INTEGRATED PROTECTED AREA CO-MANAGEMENT (IPAC)

FISH CATCH MONITORING REPORT

January 22, 2012

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COVER PHOTO:

Bangladesh's wetlands provide livelihoods and contribute to a nutritional diet for many rural poor. Degradation of these wetlands from industrial pollution as well as encroachment and land conversion threatens both livelihoods and food security. USAID's IPAC project works with the Government of Bangladesh and wetland-dependent communities to conserve and sustainably manage Bangladesh's wetlands to ensure healthy production today and into the future.

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EXECUTIVE SUMMARY

The importance of fisheries, especially wetlands fisheries as a source of nutrition, employment and income for the rural poor can hardly be emphasized enough. Fishing is a key livelihood opportunity for thousands of households in wetlands and plays an important part in food security and poverty alleviation. In the past, the management of wetlands fisheries has often excluded marginalized fishers and encouraged leaseholders to effectively 'mine' resources at non-sustainable levels of exploitation. To address these concerns, USAID supported the Government of Bangladesh to establish co-management and restoration of three major wetlands through the MACH project, and IPAC in turn is supporting continued and strengthened co-management in all these ex-MACH wetlands plus in the Sundarbans. Integrated Protected Area Co-management (IPAC) Project has re-started detailed monitoring similar to that under MACH to determine the relationship between wetlands management practices and impacts on biological significance and fish catches in wetlands.

Fish Catch Monitoring Studies have been carried out in three wetlands earlier brought under co-management by MACH, within these systems 13 representative waterbodies were monitored, and this report presents a consolidated result of the analysis carried out so far. The main findings cover:

- Fisheries production and seasonal variation of production
- Species diversity and major contributing species,
- Gear efficiency and harvesting performance, and
- Biodiversity.

Fisheries production was measured by monitoring a sample of individual catches from defined areas which were used to estimate the total catch in each wetland. The total fish catch in the study year (2010) was estimated to be about 170 tons in Hail Haor, about 28.9 tons in Kangsha-Malijhee wetland, and about 16.9 tons in Turag-Bangshi system. Through monitoring it was found that the main effective factors that positively influence production are habitat type (e.g., river section, beel), water extent during monsoon, tenure effectiveness of restriction in fishing, fish sanctuary, and higher species diversity, presence of professional fishers around water bodies, fisher's density and aquatic links with other water bodies. Data from one year are compared with those from seven years of monitoring under MACH, however as fish catches are known to vary with environmental conditions between years data from additional years of monitoring will be needed to verify the trends estimated in this study.

In **Hail Haor** the common species caught by all types of gears were Boal (*Wallago attu*), Rui (*Labeo rohita*), Common carp (*Cyprinus carpio*), Grass carp (*Ctenopharyngodon idella*) and Taki (*Channa punctata*), contributing 8.0%, 7.6%, 7.5%, 7.1% and 5.4% respectively. Analysis of catch monitoring data reveals that 20 main species contributed 75.2% of the catch by weight in 2010. The annual contribution of the other 56 species recorded was 24.8%. Boal, a predatory resident species, was the largest part by weight of the catch, unlike most openwater systems in Bangladesh where small fish particularly puti (*Puntius* spp.) dominate catches. However, the high catches of two exotic species - Common carp and Grass carp – are notable, it would appear that Common capr has natrualised in Gopla River, but as Grass carp is nt known to reproduce in the wild in Bangladesh these fish are presumably escapes from the rapidly expanding aquaculture enterprises encroaching around the fringes of Hail Haor. These exotic species did not dominate the MACH data, but floodplain aqua culture areas have expanded rapidly since the start of MACH and co-management has been unable to influence this trend.

In **Kangsha-Malijhee** system the common species caught by all types of gears were Jatputi (*Puntius sophore*), Tara baim (*Macrognathus aral*), Baila (*Glossogobius giuris*), Boal (*Wallago attu*) and Taki (*Channa punctata*) contributing 10.8%, 9.5%, 8.9%, 8.7% and 7.6% respectively. The 20 main species contributed to 89.4% of the catch by weight in 2010. The contribution of the other 43 species was 10.6% of the catch by weight.

In **Turag-Bangshi** system the common species caught by all types of gears were Guchi baim (*Mastacembelus pancalus*), Jatputi (*Puntius sophore*), Baila (*Glossogobius giuris*), Titputi (*Puntius ticto*) and Taki (*Channa punctata*) contributing 15.3%, 12.8%, 7.1%, 6.9% and 6.6% respectively. The 20 main species contributed to 94.2% of the catch in 2010. The contribution of the other 42 species was 5.8% of the catch.

The data gererated during the study period provided an opportunity to explore the continued impact of management by RMOs by comparision with the period when MACH was in operation, in terms of fisheries management performance indicators (production (kg/ha), Catch Per Unit Effort (CPUE) and biodiversity). The results suggested that the Hail Haor and Kangsha-Malijhee sites showed considerably improved biological diversity (biodiversity index H') in 2010 when compared with the baseline and impact period under MACH. However, biological diversity (H') was lower in Turag-Bangshi when compared to MACH. Simultaneously, production (kg/ha) reached 387 kg/ha in Hail Haor (compared with 322 kg/ha in the last two years of MACH) and was 279 kg/ha in Kangsha-Malijhee (compared with 307 kg/ha in the last two years of MACH). The results also suggested that occurrence of exotic cultured species may be a new challenge in Hail Haor since the present study suggested that in the river within Hail Haor exotic cultured species (Grass carp, Common carp, Mirror carp, Bighead carp and Silver carp) contributed a considerable part in the open catch. In Turag-Bangshi system fish catches fell to 147 kg/ha compared with 278 kg/ha in the last two years of MACH. Here water quality problems that arose with the growth of textile related industries during the MACH period have continued to adversely impact wetland biodiversity and fish catches and work to negotiate cleaner production systems and adoption of the mandatory effluent treatment plants are yet to bear fruit.

Recommendations

- Community-based co-management has successfully continued with minimal external inputs from IPAC in three wetland systems and fish catches and/or fish diversity have improved in the last few years in two of the wetlands, with positive consequences for the nutritional security of the poor. Community based co-management should continue .in the long term through the existing system of RMOs.
- Well managed capture fisheries in freshwater wetlands are diverse and inherently resilient to environmental variability and trends including climate change.
- Pollution from industrial development has adversely impacted the fishery in Turag-Bangshi, although the fishery is still healthier than before co-management started. In addition escapes from floodplain aquaculture are impacting the fishery in Hail Haor, and aquaculture encroachment of the haor will impact the overall natural fishery. The extent and practices of these land uses need to be regulated, but the existing co-management bodies lack the authority to do this.

1. INTRODUCTION

Bangladesh is a developing country located in the north eastern part of South Asia between 20° 34' and 26° 38' north latitude and between 88° 01' and 92° 41' east latitude. It has its boundary with India on three sides- east, north and west and with Myanmar on the southeast. The estimated population in 2011 is over 142 million. More than 20 million people living in river basins lack basic facilities and therefore do not have any access to information, national laws, regulations and human rights, and lack opportunities to participate in skill development training.

Fish is an essential staple food for the people of Bangladesh and the fisheries sector plays a vital role in the economy through employment generation, nutrition supply and poverty alleviation (Alam 2005 and Nasir Uddin *et al.*, 2003). This sector provides employment to nearly 1.2 million full time fishers and 11 million part time/artisanal fishers, fish/shrimp farmers, fish traders and processors, labourers and input suppliers (DoF-FRSS 2005-06). However, almost two-thirds of the rural households get involved in fishing during the monsoon season. Nearly 5.2 million people or 9% of the labour force were involved in fisheries full time (FSRFDS 2003a). Several studies, including FAP-17 (1994) and a study conducted by Thompson and Hossain (1998) indicate that about 80% of rural households traditionally catch fish for food or for sale. Studies have shown that, many "miscellaneous" small fish species caught from the floodplains and lakes by people, which have always been neglected in official statistics and policies, provide relatively more essential nutrients than the large fish favoured by fish culture programs (Minkin, 1989).

Bangladesh is the drainage outlet for a vast river basin complex made up of Ganges-Brahmaputra-Meghna River system in the form of rivers and estuaries (brackish water), canals, depressions (*beels*), floodplains and reservoirs. This sub-sector comprises a total of 4.5 million hectares of water areas including rivers, *haors*[1], beels[2] and large medium and small seasonal floodplains. Floodplains are low-lying areas being flooded during monsoons. Expansion of fish stocks take place in these plains which are connected to river systems. These plains are full of rich breeding, nursery and growth areas. Floodplains contribute to 31% of the total fish production, followed by rivers, estuaries and *beels*, and the total inland open water fisheries contributes to 41% of the country's total fish production. The inland openwater fisheries of Bangladesh are common property and share two characteristics; it is expensive to exclude potential users from gaining access to the resource and each person's use of the resource subtracts from the potential welfare of others. In inland fisheries, more than half of the fishermen exclusively produce fish for their own households; only a small number of fishermen deliver more than half of their catch to the market.

1.1. Integrated Protected Area Co-management (IPAC) Project

Bangladesh is rich in natural resources, especially in water and soil. The productivity of these valuable wetlands has come under increasing pressure as human population has spiraled and drainage for agricultural development and the construction of flood embankments in tandem with over-exploitation and pollution have decimated fish stocks and other aquatic species harvested by the poor. The consequences have been

[1] Deeply flooded saucer shaped depression in the northeast region of Bangladesh

[2] Deepest part of the floodplain, often with permanent area of water

devastating and also alarming for the future food security. Funded by USAID and the GoB, IPAC is being implemented over a five year period (June 2008 – June 2013) by the GoB involving the two ministries i.e. MoEF and MoFL, through the three line agencies i.e. FD, DoF and DoE. International Resource Group (IRG) is the main contractor while WorldFish Center is the core partner with principal responsibility to deal with matters relating to wetlands and fisheries. IPAC supports the co-management of a range of protected and ecologically critical areas (ECAs) in both terrestrial and aquatic ecosystems.

Goal and objective

The IPAC objective is to contribute to sustainable natural resource management and enhanced biodiversity conservation in targeted landscapes with the goal of preserving the natural capital of Bangladesh while promoting equitable economic growth and strengthening environmental governance for continued food security and poverty reduction.

Project location and beneficiaries

The project is principally located in five clusters scattered throughout Bangladesh (Figure 1):

1. North-east Cluster: Sylhet
2. Chittagong Hill Tracts Cluster: Chittegong
3. South-eastern Cluster: Cox's Bazar
4. Central Cluster: Modhupur
5. Sundarbans Cluster: Khulna

The number of beneficiaries with increased economic benefits derived from sustainable natural resource management and conservation is over 300,000.

Approaches

1. Development of a coherent strategy for integrated co-management of protected areas and biodiversity conservation.

2. Building stakeholder's institutional capacity and development of local institutions for integrated, participatory co-management of protected wetlands and forestry areas.

3. Site specific implementation of co-management in existing and new aquatic and terrestrial protected areas and ECAs.

4. Support cross-cutting approaches (e.g. gender mainstreaming, adaptation to climate change, promoting safe drinking water and improved livelihoods) based on a solid constituency for conservation.

Impacts

An integrated national system of co-managed protected areas is virtually established and to be institutionalized. The ecosystems distribute impacts in terms of goods and services to the poor, who rely upon wetland and forest resources. This ensures a reduction in vulnerability, an increased adaptation to climate change and more secure and diversified livelihoods.

Major Role of WorldFish in assisting IPAC

- Contribute to policy reviews for developing a coherent national strategy for protected area co-management and drafting a strategic framework of integrated and landscape based management of aquatic ecosystems and biodiversity.
- Undertake monitoring and evaluation of past management needs and develops models of best practices for co-managing wetland resources and biodiversity.
- Undertake participatory monitoring and action research and provides guidelines for site-specific interventions aimed at fostering sustainable development and conservation of wetland resources and livelihoods.

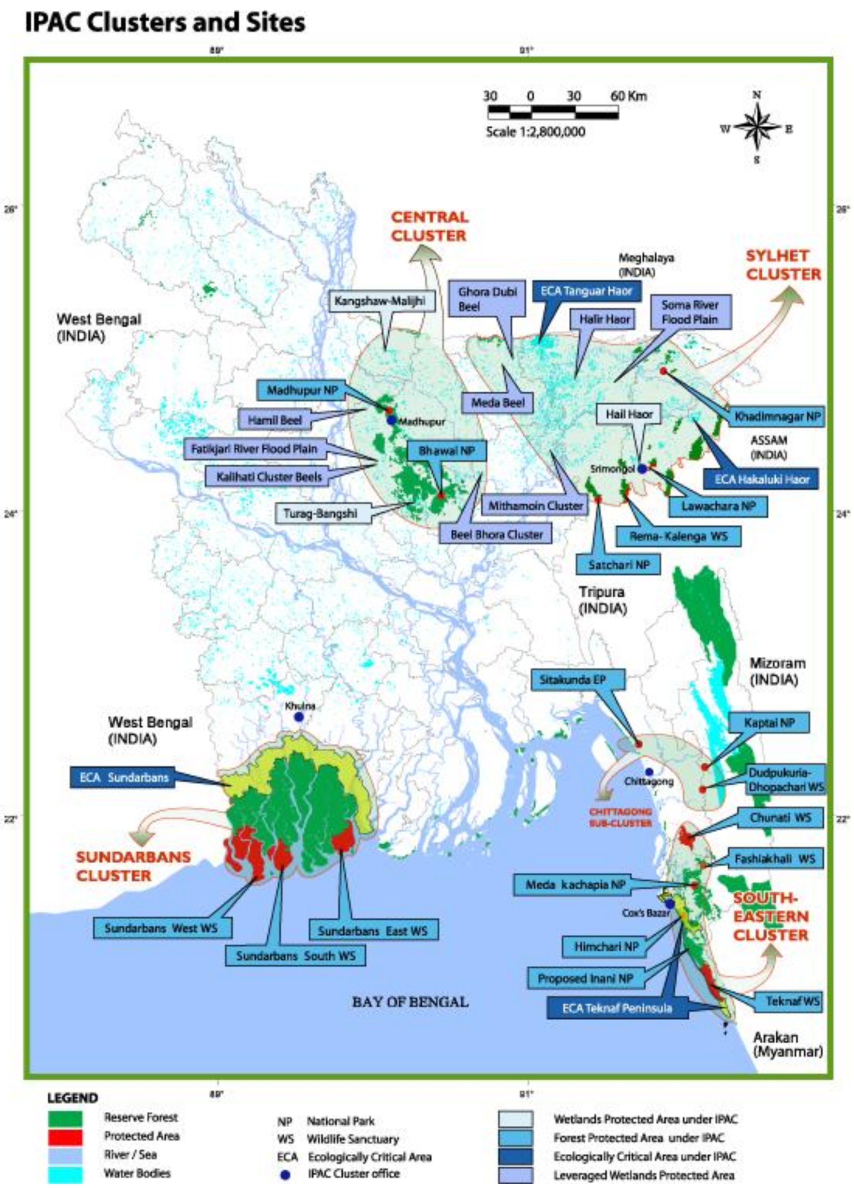


Figure 1. Working sites of IPAC project

2. METHODOLOGY

2.1. Site Selection and Waterbody Sampling

The IPAC wetlands are located in the Sylhet cluster, Cenral cluster and Sundarbans cluster. Wetlands in Sylhet and Central clusters are the intensely flooded areas of the Srimongal Upazila of Hobiganj district and Zinaigati Upazila of Sherpur district and Kaliakur Upazila of Tangail district. All adjacent waterbodies are connected during monsoon and is in fact treated as a single cluster. The IPAC project targeted to work in 6 selected waterbodies in Hail haor (Srimongal), 4 water bodies in Kangsha-Malijhee (Zanaigati) and 3 water bodies in Turagh-Bangshi (Kaliakur) sites and these water bodies are earlier MACH catch monitoring sites. However, IPAC replaced two new water bodies (directly related with earlier MACH site) in Hail haor. Fish catch monitoring sites are presented in Table 1.

