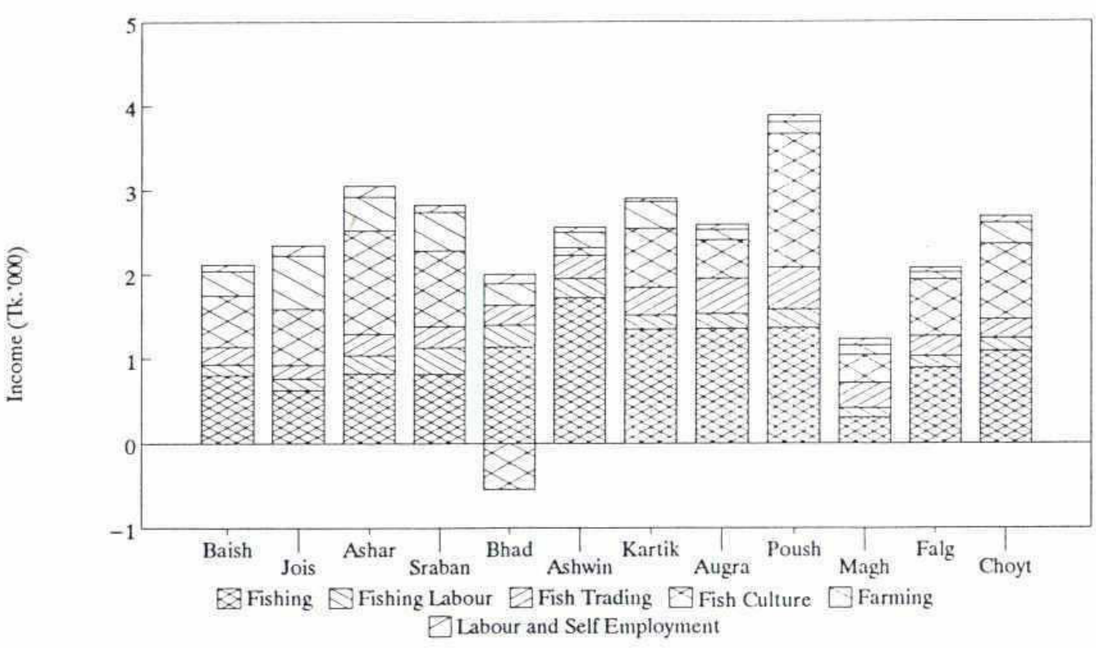
Table 4.11 Income by Fishing Category – NC

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
Comm–unity*	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

*Data on fish culture omitted

Figure 4.2 Income by Fishing Category, NC



Source: FAP17 Village Monitoring

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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 NC.

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 NC landless.

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, unless **well targeted** mitigation measures were to be introduced simultaneously.

Fishing in the main villages

Assessing the significance of fishing in the main 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 influence which mitigation measures may be appropriate.

The initial census of the main villages chosen for socio-economic monitoring suggested a lower level of part-time and subsistence fishing than has been reported elsewhere, particularly in the NW and NE 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 NC 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 4.12).

Table 4.12 Fishing Participation (%), NC

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

Fishing either for subsistence or as a source of income was more common among farmers than for the landless in all 12 NC villages. The lower participation of the landless certainly reflects lack of resources to purchase gears. It may also be that the search for work, which in NC 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.

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.

But such income rankings tell only part of the story. 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

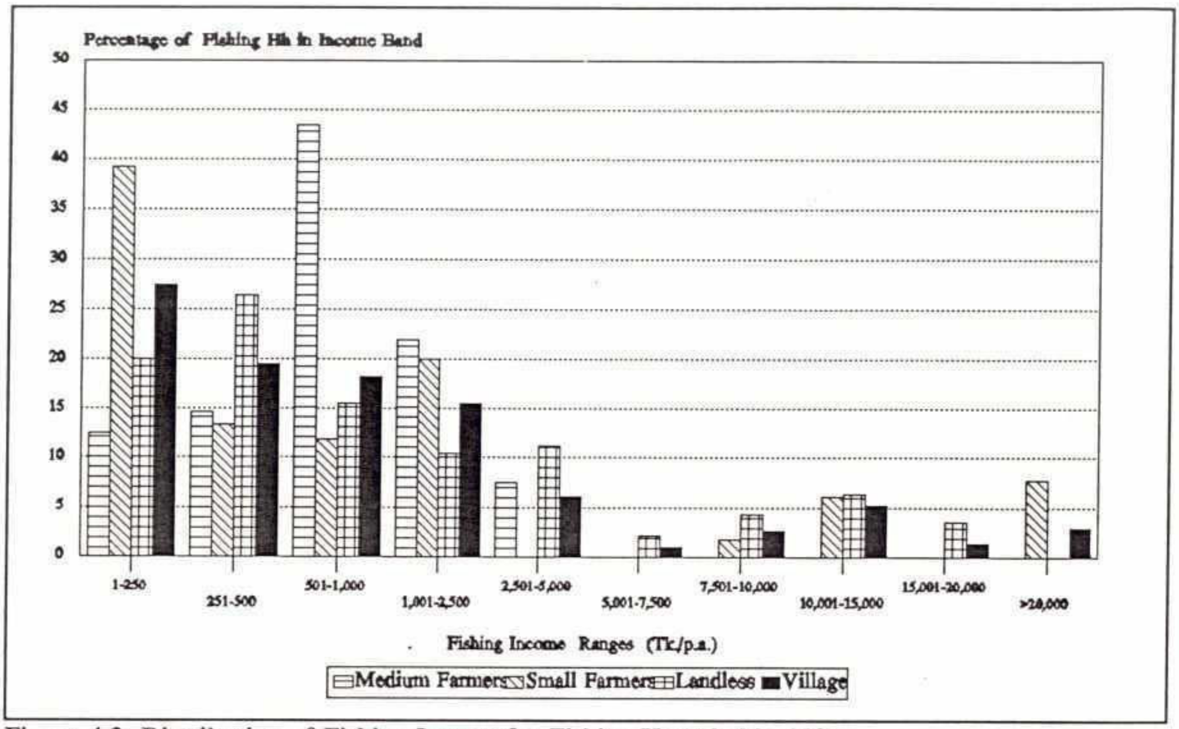

Figure 4.3 Distribution of Fishing Income for Fishing Households, NC

ranges of value is shown in Figure 4.3 above. It should be noted that the income bands are defined over progressively larger intervals, making the scale of the X-axis quasi logarithmic.

In contrast to the other regions, in NC 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.

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 4.13, which gives the average income (both cash and monetized value of consumption[4]) 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

[4] 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.

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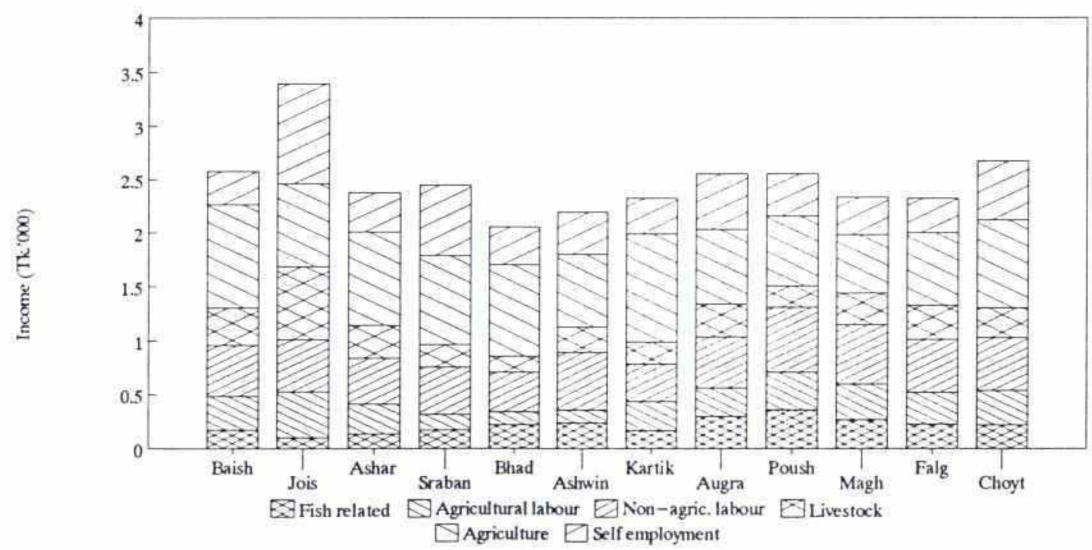
Table 4.13 North Central – Sources of Income by Landholding Category

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	–

Figure 4.4 North Central – Distribution of Income through the Year, by Source



Source: FAP17 Village Monitoring

spike in December-February. Figure 4.4 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. However, it is also witness to the vagaries of sampling, as much of the total for this stratum came from a small group in one village, NC4-1. Their pattern of income is also noteworthy, as it is consistently highest is the dry season - a feature already highlighted from a different angle in the discussion of the fisheries data.

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.

Implications for Mitigation

Mitigation measures are most needed where vulnerable groups are seriously affected by a particular activity. They are easiest to implement if such groups are both clearly identifiable and geographically clustered. By this token, where subsistence fishing - which involves many dispersed households catching relatively little - is likely to be affected by flood control, the need for mitigation is more limited while the problems of targeting it are significant. Such an argument is given additional force where subsistence fishermen are farmers and therefore likely to benefit from the more positive effects of changing hydrology.

The very high share of catch going to, predominantly landless, subsistence fishermen in NC therefore presents a problem: flood control could have a widespread and adverse impact on an economically marginal group. For this group, the best solution is perhaps to ensure that the capture fishery on the floodland that remains is both as healthy and as open as possible. This can be supplemented by aquaculture through target groups, which would give economic benefits to some of those disadvantaged, while maintaining the supply of fish. The use of low value species, such as *sarputi,* would spread the benefits of such an initiative more widely.

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Full-time professional fishermen present a different picture. Their high level of dependence on the open water fishery combined with their very limited potential for sharing the agricultural benefits of flood control, make them vulnerable to loss. However their clustering in distinct communities makes them relatively easy to target. The most appropriate mitigation measures would depend on the hydrological impacts anticipated. Maintenance of the open water capture fishery would clearly be the best option, where flooding still allows. But the significant incomes earned from pond culture by some fishing communities would suggest this could also be considered. For them, assistance in gaining access to ponds would be of greatest benefit. Some NGOs have used Food-for-Work to redevelop farmers derelict ponds in return for a fixed lease. The large NGO presence and the relatively smaller numbers of professional fishermen should ease the task of mitigation in this region.

Part-time fishermen present the most difficult case for mitigation. They can be highly seasonally dependent on fisheries just when their other sources of income are most limited, so vulnerable to loss. But they are intermingled with the wider agricultural community, so hard to target. In NC, their share of the fishery on all habitats - except the main river where they take an important share of the unaffected *Hilsa* fishery - is generally more limited than elsewhere; this reduces the scale of the problem but does not eliminate it.

4.4.2 North East

Many of the characteristics of fisheries in the *haor* region of the North-East are unique to that area. The patterns of flooding in the *haor* are quite different from other areas. The proximity of the Meghalaya Hills to the north and the Tripura Hills to the south, both areas which experience some of the highest rates of rainfall in the world, creates marked peaks in run-off. These cause frequent flash-flooding, particularly during the pre-monsoon period from March through to June. The depth and extent of flooding in the *haor* is also unparalled anywhere else in Bangladesh. The areas of perennial water are more extensive than in most other parts of the country and early flash floods mean than *beel* and residual waterbodies are frequently flooded out before harvesting can be completed. These factors contribute considerably to the richness of fisheries resources in the area.

With a few notable exceptions, flood control measures tend to be oriented towards the provision of **temporary** protection by submersible embankments. These generally aim at protecting standing *boro* crops from early floods just long enough for them to be harvested, usually at the end of April or in early May. Then embankments are designed to overtop and allow normal flooding for the rest of the season. Two village clusters were studied in Sunamganj District, one inside a submersible embankment project, the Kai Project and another in an ostensibly unprotected area in Dekker *haor*.

By contrast, FAP 17 also looked at the impacts of a full flood control, irrigation and drainage scheme, the Manu Irrigation Project in Maulvi Bazar District. A cluster of villages in the unprotected area of Hakaluki *haor* was studied for comparison

Distribution of Catch Between Different Groups

In the NE the characteristics of the fishery are determined largely by hydrology and, linked to this, limitations on access. In the peak flood, the much deeper flooding limits subsistence fishing activity to a relatively smaller proportion of the total floodplain, around the homestead area; much of the catch goes to larger seine nets, such as *ber jal,* operating on open waters. As the floods recede fish may be caught by landowners dewatering their fields or, more usually, when they become concentrated in the *beel,* by professional fishermen working for the leaseholders. Both landowners and leaseholders attempt to limit fishing that could subtract from their ultimate catch, limiting the scope for the landless.

The division of gear use between different categories of fishermen is shown in Table 4.14. As in NC, the principal users of gill and seine nets are professional fishermen; however, in the NE, their dominance also extends across many of the other gears that were dominanted by subsistence fishermen in NC. Subsistence fishermen (HFC4) strongly dominate the use of a few means of catch - hand fishing (84%), *ucha* (a scoop net, 76%), and *dharma jal* (66%). Part-time fishermen (HFC3) are (just) the dominant users of only one gear - *doiar* (small traps), but seem to use a more diversified set of gears than the subsistence fishermen.

The distribution of catch value for each FCA site by gear type is shown in Table 4.15. Most notable is the importance of *ber jal*, which is the most important gear on the secondary rivers, on *beel* and, inside FCDs, on floodplains. For the latter habitats, this reflects the extended and deep flooding that occurs in the *haor*, a feature that also explains the much lower catch taken by *thella jal.* Though unable to fish on much of the floodplain during the main flood period, subsistence fishermen benefit from the fishery during the recession, when large amounts of fish become stranded inside the bunds on farmers fields and are then taken

Table 4.14 Characteristics of Gear Users, North East Region

Gear Category	Gear Code	Bengali Gear Name	Obser-vations	Religion		Fisherman Category				First Ranked Source of Income (%)				
				Hindu	Moslem	1	2	3	4	Fishing	Farming	Labour	Trade	Other
Gill Nets	65	*Chandi jal*	35	–	100.0	65.7	14.3	11.5	8.6	80.0	11.4	5.7	2.8	–
	88	*Current jal*	511	8.9	91.1	47.4	18.1	27.4	7.2	65.4	20.8	11.1	1.0	3.2
	123	*Koi/Fashi jal*	160	6.7	93.3	44.3	28.6	22.3	4.8	72.9	18.1	5.9	1.7	1.7
	282	*Monofilament Net*	92	20.1	79.9	79.7	15.7	2.4	2.2	95.4	2.2	–	–	0.9
Seine Nets	45	*Ber jal*	387	25.7	74.3	77.5	16.1	5.4	1.0	93.6	3.9	1.7	0.8	–
	68	*Uttar jal*	203	13.5	86.5	70.4	24.9	4.7	–	95.3	2.7	1.5	0.5	–
	89	*Deol*	90	22.9	77.1	10.5	9.0	28.9	51.6	19.6	53.0	18.2	–	3.2
	325	*Dora jal*	115	34.0	66.0	84.2	11.6	4.3	–	95.7	2.5	0.9	0.9	–
Bag Nets	320	*Ghori jal*	96	1.0	99.0	77.4	17.0	1.0	4.6	94.3	4.2	–	1.5	–
Lift Nets	105	*Dharma jal*	47	4.3	95.7	2.1	8.5	23.4	66.0	10.6	53.2	21.3	4.2	13.9
	266	*Veshal jal*	400	5.0	95.0	83.8	12.5	2.7	1.1	96.1	2.4	0.9	0.3	0.3
Scoop Nets	263	*Ucha*	64	8.0	92.0	1.5	4.7	18.0	75.8	6.3	73.4	15.6	–	2.6
	321	*Afa*	66	4.5	95.5	47.8	19.9	26.2	6.1	67.7	16.7	7.7	4.7	1.8
Clap Nets	234	*Shangla jal*	49	28.6	71.4	61.2	32.7	6.1	–	94.0	2.0	2.0	2.0	–
Traps	95	*Doiar*	91	46.4	53.6	31.3	36.3	27.5	5.0	67.6	17.6	12.1	–	3.1
Hooks and Lines	30	*Sip*	336	4.0	96.0	17.6	12.8	18.0	51.6	30.5	25.7	29.3	3.1	31.7
	152	*Tana Barshi*	49	10.5	89.5	31.3	29.2	18.7	20.7	60.5	27.0	8.3	–	2.6
	272	*Daun*	325	15.1	84.9	43.6	34.1	19.3	3.1	77.6	13.8	6.7	0.6	1.8
	278	*Nol barsi*	69	4.5	95.5	94.0	1.4	2.9	1.6	95.5	1.6	2.9	–	–
Cast Nets	164	*Jhaki jal*	302	15.1	84.9	43.4	11.4	27.6	17.6	54.8	20.6	17.7	2.9	2.6
Push Nets	255	*Thella jal*	945	16.6	83.4	23.0	10.1	20.9	46.1	33.1	38.2	20.1	1.1	7.4
Hand and Dewater.	97	*By hand/Dewatering*	69	4.4	95.6	26.4	7.6	7.2	58.8	34.0	52.2	6.9	–	7.7
	307	*Hand fishing*	217	8.3	91.7	1.3	3.9	10.0	84.8	5.2	68.1	16.6	1.0	6.7

