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Research Article

The biodiversity and conservation assessment of Bamui *beel* in Bangladesh: Current status and threats

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ABSTRACT

A year-long research was conducted with a novel purpose for categorizing and documenting the existing fish diversity and abundance of Bamui *beel* in Jamalpur district located in Northeast part of Bangladesh, within a time frame from July 2022 to June 2023. A total of 46 fish species were identified that belonged to 18 taxonomical families and 8 orders. The most abundant family was Cyprinidae (25%). Among 46 species, 37% were commonly available (CA) and 11% were abundantly available (AA) in terms of biodiversity status. According to the global conservational status, around 74% were reported as least concerned (LC) whereas 4% were nearly threatened (NT). On the other hand, in consonance with the conservational status of Bangladesh 52% were least concerned (LC) and 11% were endangered (EN). Pielou's evenness score in Bamui *beel* was the highest (0.247) in pre-monsoon and the lowest (0.213) in monsoon. Shannon-Weaver diversity index was ranged from 1.992 to 2.114, whereas Simpson's dominance index value was a maximum of 0.883 in pre-monsoon and a minimum of 0.852 in monsoon. The yearly fish production of the *beel* was 7.023 metric tons during experimental year. Besides this, small indigenous species (SIS) of fish dominated with 63.34% of the *beel*'s species makeup. Nevertheless, the abundance and diversity of fish species are diminishing daily in this *beel*. For preserving the fish diversity of Bamui *beel* calls for the implementation of effective fishery management practices, vigilant monitoring to prevent overfishing, and a strong emphasis on raising awareness among fishermen.

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INTRODUCTION

Bangladesh is plentiful and blessed with huge and rich fisheries resources that are enriched and diverse with 260 freshwater indigenous fish species that belong to 145 genera and 55 families that constitute the most diverse fish biodiversity ever documented [1–3]. Bangladesh is a riverine country with numerous rivers, canals, floodplains, ponds, *beels*, haors, reservoirs, artificial lakes, and a long coastline with estuaries [4–6]. One of the top nations in the world

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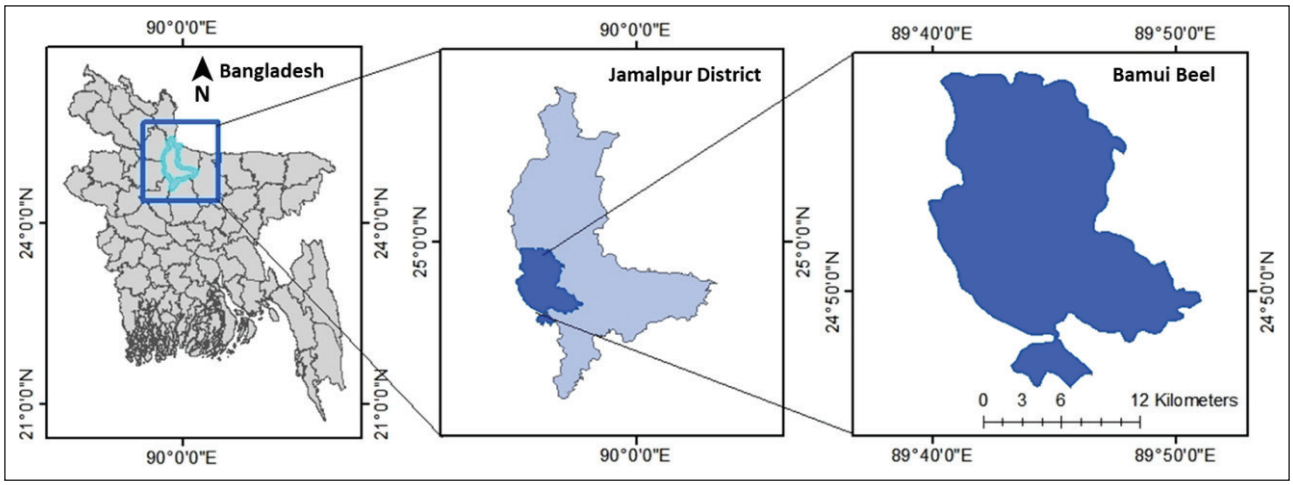

