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Community Perceptions on Sustainable Beel Fisheries Management: Bangladesh Perspective

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Abstract

The present study was undertaken on Chapai Beel in Faridpur Sadar Upazila, Bangladesh, to determine the fish biodiversity and scratch out the problem related to fisheries biodiversity and will also make a significant contribution to the development of an appropriate beel management policy to conserve the fisheries biodiversity through sustainable management. A field investigation was conducted on the current status of Chapai Beel fisheries for one 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 six 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; 25 were SIS, and the remaining 16 were large fish. Cyprinidae constitutes the highest fish population representing 15 species, and shares the highest percentage (37%) among the recorded family. Barbs & Minnows were the most influential group (22%) among the recorded 12 common groups. According to the IUCN Conservation Status (BD)- 2015 in Chapai Beel, the highest percentage was recorded as Least Concern (66%) followed by Near Threatened (19%), Vulnerable (10%), and Endangered (5%). Moreover, From the ChapaiBeel6, fish species were recorded as threatened, which is 9% of the total threatened fishes of Bangladesh. Among 41 species, 36.58% of fish species were ranked as abundant, followed by moderate (24.40%), low (19.51%), and rare (19.51%). Therefore, the current study provides a scientific foundation for fish biodiversity status, which will aid policymakers in determining beel management priorities in Bangladesh. Furthermore, the study reveals that careful planning, management, regulatory standards, and active community engagement can all help to improve biodiversity.

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

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Introduction

Bangladesh, one of the largest open-water fish-producing countries, 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 shelters to over 267 freshwater fish species [1] Beel is estimated to encompass 114161 acres in Bangladesh, accounting for around 27% of the country's inland freshwater resources [2]. Among 265 freshwater fishes (Rahman, 2005), 143 species are considered small indigenous species (SIS) in Bangladesh. 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 (IUCN, 2015). Overfishing, indiscriminate use of chemical fertilizers and insecticides, disruption of natural breeding and feeding

areas, collection of wild brood fishes, and other factors are all contributing to the decline of Bangladesh's beel fisheries [3]. Therefore, the present study aimed to discover the fish biodiversity status in the Chapai Beel, one of the largest and most important Beel for natural fish production in the Faridpur district of Bangladesh. However, there is no published article on the fish biodiversity of this beel so far. Consequently, this study would facilitate further studies on this aquatic fauna by interested researchers [4].

Objectives of the study

The main objectives of the study are

To understand the fish biodiversity of Chapai Beel under different environmental conditions.

To determine the nature of human interference on Chapai Beel.

To suggest some eco-friendly strategies for conservation and sustainable development of Chapai Beel [5].

Research Methodology

Study period

The research was carried out from January to December 2019 over a 12-month period.

Data Collection and Research Framework

Data were gathered using a questionnaire that was semi-structured. Additionally, the following techniques were applied:

Direct Observation

The status of Chapaibeel and species diversity was evaluated by close field observation.

Morphometric and hydrographic details of Chapaibeel

Hydrological condition of the Chapaibeel

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.

Fish Biodiversity of Chapai Beel

Availability of fish species was determined based on their abundance through direct sampling from fishermen catch and fish market (Chungirmor and Kanaipur Bazar), interviewing of fishermen, fish retailers, and fish traders following the questionnaire pattern. The abundance of fish was also categorized into four groups: abundant, moderate, low, and rare.

Determination of Conservation Status (IUCN Conservation Status-BD)

The IUCN Bangladesh Conservation Status database, 2015 was also used to determine the status of conservation.

Community Perceptions on fish Biodiversity

Focus group discussions (FGD) & key informant interviews (KII) were conducted to assess the perceptions on fish biodiversity of studied beel. Respondents were selected randomly and considered the oldest and experienced persons related to fish biodiversity adjacent to studied beel, such as fishermen, venerable local community leaders, fish retailers, fish traders, and the local DoF (Department of Fisheries) NGO (Non-Government organization) personnel.

Focus Group Discussions (FGD)

A total of 2 FGDs were made at different places of the study site. Each of the FGD was performed with 30 members of the fishing communities.

Key Informant Interview (KII)

A total of 30 respondents were interviewed face to face from the study areas.

Overall Threat Identification of Chapai Beel

Threats on biodiversity were collected through the survey on the fishermen, venerable local community leaders, fish retailers, fish traders, local DoF & NGO personnel, and available literature. Afterward, prioritized the list one after another based on the polling of the respondents during FGD. After analyzing the threats, the present study has also formulated specific conservation recommendations for an appropriate management policy.

Data Processing and Analysis

Descriptive analysis and graphical presentation of data were carried out using Microsoft Excel (Version 2016) for the study.

