MACH

Technical Paper 8

Trends in Fish Consumption in Community Restored Wetlands

Management of Aquatic Ecosystems through Community Husbandry

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Annex

Abstract

This paper reports on the results from detailed monitoring of fish consumption over 7 years in two wetlands and 5 years in another wetland. A total of about 950 households regularly had the fish that they were preparing to eat weighed and other details of their fishing, origins of fish, diet, and use of aquatic resources recorded by local monitors every three days throughout this period.

The first year of the study forms a baseline when no interventions had been taken by the communities to restore wetland habitat or manage fisheries. Thereafter MACH helped the communities organize, excavate areas to increase dry season fish habitat, establish sanctuaries, and adopt rules to minimize harmful fishing practices. Averaging the last four years of data compared with the baseline, fish consumption has increased by 23% in Hail Haor, by 49% in Turag-Bangshi, and by 47% (considering the last two years) in Kangsha-Malijhee site. These are averages, but the trend has been similar both in the season of low fish consumption (March-April) and the time of high consumption (October-December), but also fluctuates between years due to environmental factors. These changes have benefited poor people – fish consumption by the landless and marginal farmers increased significantly in all three sites.

Only a quarter to a third of the fish that households eat in these areas was caught by members of the household, the majority were purchased in local markets. This is consistent with other studies which indicate that over 50% of all fish consumed in rural Bangladesh are purchased. Moreover the proportion of fish consumed that they caught has fallen in all three sites (from 31% to 21% in Hail Haor; from 27% to 19% in Turag-Bangshi; and from 43% to 32% in Kangsha-Malijee site). Possible explanations are increasing specialization of households (for example MACH has supported small scale fishers to move into other occupations), and the increasing availability of fish from pond aquaculture in local markets. The prices of pond fish have not increased as much as many wild species, and so it may be more attractive for people catching these wild species that are now more abundant to sell them. Despite increasing consumption of pond grown fish, small beel and wetland resident fish and prawns constitute the main fish consumed for all households and particularly for poorer households. Overall 110 or more fish species were reported eaten over seven years in Hail Haor and Turag-Bangshi, and 98 species in five years in Kangsha-Malijhee.

There were some increases in meat consumption during the early years of MACH which are comparable to the increases in fish consumption and indicate a general improvement in welfare of the sample households. Collection and home use of other aquatic products is common in all three sites: 80% of households in Turag-Bangshi, 67% of households in Hail Haor but only 25% of households in Kangsha-Malijhee on average collected some aquatic resources each year – mainly grasses but also snails, aquatic fruits and plants that are used as vegetables, and a wide range of other products.

Further long-term simplified monitoring of fish consumption, along with market prices, by species would help to trace over a larger scale the trends in fisheries, aquaculture and biodiversity.

Acknowledgements

We thank the 1,000 or more households and particularly the women of those households who have been a part of this study and had the fish they were preparing weighed and answered the monitoring questions on up to 840 days during the study. We thank all of the 47 Resident Monitors (see Annex 3) who over the seven years undertook this survey year-round, and the 30 field based staff of CNRS who supervised the field monitoring (Annex 3). Survey design was by Sachindra Halder and Mokhlesur Rahman, data base management and data entry were overseen by Rony Rosario, and final graphs and tables were prepared by Khandakar Hasib Mahbub.

1. Introduction

1.1 Fish Consumption in Bangladesh

Historically Bangladesh has been rich in freshwater fish production and diversity. Rice and fish dominate the diet of Bangladeshis to such an extent that the old proverb, "*machee bhatee bangali,"* which can be translated as "fish and rice make a Bengali," continues to hold true. Fish is an essential and irreplaceable food in the rural Bangladeshi diet. Together with boiled rice, which is eaten at least twice per day, small amounts of vegetables and fish make up the typical meal. Meat, pulses and fruits are eaten less frequently and in smaller amounts. In the national nutrition survey conducted in rural Bangladesh in 1981–1982 (Ahmad and Hassan 1983), average fish intake was 23 g/person/day, whereas average meat consumption was 5 g/person/day. Rice contributed over 80% of the dietary energy and protein. In terms of weight of food consumed, fish ranked third after rice and vegetables.

Hence fish play an important role in the Bangladeshi diet, constituting the main and often-irreplaceable animal source food in poor rural households. Fish intake is affected by several factors, such as year, season, location, water level, and income level. In the early 1990s Minkin et al. (1997) found fish consumption in floodplain areas of 12-34 g/person/day. Thompson et al. (2002) reviewed several studies and found that fish intakes from surveys in the late 1990s were in the range 15-80 g/person/day depending on the type of household and location surveyed, with floodplain capture fishery areas and poorer households in the lower part of the range, and larger landowners and fish farmers in the upper end of the range. However, these studies did not report trends over a number of years. Fish consumption is dominated by wild small (length <25 cm) indigenous fish species (SIS).

Fish contributes animal protein which enhances the bioavailability of minerals. Moreover, certain small wild fish such as mola (*Amblypharyngodon mola*) have very high vitamin A content and since small fish are eaten whole, or almost whole, they provide more calcium and other minerals than large fish, from which the bones are removed (Thilstead and Roos 1999; Thompson et al. 2002). This is of special importance in Bangladesh as vitamin A and iron deficiencies are recognised as public health problems, and there is evidence of low intakes of other minerals such as zinc and calcium (Ahmed, 1999; Ahmed, 2000; Seshadri, 1997). Small wild fish can therefore play a very important role in food based strategies for improving vitamin A and mineral status in humans.

However, a recent review found that fish consumption fell by 11% between 1995 and 2000, and estimated that inland capture fisheries catches had fallen by 38% between 1995 and 2002 (Muir 2003). Roads, embankments, drainage, flood control, and natural siltation, along with over fishing, are commonly cited as causes of declining fish resources (Hughes et al., 1994; Ali, 1997).

1.2 MACH Project

In response to the loss of wetlands and their products, the MACH project started with USAID support in 1998. It aimed to promote ecologically sound management of floodplain resources (notably fisheries) and to ensure sustainable supply of food to the rural poor of Bangladesh, by demonstrating ecosystem restoration and community based management. The 'community' in this case included those people dependent either economically or nutritionally on the floodplain and its products. The project has worked in three large wetland sites. Activities in Kangsha-Malijhee site started in 2001, in the other sites in 1999.

Hail Haor in north-east Bangladesh is typical of deeply flooded basins in that region known as *haors*. Water from the hills to the east and west flows through 59 streams into the haor. Flood control works downstream limit its connection with the main river system The haor is located in five unions of Sreemongal Upazila and in two unions of Sadar Upazila of Moulvi Bazaar District. The watershed of Hail Haor covers about 600 km^2 (237 square miles) and 15% is in India. The average maximum wet

season area of Hail Haor is about 13,000 ha, but the dry season area is typically just over 3,000 ha. Approximately 172,000 people live in 61 villages around the haor.

The **Turag-Bangshi** site is just north of Dhaka and is typical of low-lying floodplains in Bangladesh. It covers seven unions of Kaliakor Upazila in Gazipur District and one union of Mirzapur Upazila in Tangail District. The Turag-Bangshi River runs for approximately 30 km through the site with 26 beels (wetland depressions) and numerous canals on either side of the river. Water covers about 10,000 ha at full flood, but diminishes to less than 700 ha at the end of the dry season. Dry season water has been reduced for agriculture and irrigation. Approximately 225,000 people live in 226 villages that make use of the river and floodplains.

The **Kangsha-Malijhee** site is in north-central Bangladesh in Sherpur Sadar and Jhenaigathi Upazilas in Sherpur District. The area includes the catchments of the upper Kangsha and Malijhee river system. The hills here now have only remnants of natural forest. The area is prone to regular flash floods from these hills. The wetlands and floodplain have a water area of approximately 8,000 ha during the wet season, which falls to about 900 ha in the dry season. The floodplain area contains 47 beels, of which 18 are perennial. The population of the area is approximately 279,000 living in 163 villages.

MACH introduced three broad types of interlinked intervention related to wetland and fishery management:

1. ***Physical interventions*** aimed at ecosystem management (wetland habitat rehabilitation, sanctuary establishment, swamp forest restoration, riparian vegetation restoration, strip plantations, sustainable farming system demonstration).
2. ***Community development interventions*** aimed at socioeconomic and human capital enhancement (organization of groups, alternative income generation support, skill development training, and other livelihood support for the local communities).
3. ***Institution building interventions*** aimed at sustainable management of natural resources through raising of environmental awareness, by forming community organizations, by those organizations making and implementing management plans that include rules and norms that provide for sustainable use of aquatic resources, and by linking these organizations with local government for their long term recognition.

It was expected that due to these interventions, there would be qualitative and quantitative changes in wetland productivity and biodiversity. These changes were expected to consequently impact on the fish consumption amounts and pattern of households living around the wetlands. To assess if this was the case a large scale household monitoring program was established covering regular monitoring of fish consumption on a regular basis in all the three sites throughout the project period.

2. Methods

2.1 Sample Households

Fish consumption data have been collected each year from a total of about 950 households: between 455 and 490 households from 14 villages in the Hail Haor site, from 280 households from 8 villages in Turag-Bangshi site every year, and from 280 households from 7 villages in Kangsha-Malijhee site (except in the baseline year when 289 households were covered). From each sample village, 35 sample households were selected in Hail Haor and Turag-Bangshi sites, and 40 households were selected in Sherpur site. The design was intended to cover the social classes present, this was on the basis of landholding size (landless, marginal farmers, small, medium and large farmers) and they were sampled in proportion to their presence in the villages so most of the households are functionally landless or marginal farmers. Household fish consumption monitoring started at Hail Haor site from September 1999, in Turag-Bangshi from October 1999 and from January 2001 in Kangsha-Malijhee site (Table 1).

Table 1 Sample sizes and year definition for consumption survey

Site	Land-holding	Baseline	Impact-1	Impact-2	Impact-3	Impact-4	Impact-5	Impact-6
Hail Haor (Sreemongal)	Period	(Sep 99 - Apr 00)	(May 00 - Apr 01)	(May 01 - Apr 02	(May 02 - Apr 03)	(May 03 - Apr 04)	(May 04 - Apr 05)	(May 05 - Apr 06)
	Landless	295	300	295	291	291	291	295
	Marginal	92	94	92	84	84	84	84
	Small	48	49	48	42	42	42	42
	Medium	36	36	36	28	28	28	28
	Large	19	19	19	10	10	10	10
	Total	490	498	490	455	455	455	459
Turag Bangshi (Kaliakoir)	Period	(Oct 99 - Apr 00)	(May 00 - Apr 01)	(May 01 - Apr 02	(May 02 - Apr 03)	(May 03 - Apr 04)	(May 04 - Apr 05)	(May 05 - Apr 06)
	Landless	159	160	159	159	159	159	159
	Marginal	68	69	68	68	68	68	68
	Small	22	22	22	22	22	22	22
	Medium	23	23	23	23	23	23	23
	Large	8	8	8	8	8	8	8
	Total	280	282	280	280	280	280	280
Kangsha-Malijhee (Sherpur)	Period	(Jan 01 - Dec 01)	(Jan 02 - Dec 02)	(Jan 03 - Dec 03)	(Jan 04 - Dec 04)	(Jan 05 - Dec 05)	(Jan 06 - Dec 06)	
	Landless	174	169	169	169	169		
	Marginal	65	62	62	62	62		
	Small	20	20	20	20	20		
	Medium	19	18	18	18	18		
	Large	11	11	11	11	11		
	Total	289	280	280	280	280		

2.2 Sampling Protocol

Data was collected at three-day intervals from the sample households using fixed recording formats (Annex 1). The fish that each household planned to eat that day were weighed before cooking by species as far as possible. The households were also asked about their own fishing activities in the previous day and this along with the reported catch were recorded based on recall. In Hail Haor any collection of non-fish aquatic resources was also reported based on the respondents recall and was recorded.

Local trained women were recruited and assigned as Resident Monitors (RMs) to collect data from the sample households. The field staff of CNRS-MACH supervised and assisted the RMs in data collection, they also checked the data forms and resolved problems and inconsistencies. Later at the site level office, RM activities were discussed and data forms are reviewed, coded and edited by the concerned Field Officers. The forms were then sent to MACH head office for computer processing.

2.3 Monitoring Parameters

To compare the changes in fish consumption in terms of quantity and species diversity in the baseline period with the impact years, following parameters were considered:

- Household involvement in fishing,
- Per capita fish consumption by months,
- Per capita fish consumption by land classes,
- Sources of fish consumed,
- Species composition of fish consumed,
- Ranking of species by quantity consumed, and
- Other aquatic resources used by the households.

3. Results

3.1 Seasonality and Trends in Fishing

The household monitoring confirms for this sample of households similar seasonality in fishing effort and catches to those found in the catch monitoring in specific parts of the wetlands, there is also a close correlation between effort and catches at the household level (Fig. 1). In the Turag Bangshi site typically households catch about one kilogram of fish per day of fishing, increasing slightly over the project period, while their effort in the peak late monsoon months was higher and for longer in 2004 when inundation was more extensive and prolonged. By comparison in Hail Haor effort levels have changed little between years for this panel of households and are slightly higher than in Kaliakoir, but catches are much higher – in the order of 2-4 kg/household/day depending on the season and year. Given that catch per hectare has risen in Turag-Bangshi during the same period to close to the Hail Haor level, the implication is that households who were not in the villages covered by the monitoring program have started to fish in the Turag-Bangshi floodplain system since MACH started and productivity was restored. By comparison effort levels in the Kangsha-Malijhee site are lower, and catches are low, regularly being under a kilogram per household per day. Overall fishing activity remains at a higher level in the dry season in Hail Haor than the other sites because there is more surface water remaining in the haor at that time.

