Impact of Baikka Beel Sanctuary on Protection and Restoration of Fish Biodiversity and Enhancement of Local Livelihoods

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Abstract

Fish sanctuaries have been found to be effective for the protection and conservation of fish biodiversity. This paper discusses fish biodiversity in beels adjacent to and removed from protected areas, current fishing practices, perceptions among local community members about the effectiveness of the Baikka Beel Sanctuary, and benefits that local fishers derive from the sanctuary. Data collection was carried out through catch monitoring, focus group discussions, and semi-structured interviews. Results show that there were 31 species of fish recorded in Balla Beel and 24 species in Sixty Two Beel during the study period. The dominant species in the beels adjacent to Baikka Beel is boal (Wallago attu). Some other exotic species like grass carp (Ctenopharyngodon idella) and common carp (Cyprinus carpio) are also common in both wetlands. Indigenous species like Ompok bimaculatus, Puntius sarana, Nandus nandus, Labeo gonius, and Chitala chitala, which were rare before the establishment of the fish sanctuary, are now common in both beels. Findings also reveal that most of the respondents' beliefs about the effectiveness of the sanctuary concern increased fish biodiversity, though they also report some additional direct and indirect benefits from it. This study is encouraging because it indicates that the overall fish biodiversity in Balla Beel and Sixty Two Beel is increasing as a result of the establishment of the Baikka Beel Fish Sanctuary. It suggests that careful planning, management, and regulatory practices, along with active community participation, can have a positive impact on fish biodiversity.

Introduction

Most inland fisheries in the developing world are heavily exploited. Freshwater biodiversity has declined faster than both terrestrial and marine biodiversity during the past 30 years (Jenkins 2003). Inland fisheries comprise a large share of the total fish production in Bangladesh, which makes this issue particularly important.

In Bangladesh, inland water bodies cover an area of 4,652,665 hectares, of which 4,024,934 hectares (87%) are open water and 627,731 hectares (13%) are closed

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water. The inland open-water fisheries resources of Bangladesh are the third richest in the world, following those of China and India. In 2009–2010, the total fish production of Bangladesh was 2,899,198 metric tons (DoF 2011). The fisheries sector is also rich in species composition, with 260 species of freshwater fish, 475 marine species, 24 prawn species, and 36 shrimp species. The climate and geography of Bangladesh are especially conducive to aquaculture and fisheries management (Chowdhury 2001). With an abundance of water resources, native and exotic cultivable species in Bangladesh have great potential for aquaculture.

In the past, open inland water bodies contributed more than 80% of the country's fish production, but over the last four decades this production has declined significantly. This decline has had significant negative impacts on fish biodiversity and the fishing community. Natural inland fish stocks have declined significantly and biodiversity has been seriously negatively affected due to overfishing, including the use of harmful fishing gear and fishing systems; degradation and loss of fish habitats; obstruction of fish migration routes by construction of embankments and water-control structures to increase agriculture production; and siltation of water bodies and water pollution from industrial and agricultural sources (Ali 1997). Poor fishers' livelihoods have been adversely affected. According to a study by the International Union for Conservation of Nature, some 42 fish species are endangered and another 12 species are critically endangered (IUCN 2000).

The dry season is a critical time for fish species. Water levels in the rivers, canals, and *beels* (seasonally isolated ponds) drop dramatically, leaving fewer places of refuge for the fishes and making them increasingly vulnerable to intensive and harmful overfishing. As a result, fish stocks, particularly the brood stock, have been depleted to such levels that they cannot sustain the fisheries. Both production and catch levels have gradually declined. Therefore, a major issue for sustainability is how to protect sufficient brood stock to maintain the population at sustainable levels.

Among the measures implemented to reduce stress on inland fisheries, fish sanctuaries have been found to be effective for the protection of broods, while other management measures are difficult to implement in the face of current administrative and social contexts (Ali *et al.* 2009). With this in mind, the Bangladesh Department of Fisheries (DoF) has established fish sanctuaries since the 1960s, but especially in the past decade, and the government is planning for more fish sanctuaries in the future. To date, over 400 fish sanctuaries have been established in the inland open waters of the country through different development projects and programs of the DoF and other agencies. This paper seeks to test the hypothesis that fish sanctuaries protect and restore fish biodiversity. I will attempt to determine the effect of the Baikka Beel Fish Sanctuary on the adjacent beels in terms of biodiversity. This information will help researchers, policy makers, and NGO workers in their efforts to ensure fishing sustainability. The specific objectives of this research are to:

1. Assess the biological impact of the fish sanctuary established in Baikka Beel by examining fish biodiversity in beels adjacent to and removed from the protected area;
2. Discover the current fishing practices in these adjacent sites and their implications for the sustainable management of the Baikka Beel fisheries;
3. Gauge perceptions among local community members about the effectiveness of the Baikka Beel Sanctuary; and
4. Assess the benefits that local fishers derive from the sanctuary.