Result

Direct observation

Morphometric and Hydrographic details of Chapaibeel: A biodiversity hotspot located approximately 12 kilometers from Faridpur town is Chapaibeel. The Chapaibeel is connected to the Kumar River by two significant canals: the Bashtola canal (6.103 KM) on the northwest and the Kuchiamara-1 canal (5.9 KM) on the southeast, both of which lead to the Padma River, according to the hydrological survey of the beel region **(Figure 01).** The 84.86 hectares that make up the beel's authorized area are distributed among seven villages in the two unions and two upazilas of the Faridpur district. It is semi-closed and has a water body with an arc shape. There are two adjacent beel close by (Horai Beel-40.8867 Ha & Kalkander Beel-42.4323 Ha). The natural capacity of Kalkander Beel to retain water has been exhausted, and land speculators are the main invaders. Horai Beel has year-round access to water to sustain biodiversity, although it has been partially overtaken. Despite being separate, the three beels are connected by little waterways that go from Chapai to Horai to Kalkanderbeel. The Chapaibeel joins the other two during the monsoon and grows to a size of several hundred hectares, forming a huge inland water body in the Faridpur region. Because Chapaibeel is a significant source of diversity,

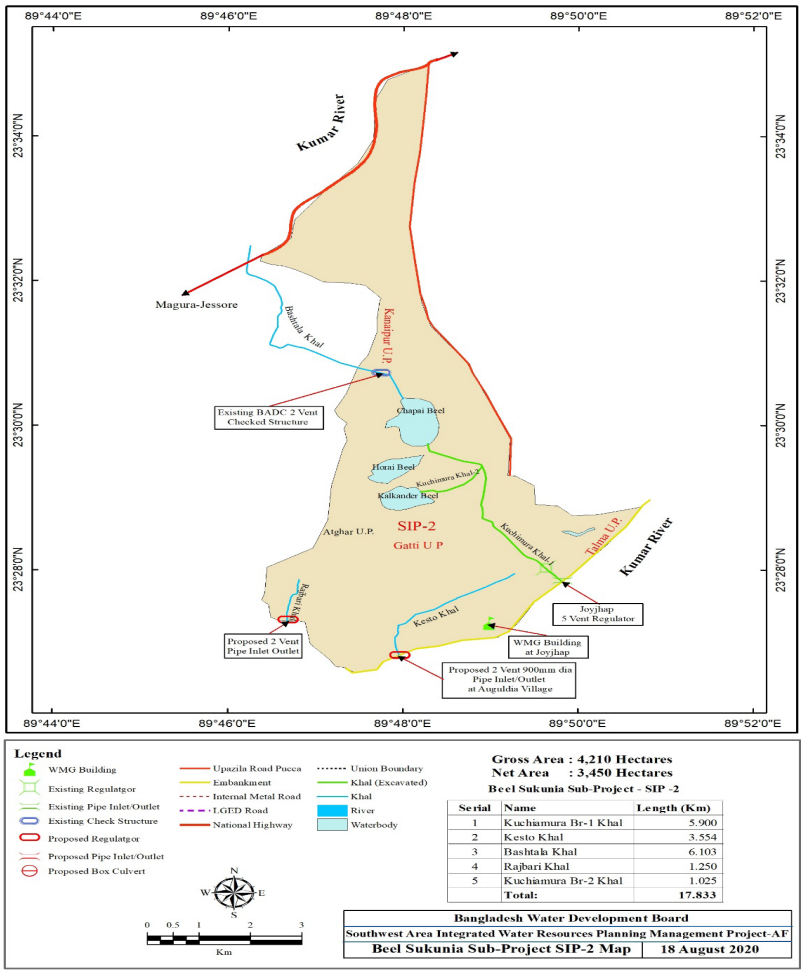

Figure 1 Map showing the study area.

this study was conducted at this hydrological boundary. Due to the size of the Chapaibeel, the water depth varies significantly between 4 and 15 feet depending on the season and location. The highest water depth was seen in August. With the aid of two vent regulators installed by Bangladesh Agriculture Development Corporation (BADC) in the Bashtola canal (now inactive) and six vent regulators installed by Bangladesh Water Development Board (BWDB) in the Joyjhap canal. The hydrological unit's Joyjhap six vent regulator aids in current flood management and drainage. The majority of the beel is naturally drained during the dry season, and fish can access the deepest part of the beel when the water level in the beel drops. The most depressed area of the beel retains water year-round and promotes biodiversity. Depending on the habitat, the fish catch changed over the course of the year. Fish movement facilities, flooding and inundation cycles, habitat types, and linkages may all play a role in some of the variances. The captures peaked in October and November when the water level began to fall. A decrease in biodiversity in some catches may be related to the seasonal change of water depth in the beel.