Name of Cluster	Name of wetland	Name of River/Beel	Habitat	Monitoring Area (ha)
Sylhet Cluster	Hail haor	Gopla River	River section	41.23
		Cheruadubi Beel	Open Beel	30.4
		62 Beels Hunamua	Open Beel	8
		Almiberi	Open Beel	30
		Balla Beel	Open Beel	159.09
		Lata River	River	7.5
Central Cluster	Kangsha-Malijhee	Kewta Beel	Open Beel	33.04
		Takimari Beel	Open Beel	34.75
		Malijhee River	Open Beel	5
		Doli Beel	Open Beel	44.1
	Turag-Bangshi	Mokash Beel	Open Beel	100
		Mokesh Khal	Cannel	2
		Turag River	River section	14

Table 1. Distribution of waterbodies by location, habitat and monitoring area.

2.2. Assignment of Monitoring Sites to PMA Research Associates

In order to design a representative sample size, the project targeted to work in 13 sample water bodies (6 in Hail Haor, 4 in Kangsha-Malijhee and 3 in Turag-Bangshi) under two IPAC clusters (Sylhet cluster and Center cluster). The respective PMA Research Associates are supervising the monitoring activities. The main task of the PMA Research Associate is to collect PMP data of daily activities.

The specific responsibilities of the PMA Research Associates have been described below:

- to oversee the method of collection and ensure data accuracy for all information collected from project participants by the respective Community Enumerators;
- to facilitate and conduct relevant training for all Community Enumerators including frequent coaching and mentoring support;

- to coordinate with RMOs (Resource Management Organizations) and FRUGs (Federations of Resource User Groups) to get information on fisheries management related activities in the sample water bodies;
- to disburse monthly salary and field expenses to respective Community Enumerators;
- to verify data sheet, data encoded and data checking;

Respective Research Associates were instructed to liaise with IPAC Cluster Director (CD), Data collector, IPAC staff, RMOs and FRUGs for ensuring proper monitoring of the water bodies.

2.3. Community Enumerator Recruitment

Eight Community Enumerators were recruited for fish catch monitoring surveys in Hail Haor, Kangsha-Malijhee and Turag-Bangshi sites. The Community Enumerators were recruited through a discussion with local stakeholders and project staff and based on their experience on fish catch monitoring with the MACH project.

2.4. Orientation of Community Enumerators

Induction on project activities consisted of a two day orientation program organized at each site by the IPAC team after the recruitment of the Community Enumerators. At the beginning, they were introduced by the PMA Research Associate to the respective partners of the IPAC project, which in turn allowed a close collaboration between Community Enumerators and IPAC staff. The session was conducted by the PMA Research Associate and the Senior Fisheries Co-ordinator of IPAC-WorldFish. In addition to orientation, each Community Enumerator briefed everyone about their assigned works linked with monitoring waterbodies - which are adjacent to the Enumerator's households. Apart from the main orientation program, several feedback sessions were organized by the PMA Research Associates to provide the Community Enumerators with a better understanding about monitoring activity. A list of the community enumerators assigned to different water bodies is given in Table 2

Name of Cluster	Name of wetland	Name of River/Beel	Name of Community Enumerator
Sylhet Cluster	Hail haor	Gopla River	Sajal Sarker
		Cheruadubi Beel	Sajal sarker
		62 Beels Hunamua	Md. Abdullah
		Lata River	Md. Abdullah
		Almiberi beel	Aurun
		Balla Beel	Aurun
Central Cluster	Kangsha-Malijhee	Kewta Beel	Md. Abdul Khaleque
		Takimari Beel	Md. Amiruzzaman
		Malijhee River	Md. Amiruzzaman
		Doli Beel	Abu Bakar
	Turag-Bangshi	Mokash Beel	Md. Delwar Hossain
		Mokesh Khal	Md. Delwar Hossain
		Turag River	Md. Amir Hossain

Table 2. List of community enumerators assigned in different wetlands.

2.5. Monitoring Framework

Three principals underlying the monitoring activities are:

- Assessment of fish production at 3 sites of IPAC (Hail Haor, Kangsha-Malijhee and Turag-Bangshi);
- Population dynamics for important fish species at project wetlands;

2.5.1. Catch Monitoring and Biodiversity

An individual catch monitoring study incorporated data from February' 10 to January' 11 in Hail Haor, May' 10 to April'11 in Kangsha-Malijhee and Mar' 10 to Feb' 11 in Turag-Bangshi sites. Two biological monitoring programmes were implemented; the Catch and Effort monitoring and the Length-frequency program. Catch and effort was monitored to estimate the annual total catch and fishing effort through a catch assessment and a frame survey. The daily catch of every individual fisherman and his gear (CPUE) was monitored for 4 days a month. The numbers and weight of all fish species in the catch were recorded. Furthermore, the gear-type, mesh size, owner status and the number of units used per fisherman were recorded 4 days a month through a standardized counting of the number of gears to estimate gear wise fishing efforts (f).

2.5.2. Data Analysis

Survey sampling covered gear census and catch monitoring. Catch monitoring is an observational process on fishing effort that was done for four days a month per site. It recorded species wise catch statistics of each gear type. Gear survey involves a regular spot survey for a sample of gears in operation and their total catch. In this case, gear census covered all the gears (types and numbers) operating in the study sites.

The total monthly catch for each water body was calculated with;

$$Monthly\ Catch\ per\ site = N * \sum_{i,j=1}^{n} \overline{f}_{i,j} * \overline{cpue}_{i,j}$$

Where:

N: Number of days per month when fishing was monitored

f: Average number of gears used per day (for each gear type)

CPUE: average daily catch per gear type (calculated yield/no of gears).

Average number of gear per day was used to estimate total number of gear-wise fishing effort for that month as well as for the whole year. Simultaneously, mean gear-wise catch rate was used to estimate total catch for that month, as well as for the whole year. Overall species distributions by gear were calculated using annual catch statistics data. Year wise as well as overall species distribution were calculated using catch statistics data. Overall production was estimated by summing all estimated production of different gear types in each year.

2.5.3. Shannon-Wiener Bio-Diversity Index

The Shannon-Wiener Index (H') is one of several diversity indices used to measure biodiversity. In this study, species wise production rates were used to estimate the Shannon-Wiener diversity index (H'). The function was originally devised to determine the amount of information in a code or signal, and is defined as:

$$H = -\sum_{i=1}^{S_{obs}} pi \; loge \; p$$

Where,

H: Information content of sample (Index of diversity or Degree of uncertainty),

s: Number of species

pi: The proportion of individuals in the i^{th} species.

(Species Diversity & Richness calculates the index using the natural logarithm).

2.5.4. Fish Catch Monitoring

Individual fish catch monitoring is an important task of the present study. IPAC has started fish catch monitoring at randomly selected sample waterbodies to observe fish biodiversity, fishing intensity, fishing activities, gear diversification, species composition, and estimated total catch. One Community Enumerator was responsible for one or two water bodies for fish catch monitoring data collection. In addition to catch monitoring, the Community Enumerators also collected information on the gear types used by each fishermen during fishing and landing from fishing. They keep records on types of gears, numbers of gears and length of gears used, etc. PMA Research Associates, who were assigned to each waterbody, provided the Community Enumerators with logistical and technical support and field orientation. Fish catch monitoring data collection started from February' 10 in Hail Haor, Mar' 10 in Turag-Bangshi and May' 10 in Kangsha-Malijhee sites.

2.5.5. Monitoring Fishing Activities

According to the activity plan, fish catch monitoring data is been collected from 13 related MACH earlier water bodies by Community Enumerators. The catch monitoring records reflect quantity of fish catches (Kg), species diversity, fishing activities and consumption during harvesting. In MACH project sufficient fund has been allocated to conduct large scale fish catch monitoring. In contrast, IPAC don't have resources or even mandate to do more general fish catch monitoring like MACH. IAPC used sub-set of MACH monitoring sites and similar methodology as MACH. However, instead of 3 days sampling per month by the MACH the IPAC conducted 4 days sampling per month following minimum detectable difference at 95% confidence limit (Zar, 1984).

When data was collected for individual catches, the total daily catch had to be estimated from the sample obtained. To verify the robustness of this estimation, responses from fishermen were collected with regards to the previous day's total catch. This was done for all waterbodies in Hail Haor, Kangsha-Malijhee and Turag-Bangshi sites, and estimated catch (by waterbody/ by fishermen interviewed) was correlated with the previous day's catch. This indicates a good estimation value. Correlation between yesterday's catch and estimated catch from catch monitoring are presented in Figures 2, 3 and 4 for Hail Haor, Kangsha-Malijhee and Turag-Bangshi respectively. These indicate a good estimated value of fish catches.

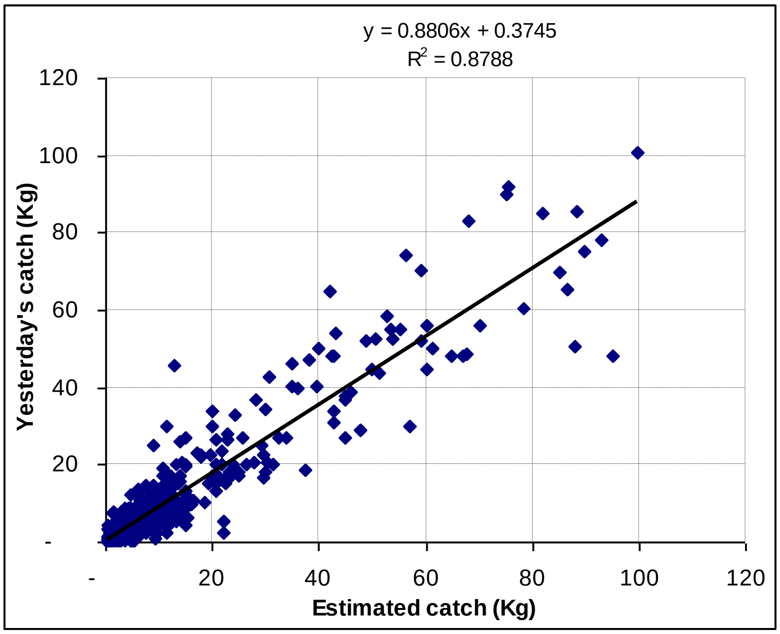


Figure 2. Estimated catch during monitoring plotted as a function of yesterdays catch (response from fishermen) with fitted regression model in Hail haor.

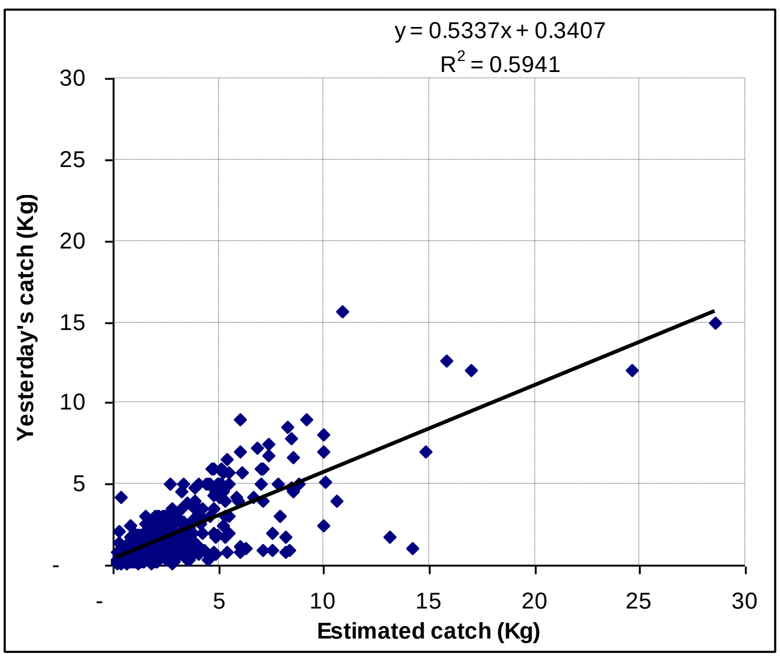


Figure 3. Estimated catch during monitoring plotted as a function of yesterdays catch (response from fishermen) with fitted regression model in Kangsha-Malijhee, Sherpur

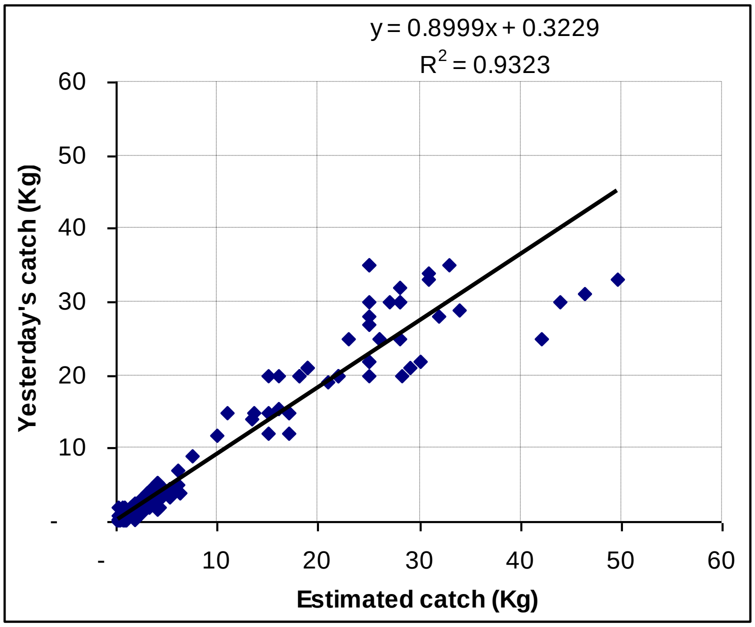


Figure 4. Estimated catch during monitoring plotted as a function of yesterdays catch (response from fishermen) with fitted regression model in Turag-Bangshi.