Background

Hail Haor is a large wetland in Sreemongol Upazila, Moulvibazar District, in northeastern Bangladesh. This haor covers an area of about 14,000 hectares in the wet season, but in the dry season it shrinks to become about 130 beels and narrow canals covering a total area of less than 400 hectares. More than 172,000 people in 30,000 households live in 60 villages surrounding the haor. Over 80 percent of those households are involved in fishing in the haor, many as regular professionals (Chakraborty *et al.* 2005).

The natural productivity and biodiversity of the haor has been declining due to both natural factors and man-made inputs. Due to the pressure from human practices such as fishing by draining ponds during the dry season, pesticides application, irrigation, harmful fishing gear use, and other practices, fish production and biodiversity in this area have declined. Furthermore, there was a natural channel between the Monu River and Hail Haor, but this channel was closed about 25 years ago by the construction of a dam. The lack of migration channels may also be a cause of declining fish stocks and biodiversity at this site. Baikka Beel is a part of Hail Haor. It currently supports about 90 species of fish and is also important as a bird sanctuary. During the winter season, hundreds of bird species come here every year and tourists from home and abroad visit this place for its natural beauty and biological diversity.

Baikka Beel Sanctuary was designed to conserve and restore fish. About 100 hectares was set aside by the government as a sanctuary in 2003. This site was managed through a project funded by the United States Agency for International Development (USAID) called Management of Aquatic Ecosystem through Community Husbandry (MACH), which was implemented by a consortium of NGOs including Winrock International, the Centre for Natural Resources Studies (CNRS), Caritas, and the Bangladesh Centre for Advanced Studies (BCAS). After the MACH project ended in 2008, the sanctuary continued to operate and now has links with a successor USAID-funded initiative called the Integrated Protected Area Co-management (IPAC) Project. IPAC provides support to a wide range of protected areas in Bangladesh, including the Hail Haor wetland of which Baikka Beel is a part.

Local communities are actively involved in the management and protection of the 100-hectare sanctuary of Baikka Beel within the greater Hail Haor in Sreemongol District. They protect this sanctuary from other communities and outsiders who are allowed to fish and collect aquatic plants in other water bodies in the haor. Previously, the local government leased out Baikka Beel for fishing. As a sanctuary, it is now protected by the local community through the Baragangina Resource Management Organization (RMO). They follow a management plan that was prepared through consultation with local communities and is approved by a committee comprised of local officials, *union parishad* (local government) chairs, and leaders of community organizations. The beel is a rare example of a successful community-managed wetland sanctuary in Bangladesh.

Study Area

Both Balla Beel and Sixty Two Beel are located within Hail Haor (Figure 1). They are situated about five kilometers west and two kilometers southeast of Baikka Beel, respectively. The villages of Monargaon and West Varaora are located in Kalapur and Sreemongol Unions. Monargaon is about five kilometers northwest and West Varaora is about two kilometers northwest from the Sreemongol Upazila headquarters. The villages are close to Baikka Beel as well as to Hail Haor. Baikka Beel is famous as a healthy fish breeding and spawning ground. Due to their proximity to the haor, most of the villagers of these two villages are engaged in fishing either full-time or as a part-time professional occupation. Traditionally, people from both villages catch fish from the haor and sell them to the local community or the nearby fish market; or, if they have sufficient volume, they sell them in the wholesale market in the upazila headquarters.

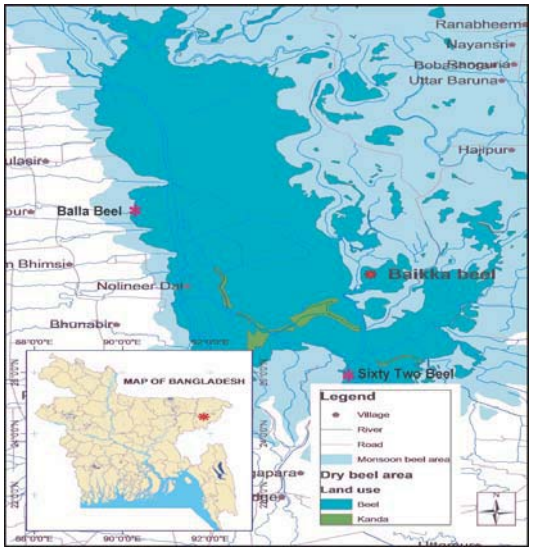

Figure 1: Map of Hail Haor showing the study area (Source: IPAC)

Methodology

Both qualitative and quantitative data were collected for this study using semi-structured questionnaires, focus group discussions, personal observations, and fish-catch monitoring. Prior to selecting the study sites, I visited the area and selected the two villages and the two beels to be representative. This initial visit offered me a better understanding of local livelihoods, socio-economic conditions, and fishing activities. Based on the information I gathered from the site visit, I designed my questionnaire to collect both qualitative and quantitative data. I visited the study area for data collection each month from August to December 2011.