Hydrological Condition of the Chapaibeel

The river itself, canals, and beels are just a few of the different habitat types that may be found on Bangladesh's floodplain. As a result, beel fisheries are greatly influenced by the hydrological conditions of the beel. Seasonal fluctuation is important for the biology and life cycle of resident species in floodplains, and in particular, early flooding encourages fish to spawn early. According to several authors' classifications of the hydrological conditions of the Beels into various parameters [8] the following hydrological conditions have been observed in Chapaibeel **(Table 1).**

Fish Specimen Identification

In total, 47 species (including six exotic species) were identified during the study. Of the 47 species, 41 were indigenous species, of which 25 were SIS (grow to a maximum size of 25 cm at mature or adult stage in their life cycle; and the remaining 16 were large fish **(Table 3).**

Fish biodiversity

The present status and the loss of fish biodiversity of ChapaiBeel have been identified and analyzed accordingly. In conducting the analysis, only indigenous species in the studied beel are considered. Exotic species are excluded from the analysis and presented separately **(Table 4).** Forty-one, as a result, indigenous

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

Dimensions	Aspects
Water sources	Rivers and Rainfall
River flood surge and recession associated with pre-monsoon weather	March-April
River flooding during the early monsoon	Early May
Persistent monsoon flooding in Beel	June-October
Beel drainage in the late monsoon	Early September
Reduced fish refuge habitat area during the dry season	Late October-January
Local rains during the dry season led to unseasonable beel flooding.	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

Table 3. Abundance status of fishes in Chapai beel during the study period.

SL	Abundance Status	No. of species	%	Small Indigenous Species (SIS)	Large fish
1	Abundant	15	36.58	Mola, Jatputi, Titputi, Molaputi, Darkina, Taki, Koi, Lal khalisha, Napit koi, Ichha, Khanpona	Shing, Shol, Guchibaim, Kuchia
2	Moderate	10	24.40	Phutanipunti, Tengra, Bujuritengra, Guratengra, Cheng, Tara baim, Chunakhalisha, Veda, Gutum	Gojar
3	Low	8	19.51	Raek/ Tatkini, Lamba chela, Phul chela, Nama chanda	Rui, Catla, Mrigal, Magur
4	Rare	8	19.51	Rani	Kalibaus, Bata, Sharpunti, Boal, Foli, Bailla, Kakila
Total		**41**	**100**	**25 species**	**16 species**

Table 4. 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	*Aristichthysnobilis*
3			Common carp	*Cyprinuscarpio var. communis*
4			Mirror carp	*Cyorinuscarpio var. specularis*
5			Grass carp	*Ctenopharyngodon idella*
6	Nile Tilapia	Cichlidae	Tilapia Nilotica	*Oreochromis niloticus*

fish species were recorded during the study period under 17 fish families belonging to 12 different common groups and 32 fish genera. They are listed together with their present abundance status and local IUCN conservation status **(Table 2).**

Species availability compared to national study

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

Family diversity in the study area

Out of the 17 families, Cyprinidae, found to be the richest family, represented the maximum 15 fish species (37%), followed by two families (Anabantidae and Channidae), representing four species (10%) each, and the Bagridae represented three fish species (7%). Another two families (Mastacembelidae and Cobitidae) represented two species (5%) each, and the rest 11 families (Siluridae, Clariidae, Heteropneustidae, Synbranchidae, Badidae, Nandidae, Notopteridae, Palaemonidae, Gobiidae, Belondiae, and Aplocheilidae) represented one species (2%) each **(Figure 3).**

Common group diversity of the species

Twelve (12) common groups were recorded in the present study. Barbs & Minnows contribute the highest percentage (22%), followed by Carps, Catfishes, and Perches (15%) each, Snakeheads (10%), Eels (7%), and Loaches (5%). The rest five common groups (Feather backs, Freshwater garfish, Tank Goby, Blue Panchax, and Prawn) represent only 2% each **(Figure 4).**

IUCN Conservation Status (Bd) Of Chapai Beel Fish Species

According to the IUCN Conservation Status (BD)- 2015 in Chapai beel, the highest percentage was recorded as Least Concern (66%) followed by Near Threatened (19%), Vulnerable (10%), and Endangered (5%) **[Figure 5:(a)].** Among the threatened fish species, Vulnerable (67%) was found to be the most abundant category, followed by the Endangered (33%) category **[Figure 5:(b)].** According to IUCN Bangladesh- 2015, a total of 64 species have been declared as threatened species in Bangladesh. Thus, it is a matter of great concern that six species of those were recorded from Chapai Beel, which is 9% of the total threatened fishes of Bangladesh **[Figure 5:(c)].** The threatened species of Chapai Beel was 13% of the total identified species **[Figure 5:(d)].** Out of the six fish species, four species (10%) were found as Vulnerable (VU), two species (5%) as Endangered (EN). During the study period, Critically Endangered (CR) was not recorded.