3.2 Fish Consumption Trends

Seasonality in fish consumption is closely associated with the availability of fish and with the household's own catches, peaking in the monsoon and post-monsoon period. In all three sites the highest quantity of fish was consumed in the post monsoon months (October to December), that is the period when fish catch and availability are at their highest. The lowest per capita consumption was in March-April, the driest months of the year when water levels are at their lowest. The monthly variation of fish consumption largely depends on the availability of fish and the purchasing capacity of the people. Fish consumption increases rapidly from June-July onwards through the monsoon. During the monsoon, when the *beels* are flooded, local people catch fish in the seasonally flooded lands with various gears as they usually have unrestricted access for fishing at that time. In the post-monsoon, fish catch is at its peak as in this time the major fishing in the *beels* is done, and so more fish reach local markets. The patterns are similar between all three sites.

Overall fish consumption has increased in all three sites, although in impact year 6 (2005-06) which was a relatively dry year it dropped in Hail Haor and Turag-Bangshi. The maximum increases over the baseline year were 33-66%, but the average over the last 2-4 impact years, when the full impacts of improved wetland management can be expected to have been achieved has been an increase in consumption of 47-49% in Turag-Bangshi and Kangsha-Malijhee, and 23% in Hail Haor (Table 2). However, fish consumption in the baseline year and throughout the study has been substantially higher in Hail Haor than the other sites which may explain the smaller increase there.

Table 2 Overview of changes in fish consumption

Site	Indicator	Baseline	Impact-1	Impact-2	Impact-3	Impact-4	Impact-5	Impact-6	Average Imp3-6
Hail Haor	consumption (g/person/d)	49	52	54	60	58	65	57	60
	% of baseline		106	112	123	119	133	118	123
Turag-Bangshi	consumption (g/person/d)	29	28	30	37	47	48	40	43
	% of baseline		98	102	129	161	166	140	149
Kangsha-Malijhee	consumption (g/person/d)	24	28	29	34	36			35
	% of baseline		118	121	144	149			147

Note that for Kangsha-Malijhee the average for impact years 3-6 covers only two years (3 and 4) since MACH activities started later there.

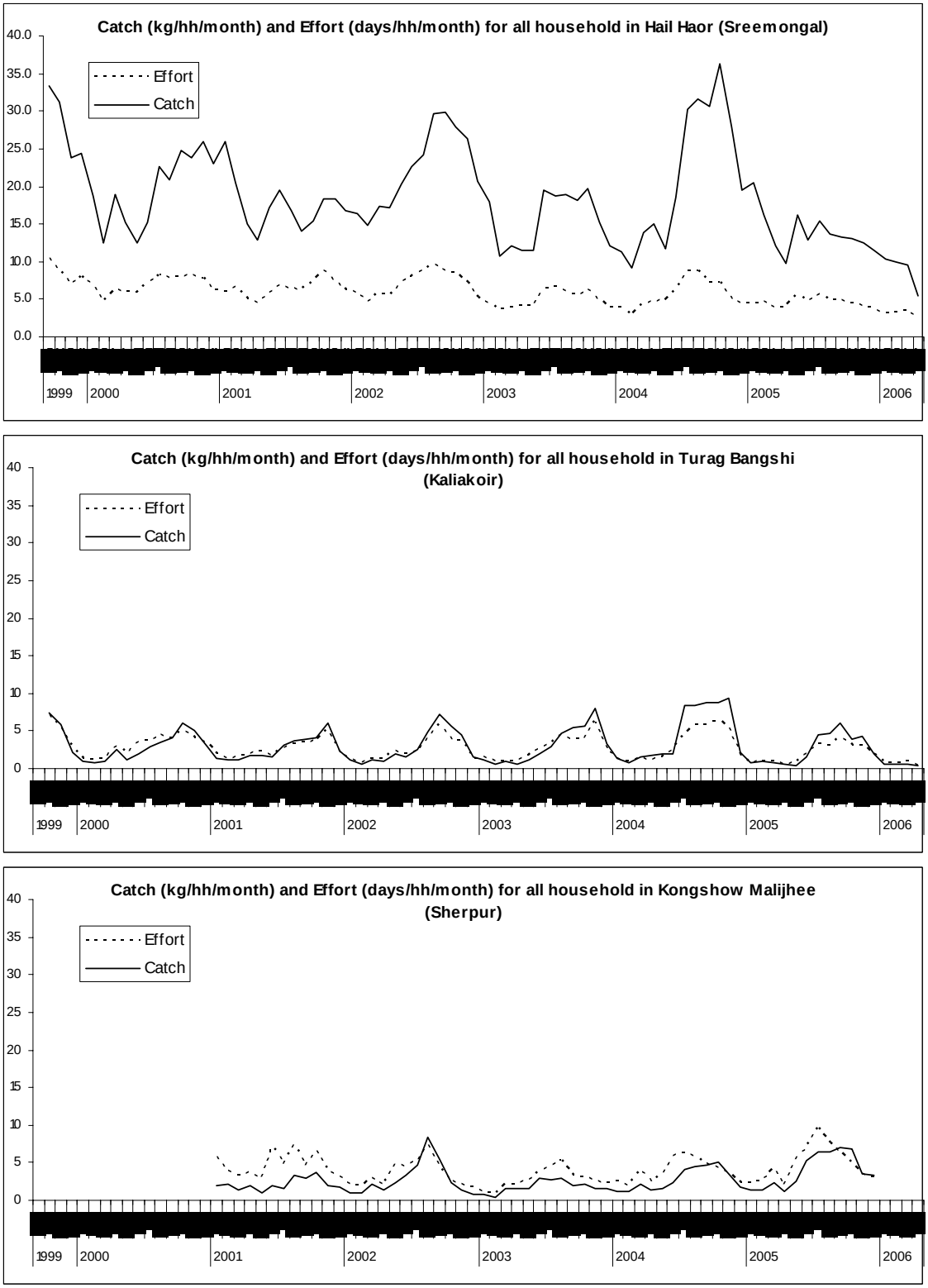


Fig. 1 Seasonal patterns of fishing effort and catch reported in household monitoring in three sites.

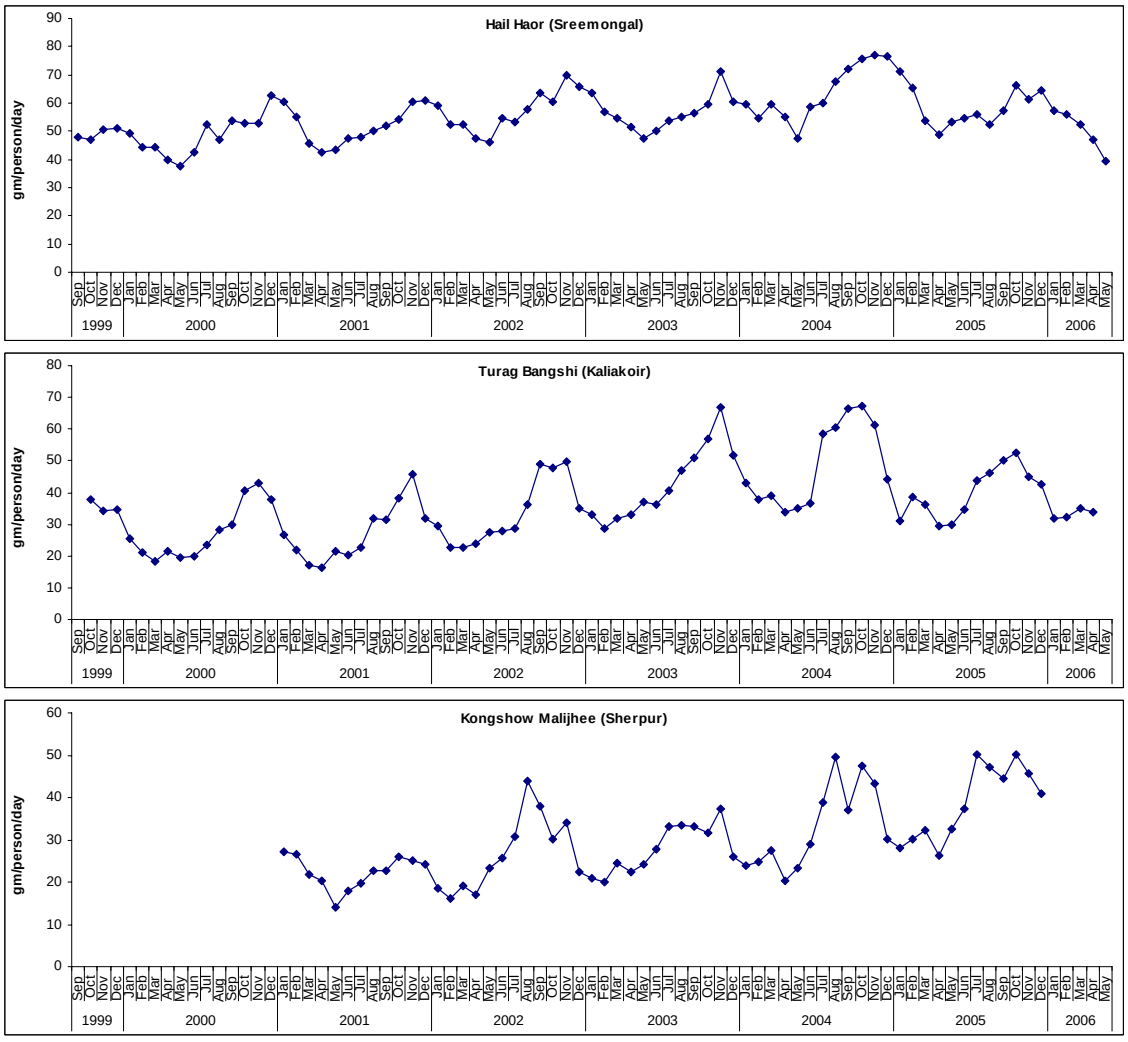


Fig. 2 Monthly pattern of fish consumption (g/person/day) by site

As shown in Fig. 3, overall fish consumption increased significantly in all sites compared with the baseline data (Tables showing results of statistical tests covering overall fish consumption and consumption by landholding category are in Annex 2). Major findings indicate that small beel and wetland resident fish and prawns constitute the main fish consumed for all households and particularly for poorer households. The vast majority (55-75%) of fish consumed in these sites are purchased in local markets. This is consistent with studies by Helen Keller International which indicate that over 50% of all fish consumed in rural Bangladesh are purchased.

3.3 Fish Consumption by Landholding Size

Hail Haor

Per capita fish consumption for all social classes increased significantly from 47 g/day in the baseline period to an average of 58 g/day in impact years 3-6. The highest increase, 36%, in fish consumption occurred among marginal farmers followed by 25% and 22% for medium farmers and landless households respectively. Per capita fish consumption of large farmers did not differ significantly: 52 g/day in impact years 3-6 compared to 56 g/day in the baseline year (Fig. 4a). Fish consumption has fluctuated with fish catches, but on average the improved habitats and management practices achieved

through MACH are expected to sustain higher supplies of fish and greater access of poor fishers to fishing grounds through the 16 Resource Management Organizations (RMOs) that have been formed covering management of most of these wetlands. Increased incomes of the poor through alternative income generating activities, such as those provided through the Federations of Resource User Groups (FRUGs) established by MACH and with a membership of about 5,200 households enjoying access to their revolving funds, are expected to continue to raise household incomes thus maintaining and increasing demand for fish among the poorer households. Therefore these trends are expected to continue.

Turag Bangshi

In Turag-Bangshi all landholding categories had similar levels of fish consumption before the project and all now eat more fish, all have experienced statistically significant increases (except that the sample of large farmers is small). Combining all social classes, per capita fish consumption significantly increased from 29 g/day at baseline to 43 g/day in impact years 3-6, an increase of 49%. Here all landholding classes gained between 43% and 75% more fish consumption and large farmers more than doubled their fish consumption, followed by 76% and 67% for small and medium farmers respectively.

Kangsha-Malijhee

Households in Kangsha-Malijhee had the lowest fish consumption levels of the three sites initially, averaging only 23 g/person/day, and this remains the case. However, by just the fourth impact year average fish consumption had increased by 50% to 36 g/person/day, and most landholding categories have made similar gains. Even after one year of project activities consumption increased significantly compared with 2-3 years in the other sites. Per capita fish consumption of landless households increased by 44% and for medium and large farm households by 73% and 59% respectively. Only small farmers failed to show significant increases in their fish consumption.