I chose these two beels because of their distance from Baikka Beel. Sixty Two Beel is adjacent to the Baikka Beel Fish Sanctuary, and Balla Beel is a short distance from it. The inhabitants of both villages are heavily dependent on these beels for fishing. I also selected these two villages because most villagers are fishers, providing a broad population from which a selection of respondents would be representative.

To determine biodiversity, I collected data from the fishermen engaged in fishing in those beels. Non-selective gear was used to collect the species composition of fish in those areas one time each month. I also visited the nearby fish markets of Baruna Ghaterbazar, Hajipur Ghaterbazar, and Bhairabgonj in order to learn more about the fish species that are collected from the study area and also the nearby area. I collected secondary data from various sources, including MACH project documents, reports, and other publications, to identify and better understand the impacts of fish sanctuaries on fish biodiversity, and the current management practices of the sanctuary. During each monthly visit, I also interviewed individual fishers to collect data about the type of fishing gear used, gear efficiency, dominant species caught, and the number of endangered species that have been revived.

There is a list of fishers in each village in the Upazila Fisheries Office. From this list, I selected those fishermen who had been engaged in fishing for several years, because they could provide historical information about fish biodiversity at the sites. As those normally engaged in fishing in this region are male, my target group for data collection was also male. To conduct the socio-economic survey of the villagers, I used a pre-tested, semi-structured questionnaire. This questionnaire included information about the following variables: age, sex, occupation, daily income, hygiene and sanitation, fish marketing channels, and attitudes towards the sanctuary.

I also conducted two focus group discussions (FGD), one in each village, to collect data about the current management practices of the sanctuary, implementation of the Fish Act, attitudes towards the sanctuary, perceived benefits from the sanctuary, current problems facing the sanctuary, and possible recommendations for enhancing its management.

All numerical data were tabulated into a spreadsheet and analyzed with Microsoft Excel. Qualitative information collected through FGDs and questionnaire surveys from the respondents was also analyzed in tabular format.

Results and Discussion

Current Management Practices of the Sanctuary

Baikka Beel Fish Sanctuary is managed by members of the Baragangina RMO. The Baragangina RMO is comprised of several members from 45 villages. There are multiple members including representatives of fishers, farmers, women, and local leaders. They follow a management plan that was prepared through consultation with local people and approved by a committee comprised of local officials, the union parishad chairman, and leaders of the community organizations. Members of this organization are also involved in managing different parts of Hail Haor.

There is also an observation tower in the sanctuary area of Baikka Beel. Baragangina RMO recruited two men to guard the sanctuary full time, in order to prevent fish poaching by some dishonest fishers in the sanctuary area. The guards only receive 4,500 BDT per month each as remuneration. In the wet season the area becomes much larger so they recruit an additional four men as guards. All these expenses are borne by the Baragangina RMO.

According to Ali *et al.* (2009), evidence from 12 case studies of fish sanctuaries in Bangladesh shows that management practices have deteriorated in eight cases due to weak capacity and conflicts in community organizations and a lack of government support; that practices have improved in two cases; and that they have remained the same in two cases. A comparison of the monitoring of biological and socio-economic parameters in one sanctuary site and a control site reveal better production and biodiversity performance in the sanctuary site. In the case of Baikka Beel Fish Sanctuary, I found that there is strong management by the local community and also that support from the local administration has yielded good results. Such factors could explain why practices have improved in some fish sanctuaries, but not in others.

Impact of Baikka Beel Fish Sanctuary on Biodiversity

To assess the impact of the fish sanctuary on biodiversity, I looked at the total number of fish species found, the presence and trend of each species in the two beels, the catch composition, and the extent of revival of previously threatened species.

Biodiversity based on catch monitoring data. During the study period, 31 species of fish were recorded in Balla Beel and 24 species were recorded in Sixty Two Beel. The

maximum number of species in both wetlands (27 and 24, respectively, as determined using different types of fishing gear) was found during the month of August. The number of species found during each month of my research in both of the wetlands is shown in Figure 2. According to MACH (2003), the number of fish species found during the baseline period was 71. Combining all six "impact years" defined by MACH (2001–2006), a total of 85 species have been recorded in Hail Haor. This number is for the whole haor, but the current study is only for two beels in the Hail Haor. In addition, the study period was only six months, and data collection was not so intensive, so the numbers of fish species differ from those found in the MACH study.