Occurrence of exotic fish species

There were six exotic species recorded in the Beel during the study **(Table 4).** In the study area, mainly carp mix culture (including Indian major carp, exotic carp, and Tilapia) was a common practice in the traditional way in household-based ponds, and the dike conditions of those majority ponds were not well developed. Apparently, they found their way to the open Beel after being washed down the different culture ponds by floods water during the monsoon season. It is clearly evident that within 41 species, 36.58% of fish species were ranked as abundant, followed by moderate (24.40%), low (19.51%), and rare (19.51%) **(Table 3).**

Community perceptions on fish biodiversity

According to the statement of Key Informants (n=30), it was revealed that Chapai beel is an important habitat for most of all kinds of indigenous fishes, but biodiversity is gradually declining, and the different species that were abundant in Chapai Beel are now under great threat. Some of them are already extinct, some

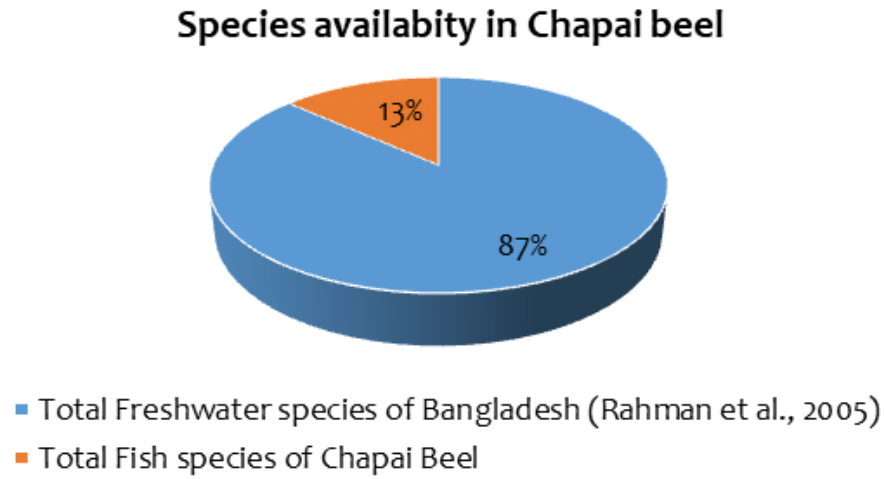

Figure 2 Species availability of Chapai eel compared to National study.

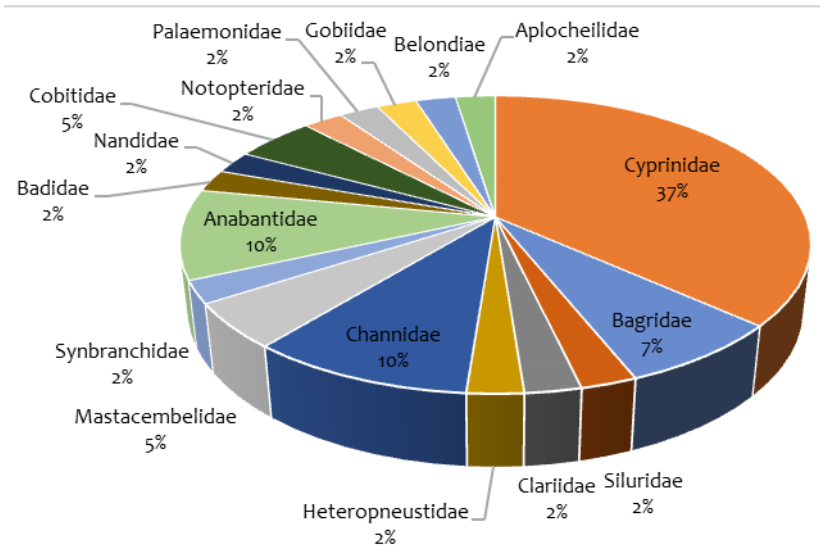

Figure 3 Percentage of Family diversity in Chapai beel fish species.

are threatened, and some are vulnerable. The study revealed that some native species are already extinct, and it was found that Dhela (Rohtee cotio), Joiya (Barilius bendelisis), Piali (Aspidopari amorar), Chapila (Gadusia chapra), Gulsha (Mystus cavasius), Air (Mystus aor), Modhopabda (Ompok pabda), Kanipabda (Ompok bimaculatus), Borobaim(Mastacembelus armatus), Chitol (Chitala chitala), Golda (Macrobrachium rosenbergii), and Potka (Tetraodon cutcutia) etc. are not found nowadays in Chapai Beel. Earlier, a large number of riverine fish were present in the beel, such as Ghaira (Clupisoma garua), Bacha (Eutropiichthys bacha), etc. This study also indicated that while 41 native fish species have been identified, not all species are found to be of equal quantity. In addition, water withdrawals for agriculture pose a threat to the ecosystem, which in turn to loss of biodiversity.

