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ORIGINAL RESEARCH ARTICLE

Fish biodiversity status and threats of Chinadi Beel in Bangladesh

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ABSTRACT

This study examined the fish fauna of Chinadi Beel in Bangladesh in terms of diversity, quantity, and state of conservation. A pre-tested questionnaire and a direct catch evaluation survey were employed to conduct the study in the beel. In the examined beel, a comprehensive count of 3,360 fish specimens, encompassing 52 distinct fish species from 8 orders and 19 families, was documented. Cypriniformes was identified as the dominating order among the 8 orders examined, accounting for 51.49% of the total. Out of 52 fish species about 31 least concern (59.61%), 8 endangered (15.38%), 6 vulnerable (11.54%), 6 near threatened (11.54%) and 1 critically endangered (1.92%) species were observed according to the International Union for Conservation of Nature. The study utilized population diversity indices, specifically the Shannon-Weiner diversity index (H'), Margalef species richness (d), Pielou's evenness index (J'), and Simpson dominance index (c), to assess the species diversity, richness, and evenness of fish which value were found to be 2.50, 4.30, 0.90, and 0.30, respectively. Chinadi Beel has the capacity to function as a significant reservoir of fishing resources and a repository of genetic information for many fish species. However, the present study emphasized several anthropogenic and environmental issues, such as unregulated fishing, agricultural pollutants, illegal or harmful fishing, the construction of infrastructure for development, and climate change. Hence, it is highly recommended to implement ecosystem-based fisheries management that actively involves the local population in order to guarantee the long-term preservation of these water bodies.

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INTRODUCTION

Bangladesh is endowed with an extensive expanse of open water bodies situated inland, including floodplains, rivers, haors, and beels (Shamsuzzaman *et al.*, 2020). The area in question comprises a wetland domain that provides a wide range of marine and inland fisheries resources (Pandit *et al.*, 2021). Haor basins, rivers, beels, flood plains, and estuaries sustain an estimated 4.24 million hectares of inland water (DoF, 2022). Particularly advantageous are beels as natural habitats for indigenous fishes with diverse feeding behaviors. The Bengali word "beel" refers to a static water body with a relatively large surface area that collects surface run-off water via an internal drainage channel comprised of tiny, marshy depressions resembling saucers. According to DoF (2022), the estimated total area of beel in Bangladesh is 114,161 hectares, which accounts for approximately 27.0% of the inland freshwater area. The majority of aquatic species, particularly fish and prawns, migrate to the

inundated regions of the beel from nearby rivers and canals in order to obtain sustenance and facilitate their growth during the monsoon season (Akhtaruzzaman & Alam, 2014).

The beel ecosystem exhibits exceptional complexity, characterized by significant temporal and geographical fluctuations in numerous crucial factors. The wetland ecology is influenced by several elements, including the depth of the wetland, the characteristics of the catchment area or river basin, and the precipitation levels and duration of connection to the river (Sugunan *et al.*, 2000). The country boasts a wide array of aquatic biodiversity, with around 260 species of freshwater fish and 730 species of marine fish, along with various other aquatic animals. A total of 253 native fish species were evaluated by IUCN Bangladesh, with 36 of them being migratory and 113 being located in floodplains and rivers (Pandit *et al.*, 2021). In addition, fish as a standalone source account for over 63% of animal protein, along with a wide range of vital vitamins and minerals within this particular ecosystem (Majumdar *et al.*, 2016; Sunny *et al.*, 2020). In recent decades, the ecological conditions of water bodies have worsened due to extensive human activities, leading to habitat loss and degradation. Consequently, a significant number of fish species have become highly endangered in various freshwater bodies. The taxonomic group of freshwater fishes, encompassing many types of waterbodies, faces significant threats due to their high susceptibility to the qualitative and quantitative fluctuations in aquatic habitats (Darwall & Vié, 2005). As of now, around 54 freshwater fish species in Bangladesh have been classified as endangered species by the International Union for Conservation of Nature (IUCN, 2020). The rapid decline of wild fish species in Bangladesh can be attributed to significant alterations in freshwater ecology and extensive degradation of natural habitats. As of now, around 54 freshwater fish species in Bangladesh have been classified as endangered species by the International Union for Conservation of Nature (IUCN, 2020) (Hossain *et al.*, 2012). These findings clearly indicate the need for biodiversity research particular to water bodies, which is essential for assessing the existing state and implementing sustainable management strategies to protect fishery resources (Imteazzaman & Galib 2013). In addition to the primary floodplains of the rivers Padma, Meghna, and Jamuna, Bangladesh is home to several beels of varying sizes, both large and tiny. Chinadi beel is situated in the Dulalpur union, precisely eight kilometers to the west of Shibpur Upazila in the Narsingdi district of Dhaka division. It is located at coordinates 24°03'40.2"N latitudes and 90°40'07.2"E longitudes. The beel spans an area of 165 acres, which is equivalent to 16,500 decimals. The beel holds considerable recognition in the Narsingdi district of Bangladesh due to its picturesque landscapes, abundant fish output, and its role as a livelihood for local fishermen. A significant proportion of fishing households rely entirely on the resources provided by the Chinadi beel. Currently, the decline in the population of fish species in the inland waters of Bangladesh is a pressing concern inside the country (Galib *et al.*, 2009). The livelihoods of over 12 million fishers in Bangladesh are facing an escalating threat due to the declining fish catch (Tsai & Ali, 1997). The beel fishery in Bangladesh is experiencing a decline in quality as a result of various factors, including overfishing, uncontrolled use of chemical fertilizers and insecticides, degradation of natural breeding and feeding habitats, and the extraction of wild brood fishes (Azher *et al.*, 2007).

