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# Impacts of Co-management and Related Institutions on Fish Biodiversity and Livelihoods of Fishers of Baikka Beel

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## *Abstract*

*Co-management has been a focus of attention in fisheries and natural resource management in the last two decades. In the case of fisheries, it has most often been taken to mean a sharing of responsibility for sustainable resource management between government and fishing communities. Baikka Beel, a 100-hectare water body in Bangladesh, has been identified and established as a wetland sanctuary by local community members in conjunction with the Management of Aquatic Ecosystem through Community Husbandry (MACH) project. In this paper, I investigate the role of co-management institutions, including federations of resource user groups (FRUGs) and resource management organizations (RMOs), as well as alternative income-generating activities (AIGAs), on sustainable wetland resource management, and I examine the resulting benefits for fish production and biodiversity. The study results suggest that the knowledge and attitudes of MACH fishers towards sustainable resource management are more positive and optimistic than those of non-MACH fishers; the income level of MACH fishers is higher than that of non-MACH fishers; MACH fishers are involved with AIGAs, non-MACH fishers are not; fishing rights of both MACH and non-MACH fishers are not well established due to current leasing systems; and fish production and biodiversity have been improved due to community-based sustainable management of Baikka Beel.*

## **Introduction**

Bangladesh is a country of wetlands with 4.90 million hectares of inland water bodies that cover 34 percent of the country where 12.5 million people are directly or indirectly involved with the fisheries sector for their livelihood. Fishing plays a major role in meeting the country's animal protein demands, earning foreign exchange, and in the socio-economic development of the rural poor, by alleviating poverty through employment generation (DoF 2009). At the same time, natural resources in Bangladesh have been gradually declining due to habitat degradation for instance, in the case of wetlands, through siltation and loss of natural breeding grounds and man-made problems like overfishing, use of destructive fishing gear, huge use of

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agrochemicals, conversion of wetlands to agricultural lands, and catching of parent, young, and undersized fish. These activities have negatively affected the breeding, growth, and development of natural fish populations, which has resulted in depleted fish production and unemployment of fishers and reduced animal protein supplies, especially for the poor. Thus, fish populations are facing continuous stress and are under threat of irreversible decline (DoF 2005).

In Bangladesh, wetlands are highly productive environments that support the livelihoods of millions of poor people. Despite the possession of a highly productive inland water area, the continuing decrease in fish catch increasingly threatens the livelihoods of 1.28 million fishers nationwide (DoF 2011). The demands on inland aquatic areas by different stakeholders have also rapidly accelerated the destruction of aquatic resources. Barriers to the access of fishers in the management of inland fisheries resources and over-exploitation by the relatively wealthier contract fishers population are reducing the options for sustaining the livelihoods of fishery-dependent communities. Under the current leasing system, in which revenue collection is the main target and biological impacts are not considered, poor fishers have failed to gain fishing rights, mainly because of high leasing value, and are less able to defend their fishing rights than more socially and economically powerful leasers who can conduct unauthorized fishing through threats and social pressure.

Community-based management of natural resources has, in the past two decades, become a common strategy for improving resources management and empowering local communities using concepts such as local knowledge, recognition of local institutions, and establishment of common property regimes (Sultana and Thompson 2007). Community-based fisheries management (CBFM) is a new tool for the sustainable management of inland fisheries resources, and the success of such management depends on the motivation and active participation of the community members (Thompson and Colavito 2007).

The Management of Aquatic Ecosystems through Community Husbandry (MACH) project was an innovative pilot program with the aim of developing community-based fisheries management and demonstrating sustainable, integrated management of wetland resources including fish, plants, agriculture, livestock, forestry, and wildlife over entire ecosystems.

In this study, I investigate the role of co-management institutions, including federations of resource user groups (FRUGs) and resource management organizations (RMOs), as well as alternative income-generating activities (AIGAs), in sustainable wetland resources management, and examine the resulting benefits for fish production and biodiversity. The specific objectives of the study are: (1) to understand the role of co-management institutions in wetland resources management; (2) to learn more about the income level of members of resource user groups (RUGs) and their rights to the fishery; (3) to understand the role of AIGAs and their benefits for wetland resources

management; and (4) to determine the status of production and biodiversity as perceived by the fishers.

Considering the potential, possibilities, and limitations related to the management of wetland resources, the present research was conducted to determine the socio-economic and ecological impacts of co-management as implemented in my study area. This may serve as a guideline for policy formulation and be useful for the government, NGO officials, fishers, and members of RUGs, FRUGs, and RMOs.