In focus group discussion (2 FGD; n = 60), most fishermen reported that fish production and diversity were declining day by day. According to the respondent, 10-15 years ago, Chapai beel was very rich with fish biodiversity, and fishermen were then satisfied with their daily catch. 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).**

Overall threat identification

Like the freshwater fish biodiversity in Bangladesh, Chapai beel fish biodiversity is under threat due to various anthropogenic and natural causes (Islam et al. 2017). The FGDs are attempting to find solutions through management strategies that will increase fisheries biodiversity and catch. The major threats to the fisheries resources of Chapai beel were subsequently identified, and conservation recommendations were developed as well as ranked based on priority and their impact on the fish biodiversity,

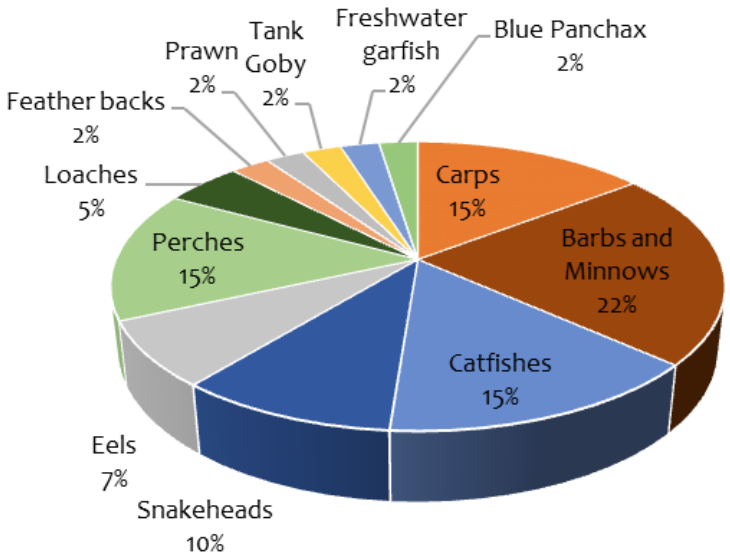

Figure 4 Percentage of Common group diversity in Chapai beel fish species.