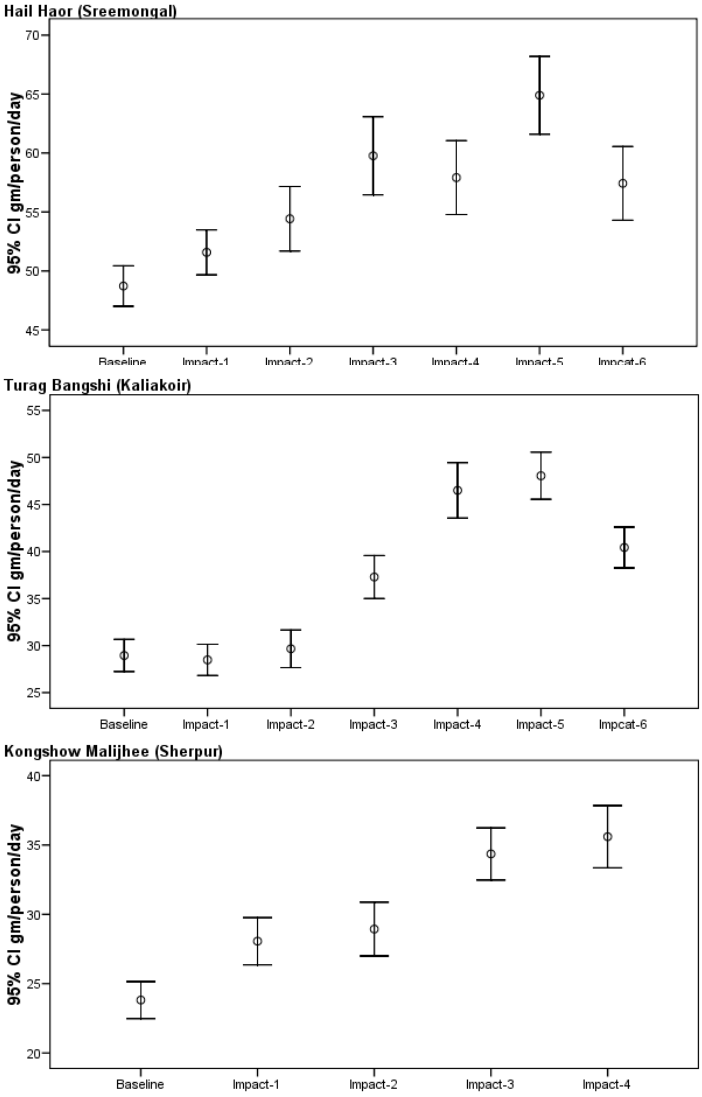


Fig. 3 Fish consumption – mean with 95% confidence interval (g/person/day) from monitoring

Thus the nutritional benefits from improvements in wetland management and restored productivity have been well distributed across poorer and better off households. Considering the numerical dominance of poorer households in all of these areas, this means that the majority of the increased volume of fish consumed has fed poorer households. However, as will be seen the extra fish eaten are not necessarily the fish caught in these wetlands.

Fig. 4a Fish consumption (g/person/day) in Hail Haor

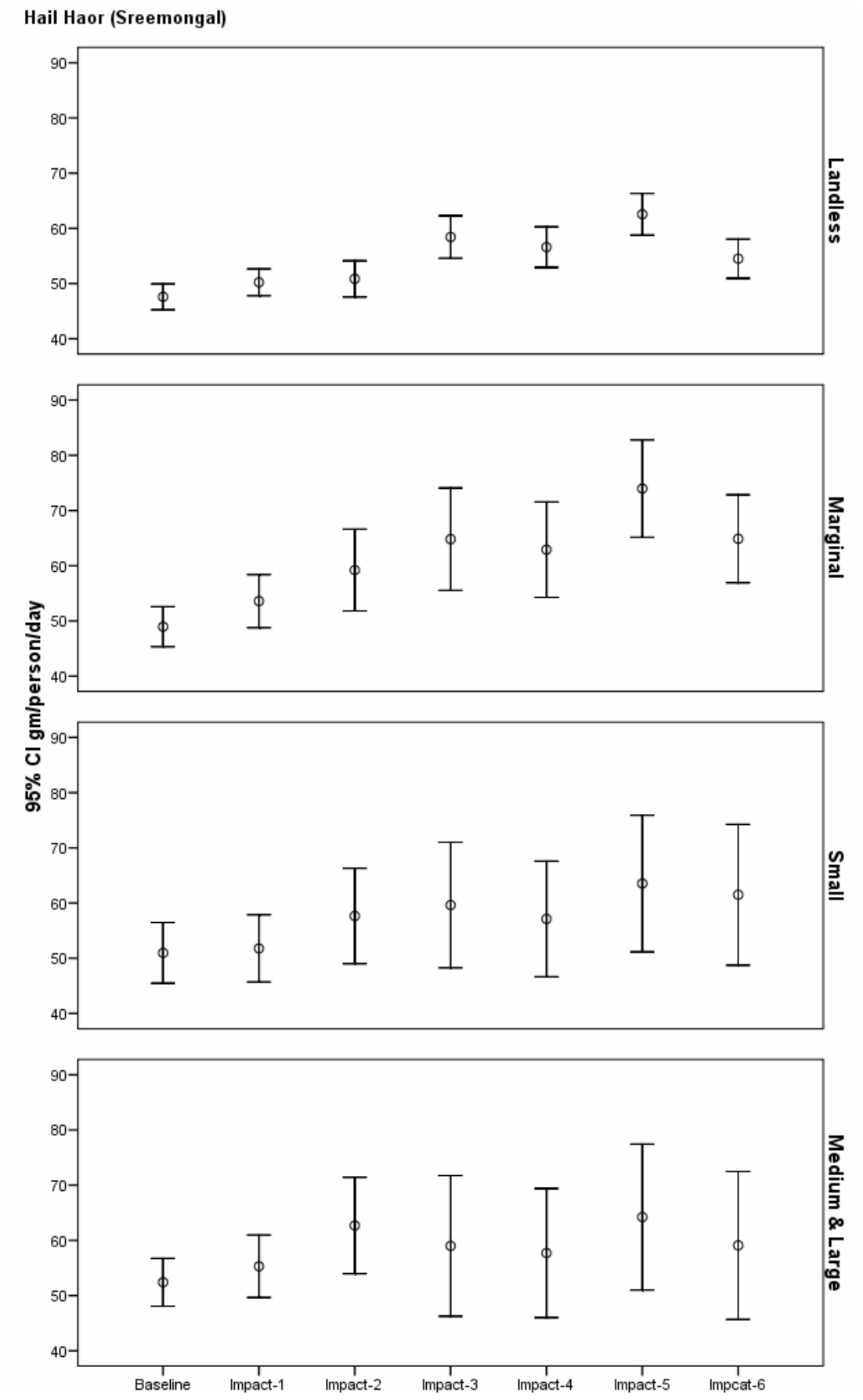


Fig. 4b Fish consumption (g/person/day) in Turag-Bangshi

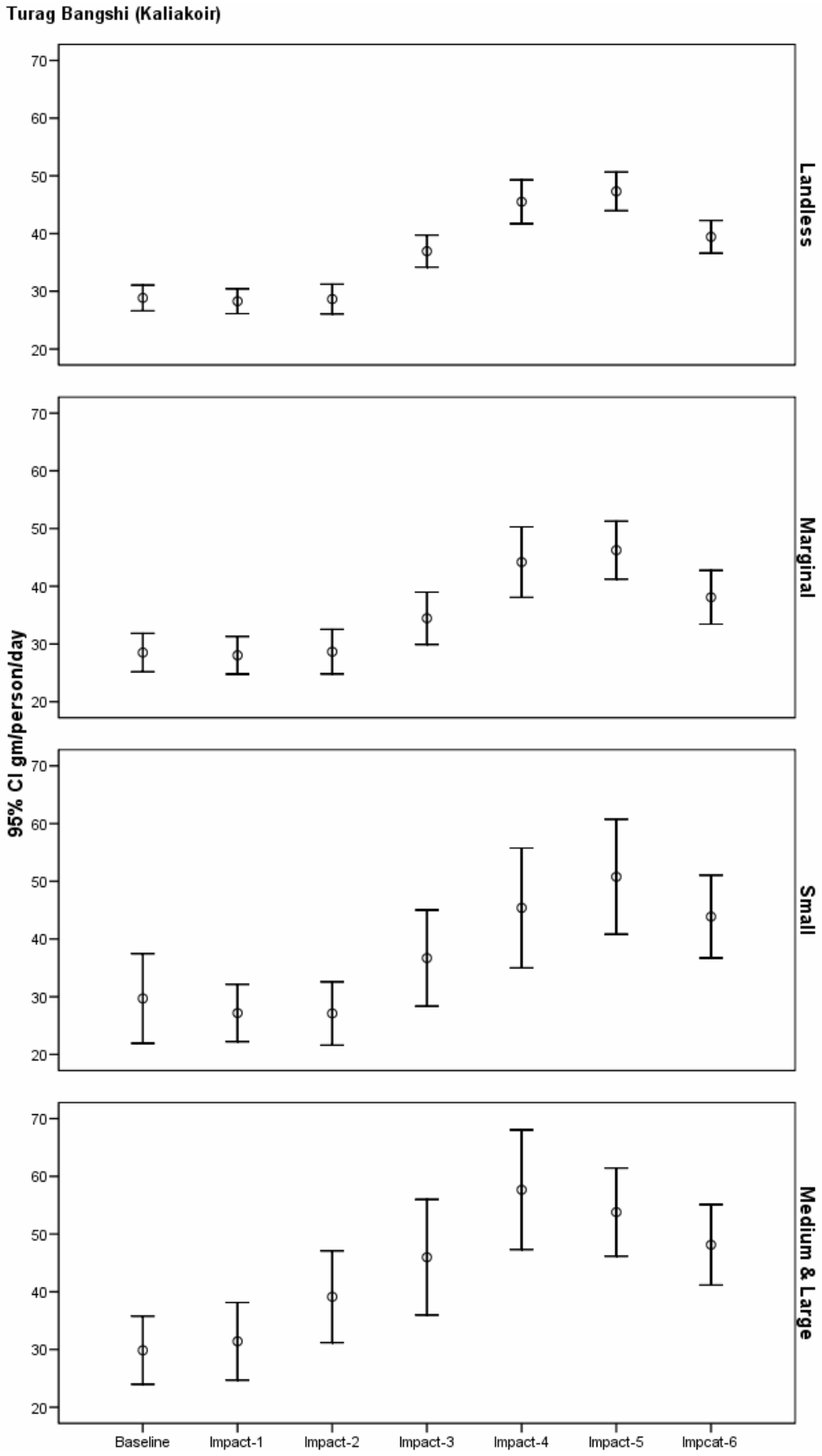
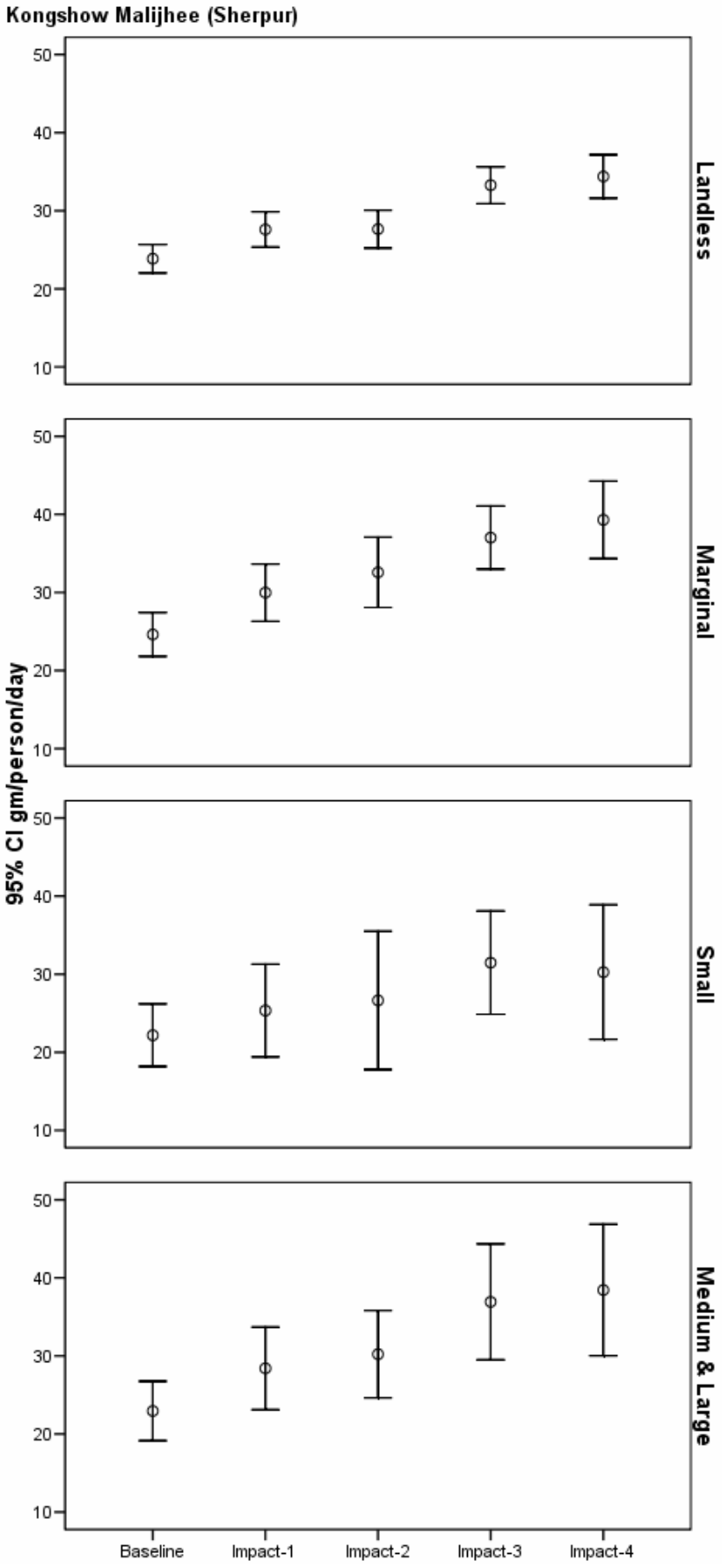