## Background

Hail Haor is an extensive wetland area situated in Moulvibazar District that reaches a maximum flooded size of 14,000 hectares, but which, in the dry season, recedes to less than 4,000 hectares and is restricted to about 130 beels and narrow canals. More than 172,000 people in 30,000 households live in 60 villages surrounding the haor. Over 80 percent of these households engage in fishing in the haor, many as a full-time profession (Chakraborty *et al.* 2005).

Baikka Beel is situated in Hail Haor, and this beel includes three other sub-beels Chapra, Maguara, and Jaduria and retains water year round. Together with the surrounding marshy areas, these beels form the fish sanctuary known as Baikka Beel Sanctuary, covering about 100 hectares. Baikka Beel was once famous for its rich fisheries and as a spawning and nursery ground in Hail Haor. The Bangladesh Government declared Baikka Beel a permanent fish sanctuary on July 1, 2003. Baikka Beel came under the management of the MACH project, funded by USAID and implemented by the Department of Fisheries, from 1998 to 2008. This sanctuary was created to improve the wetland habitat, protect sensitive avian areas, and support the diversity of aquatic plants and animals of Hail Haor.

First the MACH project and now the Integrated Protected Area Co-management (IPAC) Project have promoted a co-management approach in Baikka Beel to reduce the overuse of wetland resources and to preserve them from degradation within the project sites. Specific activities have included the development of fish sanctuaries, the implementation of alternative income-generating activities to reduce fishing pressure, reconnecting water bodies through the excavation of canals, and establishment of swamp plantations to facilitate fish migration and spawning and to preserve wetland productivity.

In Bangladesh, most wetlands are government property and are administered by the Ministry of Land (MoL). On behalf of the MoL, officials at the district and upazila levels look after these water bodies. The Department of Fisheries, the Department of Environment, and the Forest Department also share some responsibility for the management of the water bodies, including administration of Ecologically Critical Areas (ECAs).

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Baikka Beel was established as a co-management site by MACH. Around this location, both resource management organizations (RMOs) and federations of resource user groups (FRUGs) have been operating with the support of the DoF. The deputy commissioner at Moulvibazar manages Baikka Beel, with technical support from the DoF and active participation of local community RMOs, specifically the Barogangina RMO.

## Study Area

Based on supplementary information from DoF officials, IPAC staff, local communities, and a review of previous reports, I selected two villages as my study sites Hazipur and Uttar Uttarsur. These villages are adjacent to Hail Haor and also very near to Baikka Beel, about five kilometers northwest of Sreemangol and twenty kilometers southwest of Moulvibazar District town (Figure 1). Due to their close proximity to the beel, the 40 households in these two villages engage in fishing as their main occupation and also to meet their household food demands. In Hazipur, MACH provided AIGA funds to members of the RUGs, who chose alternative professions to reduce their dependence on fishing in and around Baikka Beel, but in Uttar Uttarsur there was no MACH presence. In this study, I look at changes in income levels of fishers due to AIGAs in Hazipur village, as well as the difference between the MACH (Hazipur) and non-MACH (Uttar Uttarsur) villages.