Table 4.15 Value of Catch (%) by Gear Type, North East Region

Habitat	In/	Site	Gill Nets						Seine Nets				Bag	Lift Nets			Scoop		Traps			Hooks & Lines			Cast	Push	Dewatering		Misc	Katha	Kua	Kotta	Total
	Out	Code	88	123	282	65	316	324	45	89	68	325	320	266	105	329	263	321	95	286	222	30	272	152	164	255	97	307	291	270	302	318	
Secondary River		NE06	–	–	–	–	–	–	19	–	22	–	–	7	–	–	–	5	–	–	–	–	11	9	1	3	9	–	–	–	13	–	100
		NE07	–	–	–	1	–	–	23	–	26	2	–	10	–	–	–	3	–	1	–	–	2	1	–	6	4	–	–	–	20	–	99
		NE11	2	–	–	–	–	–	55	–	5	5	–	6	–	–	–	–	–	–	–	1	4	–	–	1	1	–	–	1	16	–	99
		NE16	–	2	4	7	–	9	12	–	10	–	–	6	1	–	–	–	–	–	–	–	17	8	17	1	2	–	–	–	1	–	97
		NE20	4	–	3	–	–	–	38	–	–	30	–	18	–	–	–	–	–	–	–	–	–	2	–	1	1	–	–	–	1	–	99
		Average	1	0	1	2	–	2	29	–	13	7	–	9	0	–	–	2	–	0	–	0	7	4	4	2	3	–	–	0	10	–	99
Khal	I	NE01	–	2	–	7	–	–	1	–	11	–	16	19	–	–	–	–	–	–	–	–	–	2	–	3	1	–	–	–	36	–	99
		NE03	1	–	–	–	–	–	18	1	–	–	–	4	–	31	–	–	–	7	–	–	–	–	–	7	31	–	1	–	–	–	100
		Average	1	1	–	4	–	–	10	1	6	–	8	12	–	16	–	–	–	4	–	–	–	1	–	5	16	–	1	–	18	–	100
Floodplains	I	NE02	6	5	–	–	–	–	37	8	–	–	–	–	–	2	–	–	–	4	–	–	–	24	–	–	14	–	–	–	–	–	100
		NE05	8	3	–	–	–	–	36	1	–	–	–	–	–	–	–	–	–	–	–	–	–	7	–	4	41	–	1	–	–	–	100
		NE14	54	10	–	–	–	–	7	3	–	–	–	–	–	–	2	–	–	12	–	–	–	3	–	–	10	–	–	–	–	–	100
		Average	23	6	–	–	–	–	27	4	–	–	–	–	–	1	1	–	–	5	–	–	–	11	–	1	22	–	0	–	–	–	100
	O	NE08	5	1	–	–	–	–	30	–	–	23	–	6	–	–	–	–	–	2	–	–	1	6	–	15	11	–	1	–	–	–	100
		NE10	13	3	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	1	3	–	–	2	–	1	72	–	–	–	–	–	99
		NE17	11	–	–	–	–	–	31	1	–	–	–	–	–	–	1	–	–	–	–	–	–	5	–	–	48	1	–	–	–	–	100
		Average	10	1	–	–	–	–	20	0	–	8	–	2	–	–	0	–	–	1	1	–	0	4	–	5	44	0	0	–	–	–	100
Beel	I	NE04	21	8	–	–	–	–	31	–	–	–	3	2	–	–	–	–	–	–	–	–	–	1	–	7	5	–	–	–	15	–	94
		NE12	20	7	–	–	–	–	–	5	–	–	–	–	–	–	3	–	7	3	–	5	1	1	–	5	17	7	4	–	–	15	99
		NE13	8	1	–	–	–	–	41	1	–	–	–	–	–	–	–	–	–	1	–	–	1	1	–	1	18	–	–	–	20	2	96
		Average	16	5	–	–	–	–	24	2	–	–	1	1	–	–	1	–	2	1	–	2	1	1	–	4	13	2	1	–	12	6	96
	O	NE09	8	2	–	–	–	–	60	–	–	3	–	1	–	–	–	–	–	–	–	–	–	11	–	13	3	–	–	–	–	–	100
		NE18	6	–	–	–	–	–	39	–	–	–	3	–	–	–	–	–	–	–	–	–	–	1	–	–	4	8	35	–	–	–	96
		NE19	1	–	–	–	–	–	51	–	–	–	24	–	–	–	–	–	–	2	–	–	–	3	–	–	7	12	–	–	–	–	100
		Average	5	1	–	–	–	–	50	–	–	1	9	0	–	–	–	–	–	1	–	–	–	5	–	4	5	7	12	–	–	–	99

Source: FAP17

by hand fishing alone (code 307) or in combination with dewatering (code 97); the latter is particularly important on the floodplain sites, accounting for 44% of catch value outside FCDs and 22% inside.

Due to the importance of large gears, such as the *ber jal*, and the extensive use by professionals of gears more associated with subsistence or occasional fishermen in other regions, such as *current jal*, this group takes most of the catch in all habitats (Table 4.16). But they do not benefit correspondingly. As indicated above, leaseholders in the NE are particularly powerful. Hydrology ensures that the concentrations of fish that occur in many of the *beel* are drawn from a much wider area of floodplain than in other regions, resulting in very high returns at harvest. Leaseholders therefore have an incentive to manage fishing much more tightly. Professional fishermen have to be employed to take the catch but, given closer supervision, their catch share can be regularly adjusted to ensure that they take little more than a living wage or they are simply employed as day labourers. As a result up to 70% of the total value of the catch from these waterbodies can go to the leaseholder.

On the *khal* and the floodplains, catch is close to being evenly divided between full-time professionals and the other types of fishermen. Here occasionals take more than subsistence fishermen, with farmers predominating on the *khal*.

Table 4.16 Distribution of Value of Catch (%), NE

Habitat	Fishing Category				Non-Professionals	
	HFC1	HFC2	HFC3	HFC4	Farmers	Others
Secondary Rivers	60.5	19.9	9.0	10.2	11.0	8.6
Khal	28.0	27.9	25.5	14.6	30.5	13.6
Floodplains	30.5	27.0	23.1	19.6	23.0	19.5
Beel	75.6	9.0	7.2	8.3	10.0	5.4

Occasional fishing is rarer than in the NW and SW and in the agricultural communities monitored the limited amount of subsistence fishing that takes place is mainly undertaken by farmers, rather than the landless, despite the generally low levels of income of the latter. Fishing contributed less than 2% of total landless income in three of the four villages studied. Even at its seasonal peak in the village where it was most significant, fishing contributed less than 20% of landless monthly income.

For farmers participation in fishing, the principal objective seems to be subsistence rather than income.

Significance of Fisheries Income to Different Groups

Professional Fishermen in the Satellite Communities

The tight control over the richest fisheries resources in this region limits the incomes earned by most professional fishermen. These are shown in Table 4.17. 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 *beels* for larger leaseholders. This also accounts for the considerable irregularity in income flows from fishing, see Figure 4.5. (The average income of Tk.2,533 in *poush* was largely accounted for by one leaseholder in one community.) This stands in sharp contrast to the relatively smooth rise and fall in incomes of professional fishermen in the SW, where fisheries are both more open and more closely tied to the floods.

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 the Main 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 socio-economic monitoring was broadly consistent. In the NE, this was not the case. In the socio-economic 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 4.18; 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 reasonable

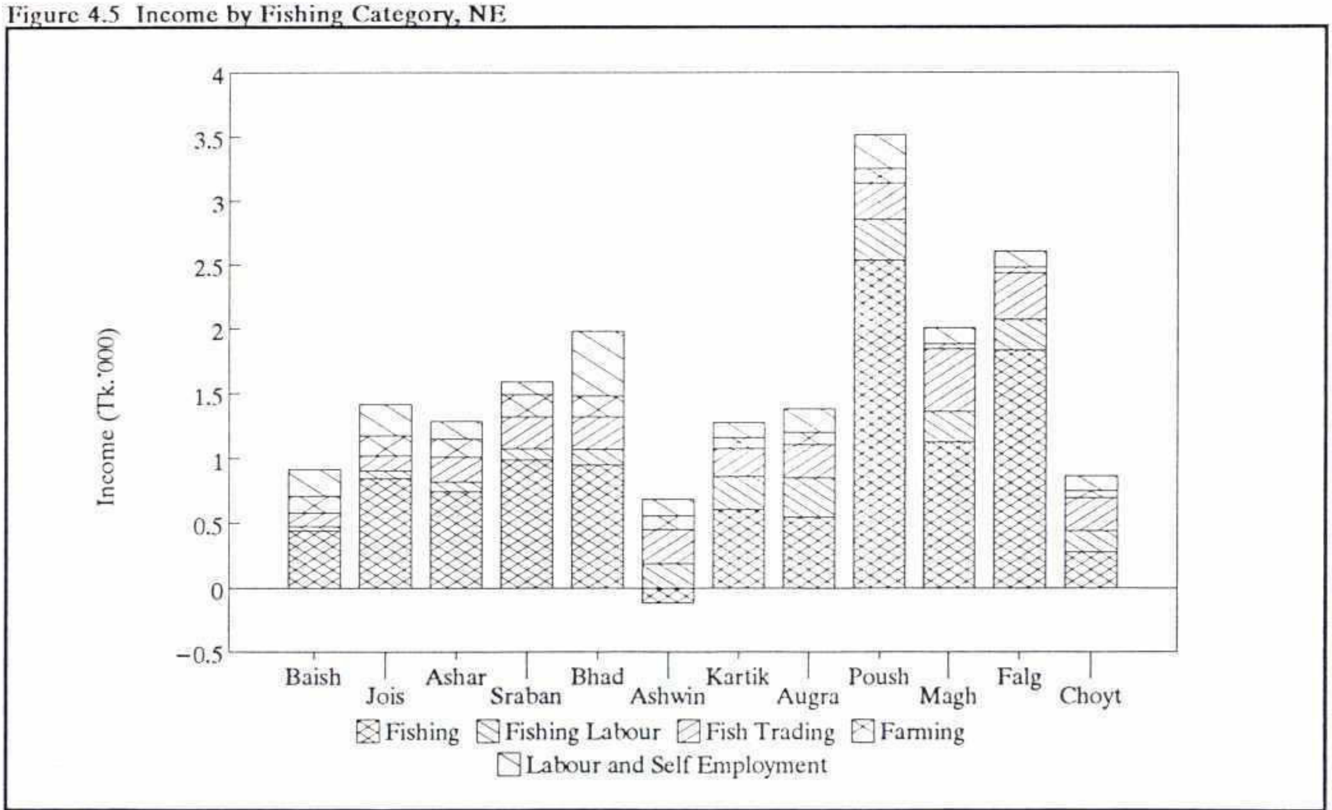
Table 4.17 Income by Fishing Category – NE

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	306	986	676	1,056	1,010	780	427	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	1,282	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

* Data on fish culture omitted

Figure 4.5 Income by Fishing Category, NE



Source: FAP17 Village Monitoring

explanantions for this (see below) **this downward bias must be borne in mind in the interpretation of the results presented.**

Table 4.18 Fishing Participation (%), NE

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

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 NE. Traditional Muslim fishermen (*maimals*) are longer and more widely established in the NE than in any of the other areas monitored by FAP17. But their social status within the wider community is particularly low and farmers from long established Sylheti families are therefore reluctant to fish for income, as they feel this to be demeaning. 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 socio-economic monitoring.

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 waterbodies. Leaseholders in the NE 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 waterbodies, they may not.

The distribution of households across different fishing income ranges (cash plus monetary value of consumption) is shown in Figure 4.6. 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).

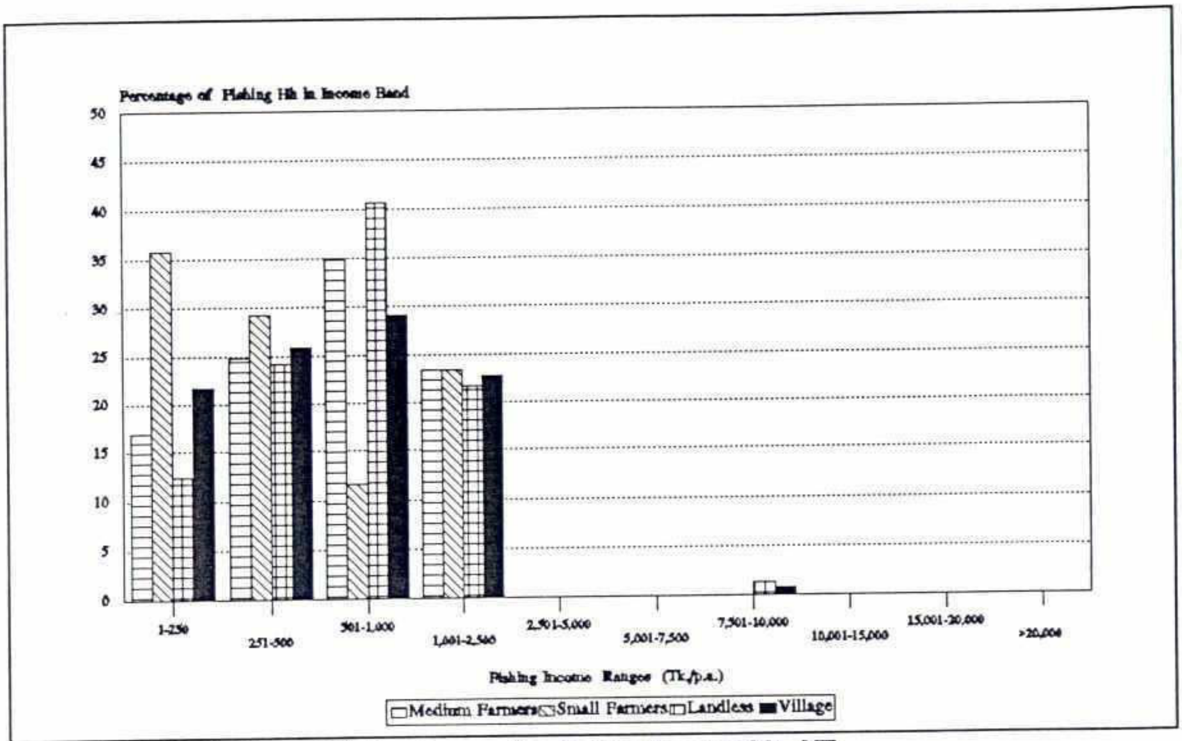


Figure 4.6 Distribution of Fishing Income for Fishing Households, NE

Together with the relatively lower participation rates (second lowest after the NW), this made fishing less important to the monitored villages in the NE, than to those covered in any other region. The overall distribution of income by source is given in Table 4.19 and Figure 4.7. 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 NE it came in *joistra, 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 NE and the heavier policing of fishing by leaseholders as soon as the floods start to recede.

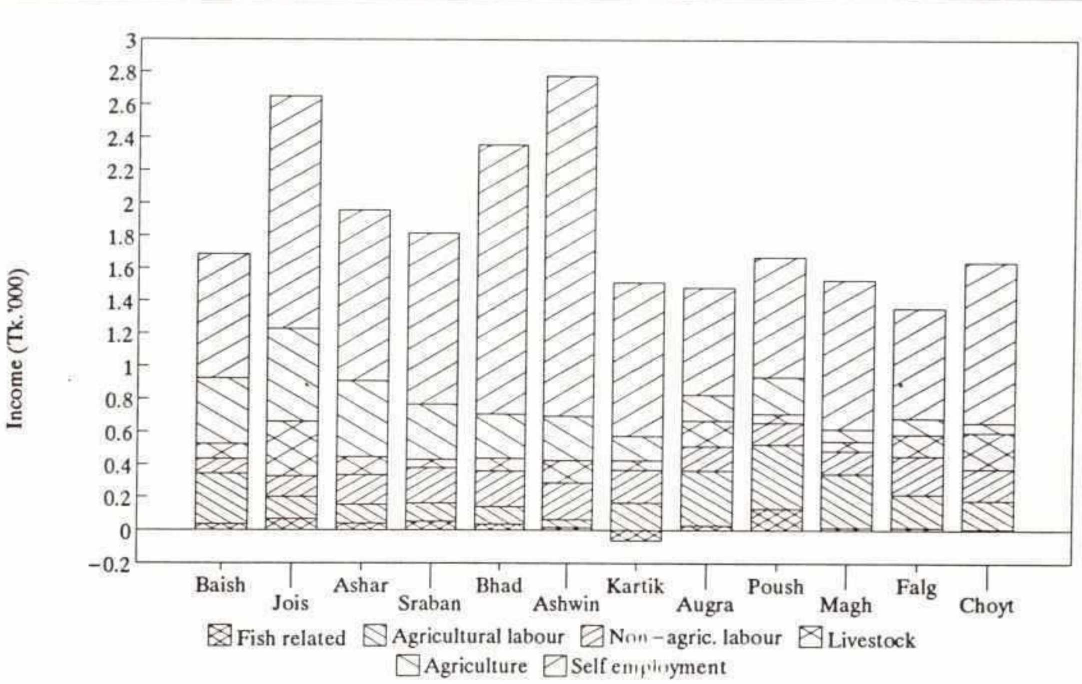
In the main villages in the NE incomes varied significantly. In the villages on the Surma-Kushiyara floodplains (NE1-1 and NE2-1), the overall levels of village income were both significantly higher than anywhere except NC. The villages in the *haor*, NE3-1 and NE4-1, which are more remote and subject to deeper and more protracted flooding, had much lower village incomes, comparable to the poorer villages of the NW or the SW. It was in the NE however that the disparity between landholding groups was the sharpest, with medium landowners generally recording much higher incomes than other groups and with the landless

Table 4.19 North East – Sources of Income by Landholding Category

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	–

Figure 4.7 North East – Distribution of Income through the Year, by Source



Source: FAP17 Village Monitoring

earning considerably less in all villages except NE1-1, where proximity to Moulavi Bazaar 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 NE, the average income earned from agriculture by medium farmers was similar to that earned by small farmers in the NW and less than that earned by them in NC. 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 NE is three times that recorded by them in the next highest region (SW).