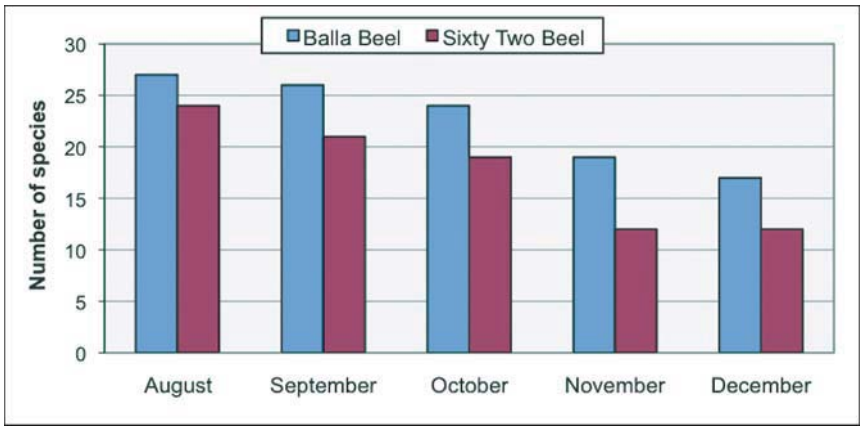

Figure 2: Number of species recorded from catch monitoring by month at two study sites (August–December 2011)

The above data show that in both beels the maximum number of species was found in the month of August, and that for each month it was lower in Sixty Two Beel than in Balla Beel. Normally the rainy season begins in Bangladesh in June or July and this is the peak breeding time for most fish species. In the wet season, all the beels in the Hail Haor area become part of a single water body. Thus, there is a close biological link between the sanctuary and the two beels in my study site. The decline of biodiversity over time may be related to the seasonal connectivity of the sanctuary with these beels. In the wet season, species diversity is generally high in the surrounding beels due to connectivity with the sanctuary; but in the dry season, the beels become separated from the sanctuary and species diversity in any one of them is lower.

In the winter season, the water level of the beels decreases and fishing intensifies in these smaller areas. The gradual decrease of fish species may be related to this. On the other hand, Balla Beel is currently managed by Baragangina RMO, and the associated restrictions and bans on the use of destructive types of fishing gear, as well as a more effective management system, may have contributed to a higher species

diversity in comparison with Sixty Two Beel. Sixty Two Beel is not under the management of an RMO and it is subject to a commercial leasing system. Leases are only valid for a limited time period, so leaseholders try to maximize profits by catching all the fish they can within this period. As a result, none of the legal restrictions, such as those of the Fish Act, are enforced in Sixty Two Beel.

Fish species found in Balla Beel and Sixty Two Beel. I identified a number of fish species from Balla Beel and Sixty Two Beel through catch monitoring data and discussions with fishers engaged in fishing in the two beels. During the study period, a total of 31 species were identified in Balla Beel and 24 species were identified in Sixty Two Beel. A list of these fish species is given in Table 1, along with the associated trend in proportion of catch in Hail Haor from the study by Thompson *et al.* (2007).

Table 1: Fish species found in Balla Beel and Sixty Two Beel during the study period

Sl No	Local Name	Scientific Name	Found in Balla Beel	Found in Sixty Two Beel	Trend in proportion in Hail Haor*
1	Ayre	*Aorichthys aor*	√	√	Decline
2	Baila	*Glossogobius giuris*	√	√	Increase
3	Bacha	*Eutropiichthys vacha*	√		-
4	Bighead	*Aristichthys nobilis*	√	√	-
5	Boal	*Wallago attu*	√	√	Decline
6	Bujuri tengra	*Mystus tengra*	√	√	Decline
7	Catla	*Catla catla*	√		Increase
8	Chapila	*Gudusia chapra*	√	√	-
9	Chital	*Chitala chitala*	√		-
10	Common carp	*Cyprinus carpio*	√	√	-
11	Darkina	*Esomus danricus*	√	√	Stable
12	Foli	*Notopterus notopterus*	√	√	Increase
13	Gazar	*Channa marulius*	√	√	-
14	Gonia	*Labeo gonius*	√	√	Increase
15	Golsa	*Mystus bleekeri*	√	√	Decline
16	Grass carp	*Ctenopharyngodon idella*	√	√	-
17	Gutum	*Lapedocephalus guntea*	√		-
18	Kakila	*Xenentodon cancila*	√	√	Increase
19	Kalibaush	*Labeo calbasu*	√		-
20	Kani pabda	*Ompok bimaculatus*	√		Increase
21	Koi	*Anabas testudineus*	√	√	Decline
22	Kholsa	*Colisa fasciata*	√	√	Decline
23	Lamba chanda	*Chanda nama*	√	√	-
24	Magur	*Clarias batrachus*	√	√	-
25	Mola	*Amblypharyngodon mola*	√	√	Increase
26	Ranga chanda	*Parambassis lala*	√		-
27	Sarputi	*Puntius sarana*	√	√	-
28	Shol	*Channa striatus*	√	√	Increase
29	Taki	*Channa punctatus*	√	√	-
30	Tit puti	*Puntius ticto*	√	√	Increase
31	Veda	*Nandus nandus*	√	√	-