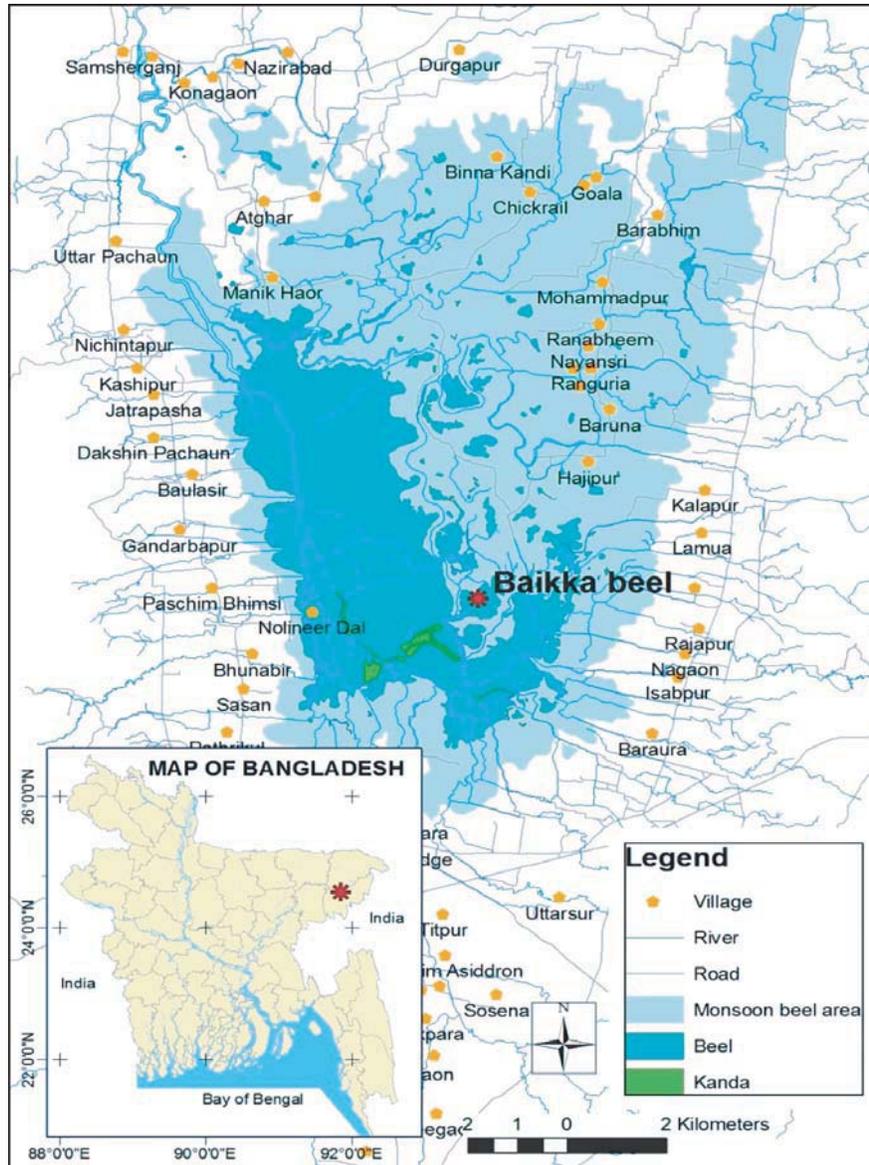


Figure 1: Map of the study area (Source: IPAC)

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## Methodology

For this study, I collected both primary and secondary data. I collected primary data through field visits and observations, semi-structured interviews, discussions with community leaders and key informants, and through participatory rural appraisal methods such as focus group discussions (FGDs), visits to fish markets, and observations of fish catch composition. Prior to selecting the study sites, I visited the area and selected two villages for data collection. I gathered information about local livelihoods, socio-economic conditions, and the fishing activities of the community members, as well as their management activities in Baikka Beel. Based on this information, I designed my questionnaire to collect qualitative and quantitative data. I visited the study area for data collection once a month from August 2011 to December 2011 (five times). I gathered secondary data on Baikka Beel, MACH activities, IPAC activities, previous and present fish catch, and AIGA trainings and funds from the reports of the Department of Fisheries, the Upazila Fisheries Office, and the local IPAC office.

Using a semi-structured questionnaire, I conducted a comparative household survey in Hazipur and Uttar Uttarsur villages; Hazipur has a RMO (and AIGAs) and Uttar Uttarsur does not. From each village, I chose 20 respondents who had been engaged in fishing for several years at that site because they could provide me with information about fish catch and biodiversity over time. In Hazipur village, all 20 respondents fish around the beel for their livelihoods and all are members of the RUG who received AIGA training and funds for alternative professions other than fishing. In Uttar Uttarsur village, all 20 respondents also fish around the beel, but they are not members of a RUG.

For qualitative data collection, I conducted two focus group discussions in these two villages, with participants not included in the semi-structured interviews, about the current management practices of the sanctuary, implementation of the Fish Act, attitudes towards the sanctuary, whether they benefited from the sanctuary, current problems with the sanctuary, and possible recommendations for enhancing its sustainable management. I also collected data through semi-structured interviews with community leaders and key informants.

To determine the biodiversity status of the beel, I visited three nearby fish markets, Baruna Ghat Bazar, Hazipur Ghat Bazar, and Bhairabganj Bazar, one time each month. I also analyzed secondary data using various types of sources to identify and better understand the impacts of fish sanctuaries on fish biodiversity. I asked the respondents from both villages, participants in the FGDs, and key informants about currently available fish species; fish species previously found but not available now (endangered and critically endangered species); currently available fish species that were previously present; the amounts of previous and current catches and fish consumption; the types of fishing gear used; implementation of Fish Acts and Rules;

fish sanctuaries; excavation; swamp plantation; AIGA funds and activities provided; and management strategies of RUGs, FRUGs, and RMOs; and I also asked whether co-management practices and AIGA activities under MACH/IPAC have brought positive results in the context of their livelihoods and fish biodiversity.

After completing data collection, I conducted an analysis to estimate impacts of AIGAs on fisheries production, biodiversity, and income generation, as well as their implications for fisheries management.