Therefore, it is necessary to conduct an area-based study in order to ascertain the current state and underlying factors contributing to the decline of fish fauna in various regions of Bangladesh. However, there is a lack of comprehensive research conducted to determine the current state of fish variety throughout the country. The purpose of this study was to identify the fish and shellfish species in Chinadi beel, determine the causes of their decline, and propose appropriate recommendations.

MATERIALS AND METHODS

Study area

The study was carried out at Chinadi beel located at Dulalpur of Shibpur upazila in Narsingdi district, Bangladesh. The study area lies in between 24°03'40.2"N latitudes and 90°40'07.2"E longitudes occupying an area of about 165 acre (Figure 1).

Study period

The study was carried out over a duration of six months, spanning from July to December 2022, in order to gather data on the present condition, patterns, and risks associated with the aquatic biodiversity of the Chinadi beel.

Data collection methods

The data was collected pertaining to the diversity of fish and the factors contributing to the decline in bee populations. This research employed focus group discussions (FGD) as a method of Participatory Rural Appraisal (PRA) for fishermen, in addition to conducting cross-check interviews with key informants.

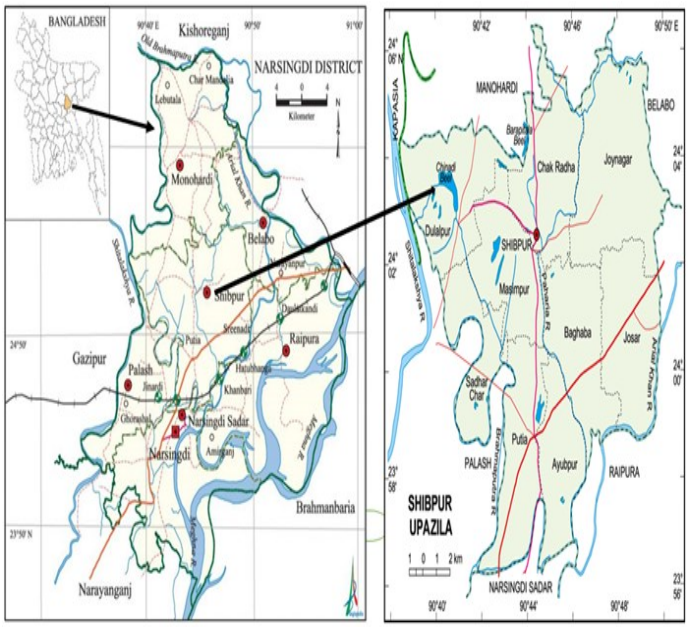

Figure 1. *Location of study area Chinadi Beel.*

A sample size of 80 fisherman was randomly chosen from four communities in the Chinadi beel to partake in questionnaire interviews with the aim of data collection. Fishers were interviewed either at their residences or on their fishing locations. A total of five Focus Group Discussions (FGDs) were conducted in the beel area, with each group consisting of 15 to 20 fishermen. The collection of fish samples was carried out concurrently in the nearby fishing communities, fishing vessels, fish markets, and landing hubs located in close proximity to Chinadi beel. The species composition and diversity of the fish taxa were examined using a monthly sampling strategy. The taxa were identified by cross-referencing them with the IUCN Red List of Threatened Species (Version 2017-1, IUCN 2017) and the Catalogue of Life 2017 Annual Checklist Roskov *et al.* (2017), taking into account the global status and trends of each taxon that was available. Numerous sources, including publications, records from government departments, and reports from non-governmental organizations (NGOs), were used to gather the secondary data.

