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Fish Biodiversity of Chapai Beel in Faridpur, Bangladesh: Present Status, Threats Identification and Recommendations for Conservation through Sustainable Management

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Abstract

The present study was undertaken on Chapai beel in Faridpur Sadar Upazila, Bangladesh to determine the fish biodiversity and to find out the problem related to fisheries biodiversity and also will make an important contribution to the development of an appropriate beel fisheries management policy in order to conserve fisheries biodiversity. A field investigation was conducted on the existing status of fishery for a period of 1 year from January to December 2020. The Chapai beel is semi-closed and has an arc-shaped water body of 84.86 ha spreading over the seven villages with covering the two unions and two Upazilas of Faridpur district. A total of 47 species (including 6 exotic species) were identified during the study. Of the 47 species, 41 were indigenous species belonging to 17 fish families, 12 different common groups and 32 fish genera; of which 25 were SIS and the remaining 16 were large fish. Cyprinidae constitutes highest number of fish population representing 15 species and shares the highest percentage (37%) among the recorded family. Barbs & Minnows was found to be the biggest group (22%) among the recorded 12 common groups. From the Chapai Beel 6 fish species were recorded as threatened which is 9% of total threatened fishes of Bangladesh. Within 41 species, 36.58% fish species were ranked as abundant followed by moderate (24.40%), low (19.51%), and rare (19.51%). The present study suggests that prudent planning, management and regulatory practices, as well as active community engagement, can positively impact fish biodiversity.

Keywords: Beel fishery; Fish biodiversity; Conservation; Sustainable management; and Chapai beel

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Introduction

Bangladesh prides itself on being very rich in fish diversity. Its numerous and diverse inland water bodies- Beels (floodplain depressions and lakes), ponds, rivers, canals, ditches, and paddy fields are home to over 267 freshwater fish species [1]. The total area of Beel in Bangladesh is estimated to be 114161 ha covering about 27% of the inland freshwater resources [2]. Among 265 freshwater fishes [3]. 143 species are considered small indigenous species (SIS) in Bangladesh. All of these species were found availably in Beel water bodies a few years back whereas, 64 of them are now threatened, 9 are critically endangered, 30 are endangered, and 25 are vulnerable [4]. Beel fishery of Bangladesh is declining day by day due to overfishing, indiscriminate use of chemical fertilizers and insecticides, destruction of natural breeding and feeding grounds, harvesting of wild brood fishes, and many other causes [5]. Therefore, the present study aimed to discover the fish biodiversity status in the Chapai Beel; which is one of the largest and most important Beel in the Faridpur district of Bangladesh.

Research Methodology

Study period

The study period was conducted for a period of 1 year from January, 2020 to December 2020.

Data Collection and Research Framework

A semi-structured questionnaire was used for data collection. Additionally, the following methods were used:

Direct Observation

The status of Chapai Beel, as well as species diversity, was assessed through personal field observation.

- Morphometric and hydrographic details of Chapai Beel
- Hydrological condition of the Chapai Beel

Fish Specimen Identification

Firstly, fish specimens were collected from the market and fisherman's catch. Then, Images of different fish specimens were taken by a digital camera. Finally, collected fish samples were identified by analyzing their morphometric and meristic characteristic [6]. By checking the Catalogue of Fishes [7] valid scientific names of the identified species were ensured. Fishes were grouped into four categories based on their abundance viz., abundant, moderate, low and rare.

Fish Biodiversity of Chapai Beel

Availability of fish species were determined based on their abundance through direct sampling from fishermen catch and fish bazar, interviewing of fishermen, fish retailers and fish traders following the questionnaire pattern.

Determination of Conservation Status (IUCN Conservation Status-BD)

Conservation status was also determined by following the database of IUCN Bangladeshc [8].

Perceptions of community (FGD) on fish Biodiversity

FGD was conducted in fish bazar (Chungirmor and Kanaipur Bazar) and fishers' village adjacent to the studied beel.