Implications for Mitigation

The NE has long been a major net exporting region of fish within Bangladesh. Any loss in the productivity of its fisheries could therefore have far reaching effects. From a broad economic perspective, therefore, there are good reasons why every effort should be made to preserve the productivity of its aquatic systems. However, as has been argued above, the need to mitigate the impact of flood control is as much a function of its potential social impact as of its effect on fish production *per se*. The socio-economic characteristics of the fishery in the NE work then in its favour. Of all the regions studied, the proportion of catch value going to subsistence and part-time fishermen was the lowest, as was the share of this taken by the landless: subsistence fishermen tend to be farmers, the group most likely to benefit from successful flood control.

Professional fishermen take most of the catch but often this is working on behalf of leaseholders, a small group of limited economic vulnerability. A significant drop in the value of the fishery would undoubtedly affect their livelihoods. Where this is anticipated, mitigation measures are essential. But they have the advantage of living in discrete and identifiable communities that could be effectively targeted.

In all other regions part-time fishermen present the greatest problem for mitigation, with relatively high dependence but greater diffusion across floodplain communities. But in the

NE their numbers are more limited and they may be more clustered than elsewhere.

4.4.3 North West

In the North-West Region, two village clusters were researched, located in different agro-ecological units inside the Pabna Irrigation and Rural Development Scheme (PIRDP) in Pabna District. In addition a community inside the Chalan Beel Polder 'B' in Natore District was studied and compared with one located in an unprotected area on the east bank of the Atrai River in Chalan *beel*.

Flood control development has been extremely widespread in the region. Much of the Chalan *beel* area, which used to constitute a major regional wetland, is now protected by polders and the remaining outside area has been drastically affected by the changes in hydrology which these polders and other local flood control works have caused. Many perennial waterbodies are reported to be silting up and large numbers of traditional fishermen from the area have moved out or migrated to India.

Distribution of Catch Between Different Groups

As has been stated, the socio-economic characteristics of the fisheries in all four regions where FAP17 was working are distinct. Ironically no two are more dissimilar than those of NC and those of the NW, despite their proximity and shared influences from the Padma and Jamuna rivers. In the NW, full time professional fishermen, who in this region are largely Muslim and frequently non-traditional, dominate all habitats except *khal*, and the share of subsistence fishermen is insignificant - less than 10% on both floodplains and *beel*, compared to around 60% in NC.

The first indicator of the character of the NW fishery comes from the distribution of gear ownership (Table 4.20). The *current jal*, which in the NC was used only 19.1% of the time by those giving fishing as their first source of income, is used in the NW by full-time professionals in more than 50% of cases. Similarly, the *koi* or *fashi jal* was used twice as often by this group in the NW (64.9%) as in the NC (30.1%).

For the seine nets, the gear type most commonly associated with professional fishermen, it is the gears that are not common which are most indicative of the differences between the

Table 4.20 **Characteristics of Gear Users, North West Region**

Gear Category	Gear Code	Bengali Gear Name	Obser- vations	Religion		Fisherman Category				First Ranked Source of Income (%)				
				Hindu	Muslim	1	2	3	4	Fishing	Farming	Labour	Trade	Other
Gill Nets	65	*Chandi jal*	34	55.9	44.1	91.2	–	8.8	–	91.2	–	5.9	2.9	–
	88	*Current jal*	1083	4.3	95.7	29.3	21.8	38.2	10.6	51.2	15.4	30.6	1.7	1.1
	123	*Koi/Fashi jal*	172	6.1	93.9	42.5	22.4	26.5	8.7	64.9	10.6	18.8	4.5	1.2
	282	*Monofilament Net*	312	17.5	82.5	47.9	23.4	26.7	2.0	71.2	6.5	16.4	3.8	2.0
	316	*Kajuli jal*	70	66.5	33.5	74.3	25.7	–	–	100.0	–	–	–	–
Seine Nets	45	*Ber jal*	561	59.0	41.0	84.5	11.2	4.4	–	95.6	1.0	1.6	1.7	–
	89	*Deol*	201	3.4	96.6	3.5	2.7	34.2	59.5	6.3	62.2	24.5	1.7	5.3
	202	*Moi jal*	555	16.3	83.7	44.2	21.7	26.4	7.7	65.9	6.4	20.4	2.0	5.3
	276	*Hat panch*	31	28.0	72.0	40.9	29.6	29.6	–	70.4	7.5	22.0	–	–
	297	*Horhori*	57	9.4	90.6	54.2	34.4	9.6	1.8	88.6	3.5	7.9	–	–
	306	*Baoli*	149	10.2	89.8	44.1	23.5	25.4	6.9	67.6	11.1	19.9	0.7	0.7
Bag Nets	271	*Suti jal*	87	27.7	72.3	55.5	11.5	26.4	6.6	67.1	10.9	7.3	13.0	1.8
Lift Nets	105	*Dharma jal*	73	1.4	98.6	6.4	1.4	67.8	24.5	7.7	43.0	26.8	12.1	10.4
	266	*Veshal jal*	522	61.1	38.9	84.6	8.4	6.7	0.4	92.9	2.7	3.3	0.8	0.4
Scoop Nets	263	*Ucha*	69	1.4	98.6	20.0	2.9	54.6	22.5	22.9	18.1	57.5	1.4	–
	287	*Hat Tana jal*	70	4.2	95.8	–	1.4	85.0	13.6	1.4	6.0	55.5	28.6	8.6
	296	*Tukri*	68	1.5	98.5	1.5	1.8	31.5	65.3	3.2	27.6	34.5	9.2	25.5
Clap Nets	234	*Shangla jal*	59	1.7	98.3	39.2	21.6	35.9	3.4	60.7	12.2	15.3	6.7	5.1
Katha	149	*Horga*	31	6.5	93.5	–	–	38.6	61.4	–	88.3	4.8	6.9	–
Traps	95	*Doiar*	938	1.9	98.1	24.0	18.5	42.5	14.9	42.6	22.7	26.6	5.4	2.7
	286	*Deal*	86	1.2	98.8	4.7	1.3	52.9	41.1	6.1	32.3	43.5	10.7	7.4
Hooks and Lines	30	*Sip*	867	2.7	97.3	3.2	4.5	33.3	59.1	7.6	34.8	32.6	11.7	13.4
	152	*Tana Barsi*	110	27.4	72.6	17.7	6.9	22.6	52.7	24.6	15.4	13.6	25.4	20.9
	272	*Daun*	652	7.8	92.2	34.9	22.0	37.7	5.5	56.9	6.0	33.6	3.0	0.6
	278	*Nol barsi*	106	3.4	96.6	19.8	18.1	48.6	13.4	38.0	11.0	46.5	–	4.5
Spear	170	*Koch*	73	–	100.0	7.5	2.7	35.8	53.9	10.3	34.4	30.0	16.1	9.2
Cast Nets	164	*Jhaki jal*	1221	21.6	78.4	36.0	12.5	29.7	21.8	48.5	17.7	21.9	5.5	6.4
Push Nets	255	*Thella jal*	655	1.6	98.4	4.1	6.9	44.0	44.9	11.1	36.5	38.2	6.0	8.2
Hand and Dewater.	97	*By hand/Dewatering*	43	–	100.0	–	–	56.7	43.3	–	53.4	43.2	–	3.5
	307	*Hand fishing*	304	1.9	98.1	3.3	1.1	27.7	67.9	4.4	48.0	32.5	5.3	9.7
Other	291	*Urani*	38	–	100.0	9.1	12.2	30.4	48.3	21.3	39.7	23.5	7.6	7.9
	298	*Akra*	335	2.2	97.8	27.2	17.0	38.8	17.0	44.2	10.3	40.3	1.2	4.0
	317	*Thushi*	34	5.8	94.2	2.9	13.4	59.5	24.2	16.3	10.0	52.3	21.4	–

two regions: gears used most exclusively by Hindu professionals in NC (such as *konaber jal* and *satiber jal*) do not feature in the NW, while the nets that appear only in the latter region (*hat panch*, *horhori*, and *baoli*) are all used predominantly by Muslims.

Other gears, with the exceptions of *veshal jal* and *jhaki jal*, though used less by full-time professionals in both regions, are used more by this group in the NW and are more often dominated by part-time professionals than by subsistence fishermen. In the NC, 14 of the other listed gears had a greater proportion of subsistence users; two gears - *shangla jal* and *daun* - were used more often by part-time professionals than by subsistence fishermen in NC, but in both cases the relative dominance of the former category was greater in the NW.

The catch value distribution by gear type for the NW is given in Table 4.21. Though the gears that were important in NC also tend to be important in the NW, there are important differences: the *thella jal*, a primarily subsistence gear dominant in many of the sites of NC, is of much lesser importance of the NW; as were lift nets - both the professionally used *veshal jal* and the subsistence *dharma jal*. In the NW, rather than there being a few dominant gears, there was a variety of gears between which the catch was spread.

The outcome of the interaction between catch value distribution in each habitat and gear ownership is shown in Table 4.22. On all habitats catch was dominated either by full-time professionals (HFC1) or part-time professionals (HFC3); only on the *khal* was a significant proportion of the catch value (25%) taken by subsistence fishermen. The much lower subsistence catch is explained by cultural attitudes: in the NW there seems to be strong residual taboo against fishing among the more traditional members of the agricultural community, particularly using gears involving immersion - hooks or *dharma jal*, for instance, which can be used from the banks of *khal*, are less frowned upon. At the same time, the withdrawal of Hindu professionals from the floodplain fisheries seems to have created opportunities that many households in this generally poor region could not afford to ignore. As a result, there is a much lower participation rate but those willing - or forced - to break with tradition, can and do fish on a more serious basis.

Table 4.21 Value of Catch (%) by Gear Type, North West

Habitat	In/	Site	Gill Nets			Seine Nets						Bag	Lift		Scoop		Traps			Lines and Hooks				Spear	Cast	Push	Dewatering		Misc.		Katha	Kua	Total
	Out	Code	88	123	282	45	306	175	297	202	89	271	266	105	263	296	95	286	222	30	278	272	152	170	164	255	336	307	298	291	270	302	
Main River	O	NW01	3	–	11	15	–	5	1	5	–	–	–	–	–	–	6	–	–	10	–	3	12	–	6	16	–	–	–	–	–	–	92
		NW02	15	–	40	5	–	–	–	11	1	–	–	–	–	–	3	–	–	4	–	1	–	–	6	–	–	1	–	–	–	–	87
		NW24	2	8	5	15	–	–	–	2	–	–	1	–	–	–	32	–	–	9	–	9	3	–	3	1	–	2	–	–	–	–	93
		Average	7	3	19	12	–	2	0	6	0	–	0	–	–	–	14	–	–	8	–	4	5	–	5	6	–	1	–	–	–	–	91
Secondary River	I	NW06	6	–	–	17	–	–	–	2	–	–	4	–	2	–	10	–	–	22	–	1	–	–	11	24	–	–	–	–	–	–	100
		NW07	1	–	–	4	–	–	–	1	–	4	41	–	–	–	8	–	–	4	–	1	–	1	16	4	–	2	3	–	9	–	100
		NW11	2	2	–	27	–	–	1	1	–	18	10	–	–	–	1	–	–	6	–	15	–	–	10	1	–	–	3	–	1	–	97
		NW14	–	–	17	14	8	–	1	8	–	–	1	–	–	–	5	–	–	6	–	1	–	–	8	–	–	–	–	–	26	–	96
		NW19	5	–	–	2	–	–	–	1	–	–	2	10	–	–	5	26	–	10	–	–	–	–	5	19	–	2	–	3	8	–	99
		NW25	5	3	1	10	–	–	–	–	–	1	6	–	–	–	1	4	–	13	–	–	5	–	10	4	–	1	–	–	–	–	64
		Average	3	1	3	12	1	–	0	2	–	4	11	2	0	–	5	5	–	10	–	3	1	0	10	9	–	1	1	1	7	–	93
	O	NW15	3	–	3	18	1	–	3	8	–	–	1	1	–	–	3	–	–	13	–	3	9	–	5	1	–	–	–	–	22	–	95
		NW27	–	1	1	–	5	–	–	3	3	27	5	3	–	–	3	3	–	7	–	1	–	–	27	–	–	–	1	–	7	–	98
		Average	2	1	2	9	3	–	2	6	2	14	3	2	–	–	3	2	–	10	–	2	5	–	16	1	–	–	1	–	15	–	97
Khal	I	NW08	3	–	–	6	–	–	–	13	1	–	12	–	–	–	9	–	–	4	–	–	–	–	24	4	–	8	6	–	7	–	98
		NW20	1	–	–	–	–	–	–	–	–	–	11	25	–	–	–	–	–	5	–	–	–	–	15	29	1	1	–	11	–	–	100
		Average	2	–	–	3	–	–	–	7	1	–	12	13	–	–	5	–	–	5	–	–	–	–	20	17	1	5	3	6	4	–	99
	O	NW16	–	2	–	11	–	–	1	12	2	–	10	–	–	–	3	–	–	5	–	9	–	–	15	9	–	5	1	–	13	–	100
		NW29	–	–	–	–	6	–	–	1	5	64	–	–	–	–	4	–	–	2	–	3	–	–	9	1	–	2	2	–	1	–	100
		Average	–	1	–	6	3	–	1	7	4	32	5	–	–	–	4	–	–	4	–	6	–	–	12	5	–	4	2	–	7	–	100
Floodplains	I	NW04	8	–	–	21	–	–	–	1	–	–	–	–	–	–	21	–	–	–	1	15	–	–	1	12	–	1	–	–	–	17	100
		NW09	12	–	–	24	–	–	–	–	–	–	3	–	–	–	17	2	–	–	–	30	–	–	3	8	–	1	–	–	–	–	100
		NW12	18	–	–	13	–	–	–	–	1	3	18	–	–	–	26	–	–	–	–	6	–	–	2	9	–	2	2	–	–	–	100
		NW22	3	–	–	–	–	–	–	–	–	–	–	–	–	1	13	–	29	10	4	1	–	–	6	1	28	3	–	–	–	–	100
		NW23	1	–	–	–	–	–	–	–	–	–	–	–	–	–	76	–	–	1	6	1	–	–	–	–	9	4	–	1	–	–	100
		NW26	–	1	–	–	–	–	–	–	–	–	–	–	–	20	14	–	–	40	–	–	–	–	–	–	25	–	–	–	–	–	100
		NW28	10	–	–	2	–	–	–	–	3	18	2	–	–	–	14	–	–	–	1	4	–	–	19	2	–	1	1	–	1	19	96
		Average	7	0	–	9	–	–	–	0	1	3	3	–	–	3	26	0	4	7	2	8	–	–	4	5	9	2	0	0	0	5	99
	O	NW17	14	6	1	20	1	–	10	6	–	–	1	–	–	–	4	–	–	5	–	4	–	–	2	–	–	4	1	–	20	–	100
		NW30	6	–	–	2	6	–	–	4	5	38	–	–	–	1	7	–	–	–	1	6	–	–	3	1	–	1	1	–	1	12	96
		Average	10	3	1	11	4	–	5	5	3	19	1	–	–	1	6	–	–	3	1	5	–	–	3	1	–	3	1	–	11	6	98
Beel	I	NW05	9	2	–	22	–	–	–	3	–	–	–	–	–	–	19	–	–	–	1	19	–	–	–	3	–	–	–	–	–	22	100
		NW10	4	1	–	17	–	–	–	1	–	–	–	–	7	–	5	–	–	–	–	7	–	–	7	10	–	1	4	–	34	–	100
		NW13	7	1	–	12	–	–	–	1	–	–	5	–	–	–	12	–	–	–	–	3	–	–	6	8	–	–	4	–	41	–	100
		NW21	8	–	–	4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	55	1	–	–	–	–	32	100
		Average	7	1	–	14	–	–	–	1	–	–	1	–	2	–	9	–	–	–	0	7	–	–	3	19	0	0	2	–	19	14	100
	O	NW18	10	10	–	44	–	–	11	4	–	–	1	–	–	–	1	–	–	–	–	1	–	–	2	3	–	2	1	–	–	6	98
		Average	10	10	–	44	–	–	11	4	–	–	1	–	–	–	1	–	–	–	–	1	–	–	2	3	–	2	1	–	–	6	98

Source: FAP17

Table 4.22 Distribution of Value of Catch (%), NW

Habitat	Fishing Category				Non-Professionals	
	HFC1	HFC2	HFC3	HFC4	Farmers	Others
Main Rivers	53.0	19.0	16.5	11.6	5.8	22.3
Secondary Rivers	41.2	13.7	35.0	10.1	17.9	27.1
Khal	26.3	11.6	37.2	24.9	23.6	38.4
Floodplains	25.4	22.5	38.9	13.4	21.3	30.7
Beel	51.3	15.2	27.5	6.1	13.5	20.1

Significance of Fisheries Income to Different Groups

Professional fishermen in the satellite communities

The income structures of fishing communities are shown in Table 4.23 and Figure 4.8. The professional fishermen in the NW 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 Scheme 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 the main villages

The importance of part-time, rather than subsistence fishermen, is also reflected in the data gathered from the socio-economic village monitoring, and has significant implications for the potential impact of flood control measures that would affect the value of the fishery.