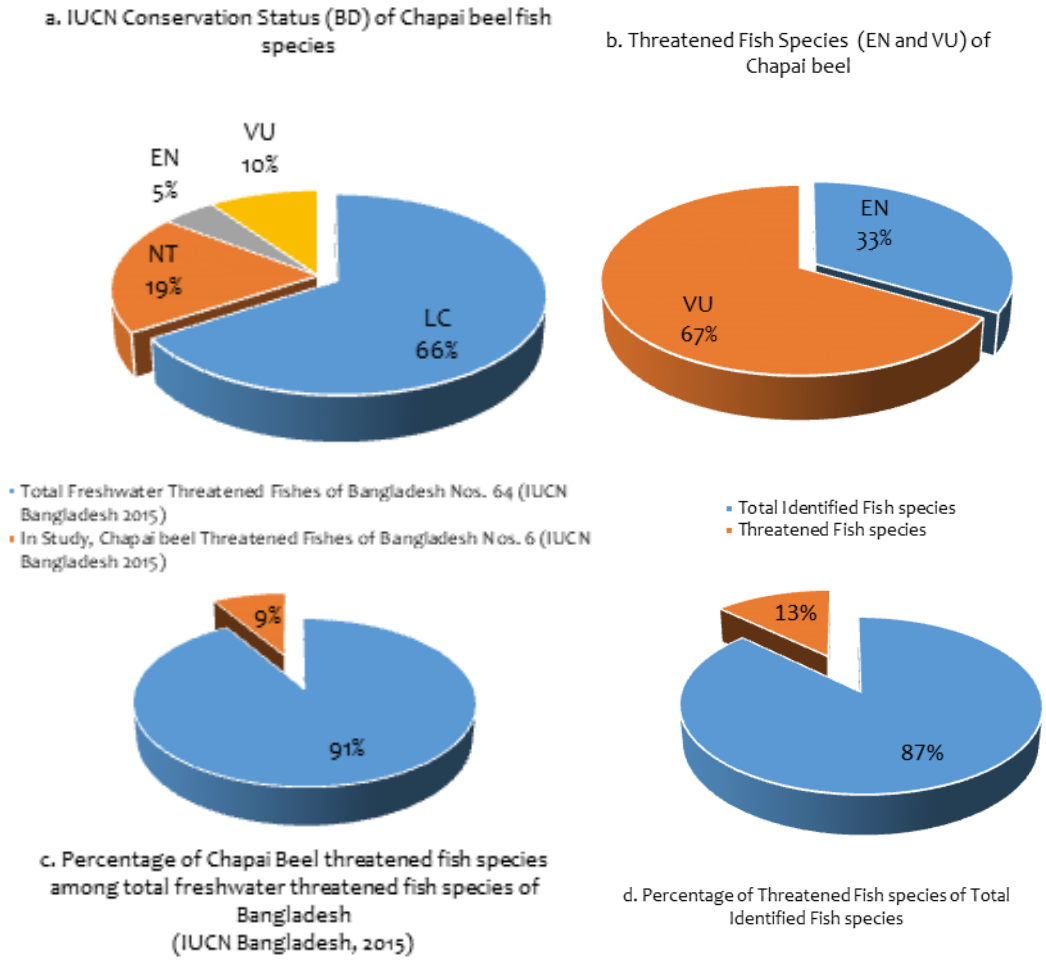

Figure 5 (a) IUCN conservation status in the found species; (b) Threatened Fish Species (EN and VU) of Chapai Beel; (c) Percentage of Chapai Beel threatened fish species among total freshwater threatened fish species of Bangladesh (IUCN Bangladesh, 2015); (d) Percentage of Threatened Fish species of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

Table 5. Perceptions comparison of local community towards fish biodiversity nowadays and during the last decade.

Perceptions (Out of the 60 respondents)	Respond	Number of respondents
Is Fish biodiversity increased or decreased than a decade ago?	Decreased	12 (20%)
Is Fish production increased or decreased than a decade ago?	Decreased	14 (23.34%)
Are Fish biodiversity and Fish production both increased or decreased than a decade ago?	Decreased	34 (56.67%)

Table 6. Threats, Impacts, and Recommendations.

Threat ranking 01: Fishing significantly increased, which resulted in overfishing.	
Impacts	Concurrent depletion of fish biodiversity and significant reduction of the natural production.
Results	(1) Gradual extinction of the local species; and (2) recruitment has failed because juvenile and gravid fish are being killed arbitrarily.
Recommendations	(1) putting into effect the laws governing the usage of fishing gear, the mesh size of nets, the amount of time spent fishing, and the size of the catch; (2) Implementation of a fishing prohibition for 3–4 months during the resident fish species' mating season; (3) special drive to conserve and multiply IUCN listed endangered fishes; and (4) establishment of a Fish Sanctuary Based on Community Approach in Certain Parts of the beel; (5) practical and necessary training on the value of fisheries variety should be offered to raise awareness of the need to safeguard one's own resource; (6) setting up alternative sources of income during lean or ban times, which can be accomplished with the help of the ecotourism concept; (7) implementing eco-friendly modern fishing techniques by local fishermen; (8) developing commercially significant native species breeding techniques; and (9) stocking juvenile of indigenous species each year through Beel nursery management.
Threat ranking 02: Water control devices (Sluice gates) were installed on the canal that leads to the river.	
Impacts	Disruption of the natural water flow on the channel.
Results	(1) interrupt the migratory routes of local species and (2) destruction of feeding & spawning ground
Recommendations	(1) During the breeding season (April to mid-July), the sluice gate must always be open to allow water to flow and riverine seedlings to reach the beel; and (2) establishing adaptive gate management that involves multiple stakeholders.
Threat ranking 03: Siltation in the connected canal (river to beel)	
Impacts	Have a considerable effect on overall fish diversity.
Results	(1) reduced water depth & flow hampered migration and (2) confinement of the species, thus reducing diversity
Recommendations	(1) The connected canal should be periodically renovated/re-excavated, and (2) fish habitat should be restored by re-excitation with an appropriate slope and making sure excavated soil is managed.
Threat ranking 04: Encroachment on the water spread area is brought on by increased development and agricultural land use.	
Impacts	Loss of freely accessible water area eventually poses a threat to fish distribution and quantity.
Results	(1) has an impact on fish habitats, habits, and reproductive tactics, and (2) decreases the fish density
Recommendations	(1) Establishing beel boundaries in accordance with ecological boundaries based on ecosystems; (2) establishing a beel management committee to balance beel management for agricultural production and biodiversity conservation; (3) keeping the water level at least one meter deep during the dry season; and (4) developing and implementing national strategies for policymaking, monitoring, and implementation.
Threat ranking 05: Non-judicial agricultural activities (excessive use of chemical-containing fertilizers, herbicides, and insecticides), and pollution coming from cross-border sources (like connected by several drains, toilets, waste disposal by residents, etc.).	
Impacts	Contaminated environments for fish and their habitats.
Results	(1) Decrease fish biodiversity; (2) harm fish spawning and feeding patterns, and (3) disturb the ecosystem of the beel community as a whole.
Recommendations	(1) judicial use of agricultural inputs along with integrated pest management by farmers (IPM); (2) increasing stakeholder participation and fostering widespread awareness of water pollution; (3) utilizing effective methods to reduce pollutant levels. Bin usage, standardized sanitation, and composting infrastructure are a few examples; and (4) observing conservation rules and regulations will help keep the environment pollution-free.
Threat ranking 06: Too much jute is decomposing in the beel and canal.	
Impacts	habitat disruption and pollution
Results	(1) polluted habitat with increased turbidity of the water; (2) dumping materials like a sack of soils, banana stems, etc. in the water body, and (3) algal blooms
Recommendations	To adopt adequate steps to control the pollution's level is advised. Introduce mechanization, such as ribbon retting, Ashkol to separate fiber, etc. in the case of jute rotting, for example, to lessen reliance on the natural water body.
Threat ranking 07: Absent of Fisherman Cooperative Societies or governing bodies for fishing in the local context	
Impacts	biodiversity degradation with no management
Results	(1) destructive fishing due to no management, and (2) no control over fishing methods, equipment, net mesh, fishing time, or size of catch.
Recommendations	(1) Formation & Strengthening Fisherman Cooperative Societies/ groups; (2) Adopting community-based fisheries management strategies is essential for effective and sustainable management, and (3) creating awareness about the benefits and possible outcomes