2.6. Gear Characteristics

Various types of fishing gear are used in the inland open water bodies of Bangladesh. Their specification differs according to target species, type of water body, labour intensity, fabrication, cost, materials available and profit. There are more than 100 types of fishing gear used by professional fishermen communities. List of most common gears by type is shown in Table 3.

Name of gears	Local Bengali name used in different district of Bangladesh
Gill net	Pata Jal, Fash Jal, Poa Jal, Current Jal, Dacon Jal
Seine net	Ber jal, Jagat ber jal, Moia jal, Katha ber jal, Gamcha jal
Set bag net	Bada jal
Lift net	Bheshal jal, Dharma jal
Cast net	Utar jal, Khepla jal, Toira jal, Jhaki jal
Push net	Thela jal, Hanga jal
Trap	Kholsun, Anta, Polo, Charai, Ghuni, Fala, Bair
Long-line	Chara Barshi, Taja Barshi
Hook and Line	Barshi, Dati Barshi, Shola borshi
Spear	Achra, Aro, Jutya, Koch, Teta
Others	Bana, Katha, Kua, by Hand

Table 3. List of common gears used in *haor* areas.

Cast nets, spears, lift nets and gill nets are operated both day and night. The trap units, long-lines and hooks and lines are operated only at night time while the push net and seine net are operated only during the daytime. Operation of spears and lift nets are occasional and seasonal. The common gears operated in this sector are briefly described as follows:

2.6.1. Push Net (*Thala Jal*)


Push net

Push net is a small net mounted on a triangular bamboo frame. The bottom crosspiece of the frame is 1.0-1.2 m long, while the two vertical pieces are longer; 1.3-1.5 m long. The netting is of nylon mosquito net (usually bright blue in color) with 2 mm bar mesh size. It is widely used in open beels and flood plain beels. The push net is used in the late monsoon and the dry season. The low cost of initial capital investment has made the push net the most popular fishing equipment for subsistence fishers. One person is involved in its operation and fishing duration varies from 5-6 hrs in open beels and 7-8 hrs in the rivers.

2.6.2. Cast Net *(Khapla Jal*)


Cast net

These are very common and primitive gears used all over the country and limited in their efficiency. They are operated by a single person very near the bank or low level water or from a boat in an open area. It is a circular net made of 1-1.5 cm mesh (stretched) multi-filament twine, with a leash line attached at the center and a series of weights along the circumference of the foot rope. The net, in a collapsed state is 3-4 m long, and the foot rope circumference is 8-12 m. Generally one person is involved in its operation and fishing duration varies between 7-8 hrs.

2.6.3. Gill Net (*Fash Jal*)


Gill net

The gill net is a rectangular net with weights on the ground rope and floats on the head rope. It hangs vertically in water. Total length size class ranges between 150-250 m, height ranges between 0.75-1.25 m and mesh size varies from 2-3 cm. The head rope is fitted with plastic floats, and the foot rope is weighted with closely spaced clay disks. Its mesh size varies with types and sizes of target fish. It is often set on the migration route of fish. There are many types of gill nets used in inland water. Common gill nets are Punti jal, Koi jal, Current jal, Fash jal, Ilish jal, Dacon jal, Pata jal, Poa jal, etc. Generally one person is involved in its operation and fishing duration varies between 5-7 hrs. Recently introduced mono-filament gill net (current jal) is the most effective gear for catching fishes. Current jal is a small mesh mano-filament gill net for catching small fish.

2.6.4. Seine Net (*Ber Jal*)

Seine nets are of medium length (150-550 m) and a height between 1.8 to 4.5 m with fine mesh. The mesh size is small (0.5-1.0cm stretched) and the netting is made of multi-filament fiber. More fish are caught by seine net than any other basic methods. A seine is a form of encircling net having a line at the bottom attached to the net. Generally 7-8 people operate this gear. Fishing duration lies between 7 to 8 hrs. Seine net contains large, medium and very small meshes.

2.6.5. Lift Net (*Bhel Jal*)

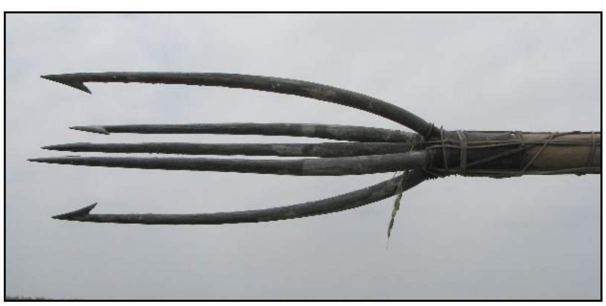
Lift net is a large multi-filament triangular net used to catch fish and is operated from a bamboo platform built in Khals (canals) in areas with gentle flowing water in flood plains. The net is mounted on a bamboo frame. There are different sizes of veshal jal and they vary from 8m by 5m to 15m by 14m. The mesh sizes are ±5 mm in the conical end and 10-20mm in the front portion. Alternatively 2 people are involved with this gear during operation, and fishing duration varies from 8-9 hrs. Generally the small lift net is known as the Dharma jal, and the large lift net as the Vheshal jal. Dharma jal is operated from river banks. Vheshal or Khora jal is a large lift net with a bamboo frame.

Lift net

Lift net

2.6.6. Spear

Several types of spears are used in open water fisheries such as fulkuchi, jhupi, konch, etc. Fulkuchi is a cluster of 12-22 sharply pointed steel wires at the end of a bamboo pole. Jhupi consists of a detachable iron fork with 5-13 barbed points and a bamboo handle. Konch has 8-14 pieces of split bamboo firmly bound together. Spears are used during early and late monsoon.

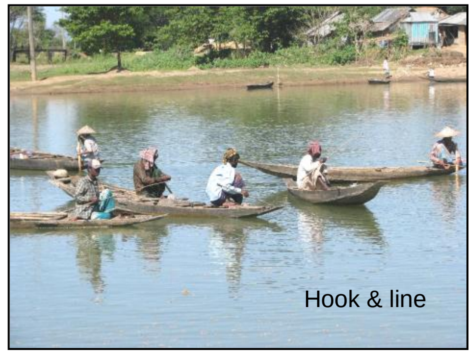


2.6.7. Long Line (*Borshi*)

This gear consists of a heavy main line (ranging up to 500 ft long) to which short leader lines with hooks are tied. The line can have 300 to 800 hooks. Hook size is between 2.0-2.5 cm high.

2.6.8. Hook & line

Hook and line is a common fishing practice in inland open water in the form of Chhip, Barshi, Don Barshi, Barshi chara, and Nol barshi. This practice is used all the year round.


Hook & line

2.6.9. Trap

Traps are common fishing devices of the inland openwater fisheries. There are many types of traps used in this sector and are mostly made of bamboo and pieces of old net. Vair, Dugair, Ghuni, Charai, Polo, Billa, Tubo, etc are the most common types of traps used all over the country. Each trap unit consists of 40-50 traps set one after another at an interval of about 2-3 m. Fish/mollusk meat (usually decayed flesh) is used as bait and is kept inside the trap. The traps are generally set in the water body in the evening and carefully pulled up during early morning when the fish are collected.


Chai


Gui


Ronga


Polo

3. RESULTS AND DISCUSSION

3.1. Fisheries Production

The fish production at each cluster site was obtained from fish catch monitoring. Total fish catch from monitored sites was found to be 107 tons in Hail haor, 29 tons in Kangsha-Malijhee and 16 tons in Turag-Bangshi sites. From this, Gopla river, Almiberi beel and Cheruadubi beel comprises of 35%, 25% and 19% respectively in Hail haor while Doli beel, Kewta beel and Takimari beel comprises of 32%, 26% and 24% respectively in Kangsha-Malijhee, and the Mokash beel compreses of 75% in Turagh-Bangshi sites. A short statement regarding monitoring periods and estimated production is given in table 4. However, this is a one year study. Further study is required to know how it may affect total production.

Name of Cluster	Name of wetlands	Monitoring periods	Est. total catch from monitoring (Kg)	Ramarks
Hail Haor	62 Beels Hunamua	Feb'10 to Jan'11	3612.7	
	Almiberi beel	Feb'10 to Jan'11	26831	
	Balla beel	Feb'10 to Jan'11	15574	
	Cheruadubi beel	Feb'10 to Jan'11	19878	
	Gopla River	Feb'10 to Jan'11	37358	
	Lata River	Feb'10 to Jan'11	3537	
Kangsho-Malijee	Malijhee River	May'10 to April'11	5,321	
	Doli beel	May'10 to April'11	9,122	
	Kewta beel	May'10 to April'11	7,586	
	Takimari beel	July'10 to April'11	6,841	Monitoring starts in July'10
Turagh-Bangshi	Mokash beel	Mar'10 to Feb'11	12,243	
	Mokash khal	Mar'10 to Feb'11	3,087	
	Turagh River	Mar'10 to Feb'11	1,040	

Table 4. Total harvests from fish catch and monitoring in all monitored sites.

Fish Production (Kg/ha)

There was substantial variation in production (Kg/ha) at most sampling sites and production varied from 64 to 1544 Kg/ha with overall production of 387 Kg/ha, 279 Kg/ha and 147 Kg/ha in Hail haor, Kangsho-Malijhee and Turagh-Bangshi sites, respectively. Lowest production (Kg/ha) was found in Turagh river (64 Kg/ha), Mokash beel (85 Kg/ha) and Balla beel (94 Kg/ha). Two water bodies (Malijee River and Mokesh Khal) stand away from this general production value and have the highest production (1277 and 1544 Kg/ha respectively). Fish production (Kg/ha) in the 13 waterbodies are shown in Figure 5. The present study is directly related to tracking the impact from improved management practices being applied by IPAC Co-management and also compare with MACH result on fish production (Kg/ha). A comparision of fish production (Kg/ha) between MACH and IPAC for Hail haor, Kangsha-Malijhee and Turag-Bangshi sites are shown in Figure 6. Simultaneously a comparision of fish production (kg/ha) between MACH and IPAC waterbodies in three sites are shown in Figure 7. Fish catch trends in Hail Haor are presented in Figure 8. Production (Kg/ha) has increased by 70%, 32% and 20% in Hail Haor, Kangsha-Malijhee and Turag-Bangshi sites when compared to MACH average impact year 3 (production, Kg/ha). However, there are variations of sampled water bodies of MACH and IPAC. In MACH, numbers of sampled water bodies were 7, 8 and 8 in Hail Haor, Kangsha-Malijhee and Turag-Bangshi, respectively.

In contrast, the numbers of sampled water bodies in IPAC are 6, 4, and 3 in Hail Haor, Kangsha-Malijhee and Turag-Bangshi respectively. MACH project covered a total area of 1174.26 ha, 267.7 ha and 382.7 ha in Hail-Haor, Kangsha-Malijhee and Turag-Bangshi, respectively. On the contrary, present fish catch monitoring areas are 276.22 ha, 116.89 ha and 116 ha in Hail-Haor, Kangsha-Malijhee and Turag-Bangshi, respectively.

The main effective factors that influence better production performance (> 400 kg/ha) at seven waterbodies (62 Beels Hunamua, Almiberi beel, Cheruadubi beel, Gopla River, Lata River, Kalijhee beel and Mokashkhal) are habitat type (e.g., beels, river, catchment khal), water extension during monsoon, tenure effectiveness of restriction in fishing, fish sanctuary, higher species diversity, presence of professional fishers around water bodies, fisher's density, good link with other water bodies or big *haors*, no restriction during monsoon & near by *beel* areas and interruption of organized harvest at some sites, etc. Simultaneously, the effective factors that may cause a lower production at three water bodies (Balla beel, Mokash beel and Turagh river) may be the RMOs restricting fishing in and around beels, a lower fisher density, restricted fishing with destructive fishing nets and huge pollution in Mokash beel and Turagh river. Mokash beels pollution is industrial in nature and for the last two decades enormous and uncontrolled industrial development contributing to significantly decline fisheries production. Afrin (2010) reported that local residents of the Mokash beel strongly believe that the main reason hehind the pollution problem is increasing Industrial development.

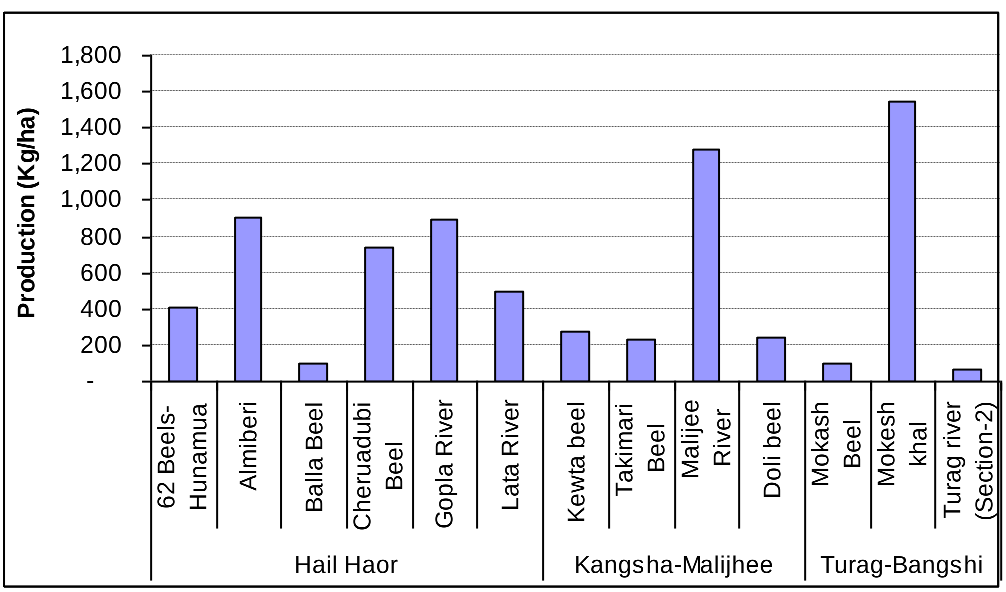


Figure 5. Estimated production (Kg/ha) based on catch monitoring (annual for Hail haor and Turag Bangshi, 10 months for Kangsha-Malijhee) in all studied sites.