Key Informant Interviews

Key informants such as oldest and experienced persons related to fisheries sectors adjacent to studied beel (fishermen, venerable local community leaders, fish retailers, fish traders etc.) local DoF (Department of Fisheries) and NGO personnel were interviewed face to face.

Overall Threat Identification of Chapai Beel

Threats on biodiversity and its conservation were collected through the survey on the fishermen and local community leaders, fish retailers, fish traders, local DoF & NGO personnel and available literature.

Data Processing and Analysis

Descriptive analysis and graphical presentation of data were carried out using Microsoft Excel [9].

Source

Hydrological boundary and unit water body demarcation were completed in the 2012-13 period under the feasibility study of the Southwest Area Integrated Water Resources Planning and Management Project, implemented by the Bangladesh Water Development Board (**Figure 1**).

Result

Direct observation

Morphometric and Hydrographic details of Chapai Beel

Chapai beel is located about 12 km away from Faridpur town and is rich in biodiversity. As per the hydrological survey of the beel area (**Figure 1**), the Chapai beel is connected to the Kumar river which in turn is connected to the Padma river through two major canals, Bashtola canal (6.103 KM) on the northwest, and Kuchiamara-1 canal (5.9 KM) on the southeast. The demarcated area for the beel 84.86 ha spreading over the seven villages with covering the two unions and two Upazilas of Faridpur district. It is semi-closed and has an arc-shaped water body. There are two adjacent beel nearby (Horai Beel-40.8867 Ha & Kalkander Beel-40.4323 Ha). Kalkander Beel lost its' natural water retention capacity and is mostly encroached by the land grabbers. Horai Beel still has year-round water in places to retain the biodiversity but encroached partially as well. Though these three beels are consistently being different but they are connected through small canals among them, from Chapai to Horai to Kalkander beel. During the monsoon, the Chapai Beel is merged with the other two and spread out to several hundred hectares and turns out to be a vast inland water body under the Faridpur district. This study was conducted in this hydrological boundary considering a major source of diversity is from Chapai beel. As the Chapai beel is large, the water depth varies in different areas and fluctuates in different months ranges from 4 to 15 ft. The highest water depth was recorded in August. In the dry season, most of the beel is drained naturally, and with the support of the water retention and drainage structure, two vent regulators by Bangladesh Agriculture Development Corporation (BADC) in Bashtola canal (Inactive now), and by Joyjhap six vent regulator by Bangladesh Water Development Board (BWDB). The current flood control and drainage facilitate by the Joyjhap six vent regulator for the hydrological unit. The most depressing part of the beel retains water throughout the year and supports biodiversity retention. The fish catch was different with different habitats over the year. Some variation may have related to the fish migration facilities, flooding & inundation regime, type of habitats, and its linkages. The peak catches were observed in October and November each year when water is receding. The decline of biodiversity in different catch may be related to the seasonal fluctuation of water depth in the beel. In the rainy season, species diversity is generally high through the beel because of frequent movement

of fishes. In the winter season, the water level of the beel decreases and fishes enter into the deepest part of the beel. The gradual decrease of fish species in catch composition may be related to this phenomenon. Due to structural development in beel surrounding area, a lot of real fishermen living around the Chapai beel who are directly reliant on beel fisheries for their subsistence are shifting to other trades nowadays.

Hydrological Condition of the Chapai beel

With over half of the country comprised of floodplains, in the past, agriculture and capture fisheries complemented one another in a natural cycle of wet and dry season and monsoon rains. During the dry season (approx. May-December), most of the land was cultivated and fish were restricted to Beels, rivers and canals. In the monsoon and post-monsoon periods (June-November), the floodplains were inundated and cultivation of deep water rice was practiced. This vast area provided an ideal habitat for the many freshwater fish species and people had access to fish (Payne and Temple, 1996).

The hydrological condition of the beel strongly influences the beel fisheries. Early flooding is particularly important for fisheries as it stimulates the early spawning of many floodplain resident species of fish. In addition, seasonal changes are very important for the biology and life cycle of fish residing in floodplains [10]. Various authors categorized the hydrological conditions of the Beels into different parameters (**Table 1**).