*Source: Thompson *et al*. 2007. Note: Dash (-) means data is unavailable.

From the proportion trend of different fish species (Thompson *et al.* 2007), it appears that some species are declining in Hail Haor. However, in my study, most of the declining species were available in both of the beels. This may be partially due to the establishment of the Baikka Beel Sanctuary.

C***atch composition based on catch monitoring data.*** I have ranked the top 10 species according to their overall contribution to the total catch. In Balla Beel, common species caught by various types of gear (and their percentage of the total catch) were boal (W*allago attu,* 8.9%), taki (C*hanna punctatus,* 7.2%), shol (C*hanna striatus,* 6.5%), foli (N*otopterus notopterus,* 6.3%) and common carp (C*yprinus carpio,* 5.8%). This analysis reveals that 10 main species contributed 58.7% of the total catch by weight. Figure 3 shows the percentages of total catch for each of these 10 main species. In Balla Beel, W*allago attu* (boal) *i*s the species with the highest contribution to total catch in Balla Beel.

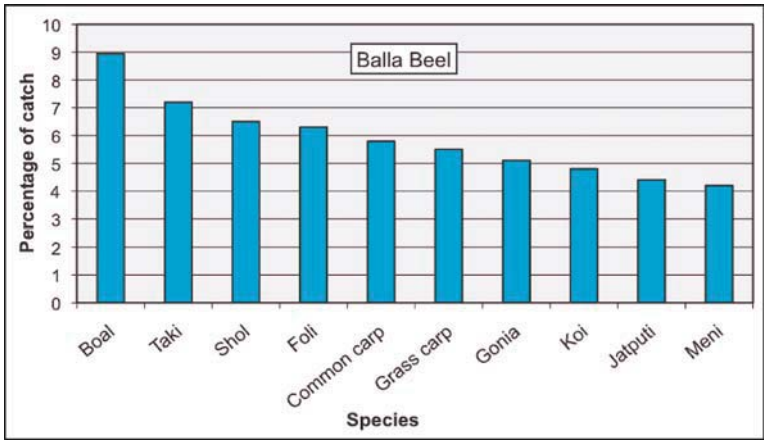

Figure 3: Percentage contribution to total catch of the 10 main species in Balla Beel

In the case of Sixty Two Beel, the most common species caught by various types of gear were boal (W*allago attu,* 8.40%), grass carp (C*tenopharyngodon idella,* 7.90%), gonia (L*abeo gonius,* 7.10%), foli (N*otopterus notopterus,* 6.45%), and shol (C*hanna striatus,* 6.12%). My analysis reveals that the 10 main species contributed 60.02% of the total catch by weight. The percentage contribution of the 10 main species to the total catch in Sixty Two Beel is shown in Figure 4. W*allago attu (*boal) is the species with the highest contribution to the total catch in Sixty Two Beel as well .

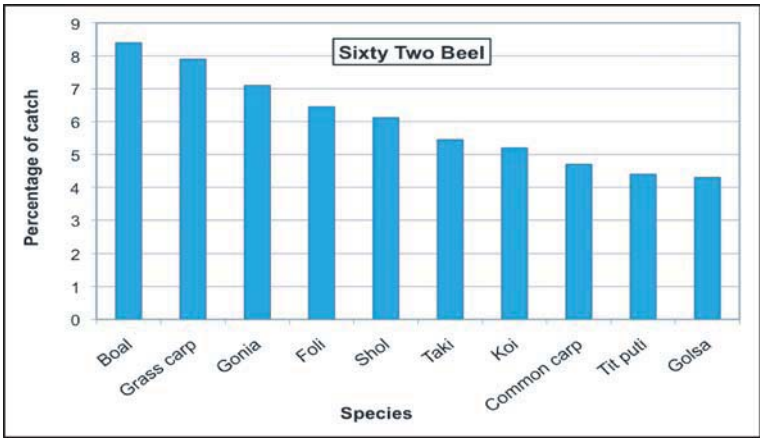

Figure 4: Percentage contribution to total catch of the 10 main species in Sixty Two Beel