## Results and Discussion

In this section I first describe the role of co-management institutions (RUGs/ FRUGs/ RMOs) in wetland resources management. Next I look at the income level of members of resource user groups (RUGs) and their rights to the fishery. I also examine the role of AIGAs and their benefits for wetland resources management. In addition, I discuss the status of production and biodiversity as perceived by the fishers.

### *Role of Co-management Institutions in Wetland Resources Management*

I gathered data from the respondents of both MACH and non-MACH villages in order to understand the role of co-management institutions and the respondents' attitudes and perceptions concerning co-management. I asked respondents about the objectives of the MACH project and sought out additional information from focus group discussions. In the FGDs, I asked about different factors concerning co-management, such as fish production, AIGA-related training and activities, AIGA funds, fish sanctuaries, habitat improvement, fish fry stocking, and some other factors shown in Table 1. In the MACH village, all 20 respondents (100%) said that fish production had increased, while in the non-MACH village, 16 respondents (80%) said that fish production had increased. Nineteen respondents (95%) in the MACH village and none in the non-MACH village had received AIGA training and funds. Fourteen respondents (70%) in the MACH village are involved with AIGAs and only two (10%) respondents from the non-MACH village are involved with AIGAs. Nineteen respondents (95%) are aware of the Fish Act in the MACH village, while only four (20%) of the respondents from the non-MACH village are aware of it. The respondents from the MACH village are also more aware than respondents from the non-MACH village of some other issues important for effective co-management and sustainable wetlands resource management, such as establishment of the fish sanctuary, prohibitions on the use of destructive gear, the fishing ban in the sanctuary, biodiversity, habitat improvement efforts, and the introduction of new species (see Table 1). Most of the respondents in the MACH village are well informed about co-

management and have a positive attitude about sustainable wetland resources management. On the other hand, the non-MACH village fishers reported having received little information about these issues and they responded less frequently to questions on the importance of conserving wetlands. My analysis suggests that MACH village fishers are more aware of co-management, sustainable wetlands resources management and conservation, and biodiversity, and I found them optimistic compared to the non-MACH village fishers. Based on this analysis, it may be argued that the positive attitude of the respondents in the MACH village towards sustainable wetlands resources management is due to the appropriate role of co-management institutions, community-based organizations, and the provision of funds for AIGAs.

**Table 1: Perception of local inhabitants towards sustainability of co-management**

Responses concerning co-management	No. of Respondents	
	MACH village (Hazipur)	Non-MACH village (Uttar Uttarsur)
Report that fish production has increased	20 (100%)	15 (75%)
Have received AIGA-related training	20 (95%)	3 (15%)
Received AIGA funds individually	19 (95%)	0 (0%)
Engage in AIG activities (plant nursery, fish nursery, cow fattening, goat rearing, driving)	14 (70%)	2 (10%)
Aware of fish sanctuary management	19 (95%)	10 (50%)
Aware of fishing ban	20 (100%)	8 (40%)
Aware of Fish Acts and Rules	19 (95%)	4 (20%)
Support stocking/releasing of new fish species	16 (80%)	2 (10%)
Have knowledge on biodiversity and natural resource conservation	17 (85%)	4 (20%)
Aware of destructive gear	20 (100%)	7 (35%)
Aware of habitat improvement	18 (90%)	3 (15%)
Engage in resource sustainability activities (RMO meetings, organized trainings, etc.)	18 (90%)	2 (10%)
Support environmental protection (e.g. swamp plantation)	18 (90%)	5 (25%)
Have savings individually	12 (60%)	2 (10%)

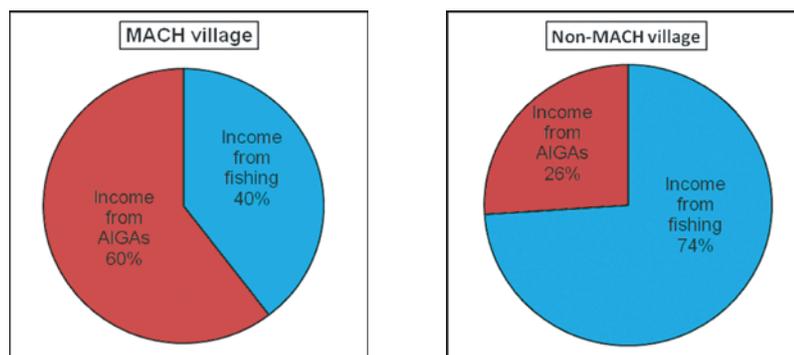
There are 22 RUGs (with 15–30 members in each RUG) active in Baikka Beel management activities. These 22 RUGs are formed of fishers/villagers from three villages, Hazipur, Baruna, and Nayanshri. Four FRUGs (federations of resource user groups) have also been formed by members of these RUGs three FRUGs in Sreemangol Upazila and one in Moulvibazar Sadar Upazila. The main function of the FRUGs is to maintain and manage a revolving fund provided by the MACH project. The fund has been provided to the FRUG authorities' accounts to provide loans to individual RUG members for AIGAs. Fund disbursements are supervised and controlled by the FRUGs. The RMOs are responsible for coordination with the upazila