Fish sample collection

Samples of fish and shellfish were collected during the study period at monthly basis from fish landing sites in the area and from previously identified fishermen. Within the research area, nearby fishermen use a range of fishing gear, including lift nets, hooks, traps, gill nets, and seine nets. According to Kundu *et al.* (2020) study, each of these techniques is intended to catch a certain kind and size of fish, and their levels of effectiveness differ. Throughout the dry season, the data gathering procedures for sampling remained constant.

Identification of fish sample

The fish and shellfish that were collected were classified based on their distinct physical attributes. If a species proved challenging to identify in the field, it was preserved in a 10% buffered formalin solution prior to being transported to the Fisheries Biology and Genetics department at Bangladesh Agricultural University for a comprehensive analysis. The process of identification encompassed the analysis of the specimens' coloration, morphometric attributes, and meristic characteristics. The taxonomic evaluation adhered to the principles outlined by IUCN Bangladesh (2015), Talwar & Jhingran (1991), and Rahman (2005), whilst the categorization of fish species was conducted using Nelson (2006) methodology.

Data analysis

The data obtained from the questionnaire interviews was subjected to analysis using Microsoft Excel 2013. Diversity of the species assemblage was analyzed by the Shannon-Wiener index (H') (Shannon & Wiener, 1949), species richness was measured by Margalef index (d) (Margalef, 1978), evenness was measured by Pielou's index (J') (Pielou, 1966) and dominance was measured by Simpson index (c) by using following formula:

Shannon-Weiner diversity index (H')

$$H' = \sum [Pi \acute{} ln(Pi)]$$

Where, H' = Shannon Wiener index and
Pi = ni/N
(ni = No. of individuals of species N = Total number of individuals)

Margalef species richness (d)

$$d = (S-1)/log(N)$$

Where, S = Total species N = Total individuals.

Pielou's evenness index (J')

$$J' = \frac{H(s)}{H(max)}$$

Where, H (s) = The Shannon-Wiener information function.
H (max.) = The theoretical maximum value for H(s) if all species in the sample were equally abundant

Simpson dominance index (c)

$$c = \sum_{i=1}^{S} (ni/N)^2$$

Where, ni = Number of individuals in the 'each' species; N = Total number of individuals; S = Total number of species.

RESULTS AND DISCUSSION

Catch composition

A total of 3,360 fish individuals, consisting of 52 fish species from 8 orders and 19 families, were recorded in the investigated beel (Table 1). Cypriniformes was identified as the dominating order among the 8 orders examined, accounting for 51.49% of the total. The remaining 7 orders, namely Siluriformes, Perciformes, Synbranchiformes, Channiformes, Clupeiformes, Cyprinodontiformes, and Osteoglossiformes, comprised 25.15%, 16.88%, 2.30%, 2.24%, 1.11%, 0.71%, and 0.11%, respectively. Both the order Cypriniformes and Siluriformes consist of 15 species each. This is followed by Perciformes (10 species), Channiformes (4) species, Synbranchiformes (3) species, Clupeiformes (2) species, Osteoglossiformes (2) species, and Cyprinodontiformes (1) species. (Table 1, Figure 3). The species *Esomus danricus* (Darkina) and *Puntius terio* (Teri puti) had the highest abundance, accounting for 12.23% of the total, while Chitala chitala (Chital) displayed the lowest abundance, representing only 0.03% (Table 1). About 53 fish species (from 10 orders, 28 families, and 47 genera) were identified and collected from the Andharmanik River in the Patuakhali district, according to Mohsin *et al.* (2014). The dominant order is Perciformes, which has 18 species, followed by Siluriformes,