Fish Specimen Identification

A total of 47 species (including 6 exotic species) were identified during the study. Of the 47 species, 41 were indigenous species, of which 25 were SIS (which grow to a size of 25 cm or 9 inches at mature or adult stage in their life cycle) [11] and the remaining 16 were large fish (**Table 3**).

Fish biodiversity

From the collected information as per the questionnaire through different methods (described in the data collection framework) conducted in the field, the present status and the loss of fish biodiversity of Chapai Beel has been identified and analyzed accordingly. In conducting the analysis, only indigenous species that currently exist in the studied beel are taken into consideration. Exotic species are excluded from the analysis and presented separately (**Table 4**). A total of 41 indigenous fish species were recorded during the study period under 17 fish families belonging to 12 different common groups and 32 fish genera and are listed together with details of their present abundance status and local IUCN conservation status as well (**Table 2**).

LC- Least Concern, NT- Near Threatened, EN- Endangered, VU- Vulnerable

Species Availability Compared to National Study

The identified fish species (41) of the Chapai Beel is 13 % of the total fresh water fish species (265) recorded by Rahman, 2005 (**Figure 2**).

Family Diversity in the Study Area

According to the pie chart it is clear that among 41 species, Cyprinidae found to be the richest family represented the maximum 15 fish species (37%) followed by two families (Anabantidae and Channidae) represented 4 species (10%) each and the

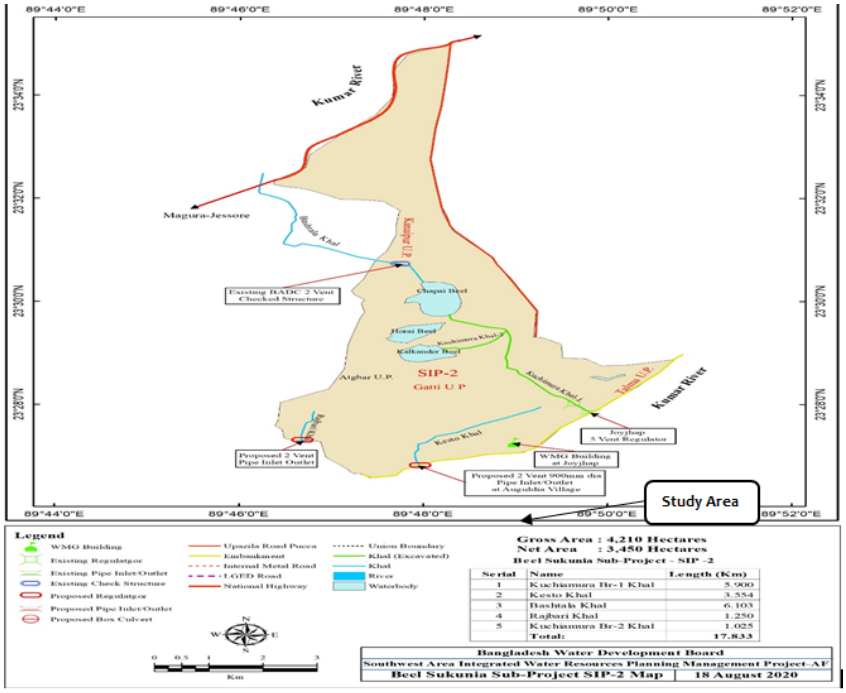

Figure 1 Map showing the study area.

Table 1. Hydrological condition of the river-floodplain-Beel.

Parameters	Aspects
Sources of water	Rivers and Rainfall
Pre-monsoon river flood surge and recession	March-April
Early-monsoon river flood surge	Early May
Sustained monsoon Beel flooding	June-October
Late-monsoon Beel drainage	Early September
Dry season fish refuge habitat area contraction	Late October January
Unseasonable Beel inundation from local rainfall during dry season	December-February

Table 2. Fishes of Chapai beel and their status.