Fig. 4c Fish consumption (g/person/day) in Kangsha-Malijee

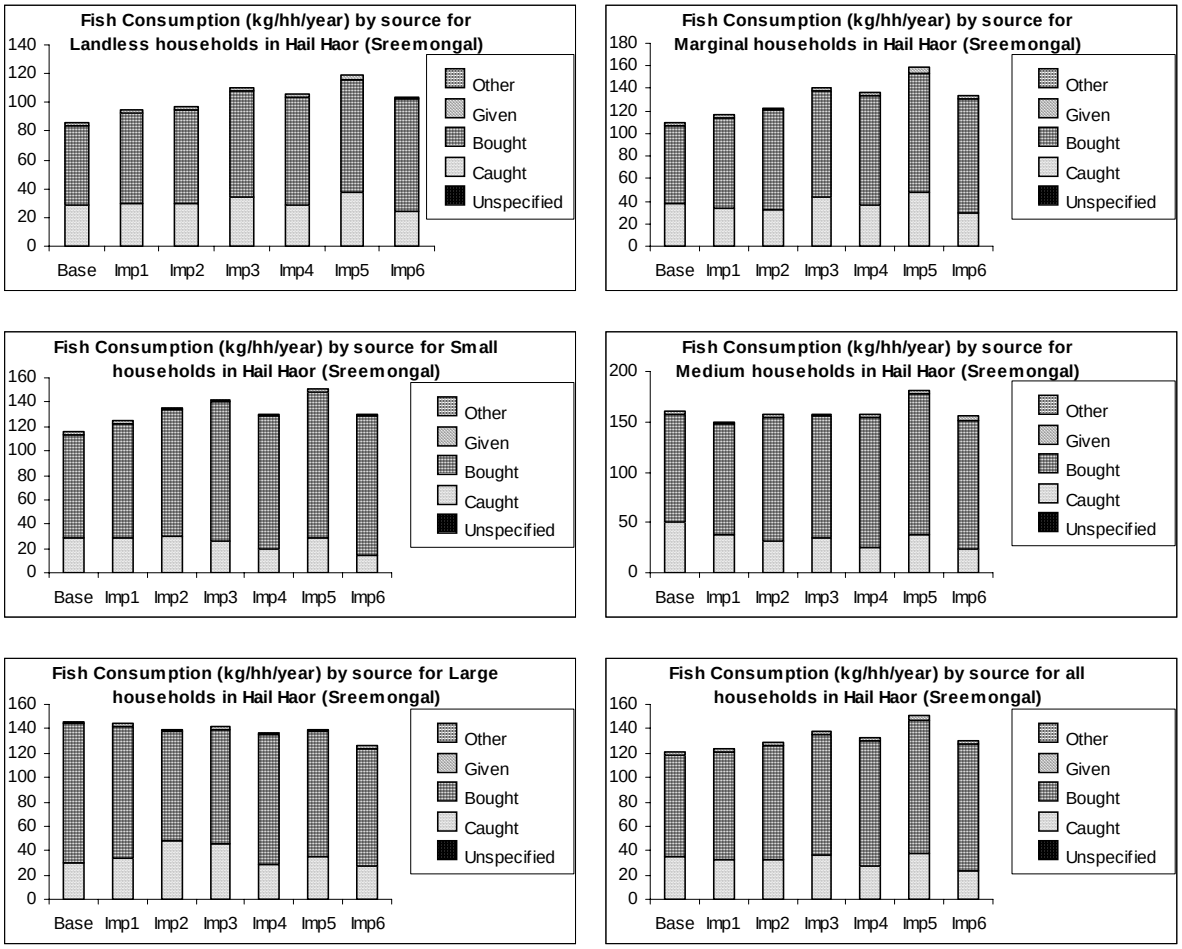


3.4 Sources of Fish

In all three sites a majority of households from all landholding categories bought the majority of the fish they consumed, even though many of these households also catch fish for sale and/or for own consumption. In none of the sites were increases in fish consumption associated with a greater share coming from own catches. Only a quarter to a third of the fish that households eat in these areas was caught by members of the household, the majority is bought. Moreover the proportion that they catch has fallen in all three sites (from 31% to 21% in Hail Haor; from 27% to 19% in Turag-Bangshi; and from 43% to 32% in Kangsha-Malijee site). In Hail Haor households on average became more dependent on purchased fish – the quantity per household consumed from own catch fell in impact years 5 and 6 to 86% of the baseline level, while the quantity purchased for consumption rose by 29%. In Turag Bangshi in the same period the average quantity caught and consumed per household rose by 81%, against an increase of 68% in the quantity bought for consumption. In Kangsha-Malijee in a shorter period to impact years 3 and 4, the average quantity caught and consumed per household rose by 21% when the amount bought and consumed increased by 86%. When disaggregated the data indicate to some extent that more of the direct consumption benefits from restored fisheries and higher fish catches went to poorer households.

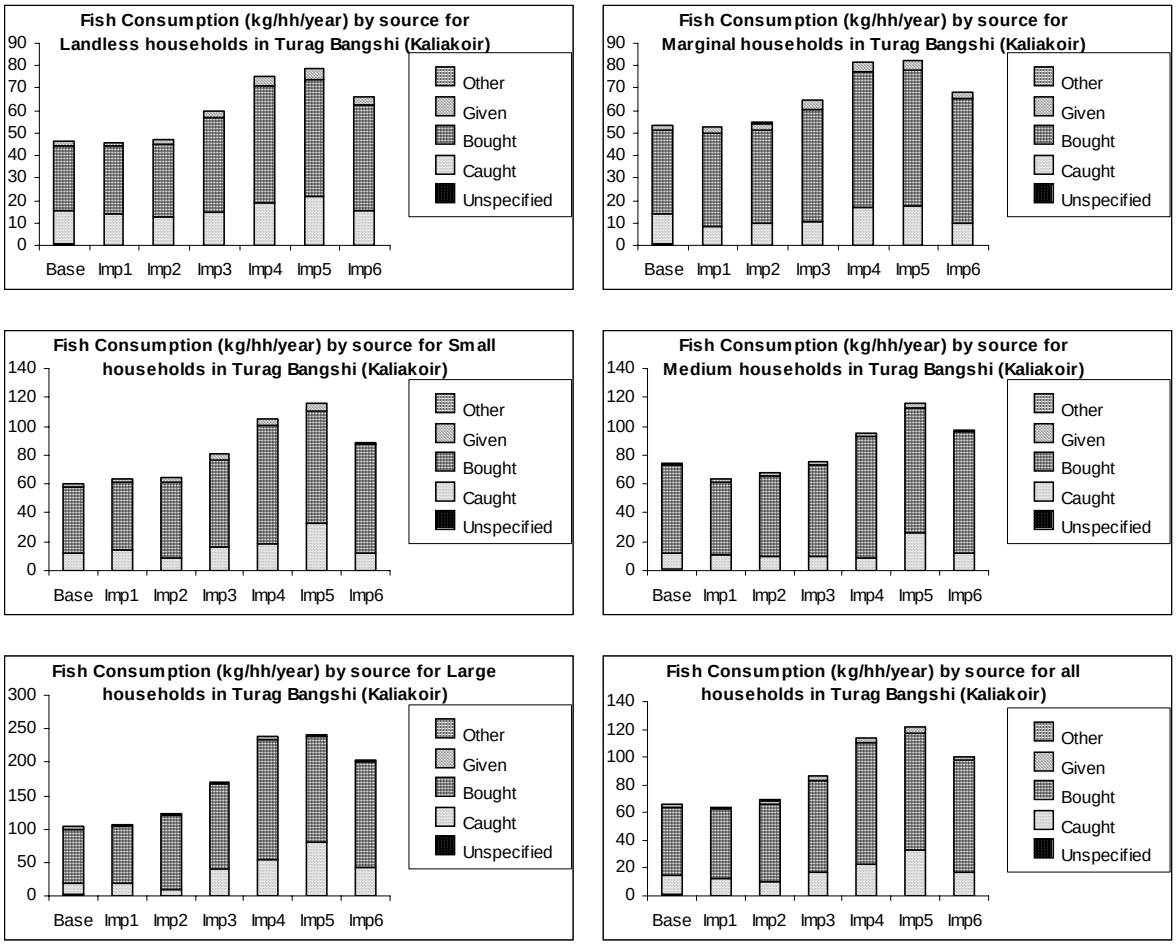
In Hail Haor landless and marginal households increased the quantity of fish consumed from own catches, while small to large landowners tended not to change the quantity coming from own catch although their total consumption of fish increased (Fig 5a). This indicates that landowners bought relatively and in absolute terms more fish, providing an income to the mainly landless and marginal households that fish for an income.

Fig. 5a Sources of fish consumed by different classes of household in Hail Haor



In Turag Bangshi although most landowners catch very little of the fish they consume, the trends in terms of sources of fish consumed are similar for all classes of household – even large farmers increased the amount they themselves catch, particularly in the years of highest fish production (Fig 5b). This presumably reflects the increased availability of fish in the floodplain lands that landowners cultivate and where they can fish when water levels recede at the end of the monsoon. The amounts of fish purchased have also increased substantially for all classes of household.

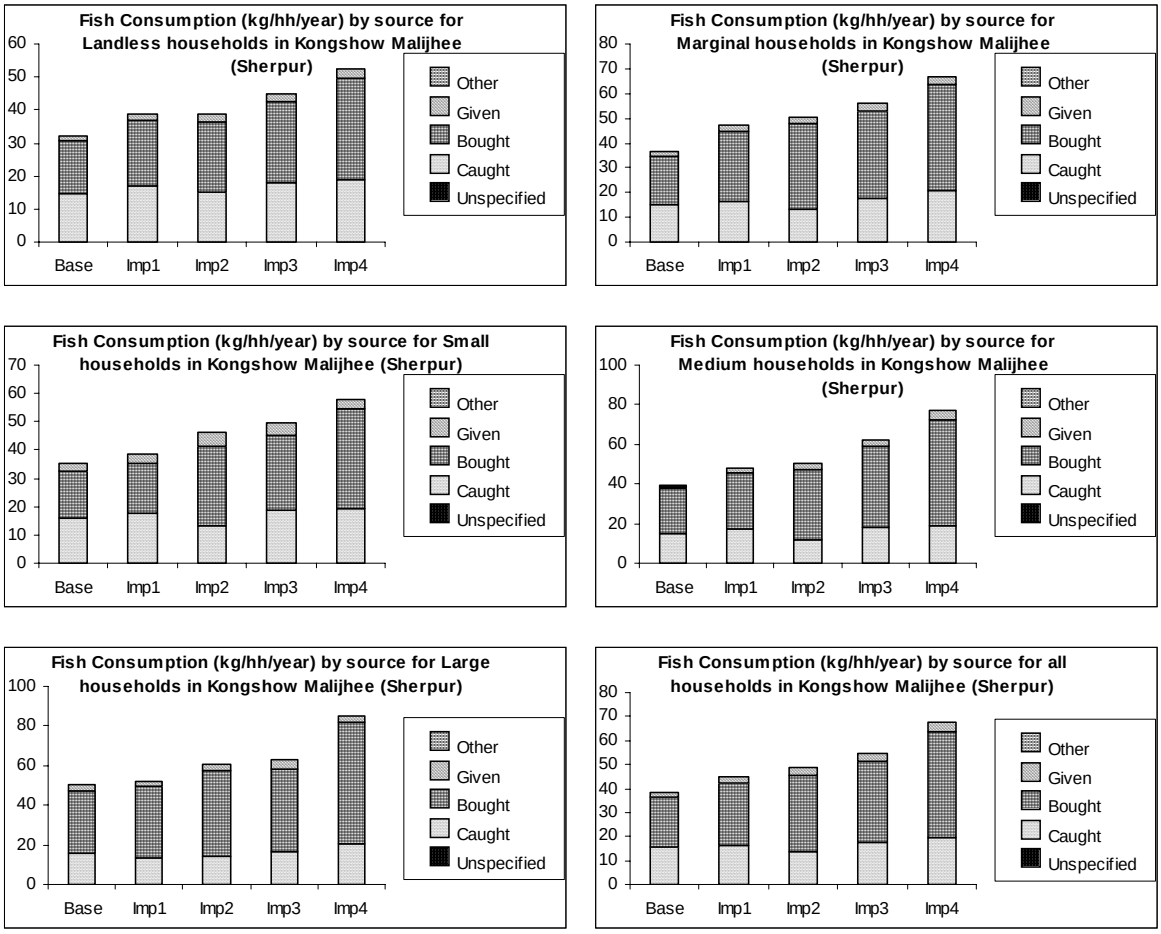
Fig. 5b Sources of fish consumed by different classes of household in Turag-Bangshi



In Kangsha-Malijee in the baseline year own catches of fish were relatively more important as a source of food for poorer households (landless, marginal and small farmers) than in the other sites. Although households on average caught more fish in later years, the increases in consumption are mainly derived from fish purchased in local markets (Fig. 5c). This suggests that subsistence fishing has changed little, but professional and part time fishers have increased fish catches and have more to sell, and all categories of household have been able to buy this increased production.

If the availability of fish in the wetlands has increased, and a majority of households are landless and marginal farmers, why has such a large part of their increased fish consumption been bought? One factor is increasing specialization which the training and credit provided through MACH has also contributed to – some households have dropped out of fishing, while others continue. But another factor is the relative prices of different types of fish, since the proportion of higher value larger fish in the catch has grown since the start of MACH.