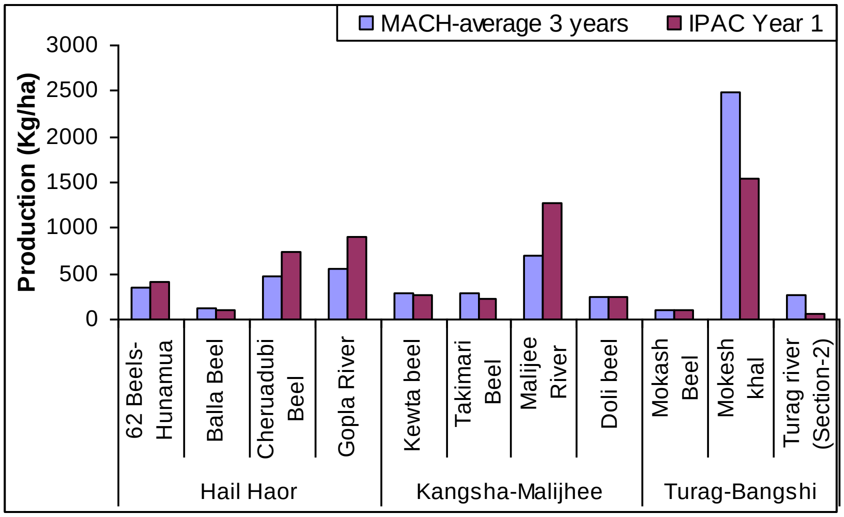


Figure 6. Comparision of fish production between MACH (average of 3 years impact) and IPAC water bodies in Hail haor, Kangsha-Malijhee and Turag-Bangshi sites.

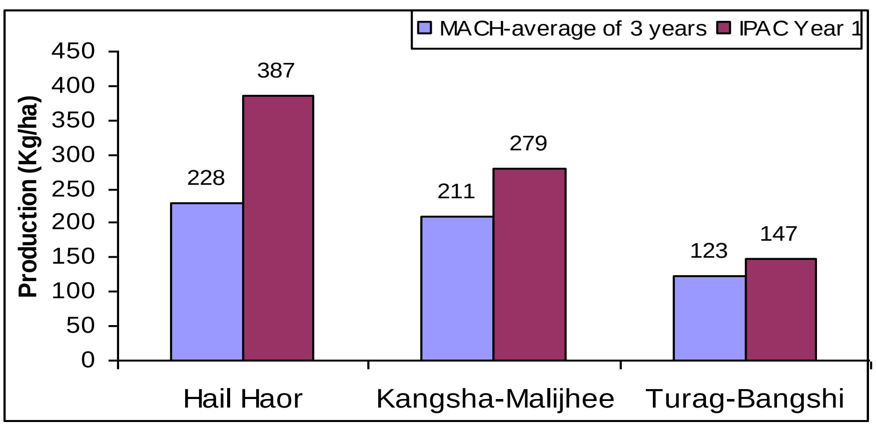


Figure 7. Comparision of fish production between MACH (average of 3 years impact) and IPAC in Hail haor, Kangsha-Malijhee and Turag-Bangshi sites.

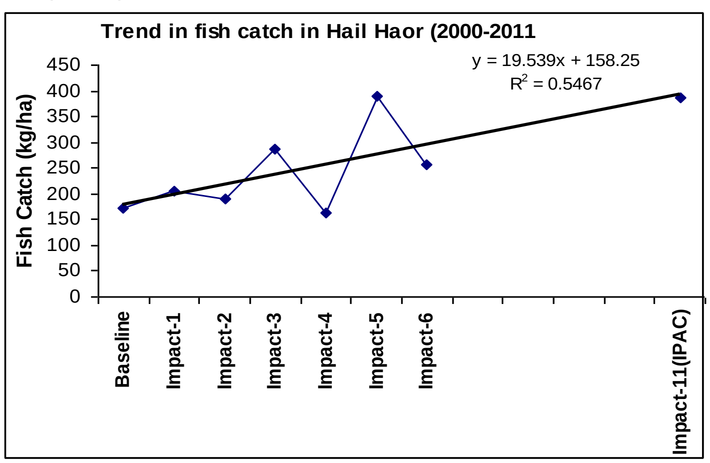


Figure 8. Fish catch trands in Hail Haor.

Using the fish catch monitoring data, the study presents a graphical distribution of fish production (Kg/ha) and total number of species in the monitored sites of Hail haor, Kangsha-Malijhee and Turag-Bangshi sites. Simultaneously, using species data, the study also presents a pictorial distribution of key fish species in the monitored sites. Figure 9 shows pictorial distribution of key species at monitored sites, fish production (Kg/ha) and total number of species in Hail haor. Figure 10 presents pictorial distribution of key fishes, fish production (kg/ha) and total number of species in Kangsha-Malijhee. Figure 11 presents pictorial distribution of key species, fish production (Kg/ha) and number of species in Turag-Bangshi site.

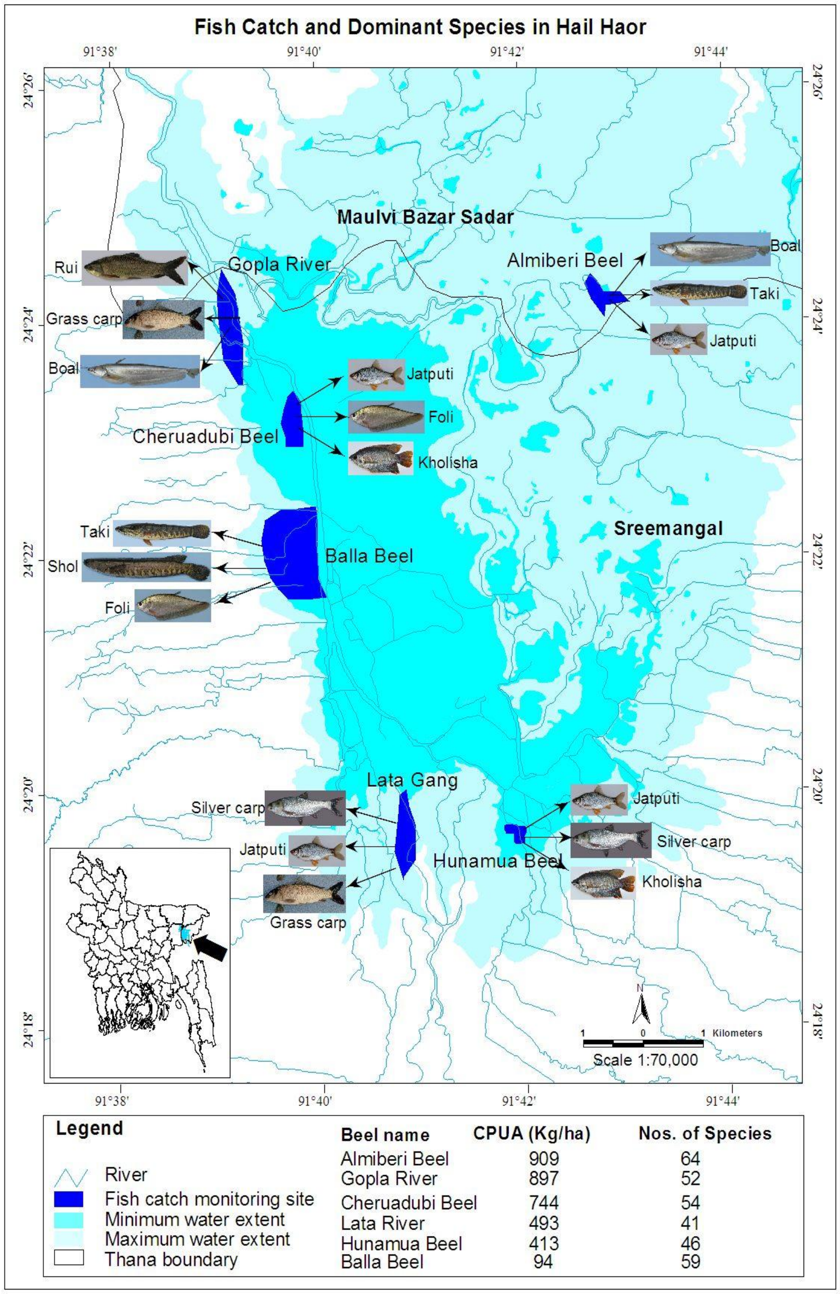


Figure 9. Dominent fishes, production (Kg/ha) and total number of species at six monitored sites in Hail Haor.

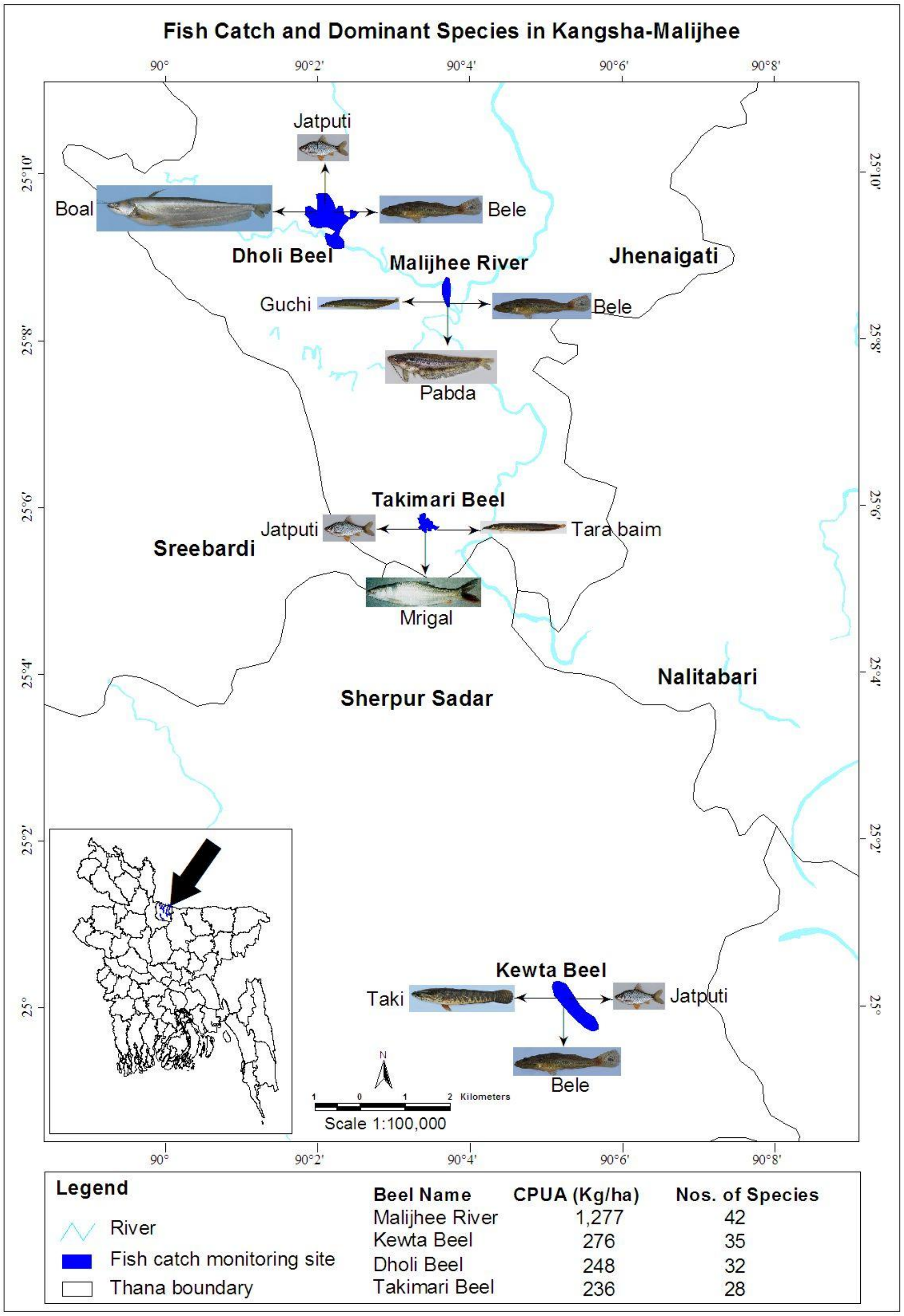


Figure 10. Dominent fishes, production (Kg/ha) and total number of species at four monitored sites in Kangsha-Malijhee.

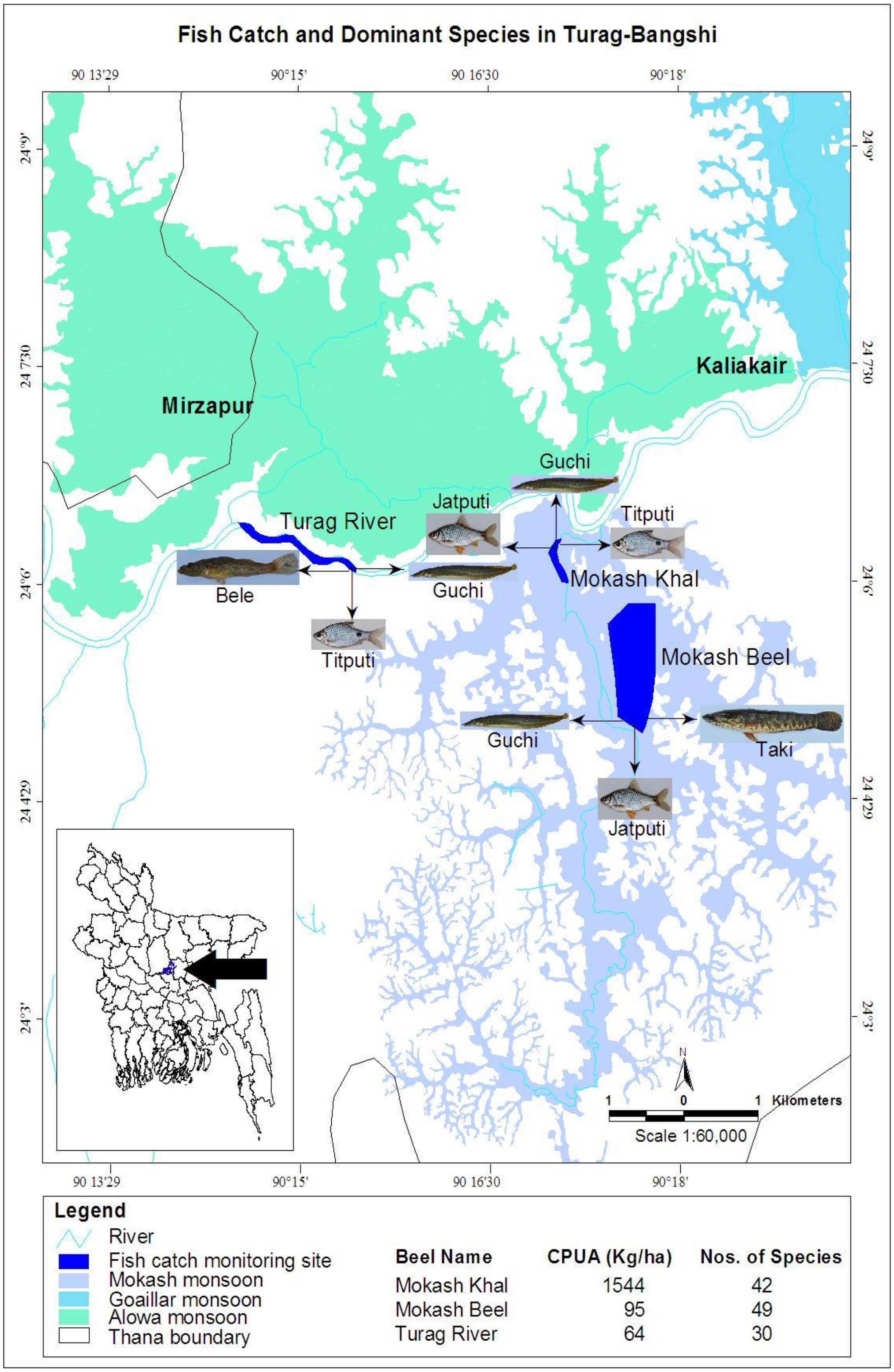


Figure 11. Dominent fishes, production (Kg/ha) and total number of species at three monitored sites in Turag-Bangshi.