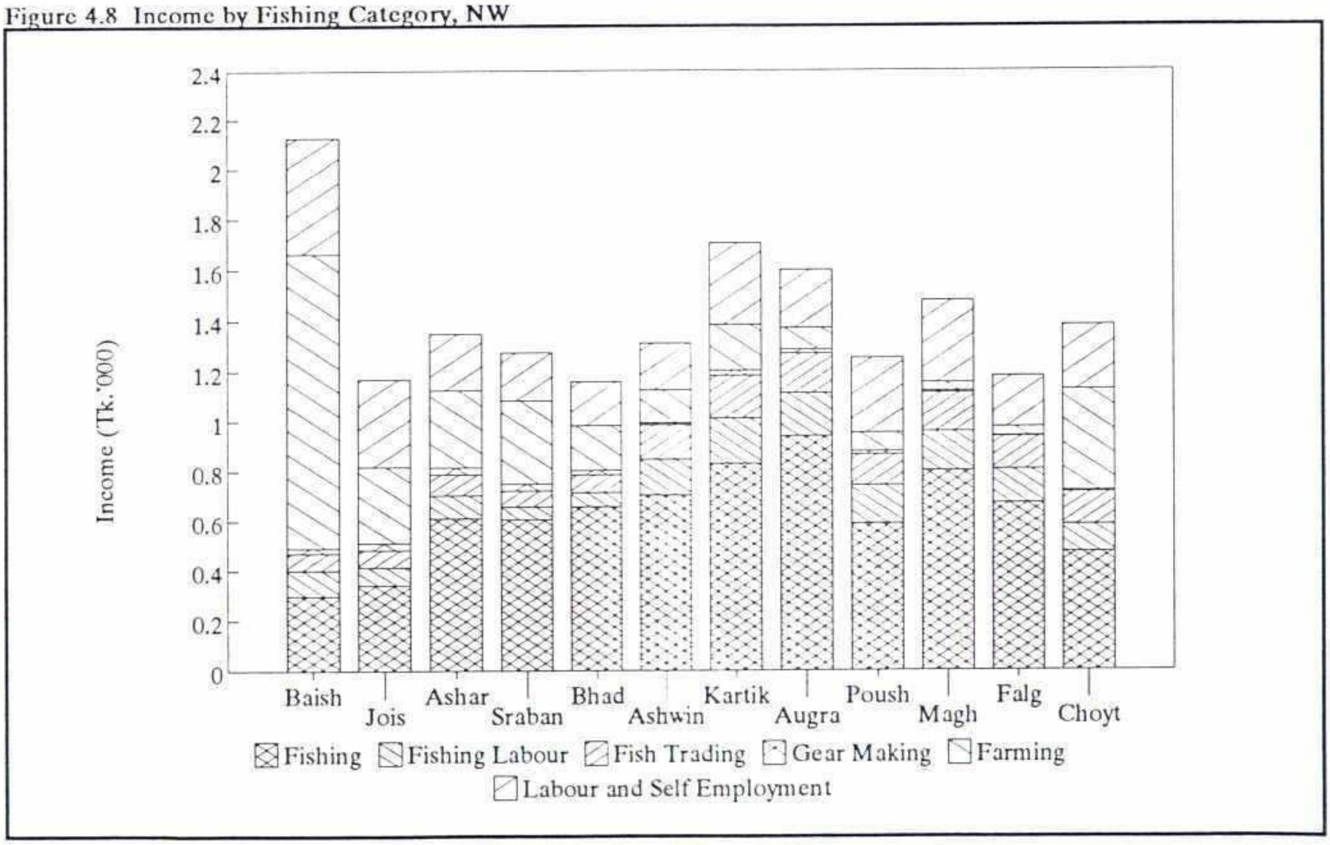
The participation percentage in the fishery of different landholding classes is given in Table 4.24. Of all regions the NW had the highest proportion of non-fishing households (53%). The the next highest, NE, was 16 percentage points lower, and the other two regions were

Table 4.23 Income by Fishing Category – NW — 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
Comm–unity	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

* Negative values for fish culture removed

Figure 4.8 Income by Fishing Category, NW



Source: FAP17 Village Monitoring

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 4.24 Fishing Participation, (%), NW

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

The distribution of households across different income ranges (cash income plus the monetized value of catch consumed) is shown in Figure 4.9. In contrast to NC, where the modal income was less than Tk.250, in the NW 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.

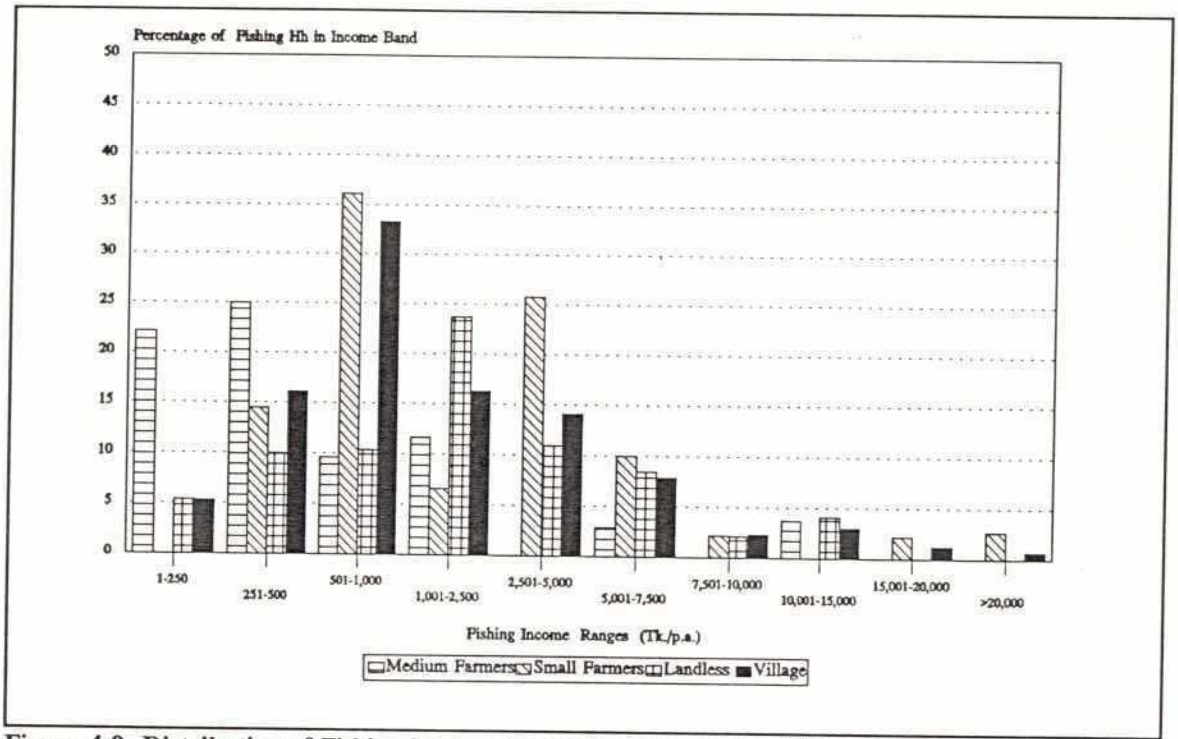


Figure 4.9 Distribution of Fishing Income for Fishing Households, NW

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 4.25 and Figure 4.10. 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 NW, 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.

Implications for Mitigation

The low levels of subsistence fishing imply that the incomes (including non-cash income) of the bulk of the rural population would be largely unaffected by a decline in the value of the fishery, though, as everywhere, all would be hit if there were a decline in the availability of fish. But the corollary of this is that most fish is caught by those for whom fishing is an important contributor to their livelihood. This makes some form of mitigation imperative.

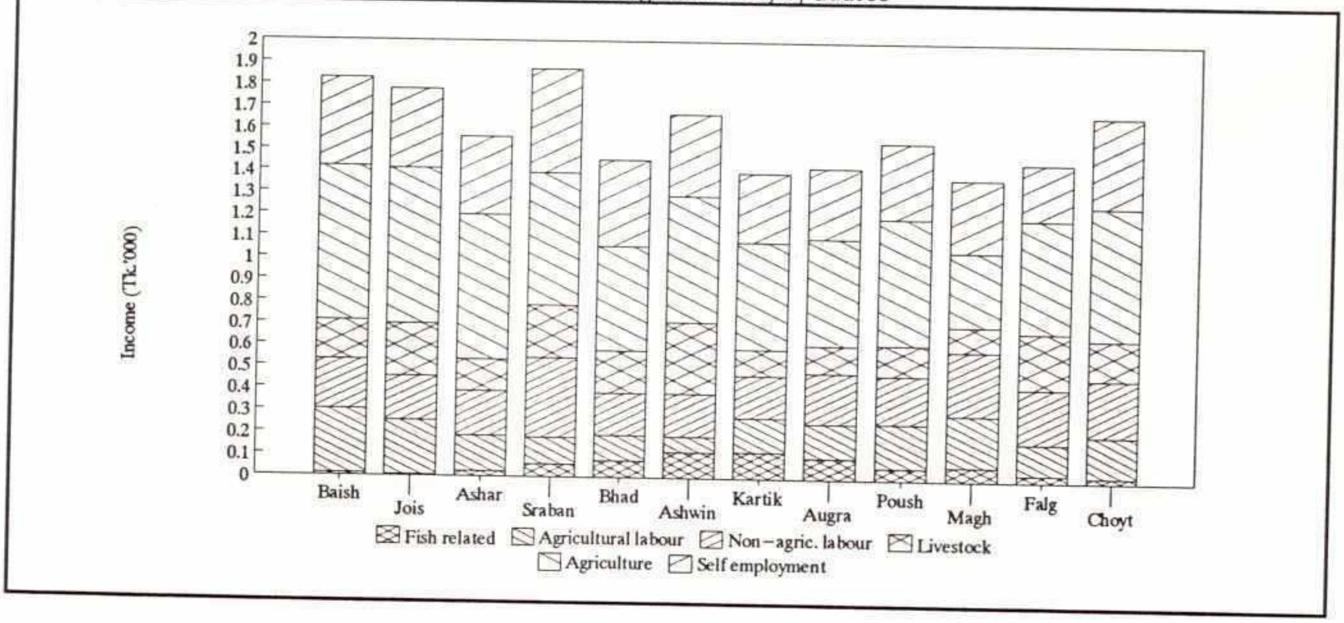
Unfortunately, the high share of the catch taken by part-time fishermen also makes it very difficult. Many of the fishermen in the NW are landless labourers, drawn from the wider agricultural community, who simply have no other viable options. Flood control, if it were to seriously damage the fishery, would hit them hard.

Table 4.25 North West – Sources of Income by Landholding Category

Units: Tk.

Category	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		
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	–

Figure 4.10 North West – Distribution of Income through the Year, by Source



Source: FAP17 Village Monitoring

As always, the best solution would be to ensure that the open water capture fishery retained its value. Aquaculture may replace some of the lost production but it would be difficult to target its benefits to those who had lost out from the decline in capture fisheries.

One positive feature of these fisheries is the relatively high contribution of farming to the incomes of professional fishermen. Though some obtain much more of their income from this source than others, its contribution, on average, is more significant (19.1%) than in other regions. Some fishermen would therefore stand to gain from flood control's intended effects.

4.4.4 South West

In the SW, like the NE, hydrology is the principal factor determining the socio-economic characteristics of the fishery. Here, the difference between the elevation of ridge crests and basin centres is generally less than two metres and though there are areas that are extensively and deeply flooded, there are few permanent waterbodies on the floodplain. Drawdown is into a series of dispersed pools, rather than a single sump; and it occurs early enough for most of the area to be cultivated. As a result, there is little government (*khas*) land on the floodplain that is available for leasing and most of the benefits from the concentrations of fish that occur go to owners of the bottom lands, many of whom have fish pits (*kua*).

Traditional fishing communities are mainly active on the only perennial waterbodies which are both available and subject to some kind of control: the rivers and *khal*. These water courses serve the same fisheries function as *beel* in most other areas, as the principal overwintering grounds for the floodplain resident species. Conflicts and competition over fisheries access tend to be concentrated on these areas and, compared to other regions, *arotdar* or fish traders are particularly important players in this. Many of the principal *jalmahal* on the *khal* around Poysa and Kotalipara are controlled by groups of fish traders who then sub-lease sections of *khal* to fishermen.

In contrast to NW and particularly to NC, where Hindus fishing tended to be traditional *caste* fishermen, in the SW they are not. Though members of this religious group do take a significant proportion of the catch in some areas, this is more a reflection of their higher representation within the wider agricultural community than of their specialisation in fishing.

The FAP17 socio-economic studies were concentrated on Satla-Bagda Polder 1 and Chatla-Fukurhati Scheme.

Distribution of Catch Between Different Groups

The strong seasonality in opportunities reduces the scope for professional full-time fishing, though there are significant numbers of professionals with other sources of income. This is clear from Table 4.26. In all the other regions, seine nets and, to a lesser extent, gill nets were used predominantly by HFC1 fishermen (those with no other ranked source of income). In the SW only one gear (the monofilament drift net) was used more by this group than any other. The principal users of nearly all other gears were either professionals with other ranked sources of income (HFC2) or subsistence fishermen (HFC4). Though the principal users for only two gears - the *shangla jal* and the *koch* (spear), part-time fishermen are nevertheless a very important part of the fishery, accounting for between a fifth and a third of the use of most gears.

Professionals (HFC1 and HFC2) take the majority of the catch only on the secondary rivers - on the main rivers the very important *Hilsa* fishery attracts large numbers of part-timers, reducing the share of professionals to less than half. On the other habitats, subsistence and part-time fishermen dominate, taking around three fifths of the total catch. The distribution of catch value for each FCA site by gear type is shown in Table 4.27.

There is also a distinct trend in the division of that portion of the catch not taken by professionals. On the rivers, the landless (taken to be those not giving farming as their main source of income) catch more than farmers. On the *khal*, the division between these two groups is almost equal. But on the floodplains and, to an even greater extent, on the *beel,* it is the farmers who take more (Table 4.28). Within this general picture there are distinct seasonal variations.

On the *beel* during the peak floods and the drawdown professional fishermen and landless part-timers take advantage of the open-access nature of the resource and secure the bulk of the catch. In the dry season, however, it is the *kua* owners (farmers) who benefit as the remaining fish become concentrated. As 33% of the annual catch value on inside sites and 42% on outside sites is taken by *kua*, this, together with their lesser catch from earlier in the season, leaves farmers with around half the value of annual catch.

Table 4.26 Characteristics of Gear Users, South West Region

Gear Category	Gear Code	Bengali Gear Name	Obser– vations	Religion		Fisherman Category				First Ranked Source of Income (%)				
				Hindu	Muslim	1	2	3	4	Fishing	Farming	Labour	Trade	Other
Gill Nets	88	*Current jal*	1210	47.7	52.3	2.2	45.7	38.8	13.2	48.0	22.9	24.0	4.0	1.2
	123	*Koi/Fashi jal*	289	55.8	44.2	2.4	60.9	27.0	9.8	63.3	18.1	15.1	3.1	0.3
	282	*Monofilament Net*	76	39.5	60.5	41.7	28.8	26.9	2.6	70.5	4.0	24.3	1.3	–
Sein Nets	45	*Ber jal*	135	55.5	44.5	33.3	47.7	18.3	0.7	81.0	7.6	8.3	3.1	–
	202	*Moi jal*	158	35.5	64.5	16.6	52.8	26.5	4.1	69.4	6.4	21.1	2.5	0.6
Lift Nets	105	*Dharma jal*	75	53.3	46.7	–	16.0	33.4	50.7	16.0	32.0	44.0	4.0	4.0
	266	*Veshal jal*	311	78.6	21.4	28.5	52.9	17.6	1.0	81.4	10.1	7.2	1.3	–
Scoop Nets	263	*Ucha*	78	2.6	97.4	1.3	3.9	19.5	75.3	5.2	29.2	39.6	15.6	10.4
	296	*Tukri*	373	38.9	61.1	0.3	7.9	12.2	79.6	8.2	43.3	28.6	14.7	5.2
Clap Nets	234	*Shangla jal*	162	1.2	98.8	6.5	36.8	49.5	7.1	43.4	17.7	37.6	0.7	0.6
Traps	95	*Doiar*	559	49.4	50.6	5.9	44.0	36.8	13.2	50.0	24.0	19.5	5.7	0.7
	222	*Polo*	64	48.4	51.6	–	17.2	31.3	51.5	17.2	42.2	26.6	12.5	1.6
Hooks and	30	*Sip*	664	53.9	46.1	2.7	16.0	20.9	60.3	18.7	27.2	33.7	13.5	6.8
Lines	272	*Daun*	203	38.9	61.1	19.5	43.0	35.0	2.5	62.5	11.1	20.4	6.0	–
	278	*Nol barsi*	428	56.4	43.6	5.9	51.9	34.7	7.4	57.8	13.9	24.3	3.2	0.7
Spear	170	*Koch*	166	58.7	41.3	0.6	17.8	31.5	50.1	18.4	39.8	27.9	8.5	5.4
Cast Nets	164	*Jhaki jal*	585	35.5	64.5	2.4	12.7	22.0	62.9	15.1	37.3	27.1	14.5	6.0
Push Nets	255	*Thella jal*	256	8.6	91.4	1.2	7.1	16.8	74.9	8.3	38.2	31.0	17.8	4.7
Hand	307	*Hand fishing*	86	15.1	84.9	1.2	3.8	11.0	84.0	5.0	49.9	31.3	8.7	5.1