From these results we see that the dominant species of the beels adjacent to Baikka Beel in Hail Haor is boal (W*allago attu)*. Some other exotic species like grass carp (C*tenopharyngodon idella) a*nd common carp (C*yprinus carpio)* are also common in both wetlands. This suggests the increasing trend towards the stocking of exotic species around the Baikka Beel. Although these species compete with native species for food and habitat, they are not directly harmful in terms of predation on native species or domination of total fish production. These results suggest that the Baikka Beel Fish Sanctuary helps to protect not only native species, but also some exotic species.

Species revived after establishment of the sanctuary. According to the catch monitoring data and interviews with community members, I found five species of fish that had been revived and are commonly caught now in the study area. These species were rare in that area before, but they are now more widely available due to the establishment of the sanctuary and to the managed reintroduction of some species. A list of these revived species is shown in Table 2.

Table 2: Fish species revived and their status after sanctuary establishmente

Local name	Scientific name	IUCN (2000) status	Current status in the sites*
Kani pabda	*Ompok bimaculatus*	Endangered	Common
Sarputi	*Puntius sarana*	Critically endangered	Common
Meni/Veda	*Nandus nandus*	Vulnerable	Abundant
Gonia	*Labeo gonius*	Endangered	Abundant
Chital	*Chitala chitala*	Endangered	Common

*Note: Assessment based on local fishers' perceptions

These revivals are due to the re-introduction of some species in the sanctuary area and to the creation of a suitable environment for breeding of these species by providing shelter, restoring habitat, guarding them from theft, and facilitating their movement. Because of the high connectivity among the beels during the monsoon season, the presence of these species in Balla Beel and Sixty Two Beel can be used as a proxy for their availability in the Baikka Beel Sanctuary.

Current Fishing Practices and Implications for Biodiversity

Major gear used in the beels. Various types of fishing gear are used in Balla Beel and Sixty Two Beel, as well as in Hail Haor. The type of gear used differs according to the target species, type of water body, labor intensity, cost, materials available, and profit. Cast nets, spears, lift nets, and gill nets are operated both day and night. However, the trap units are used only at night, while push nets and seine nets are used only during the daytime. Furthermore, the use of spears and lift nets is seasonal, limited to the wet season. A list of the most common gear used in the two beels is included in Table 3.

Table 3: Name, use, and impact of common gear types used in the study area

Name of gear	Local Bengali name	Main use of the gear types	Impact on biodiversity
Gill net	Pata jal, Fash jal, Current jal	Mono-filament gill net (current jal); the most effective for catching small fish More fish are caught by seine nets than	High: The most commonly used and most destructive for fish biodiversity
Seine net	Ber jal, Jagat ber jal, Katha ber jal	any other basic method. Can have large, medium or very small mesh. Operated from water bank	Medium/High: Impact depends on mesh size; small-mesh seine net (chat jal) is much more destructive than small-mesh gill nets
Lift net	Dharma jal/Veshal jal	Common and primitive nets used all	Medium: Use of this gear during post breeding season is destructive for biodiversity
Cast net	Khepla jal, Toira jal, Jhaki jal	over the country, operated by a single person on the bank, in shallow water, or from a boat in open areas Small net mounted on a triangular	Low: Generally not harmful for fish biodiversity
Push net	Thela jal	bamboo frame. Used in late monsoon and dry seasons. Generally set in the water in the	Medium: Harmful during post breeding season
Trap	Kholsun, Polo, Charai, Fala, Bair	evening and carefully pulled up during early morning Spears are used during early and late	Medium: Harmful during post breeding season
Spear	Achra, Koch, Teta	monsoon periods In dry season, fish are often caught	Low: Not harmful
Others	Bana, Katha, Kua, by Hand	with these traditional gear types.	Low: Not harmful

Gear efficiency. Use of different fishing gear and traps can also serve as a rough indicator of the availability of different fish species. Some gear is species-selective such as gill nets, traps, hook and lines, and long lines. After assessing the efficiency of each gear type, I observed that gill nets resulted in the highest catch during the study period in both Balla Beel (29%) and Sixty Two Beel (36%), while fish traps produced the second highest catch in both Balla Beel (23%) and Sixty Two Beel

(28%). The proportion of catch using different types of fishing gear and traps in the two beels is presented in Figure 5.