Figure 1. Map depicting the study area of Bamui *beel* in Bangladesh (89.42°12′35″ E Longitude and 24.50°10′87″ N Latitude).

for fish production is a country named Bangladesh [7]. Bangladesh ranked fifth in the world and third in Asia in aquaculture production in 2019 [8]. In Bangladeshi diets, fish alone provides over 63% of animal protein and many of other important vitamins and minerals [9–11]. Major subsistence and commercial fishing are supported by *haors* and *beels*, while extensive aquatic flora from those ecosystems provides rich grazing for domestic cattle, as well as fuel and fertilizer for the local purposes [12]. Environmental, sociological, and commercial dynamics link with biotic and abiotic components, particularly people and are useful in protecting aquatic habitats as a part of nature [13]. The significant decline in natural fish habitats and global biodiversity has elevated the exploration of heterogeneity as a primary focus for fisheries scientists. Genetic taxa, assemblages, ecosystems, and essential features should be considered in biodiversity experiments for assessing diversity and conservational status [14]. Besides, Bangladesh has a substantial capture rate due to its extensive river systems. The favorable topographical position and climatic conditions have facilitated the capture fishing and aquaculture potential of that nation [15]. The Bengali word "*beel*" refers to a static, rather large water body that collects run-off through an internal drainage canal. In low-lying floodplain regions of Bangladesh, this kind of seasonal and shallow water body is typical [16]. *Beel* covers about 114,161 acres, or 27.0% of inland freshwater of Bangladesh [17]. A *beel* becomes a very large water body in the monsoon and primarily dries out in the post-monsoon season because it absorbs surface run-off water from rivers and channels (Khal) [18–20]. But in the past 150 years, wetlands across the world have changed, degraded and/or perhaps disappeared up to 50% because of climate change, population increase, urbanization, conversion to agricultural field and others [21]. Developing nations like Bangladesh already perceived the importance of keeping an eye on biodiversity in protected regions [22].

Regrettably, encroachment and ecological pollution, which includes activities like renovating embankment structures, have posed a significant threat to freshwater ecosystems. Additionally, the degradation caused by sewage, commercial waste, agricultural litter, and drainage has contributed to the decline of a substantial number of aquatic species [13]. The diversity indexes are useful methods that offer crucial data on the status of species variation found in a water body [23]. A few researches have been carried out to determine the diversity of fish and fish-related other aquatic organisms in Bangladesh [24, 25]. In Bangladesh, several researches have been conducted for the greater biodiversity of *beel* fisheries, including Chalan *beel* [26], Gharia *beel* [20], Chanda *beel* [27] and Kawadighi *beel* [28] to name some. The Chalan *beel* species diversity is shrinking continuously, mainly because of the deterioration of the water quality due to pollution, exploitation, improper use of crop pesticides and uncontrolled over-fishing [26].

Up to date, no research has been conducted yet on the fisheries biodiversity status of the Bamui *beel*. Therefore, this would be the first documentation of fish biodiversity for that inland waterbody. This experiment was mainly focused on the documentation of fishes and prawns available and also entails the threats and condition of aquatic biodiversity in the Bamui *beel* of Bangladesh.

MATERIALS AND METHODS

Study Area and Time Frame

The experiment was conducted at Bamui *beel* within the Jamalpur Sadar upazilla at approximately between the 89.42°12′35″ E Longitude and 24.50°10′87″ N Latitude in the Jamalpur district under the Mymensingh division of Bangladesh. This water body is situated 5.5 kilometers away from Digpait Bazar and is placed directly beside the Tangail-Jamalpur highway. The Bamui *beel* is connected with the Bangshi river (Fig. 1). Data were collected from the selected areas during the months of July 2022 to June 2023.