3.2. Seasonal Variations of Fish Production

The seasonal variation of fish production is very high in the Haor habitat and is mainly affected by inundation regimes, gear use, fishing patterns, fishing intensity and availability of fishes. Assessing seasonality and production reveals that the highest production occured between September and February (following year) in Hair haor, between July and November in Kangsha-Malijhee and between September and December in Turagh-Bangshi. In Hail haor sites, 38 % of the annual catch was caught in the post monsoon season (Oct-Dec), 35% in the dry season (Jan-Mar), 18% in the full monsoon (Jul-Sept) and only 9% in the pre monsoon (Apr-Jun) season (Figure 12). The pre-monsoon is a very critical period of the year in the Hail Haor site as the area of water coverage becomes reduces during dry season.

In the Kangsha-Malijhee sites, 42 % of the annual catch was caught in the monsoon season (July-Sept) 29% in the post monsoon (Oct-Dec), 18 % in the dry season (Jan-Mar) and 11% in the pre monsoon (Apr-Jun) (Figure 13). The pre-monsoon is also a very critical period of the year in Kangsha-Malijhee site as the area of water coverage is reduced.

In the Turag-Bangshi sites, 60 % of the annual catch was caught in the post monsoon season (Oct-Dec), 27% in the full monsoon (Jul-Sept), 9% in the pre monsoon (Apr-Jun) and only 4% in the dry season (Jan-Mar), (Figure 14). The dry season is a very critical phase of the year in Turag-Bangshi site as the area of water coverage is reduced.

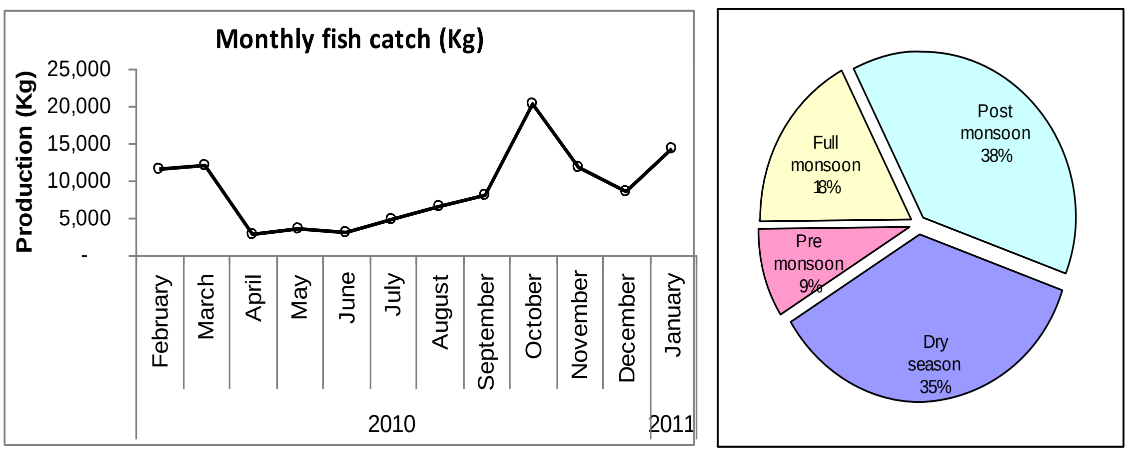


Figure 12. Monthly & seasonal variation of total estimated production (kg) in **Hail Haor** sites.

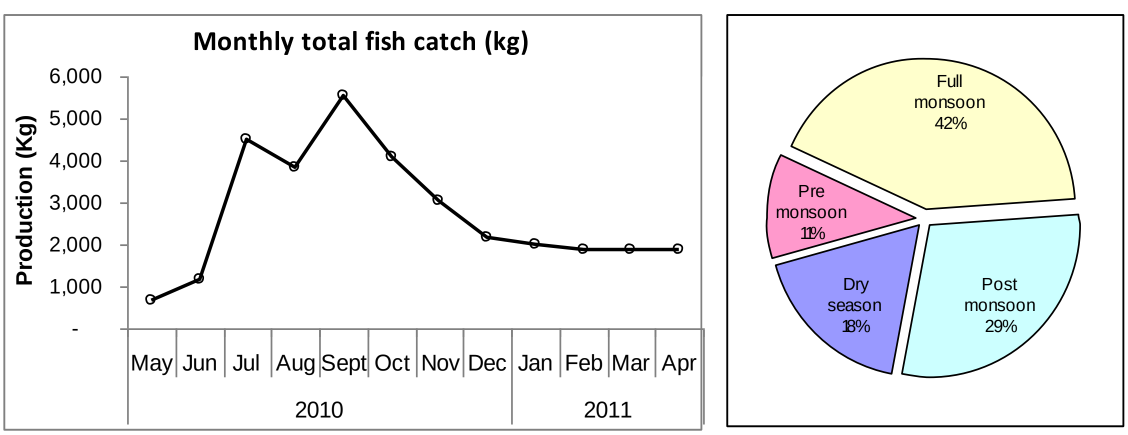
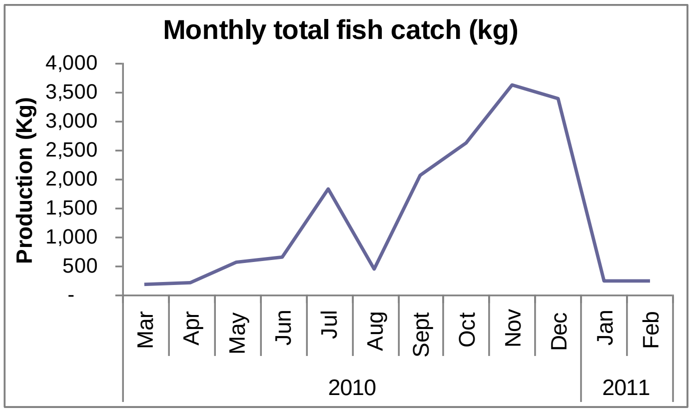


Figure 13. Monthly and seasonal variation of fish production (kg) in **Kangsha-Malijhee** sites.



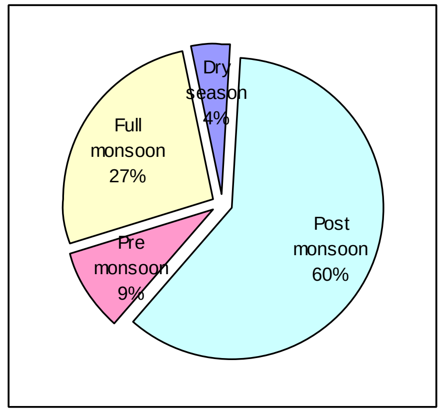


Figure 14. Monthly and seasonal variation of fish production (kg) in **Turag-Bangshi** sites.

3.3. Catch Composition Based on Catch Monitoring Data

The top 20 species are ranked according to their contribtion in the annual catch. In Hail Haor the common species caught by all types of gear were Boal (*Wallago attu*), Rui (*Labeo rohita*), Common carp (*Cyprinus carpio*), Grass carp (*Ctenopharyngodon idella*) and Taki (*Channa punctata*) contributing to 7.95%, 7.64%, 7.51%, 7.13% and 5.39% of overall catches respectively. Analysis reveals that 20 main species contributed to 75.24% of the annual catch by weight. The annual contribution of the other 61 species was 24.76% of the catch by weight. The percentage compositions of the 20 main species in annual production are given in Figure 15. *Wallago attu* (Boal) is the species making the highest contribution in Hail haor. However, the highest abundance of Common carp (exotic speces) occurred in Gopla River of the Hail haor. This reveals the increasing trend towards stocking of exotic species around the Hail haor. Main contributor species in three co-managed systems are shown in Appendix 1.

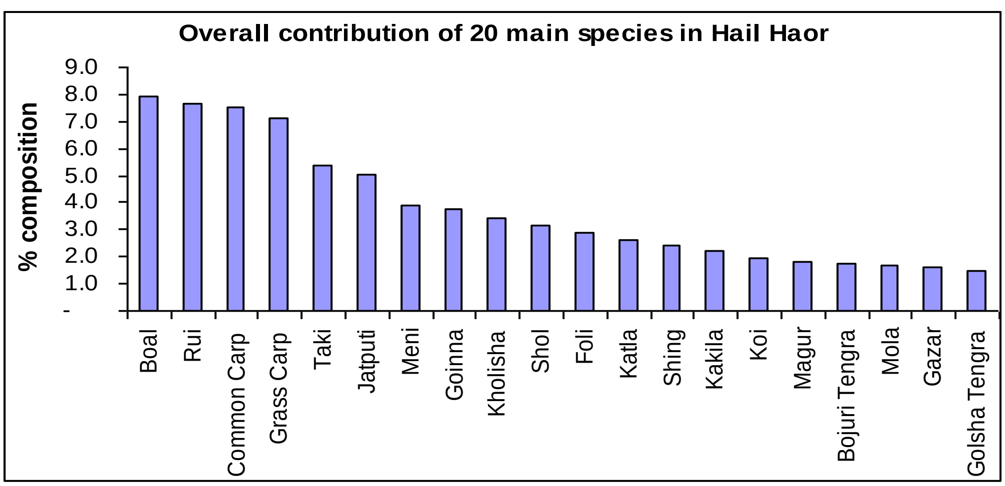


Figure 15. Species composition by weight (20 main species) in Hail haor site.

In the Kangsha-Malijhi sites, the common species caught by all types of gear were Jatputi (*Puntius sophore*), Tara baim (*Macrognathus aral*), Baila (*Glossogobius giuris*), Boal (*Wallago attu*) and Taki (*Channa punctata*) contributing to 10.83%, 9.54%, 8.94%, 8.73% and 7.63% of overall catches respectively. The 20 main species contributed to 89.41% of the catch by weight in 2010. The contribution of other 43 species was 10.59% of the catch by weight. The percentage compositions of 20 main species are presented in figure 16. *Puntitus sophore* (Jatputi) is making the highest contribution in Kangsho-Malijhee site.

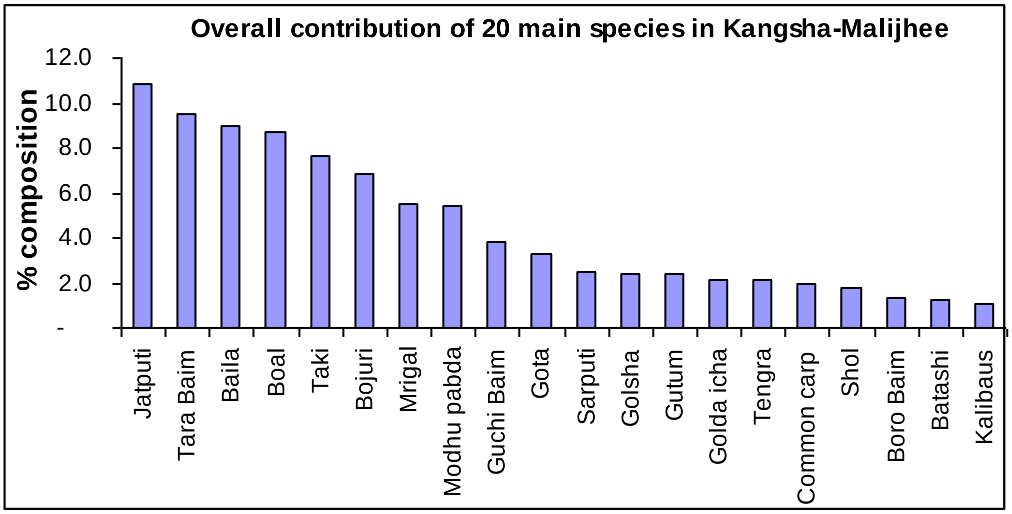


Figure 16. Species composition by weight (20 main species) in Kangsha-Malijhee site.

In Turagh-Bangshi site the common species caught by all types of gear were Guchi baim (*Macrognathus pancalus*), Jatputi (*Puntius sophore*), Baila (*Glossogobius giuris*), Titputi (*Puntius ticto*) and Taki (*Channa punctata*) contributing to 15.25%, 12.82%, 7.05%, 6.88% and 6.58% respectively. The 20 main species contributed to 94.23% of the catch by weight in 2010. The contribution of other 42 species was 5.77% of the catch by weight. The percentage compositions of 20 main species are presented in Figure 17. Guchi biam is the main specie making the highest contribution in Turagh-Bangshi site.

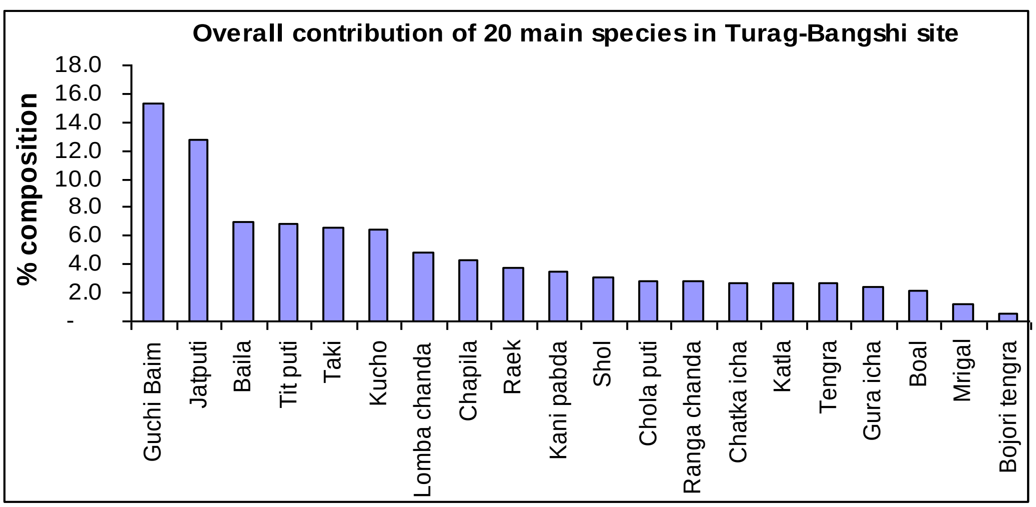


Figure 17. Species composition by weight (20 main species) in Turag-Bangshi site.