SL	Common Group	Family	Local Name	Scientific Name	Status	IUCN-BD, 2015
1	Biodiversity of Carps	Cyprinidae	Rui	Labeo rohita	Low	LC
2			Catla	Gibelion catla	Low	LC
3			Mrigal	Cirrhinus cirrhosus	Low	NT
4			Kalibaus	Labeo calbasu	Rare	LC
5			Bata	Labeo bata	Rare	LC
6			Raek/ Tatkini	Cirrhinus reba	Low	NT
7	Biodiversity of Barbs and Minnows		Mola	Amblypharyngodon mola	Abundant	LC
8			chela	salmostoma bacaila	Low	LC
9			Phul chela	salmostoma phulo	Low	NT
10			Phutani punti	Puntius phutunio	Moderate	LC
11			Jatputi	Puntius sophore	Abundant	LC
12			Titputi	Puntius ticto	Abundant	VU
13			Mola puti	Pethia guganio	Abundant	LC
14			Sharpunti	Systomus sarana	Rare	NT
15			Darkina	Esomus danrica	Abundant	LC
16	Biodiversity of Catfishes	Bagridae	Tengra	Mystus vittatus	Moderate	LC
17			Bujuri tengra	Mystus tengara	Moderate	LC
18			Gura tengra	Chandramara chandramara	Moderate	LC
19		Siluridae	Boal	Wallago attu	Rare	VU
20		Clariidae	Magur	Clarias batrachus	Low	LC
21		Heteropneustidae	Shing	Heteropneustes fossilis	Abundant	LC
22	Biodiversity of Snakeheads	Channidae	Taki	Channa punctata	Abundant	LC
23			Cheng	Channa orientalis	Moderate	LC
24			Shol	Channa striata	Abundant	LC
25			Gojar	Channa marulius	Moderate	EN
26	Biodiversity of Eels	Mastacembelidae	Tara baim	Macrognathus aculeatus	Moderate	NT
27			Guchi baim	Macrognathus pancalus	Abundant	LC
28		Synbranchidae	Kuchia	Monopterus cuchia	Abundant	VU
29	Biodiversity of Perches	Anabantidae	Koi	Anabas testudineus	Abundant	LC
30			khalisha	Trichogaster fasciata	Abundant	LC
31			Lal khalisha	Trichogaster lalius	Moderate	LC
32			Nama chanda	Chanda nama	Low	LC
33		Badidae	Napit koi	Badis badis	Abundant	NT
34		Nandidae	Veda	Nandus nandus	Moderate	NT
35	Biodiversity of Loaches	Cobitidae	Gutum	Lepidocephalichthys guntea	Moderate	LC
36			Rani	Botia dario	Rare	EN
37	Feather backs	Notopteridae	Foli	Notopterus notopterus	Rare	VU
38	Prawn	Palaemonidae	Ichha	Macrobrachium lumarre	Abundant	LC
39	Tank Goby	Gobiidae	Bailla	Glossogobius giuris	Rare	LC
40	Freshwater garfish	Belondiae	Kakila	Xenentodon cancila	Rare	LC
41	Blue Panchax	Aplocheilidae	Khanpona	Aplocheilus panchax	Abundant	LC

Bagridae represented 3 fish species (7%). Another 2 families (Mastacembelidae and Cobitidae) represented 2 species (5%) each and the rest 11 families (Siluridae, Clariidae, Heteropneustidae, Synbranchidae, Badidae, Nandidae, Notopteridae, Palaemonidae, Gobiidae, Belondiae, and Aplocheilidae) represented 1 species (2%) each. Below pie chart represent the percent composition (**Figure 3**).

recorded in the present study. Barbs & Minnows contributes the highest percentage (22%) followed by Carps, Catfishes and Perches (15%), Snakeheads (10%), Eels (7%), Loaches (5%). Another and the rest 5 common group (Feather backs, Freshwater garfish, Tank Goby, Blue Panchax and Prawn) represent only 2% each (**Figure 4**).