Water Quality Parameters

A number of clear 500 ml marked black bottles were used for collection of water samples. Then water samples were taken in the vial immediately after sample collection at the site. Different analyses were done by using an YSI digital wa-

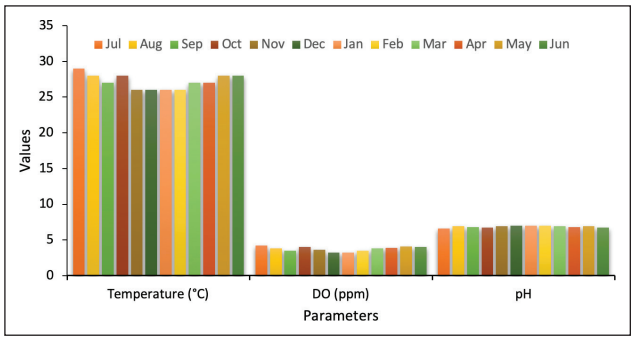

Figure 2. Month-wise water quality parameters of Bamui beel from July 2022 to June 2023.

ter quality multimeter (USA) for determining the value of water parameters (Temperature, Dissolved oxygen and pH).

Data Collection

Before collecting the necessary data, a questionnaire was prepared which was checked and verified by biodiversity experts. All data were collected by the research personnel himself using personal interviews from local fish farmers (n=357). Fish sampling was carried out at various locations with the assistance of fishermen by utilizing traditional fishing techniques with a variety of nets (gill nets, cast nets, and drag nets) and from nearby local fish markets adjacent to the *beel*. The data was collected from both primary and secondary sources. The researchers personally gathered the primary data from fishermen. Around 3 field visits per month were made to collect water quality parameters and detailed information on aquatic fauna with high biological diversity.

Biodiversity Status Analysis

Different diversity indexes were calculated to analyze the fish diversity including Simpson's dominance index (D), Pielou's evenness index (J´), and Shannon-Weaver diversity index (H).

The above-mentioned diversity indexes were calculated using the following formula [29]. Shannon-Weaver Diversity Index:

$$H = -\sum Pi(lnPi)$$

Here, Pi is the relative abundance (s/N) and H is the diversity index. Shannon-Weaver variation is a popular metric for assessing the degree of variety among many habitats. Simpson's Dominance Index:

$$D = \{\sum n(n\text{-}1)/N(N\text{-}1)\}$$

The calculation of habitat biodiversity, considering both the overall species count and their proportional representation, was typically performed utilizing the following equation [30]. Pielou's Evenness Index:

$$J' = H/lnS$$

Here, S is the total number of species, ln is the natural logarithm, J' is the similarity or evenness index, and H' is the Shannon-Weaver index. The probability that two individuals, picked randomly and separately from a population would belong to different species was represented by Pielou's evenness index [31].