committee and overall management of the beel. The president and member secretary of the RMO are members of the upazila fisheries committee (UFC). The RUGs, FRUGs, and RMOs are linked with each other, and these local, community-based organizations have a linkage with the upazila administration, which helps in sustainable Baikka Beel management.

### ***Resource User Group Members: Income Level and Rights to the Fishery***

In Hazipur village, the average monthly income per respondent from fishing is 3,210 BDT and from AIGAs or other sources is 4,895 BDT. In Uttar Uttarsur village, the average monthly income per respondent from fishing is 4,645 BDT, and from AIGAs or other sources is 1,635 BDT. The analysis of income level of the respondents of these two villages shows that the average monthly income per respondent from fishing in Hazipur village is lower than it is in Uttar Uttarsur village, but the average monthly income per respondent from AIGAs or other sources is higher in Hazipur village than in Uttar Uttarsur village (Figure 2). The combined average monthly income from both fishing and AIGAs or others sources was higher in Hazipur village than in Uttar Uttarsur village.

Twenty respondents (100%) from the MACH village and 15 respondents (75%) from the non-MACH village said that, in the rainy season when all the beels situated around the Baikka Beel get connected with each other, fishing remains open to all fishers using environmentally friendly fishing gear. But in the dry season, when the embankment of each beel is visible, then contract leaseholders prevent the local fishers from fishing. Thus, during the dry season, many fishers of the non-MACH village work as day laborers for the contract leaseholders to guard and also to catch fish. Therefore, due to the current leasing system, the fishing rights of the fishers of my study area are at risk.



**Figure 2: Percentage of average monthly income from fishing and non-fishing in MACH and non-MACH village**

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### ***Role of AIGAs and Their Benefits for Wetland Resources Management***

AIGA-related trainings for different income-generating activities have been provided to the members of RUGs, FRUG, and RMOs of the MACH village. These include (a) plant nursery, (b) fish nursery, (c) fish cultivation, (d) cow fattening, (e) goat rearing, (f) vegetable culture, (g) driving (h) weaving, and (i) handicrafts production.

***Funds for alternative income-generating activities (AIGAs).*** Before the end of the MACH project activities, the authority of the project provided two types of funds for the proper and sustainable management of the Baikka Beel water resources—an endowment fund and a revolving fund. The amount of the endowment fund was 13,000,000 BDT. It was deposited in a bank account, which is administered through the joint signature of the Deputy Commissioner and the District Fisheries Officer at Moulvibazar District. The bank gives interest at a rate of 8.25 percent, and 90 percent of the earned interest is expended on maintenance costs of the resource management organizations of Baikka Beel and the Sreemangol Upazila Water Resource Management Committee, while the remaining 10 percent is added to the main endowment fund. In this way, the endowment fund is being increased gradually. The amount of the revolving fund is 8,700,000 BDT, which is also deposited into a bank account controlled jointly by the president, member secretary, and treasurer of the FRUG. The fund is used to provide loans at a 12 percent interest rate to RUG members for AIGAs, and is controlled by the FRUG's executive committee and reviewed during the FRUG's general assembly. Fund disbursement is supervised and controlled by the FRUG. The first loan amount for individual RUG members is 5,000 BDT, and after repayment of this loan within the scheduled time they can get another loan of up to 40,000 BDT. A total of 450 RUG members are receiving such loans and investing their funds in AIGAs.