Common Group Diversity of the Species

It is clearly evident that Twelve (12) common groups were

Table 3. List of Exotic species recorded in Chapai Beel during the study period

SL	Common Group	Family	Local Name	Scientific Name
1	Carps	Cyprinidae	Silver carp	Hypophthalmichthys molitrix
2			Bighead carp	Aristichthys nobilis
3			Common carp	Cyprinus carpio var. communis
4			Mirror carp	Cyorinus carpio var. specularis
5			Grass carp	Ctenopharyngodon idella
6	Nile Tilapia	Cichlidae	Tilapia Nilotica	Oreochromis niloticus

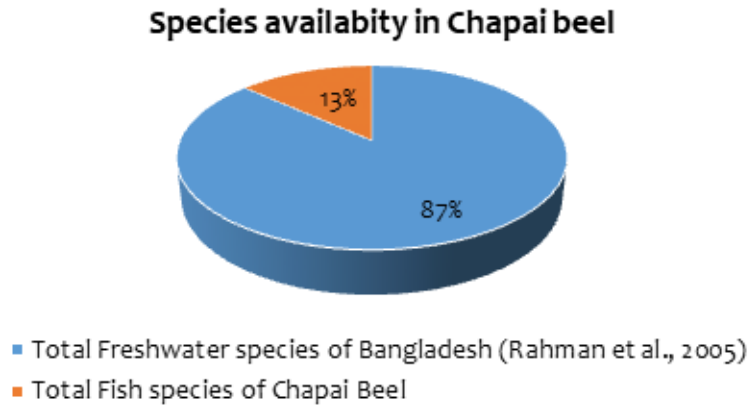

Figure 2 Species availability in Chapai beel compared to national status.

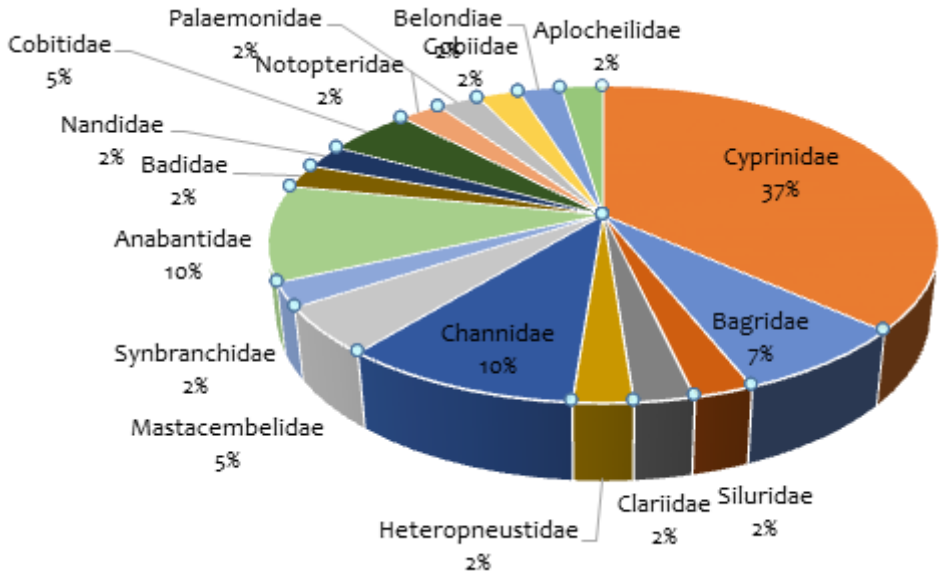

Figure 3 Family diversity percentage of Chapai Beel fish species.