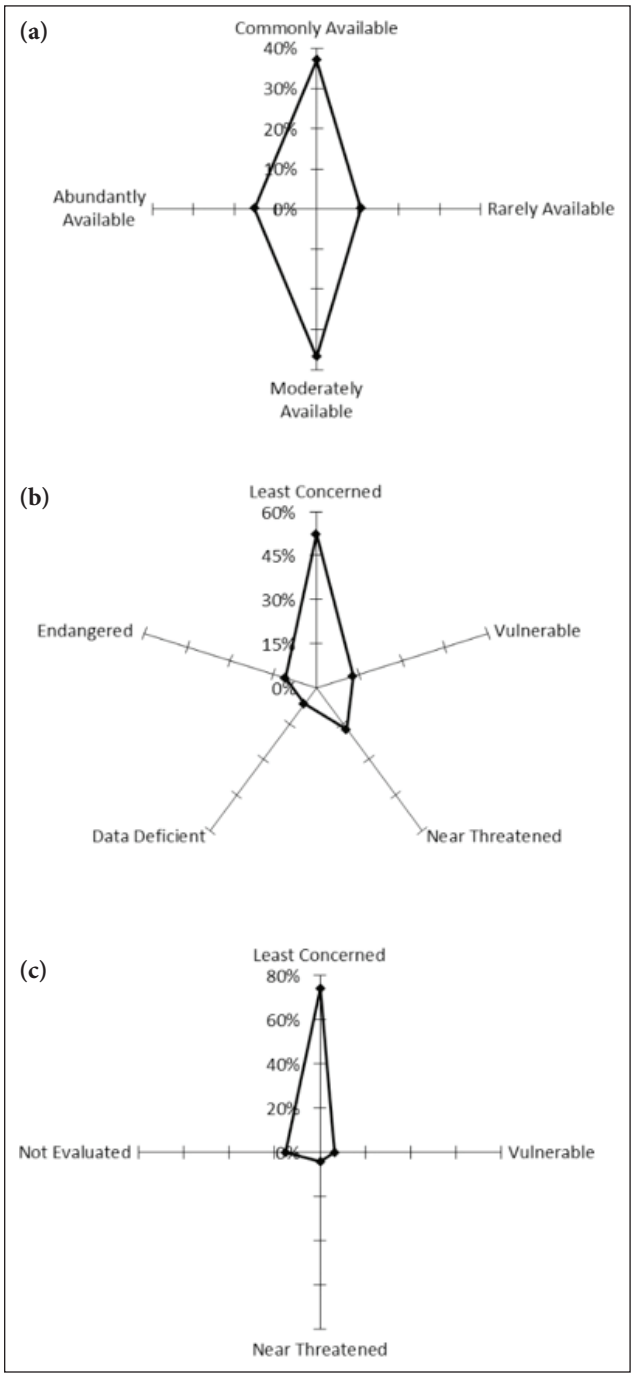

Figure 3. **(a)** Present status of fish species in Bamui *beel*, **(b)** Conservational status according to Bangladesh, **(c)** Global conservational status of existing species.

Statistical Analysis

All the data were accumulated to analyze the findings. Tabular technique was applied by using simple statistical tools such as percentages and averages. For processing and analyzing the data "Microsoft Office 2019" and "IBM SPSS 26" were used, finally presented through textual, tabular and graphical format for better understanding.

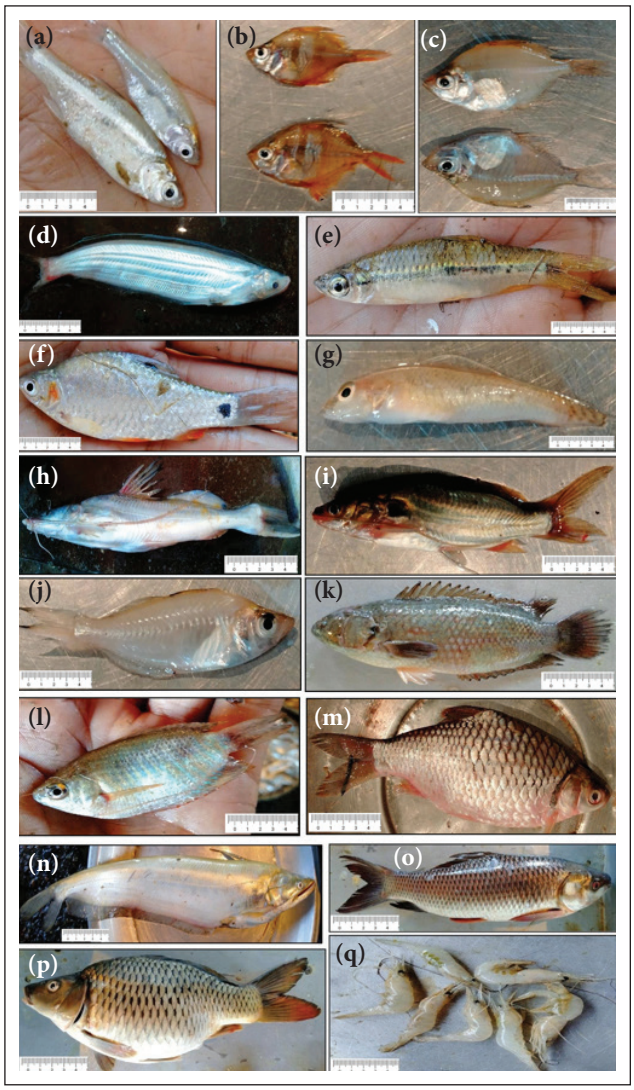

Figure 4. Some important fish species in the Bamui *beel* according to the conservational status of Bangladesh: **(a)** *Amblypharyngodon mola*, **(b)** *Chanda lala*, **(c)** *Chanda beculis*, **(d)** *Ompok pabo*, **(e)** *Esomus danricus*, **(f)** *Pethia ticto*, **(g)** *Glossogobius giuris*, **(h)** *Sperata aor*, **(i)** *Mystus vittatus*, **(j)** *Chanda nama*, **(k)** *Anabas testudineus*, **(l)** *Trichogaster fasciata*, **(m)** *Barbodes sarana*, **(n)** *Wallago attu*, **(o)** *Labeo rohita*, **(p)** *Cyprinus carpio*, **(q)** *Solenocera crassicornis*.