The analysis of monthly average income levels of respondents in the two villages shows that in the non-MACH village, 74 percent of their monthly income comes from fishing and 26 percent of their monthly income comes from other sources. On the other hand, in the MACH village, 40 percent of their monthly income comes from fishing and 60 percent of their monthly income comes from AIGAs or other sources. The previous main occupation of most of the respondents of Hazipur village was fishing, and at present they are involved with different types of AIGAs such as plant nursery, cow fattening, goat rearing, fish nursery and culture, driving, and others (Figure 3). On the other hand, 15 respondents (75%) in Uttar Uttarsur village were engaged in fishing as their main occupation, and they are still engaged in fishing at present (Figure 4). It is assumed that the additional income from AIGAs and other sources of respondents in Hazipur village has increased their monthly income level and reduced their dependence on fishing. There has been no AIGA-related training, no AIGA funds, and no motivational work done in Uttar Uttarsur village. Therefore, there are no community-based co-management organizations (RMOs, RUGs, or FRUGs) functioning in this village. The fishermen of this village are engaged in

traditional fishing around Baikka Beel. They are not very aware of or motivated about co-management, the Fish Conservation Act and Rules, biodiversity, or sustainable wetland resources management. Thus, it might be said that AIGAs help to reduce dependence on fishing and to promote sustainable wetland resources management.

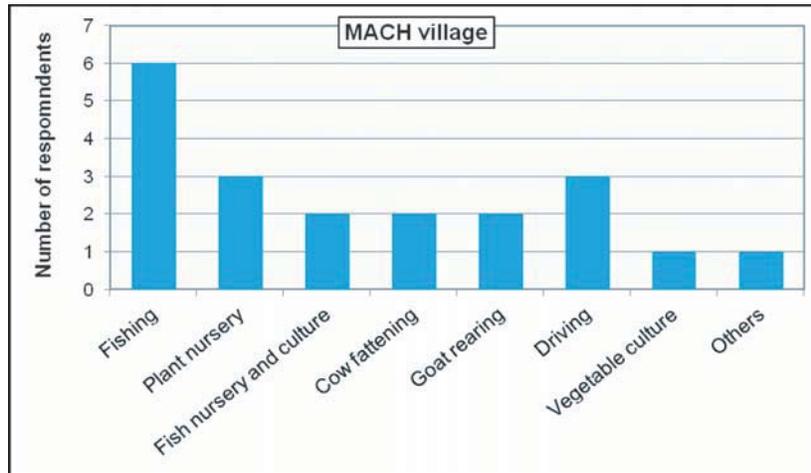


Figure 3: Present occupational status in the MACH village

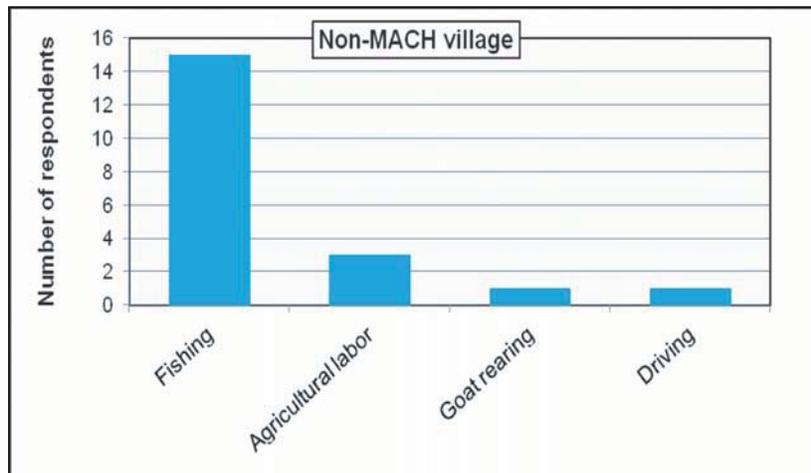


Figure 4: Present occupational status in the non-MACH village

***Fish production status and biodiversity as perceived by the fishers.*** The fish production was figured by asking about the daily individual catch of the 40 respondents and then calculating the average to compare their daily catch with the IPAC fish catch monitoring report of 2011. According to the report (IPAC 2011), the daily fish catch by individual fishers was, on average, 2.83 kilograms per fisher per day. I found similar levels: the present fish catch in the study villages is, on average,

2.70 kilograms per fisher per day. Twenty MACH respondents (100%) and 16 non-MACH respondents (80%) expressed their opinion that the trend of fish production is increasing in comparison to previous years (Table 3). The catch per fisher per day has increased when compared with the catch reported in the 2003 MACH report. To determine the fish biodiversity status, I made a list of major fish species from the daily catch results of the 40 respondents, and from my observations of the three nearby fish markets, shown in Table 2.