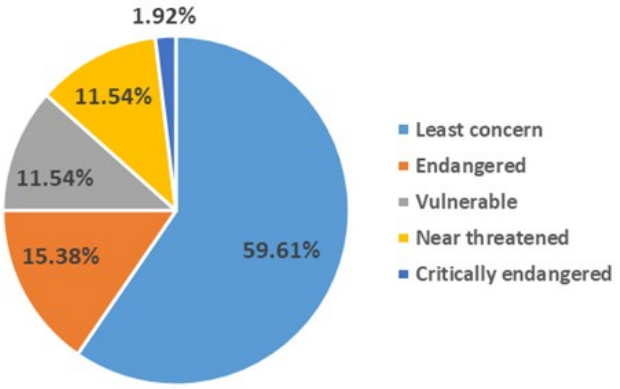

Figure 2. *Present status of fish biodiversity of Chinadi beel.*

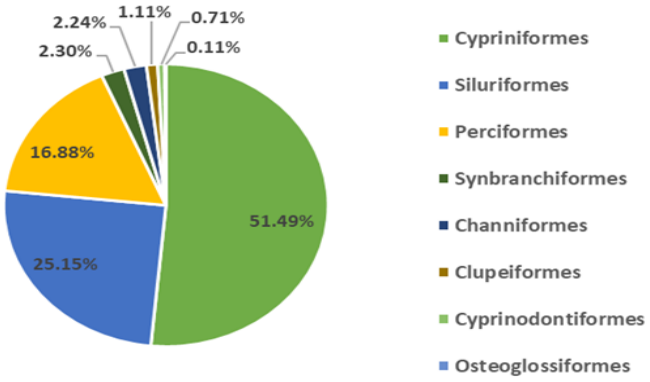

Figure 3. *The variety of fish species under various orders found in Chinadi beel.*

which has 12 species, and Clupeiformes, which has 9 species. About 114 and 52 fish species were discovered in Chalan beel (Natore-Pabna-Sirajganj) and Shakla beel (Brahmanbaria), respectively, by Hossain *et al.* (2009) and Ahmed *et al.* (2004). Consistent with our results, Kostori *et al.* (2011) reported that 82 small indigenous species (SIS) were classified into 22 families, 10 orders, and 46 genera, with 35 species belonging to the major order Cypriniformes (42.68%). With 54 species from the Charar beel, the Cyprinidae Family contained the greatest number of fish species (Raushon *et al.*, 2019). The Cyprinidae family is the largest family in the Bhawal beel, with 17 species contributed, according to Sultana *et al.* (2019). Similar to the current study, the majority of the sixteen fish species belonging to the Cyprinidae family were observed in the Dogger beel (Siddiq *et al.*, 2013). 52 fish species were studied in the Chinadi Beel during that time. 31 (59.61%) were categorized as least concern, 8 (15.38%) as endangered, 6 (11.54%) as vulnerable, 6 (11.54%) as near threatened, and 1 (1.92%) as extremely endangered. This data is derived from the IUCN 2015 global conservation status report (Table 1, Figure 2). It was noteworthy that no species found throughout the inquiry fell under the IUCN conservation status (IUCN 2015), which classifies them as internationally endangered.

The IUCN conservation status of Bangladesh (IUCN 2015) states that during the study period, 23 species were identified as least concern (44.23%), 8 species as endangered (15.38%), 5 species as vulnerable (11.54%), 6 near threatened (11.54%), 8 species as not available (15.38%), and 1 critically endangered (1.92%). Among the many fish species found in the Gurukchi River, Pandit *et al.* (2020) counted 29.82% of RAs, 28.07% of CAs, 22.81% of MAs, and 19.30% of AAs. The challan beel was enrolled by CA (23%), AA (17%) and RA (19%) according to Galib *et al.* (2013). In Bhawal beel, 44.65% were available, 19.64% were seasonal, and 16.08% were rare, according to Sultana *et al.* (2019). There are 44 different species of fish found in the Netrokona district's Pirla beel, 30 of which are common, 9 of which are uncommon, and 5 of which are critically endangered (Siddique, 2001). From Chalan beel, Ahsan (2008) found 105 species of fish, of which 6 are classed as critically endangered, 14 as vulnerable, 25 as endangered, and 45 as threatened. Ten endangered and seven severely endangered fish species were among the 54 fish species found in the Kafrikhal beel by Halim *et al.* (2017). In the Andharmanik River in Patuakhali, Mohsin *et al.* (2014) found five vulnerable, three endangered, and two highly endangered species. Here, six fish species from the Choto Jamuna River that are severely endangered, ten endangered, and ten vulnerable were documented by Galib *et al.* (2013). Our results were in line with those of Rahman *et al.* (2015), who discovered two fish species in the Rabnabad Canal that are critically endangered, seven endangered, and seven vulnerable. In Bangladesh's Khiru River, Akter *et al.* (2020) found that cypriniformes had the highest order-based proportion (31.25%), followed by siluriformes (28.13%) and perciformes (14.06%).