The main five species that contributed to Hail haor wetlands were Boal 8,559 kg, Rui 8,220 kg, Common carp 8,080 kg, Grass carp 7,680 and Taki 5,806 kg. Simultaneously, the five main species that contributed to the Kangsha-Malijhee wetlands are Jatputi 3127 kg, Tara baim 2756 kg, Baila 2582 kg, Boal 2520 kg and Taki 2204 kg. Whilst the five main species represented in Turag-bangshi wetlands were Guchi biam 2579 kg, Jatputi 2167 kg, Baila 1192 kg, Titputi 1164 kg and Taki 1114 kg. Table 5 shows the production of main species in Hail haor, Kangsha-Malijhee and Turag-bangshi. Fish and prawn species recorded and IUCN status (IUCN 2000) in three co-managed wetland systems are given in Appendix 2.

Cluster and no of monitored sites	Name of species		Estimated catch (Kg)	Weight (%)
	Local Name	Scientific Name		
Hail Haor (6 water bodies)	Boal	*Wallago attu*	8,559	7.95
	Rui	*Labeo rohita*	8,220	7.64
	Common carp	*Cyprinus carpio*	8,080	7.51
	Grass carp	*Ctenopharyngodon idella*	7,680	7.13
	Taki	*Channa punctata*	5,806	5.39
	Other Species	(71 species)	69,307	64.38
Kangsha-Makijhee (4 water bodies)	Jatputi	*Puntius sophore*	3,127	10.83
	Tara baim	*Macrognathus aral*	2,756	9.54
	Bailla	*Glossogobius giuris*	2,582	8.94
	Boal	*Wallago attu*	2,520	8.73
	Taki	*Channa punctata*	2,204	7.63
	Other Species	(58 species)	15,681	54.33
Turag-Bangshi (3 water bodies)	Guchi biam	*Macrognathus pancalus*	2,579	15.25
	Jatputi	*Puntius sophore*	2,167	12.82
	Baila	*Glossogobius giuris*	1,192	7.05
	Titputi	*Puntius ticto*	1,164	6.88
	Taki	*Channa punctata*	1,114	6.58
	Other Species	(57 species)	8,694	51.42

Table 5. Total production of main species (top five), and their % composition by weight.

3.4. Sale Prices

Doli beel, Malijhee River and Takimari beel in Kangsha-Malijhee was found to have the highest per kilogram value of harvested fish (Tk 196, Tk 185 and Tk 185 per kg respectively); whilst Almiberi beel and Balla beel in Hail Haor, had the lowest per kilogram value (Tk 88 and Tk 87 per kg). The average values (Tk/kg) in Hail haor, Kangsha-Malijhee and Turag-Bangshi were Tk 110, Tk 183 and Tk 123 respectively. However, throughout the study period, there were variations in fish sale prices. This was due to factors such as the habitats (River, Beels etc), the presence of high priced species in the catch; and the distance from a city market or marketing system. Average sale values (Tk per kg) in all monitored sites is presented in Figure 18.

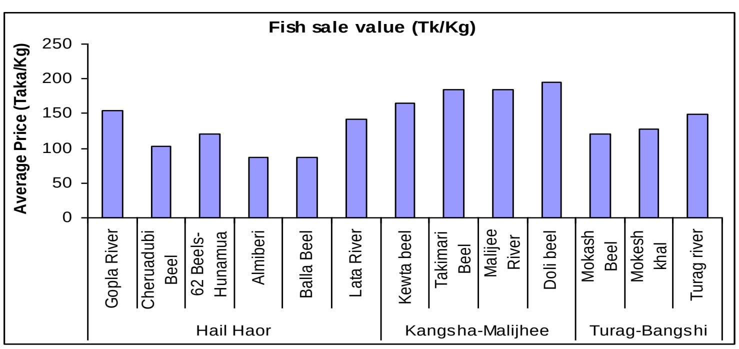


Figure 18. Sale prices (Tk per kg) of harvested fish at different water bodies.

3.5. Gear Efficiency and Production

The main fishing gears operated in the IPAC wetlands sites harvested most of the available species in the *haor* habitat. Some species are caught selectively with different gears and some gears themselves are selective such as gill nets, traps, hook and lines and long lines. After assessing the gear efficiency (fisher's day by gear) and fish production (catch by gear), it was observed that in Hail haor, the highest catch occurred through gill nets (43%) and Trap units (32%), and in Kangsha-Malijhee, the highest catch occurred with gill nets (64%), cast net (15%) and seine net (13%). Similarly the highest catch was observed by the seine nets (59%), gill nets (15%) and cast net (12%) in Turag-bangshi. Variation of gear efficiency and fish production were calculated for Hail haor, Kangsha-Malijhee and Turag-bangshi using data from all monitored sites. Figures 19, 20 and 21 prensents the total fish production in Hail haor, Kangsha-Malijhee and Turag-Bangshi.

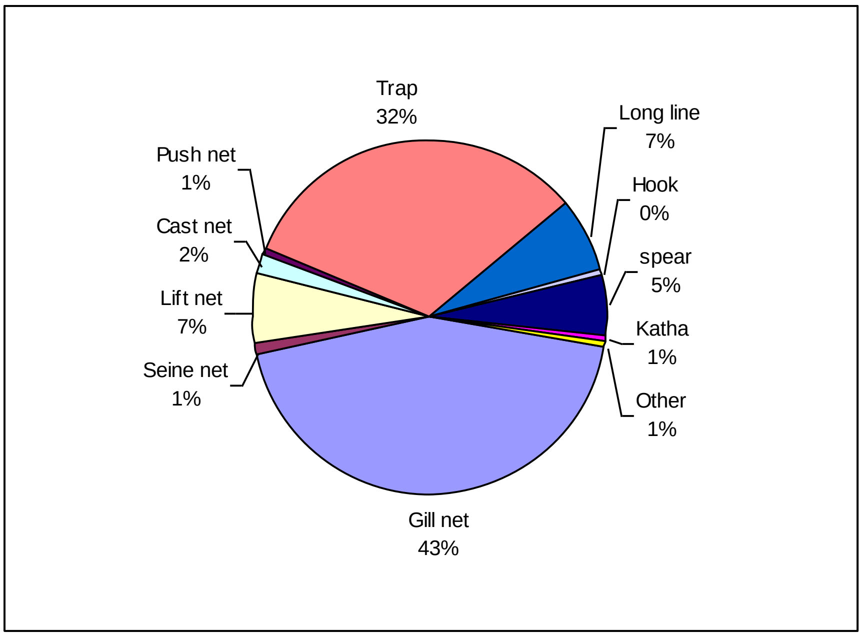


Figure 19. Gear wise production from *Hail haor* site during study period.

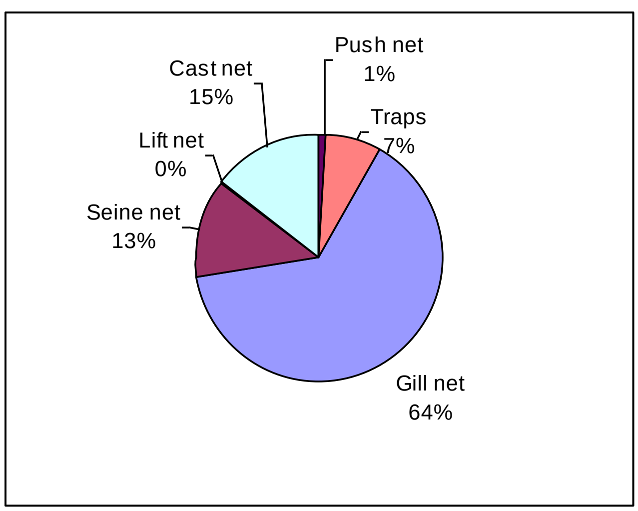


Figure 20. Gear wise production from Kangsha-Malijhee site during study period.

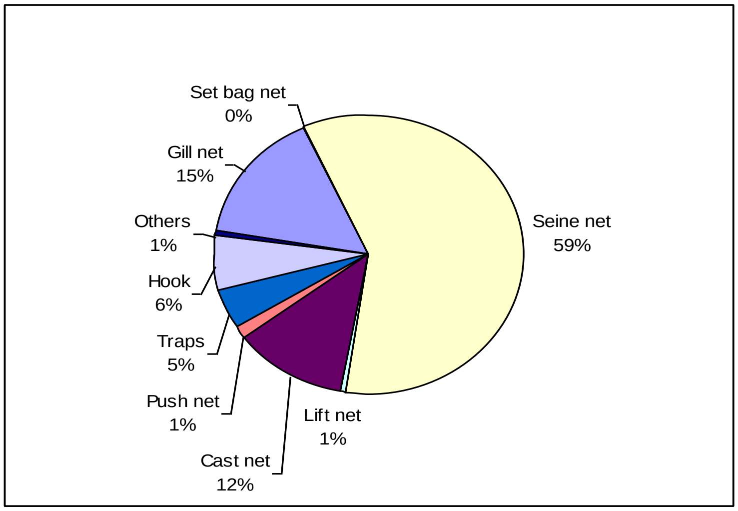


Figure 21. Gear wise production from Turag-Bangshi site during study period.

Catch Per Unit Effort (CPUE)

Catch Per Unit Effort (CPUE) is the average daily catch per gear type (calculated yield/no of gears). Fish production derived from fishing activities is influenced by several factors, such as the catch rates of different gear, gear intensity, effiency of gears and number of active fishing days. It was observed CPUE varies for different gears in haor areas. However, in Hail haor and Turagh-Bangshi the Seine net showed significantly higher CPUE. Whilst in Kangsha-Malijhee Seine net, Gill nets, Cast nets and Lift nets showed higher CPUE. Gear wise catch per unit effort in Hail haor, Kangsha-Malijhee and Turagh-Bangshi sites are presented in Figures 22, 23 and 24 respectively. Annual CPUE by all gears in three co-managed wetland systems during MACH and IPAC are shown in Figure 25.

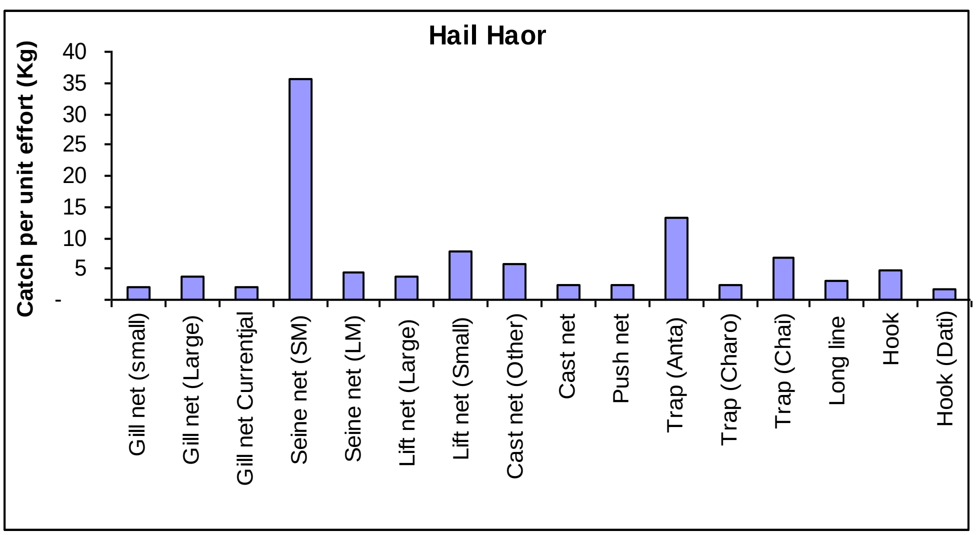


Figure 22. Annual Catch Per Unit Effort (CPUE) by different gears in Hail haor site.

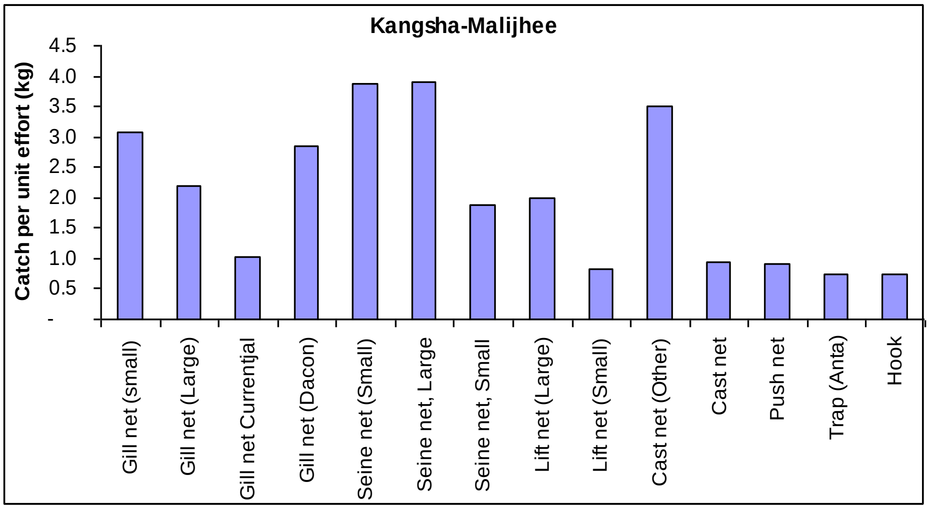


Figure 23. Annual Catch Per Unit Effort (CPUE) by different gears in Kangsha-Malijhee site.

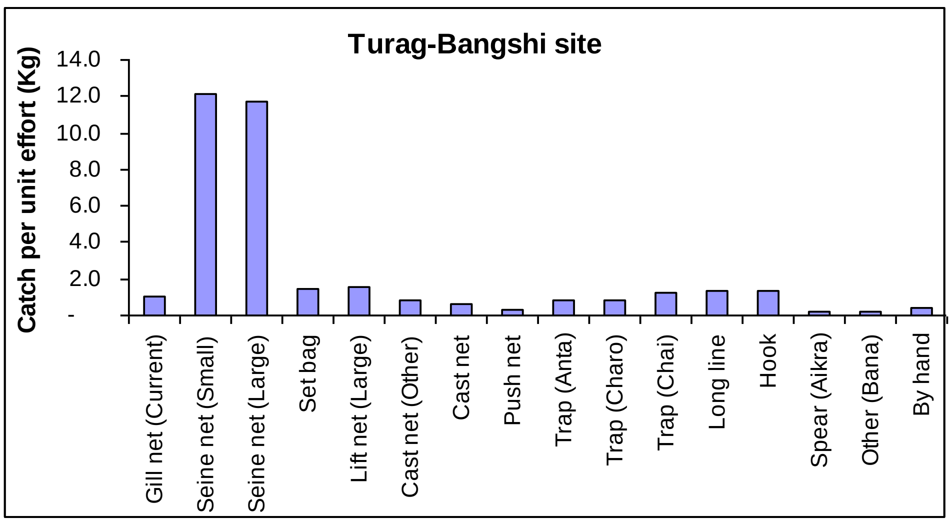


Figure 24. Annual Catch Per Unit Effort (CPUE) by different gears in Turag-Bangshi site (Seine net: Small mesh and Large mesh).