Fig. 5c Sources of fish consumed by different classes of household in Kangsha-Malijee

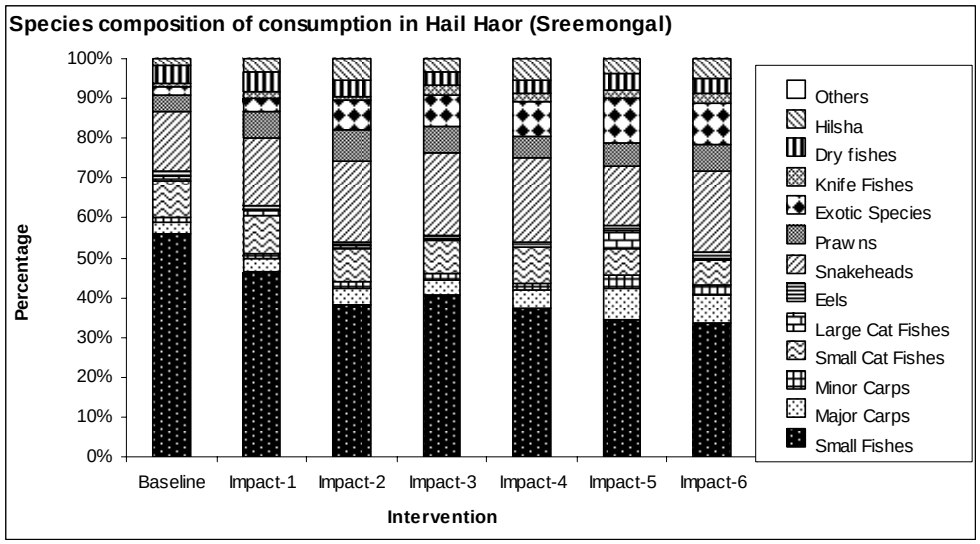


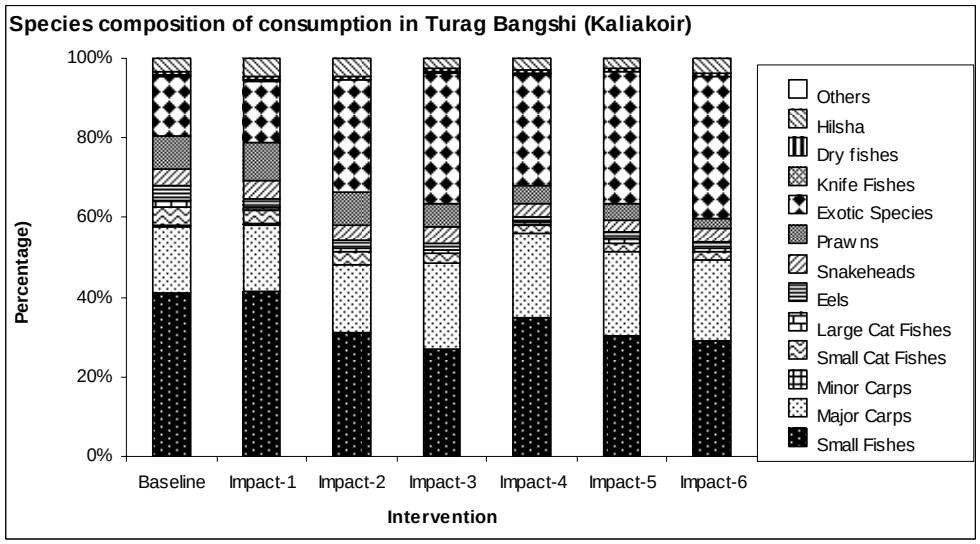
3.5 Species Composition of Fish Consumption

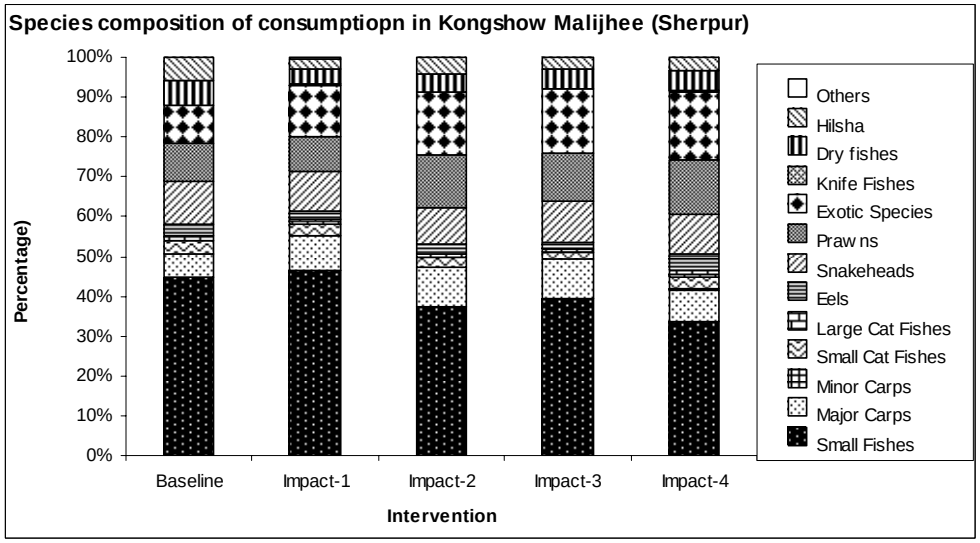
A wide range of species were recorded in the household consumption monitoring, just as in the catch surveys. The total number of species recorded throughout the monitoring period was similar between sites: 113 in Hail Haor and 110 in Turag-Bangshi, but less at 98 in Kangsha-Malijhee where there were two less years of data (of these 10 species are exotic fish and 3-6 species of prawns were recorded in the diet per site). Table 3 shows the top 20 species consumed and confirms the overall importance of small native species such as puti and taki (note that in Table 3 “gura mach” are mixed small fishes, while gura icha are various small shrimps). However, some larger (and high value) beel resident carnivorous fishes such as snakeheads (shol) which have benefited from conservation and restoration measures have risen in the league table of species consumed in Hail Haor.

A second trend that is not project related is apparent. In Hail Haor some of the growth in fish consumed is for cultured exotic species notably Thai Pangas and Silver Carp. Although exotic fish are still a small proportion of total fish consumed here, where there is a large supply of wild caught fish from the haor, exotic cultured species still rose from 2% to 11% of fish consumed, with the quantity increasing by 10 times over 6 years (Fig. 6). Fig. 7 expands on this by showing the trends in contribution to consumption of the main species eaten, showing the relative decline of some native fishes and increasing importance of cultured species.

Fig. 6 Types of fish consumed as a percentage of total consumption







This trend is stronger in Turag Bangshi. Despite the dramatic growth in fish catches in the floodplain there, fish consumption is now dominated by cultured species. For example, Thai Pangas was not in the top 20 most frequently eaten species of fish in the baseline year, but rose to be in the top three places in each of impact years 3-6 (2002-03 onwards). Exotics and major carp, almost all of which are cultured, contributed just over half of the fish consumed in that site by 2004-05. This growth in fish consumption from aquaculture sources is independent of MACH activities. While the growth in aquaculture is one factor behind this trend, another factor is the demand for more highly prized native fishes. With ready access to Dhaka and high prices there for those native species it is likely that a good proportion of increased catches from the wetlands here are traded out of the locality.

Table 3a Top 20 species in terms of frequency of consumption in Hail Haor (Sreemongal)

Baseline	Impact 1	Impact 2	Impact 3	Impact 4	Impact 5	Impact 6
Dry fish	Dry fish	Dry fish	Dry fish	Dry fish	Dry fish	Dry fish
Jat Puti	Jat Puti	Taki	Taki	Taki	Jat Puti	Taki
Khalisha	Taki	Jat Puti	Jat Puti	Jat Puti	Taki	Jat Puti
Taki	Mola	Gura Echa	Gura Echa	Gura Echa	Gura Echa	Gura Echa
Koi	Gura Echa	Gura mach	Khalisha	Khalisha	Gura mach	Gura mach
Shing	Shing	Mola	Meni/Bheda	Meni/Bheda	Khalisha	Khalisha
Gura mach	Gura mach	Shing	Gura mach	Shing	Meni/Bheda	Meni/Bheda
Gura Echa	Khalisha	Meni/Bheda	Mola	Shol	Mola	Shol
Mola	Meni/Bheda	Khalisha	Shing	Gura mach	Shing	Shing
Meni/Bheda	Tengra	Shol	Shol	Koi	Shol	Mola
Chuna Khalisha	Shol	Hilsha	Koi	Hilsha	Tengra	Hilsha
Okol/Cheng	Hilsha	Tengra	Tengra	Mola	Goinna	Koi
Lal Khalisha	Koi	Chuna Khalisha	Foli	Foli	Koi	Tengra
Shol	Gol Chanda	Koi	Lal Khalisha	Tengra	Thengua Echa	Thengua Echa
Magur	Chuna Khalisha	Lal Khalisha	Hilsha	Chuna Khalisha	Mrigel	**Thai Pangas**
Tengra	Magur	Gol Chanda	Magur	Magur	Boal	Goinna
Kanchan Puti	Kaikla	**Thai Pangas**	Gol Chanda	Mrigel	Hilsha	Mrigel
Hilsha	Foli	Goinna	Goinna	**Silver Carp**	Rui	Foli
Gutum	Thengua Echa	Magur	Chuna Khalisha	Gol Chanda	Foli	**Silver Carp**
Rui	Goinna	Kaikla	**Thai Pangas**	Goinna	**Thai Pangas**	Rui

Exotic species in bold

Table 3b Top 20 species in terms of frequency of consumption in Turag-Bangshi (Kaliakoir)

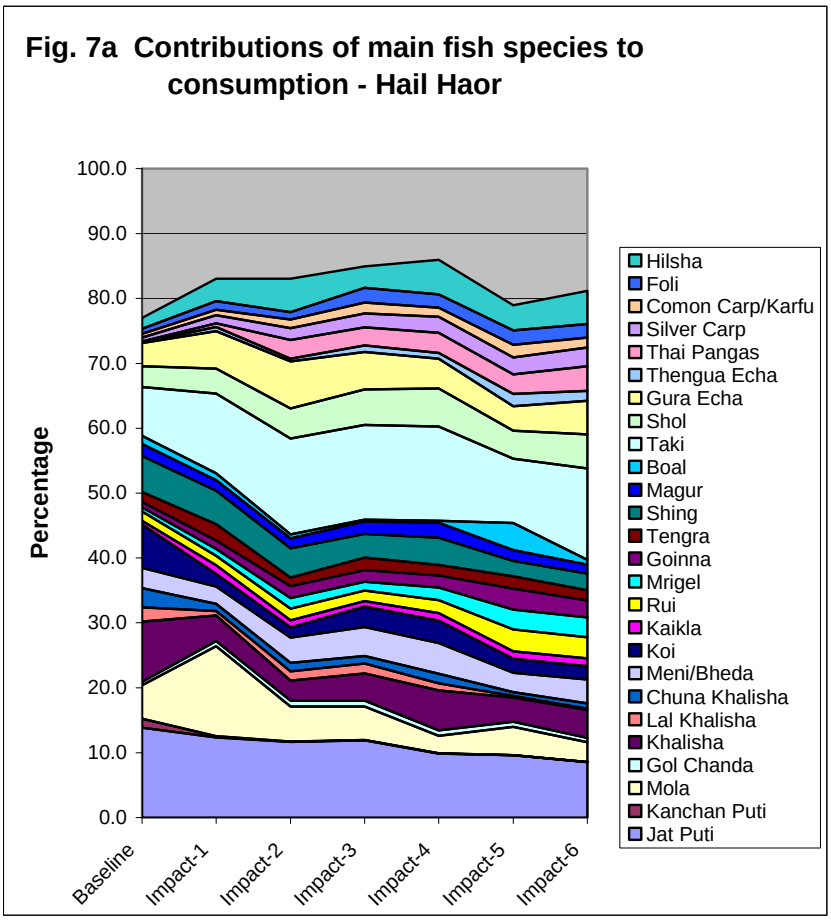
Baseline	Impact 1	Impact 2	Impact 3	Impact 4	Impact 5	Impact 6
Gura mach	Jat Puti	Gura mach	Gura mach	Gura mach	Gura mach	**Thai Pangas**
Jat Puti	Gura mach	Gura Echa	**Thai Pangas**	Jat Puti	**Thai Pangas**	Gura mach
Gura Echa	Gura Echa	Jat Puti	Jat Puti	**Thai Pangas**	Jat Puti	Jat Puti
Rui	Rui	**Thai Pangas**	Rui	Rui	Rui	Rui
Tengra	Lamba Chanda	Rui	Gura Echa	Gura Echa	Gura Echa	**Silver Carp**
Taki	Taki	Taki	**Silver Carp**	Mrigel	Chapila	Gura Echa
Lamba Chanda	Chapila	**Silver Carp**	Mrigel	Chapila	**Silver Carp**	Mrigel
Boro Baim	Tengra	Dry fish	Taki	Dry fish	Dry fish	Chapila
Chapila	Mrigel	Hilsha	Dry fish	**Silver Carp**	Mrigel	Taki
Thai Sharputi	Dry fish	Mrigel	**Thai Sharputi**	Taki	**Comon Carp**	Dry fish
Dry fish	Hilsha	Tengra	Chapila	Hilsha	**Thai Sharputi**	Hilsha
Mrigel	Boro Baim	**Thai Sharputi**	Tengra	**Thai Sharputi**	Taki	**Comon Carp**
Silver Carp	**Silver Carp**	Chapila	**Comon Carp**	**Comon Carp**	Catla	Catla
Comon Carp	**Thai Pangas**	**Comon Carp**	Hilsha	Tengra	Tengra	**Thai Sharputi**
Bele	**Comon Carp**	Lamba Chanda	**Tilapia**	Catla	Hilsha	Tengra
Hilsha	**Thai Sharputi**	Boro Baim	Boro Baim	Boro Baim	Boro Baim	**Bighead Carp**
Shing	Mola	Catla	Lamba Chanda	**Tilapia**	**Tilapia**	Boro Baim
Mola	Bele	Bele	Catla	Lamba Chanda	Lamba Chanda	**Tilapia**
Catla	Catla	**Tilapia**	Guchi Baim	Shol	Guchi Baim	Guchi Baim
Air	Shing	Guchi Baim	Shol	Guchi Baim	**Bighead Carp**	Shar Puti