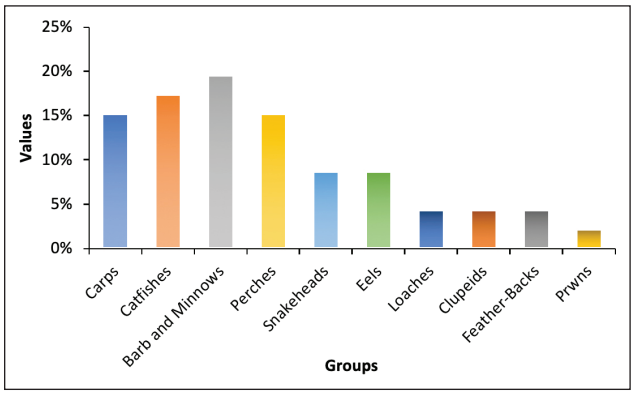

Figure 5. Status of different fish groups in the Bamui *beel*.

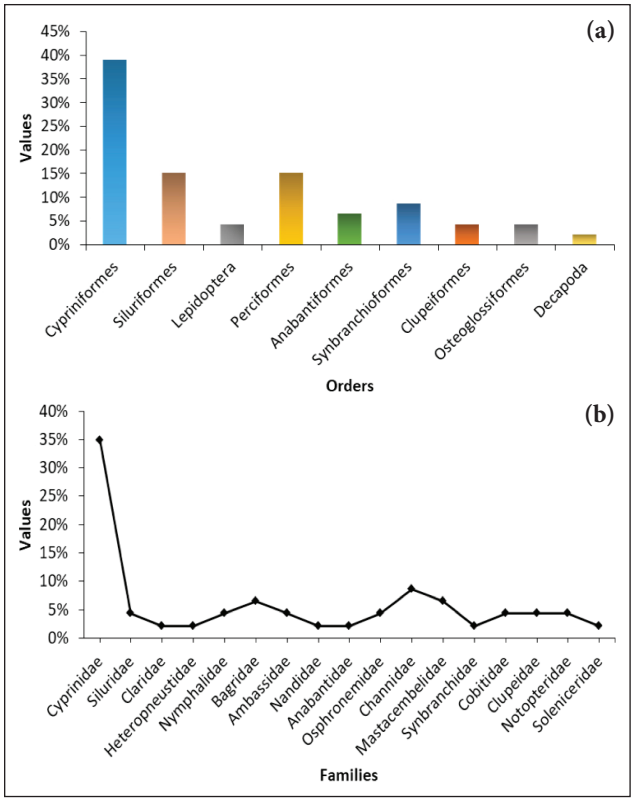

Figure 6. Fish species in the Bamui *beel* under different **(a)** order and **(b)** families.

RESULTS AND DISCUSSION

Water Quality Parameters

Water quality parameters like temperature, dissolved oxygen (DO) and pH of the study area are presented in (Fig. 2) throughout the study period. The average highest temperature and DO of the *beel* was found in the month of July and pH was found in the months of December to February.

Fish Biodiversity and Conservational Status of Bamui *Beel*

Top ten mostly abundant fish species prior to its availability of Bamui *beel* has been enlisted during the experiment (Table 1). Additionally, seven different species of carp were identified in the study. Among them *Labeo rohita*, *Labeo calbasu*, *Ctenopharyngodon idella*, *Cyprinus carpio* and *Labeo gonius* were moderately available (MA) (Fig. 3). Rest of the carp species were commonly available (CA). During the research period, eight (08) different species of catfish were found in the Bamui *beel*. *Wallago attu*, *Ompok pabo*, *Heteropneustes fossilis* and *Sperata aor* were commonly available (CA) of catfish while *Pseudeutropius atherinoides*, *Mystus bleekeri* and *Mystus vittatus* were abundantly available (AA). On the other hand, *Clarias batrachus* was moderately available (Fig. 3). Additionally, nine (09) different species of barbs and minnows were recorded. Among different types of Barbs and Minnows, *Puntius ticto*, *Puntius sophore*, *Puntius guganio* and *Amblypharyngodon mola* were abundantly available (AA). *Puntius chola*, *Barbodes sarana* and *Securicula gora* were moderately available (MA). While the abundance of *Salmostoma acinaces* and *Osteobra-*