Table 4.27 Value of Catch (%) by Gear Type, South West

Habitat	In/	Site	Gill Nets			Seine Nets					Bag		Lift		Scoop		Traps			Lines and Hooks				Spear	Cast	Push	Dewatering		Misc.		Katha	Kua	Total
	Out	Code	88	123	282	45	306	175	297	202	89	271	266	105	263	296	95	286	222	30	278	272	152	170	164	255	336	307	298	291	270	302	
Main River	O	SW01	1	–	3	16	–	–	–	4	1	–	2	–	1	–	1	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	31
		Average	1	–	3	16	–	–	–	4	1	–	2	–	1	–	1	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	31
Secondary River	O	SW02	–	–	2	18	–	–	–	7	–	–	11	–	–	1	6	–	–	8	–	13	1	–	3	5	–	–	–	–	7	–	81
		SW03	2	–	–	6	–	–	–	2	2	–	47	–	1	–	1	–	–	1	–	–	–	–	17	4	–	16	1	–	–	–	100
		SW07	–	–	2	32	–	–	–	6	–	–	3	–	–	–	7	–	–	7	–	10	–	–	10	6	–	1	–	–	14	–	98
		Average	1	–	1	19	–	–	–	5	1	–	20	–	0	0	5	–	–	5	–	8	0	–	10	5	–	6	0	–	7	–	93
Khal	I	SW04	1	–	–	21	–	–	–	–	–	–	32	–	–	–	6	–	1	4	–	–	–	–	15	2	–	4	8	–	5	–	100
		SW20	3	1	–	4	–	–	–	–	4	–	1	–	–	10	21	–	–	5	–	–	–	2	18	–	–	6	–	–	6	19	100
		Average	2	1	–	13	–	–	–	–	2	–	17	–	–	5	14	–	1	5	–	–	–	1	17	1	–	5	4	–	6	10	100
	O	SW08	1	–	–	4	–	–	–	–	–	–	44	–	–	–	1	–	–	3	–	–	–	–	17	9	–	6	–	–	10	–	95
		SW11	–	–	–	19	–	–	–	–	–	–	8	–	–	–	15	–	–	2	–	24	–	–	7	–	–	–	–	–	23	–	100
		SW12	–	–	–	5	–	–	–	–	19	–	12	4	–	26	1	–	–	1	–	–	–	10	11	–	–	3	2	–	2	–	96
		SW17	–	–	1	–	–	–	–	3	–	1	–	–	–	5	11	–	–	2	–	10	–	2	11	4	–	–	–	–	34	–	85
		Average	0	–	0	7	–	–	–	1	5	0	16	1	–	8	7	–	–	2	–	9	–	3	12	3	–	2	1	–	17	–	94
Floodplains	I	SW05	15	–	–	5	–	–	–	–	–	–	5	–	2	–	20	–	–	–	–	1	–	–	2	5	–	–	–	–	–	44	100
		SW18	23	7	–	–	–	–	–	–	–	–	–	–	–	9	2	–	–	14	25	–	–	3	–	–	–	–	–	–	–	16	99
		SW21	23	6	–	–	–	–	–	–	–	–	3	–	–	3	16	–	–	10	6	–	–	1	–	–	–	–	–	–	–	31	100
		SW22	9	2	–	–	–	–	–	–	–	–	8	–	–	4	10	–	–	1	3	–	–	1	9	1	–	2	–	–	–	16	66
		Average	18	4	–	1	–	–	–	–	–	–	4	–	1	4	12	–	–	6	9	0	–	1	3	2	–	1	–	–	–	27	91
	O	SW09	24	1	–	–	–	–	–	–	–	–	2	–	–	–	3	–	–	6	1	1	–	–	2	9	–	2	–	–	–	50	100
		SW13	33	9	–	–	–	–	–	–	–	–	–	–	–	–	1	–	3	27	16	–	–	–	–	–	–	–	–	–	–	10	100
		SW15	25	12	–	–	–	–	–	–	–	–	7	1	–	–	6	–	–	18	6	–	–	4	–	–	–	–	–	–	–	11	90
		Average	27	7	–	–	–	–	–	–	–	–	3	0	–	–	3	–	1	17	8	0	–	1	1	3	–	1	–	–	–	24	97
Beel	I	SW06	12	–	–	6	–	–	–	–	–	–	4	–	–	–	12	–	1	–	–	1	–	–	2	3	–	–	–	–	–	57	100
		SW19	31	11	–	–	–	–	–	–	–	–	–	–	–	33	1	–	–	1	13	–	–	1	–	–	–	–	–	–	–	8	100
		Average	22	6	–	3	–	–	–	–	–	–	2	–	–	17	7	–	1	1	7	1	–	1	1	2	–	–	–	–	–	33	100
	O	SW10	25	1	–	1	–	–	–	–	–	–	–	–	2	–	1	–	13	4	–	1	–	2	2	5	–	–	–	–	–	43	100
		SW14	18	4	–	–	–	–	–	–	–	–	5	1	–	1	4	–	3	2	4	–	–	4	–	–	–	–	–	–	–	47	96
		SW16	17	6	–	2	–	–	–	–	–	–	9	1	–	2	9	–	–	1	12	–	–	1	–	–	–	–	–	–	1	36	98
		Average	20	4	–	1	–	–	–	–	–	–	5	1	1	1	5	–	5	2	5	0	–	2	1	2	–	–	–	–	0	42	98

Source: FAP17

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Table 4.28 Distribution of Value of Catch (%), SW

Habitat	Fishing Category				Non-Professionals	
	HFC1	HFC2	HFC3	HFC4	Farmers	Others
Main Rivers	14.4	32.2	47.1	6.2	15.0	38.3
Secondary Rivers	28.3	33.4	15.2	23.0	15.1	23.1
Khal	9.2	32.2	31.7	27.4	28.3	30.2
Floodplains	4.3	36.7	45.6	19.3	34.9	24.0
Beel	2.6	32.6	51.1	14.1	49.8	15.1

Significance of Fishing to Different Groups

Professional fishermen in the SW satellite communities have a higher average income than those in either the NW or the NE. The breakdown of their income is shown in Table 4.29 and Figure 4.11. 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.

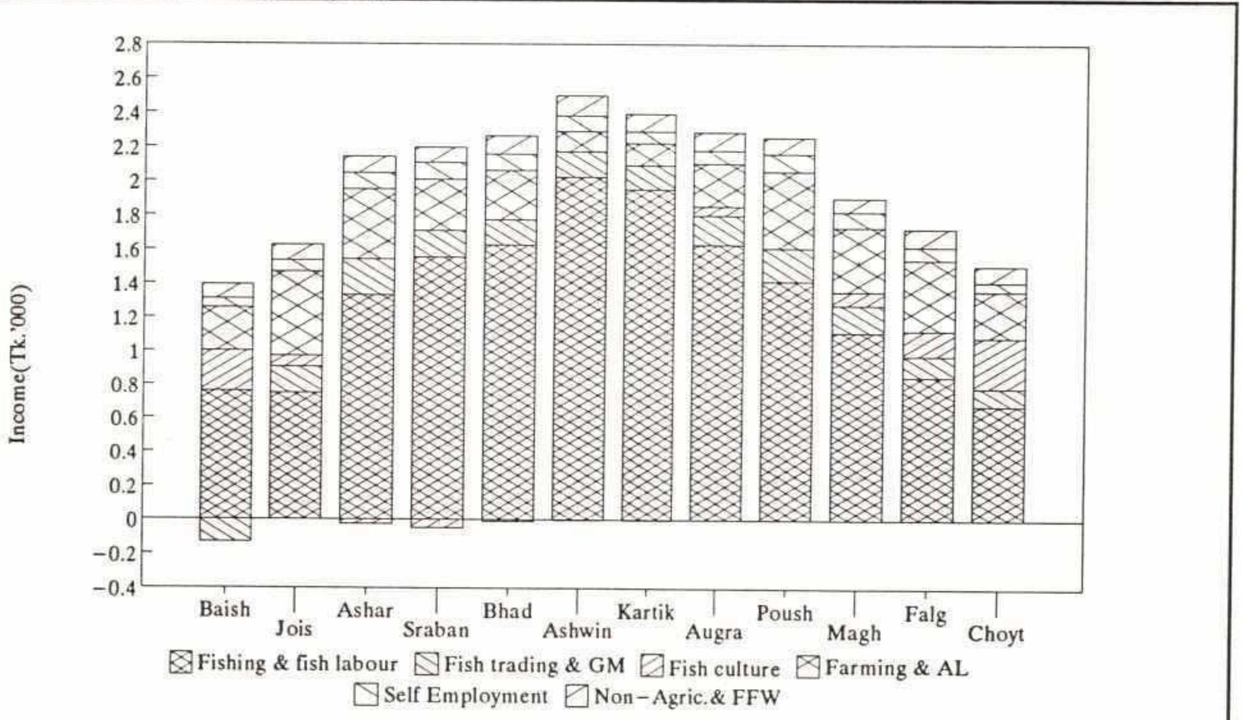
The HFC2 households earn slightly more (Tk.16,500) than the HFC1 from open-water fishing, which is close to or above the total annual income of many fishing households in the NE and NW. But their sources are more diversified, they get less from fishing labour and more from farming and agricultural labour (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).

Table 4.29 Income by Fishing Category – SW

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
	Gear Making	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

Figure 4.11 Income by Fishing Category, SW



Source: FAP17 Village Monitoring

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 the main villages

Fishing was a major contributor to household incomes for the wider agricultural community in the SW. 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 4.30 Fishing Participation (%), SW

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

This is reflected in the participation rates of different groups in the fishery, shown in Table 4.30. Though the region has a slightly higher rate (29%) of non-participation than NC (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 main 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 SW, fishing was ranked as a source of income by 26% and 15% of these groups respectively, compared to 12% and 11% in the NW, the next highest region.

The distribution of fishing households across income bands is shown in Figure 4.12. The modal range is, again, Tk.500-Tk.1,000 but the distribution is less sharply peaked than in the NW, with a greater proportion of households on either side of the mode. Like the NW, 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 SW, the overall participation rate was not as high as in NC, and the levels of income earned by households that did fish was not as high as for the NW. But the combination of high participation and high incomes, gave

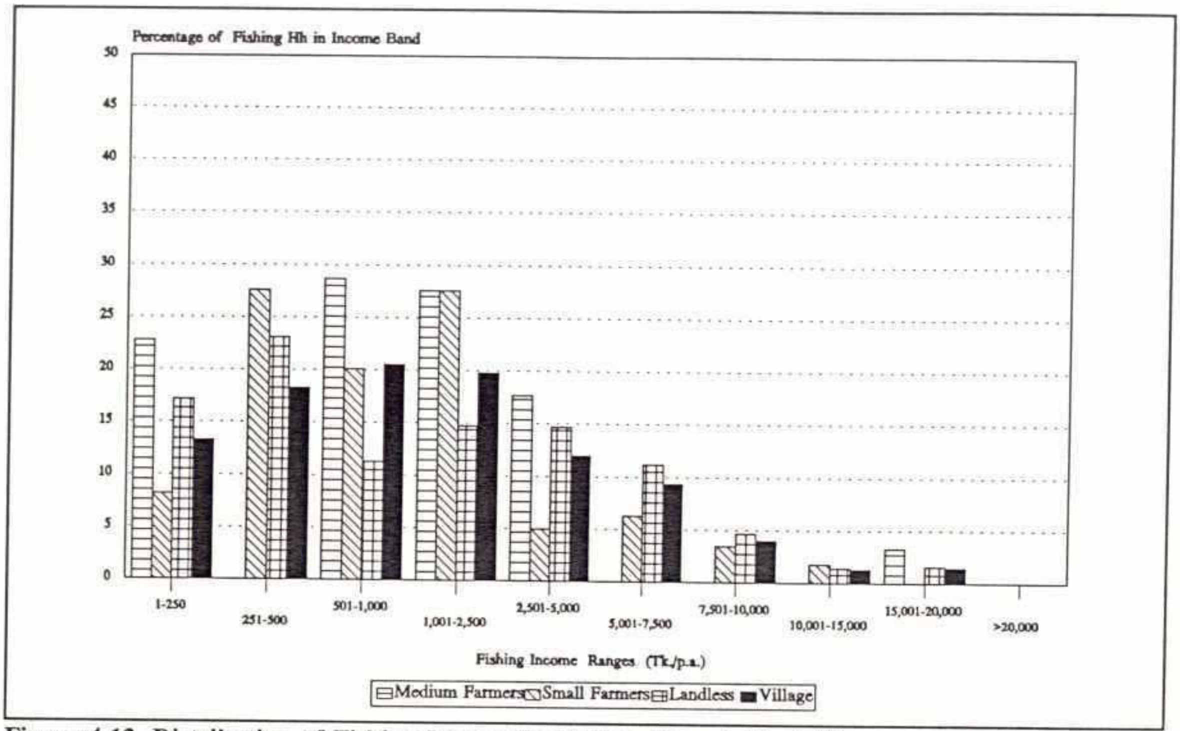


Figure 4.12 Distribution of Fishing Income for Fishing Households, SW

villages in the SW 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 4.31 and the distribution for the latter is shown in Figure 4.13. 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 interseting 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.

Implications for Mitigation

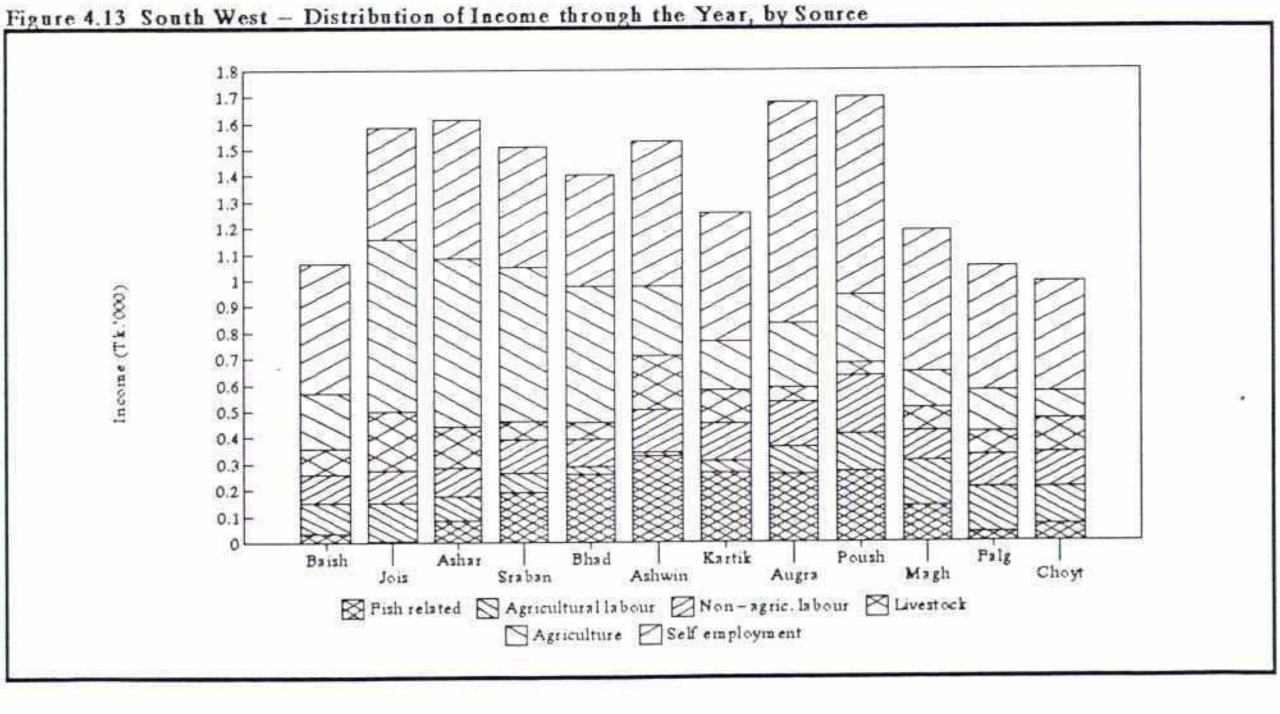
The SW had the richest fisheries of any of the regions studied by FAP17. It was also the most open. The widespread dependence of all social groups on fishing and the significance

Table 4.31 South West – Sources of Income by Landholding Category

Units: Tk.

Category	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		
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	2384	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	–

Figure 4.13 South West – Distribution of Income through the Year, by Source



Source: FAP17 Village Monitoring

of its contribution to total income for small farmers and, in particular, for the landless make planning decisions which affect this resource especially sensitive.

Maintenance of the value of the open water capture fishery would seem, as elsewhere, the best option. Though the dangers of benefit capture by the landed are ever present, as evidenced by the experience of the Third Fisheries Project *beel* stocking and the widespread reports of similar trends in the FAP17 communities studied.

Aquaculture has considerable potential in this region, in part because the principles are well understood due to the widespread use of fish-pits and because of the stark seasonality of the open-water fishery. Professional fishermen, who tend to be increasingly exluded from dry season fishing on the floodplain by the territorial claims of farmers, can therefore keep their incomes going through the year with pond culture. It should therefore be promoted as a complement to any measures supporting the open water fishery, with a particular view to including professional fishermen.

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5. RECOMMENDATIONS FOR MITIGATION OF IMPACTS

5.1 THE NATURE OF IMPACTS FOR MITIGATION

5.1.1 Scope for Mitigation

The role of fisheries in the FAP is a sensitive area. The scale of the fishery, with some 450,000 mt of fish produced annually from inland fisheries, renders it a sector of major economic activity. Any changes in fisheries production or practices which are attributable to the FAP are, therefore, tangible and accountable in economic terms.

The FAP is designed to influence the land/water interface by its control of the distribution of water between river and floodplain. For many species it is the seasonal interaction of land and water which determines their ability both to feed and grow and to reproduce sustainably. The outcome of changes in this interaction will affect the species composition and size of the fish stock. But the FAP, through its effect on agriculture, will also affect the seasonal availability of underutilized labour and the claims on land underlying the floodwaters. In addition, by reducing flood depth, it also modifies the range of gears which may be used successfully. These factors will influence the level of effort that is applied to fish stock harvesting and hence the level of production.

The analysis of the FAP 17 field data has been complicated by these multiple interactions, particularly as the control areas outside FCDs have often been subject to similar processes of change, triggered by siltation, spreading mechanical irrigation, road building etc. Nevertheless, the FAP 17 studies demonstrate the value of the fisheries resource and of the losses that can occur when the area and depth of flooding is successfully reduced.