The current result is validated by Imteazzaman & Galib's (2013) findings that Cypriniformes (41.27%) was the dominant order in Halti Beel, Bangladesh, followed by Siluriformes (22.22%) and Perciformes (20.63%). The Medha Beel is home to a diverse range of aquatic animals, including four types of prawns, one type of crab, one type of snail, and seven species of native fish. According to Chakraborty *et al.* (2009), the aforementioned species are divided into 50 different genera and 23 different families. It was reported that a total 47 fish species were found in BSKB beel (Rahman, 2000) and 40 species of fish in Chanda beel (Ehshan *et al.*, 2000) which was less than our study. Chakraborty & Mirza (2007) found 70 fish species from the Gharia beel. Halim *et al.* (2017) reported that approximately 54 species of fish fauna were observed in Kafrikhal beel. According to a separate study, a total of 68 fish species were documented in the aquatic environments of Itna, Kishoregonj (Sakawat, 2002). As per the findings of Galib *et al.* (2009), an investigation carried out at Chalan beel documented the existence of 81 distinct species of fish, of which 81 were native and 9 were non-native or exotic. There were a total of 59 genera, 27 families, and 12 orders among the species. Bogjan Beel was the source of 93 aquatic species, as determined by Kumar (2011), which is an increase over the current count. Saha & Hossain (2002) reported that there were 40 fish species in Saldu beel. Haroon *et al.* (2002) documented 92 species of finfish and crustaceans from the sub basins of Sylhet and Mymensingh, which is comparable to the current investigation.

Due to over exploitation of fishery resources in the beel, the population of these species is steadily declining. The decline in fish biodiversity is mostly attributed to factors such as fast urbanization, overfishing, lack of awareness among fishermen,

Table 1. Catch composition and conservation status of different fish species identified in Chinadi beel.