**Table 2: Major fish species in Baikka Beel**

Sl. No.	Local Name	Scientific Name	Previous Status	Present Status
1	Ghonia	<i>Labeo gonius</i>	Endangered	Common
2	Rui	<i>Labeo rohita</i>	Common	Common
3	Catla	<i>Catla catla</i>	Common	Common
4	Mrigal	<i>Cirrhinus mrigala</i>	Common	Common
5	Calibaus	<i>Labeo calbasu</i>	Endangered	Common
6	Carpio	<i>Cyprinus carpio</i>	Common	Common
7	Koi	<i>Anabas testudineus</i>	Common	Common
8	Titputi	<i>Puntius ticto</i>	Vulnerable	Common
9	Sarpunti	<i>Puntius sarana</i>	Critically Endangered	Common
10	Shing	<i>Heteropneustes fossilis</i>	Common	Common
11	Magur	<i>Clarias batrachus</i>	Decline	Common
12	Tengra	<i>Mystus tengara</i>	Common	Common
13	Gulsha	<i>Mystus vittatus</i>	Data deficient	Common
14	Chital	<i>Notopterus chitala</i>	Not shown	Common
15	Boal	<i>Wallago attu</i>	Common	Common
16	Ayre	<i>Mystus aor</i>	Common	Common
17	Gutum	<i>Lepidocephalus guntea</i>	Common	Common
18	Tara baim	<i>Mastacembelus armatus</i>	Vulnerable	Common
19	Taki	<i>Channa punctatus</i>	Common	Common
20	Gojar	<i>Channa marulius</i>	Endangered	Common
21	Rani	<i>Botia dario</i>	Not shown	Common
22	Madhupabda	<i>Ompok pabda</i>	Endangered	Common
23	Ketchki	<i>Corica suborna</i>	Not shown	Common
24	Kanipabda	<i>Ompok bimaculatus</i>	Endangered	Common
25	Foli	<i>Notopterus notopterus</i>	Vulnerable	Common
26	Bheda	<i>Nandus nandus</i>	Vulnerable	Common
27	Kholisa	<i>Colisa fasciatus</i>	Common	Common
28	Lombachanda	<i>Chanda nama</i>	Vulnerable	Common
29	Lalkholisa	<i>Colisa lalia</i>	Common	Common
30	Kakila	<i>Xenentodon cancila</i>	Common	Common
31	Dhela	<i>Rohtee cotio</i>	Common	Common
30	Bacha	<i>Eutropiichthys vacha</i>	Critically endangered	Common
31	Bighead	<i>Aristichthys nobilis</i>	Common	Common
32	Baila	<i>Glossogobius giuris</i>	Common	Common
33	Darkina	<i>Esomus danricus</i>	Data deficient	Common
34	Shoal	<i>Channa striatus</i>	Common	Common
35	Mola	<i>Amblypharyngodon mola</i>	Common	Common

Among these species, sarpunti, ghonja, madhupabda, chital, and bheda were endangered and shoal, koi, shing, magur, ayre, and gulsha were declining before the activities of the MACH project. Now all these fish are commonly found in and around Baikka Beel. A number of activities begun by the MACH project are being done to increase fish production and biodiversity. These include: (a) habitat improvement activities such as excavation of canals to ensure fish migration and spawning; (b) establishment of fish sanctuaries; (c) restriction of illegal fishing gear by the Fish Conservation Act and promotion of use of environmentally friendly gear; (d) maintenance of closed areas (fish sanctuary zones); (e) planting of swamp trees (hijal, koroch); (f) fish fry stocking; (g) restocking of two new fish species; and (h) restoration of breeding grounds for chital fish. According to a study by the International Union for Conservation of Nature (IUCN 2000), in this area some 54 fish species are endangered, of which 12 are either critically endangered or extinct. Most of the respondents of the two villages thought that both fish production and biodiversity have increased (Table 3). According to respondents and key informants, five endangered fish species have been revived sarpunti (*Puntius sarana*), madhu pabda (*Ompok pabda*), chital (*Notopterus chitala*), bheda (*Nandus nandus*), and ghonja (*Labeo gonius*). The revival of endangered and declining fish species around Baikka Beel is due to completion of a number of habitat improvement activities, establishment of the fish sanctuary, restocking of two fish species, the use of environmentally friendly gear, and ongoing effective operation of co-management institutions. These findings support those of Azher *et al.* (2007), who investigated the impacts of sanctuary zones on fish production and fish biodiversity in Dopi Beel in Joanshahi Haor and found that the total production obtained from Dopi Beel was much higher than before the sanctuary zones were established. Fish species previously deemed as threatened were found to have reappeared in Dopi Beel.

**Table 3: Perceptions of local community towards effectiveness of Baikka Beel sanctuary**

Perceptions	Number of respondents (percent)
Baikka Beel fish sanctuary effectively increased fish biodiversity.	34 (85%)
Baikka Beel fish sanctuary effectively increased fish production.	36 (90%)
Baikka Beel fish sanctuary effectively increased fish catch and improved fish biodiversity.	32 (80%)
Not effective	0 (0%)

Note: Due to multiple responses, percentages do not add up to 100%.