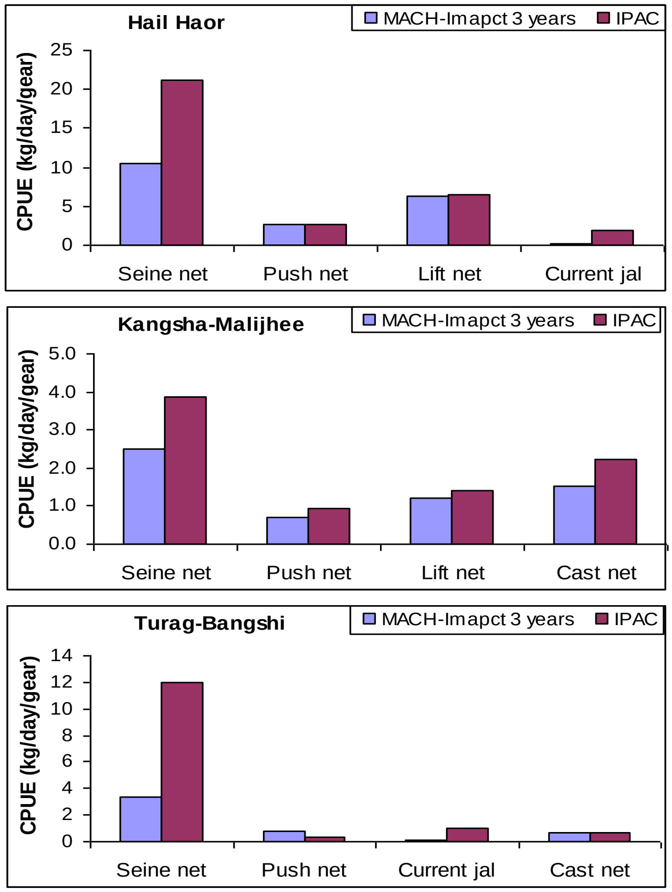


Figure 25. Comparison of Catch Per Unit Effort (CPUE) by all gears in three wetland systems.

Catch per person per day *(kg person−1 day−1)*

Income derived from fishing activities are influenced by several factors, such as the catch rates of different species, ownership of gears, and family participation in the work process, the number of active fishing days and fish prices. Annual variations of average catches (kg) gear−1 day−1, number of person days and catch person−1 day−1 in the three study sites – Hail haor, Kangsha-Malijhee and Turagh-Bangshi are presented in figures 26, 27 and 28 respectively. Generally, the catch person−1 day−1 in the Hail haor sites was higher compared to the Kangsha-Malijhee and Turagh-bangshi sites, possibly due to the higher number of professional fishers (Figure 29). This data can be an indicator of abundance and shows a significantly higher annual average daily catch with Seine net (Small mesh) and Traps (Anta and Chai) in Hail haor sites; Gill nets and Cast nets in Kangsha-Malijhee sites, and Large lift nets, Seine nets (both small and large mesh), Long lines and Hooks in Turagh-Bangshi sites.

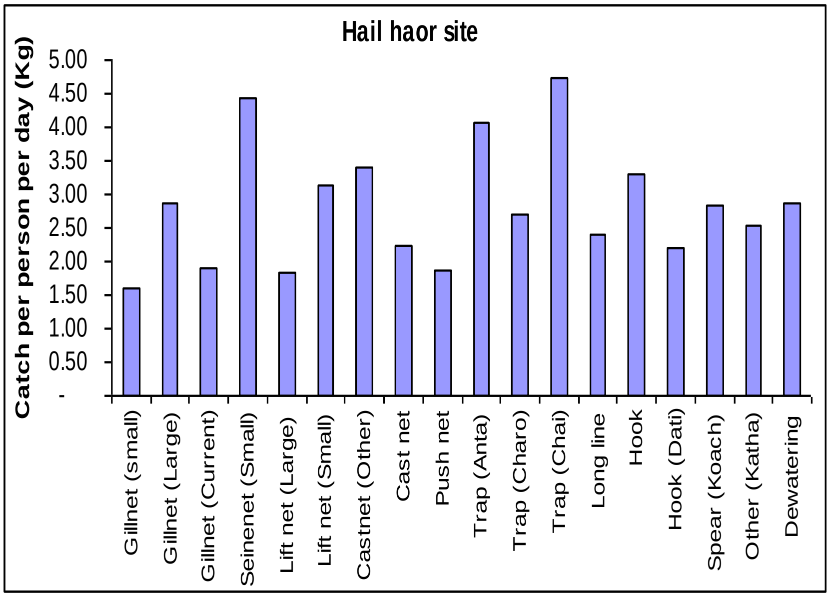


Figure 26. Catch per person per day (*kg person*−1 *day*−1) by different gears in Hail haor site.

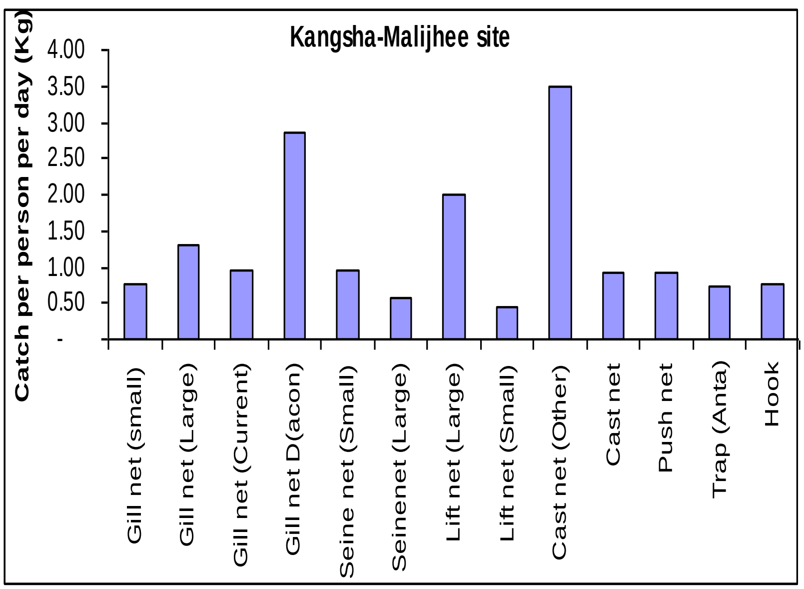


Figure 27. Catch per person per day (*kg person*−1 *day*−1) by different gears in Kangsha-Malijhee site.

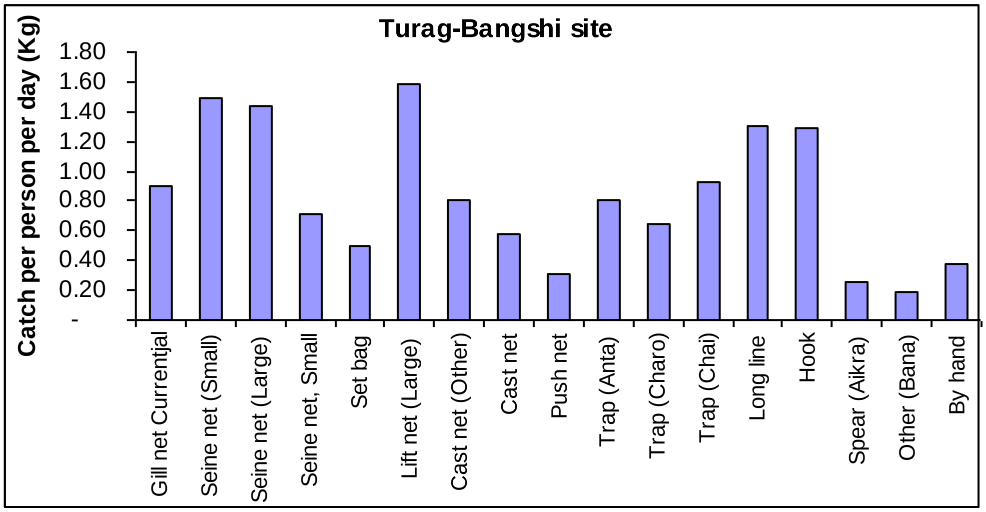


Figure 28. Catch per person per day ($kg\ person^{-1}\ day^{-1}$) by different gears in Turag-Bangshi site.

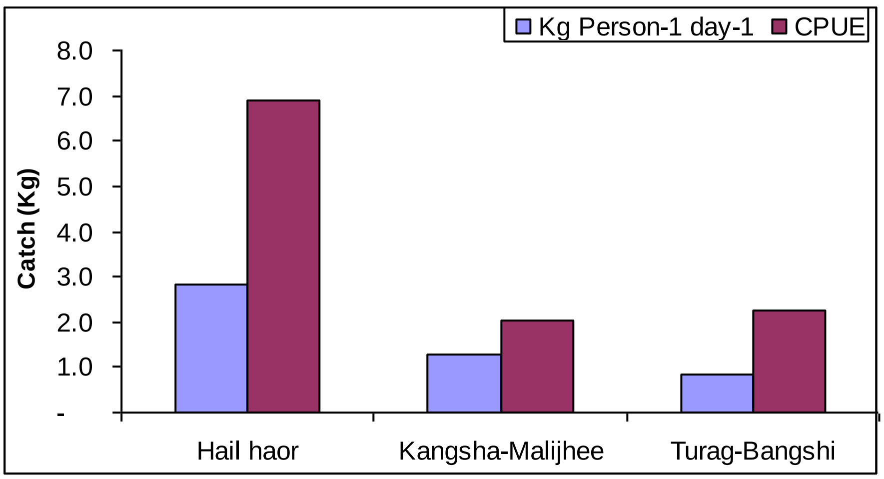


Figure 29. Catch per person, per day and Catch per unit effort in Hail Haor, Kangsha-Malijhee and Turag-Bangshi sites.

3.6. Biodiversity Based on Catch Monitoring Data

A total of 81, 63 and 62 species of fish and prawn were recorded during the study period in Hail haor, Kangsho Malijhee and Turag-Bangshi respectively. In Hail haor, the number of species caught in the monitored sites, revealed that the maximum number of species (64) was found in the Almiberi beel, Balla beel (59), Cheruadubi beel (54), Gopla river (52), Hunamua beel (46) and Lata river (41). In Kangsho-Malijhee, the number of species caught in the monitored sites revealed that the maximum number of species (41) was found in the Malijhee River, followed by Kewta beel (35), Doli beel (32) and Takimari beel (28). Total number of species varied from 41 to 64 in Hail haor, 28 to 41 in Kangsho-Malijhee and 35 to 49 in Turagh-Bangshi. Total number of species in each sampled wetland is shown in Figure 30. Ranges of species: 26 to 35, 36 to 45, 46 to 55 and 56 to 65 were found in 4, 3, 4 and 2 water bodies respectively. This reveals that the maximum numbers of water bodies are the habitats of 26 to 35 and 46 to 55 species. There was a substantial variation in species in each cluster and among wetlands. Number of species was found to be higher in Hail haor, when compared with MACH impact year 5. However, number of species was found to be lower in

Kangsha-Malijhee and Turag-Bangshi when compared with MACH, which might be the difference of number and area of sampling water bodies. In MACH project, number of sampling water bodies were 7, 8 and 8 in Hail Haor, Kangsha-Malijhee and Turag-Bangshi respectively. In contrast, in IPAC, number sampling sites are 7, 4 and 3 in Hail Haor, Kangsha-Malijhee and Turag-Bangshi respectively. The MACH project covered a total area of 1174.26, 267.7 and 382.72 ha in Hail-Haor, Kangsha-Malijhee and Turag-Bangshi respectively. In contrast, fish catch monitorig sampling areas are 276.22, 116.89 and 116 ha in Hail-Haor, Kangsha-Malijhee and Turag-Bangshi respectively.

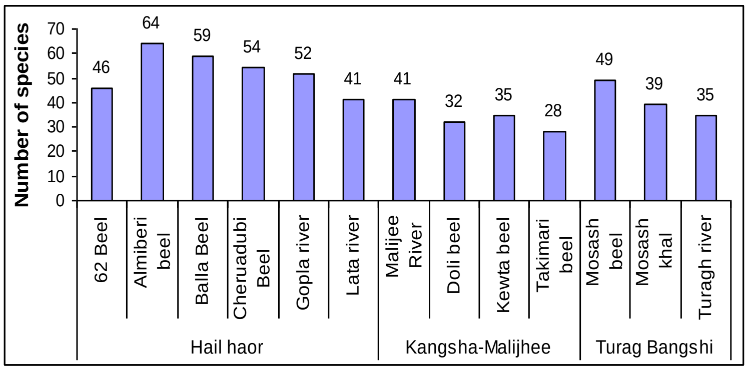


Figure 30. Total numbers of species recorded from catch monitoring at all studied sites.

Biodiversity of all fish species using the Shannon-Weiner index (H') in the study sites, ranged from 2.268 to 3.581 in 2010. The biodiversity monitoring research has demonstrated optimum level of biodiversity at most water bodies. However, the project management needs to focus very clearly on increasing biodiversity at some water bodies (H'>2.5), since *haor* and *beels* generally depend on what is happening in other surrounding water bodies. The comparison of biodiversity index (H') for 13 sites, based on all species is shown in Figure 31. A comparison of biodiversity index during MACH and IPAC for Hail haor, Kangsha-Malijhee and Turag-bangshi are given in Figure 32. Biodiversity index has increased in Hail haor and Kangsho-Malijhee when compared with MACH impact year 5 and 3 respectively. However, fish biodiversity has decreased in the Turagh-Bangshi site when compared with MACH impact year 5. Afrin (2010) reported that in focus group discussion participants and key informants also reported that in rivers and other bodies of water affected by pollution the species diversity and numbers of fish have dramatically dropped. Figure 33 presents the species abundance against log rank order for Hail haor, Kangsha-Malijhee and Turag-bangshi wetlands. Log abundance is the percentage of the total number of species found in one wetland, note that it is shown as a log-scale. Species in a wetland are ranked from the most to the least abundant on the x-axis. Simulated tests also showed that Hail haor is more diverse then Kangsha-Malijhee at 5% level.

The number of species, biodiversity indices, CPUA, CPD and CPUE in the Hail haor, Kangsha-Malijhee and Turag-bangshi are given in Table 6.