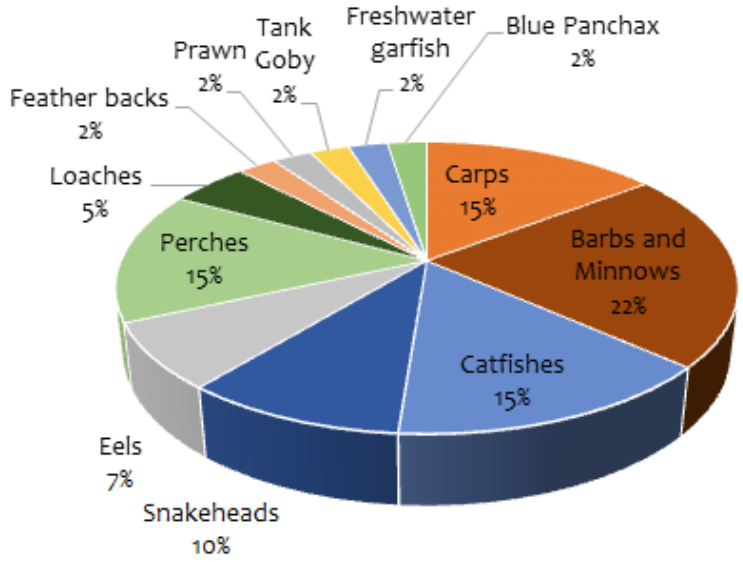

Figure 4 Common group diversity of the species of Chapai beel.

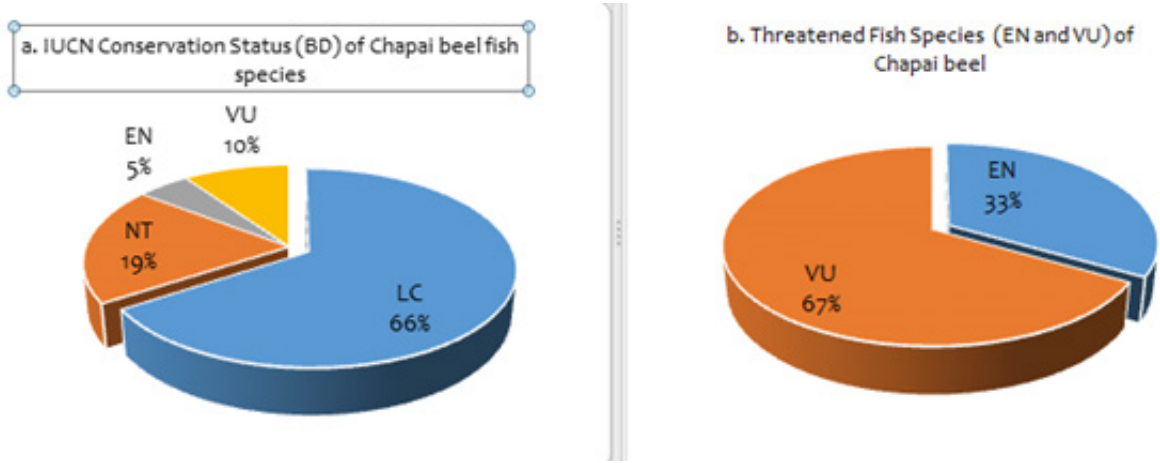

Figure 5 (a) IUCN conservation status in found species; (b) Threatened Fish Species (EN and VU) of ChapaiBeel; (c) Percentage of Chapai Beel threatened fish species among total freshwater threatened fish species of Bangladesh (IUCN Bangladesh, 2015); (d) Percentage of Threatened Fish species of Total Identified Fish species.

IUCN Conservation Status (BD) of Chapai Beel Fish Species

IUCN Conservation Status (BD) of Chapai Beel fish species showed that the highest percentage was recorded as Least Concern (66%) followed by Near Threatened (19%), Vulnerable (10%), and Endangered (5%) (**Figure 5**). Among the threatened fish species, Vulnerable (67%) was found to be most abundant category followed by Endangered (33%) category (**Figure 5**). 64 native freshwater fish species of Bangladesh have been declared as threatened species (IUCN-2015). Among them 6 fish species were recorded from the Chapai Beel, which is 9% of total threatened fishes of Bangladesh (**Figure 5**). The threatened species of Chapai Beel was 13% of the total identified species (**Figure 5**). Out of the 6 fish species, 4 species (10%) were found as Vulnerable (VU), 2 species (5%) as Endangered (EN). During the study period Critically Endangered (CR) were not recorded.