Measures to reduce or mitigate the anticipated effects of flood control on fisheries should be costed into scheme planning for each option considered. This conforms with World Bank guidelines on the interaction of environmental assessment with the development project cycle.

But the design of these mitigation measures cannot be based on considerations of replacement of fish production alone. The effect of flood control on fisheries has an important socio-economic dimension that must also be taken into account. Despite the fact that floodplain fisheries in Bangladesh are frequently characterised as an open-access resource, the distribution of fishing opportunities is far from evenly spread across the rural community. Two principal features limit fishing for certain groups: hydrology, which defines the types of gear that can be used successfully, and access restrictions, which apply in varying degrees to leased waterbodies and to privately owned bottom lands. In addition to its effects on fish production, flood control may also affect this distribution of fishing opportunities. The first step in designing appropriate mitigation measures is therefore to obtain an understanding of:

- how fish production is likely to be affected
- who is fishing before flood control
- who will probably be able to fish after flood control

Once the expected pattern of loss (and gain) across society has been identified, the necessity and feasibility of directing mitigation measures to those affected can then be evaluated. The various options are considered in Table 5.1.

As noted in Section 4 above, the distribution of fishing opportunities varies significantly from region to region and from habitat to habitat. In some areas, notably the floodplains and to a lesser extent the *beel* of NC, the fishery is dominated by large numbers of the landless, fishing for both subsistence and income. In the NE and NW full time professional fishermen are more likely to be affected. In the SW, full time professionals are much rarer, and an adverse impact on fisheries would be felt more widely.

Particular emphasis is given in Table 5.1 to the question of how widely the impact is spread within each group. This is important if the question of mitigating income/welfare losses is to be taken seriously: a drop in fishing income of Tk.1,000,000 will have very different effects if spread relatively evenly across 2,000 households that fish seasonally for subsistence than if it is spread across 150 households fishing on a part time basis. For mitigation measures that do not simply attempt to maintain the level of open water fish production, this also influences how easy those households who are affected can be reached; 150 households could conceivably be drawn into an aquaculture programme, 2,000 households could not.

Table 5.1 Need and Opportunity for Appropriate Mitigation Measures

Societal Group Affected	Dispersal of Impact	Necessity for Mitigation	Ease of Targeting
Professional (traditional) fishermen	Narrow	High: most are poor and own little land that would benefit from flood control. They have little experience of agricultural labouring.	Easier, as households are usually clustered in identifiable groups
Landless	Wide	Moderate, as this group is more vulnerable than farmers and fishing income can assume a greater relative seasonal importance	Difficult
	Narrow	High, as effects will be stronger and group more vulnerable	More difficult than for professional fishermen
Farmers	Wide	Low, as farmers should be more than compensated by the agricultural effects of flood control	Difficult
	Narrow	Limited, as above	Difficult

5.1.2 Summary of Potential Impacts

FAP 17 set out to identify changes which might be caused to fisheries by implementation of the FAP. Paired studies inside and outside a number of FCD/FCDI schemes were conducted looking at both fisheries production and the flows of income in representative villages. There has also been supporting work on the passive drift of hatchlings, spawned in the rivers, and the opportunities for them to gain entry to empoldered systems and contribute to recruitment inside.

The findings have been presented in a series of Supporting Volumes to the FAP 17 Final Report and summarized as a final synthesis in Section 3 of this Main Volume. The most probable impacts of the FAP indicated by these inside/outside comparisons are summarised below. Points 1 to 8 cover impacts on fisheries; points 9 to 14 cover their socio-economic implications.

1. *Total loss of yield*. The mean value of total catch from all outside sites sampled during 1993/4 was 107 kg/ha. If areas of floodplain are entirely excluded from flooding, either controlled or otherwise, this is the average yield which would be lost.

2. *Relative loss of yield*. Inside empoldered schemes, it was expected that there might be a relative loss in yield compared to outside. Though this was the case in some places, the average fish production per unit area of floodplain/beel was not significantly different in control areas and within embankments. This was true both when all schemes studied by FAP 17 were taken into account, and when only projects considered to be working fairly well were included. Thus no consistent relative loss of fish yield due to empolderment was demonstrated.

3. *Reduction in biological productivity*. This is difficult to ascertain, but statistical analysis of fish abundance inside and outside schemes, after removing effects of effort, indicate that whilst in some cases there was no significant difference in fish abundance or density inside and out, on average density was around 10% less inside. Compartmentalization, therefore, does have a significant biological effect on fish populations inside compared to outside.

4. *Differential deployment of fishing effort*. In some cases the empolderment of an area has reduced the options for fishing, with the result that low effort inside leads to correspondingly low catches compared to outside. However, in others the agricultural and social changes inside appear to encourage more people to fish, with the result that the total yield inside is greater than that outside, effectively swamping any negative biological effects. It is not necessarily the same class of people, however, who benefit from the fishing inside, compared to those outside who benefited before compartmentalization. The question also remains as to the extent of the ability of the fish stocks inside to sustain these rather higher levels of exploitation.

5. *Differential status of fish stocks*. The high fishing effort levels inside compartments, leading to higher catches inside compared to out, may have the effect of impairing the long-term capability of the fish stocks to sustain this level of exploitation, particularly if recruitment and replenishment from outside is restricted by water control measures.

6. *Reduction in species number and biodiversity*. One of the most consistent differences between catches inside and outside **working** empoldered schemes was the reduction in number of species inside. The number of species was sometimes reduced by 30-40%. The same dominant species also keep recurring in catches. The bulk of the fishery is therefore sustained by a relatively few sedentary species nationally, twenty to thirty in all, several of which are closely related.

7. *Reduction in migratory species*. The contribution of migratory species, such as major carps and several river catfishes, to catches is relatively small in the North Central and South West but greater in the North East and North West. However, their contribution to catches is consistently lower inside embankments and frequently negligible. The hatchling survey shows how eggs and fry spawned upstream are often prevented from drifting into empoldered areas due to the sluice gates being closed at critical times.

8. *Reduced recruitment*. Whilst compartmentalization and controlled water flow does not necessarily exclude the entry of the downstream drift of eggs and larvae into the schemes, the hatchling survey does show that some species can be excluded, depending upon the timing of gate closures. This effect has undoubtedly contributed to the much lower number of species occurring in catches inside schemes.

The socio-economic impact depends on who is exploiting the fishery prior to flood control and the types of hydrological and biological effects anticipated.

Where flood control reduces the extent and depth of flooding, there can be multiple losers:

9. ***Professional fishermen*** *lose from intensified competition with local agricultural communities* . Professional fishermen are likely to lose out both as production declines and as the remaining stocks become increasingly accessible to subsistence or part-time fishermen whose patterns of gear ownership previously excluded them from the more deeply flooded areas. Such losses will be most dramatic where traditional Hindu fishermen find themselves in competition with members of local Muslim communities; but traditional Muslim fishermen would also be at a disadvantage, in both numbers and status.

10. ***Professional fishermen** lose from the decline in khas land.* The extension of cultivation onto *khas* land will establish *de facto* claims to fish, concentrating on farmers plots during the drawdown, particularly if the residual stock is of sufficient value to encourage the development of *kua*. This will, again, be to the detriment of professional fishermen (and leaseholders).

11. ***Subsistence and part-time fishermen** can sometimes gain but will more usually lose.* The overall impact on subsistence and part-time fishermen will depend on the balance between the overall decrease in the stock and the increased fishing opportunities which they enjoy due to changed hydrology; if changes in stocks are significant or professional fishermen played little role in the fishery prior to flood control, these groups are likely to lose out.

12. ***Leaseholders** are likely to lose, but can sometimes gain if greater water control allows more complete harvesting.* Wherever there is a significant decline in the value of the stock, leaseholders are likely to lose out (as will the government, due to reduced revenue). However, in some circumstances, reduction in the depth of flooding may benefit leaseholders (in the short term at least), if they are able to secure greater control of water levels in *beel* following the drawdown. Low water levels increase fish catchability, thus allowing them to harvest a larger proportion of the residual stock with lower labour costs. Such effects may offset a reduction in the total stock (at least partially) for the leaseholder but will compound the disbenefits for the professional fisherman.

Where the timing of the flood is affected, but area and duration change little[5], the principal fisheries impact is likely to be on species composition and so on the average value of the catch per kilogramme.

13. ***Professional fishermen** lose most from changes in species composition but there may be benefits to the poor.* Professional fishermen (and leaseholders) are more likely to be affected by this than other groups. To the extent that they then choose to fish elsewhere, this will benefit subsistence fishermen and local consumers, for whom fish will become more abundant/cheaper.

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[5] Flood control that delays flooding often delays drainage as well, so flood timing can be affected without significantly changing duration.

5.2 MITIGATION MEASURES

5.2.1 Fish Passes, Sluice Gates and Water Management

Technical Aspects

The provision of fish access routes to and from an area subject to compartmentalization or empolderment has been the subject of a special study by FAP 17 (Interim Report, Annex A) and has also received considerable attention from FAP 6.

There are two reasons why access might be provided as a specific mitigation:

- To offset any reduction in yields (or average value of production) through lack of natural recruitment.

- To allow as many species as possible to persist in the modified conditions, maintaining biodiversity.

The species that would benefit most from maintaining access routes open are those for which movement between river channel and the floodplain is essential for successful reproduction, feeding and growth. Prominent here are the major carps and certain catfish species, all of which are traditionally highly valued in Bangladesh.

Three aspects of the movement of these fishes need to be taken into account to ensure full floodplain access and the sustainability of their populations:

- The upstream migration of adults, typically in the early monsoon, with subsequent movement onto the floodplain for feeding and/or spawning.

- The passive, downstream drift of recently spawned eggs and hatchlings, also in the early monsoon, onto the floodplain for early feeding and growth.

- The active/passive downstream escapement of adults and juveniles from the floodplain back to their dry season refuges in the rivers and canals as the flood recedes in October/November.

(a) Upstream Entry

The conventional fish ladder is a structure designed to allow upstream migrating adults to pass through or around barriers. Reviews of fish pass design conducted by both FAP 17 and FAP 6 suggested that the most appropriate for Bangladesh would be a 'pool and weir' type, with vertical slots to allow the passage of less active and bottom-dwelling species. (These would also allow fish to move out of embanked areas as the flood recedes.) They are not, however, specifically designed to allow any drift of hatchlings into the compartment: these would need other types and points of access.

However, most regions of Bangladesh are very flat. For their effective operation, fish passes require a minimum water head difference between their upstream and downstream ends of around 2 or 3 metres. Only in the North East FAP region of Bangladesh, where differences of up to 10m are encountered, would heads of water be sufficient for the operation of such fish ladders. Outline designs for use in the North East have been included in the FAP 6 proposals for fisheries engineering measures.

Furthermore, the studies of FAP 17 in the North West, North Central and South West Regions, and of FAP 5 in the South East, have shown that most types of existing regulator do not present an impassable barrier to the movements of fish - provided they are open. Thus in most areas of Bangladesh there is no need to build specially designed structures to allow fish passage, and instead attention has focused on modifications to the operational regime of existing water regulation structures. Existing FCD/FCDI compartments typically contain a number of sluice gates which can be opened to either let water in for agricultural purposes, or to allow drainage if levels of excess flooding inside exceed river levels outside.

Opening the sluice gates at the right time to let water out during the pre-monsoon allows, and indeed encourages, migratory adults to enter the compartment, as they instinctively move upstream in response to increasing current at this time in the year. In a typical year, drainage sluices may be opened during the pre and early monsoon to drain out the excess rainwater. This may well coincide neatly with the period when the adults are migrating upstream.

However, due to the rather arbitrary management system for most regulators, there is unfortunately inadequate information available on exactly when drainage sluices are open. Similarly, knowledge of the precise timing of the migrations of adult fish is also lacking. The latter element is difficult to determine, and requires a specially designed study.

Even if the opening of sluice gates and the upstream migration of adult fish do coincide, the possibility that the fish will enter through the sluice gates depends upon their design and operation. To induce fish to pass through, the current velocity of the water flowing through the sluice must be sufficient to stimulate the fish to swim against it but not so fast as to make this impossible.

Again, hard data on the swimming response of Bangladeshi species is not available but the review conducted in the FAP 17 Fish Pass Study indicated a suitable range of current speed of between 0.3 and 1.8 m/sec. However, marked differences between species and sizes of fish are to be expected.

Further studies would be required to test whether the management of drainage sluices in Bangladesh produces currents within the required range, or could be adjusted to do so.

Also of considerable advantage would be a regulator design which minimises turbulence, since this tends to disorientate migrating fish. Available evidence suggests that flap type sluice gates are unsuitable in this regard.

The basic needs for the use of regulators to allow the passage of upstream migrating species have begun to be addressed by several of the FAP and related projects. FAP 20 conducted simulation trials for the design of a regulator across the Lohajang River. Testing of fully retracted gates with a number of vents indicated that fine regulation of water flow was difficult without frequent gate adjustments, and even then oscillations in flow and current speed may occur. Similar characteristics were found for overshot sluices.

By contrast, simulation runs with simple undershot sluices showed that these would allow more finely tuned and stable regulation. This is consistent with operational experience and recommendations from elsewhere.

In the design of pumping stations and water control structures for the Gumti Phase II Scheme, the need for fish friendly structures was taken into account. Most of the control structures described were sliding gate undershot sluices, although some collapsible gates were also recommended. The regulatory effect of collapsible gates with regard to fish passage is unknown. However, some flap gates were also suggested. Given the general experience of the turbulence caused by such gates and the consequent difficulty caused for the passage of fishes, this type of gate ought to be avoided.

The plan for Gumti Phase II also mentions major pumping stations and the need to protect intakes with trash screens. This raises the question of the need to screen intakes from the entrainment of fish. The intake currents can cause substantial damage to migrating adults and drifting eggs and juveniles, but a number of screening methods of varying complexity are available.

The physical design of a regulator will not, on its own, guarantee fish passage. The mode of operation is equally important.

In one of the few direct observations made on the interaction of migratory fishes with a regulatory structure in Bangladesh, it was noted by FAP 17 that when the Charghat regulator on the Baral River had all three of its undershot gates open to some 2.5 m, during the 1992 monsoon, large numbers of adult *Hilsa* were being caught immediately downstream of the regulator but none above it. The water discharge rate was estimated at 2.8 m/sec which is considerably higher than the 1.8 m/sec often found to be the working maximum for non-salmonid fishes. In fact, for such fishes, the maximum found usable in both Russia and South America is 0.8 - 1.1 m/sec. Even with all the gates open, therefore, the Charghat regulator was probably acting as a barrier to upstream adult migration.

In most cases, however, the operational current speeds are currently unknown from compartmentalized schemes, although they can be easily measured. In general, the gates of drainage sluices or those across major waterways might be managed to allow at least some to be open sufficiently to produce a current velocity within the range required to permit the entrance of fishes. If higher discharge rates are operationally essential, a by-pass canal cut around the main regulator should be considered. This could be controlled by an undershot sluice to adjust the current speed appropriately, and would emerge some way above the main regulator.

(b) Downstream drift

The FAP 17 hatchling surveys in the North West, North East and North Central Regions

(Supporting Volume 11) have shown that there is a substantial downstream drift of eggs and hatchlings during the monsoon season. In virtually all sites outside empoldered schemes two peaks in hatchling drift were found; one in the early monsoon, from June to July in North Western and North Central sites, and one in September to October. In the North East the first peak occurred rather earlier, in March to May, reflecting the earlier rise in the floods around Sylhet. A similar study on hatchling drift at sites in the Lohajang river in North Central Region by FAP 20 also showed peaks over the same period as the FAP 17 North Central sites, but noted that both these and subsidiary peaks coincided with increases in water level. This apparently stimulates the adults to spawn and results in a pulse of hatchlings coming downstream.

It is apparent from both FAP 17 and FAP 20 studies that the initial peak is the largest and also that major carp hatchlings are principally to be found in the first wave.

The hatchlings typically drift downstream and are ultimately carried onto the floodplain where they would proceed to feed and grow. If the floodplain is compartmentalized, then the seeding of the floodplain will depend on regulators being open to allow an inflow of drifting hatchlings. However, at this time, when the tendency to flood compartments is being minimised, the sluice gates are more likely to be closed.

The effect of this is exemplified by the situation of the sluice gate at Bauitara in the Brahmaputra Right Embankment Scheme and the operation of the Charghat Regulator which reduced the numbers of hatchlings on the Old Hurasagar and Baral rivers respectively. Within the Manu Irrigation Project in the North East, Kawadighi *Haor* would not have received any recruitment of hatchlings from outside, had not breaches occurred in the embankment early in June. By this time, however, the greatest peak in hatchling drift, including that of the major carps, had passed. Even submersible embankments, as around the Shanghair *Haor* Project in the North East, prevent the entry of the early peak of hatchlings, which have passed by the time embankments over-top (Supporting Volume 11).

It would seem important, therefore, that if recruitment and colonisation of the compartment from outside is to take place, then provision must be made for some sluice gates to allow inflow in the critical period as the first wave of hatchlings pass. This first peak in supply of young fish comprises a significant proportion of the total annual quantity of vulnerable and valuable migratory species which appear to be casualties of compartmentalization. The critical periods appear to be June/July in the North West and North Central Regions and March - May in the North East.

It is not clear whether adults would be most likely to enter a compartment via drainage sluices on their active upstream spawning migration or more passively through inflow sluices on their lateral movement onto the floodplain following spawning. However, some opening of inflowing sluices to facilitate larval drift might also accommodate post-spawning adults.

Unfortunately the needs of hatchlings and adults are not identical. The hatchling study of FAP 20 demonstrated that significantly higher densities of hatchlings are to be found in the upper layer of water where water velocities are also higher, favouring the use of overshot sluices. The optimal conditions for the passage of adults, on the other hand, are met better by undershot sluices. Undershot sluices however have greater versatility, since considerable quantities of hatchlings are still to be found in the lower water levels and turbulence in passage through the sluices will promote mixing of the layers. Certainly, virtually all of the sluices examined have been undershot sluices and, where they are open, they have been shown to let through substantial quantities of hatchlings.