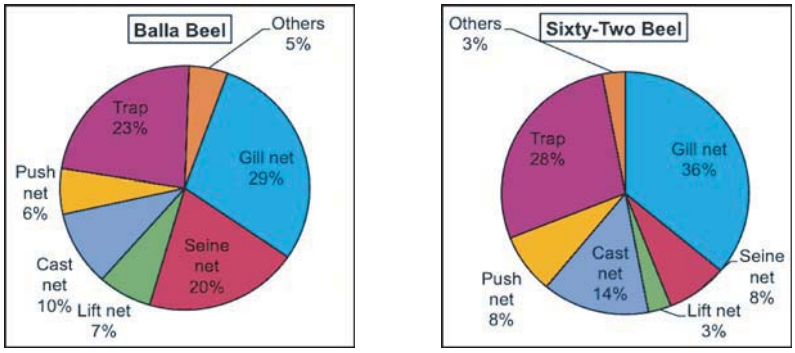

Figure 5: Proportion of catch by different gear types in Balla Beel and Sixty Two Beel

Gill nets are mainly used in open water bodies, including those of Balla Beel and Sixty Two Beel, because they are cheaper and require less effort to operate. Due to these characteristics, they can harvest many fish, especially small ones, which makes small-meshed gill nets especially harmful for fish biodiversity. The use of various types of gill nets and traps in the breeding season is excessive in both beels and is very harmful for both fish fry and small indigenous species. Therefore, it should be a matter of concern to the local administrative authorities. In order to address this issue, the use of different types of fishing gear (such as small-meshed gill nets and small-meshed seine nets) must be restricted during the breeding season.

Local Community Perceptions towards the Effectiveness of the Fish Sanctuary

I asked the respondents in each village about the sanctuary by using a questionnaire to gather information about community perceptions towards the sanctuary. Out of the 40 respondents, none had a negative perception of the sanctuary, but the level of positivity varied. Nineteen respondents (47.5%) indicated that this sanctuary is very effective in regards to increasing fish biodiversity. Fourteen respondents (35%) responded that it is "effective in regards to increasing fish catch," and only seven (17.5%) responded that the sanctuary was effective in regards to both increasing fish catch and improving fish biodiversity. No one responded that the sanctuary was "not effective" in achieving these outcomes. The responses of the local community towards the sanctuary are summarized in Table 4.

Table 4: Perceptions of local community towards effectiveness of Baikka Beel Sanctuary

Perceptions	Number of respondents
Baikka Beel Fish Sanctuary is very effective in regards to increasing fish biodiversity.	19 (47.5%)
Baikka Beel Fish Sanctuary is very effective in regards to increasing fish catch.	14 (35%)
Baikka Beel Fish Sanctuary is effective in regards to both increasing fish catch and improving fish biodiversity.	7 (17.5%)
Baikka Beel Fish Sanctuary is not effective in achieving any of these outcomes.	0 (0%)

Note: Due to multiple responses, totals equal more than 100 percent.

Direct and Indirect Benefits to Local Fishers from Baikka Beel Fish Sanctuary

To assess the positive effects local fishers receive from the sanctuary, I asked all 40 respondents about both direct and indirect benefits. Thirty respondents (75%) believe that their fish catch has increased due to the establishment of the fish sanctuary; and 26 respondents (65%) reported that they have benefited from a better food supply. Views on the specific direct and indirect benefits, and the number of fishers who reported receiving them, are shown in Table 5.

Table 5: Perceived direct and indirect benefits from the Baikka Beel sanctuary

Direct benefits	Number of respondents	Indirect benefits	Number of respondents
Increased fish catch	30 (75%)	Improved housing facilities	20 (50%)
Income increased	12 (30%)	More food available	26 (65%)
Increased fish intake	24 (60%)	Improved sanitation facilities	16 (40%)
Employment opportunities	8 (20%)	Better health facilities	22 (55%)
Saved money	12 (30%)	Improved education facilities	23 (57.5%)

Note: Due to multiple responses, totals equal more than 100 percent.

According to MACH (2003), the overall fish consumption increased significantly in all sites including the Hail Haor. Major findings indicate that small-beel and wetland resident fish and prawns constitute the main fish consumed for all households, and particularly among poorer households.

Problems and Recommendations Regarding Baikka Beel Fish Sanctuary

As fish become more abundant in a sanctuary it becomes more attractive for poaching; this is a major problem for the Baikka Beel Fish Sanctuary. By setting a gill net (current jal), one can catch a lot of fish easily. Using brush piles or other

structures in the sanctuary to deter such practices by creating obstacles helps to reduce this risk, but negligence or dishonesty by guards is a big risk. Another potential problem is that naturally occurring extreme drought or the pumping of water out of the sanctuary for agriculture can reduce the water depth and area of the beel, resulting in heavy natural mortality and degradation of water quality, and increasing the likelihood of fish disease outbreaks.