Abundance Status of the Study Area

It is clearly evident that within 41 species, 36.58% fish species were ranked as abundant followed by moderate (24.40%), low (19.51%), and rare (19.51%) (**Table 3**).

Occurrence of Exotic Fish Species

There were 6 exotic species were recorded in the Beel during the study (**Table 4**). Over the last six decades, 23 fish species have been introduced in Bangladesh, mainly for cultivation in closed pond systems. Because of low price and high nutritional value few species are very popular culture species in Bangladesh. It is reported that the escape of these species to rivers and floodplains

Table 4. Perceptions comparison of local community towards fish biodiversity now a days and during the last decade

Perceptions (Out of the 60 respondents)	Respond	Number of respondents
Increased/ Decreased fish biodiversity	Decreased	12 (20%)
Increased/ Decreased fish production	Decreased	14 (23.34%)
Increased/ Decreased both fish production and fish biodiversity	Decreased	34 (56.67%)

during the monsoon and floods is a threat to the biodiversity of small indigenous fish species (SIS), as some are highly carnivorous and predatory. Recorded species were cultured in ponds of the study area and apparently, they found their way to the open Beel after being washed down the different culture ponds by floods water during the monsoon season. In addition, if these alien species once get established, it will be difficult to eliminate them. They will compete with the native species for food and

Table 5. Threats, Impacts and Recommendations.

SL	Threat	Impact	Recommendation
1	Sluice gates were commissioned in the river connected canal	Disrupts the water flow that may interrupt the migratory routes of fishes.	♣ Maintain environmental flow in the beel considering the aquatic biodiversity through adaptive management engaging the multi-stakeholder.
		It may have a detrimental effect on physical attributes and destruction of feeding & spawning ground.	♣ Sluice gate should be kept open during the monsoon especially the breeding season each year (April- mid July) to allow the water flow by which entering the natural riverine seedlings into the beel.
2	Siltation in the connected canal (river to beel)	Reduces the water depth & flow, which may affect the overall fish diversity to a large extent.	♣ Renovation/ re-excavation of river connecting canal under different developmental programs after a certain period of interval. Continuous water flows facilitate fish migration.
			♣ Fish habitat restoration is primarily on re-excitation with an appropriate slope & ensuring management of excavated soil.
3	Encroachment to water spread area due to new establishments and demand for agricultural land	Loss of water area which not only decreases the fish density but also greatly effects on the reproductive strategies of the fishes and their habit & habitats; eventually hazardous to the abundance and distribution of fish.	♣ Redefining beel boundary based on ecosystem and in accordance with the ecological boundary is required to revert encroachment trends.
			♣ Government authorities should take necessary action as well as National strategies should be formulated for policy making, monitoring and implementation.
			♣ It is necessary to make a trade-off between beel management for biodiversity conservation & agricultural production with the establishment of a beel management committee.
			♣ Maintenance of minimum water depth (at least 1 m) during water extraction in dry season.
4	Unsafe agricultural activities practices (use of excessive chemical fertilizers, insecticides and pesticides) and pollution from the transboundary sources	Water pollution cause harm not only to the fish biodiversity but also the entire community of the ecosystem.	♣ Rational use of chemical fertilizers, insecticides and pesticides. At the same time, encourage the introduction of integrated pest management by farmers (IPM).
		Besides, increased turbidity of the water, creation of algal blooms, which effect many species.	♣ Strong implementation of conservation laws and acts to make free from pollution.
		It could also negatively affect the spawning and feeding behavior of fishes.	♣ Creating mass awareness among local people and their participation is must in controlling the water pollution.
5	Fishermen intension significant increase in fishing effort owing to not implementation of the legislations on fishing regarding the use of fishing gear, regulation of mesh size of nets, time of fishing and size of the catch	Overfishing leads to highly depletion of fish biodiversity and production, as well as recruitment failure by indiscriminate killing of gravid female & Juvenile fish.	♣ Fishing gears maintenance
			♣ Enforcement of Govt. laws to stop destructive fishing
			♣ Implementation of fishing ban period for 3-4months during breeding season of resident fish species.
			♣ Special drive to conserve and multiply IUCN listed endangered fishes as well as introduce new SIS which are already extinct from the Beel.
			♣ Establishment of fish sanctuary in certain part of the Beel based on a community approach. Also introduce guarding system engaging the community.
			♣ Functional and need-based training related to the importance of fisheries diversity should be provided in order to increase awareness of protecting their own resource.
			♣ Arrangement of alternate livelihood options during lean/ ban period, which can be done only by the help of eco-tourism.
			♣ Ecofriendly modern fishing technology should be implemented through local fisherman.
			♣ Breeding technologies of commercially important native species should be developed.
			♣ Stocking juvenile of indigenous species every year through Beel nursery management.
6	Absent of Fisherman Cooperative Societies	Destructive fishing due to no management which results in biodiversity degradation.	♣ Formation & Strengthening Fisherman Cooperative Societies.
			♣ Community based fisheries management policy should be taken up for effective and sustainable management.