Whilst a proportion of the hatchlings which may be excluded are migratory species, it is also clear from all the hatchling studies that a large proportion belong to the category of sedentary species which support the main part of the fishery (Section 3). Though these species will undoubtedly spawn within the compartments, it is unclear whether this local spawning is adequate to support the population or whether reinforcement by recruits from refuges in *khal* and rivers outside the scheme is essential for their maintenance. Given the dependence of the fishery on these species, this provides another reason for allowing some inflows into the compartments during the reproductive period.

(c) ***Exits from Compartments***

Adults of most migratory species must leave the compartment on the floodplain for their dry season habitats in the river channels and canals. As a rule this is not a problem, since normal use of polders for agriculture involves drainage for harvesting and planting towards the end of the flood season. In fact, from most of the sites investigated by FAP 17, the waters are retained for two to four weeks beyond the fall of the flood outside, thereby marginally increasing the fish growing season.

There is also the question of the sedentary species which provide the bulk of the catch. There is considerable evidence that fishing effort tends to be greater inside an FCD scheme compared to outside. These sedentary stocks are, therefore, under considerable pressure. It may therefore be significant that, whilst they are able to reproduce inside the compartment, they may also depend upon a proportion of individuals escaping to refuges outside the compartment to enable recolonisation, assuming hatchlings or adults can enter during the following monsoon.

But not all exits from the scheme are desirable: mode and timing are also critical. A forcible exit, particularly for hatchlings, may be provided by pumping stations. These are called into play when excess flooding within a scheme threatens the paddy. Observations of hatchling numbers inside and outside a working pumping station at Kaitola on the Pabna Irrigation Scheme, made in September 1993, showed greatly reduced numbers of live hatchlings outside the pumping station. It was evident that hatchling recruits were being pumped from within the scheme, where they were needed, to outside, with high levels of mortality. Some form of screening across the pump intakes would reduce this loss.

Socio-economic Aspects

Of all the options for mitigation the maintenance of fish access routes is that most likely to have the least effect on the *status quo*. Nevertheless, there will be distributional effects.

An unempoldered floodplain will typically be drained by a large network of *khal* connecting it to adjacent rivers. Due to the cost of building and managing sluice gates, the number of access points will usually be reduced when embankments are constructed. Thus, though an aquatic connection may be maintained when these sluices are properly managed, the fish and the hatchlings are channelled to a much greater extent than before. This increases their chance of capture and thus the incentives for controlling the fisheries on the remaining migration routes. Communities adjacent to these routes stand to benefit; those on the routes that have been blocked stand to lose. The design and targeting of additional mitigation measures should reflect this.

5.2.2 Stock Enhancement

Technical Aspects

The fish yields inside FCD/FCDI compartments depend very largely upon sedentary, floodplain resident species (Section 3). The contribution of migratory species, including major carps, is often negligible. Even outside embankments, the contribution to floodplain catches is frequently 10% or less. Under earlier circumstances, before modification of floodplains began, the migratory species and specifically the major carps almost certainly contributed a much greater percentage to the catch. For example, during the late 1950's major carps made up 20 - 45% of the catch on the lower Ganges in India. The perception of a vacant niche appearing in the floodplain fish community resulting from a decline in these species became the rationale for the World Bank Third Fisheries Project, and others including the Asian Development Bank Second Aquaculture Project, which promoted large scale stocking of the floodplain.

Stock enhancement by restocking is a method of offsetting potential losses in fish production or even increasing fisheries yield. For example, during the implementation of the Third Fisheries Project the yield from BSKB beel, a totally empoldered scheme in the South West Region, increased from 82 kg/ha prestocking to 149 kg/ha after stocking in the moderate to heavy flooding year of 1993.

This technique, however, does require a considerable investment and, in the short run, when the supply of fingerlings is less than completely elastic, entails an opportunity cost of lost production from aquaculture, the use from which such fingerlings may be diverted. In the first year of the Third Fisheries Project 434 tonnes of fingerlings were put into five *beel* covering 26,000 ha, at a target stocking density of 20 kg/ha. With each fish weighing close to 7g, almost 62 million fingerlings were required. The fact that such numbers are available is a tribute to the striking success of the rapidly expanding numbers of small private hatcheries in Bangladesh. It needs to be borne in mind, however, that these hatcheries are already supplying a vigorous aquaculture sector in Bangladesh. One unplanned and undesirable result of the large scale stocking programmes was a shortage of supply, and rise in the price, of young fish for on-growing in ponds. Any further large scale stocking programme will depend upon a further expansion of juvenile supplies from hatcheries.

In general, in an average to good flood year, the Third Fisheries stocking has produced a harvest of stocked fishes 4 to 10 times the weight of the fingerlings released, over a time period of 3 -4 months between stocking on the rising flood in July and harvesting as flood levels decline from October onwards. The production, however, is partially dependent on hydrological factors. Therefore, just as yields from virtually all sites sampled by FAP 17, both inside and outside embankments, were much lower in the drought year of 1992 than in 1993, so the yields of both stocked and wild fish were smaller during 1992.

The costs of stock enhancement are relatively large, but the most recent economic appraisal of Third Fisheries procedures by the World Bank showed an average IRR of 25%, with BSKB rating 14%, i.e. above the target for economic viability. The problem, however, for any stocking scheme is cost recovery. It may be that, in coherent compartmentalization schemes, it is easier to organise fishermen's groups to take on responsibility for the cost of fingerling purchase than it would be on open floodplain systems.

As a mechanism for offsetting fisheries losses and for rehabilitation of certain sections of the fishery, restocking is technically feasible for the type of compartmentalization envisaged by the FAP and can be economically viable. There do remain questions, however, of who will pay for it and how the benefits can best be distributed. In addition, the Third Fisheries Project began with a fixed species composition involving three species of major carp plus the exotic silver, common and bighead carps, and a fixed stocking rate. It has become clear that species composition, stocking density and size of fingerlings are variables which need adapting to environmental circumstances. No doubt trials would be needed across regions and habitats to finalise such factors for the FAP project areas.

Socio-economic Aspects

One of the more important insights provided by the village studies was to the degree of competition that exists for all fisheries resources of value in rural Bangladesh. This has been reflected in the experience of restocking by Third Fisheries. In the SW in particular, a large proportion of restocking benefits have been taken by *kua* owners, who captured up to 40% of the stocked species. Many of these *kua* were dug in response to the higher returns made possible by stocking. Thus rather than simply benefitting (landless) fishermen, restocking has been to the advantage of landowners.

While it is true that *kua* are more important in the fisheries of the SW than elsewhere, their widescale development there is a reflection of the wide distribution of land rights across the bottom lands in this region, not an indicator of a unique degree of avarice among non-fishermen.

Elsewhere in Bangladesh, the distributional impact of restocking may differ, but it is unlikely to result in a simple increase in benefits for the professional fisherman. Outside the SW, bottom lands may more often be *khas* land as they are occupied by permanent waterbodies or land that is flood free for too short a period to be taken into the agricultural cycle. (Though, due to siltation and the spread of mechanical irrigation unoccupied *khas* land is getting rarer.) Here government *jalmahal* are often available for leasing. Where these are of limited economic value, they may be under the exclusive control of professional fishermen. Where their economic value is high they are more often controlled by leaseholders from outside the fishing community, sometimes fronted by a notional fishermen's co-operative. Stocking, by increasing the value of a *jalmahal*, correspondingly increases the incentive to gain control of it. Sometimes this will result in an increase the amount of money bid for the lease - thus recouping some of the cost of stocking.

Where such a lease is already controlled by someone from outside the fishing community, fishermen are likely to benefit at least to the extent that a greater quantity of their labour is required for harvesting. (Though the interactions can be more complex, see Supporting Volume 19 on Leasing.) The balance of the economic surplus created, over and above that going to the government as additional leasing fees, will tend to accrue to the leaseholder.

Where such a lease is controlled by professional fishermen, they may find themselves unable to compete for the renewal of their lease: they will either be outbid or bureaucratically out-manoeuvered.

The most realistic method of reducing the chances of the benefit capture by outside interests is through the involvement of NGOs in fisheries management. This has been successful in the *baor* in the SW and is now being pursued by Third Fisheries.

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5.2.3 Refuges and Closed Seasons

Technical Aspects

The sedentary species which make up the bulk of the catch have been shown to persist in the canals and any residual water remaining in the *beel*. For the fishery to be maintained, sufficient adults must survive the dry season to repopulate the flooded area in the monsoon. But flood control can make such systems shallower and - perhaps related to this - can lead to increased intensity of fishing effort. Together these effects could greatly increase the chance of stock levels being driven below the sustainable level.

The most obvious ways to conserve the sedentary species are to give their refuges some protection, or to construct more refuges. The recommendations of FAP 6 in the North East support these conclusions. Refuges may vary in form and size depending on size and seasonality of the water body. In the North East, large *katha* are normally used to attract fish during the fishing of leased *beel* in the dry season. These same *katha* can be extended to form brush-parks or sanctuaries which would provide shelter and prevent fishing with nets and other devices. The Department of Fisheries demonstrated a practical way in which such large refuges can be constructed when it developed an 18 hectare pit in Halti *Beel* in the North West Region using resources provided by the Food for Work Programme. On smaller *beel* in other regions of Bangladesh the same method could be adopted to provide dry season shelters for fish. However, before methods of improving fisheries management in these small *beel* can be considered, the water resource upon which they are based must be protected and conserved. FAP 20 recognised the importance of maintaining the dry season water levels in the small *beel* within the Tangail CPP and included a provision in their future plans to maintain these levels above a certain minimum level recommended by their fisheries team by the establishment of protective sills in re-excavated drainage canals of each *beel*. This approach should be adopted as a standard procedure in future FCD/I proposals and existing FCD/I schemes where canal re-excavation is being considered.

On slightly higher land which dries out completely, fish pits (*kua*), often containing *katha* are excavated to attract fish during the flood drawdown and are fished later in the dry season when fish are more scarce and prices are higher. Traditionally, some *kua* were left unfished by their owners so that the broodstock they contain could replenish the floodplains in the following year. Today, most *kua* are fished-out completely. This practice has been made easier in recent years by the widespread availability of mechanical pumps which allow farmers to dewater *kua*. A return to traditional fisheries management practices using existing or new *kua* as fish sanctuaries is technically simple but would probably require the involvement of farmers or fisheries groups under NGO supervision.

An alternative way of providing a refuge would be to declare a closed season on certain canals or other water bodies. This again would need policing, but it would represent a discrete area for surveillance. If it were carried out under NGO co-operation with fisheries groups who became convinced of its benefits, a certain amount of self policing might be possible.

Establishing such closed seasons would however face obstacles, as the trend is in the opposite direction: fishing rights to a *khal* are being increasingly leased out and their whole length then dewatered. This is a particularly damaging practice which is more prevalent inside existing FCD/I schemes and should be prevented at all costs.

Socio-economic Aspects

By sustaining populations of floodplain resident species, refuges have the potential of ensuring the continued availability of the species on which all the social groups engaged in fishing principally depend.

The problem with refuges is that the concentrations of overwintering fish that they are designed to create are extremely economically attractive. Whatever the disadvantages for the wider community, any individual or group that fishes them out gains significant and immediate returns. Moreover, even when created with the best will by one arm of government, they are open to exploitation by another. The refuge constructed by DoF in the NW is a case in point, as its use as a refuge was countermanded by the Ministry of Land which then leased it out to a private individual as a *kua* or 'tank' with all fishing rights. Thus far from conserving the fish stocks to provide a sustainable yield, it is now contributing to the damage.

There are, therefore, three difficulties with the construction of refuges: they need resources for construction, they are open to misuse, and they need policing. Again, the involvement of NGOs in this would seem the only realistic way forward.

5.2.4 Fisheries Management Information

Technical Aspects

Virtually nothing is known of the population dynamics of the species which form the bulk of the catch inside compartmentalized systems, and their interaction with hydrological variations and increases in fishing effort. The ability to diagnose whether the fisheries are under-exploited or over-exploited remains limited. This, however, is critical for a full evaluation of the long-term effects of compartmentalization on the fish stocks.

Whilst the inland waters of Bangladesh do contain a high number of species, it is clear from the FAP 17 surveys that the bulk of the catch comes from about 25 species. Many of these are related and fulfill similar ecological roles. It is probable, therefore, that these species could be reduced to fewer groups which are likely to have similar population characteristics. As a specific act of mitigation, the population dynamics of these groups could be investigated and introduced into the various available predictive models to determine the levels of effort beyond which the fishery cannot be sustained, the likely interaction of hydrology and effort which could cause a collapse of the fishery and the limits to resilience of the populations. This would contribute to the integrated management of the compartments as agrofisheries systems.

Socio-economic Aspects

It must, however, be recognized that even if the scientific data were available, the practical problems facing any attempts at fisheries management in rural Bangladesh are enormous. In the *haor* of the North East Region, some leaseholders are able to effectively "manage" their *beel*, but it involves much expense, intensive manpower use and frequent application of serious intimidation and violence. It is hard to imagine government services being able to implement a country-wide programme of improved fisheries management and effective enforcement of regulations, even if the heavy-handed measures which would inevitably be required were considered justifiable and ways could be found to target the improvements towards the right beneficiaries.

5.2.5 Aquaculture

Technical Aspects

The development of fish culture is an obvious way to replace the tonnage of fish lost due to construction of flood control schemes. Simply put, if each hectare of fish pond is capable of producing 2 tonnes of fish per year and each hectare of inundated floodplain contributes 100 kg to the annual yield from capture fisheries, then each hectare of pond brought into use can compensate for the loss of fish production resulting from a reduction of flood extent by 20 ha.

Flood protected areas have substantial advantages over "outside" areas for pond culture in Bangladesh, because they enjoy better security against fish losses through escapes during seasonal flooding. Average fish pond yields in Bangladesh of less than a tonne per hectare per year are very low compared with other Asian countries enjoying similar climates. One of the main reasons for this is the generally low level of inputs deployed. Many ponds are still stocked naturally, i.e. by colonization with wild fry and fingerlings during the flood season, and inadequate pond preparation, fertilization and feeding is done. There is now a strong nationwide trend towards intensification of fish culture by increased investment in fish seed, feeds etc., but this process might be expected to accelerate faster where pond owners enjoy the security of protection from accidental losses of stock through flooding.

Socio-economic Aspects

It is already clear that aquaculture developments taking place in the private sector in Bangladesh will make a substantial contribution towards replacing losses in capture fisheries outputs caused by FCD and other environmental changes. However, the impact of such increases in fish output on the nutritional and economic status of those social groups which stand to lose most from reductions in floodplain production is limited by the following factors:

a) The seasonal pattern of aquaculture activity generally entails stocking ponds in the wet season and harvesting in autumn/winter (though partial harvesting may be done before this). Thus the main fish production and income from aquaculture does not coincide with the period of most importance for open access floodplain capture fisheries, i.e. July to September.

b) For economic reasons, the species generally used for culture are of high commercial value, placing them beyond the reach of the poorer sections of the community.

c) Clearly it is difficult for people who do not own a pond to become involved in fish culture. Efforts to involve the landless generally entail some form of pond leasing. This works well until the owners realize that fish farming is profitable, when they take the pond back. Similar problems are encountered with leases on government-owned water bodies. These are often regarded as community property, and attempts to allocate them to special target groups can be vigorously, even violently opposed.

d) The involvement of women in aquaculture is seriously limited by social convention. A number of projects specifically targeted at groups of women have succeeded in involving women in feeding fish, fertilizing ponds etc., However, all purchasing of inputs and selling of the fish produced must be done by men, who therefore control the financial benefits. Further, capture of fish from the ponds must be contracted out to men, who charge a lot for this service.

Whilst it is recognized that some of the above problems may be intractable under the existing social system in Bangladesh, nevertheless progress has been made in involving groups disadvantaged by FCD in fish culture. In particular, integrated rice/fish production shows promise for increasing nutritional status and incomes for many small farmers. In principle, fish can be grown in ordinary rice fields while water is present to a depth of about 10cm or more. Only minor construction work is needed to raise dyke heights enough to prevent escape of fish, and to provide a trench or pit in which fish can survive (and be captured) when the rice field dries. In addition to providing a crop of fish, rice/fish cultivation seems to slightly increase rice yields (presumably due to the fertilizing effects of the fish's excrement), and reduce the need for fertilizer and pesticide usage, therefore saving money and reducing environmental pollution. In most parts of Bangladesh, two rice/fish crops can be produced each year. The *boro*, or winter rice, is planted in autumn/winter and harvested in April/May, just before the monsoon starts. *Aman* is planted in summer, and harvested in autumn. The winter crop requires irrigation, and sometimes protection from early flooding. Culture of this crop in a protected environment is one of the main motivations for construction of flood control, drainage and irrigation schemes. Once a few "demonstration" farmers are trained, the technology of rice/fish culture quickly spreads by word of mouth.

Pond aquaculture is most easily targeted at small farmers who own a pond, but some success has also been achieved in involving landless people by organizing them into groups under the guidance and assistance of NGO's. FAP 17 undertook a special study of the target group approach to aquaculture development adopted by NGO's in Bangladesh (Supporting Volume 22). In addition, FAP 17's socio-economic studies have shown that professional fishermen, who are being progressively squeezed out of their traditional fishing grounds by the rigorous enforcement of private controls over previously open-access fisheries, are finding alternative employment in pond harvesting (see Supporting Volume 16). This trend is strongest in those regions of the country where aquaculture is most "advanced", e.g. the South West, and can therefore be expected to continue as Bangladeshi fish culture practices improve and intensify nationwide.