Family	Local name	English name	Species	Total catch	% catch composition			IUCN status	
					Individual	Family	Order	GL	BD
Cypriniformes									
Cyprinidae	Catla	Catla	*Gibelion catla*	5	0.14	51.49	51.49	LC	LC
	Silver carp	Silver carp	*Hypophthalmichthys molitrix*	7	0.21			NT	LC
	Bighead carp	Bighead carp	*Hypophthalmichthys nobilis*	5	0.14			DD	LC
	Ruhu	Ruhu carp	*Labeo rohita*	9	0.27			LC	LC
	Mrigal	Mrigal	*Cirrhinus cirrhosis*	4	0.12			LC	NT
	Grass carp	Grass carp	*Ctenopharyngodon idella*	3	0.09			LC	LC
	Common carp	Common carp	*Cyprinus carpio*	5	0.14			VU	LC
	Mola	Mola carplet	*Amblypharyngodon mola*	367	10.92			LC	LC
	Darkina	Flying barb	*Esomus danricus*	411	12.23			LC	LC
	Bata	Bata labeo	*Labeo bata*	73	2.17			LC	LC
	Kalibaus	Orange fin labeo	*Labeo calbasu*	4	0.12			LC	LC
	Gonia	Kuria labeo	*Labeo gonius*	11	0.33			LC	NT
	Tit punti	Ticto barb	*Pethia ticto*	361	10.74			LC	VU
	Teri puti	One spot barb	*Puntius terio*	411	12.23			LC	LC
	Raj puti	Java barb	*Barbonymus gonionotus*	55	1.64			LC	LC
Cyprinodontiformes									
Aplocheilidae	Kanpona	Blue panchax	*Aplocheilus panchax*	24	0.71	0.71	0.71	LC	LC
Siluriformes									
Clariidae	Magur	Air breathing catfish	*Clarias batrachus*	89	2.65	2.65	25.15	LC	LC
Heteropneustidae	Shing	Stringing catfish	*Heteropneustes fossilis*	221	6.58	6.58		LC	LC
Pangasiidae	Pangas	Yellow tail catfish	*Pangasius pangasius*	11	0.33	0.33		LC	EN
Siluridae	Boal	Freshwater shark	*Wallogo attu*	5	0.15	7.92		VU	VU
	Kani Pabda	Pabo catfish	*Ompok bimaculatus*	125	3.72			NT	EN
	Pabda	Pabda catfish	*Ompok pabda*	134	3.99			NT	EN
	Baghair	Dwarf goonch	*Bagarius bagarius*	2	0.06			NT	CE
Schilbeidae	Baspata	Jamuna aila	*Ailia coila*	32	0.95	1.31		NT	LC
	Garua	Garua bachua	*Clupisoma garua*	12	0.36			LC	EN
Bagridae	Rita maach	Rita	*Rita rita*	21	0.63	6.37		LC	EN
	Tengra	Striped river catfish	*Mystus vittatus*	67	1.99			LC	LC
	Gulsha tengra	Tengra mystus	*Mystus tengra*	60	1.79			LC	LC
	Aor	Long-whiskered catfish	*Sperata aor*	9	0.27			LC	VU
	Gang tenga	Gangetic tengra	*Mystus cavasius*	55	1.64			LC	NT
	Guizza aor	Giant river-catfish	*Sperata seenghala*	2	0.06			LC	VU
Perciformes									
Ambessdae	Ranga chanda	Indian glassy fish	*Chanda ranga*	64	1.90	4.02	16.88	LC	LC
	Nama chanda	Elongate glass perchlet	*Chanda nama*	71	2.11			LC	LC
Anabantidae	Koi	Climbing perch	*Anabas testudineus*	67	1.99	1.99		LC	LC
Belontiidae	Kholisha	Striped gourami	*Trichogaster fasciata*	73	2.17	2.17		LC	LC
Cichlidae	Tilapia	Mozambique tilapia	*Oreochromis mossambicus*	41	1.22	2.80		VU	LC
	Nilotica	Nile tilapia	*Oreochromis niloticus*	53	1.58			LC	LC
Gobiidae	Bele	Tank goby	*Glossogobius giuris*	71	2.11	2.11		LC	LC
Nandidae	Napit koi	Badis	*Badis badis*	51	1.52	2.53		LC	NT
	Meni	Gangetic leaffish	*Nandus nandus*	34	1.01			LC	NT
Osphronemidae	Kholisha	Banded gourami	*Colisa fasciata*	42	1.25	1.25		LC	LC
Clupeiformes									
Clupeidae	Chapila	Ganges River Gizzard Shad	*Gonialosa manmina*	16	0.48	1.11	1.11	LC	LC
	Kachki	Ganges river sprat	*Corica soborna*	21	0.63			LC	LC
Osteoglossiformes									
Notoptetidae	Chital	Humped feather-back	*Chitala chitala*	1	0.03	0.11	0.11	NT	EN
	Foli	Grey featherback	*Notopterus notopterus*	3	0.09			LC	VU
Synbranchiformes									
Mastacembelidae	Tara baim	Striped spiny eel	*Macrognathus aculeatus*	39	1.16	2.30	2.30	NE	NT
	Sal baim	Tire track eel	*Mastacembelus armatus*	21	0.63			LC	EN
	Kuchia	Cuchia	*Monopterus cuchia*	17	0.51			VU	VU
Channiformes									
Channidae	Taki	Spotted snakehead	*Channa punctatus*	41	1.22	2.24	2.24	LC	LC
	Shol	Stripped snakehead	Channa striatus	11	0.33			LC	LC
	Gozar	Great snakehead	*Channa marulius*	13	0.39			LC	EN
	Gachua	Walking snakehead	*Channa orientalis*	10	0.30			VU	LC

*GL= Global; BD = Bangladesh; LC = Least concern; EN = Endangered; VU = Vulnerable; NT = Near threatened; NE = Not evaluated; NA = Not available; DD = Data deficient; CE = Critically endangered.