## Conclusion

Co-management and effective co-management institutions help to promote the active participation of community members and sustainable wetlands resource management. Associated management measures, AIGAs, and fishing rights can increase the income level of poor fishers by supporting strategies for better fisheries management. Based on the findings of this study, I believe that the active involvement of fishers in co-management activities, the role of community-based organizations such as RUGs,

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FRUGs, RMOs, and the upazila administration, and providing funds for AIGAs are the key factors for sustainable management of Baikka Beel.

The major aim of this study was to investigate the role of co-management institutions, such as the federations of resource user groups (FRUGs) and resource management organizations (RMOs), as well as alternative income-generating activities (AIGAs) in sustainable wetland resource management, and to examine the resulting benefits for fish production and biodiversity. In my assessment of the role of co-management and the perceptions of respondents towards co-management, I found that most of the respondents of the MACH village are well informed about co-management and have a positive attitude towards sustainable wetland resources management. On the other hand, non-MACH fishers have little information on these issues and they responded less frequently about the importance of conserving wetlands. Overall, MACH village fishers were more aware and optimistic about co-management and measures for sustainable wetland resources management and biodiversity conservation than non-MACH village fishers.

In terms of the income and fishing rights of fishers, I found that the average monthly income per respondent from fishing in the MACH village is lower than in the non-MACH village, but the average monthly income per respondent from AIGA or other sources is significantly higher in the MACH village than in the non-MACH village. Furthermore, the combined average monthly income from both fishing and AIGAs or other sources is higher in the MACH village than in the non-MACH village.

Twenty respondents (100%) in the MACH village and 15 respondents (75%) in the non-MACH village said that in the rainy season, when all the beels situated around Baikka Beel are connected with each other, fishing remains open to all fishers using environmentally friendly fishing gear. However, in the dry season, when the embankment of each beel is visible, contract leaseholders occupy the leased-out beels and the fishers are usually not entitled to fish in those beels due to the terms and conditions of leasing system. During this time, fishers from the non-MACH village work as day laborers for contract leaseholders to guard and catch fish. Under this current leasing system, the fishing rights of the fishers in the study area are not well established and remain at risk. The fishing rights both of MACH and non-MACH fishers could be strengthened by changing the present leasing system and by expanding community-based management of the wetlands for sustainability.

In terms of AIGAs, I found that in the non-MACH village 74 percent of respondents' monthly income came from fishing and 26 percent came from other sources. On the other hand, in the MACH village, 40 percent of their monthly income came from fishing and 60 percent from AIGAs or other sources. The previous main occupation of most respondents in the MACH village was fishing and at present many are involved with AIGAs. On the other hand, 20 respondents (100%) in the non-MACH village previously were and still are engaged in fishing as their main occupation.

These responses suggest that the additional income from AIGAs and others sources for respondents in the MACH village has increased their monthly income level and thereby reduced their dependence on fishing.

In terms of fish production and biodiversity, the IPAC (2011) report shows that the daily fish catch by individual fishers was, on average, 2.83 kilograms per fisher per day. My study found similar amounts, at 2.70 kilograms per fisher per day, in the area around Baikka Beel. Most respondents of the MACH and non-MACH villages expressed their perception that the trend of present fish production is increasing in comparison to previous years. Catch per fisher per day has increased when compared with the MACH (2003) report. Among the major fish species, sarpunti, ghonia, madhu pabda, chital, and bheda were endangered before the activities of the MACH project. Now these fish are available. It was found that these fish species have been revived, which could be due to the activities conducted by the MACH project to increase fish production and biodiversity.

There are differences between MACH and non-MACH fishers regarding resource use, access to AIGAs, occupational status, and attitudes towards sustainable wetland management. AIGAs appear to have considerable impact on the quality of people's livelihood and fishing practices. Based on the data I have presented in this paper, I conclude that the role of co-management institutions, including the federations of resource user groups (FRUGs) and the resource management organizations (RMOs), as well as alternative income-generating activities (AIGAs), have had a great impact on sustainable wetland resource management and fish production and biodiversity in Baikka Beel.

The results of this study suggest that, for the co-management of Baikka Beel to be further enhanced, fishers of all surrounding villages must actively participate in co-management institutions and activities. The MACH project operated in only three villages around Baikka Beel. It would be better if IPAC would begin motivational trainings and other activities like AIGAs for sustainable Baikka Beel management in all villages, because most of the fishers outside of the three MACH project villages are not very aware about co-management and sustainable wetland resource management.

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