7	Lack of financing for fishermen	Not developing as organized sector	♣ Easy Finance Schemes from Govt. credit agencies
			♣ Commercial Banks and other financial institution should come forward with collateral free special supervisory credit-program
8	Climate change and associated effects	Loss of habitats due to water quality degradation, change in salinity, flood, drought etc.	♣ Mass awareness should be built to save the environment.
			♣ Sufficient forest trees should be planted around the border of the Beel and along the dike of the canal.
9	Priority to given cultures of fast growing non-resident species	Many native SIS are on the verge of extinction.	♣ Govt. should take the initiative for developing the breeding technologies of selective native SIS and bring them under production commercially.
			♣ Zero tolerance to new exotic fish introduction in the beel.

space. Furthermore, they will carry different types of diseases. Currently, no information exists whether these exotic species have established breeding populations in the wild, and such studies need to be carried out in the future along with the development of management plans for their control and eradication.

Perceptions of Community (FGD) on Fish Biodiversity

In focus group discussion (2 FGD; n = 60), most fishermen reported that fish production and diversity were declining day by day. Out of the 60 respondents, thirty-four respondents (56.67%) indicated that both decreasing fish production and fish biodiversity. Fourteen respondents (23.34%) responded that decreasing fish production and only twelve responds (20%) noted that decreasing fish biodiversity (**Table 5**).

During FGD, two agendas were similarly discussed with the participants including the major threats and its impact on the fish biodiversity of Chapai Beel. Participants in consensus pointed out some probable solutions with management strategies to enhance fisheries biodiversity and fish catch.

Key Informant Interviews

According to the statement of Key Informants, it was revealed that Chapai beel is an important habitat for most of all kinds of indigenous fishes; therefore, sanctuaries need to be set up to provide a safe refuge for the species, in particular during the breeding season. However, the biodiversity of resident species in studied Beel is gradually declining and different species of fish that were abundant in Chapai Beel are now under great threat. Some of them are already extinct, some are threatened, and some are vulnerable. Study revealed that some native species are already extinct and it was found that Dhela (Rohtee cotio), Joiya (Barilius bendelisis), Piali (Aspidoparia morar), Chapila (Gadusia chapra), Gulsha (Mystus cavasius), Air (Mystus aor), Modho pabda (Ompok pabda), Kani pabda (Ompok bimaculatus), Borobaim (Mastacembelus armatus), Chitol (Chitala chitala), Golda (*Macrobrachium* rosenbergii), and Potka (Tetraodon cutcutia*)* etc. are not found nowadays in Chapai Beel. The study also indicated that while 41 native fish species have been identified, not all species are found to be of equal quantity. A major concern is the loss of biodiversity as water abstraction for agriculture, however, are threatening the ecosystem. Therefore, there is a need for a trade-off between managing beel for biodiversity conservation

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