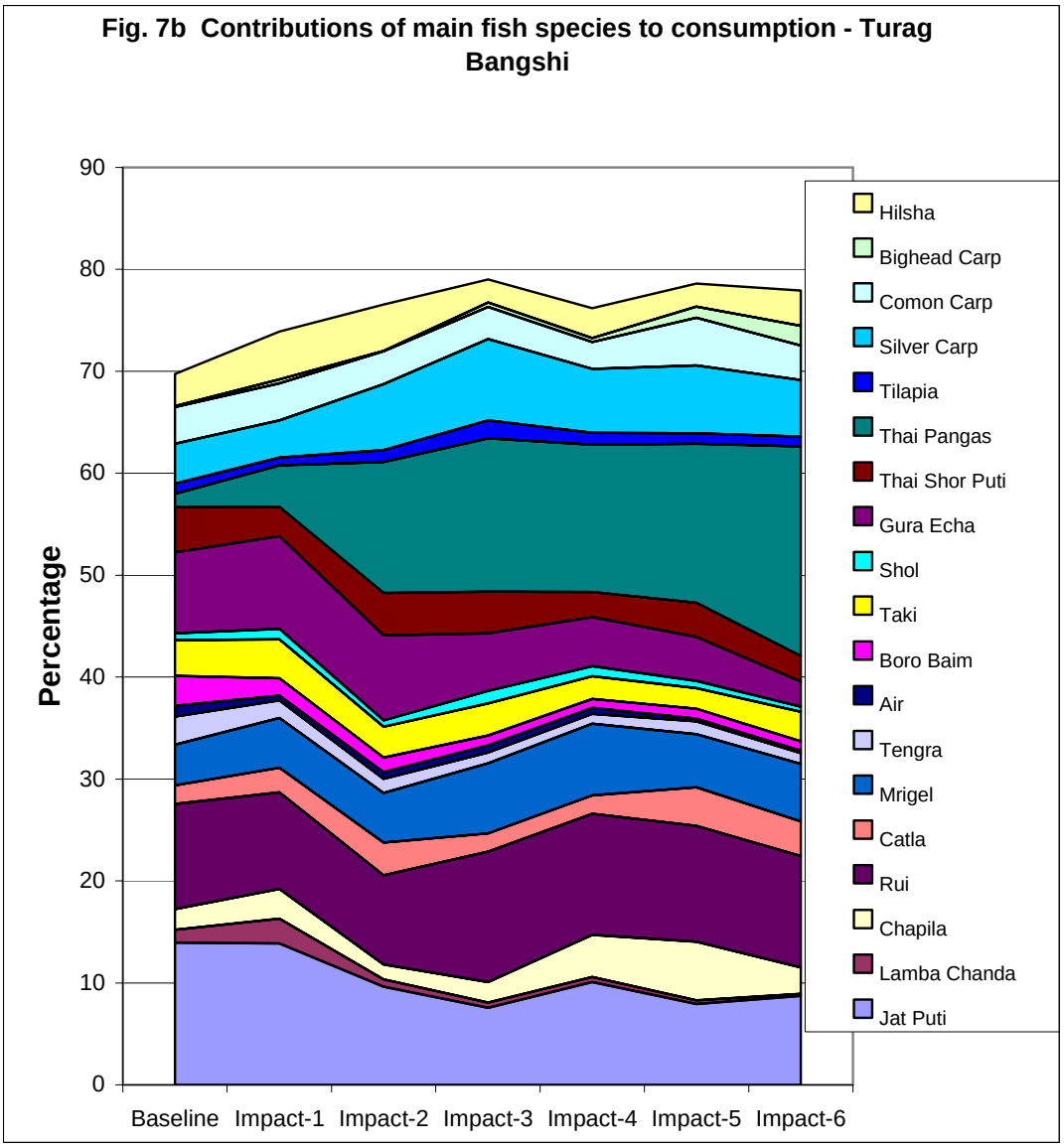
Exotic species in bold

Table 3c Top 20 species in terms of frequency of consumption in Kangsha-Malijee (Sherpur)

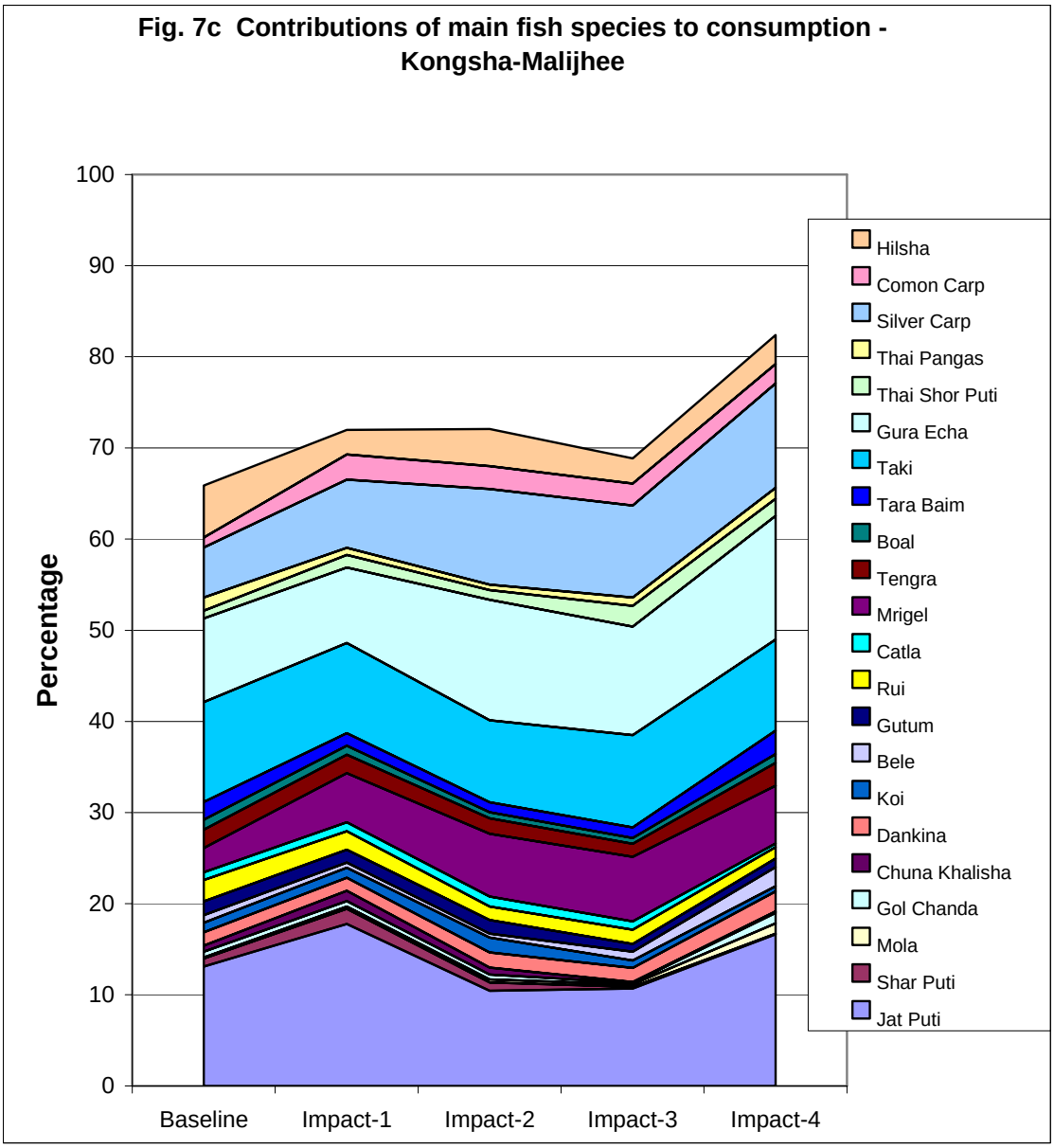
Baseline	Impact 1	Impact 2	Impact 3	Impact 4
Dry fish	Dry fish	Dry fish	Dry fish	Dry fish
Gura mach	Jat Puti	Gura mach	Gura mach	Jat Puti
Jat Puti	Gura mach	Gura Echa	Gura Echa	Gura Echa
Taki	Taki	Jat Puti	Jat Puti	Taki
Gura Echa	Gura Echa	Taki	Taki	**Silver Carp**
Hilsha	**Silver Carp**	**Silver Carp**	**Silver Carp**	Tengra
Silver Carp	Hilsha	Mrigel	Mrigel	Mrigel
Tara Baim	Mrigel	Hilsha	Hilsha	Tara Baim
Tengra	Tengra	Tengra	**Thai Sarputi**	Bele
Mrigel	**Common Carp**	**Common Carp**	Tengra	Gura mach
Rui	Gutum	Dankina	**Common Carp**	Dankina
Gutum	Dankina	Gutum	Dankina	Hilsha
Dankina	Rui	Koi	Tara Baim	Guchi Baim
Koi	Tara Baim	Rui	Bele	Gol Chanda
Thai Pangas	Chuna Khalisha	Chuna Khalisha	Gutum	Ranga Chanda
Chuna Khalisha	Shar Puti	Tara Baim	Rui	Gutum
Bele	**Thai Sarputi**	**Thai Sarputi**	Ranga Chanda	Mola
Thai Sarputi	Koi	Boro Baim	Koi	**Thai Sarputi**
Gol Chanda	Gol Chanda	Khalisha	**Thai Pangas**	**Common Carp**
Common Carp	Boro Baim	Catla	Catla	Meni/Bheda

Exotic species in bold





There is no clear trend in changing composition of fish consumed in Kangsha-Malijee (Table 3c) – already some cultured exotic species were in the diet in the baseline year, and have retained their position. The increases in fish catches mostly involve small species and as the area is relatively remote it would appear that growth in consumption has been even, with little change in the proportions of species and types of fish consumed.



3.6 Trends in Consumption of Other Foods

Besides fish, people also consume other foods high in protein including meat, pulses, milk, and eggs. Data on the amounts of these four types of foods was also collected from the sample households in the first four years of monitoring (Table 4). Consumption of pulses hardly changed in any of the sites during these years. In both Hail Haor and Turag-Bangshi consumption of meat increased substantially by impact year 3 (by 78% and 64% respectively), but was still low compared with fish consumption.

Table 4 Consumption of other high protein food items (g/person/day)

Items	Baseline	Impact Year-1	Impact Year-2	Impact Year-3
Hail Haor				
Pulses	11.6	10.8	10.0	10.4
Meat	4.9	6.7	6.9	8.7
Egg (No.)	0.0	0.1	0.1	0.1
Milk	6.0	3.8	3.7	5.5
Turag-Bangshi				
Pulses	14.8	9.7	11.0	13.2
Meat	8.7	11.1	15.1	14.3
Egg (No.)	0.0	0.0	0.1	0.1
Milk	17.1	20.8	25.6	30.8
Kangsha-Malijhee				
Pulses	6.0	5.3		
Meat	8.4	8.2		
Egg (No.)	0.1	0.1		
Milk	14.4	13.8		

Consumption of eggs was low in all three sites (not more than one per person every 10 days) and remained constant at this level. However, in Turag-Bangshi site consumption of milk almost doubled in these four years. Overall there were changes in diet occurring that were independent of fishery and wetland management, and so some of the changes in fish consumption were more likely driven by falling poverty and access to foods than just changes in wetland productivity.

3.7 Use of Other Aquatic Resources

Although fish are the single most important aquatic resource exploited from the wetlands in these three sites, a range of other resources are also used. Therefore the household monitoring program included recording involvement in collection and use of a wide range of other aquatic resources – plants and animals.

Around two-thirds of households living around Hail Haor collect non-fish aquatic resources of at least one type each year (Table 5). The main resources used are plants – grasses and straw for fodder and Dhol kolmi (*Ipomea*) which has various local names and is used as fuel; while around 14% of households collect snails for poultry and fish feed, and several plant species for human consumption. Households on average (across all the monitored households) spend 30 or more days a year collecting non-fish aquatic resources from the haor. Here poorer and better off households appear to be just as much involved. There is no clear trend between years in use, indicating that in general there have been no changes in either access to these resources or their productivity.