Threat ranking 08: Lack of financing for fishermen	
Impacts	Fishermen stuck in the cycle of poverty
Results	A poverty trap caused by self-reinforcing mechanisms
Recommendations	Commercial banks, government credit agencies, and other financial institutions that provide straightforward financing programs ought to establish a distinct, collateral-free supervisory credit scheme.
Threat ranking 09: Environment impact, Climate change, and associated effects	
Impacts	changing favorable conditions for the sustainable biodiversity
Results	Habitat degradation is the result of deteriorating water quality, changing salinity, flooding, droughts, etc.
Recommendations	(1) Mass awareness should be built about the environment and climate change; (2) The beel's border and the canal's dike need to have proper agroforestry practices, and (3) Environmental impact analyses must be conducted in order to ascertain, anticipate, and minimize the effects of any development activity within the beel confines.
Threat ranking 10: Competition with the culture of non-native/ non-local fast-growing species	
Impacts	local biodiversity and genetic pool declining
Results	Many native SIS are in danger of going extinct.
Recommendations	(1) Government/ research organizations/ private sector should take the lead in creating the techniques for selective native SIS breeding and put them into commercial production, and (2) Do not let any exotic fish species be introduced into the Chapaibeel.

Table 7. Comparison of the Beel Area (Ha) of present study with those of previous studies in Bangladesh.

Study Site	The study area (Ha)	References
Chapai beel, Faridpur	**84.86 Ha**	**Present study**
Charia beel,Mymensingh	1050 Ha	Chakraborty et al. (2021)
Basuakhali beel, Khulna	1012.5 Ha; during monsoon and 15.95 Ha; during the dry season	Rahman et al. (2019)
Kumari beel, Rajshahi	500 Ha	Joadder (2008)
Gharia beel, Mymensingh	62 Ha	Chakraborty and Mirza (2007)
Shakla beel, Brahmanbaria	75.0 Ha	Ahmed et al. (2004)
Rajdhala beel, Netrakona	53 Ha	Rahman (2000)

Table 8. Comparison of the Fish biodiversity of present study with those of previous studies in Bangladesh.