The most important part of a sanctuary is its management, especially protection against poaching. Community participation and co-management approaches have, in many cases, proven to be more effective than traditional approaches, with higher compliance with rules, provided that the community is properly organized and motivated. Precautionary measures have to be taken to protect major species and to maintain the sustainability of the resources.

The use of seine and gill nets (mono-filament) needs to be reduced during the peak breeding season. And also the high dependence on fishing of the local community must be reduced. There is a need to establish more sanctuaries in the Hail Haor area that are effectively managed by the local community, like Baikka Beel Sanctuary. Some additional sanctuaries were established in the Hail Haor area based on the fisher community's interests, but they are not well managed yet.

Siltation is another issue. It results in a raised bottom of the beel and therefore the overall water level of the sanctuary drops. Fish movements are more visible due to this low water level. This can contribute to poaching in the sanctuary area. Excavation of the sanctuary site is the best remedy for this problem. Leasing of the beels for commercial harvesting adjacent to Baikka Beel is another problem that must be addressed. The Ministry of Land through the Deputy Commissioner and the Upazila Nirbahi Officer has taken steps to lease out some of the beels adjacent to Baikka Beel, which could have an effect on Baikka Beel itself. Those who take a lease from the government have no incentive to take any steps to safeguard the ecological integrity or biodiversity of the beels. As a result, the biodiversity of the area may decrease in the future. To solve this problem, the best approach would be to cancel these leases.

Conclusion

From the data collected from the adjacent beels, and also from the perceptions of local people dependent on the beels, it is clear that the Baikka Beel Fish Sanctuary is quite effective in terms of promoting the restoration of fish biodiversity and fish production. It also indirectly affects the livelihoods of the surrounding communities. The management practices in this sanctuary are based on a community approach. This approach can be replicated in other parts of the country. This study also identified some issues that need to be addressed.

Future management and development plans for the Baikka Beel Fish Sanctuary should be geared towards improving fish diversity, conservation, and restoration. The fishing communities adjacent to the beels are an important component of this management. There are several fisher groups in the Baikka Beel area that have traditionally been engaged in fishing as their full-time occupation. This study is encouraging because it suggests that the overall fish biodiversity in Balla Beel and Sixty Two Beel is increasing, perhaps as a result of the establishment of the Baikka Beel Fish Sanctuary, which has been supported by the Government of Bangladesh, the MACH program, other NGOs, the upazila administration, local government, and the community members themselves.

Thus, careful planning, required management and regulatory practices, and active community participation in management can have a positive impact on fish biodiversity. However, more long-term, participatory research is needed to gain greater insights into fish biodiversity trends in the Baikka Beel Fish Sanctuary and its effect on adjacent beels. This type of research is very important for biodiversity conservation and natural resources management. It is needed both for better planning and for raising awareness among policymakers, government agencies, NGOs, and local community members.

Ali, M.L., Hossain, M.A.R., and Ahmed, M. 2009. Impact of Sanctuary on Fish Production and Biodiversity in Bangladesh. Bangladesh Fisheries Research Forum: Dhaka.

Ali, M.Y. (1997). *Fish, Water and People*. University Press: Dhaka.

Chakraborty, T.R., Adrika, A., and Hussain, M.B. 2005. Fish and Wildlife of the Chanda Beel Area. IUCN-Bangladesh: Dhaka.

Chowdhury, S.N. 2001. Brief on Development of Fisheries, Bangladesh. Department of Fisheries, Ministry of Fisheries and Livestock, Government of Bangladesh: Dhaka.

DoF (Department of Fisheries). 2011. Fish Week Compendium. DoF, Ministry of Fisheries and Livestock, Government of Bangladesh: Dhaka.

IUCN (International Union for Conservation of Nature). 2000. *Red Book of Threatened Fishes of Bangladesh.* The World Conservation Union: Dhaka.

Jenkins, M. (2003). Prospects for Biodiversity. *Science* 302(5648): 1175–1177.

MACH (Management of Aquatic Ecosystems through Community Husbandry). 2003. Fish Catch & Consumption Survey Report, Vol. 3. Winrock International: Dhaka.

Thompson, P., Das, A.K., Deppert, D.L., and Choudhury, S.N. 2007. Changes in Biodiversity with Wetland Restoration and Fish Reintroduction. MACH Technical Paper 5. Winrock International: Dhaka.