Table 5 Percentage of households involved in collection of natural resources from the project wetlands

Natural resource	Baseline	Impact-1	Impact-2	Impact-3	Impact-4	Impact-5	Impact-6	Average
Hail Haor (Sreemongal)								
Any item	66.1	76.2	62.4	65.7	60.9	71.0	69.7	67.4
Grass	41.8	40.7	26.7	28.1	21.3	29.7	28.4	31.0
Straw	0	29.3	29.2	36.0	29.9	35.4	33.8	27.7
Dholkolum/Daokolum	19.8	32.0	24.1	29.0	31.0	24.2	24.0	26.3
Snail/Oyster	14.7	20.2	13.1	18.5	10.3	12.5	8.4	13.9
Kolmi/Barisa Leaf	6.3	12.4	10.6	11.9	9.0	9.5	12.5	10.3
Earthworm	3.5	15.1	11.8	9.7	9.2	6.6	8.4	9.2
Fokol	1.4	6.3	10.2	12.3	11.0	9.5	8.4	8.4
Aram Tubercle	0.8	11.4	6.7	7.0	6.6	7.5	4.8	6.4
Shaluk	2.2	8.1	8.8	9.5	6.2	2.0	7.3	6.3
Bird	3.3	7.5	4.5	5.9	4.4	2.9	2.0	4.4
Frog	2.0	3.9	2.9	2.0	1.5	3.5	2.9	2.7
Hyacinth	0	6.1	1.0	3.1	1.1	3.3	0.2	2.1

Natural resource	Baseline	Impact-1	Impact-2	Impact-3	Impact-4	Impact-5	Impact-6	Average
Turtle	4.3	3.7	1.2	2.2	0.9	1.5	0.9	2.1
Turag Bangshi (Kaliakoir)								
Any item	58.9	85.7	87.5	86.8	89.3	81.4	78.6	81.2
Grass	40.0	47.9	50.7	53.2	55.7	53.9	43.6	49.3
Shaluk	1.1	52.5	55.4	63.6	52.5	50.7	45.4	45.9
Frog	17.9	39.6	42.5	33.6	49.3	17.1	27.1	32.4
Fokol	0.4	21.4	32.9	37.9	35.0	26.1	28.9	26.1
Snail/Oyster	15.4	13.6	17.1	20.4	25.7	20.0	17.1	18.5
Bird	1.4	9.6	12.1	21.8	31.8	21.8	11.1	15.7
Panikola	0	16.4	18.9	26.8	22.5	10.4	7.1	14.6
Wild animal	0	5.7	6.1	10.7	10.7	2.1	1.4	5.3
Dholkolum/Daokolum	2.1	5.7	8.2	2.5	10.4	2.1	0.0	4.4
Kangsha-Malijhee (Sherpur)								
Any item	35.4	11.1	11.8	29.6	36.9			24.9
Grass	24.3	7.9	10.0	24.3	30.6			19.4
Snail/Oyster	16.8	1.1	5.0	8.6	9			8.0
Bird	2.5	2.9	0.4	1.1	3.1			2.0

Only resource types collected by 2% or more of households are included in the table

In the Turag Bangshi site about 80% of households have collected some non-fish aquatic resources in each year after the baseline. There the baseline year data may not have been representative of use of some types of resource since it is unlikely that some of the plants suddenly became much more abundant in 2000-2001 (impact year 1). This greater involvement in using aquatic resources may reflect households living closer to parts of the wetland, and it is also associated with a wider range of resources being commonly used: over a quarter of all households collect grass, frogs (as fishing bait), shaluk and fokol (edible water plants). Moreover poorer households tend to spend more days per year collecting these resources, indicating that they are relatively more important for their livelihoods. However, the growing incidence of bird hunting there, involving up to a quarter of all households, is a concern as the project has advocated a complete end to hunting birds with some success in Hail Haor, but apparently the reverse trend is occurring in Turag-Bangshi.

Surprisingly, since on average household incomes are lower there, the incidence of collecting non-fish aquatic resources is was reported to be much lower involving only a quarter of households in Kongsha-Malijhee site, and better off households are more involved. Also very few types of aquatic resources were reported to be used there. These unexpected patterns deserve further investigation at this site, since on first impressions the resources present should be similar to those in Turag-Bangshi site, although the flash flood nature of the site in the upper catchment of the river basin may limit presence of some aquatic resources.

Lastly for Hail Haor the use of non-fish aquatic resources was monitored and analyzed in more detail for the baseline year and impact years 1-3, this reveals very major levels of exploitation. For example, each monitored household on average collected about 20 kg of snails and 70 bundles of grass in a year (Table 6). With perhaps 30,000 households in total using the haor, this would imply 600 t of snails and 2.1 million bundles of grass collected each year. Most of the non-fish natural resources were used for family maintenance and consumption, but some were sold notably some aquatic fruits – fokol and shinga – and turtles. Although very few turtles were reported caught the ready market for these is a concern as most of the species recorded in Hail Haor are nationally threatened and have suffered a serious population decline. Demand for some of the aquatic resources appears to be high – the prices of several products that are regularly sold in local markets have either remained the same or increased during the project period (Table 7).

Table 6 Effort (days/household/year) and amount collected (unit/household/year) by use of natural resources in Hail Haor.

Resource	Baseline		Impact-1		Impact-2		Impact-3	
	Effort (d/hh/y)	Amount (/hh/y)	Effort (d/hh/y)	Amount (/hh/y)	Effort (d/hh/y)	Amount (/hh/y)	Effort (d/hh/y)	Amount (/hh/y)
Grass (bundle)	**23.9**	**154.3**	**14.0**	**73.8**	**17.2**	**70.1**	**11.8**	**40.8**
To Sell		13		10		7		4
Fodder		87		90		93		96
Snail/Oyster (kg)	**5.4**	**23.3**	**5.1**	**20.7**	**5.7**	**15.0**	**7.3**	**23.8**
To Sell		3		1		0		0
Poultry feed		23		14		16		7
For Fishing		74		85		84		89
Fish feed		0		0		0		4
Earthworm (Nos.)	**2.2**	**1033.4**	**3.3**	**1783.5**	**4.4**	**1818.4**	**2.8**	**1572.4**
To Sell		7		13		1		0
For Fishing		93		87		99		98
Fish feed		0		0		0		2
Dhol kolum/Kolum (bundle)	**4.9**	**38.9**	**8.7**	**30.3**	**9.4**	**25.5**	**7.7**	**19.7**
To Sell		13		7		3		4
Use for Roof/Fence		0		0		0		0
Use as Fuel		87		93		97		96
Frog (Nos.)	**0.7**	**102.1**	**0.4**	**43.3**	**0.4**	**48.9**	**0.2**	**39.8**
To Sell		0		2		0		0
For Fishing		100		98		100		100
Turtle (g)	**0.4**	**706.4**	**0.3**	**621.4**	**0.3**	**460.4**	**0.7**	**1744.9**
To Eat		29		8		0		0
To Sell		71		92		100		100
Bird (Nos.)	**0.6**	**1.1**	**1.2**	**5.5**	**0.6**	**2.0**	**0.8**	**3.0**
To Eat		53		100		100		100
To Sell		2		0		0		0
To Rear		45		0		0		0
Shaluk (bundle)	**0.4**	**1031.9**	**0.6**	**2183.5**	**0.6**	**1289.8**	**0.7**	**2111.7**
To Eat		24		59		100		96
To Sell		77		41		0		4
Kolmi/Barisa Leaf (bundle)	**0.9**	**5.5**	**0.7**	**1.8**	**1.2**	**2.7**	**0.6**	**1.7**
To Eat		37		77		78		87
To Sell		62		11		22		13
Fodder		2		13		0		0
Fokol (g)	**0.2**	**2.6**	**0.7**	**23.3**	**1.9**	**75.5**	**3.2**	**170.3**
To Eat		7		1		0		0
To Sell		93		99		100		100
Panikola (g)	**0.1**	**137.6**	**0.1**	**63.7**	**0.1**	**107.2**	**0.0**	**57.2**
To Eat		100		100		100		100
Aram Tubercle (Nos.)	**0.7**	**1.8**	**0.8**	**2.0**	**1.1**	**4.4**	**1.4**	**1.9**
To Eat		64		54		24		75
To Sell		36		46		76		25
Shingrai (kg)	**0.1**	**0.2**	**0.9**	**2.0**	**0.7**	**1.5**	**0.7**	**1.4**
To Eat		15		2		1		3
To Sell		85		98		99		97
Straw (bundle)	**0.1**	**0.3**	**8.4**	**27.4**	**7.6**	**21.7**	**6.6**	**15.3**
To Sell		0		1		0		0
Fodder		81		29		27		37
Roof/Fence		0		1		5		0
Fuel		19		69		68		62

Figures are averaged across all households covered by regular monitoring for fish consumption

Table 7 Prices of non-fish aquatic resources reported by households collecting and selling them in Hail Haor

Price (Tk/unit)	Baseline	Impact-1	Impact-2	Impact-3
Grass (bundle)	**5.87**	**5.67**	**5.37**	**12.81**
Snail/Oyster (kg)	13.87	18.06		
Earthworm (per hundred)	1.00	2.00	1.00	
Dhol kolmi (bundle)	**3.51**	**6.45**	**11.16**	**10.87**
Frog (Nos.)		0.30		
Turtle (kg)	**90.49**	**78.15**	**77.57**	**90.79**
Bird (Nos.)	83.33			
Shaluk (bundle)	0.03	0.02		0.01
Kolmi/Barisa Leaf (bundle)	**4.61**	**2.91**	**3.96**	**2.54**
Shapla (bundle)	5.00			
Fokol (kg)	**4.95**	**4.80**	**5.77**	**5.30**
Aram Tubercle (Nos.)	**2.89**	**2.50**	**5.08**	**3.60**
Shingrai (kg)	**36.29**	**32.34**	**32.75**	**39.14**
Straw (bundle)		5.00	20.00	

Bold = resources that were sold by at least some households in each year

4. Conclusions

Apart from national level data, there is a lack of long term sample based monitoring of fish consumption in Bangladesh, despite the importance of fish to diet. The MACH data set reported here covers up to seven years in a site (an additional last year of data was collected but is in process of being entered and analyzed). Although Muir (2003) concluded that in the 1990s fish consumption at the national level fell, more recently the official Household Expenditure Survey (Bangladesh Bureau of Statistics, pers. comm.) claims that national fish consumption in general has risen in the 2000s (Table 8). These national figures also show consumption levels that are higher than many of those recorded in past studies, and that are slightly lower in rural areas than the national average.

The evidence from the MACH sites is that fish consumption has risen significantly over the baseline year of 1999. Although fish consumption fluctuates in a regular seasonal pattern in line with total fish production from floodplain wetlands, it also varies between years according to catches and the characteristics of flooding and extent of inundation each year. The evidence for substantially increased fish catches in the MACH sites over the baseline year (MACH 2007) is thus reflected in local fish consumption. Moreover these benefits have been spread widely – with the poor enjoying statistically significant increases in their fish consumption in all three sites, and in some sites catching up to some extent with better off households.

Table 8 Trends in fish consumption (g/person/day)

Year	National*	Hail Haor	Turag-Bangshi	Kangsha-Malijhee
1975-76[a]	23			
1981-82[b]	23			
1992[c]			12	
1992[d]		18[5]		
1999	33	49	29	-
2000	35	52	28	
2001	37	54	30	24
2002	38	60	37	28
2003	40	58	47	29
2004	41	65	48	34
2005	43	57	40	36

* Source: Household Expenditure Survey (Bangladesh Bureau of Statistics pers. comm) except where stated; including all types of fish

[a] Institute of Nutrition and Food Science, 1997

[b] Ahmad and Hassan, 1983

[c] Minkin et al. (1997) data for Tangail also in central Bangladesh

[d] Minkin et al. (1997) data for Surma-Kushiara also in northeast Bangladesh

Note for MACH sites the data is for 12 month periods that overlap years, with most of the12 months in the following year

Despite the gains in production and local consumption of fish from better management, the more detailed information available from the surveys showed that most of the fish consumed had been bought. Although the quantities of wild indigenous fish caught and consumed by the sample households had increased in Turag-Bangshi and to some extent in Kangsha-Malijhee, fish produced from pond aquaculture by now play a substantial part in the average diet in both of these sites, especially in Turag-Bangshi. Only in Hail Haor where

the total catch of wild fish is much larger (and fish consumption is higher) have cultured species made smaller inroads on consumption.

Implications of the study:

1. Restoring wetland productivity and fish catches does increase substantially the fish consumption of local people both poor and rich, which has positive impacts on nutritional status especially of the poor.
2. Local people buy much of the fish they consume – mostly from local sources, but this includes cultured carps and exotic fish which are not so costly. The relative prices of wild fish have been rising, and some of the species that have been restored are high value, it seems likely that these are being sold on to urban markets where they command even higher prices. Further study of the marketing and relative prices of indigenous floodplain fishes should be undertaken.
3. Many households are involved in collecting and using non-fish aquatic resources. This has remained at a high level, but it is not sure how sustainable some of this exploitation is. The RMOs should review the trends and consider what measures and rules might be needed to ensure the continued health of these products.

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Annex 1: Monitoring Form

MACH (Form-2) **HH Code** | | | | | | |

Fish Consumption and Natural Resource Collection Monitoring Form

Project Area: _____ **Village:** _____ **Date:** _____

Head of Household: _____ **HH Members:**_____ **Name of Enumerator:**_____

1. Fish Consumption Related Information

Today Morning: Meal Number……				**Today Noon: Meal Number……**				**Today Night: Meal Number……**			
Species	**Weight (g)**	**Measured (1)/ Estimated (2)**	**Source of Fish**	**Species**	**Weight (g)**	**Measured (1)/ Estimated (2)**	**Source of Fish**	**Species**	**Weight (g)**	**Measured (1)/ Estimated (2)**	**Source of Fish**
Members eaten		M…...F…..Children….		Male……Female…….Children……				Male……Female…….Children…			
(When Method: 1. Self 2. Estimated, Source: 1. Catch 2. Buy 3. Gift 4. Others (Mention)											

2. Other Protein Consumption

Today (Morning: breakfast)		**Today (Noon: lunch)**		**Today (Night: dinner)**	
Name of Food	**Weight (g)/No.**	**Name of Food**	**Weight (g)/No.**	**Name of Food**	**Weight (g)/No.**
Consuming members: Male:...….Female……Children……...		Male:…....Female……Children……...		Male:…….Female……Children……...	