Number of Species	Number of Families	Study Site	References
41	**17**	**Chapai beel, Faridpur**	**Present study**
91	Not mentioned	Charia beel, Mymensingh	Chakraborty et al. (2021)
38	21	Basuakhali beel, Khulna	Rahman et al. (2019)
63	20	Halti beel, Natore	Imteazzaman and Galib, (2013)
82	26	Chalan beel	Kostori et al. (2011)
72	27	Chalan beel	Galib S.M. et al. (2009)
76	22	Kumari beel, Rajshahi	Joadder (2008)
52	20	Shakla beel, Brahmanbaria	Ahmed et al. (2004)
40	Not mentioned	Saldu beel, Tangail	Saha and Hossain (2002)
33	Not mentioned	Rajdhala beel, Netrakona	Rahman (2000)

aimed at a sustainable management approach presented in **Table 6.**

Discussion

Bangladesh enriched in aquatic fish biodiversity with 265 freshwater fish species where minnows, catfish, eels, perch, gobies, clupeids, and prawns constituted the significant portion **[9].** For instance, A rich diversity of fish fauna is contributing significantly to the ecology and sustainable productivity of the floodplains. During the monsoon, the floodplains of Bangladesh become integrated into a single biological productive system [10]. Among the various inland fisheries resources, beel has played a major role in fish production from time immemorial. Total inland waterbodies cover an area of 4.6 million ha, of which 83.53% comprise open water capture fisheries, and only 16.47% close water system (DoF, 2013). In the present study, the area of the Chapai beel is about 84.86 ha (during the monsoon spread out to several hectares; more than 500 Ha) which is very little compared to the whole area of inland water bodies in Bangladesh but sometimes large and mostly similar in comparison to the other beels **(Table 7).** In Chapai beel, a total of 47 species (including six exotic species) were identified. 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. The present study (41 species) represents 13% of the country's total fish species. It is not possible to compare other studies in Chapai beel because there has been no Governmental and non-governmental survey conducted before. Therefore, the present study recorded fish species as

much lower that indicates the lower biodiversity of Chapai beel and is sometimes mostly similar compared to some other studies on beel fisheries biodiversity of Bangladesh **(Table 8).**

Availability of exotic fishes in open or semi-open water bodies was also reported by ARG from the Kaptai Lake (the largest manmade lake of Bangladesh) and Saldu Beel of Tangail district, respectively. Were also recorded 4, 9, and 8 exotic species from Basuakhali beel, Chalanbeel (the largest beel wetland of Bangladesh), and Halti beel, respectively. According to IUCN Bangladesh- 2015, the present study found that (66%) of the species were of least concern, followed by near threatened (19%), vulnerable (10%), and endangered (5%). Out of the six identified threatened species, four species (10%) were found as Vulnerable (VU), two species (5%) as Endangered (EN). Compared to other studies on beel fisheries biodiversity in Bangladesh, it can be seen that found almost 57.89% of species were the least concerned, 13.16% threatened, 10.53% vulnerable, 2.63% endangered, and 15.79% not threatened considering the fish biodiversity of Basuakhali beel. Reported out of 63 fish species, three critically endangered, 11 endangered, and eight vulnerable fish species of Bangladesh in the Halti beel. Indicated out of 72 species, 28 species were threatened fishes of Bangladesh, including 11 vulnerable, 12 endangered, and five critically endangered species. This study also shows that while 41 native species have been identified, not all species are equal in quantity, albeit Chapai beel is an ideal habitat for most of all kinds of indigenous fishes. Loss of fish biodiversity is considered an alarming threat, and its conservation is the only solution to this problem. In studied beel, biodiversity of resident species is gradually declining due to environmental degradation, siltation in the river connected canal, irrigation for agriculture, a significant increase in fishing effort, encroachment of water spread area due to the demand of land, priority to given non-resident fast-growing culture species, and many other causes. Compared to other studies on threats to fisheries biodiversity, it can be seen that Duttaa and indicated similar causes of wetland degradation of Chatra Beel, Malda, W.B, India. Reported similar threats to the fish diversity of inland waters of Bangladesh. Identified the similar causes for the reduction of species in the inland waters of Bangladesh. Likewise, indiscriminate catching of gravid female & juvenile fish, water flow reduction, modification, and loss of fish habitat, are also reflected as major threats for declining freshwater species diversity.

Conclusion

According to the report, there has been a dramatic drop in fish species during the last decade. It can be inferred that the biodiversity of Bangladesh's Beel fishery has become a major concern in recent years, and is at a critical stage compared to prior times. Many fish species are disappearing from our water bodies for a variety of reasons. This is high time to address the biodiversity of native fish – Bangladesh's pride, heritage, and livelihoods before they are lost forever. Each of the Beel has its own biological, environmental, and social characteristics. The local management approach should be developed because the biodiversity of an area is closely related to the local people's livelihood. Hence, there is a great need for scientific management to utilize the Beel fisheries to their potential and sustainable level. The aftermaths of the present study would help to evolve appropriate strategies for the sustainable development of fisheries resources in Chapai Beel. In Chapai Beel, there is no Governmental and non-governmental survey conducted before. Long-term studies on biodiversity, fishing gears, and socio-economic condition are much essential to know the changes in the biodiversity and socio-economic development of the fisher community for better and sustainable Beel fishery management.

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