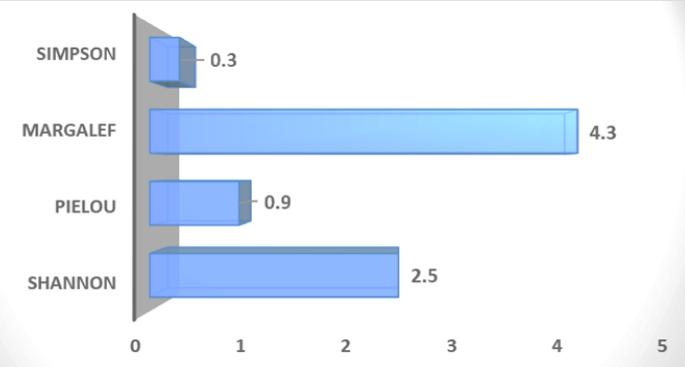

Figure 4. *Comparison of species diversity indices.*

Figure 5. *Threats and stressors of Chinadi beel.*

and the utilization of harmful fishing gear. Furthermore, the SIS (small indigenous species) are in imminent danger of extinction as a result of habitat and environmental degradation, which hinders their ability to reproduce naturally. For the destruction of our fishery resources, the construction of elevated roads, drainage systems, embankments, and destructive fishing gear in excess of natural habitats have been identified as contributing factors (Ali, 1997; IUCN 2020). According to the findings of Joadder *et al.* (2015), a significant proportion of fish species, specifically 72%, were classified as least concern according to the IUCN Global conservation status. None of the listed fish species are classified as endangered according to global conservation criteria. In Bangladesh, those fishes were classified as threatened, indicating that they were either of least concern or near threatened on a global scale. In the context of Bangladesh, the species *Chitala chitala* and *Ompok pabda* were classified as endangered, however on a worldwide scale, they were found to be classified as near threatened species. The primary aim of the IUCN Red List is to facilitate the monitoring of species availability and the management of species extinction by highlighting the importance of conservation concerns to both the general public and policymakers (Alam *et al.*, 2013).

Species diversity status

Sample size, species richness, and evenness all affect the Shannon-Wiener diversity index (H') (Sunny *et al.*, 2020; Islam & Gnauck, 2007). The Shannon-Wiener diversity index (H') was determined to be 2.5 (Figure 4), whereas Sunny *et al.* (2020) found it to be 3.72. Pielou recorded an evenness index (J') of 0.90 (Figure 4). Pielou's evenness index, which was roughly comparable to the results of the current study was measured at 0.71 in the Bakkhali muddy beach in Cox's Bazar (Sunny *et al.*, 2018). Because the Margalef index is improperly confused with the evenness and species richness values, its value may vary somewhat from the real diversity value. The Margalef richness index (d) was 4.30 in Figure 4, whereas Sunny *et al.* found it to be 4.3 (Sunny *et al.*, 2018), which was in line with the results of the current investigation. In the Chinadi beel, the Simpson dominance index (c) was found to be 0.30 (Figure 4). Sunny *et al.* (2018) found a similar outcome in Dekhar haor. H changed from 2.04 (December) to 2.50 (February), d from 4.11 (February) to 4.30 (January), J' from 0.27 (December) to 0.30 (February), and C from 0.86 (December) to 0.90 (February) at different points in the current study. According to the data for H, J', and C, the month with the most fish fauna was February. The greatest number of fish species were discovered during this time. The lowest species were reported in December. The Talma River displayed fluctuations in H, D, and e values throughout the year, according to Rahman *et al.* (2015). Between June and October, the H values varied from 1.06 to 1.51, while between July and October, the D values varied from 5.34 to 7.41. The e values also differed, ranging from 0.65 in May to 0.73 in October. In Hakaluki Haor, the values of the diversity index ranged from 1.726 (November) to 3.406 (May), the evenness index values from 0.4879 (September) to 0.8252 (May), the dominance index values from 0.625 (September) to 0.9423, and the richness index values from 3.889 (November) to 8.679 (January) (Iqbal *et al.*, 2015). Das *et al.* (2022) observed that in the Shari-Goyain River, the values of C, J, and D fluctuated from 0.244 (January) to 0.294 (November), 3.430 (December) to 2.325 (March), and 0.508 (November) to 0.561 (March). H had a maximum value of 3.49 and a minimum of 3.29, C had a maximum value of 0.06 and a minimum value of 0.05, D had a range of 7.91 to 6.60, and J had a range of 0.50 to 0.61. D fluctuated from 3.13 (December) to 2.11 (March), J value varied from 0.48 (November) to 0.51 (March), and C varied from 0.21 (January) to 0.27 (November) in Dekhar Haor, according to Sunny *et al.* (2020) findings. The values of H, C, D, and J range from 6.71 to 6.80, 2.11 to 0.45, 0.45, and 0.53, respectively, and are comparable to our findings. The maximum and lowest values of C were measured at 0.04 and 0.02 respectively.