3. Fish Catch Data

Who fished	**Age**	**Sex**	**Gear Used**	**Fishing Duration (Hours)**	**Weight (g) of Fish Caught**	**Fish sold**		**Fish Eaten**	**Habitat**
						Weight (g)	**Taka**	**Weight (g)**	

4. Other Natural Resources Harvesting Data: (If any member of your HH collect other natural resources as aquatic vegetation, bird, wild animal, frog etc. from Haor/Beel/River/Khal etc.)

Reeds			Fodder/Grass			Mollusks			Birds		
Who	Quantity	purpose	Who	Quantity	Purpose	Who	Quantity	Purpose	who	Quantity	Purpose

Other resources: specify

Who	Quantity	purpose	Who	Quantity	Purpose	Who	Quantity	Purpose	who	Quantity	Purpose

5. Income from Selling of other Natural Resources

Reeds											
Qty. sold	Taka	Qty. sold	Taka	Qty. sold	Taka	Qty. sold	Taka	Qty. sold	Taka	Qty. sold	Taka

Comments_____

Annex 2 Supporting Tables

Per capita fish consumption (g/person/day) in MACH sites

Site	Land category	Baseline	Impact-1	Impact-2	Impact-3	Impact-4	Impact-5	Impact-6
		(A)	(B)	(C)	(D)	(E)	(F)	(G)
Hail Haor (Sreemongal)	Landless	47.60	50.23	50.86	58.43	56.61	62.55	54.50
					A B C	A	A B C G	
	Marginal	48.95	53.59	59.20	64.80	62.91	73.97	64.87
							A B	
	Small	50.97	51.78	57.65	59.64	57.12	63.53	61.50
	Medium	50.56	56.21	64.41	62.92	60.50	67.10	61.63
	Large	55.93	53.59	59.46	48.02	49.88	56.18	51.98
	Total	48.72	51.58	54.43	59.77	57.92	64.90	57.43
					A B	A B	A B C E G	A
Turag-Bangshi (Kaliakoir)	Landless	28.85	28.27	28.65	36.94	45.51	47.31	39.43
					A B C	A B C D	A B C D G	A B C
	Marginal	28.52	28.04	28.67	34.45	44.19	46.25	38.10
						A B C D	A B C D	B
	Small	29.70	27.18	27.11	36.70	45.40	50.79	43.88
						B C	A B C	C
	Medium	28.99	32.25	39.74	46.72	55.31	52.85	47.91
						A B	A B	
	Large	32.34	28.98	37.41	43.96	64.15	56.47	48.79
	Total	28.95	28.48	29.66	37.29	46.50	48.05	40.43
					A B C	A B C D G	A B C D G	A B C
Kongsha-Malijhee (Sherpur)	Landless	23.85	27.60	27.64	33.28	34.39		
					A B C	A B C		
	Marginal	24.62	29.98	32.57	37.03	39.30		
					A	A B		
	Small	22.18	25.34	26.64	31.47	30.26		
	Medium	21.18	27.83	29.59	35.26	36.66		
					A	A		
	Large	26.01	29.37	31.27	39.65	41.35		
	Total	23.82	28.06	28.94	34.36	35.60		
			A	A	A B C	A B C		

Results are based on two-sided t-tests assuming equal variances with significance level 0.05. For each significant pair, the key of the smaller category appears under the category with larger mean.
Tests are adjusted for all pair-wise comparisons within a row of each innermost sub-table using the Bonferroni correction.

Percentage change in fish consumption – impact years 3-6 compared with baseline

Landholding class	Hail Haor (Sreemongal)			Turag-Bangshi (Kaliakoir)			Kongsha-Malijhee (Sherpur)		
	Consumption (g/person/day)		Impact years 3-6 as % of baseline	Consumption (g/person/day)		Impact years 3-6 as % of baseline	Consumption (g/person/day)		Impact years 3-4 as % of baseline
	Baseline	Impact years 3-6 average		Baseline	Impact years 3-6 average		Baseline	Impact years 3-4 average	
Landless	48	58	122	29	42	147	24	34	144
Marginal	49	67	136	29	41	143	25	38	160
Small	51	60	119	30	44	149	22	31	136
Medium	51	63	125	29	51	175	21	36	173
Large	56	52	92	32	53	165	26	41	159
Total	49	60	123	29	43	149	24	35	149

Breakdown of fish consumption by type of fish (% by weight)

Type of fish	Baseline	Impact 1	Impact 2	Impact 3	Impact 4	Impact 5	Impact 6
Hail Haor (Sreemongal)							
Small Fishes	56.0	46.4	38.2	40.7	37.4	34.4	33.6
Major Carps	2.8	3.2	4.0	3.5	4.4	8.1	7.0
Minor Carps	1.1	1.3	1.9	1.9	1.9	3.2	2.6
Small Catfish	9.4	9.8	8.1	8.2	8.8	6.8	6.0
Large Catfish	1.4	1.1	0.8	0.3	0.3	4.3	0.8
Eels	1.3	1.1	1.0	1.1	1.1	1.3	1.5
Snakeheads	14.8	16.9	20.2	20.5	21.2	15.0	20.5
Prawns	3.9	6.6	8.1	6.8	5.5	5.7	6.7
Exotic Species	2.2	3.6	7.2	7.8	8.4	11.2	10.3
Knife Fishes	0.9	1.4	1.1	2.3	2.1	2.3	2.2
Dried Fish	4.5	5.0	4.2	3.4	3.4	3.8	3.8
Hilsha	1.7	3.5	5.2	3.3	5.3	3.9	5.1
Others	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Turag Bangshi (Kaliakoir)							
Small Fishes	41.2	41.5	31.2	26.9	34.8	30.5	29.0
Major Carps	16.3	16.8	17.1	21.8	21.1	20.8	20.3
Minor Carps	0.4	0.2	0.1	0.1	0.1	0.1	0.1
Small Catfish	4.4	3.2	2.9	2.2	2.0	2.3	1.8
Large Catfish	2.0	0.9	1.1	0.9	0.8	1.2	0.9
Eels	3.6	2.1	1.9	1.5	1.4	1.7	1.7
Snakeheads	4.2	4.9	3.7	4.4	3.2	2.7	3.5
Prawns	8.1	9.2	8.3	5.8	4.8	4.3	2.5
Exotic Species	15.2	15.7	28.2	32.9	27.8	32.9	35.7
Knife Fishes	0.3	0.2	0.3	0.4	0.3	0.2	0.2
Dried Fish	0.9	0.6	0.6	0.8	0.7	0.8	0.7
Hilsha	3.1	4.7	4.5	2.3	2.9	2.2	3.5
Others	0.1	0.1	0.2	0.1	0.1	0.2	0.2
Kongsha-Malijhee (Sherpur)							
Small Fishes	44.7	46.5	37.4	39.4	33.4		
Major Carps	6.0	8.6	9.8	9.8	8.1		
Minor Carps	0.1	0.1	0.1	0.1	0.3		
Small Catfish	3.2	2.9	2.6	1.9	2.9		
Large Catfish	1.2	1.2	0.9	0.8	1.6		
Eels	2.9	2.3	2.5	1.7	4.0		
Snakeheads	11.0	9.9	9.0	10.2	10.1		
Prawns	9.4	8.4	13.2	11.9	13.6		
Exotic Species	9.5	13.2	15.8	16.2	17.2		
Knife Fishes	0.0	0.1	0.1	0.1	0.2		
Dried Fish	6.2	3.9	4.7	5.0	5.2		
Hilsha	5.7	2.7	4.1	2.8	3.2		
Others	0.1	0.2	0.0	0.1	0.0		

Annex 3 Resident Monitors and Supervisors

Hail Haor Site, Sreemangal

Household monitors:

Sl. #	Monitors Name	Duration	Village
1	Ms. Mili Rani Das	1999 - 2007	Shoilpur
2	Ms. Shita Rani Dev	1999 - 2007	Mirzapur(Namapara)
3	Ms. Shima Rani Das	1999 - 2001	Boulashir(Namapara)
	Ms. Lakshmi Rani Baiddha	2001 - 2007	
4	Ms. Nomita Ray	1999 - 2002	Vimshi(Namapara)
	Ms. Kobita Ray	2002 - 2007	
5	Ms. Juma Rani Sarker	1999 - 2007	Bade Alisha
6	Ms. Lolita Rani Sarker	1999 - 2006	Rustompur
	Ms. Bishakha Rani Sarker	2006 - 2007	
7	Ms. Progoti Rani	1999 - 2002	Dighapara
	Mr. Samraz Mazumdar	2002 - 2007	
8	Ms. Anjana Ray	1999 - 2005	Lalbag
	Ms. Beuty Ray	2005 - 2007	
9	Ms. Rokshana Begum	1999 - 2007	Paschim Varaura
10	Mr. Rokunuzzaman Mia	1999 - 2004	Hazipur
	Ms. Jafrun Aktar	2004 - 2007	
11	Ms. Sidratunnesa	1999 - 2007	Baruna(Migherhati)
12	Ms. Shefali Aktar	1999 - 2005	Baruna(Boroibari)
	Mr. Jewel Mia	2005 - 2006	
	Mr. Joni Mia	2006 - 2007	
13	Ms. Sudevi Rani Sarker	1999 - 2007	Baruna

Household monitors supervisors:

Name	Duration	Remarks
Mr. Md. Ashrafuzzaman, Mr. Md. Joynal Abedin, Mr. Md. Basiruddin, Mr. Md. Shahinur Rahman	1999 - 2000	At initial stage all the staff were responsible to supervise
Mr. Md. Saleh Kazbin	2000 - 2001	Single supervisor
Mr. Md. Touhidur Rahman, Mr. Md. Zakir Hossin, Mr. Md. Joynal Abedin, Mr. SM Monjurul Ahsan, Mr. Md. Amanulla, Mr.Md. Rafiqul Islam, Mr. Md. Montasir Rahman, Mr. Md. Sazzadur Rahman, Mr. Md. Saleh Kazbin, Mr. Md. Hamdu Mia, Mr. Achintya Kumar Sarker, Mr. AKM Forhad Kabir, Mr. AH Mostafa Kamal , Mr. Md. Zahed Sadeque Chowdhury, Mr. Md. Mukhlesur Rahman, Mr. Md. Zahedul Islam, Mr. Md. Khairul Islam Akanda	2001 - 2003	Field officers were responsible to supervise the houseold monitors under their zone (Working area was divided into four zones with a maximum of 10 Field Officers (others (7) were replacements)
Mr. Md. Touhidur Rahman	2004 - 2007	Single supervisor

Turag Bangshi Site, Kaliakoir

Household monitors:

SL.	NAME	Duration	Village
1	Ms. Kamala Akter-Koli	1999 to 2006	Baraibari
	Ms. Alo Rahman	2006 to 2007	
2	Ms. Kohinoor Begum	1999 to 2002	Bashtoli
	Ms. Laksmi Rani	2002 to 2007	
3	Ms. Parbati Rajbangshi	1999 to 2007	Gopinpur
4	Ms. Kohinoor Begum	1999 to 2000	Kaliadaha
	Ms. Hasna Akter Hena	2001 to 2005	
	Ms. Salina Akter	2005 to 2006	
	Ms. Salma Akter	2006 to 2007	
5	Ms. Salma Akter	1999 to 2007	Majukhan
6	Ms. Marzina Begum	1999 to 2005	Mediasulai
	Ms. Nasrin Akter	2006 to 2007	
7	Ms. Panchami Rani Mandal	1999 to 2000	Sholahati
	Ms. Lipi Sarker	2000 to 2007	
8	Ms. Sufia Akter	1999 to 2004	Taltoli
	Ms. Beauty Rani Poddar	2004 to 2007	

Household monitors supervisors:

SL.	Supervisors	Duration	Remarks
1	Md. Rafiqul Islam	1999 to March 2004	Single supervisor
2	Md. Shourav Mahmood	April 2004 to January 2005	
3	Md. Faruk Ahmed	February 2005 to October 2005	
4	Sree Nirmal K Kundu	November 2005 to April 2007	

Kangsha-Malijhee Site, Sherpur

Household monitors:

Sl. #	Monitors Name	Duration	Village
1	Ms. Kapashi Begum	2001-2003	Tirsa
	Ms. Roksana Parvin	2004-2005	
	Ms. Kapashi Begum	2006-2007	
2	Ms. Parvin Begum	2001 - 2007	Tatalpur
3	Ms. Jorina Khatun	2001-2007	Sonabor Kanda
4	Ms. Rokshana Parvin	2001 - 2007	Baniapara
5	Ms. Lipi Parvin	2001 - 2007	Dorikali Nagar
6	Ms. Zakia Nazneen	2001 - 2007	Balia Chondi
7	Mr. Sultan Ahmed	2001 - 2007	Doriarpar
8	Ms. Morsheda Begum	2001 - 2007	Kanduli

Household monitors supervisors:

Name	Duration	Remarks
Mr. Md. Khalilur Rahman	2001-2001	Single supervisor
Mr. Md. Khalilur Rahman Mr. Md. Nuruzzaman Mr. Md. Liakat Ali Mr. Md. Milton Kumar Sarker Mr. Md. Noor Ahmed	2002 – July 2004	Field officers were responsible to supervise the household monitors under their Complex (working area was divided in to four Complexes and maximum Field Officers were 5)
Mr. Md. Liakat Ali	August 2004 - March 2007	Single supervisor

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