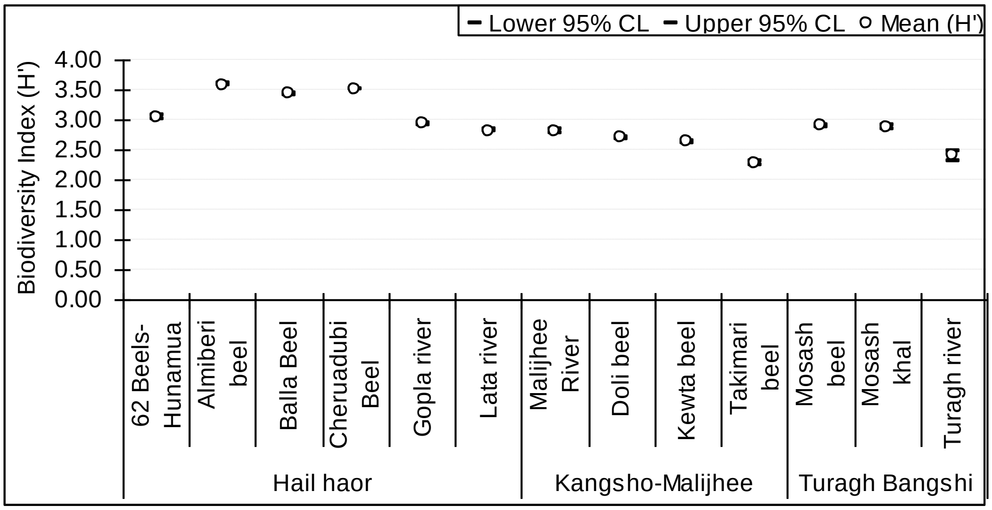


Figure 31. Biological significance (biodiversity index - H') of fish catches monitoring sites.

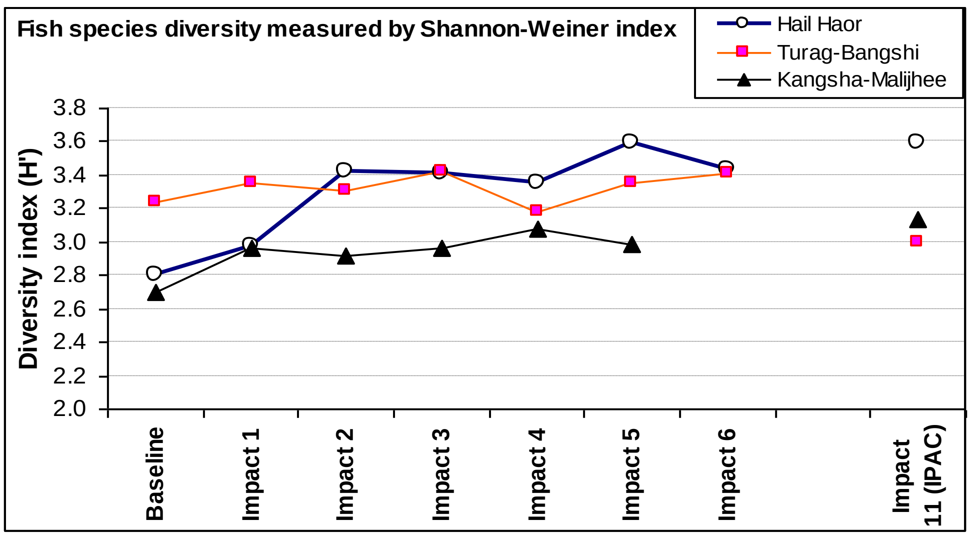


Figure 32. Species diversity trends in three wetland systems during MACH & IPAC.

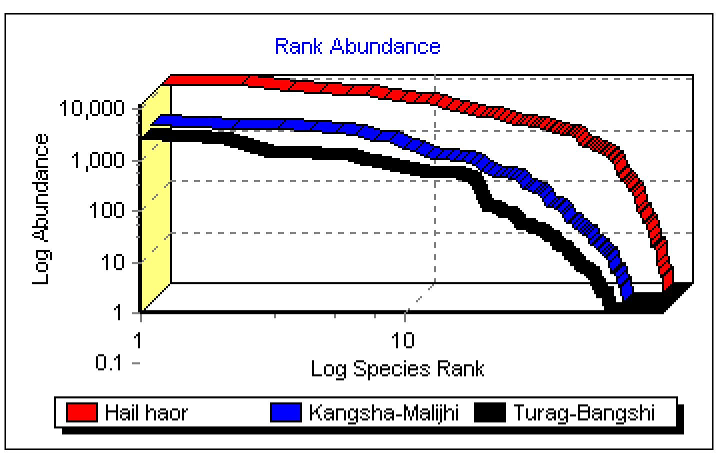


Figure 33. Species abundance in Hail haor, Kangsha-Malijhee and Turag-Bangshi sites during study periods.

Name of Cluster	Name of sampled wetlands	No. species (all)	No. species (native)	H’ (all sp)	H’ (native sp)	CPUA* (Kg/ha)	CPD* (Kg)	CPUE* (Kg)	Sale value (Tk/Kg)
Hail Haor	62 Beels Hunamua Almiberi beel Balla beel Cheruadubi beel Gopla River Lata River	81	74	3.599	3.513	387	2.83	6.905	110
Kangsho-Malijee	Malijhee River Doli beel Kewta beel Takimari beel	63	59	3.134	3.064	279	1.28	2.035	183
Turag-Bangshi	Mokash beel Mokash khal Turagh River	62	61	2.994	2.987	147	0.83	2.255	123

*CPUA – Catch per unit area, CPD – Catch per person per day, CPUE – Catch per unit effort

Table 6. Summary results of fisheries performance indicators

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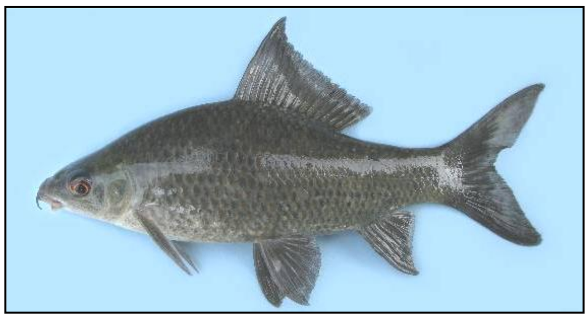
APPENDIX 1: Main Contributor Species in IPAC Wetlands

Family: Cyprinidae
Genus: *Puntius*
Species: *Puntius sophore*
Local name: Jat Puti



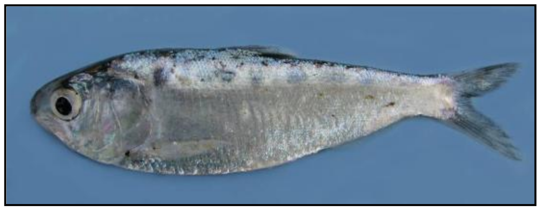
Family: Cyprinidae
Genus: *Labeo*
Species: *Labeo calbasu*
Local name: Kalibaus

Family: Channidae
Genus: *Channa*
Species: *Channa punctatus*
Local name: Taki

Family: Nandidae
Genus: *Nundus*
Species: *Nundus nundus*
Local name: Meni

Family: Palaemonidae
Genus: *Nematopalaemon*
Species: *Nematopalaemon tenuipes*
Local name: Gura Icha

Family: Cyprinidae
Genus: *Labeo*
Species: *Labeo rohita*
Local name: Rui



Family: Clupeidae
Genus: *Gudusia*
Species: *Gudusia chapra*
Local name: Fuka

Family: Anabantidae
Genus: *Colisa*
Species: *Colisa fasciatus*
Local name: Pata kholisha

Family: Siluridae
Genus: *Wallago*
Species: *Wallago attu*
Local name: Boa

Family: Anabantidae
Genus: *Anabus*
Species: *Anabus testudineus*
Local name: Koi

APPENDIX 2: Fish and Prawn Species Recorded and Their Contribution in the Hail Haor, Kangsha-Malijhee and Turag-Bangshi Sites.

Local name	Scientific name	* IUCN Status	Estimated production (Kg)		
			Hail haor	Kangsha-Malijhi	Turag-Bangshi
Ayre	*Mystus aor*	C	377		5.3
Bacha	*Eutropiichthys vacha*	CE	95	13.5	
Bagha Ayre	*Bagarius bagarius*	CE		294.3	
Baila	*Glossogobius giuris*	C	1229	2,582.1	1,192.4
Bali chata	*Nemacheilus botia*	C	4	15.6	
Balitora	*Psilorhynchus balitora*	DD		2.5	
Bashpata	*Danio devario*	C			
Bashpata/Kajoli	*Aillichthys punctata*				0.1
Bata	*Labeo bata*	E	8		
Batashi/Batai	*Pseudeutropius atherinoides*	NE		348.5	37.1
Baus/Bamus	*Anguilla bengalensis*	V	100	78.2	
Bighead Carp	*Aristichthys nobilis*	C	881		
Boal	*Wallago attu*	C	8559	2,519.9	364.5
Boiragi/Boirali	*Salmostoma argentea*	DD	11		
Bojuri Tengra	*Mystus tengara*		1867	1,976.1	98.1
Boro Baim	*Mastacembelus armatus*	E	387	397.6	
Chaika/Choukka	*Pellona ditchela*		3	6.4	8.7
Chapila/Korti	*Gudusias chapra*		44		717.4
Chatka Icha	*Macrobrachium malcolmsonii*		63	70.5	460.7
Chela	*Coila ramacaratia*		172		0.1
Chela/Katari	*Salmostoma bacaila*	NE	75	27.7	1.7
Chep chila	*Chela cachius*			60.6	
Chola Puti	*Puntius chola*	C	867		483.8
Chuna Kholisha	*Colisa sota*	NE	335		32.4
Common Carp/Carfu	*Cyprinus carpio (specularis)*		8080	556.8	17.8
Darkina	*Esomus danricus*	DD	1196	8.9	6.3
Dhela/Lohasur	*Rohtee cotio*	C		107.4	34.0
Dimua Icha	*Macrobarchium villosimanus*		1044		1.8
Ekthota/Subol	*Dermogenys pussilus*		147		
Foli	*Notopterus notopterus*	V	3101	27.1	24.8
Futani Puti	*Puntius phutunio*	C	8		
Gachua	*Channa orientalis*	V	107	11.8	5.7
Gang Magur	*Plotosus canius*	V	17		3.0
Gazar/Gazal	*Channa marulius*	E	1707	10.4	
Gogla	*Apogon septrmstritus*				1.2

Local name	Scientific name	* IUCN Status	Estimated production (Kg)		
			Hail haor	Kangsha-Malijhi	Turag-Bangshi
Goinna	*Labeo gonius*	E	4013	2.9	
Golda Icha	*Machrobrachium rosenbergii*		502	615.3	
Golsha Tengra	*Mystus bleekeri*	NE	1586	705.0	14.7
Gota	*Unidentified*		159	938.3	2.2
Grass Carp	*Ctenopharyngodon idellus*		7680	4.3	
Guchi Baim	*Mastacembelus pancalus*		1303	1,096.0	2,578.8
Guji Ayre	*Mystus seenghala*	C	164		23.8
Gura Icha	*Nematopalaemon tenuipes*		1224	22.0	403.9
Gutum	*Lepidocephalus guntea*	C	919	693.1	12.4
Ilish	*Hilsa ilisa/ Tenualosa ilisha*				45.9
Jatputi/Vadi Puti	*Puntius sophore*	C	5391	3,126.5	2,167.3
Jhili Puti	*Puntius gelius*	C	358		88.6
Kabashi Tengra	*Mystus cavasius*	V	7	37.6	97.5
Kajoli	*Ailia coila*	V		0.3	1.5
Kakila	*Xenentodon cancila*	C	2356	176.2	7.3
Kakra	*Stylla sp*				
Kali Koi/Napit Koi	*Badis badis*	E		1.2	2.0
Kalibaus	*Labeo calbasu*	E	560	303.2	42.6
Kanchon Puti	*Puntius conchonius*	C	953		0.1
Kani Pabda	*Ompak bimaculatus*	E	994	52.8	585.3
Katla/Katol	*Catla catla*	C	2849	13.8	453.5
Kaua/Jongla/Telia	*Gagata cenia*	C	401		
Kholisha	*Colisa fasciatus*	C	3701	286.4	11.9
Koi/Gachua Koi	*Anabas testudineus*		2063	231.9	41.2
Koral/Vetki	*Lates calcarifer*	C	21		
Kucho	*Metapenneus lysianassa*				1,081.0
Kuichcha/Kuichcha Baim	*Monopterus cuchia*	V	615	1.8	9.0
Lal Kholisha	*Colisa lalius*	C	240		58.7
Lomba Chanda	*Chanda nama/Leiognathus equulus*	V	969	76.7	822.5
Magur/Mojgur	*Clarias batrachus*	C	1968	8.4	16.4
Meni/Veda	*Nandus nandus*	V	4222	279.4	16.1
Mirror Carp	*Cyprinus carpio (communis)*		343	146.5	
Modhu Pabda	*Ompak pabda*	E	93	1,553.2	
Mohashol	*Tor tor*	CE	35	24.4	
Mola Puti	*Puntius guganio*		1799	8.0	
Mola/Moa	*Amblypharyngodon mola*	C		72.4	4.7
Mrigal/Mirka	*Cirrhinus mrigala*	C	604	1,591.4	196.2

Local name	Scientific name	* IUCN Status	Estimated production (Kg)		
			Hail haor	Kangsha-Malijhi	Turag-Bangshi
Naftani/Naptani	*Ctenops nobilis*	E	501	3.6	2.8
Nilotica	*Oreochromis niloticus*				
Parshey	*Lisa parsia*				
Raek/Bogna	*Cirrhinus reba*	V	1		629.4
Ranga Chanda	*Chanda ranga*	C	1322	136.7	467.6
Rui/Ruhit	*Labeo rohita*	C	8220	36.7	69.4
Sarputi	*Puntius sarana*	CE	46	713.9	7.1
Shilong/Shilon	*Silonia silondia*	E		12.4	
Shing	*Heteropneustes fossilis*	C	2617	302.0	78.3
Shol/Shoil	*Channa striatus*	C	3410	524.5	511.8
Silver Carp	*Hypophthalmichthys molitrix*		1187	145.1	
Taki/Ladi	*Channa punctatus*	C	5806	2,204.2	1,113.5
Tara Baim	*Macrognathus aculeatus*	V	1317	2,755.6	73.6
Tatkini	*Crossochelius latius*	E		33.2	
Telapia/Telapata	*Oreochromis mossambica*		521		3.6
Tengra/Guinga	*Mystus vittatus*		1	610.5	443.6
Tepa/Potka	*Tetraodon cutcutia*	C	1013		25.6
Teri Puti	*Puntius terio*	C	725	3.6	
Thai Sarputi/Raj Puti	*Puntius gonionotus*		605		
Thangua Icha	*Macrobrachium birmanicum*				37.9
Tinchokha/Kanpona	*Aplocheilus panchax*	C	23		
Tit Puti	*Puntius ticto*	V	988	180.1	1,164.0
Vala/Vol	*Barilius bola*		770		
Vangra	*Labeo boga*	CE		22.3	

*Note: C=Common, E= Endangered, V=Vulnerable, CE=Critically Endangered, NE=Not endangered, DD=Data deficiency.

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