6. GUIDELINES FOR ASSESSMENT OF IMPACTS OF FUTURE FCD/I SCHEMES

6.1 BACKGROUND

All of the data on production-based aspects of the floodplain fisheries in relation to the FAP obtained by FAP 17 were derived from direct enumeration of gears operating in the field on a day by day basis and estimation of their observed catch rates. Such surveys were carried out on paired series of inside and outside open floodplain sites, around nine existing FCD/FCDI schemes, across four FAP regions of the country, over a 19 month period. Essentially this has been an intensive gear dependent monitoring system. Socio-economic data on incomes and participation have been obtained from village surveys inside and outside the same schemes.

Gear based monitoring systems necessitate numbers of each gear fished at a site per unit time being continually counted in the field, along with measurement of their catch rates. This becomes particularly complex when such large numbers of types of gear are to be found as appear on the floodplains of Bangladesh. Gear dependent monitoring systems offer the most direct method of measuring catch, but they are also the most costly and resource intensive. It is unlikely that such a widespread and intensive gear dependent monitoring system will ever again be deployed in the inland fisheries of Bangladesh, purely because of the high cost. The resulting database, however, now contains an incomparable set of data on catch, effort, fishing patterns, gear types and species composition for future comparisons. The database, which is being left with the Government of Bangladesh through the Department of Fisheries and the Flood Plan Coordination Organisation, and with ODA, can be directly accessed by those familiar with relational database or is more generally accessible through a flexible menu-driven sequence of prompts for those less familiar with computer procedures.

The database remains a planning tool for use in future comparisons and projections. The main patterns and planning estimates have been extracted in the present report. These estimates and the overall experience gained in FAP 17 need to be channelled into guidelines whereby the pre and post-project impacts on fisheries and communities of any subsequent implementation of some or all of the schemes proposed under the FAP can be assessed in a way which can assist decision-making by planners, managers and engineers.

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The role of engineering options and engineering designs is obviously crucial to the identification and the assessment of any impact on fisheries. For this reason it will be necessary to outline what basic information would be required in those designs to help formulate the fisheries impacts from the most probable pre and post-project conditions.

6.2 REQUIREMENTS FROM ENGINEERING DETAILED DESIGNS

In the build up to any potential scheme proposed under the FAP, a particular site on the riverbank or floodplain will be selected and detailed engineering designs for a working system, most often including some degree of empolderment or compartmentalization, will be produced. There are a number of points of information, which will almost certainly have been collected or estimated during the design phase, that would greatly facilitate the assessment of fisheries impacts. Many of these points may normally be provided as part of the engineering design, but for illustration, a list of those basic points is given below.

Information to be provided by engineering detailed designs

1. Total site area.
2. Total lengths and mean widths of major embankments.
3. Area elevation curves for the whole scheme or any sub-compartment/drainage basin identified within it together with detailed contour mapping.
4. Total areas inundated at different depths for specified durations under pre-determined conditions of flood control. These areas should be mapped using GIS if possible.
5. Total number and area of perennial *beel* pre and post-project.
6. Total lengths of canals and rivers in project area pre and post-project.
7. Total numbers of drainage canals, and their size (width) which connect to outside rivers/canals pre and post-project.
8. Seasonal changes in drainage patterns pre and post-project.
9. Technical specification of sluice gates.
10. Operational plans for sluice gate operation.

6.3 HYDROLOGICAL SURVEYS

There may be a need to ground-truth or verify some of the models or assumptions used in the detailed designs to estimate flood area and duration. For this reason investigative surveys similar to those used by FAP 17, which involve the reading of depth gauges placed at different elevations across the site, at regular times throughout the flood period, may be needed. From these hydrographs through elevation and time can be produced. Discharge rates may also be determined for canals and rivers, given their importance in fish movement.

Defining areas, particularly flood areas, is a major problem in shallow flat flood systems such as those in Bangladesh. A slightly more sophisticated way by comparison with conventional mapping is the use of Global Position System (GPS). A hand-held unit taken around the project site at peak flood would considerably help in defining area flooded. If done regularly it would also provide information on the relationship between flooded area and duration of flood.

6.4 BASELINE PRE-PROJECT FISHERIES AND SOCIO-ECONOMIC ASSESSMENTS

A baseline assessment of the pre-project magnitude and nature of the fishery on the open floodplain is required, against which to judge costs and benefits following the implementation of construction.

The first point to define is the intended project area. Areas have proved to be relatively difficult to establish in floodplain systems, but at least the project area for the planned system should be specified as mentioned in Section 6.3 above.

Baseline, pre-project assessment can be conducted at two levels, depending upon urgency and resources available, as outlined below.

6.4.1 Option 1: Desk Level

If a very rapid order of magnitude assessment is required then the baseline assessment of the pre-project open floodplain can be conducted as a desk study, which draws heavily upon FAP 17 generalised planning estimates and the engineering detailed design information.

Given an estimate of flooded area from the engineering detailed designs, or from extrapolation from a topographic map, the mean catch per unit area of open floodplain/beel from the FAP 17 surveys of 107 kg/ha can be applied to give total baseline yields for the floodplain element. To this should be added estimates from canals and rivers in the project area. It proved unrealistic to generate a mean catch rate per kilometre of canal or river from the FAP 17 surveys, but taking into account width and region, it will be possible to find a comparable catch rate either in the tables of the present Final Report or on the FAP 17 database. Such catch rates can then be applied to estimates of total lengths of canals and rivers in the project area for addition to the floodplain/beel total to produce an overall working pre-project estimate of fish production from the project area.

An estimate of most probable number of fish species to be found in the project area can be obtained from the FAP 17 analysis, since this is reasonably consistent with a working average of 79 overall being a first estimate, although some disaggregation might suggest a lower value for projects in the South West, perhaps around 55, but a much larger one for other regions of around 87. Species composition does show some regional variation so, although the core communities may be similar, a better picture with regard to most probable species will be obtained from the database, particularly with respect to rarer or more local species.

A projection of most probable socio-economic baseline conditions will present rather more difficulties from a desk study. The only data available will be demographic data from censuses and village lists for food security and other purposes. From these and regional examples in the FAP 17 studies some indication as to the most likely breakdown of population by occupation, income groups and overall social conditions should be possible, although even one-off village visits would greatly amplify understanding.

6.4.2 Option 2: Survey Level

(a) General Outline

If more resources are available for the impact assessment, then a more site specific evaluation can be conducted by augmenting existing planning estimates with site surveys. Ideally these should be conducted over a 12 month period to allow seasonal variations to be taken into account. This, however, may not always be possible.

In assessing baseline fish catch, the average floodplain catch per unit area derived from FAP 17's results can be accepted to provide a first estimate of total floodplain production, as above in the desk option. However, specific surveys of representative canals and rivers in the site should be conducted, since catch rates here are generally more variable.The great majority of the catches from these waterways tend to occur during the drawdown period of October to December. Catch surveys can, therefore, be targeted at this period, or even more specifically with reference to seasonal patterns in particular regions. Catch surveys along these waterways can be carried out with reference to FAP-17 survey methods, as detailed in the project Interim Report. Such surveys will also give indications as to fish species number and species composition directly.

There are, however, less direct methods of obtaining catch estimates over the whole of the project area without reference, necessarily, to specific habitats. A properly structured household or fisherman survey, based upon questionnaires and statistically based stratified sub-sampling, allows a picture to be built up of who is fishing, when, how often and how much they are catching. Such a survey can also incorporate key socio-economic indications, thereby giving estimates of both production and benefits. Whilst a household survey offers a less direct way of estimating production than a gear based estimate, the variance of the estimate is often considerably less. A gear based survey makes an estimate of total effort fished, which is often subject to a large variance, and a second series of estimates of catch per unit effort for each gear, which is equally subject to a wide variance. When the two are multiplied together the variance of the total estimate becomes considerable. In a household survey effort of the sub-sample and catch per unit effort are obtained by interview and therefore subject to some variance. However, the raising factor for total catch from sub-sampled households to total households is obtained from demographic census data which are usually accurate and, therefore, subject to quite a small variance. This gives a less direct but more statistically reliable estimate. Properly structured household surveys can also be operated economically with relatively small numbers of enumerators.

Estimates of the catch per unit effort can be further improved by the survey teams taking more direct observations of fishermen's catches in the field or at the landing areas to augment those estimates based on interview. It is usually unreasonable to ask fishermen how much they caught more than two or three days earlier. The ultimate survey structure would optimally be a household survey to provide both catch and socio-economic indicators, augmented by limited field surveys to obtain catch per unit effort data more directly. In addition, household surveys often underestimate the rarer gears which are often the larger ones, such as lift nets, which can take a significant proportion of the catch. Larger gears such as lift nets, *kua* and *katha* can be censused directly in the field by direct counting or sub-sampling. This can still be carried out in a much more economical fashion than by a purely gear dependent programme. Again it could be targeted at the declining phase of the flood, when the majority of the catch is taken.

(b) Household Monitoring

(i) General features

Determining any reasonably accurate estimate of catch requires knowledge of :

- o the proportion of households that fish
- o the frequency with which they fish
- o the amount that they catch

It is thus of the greatest importance to get a good estimate of the catch being taken by professional fishing households, who: fish intensively, often throughout the year; fish for longer hours each fishing day; and, due to greater skills and better gear, usually have higher catch rates for each hour fished. Indeed in most regions/habitats professional fishermen take the greatest share of the catch over the year, despite being numerically far fewer than subsistence or part-time fishermen.

(ii) Professional Fishermen

Multi-stage random sampling should be used. But it is important that the sample frame is correctly defined and that the number of clusters is not too small.

Defining the sample frame

Since professional fishing households tend to live in clusters, sometimes as a distinct *para* within a larger agricultural community, their proportion within a sample taken from a simple random selection of villages may be quite unrepresentative. It is therefore essential that a separate sample frame of professional fishing households is established. A recent and accurate list of professional fishermen could be derived from the 1991 Population Census of Bangladesh by BBS. This required each household to give its principal source of income; one of the response codes was "fishing". This information was not made available to FAP 17, but should be obtainable. Ideally a database containing the numbers of professional fishermen in each *mauza* in each *thana* should be obtained from BBS by the DoF and then made available, as needed, for this purpose.

Defining the number of clusters

Though there are logistical advantages in keeping the number of clusters sampled small, it is essential to recognise that the degree of intra-cluster correlation of income tends to be high. Certain communities have particular traditions both in terms of the gears that they use and waterbodies that they exploit. Monitoring by FAP 17 found several pairs of adjacent fishing communities where the patterns of income through the year were highly dissimilar, due to differences in patterns of gear ownership and access rights. If the number of communities sampled is too small, the results may be biased by this.

Household lists

In each of the clusters chosen for sampling, the data on the number of households giving fishing as their principal source of income should be verified and a list compiled. In a number of the fishing villages covered by FAP 17, the livelihood strategies of the majority of households were no longer dependent on open water fisheries. For various reasons other activities had assumed greater prominence: communities in both NC and the NE had very successfully moved into pond culture, others had moved into fish trading. Nevertheless households in these communities gave their principal source of income as fishing. Where the principal objective of household monitoring is to obtain estimates of catch, such communities/households should be avoided. Other fishing communities, though located within a proposed scheme, may be primarily dependent on riverine fisheries outside the area to be empoldered. These too should be avoided.

When a list of fishing households dependent on the floodplain system to be impacted has been compiled, a sample should be selected at random. Stratification should be considered where some have access to particularly important *jalmahal*, though this may be difficult to predict.

(iii) Part-time Fishermen

Clustering of part-time and subsistence fishermen can also occur. In the NE, there seems to be a strong resistance among established Sylheti households to become engaged in part-time professional fishing: catch is for consumption, irrespective of income level. More recent migrants to the area, who often live further down the slopes towards the centre of the *haor*, are reported to be less constrained. This, however, is the exception rather than the rule; generally they are scattered across agricultural floodplain communities and sampling should reflect this.

Choice of Villages
It is important that villages are chosen from across the range of landtypes within the proposed scheme. Though there can be important differences between villages on the same landtype, proximity to the more deeply flooded areas will affect both the range of alternative livelihood strategies in the monsoon and the value of local fisheries resources.

If information on the area proposed for flood control includes detailed hydrological studies of depths and durations of flooding, this should be used as a sample frame for the villages. Failing this, 8" to the mile contour maps are useful in defining the lower areas. The agro-ecological units (AEUs) defined by the Land Resources Inventory of Bangladesh (FAO, 1988) are also useful in obtaining a broad understanding of land types and flood depths, though the information on which they are based is now somewhat dated.

Choice of households
Stratification is essential. By far the most important determinant of total annual catch/income is the number of days fished, which can vary by two orders of magnitude. The numbers of hours fished per day and the total catch/income derived vary much less, even where gears used are very different. The only significant exception to this rule is for owners of *katha* or *kua*, who may earn income that is quite disproportionate to effort.

The initial census should make every effort to establish the amount of fishing undertaken by each household in the previous year and of ownership of *katha* and *kua*. Stratified sampling should then be undertaken based on the results of this initial census.

Frequency of sampling
If the principal objective is to gain an understanding of the value of the fishery through the year, rather than of issues such as species distribution, questions should be directed towards catch values and a longer sampling interval used. (If estimates of total catch are also required, information on average price per kilogramme can be obtained either from the fishermen themselves or from local markets.)

The length of the sampling interval is particularly important because, with finite survey resources, it determines the number of households/ clusters that can be covered. Household monitoring by FAP 17 suggested that households were able to recall periods of at least a month, and often two, with reasonable assurance. The accuracy of such estimates is clearly more questionable the longer the interval becomes, particularly for households where fishing is highly intermittent. But, given the degree of inter-household variation, longer intervals would seem preferable to shorter.

(c) Cross Referencing Surveys

A combination of results from the household survey, which should give an indication of total effort and CPUE, the limited field surveys which should give more direct CPUE estimates and estimates of fish production from large gears will provide an estimate of total catch for the project area which should be comparable to that obtained from summing floodplain output with that from canals and rivers on a habitat basis. This should, therefore, provide a specific check on production as well as providing socio-economic indicators on incomes and values of the present beneficiaries of the pre-project system. In addition, if a question on household or personal fish consumption is included as a socio-economic indicator, multiplication by demographic totals will provide an additional estimate of total non-exported fish production in the area, a further useful check.

6.5 COST/BENEFIT POST-PROJECT ASSESSMENT

From the estimates of the baseline, pre-project conditions obtained by one or more of the methods outlined above, the most probable changes brought about by the scheme given in the engineering designs need to be derived.

There is no consistent raising or lowering factor by which the baseline production from the project area can be decreased or increased following compartmentalization. In fact, on average, the rate of yield inside fully compartmentalized schemes appears to be about the same as outside. On this basis, any loss in production inside compared to outside would be due to loss of flooded area at the project site, as floodable area is lost to infrastructure and more controlled flooding. In this way any project losses or gains can be simply calculated from a subtraction of post-project from pre-project area, or vice versa. This can then be turned into value. In the light of the general findings of FAP 17, this is the simplest and crudest way of estimating net change in benefit from fisheries, but in some circumstances it may be the only one.

The apparent equality in rates of production inside and out does mask, however, the tremendous effect of changes in effort between inside and out. The fact is that in several cases the yields inside were higher due to much higher fishing effort.

To take this into account needs a projection of the likely change in effort, i.e., numbers of people fishing or the amount of time people spend fishing, once the open floodplain is enclosed by the FAP scheme. At present there is no rational way of arriving at the raising or lowering factor for effort. It is not clear, for example, if heavier fishing inside is due to more people coming in and having access to water rights and land following the intensification of agriculture, or whether the number of people in the project area remains more or less the same but that fishing is more convenient and accessible to farmers, i.e. part-time fishermen, after compartmentalization and control of flooding.

There is no consistent way of extrapolating from effort pre-project to effort post-project. There are specific project schemes which have been analysed in the FAP 17 surveys, and probably the best means of extrapolation is to select the scheme closest to that under consideration and take the changes in degree of effort, and therefore catch rates, from that example. From this, using flooded area before and flooded area following the project inception, combined with inside and outside catch rates from FAP 17 examples, will provide the estimate of production from the project area before and production from the project area afterwards.

The most likely value of the catches can be gained from estimates of prices based on species composition. Most probable net changes in fisheries value can then be put together with probable net increases due to agriculture and economic benefits due to flood protection, compared to the costs of construction.

The FAP 17 socio-economic analyses will help in suggesting how the profiles of beneficiaries changes after the scheme has been built, in terms of sources of income and social structure. This should also allow some indications to be gained of changes in distribution of benefits. In environmental terms, it is fairly clear that compartmentalization leads to a reduction in number of species supported, by an average of about 30%. The community is simplified and it is the rarer and migratory species which are most at risk. However, the baseline field surveys should show which species are likely to be the most vulnerable.

A corollary of this simplification of the community to a residual group of about 25 small sedentary species, combined with the potential significant increases in effort, is that there is indication as to how long this community might be able to sustain any elevated yields. Therefore, over a ten or twenty year planning horizon, although initial yields and value may be higher, it may be necessary to factor in a declining income line from the fishery, or even a collapse under certain circumstances. This would no doubt affect the IRR for the project as a whole. This information, however, is as yet unknown.

6.6 MONITORING

A selection of key production and socio-economic indicators can be made from the selective household and supporting field surveys conducted at the initial impact appraisal. These can be incorporated into a further reduced survey which would be conducted along the same lines, following the implementation of the scheme. Emphasis should almost certainly be placed on long-term factors governing production and upon the real changes emerging in the distribution of benefit. In addition, follow-up surveys on the effectiveness of mitigation measures should also be included. These together with the costs of the mitigation measures themselves should be included in the cost benefit analysis.