Threats of Chinadi beel

The fish biodiversity of the wetland ecosystems is imperiled by exploitation, environmental degradation, and the ongoing phenomenon of climate change (Islam *et al.*, 2018; Sunny, 2017). The length of the rainy season can vary, occurring in the early summer or early winter. The study also identified indiscriminate use of pesticides and herbicides during the dry season, overfishing, illegal fishing, dewatering, irrigation, fry and brood fishing, and the failure to implement a natural resource management strategy as potential threats (Figure 5). These results amply

demonstrated that the reduction in wetland biodiversity was caused by both natural and human-caused factors, which corroborated the findings of Islam *et al.* (2018) and Sunny, (2017). In that area, political power over natural resources was quite strong. The study discovered a leasing system that is prompted by the political leaders in the area, which prevents ordinary people from fishing and encourages the practice of illicit fishing. Similar declining reasons of fish diversity in Bangladesh's inland water bodies were noted by Stoddard *et al.*, (2006). The present findings are supported by the findings of Chakraborty and Nur (2009), Siddiq *et al.* (2013), Galib *et al.* (2009), Nishat (1993), Chakraborty & Mirza (2007), Khan (1993), Ali (1991), and Zaman (1993), which showed essentially the same causes of fish diversity loss.

Major jeopardize associated in fishing

A total of 68±2% of the respondents in this study confirmed that they were increasingly losing hope for a career in fishing. They determined that a number of reasons contributed to this state of affairs, including the decreasing trend in fish availability, the absence of alternative sources of income, environmental uncertainty, low income, high daily commodity prices, and volatile market prices. They asserted that if these conditions persisted for an extended length of time, the fishing community's way of life would be more precarious and this vocation would be in danger. Additionally, it was noted that 60±6% of respondents said that high daily commodity prices and poor income facilities were the primary factors that put them in a precarious situation, whereas 38±1% of respondents said that uncertainty was the primary reason of this danger.

Socio-economic concern

The lifestyle of resource users residing in the Chinadi beel exhibited notable distinctions when compared to other regions within the country. The majority of the fisherman lacked land ownership. Certain fishers who possessed land exhibited a limited quantity and were unable to meet their fundamental necessities. Their dwellings were constructed from soil, dilapidated, submerged in water, or remained abandoned. The susceptibility of their house structure and living environment to environmental changes was heightened. The economic sustenance of the individuals residing in this community was directly or indirectly interconnected with the resources found within this marsh. The well-being of communities is significantly affected by any changes in fishing biodiversity, whether they are improvements or declines. The community's engagement in illegal fishing was exacerbated by the frequent incidence of natural disasters, which adversely affected their productive assets and infrastructures. The heightened vulnerability to natural disasters has a detrimental impact on the health infrastructure, availability of safe drinking water, insufficient sewage infrastructure, and inadequate structural safeguards. The residents of this hamlet are also susceptible to sudden illnesses, floods, droughts, fluctuations in fishery resources throughout the year, and illicit fishing. The inclination towards illegal fishing as a means to mitigate climatic loss ultimately led to a decline in biodiversity.

Conclusion

Based on the findings of the present investigation, it has been observed that the Chinadi beel harbors a diverse array of fish species. Nevertheless, the population of fish within this beel is progressively diminishing as a result of anthropogenic activities such as overfishing, habitat degradation, the utilization of destructive fishing equipment, the construction of dams, embankments, and siltation, among other factors. Additionally, certain natural factors, including the presence of a highly drought-prone region and alterations in the river course, have also contributed to this decline. The problem exacerbates as a result of illicit juvenile fishing, brood fishing, and overfishing, ultimately exerting a significant impact on the self-sufficiency of the reliant population. The improvement of the situation necessitates the rigorous adoption of sustainable wetland management approaches, including Community Based Fisheries Management (CBFM), Co-management, and the Ecosystem Approach for Fisheries Management (EAFM). Aside from the management plan, it is crucial to prioritize the establishment of both temporary and permanent havens. In order to reduce dependence on wetland resources, it is imperative to explore alternative avenues for producing revenue, taking into consideration the perspectives of the local community. The introduction of native fry into the natural wetland will contribute to the enhancement of biodiversity. To ensure the conservation of biodiversity and effective management of wetland ecosystems in Bangladesh, it is recommended to conduct a thorough and extensive biodiversity census.

DECLARATIONS

Author contribution statement

Conceptualization: MHM and MM.; Methodology: MHM.; Software and validation: MHM., IR.; Formal analysis and investigation: SP; Resources: MHM.; Data curation: IR.; Writing—original draft preparation: MHM.; Writing—review and editing: MHM.; Visualization: RY.; Supervision: IR.; Project administration: MHM.; Funding acquisition: MM. All authors have read and agreed to the published version of the manuscript.

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