Table 1. Top ten fish species (abundance) of the Bamui *beel*

Serial number (chronologically)	Species
01	*Puntius ticto*
02	*Channa punctata*
03	*Labeo rohita*
04	*Catla catla*
05	*Cyprinus carpio*
06	*Ctenopharyngodon idella*
07	*Heteropneustes fossilis*
08	*Mystus vittatus*
09	*Wallago attu*
10	*Mystus bleekeri*

ma cotio was common and rare, respectively. Biodiversity research using catch observation surveys in this experiment was demonstrated that many species of Snakehead, Perch, and Eels were available in the Bamui *beel*. Seven species of Perch were identified in Bamui *beel* throughout the study. *Chanda lala*, *Chanda nama* and *Anabas testudineus* were moderately available (MA) among them. According to local fishermen, the rest of them were commonly available (CA) (Table 2). Four snakehead species were identified in this study period. *Channa punctate* and *Channa orientalis* were commonly available (CA). In addition to this, *Channa striata* was moderately available (MA), whereas *Channa marulius* was rarely available. Various Eels species such as *Macrognathus aral* and *Mastacembelus armatus* were moderately available (MA), but *Mastacembelus pancalus* and *Monopterus cuchia* were rarely available (RA). Two kinds of Loaches were found in Bamui *beel* throughout the research period and both were commonly available (CA). Moreover, Clupeids were identified in which Indian River Shad was rarely available and the Ganges River Sprat was commonly available. Because there was no prior experiment on fish biodiversity and abundance of Bamui *beel*, it was not possible to analyze the development in diversification of the *beel* by comparing with earlier ones. Species compositions (%), productivity (kg/ha) and production (MT) of different species groups was observed in Table 3. The highest composition, productivity and production was found for Small Indigenous Species (SIS) with the value of 63.4%, 256.25 kg/ha and 3.672 MT, respectively. The diversity and abundance of aquatic organisms in the Bamui *beel*, however, was comparable to that of several wetlands and *beel* ecosystems [32]. However, the current study could be a useful starting point for any future assessments of fish diversity of Bamui *beel*.

However, two feather-back species were observed in all the catches. Finally, only species of prawn (*Solenocera crassicornis*) found in this *beel*, and it was critically endangered (Table 2). Several important species of the *beel* have been highlighted in this experiment (Fig. 4). The Pilati *beel* hosted a total of 55 fish species, among them most dominant order was cypriniformes (38.18%) mirroring the findings of present study [33]. The presence of 16 fish species from the Cyprinidae family in the Dogger *beel* was documented which was similar to our current study [34].

In terms of group abundance, Barbs and Minnows was dominated (19.56%) followed by Catfishes (17.38%), Carps (15.22%), Perches (15.22%), Snakeheads (8.70%), Eels (8.70%), Loaches (4.35%), Clupeids (4.35%), Feather-backs (4.35%) and Prawns (2.17%) (Fig. 5). In Figure 6, Cypriniformes (39.12%) was the most dominating order followed by Siluriformes (17.40%), Perciformes (17.40%), Synbranchioformes (8.68%), Anabantiformes (6.51%), Clupeiformes (4.35%), Osteoglossiformes (4.35%) and Decapoda (2.18%). Moreover, the highest amount of fishes was under the family Cyprinidae (34.76%) followed by Channidae (8.68%), Bagridae (6.51%), Mastacembelidae (6.51%), Siluridae (4.35%), Cobitidae (4.35%), Ambassidae (4.35%), Osphronemidae (4.35%), Clupeidae (4.35%), Nymphalidae (2.18%), Claridae (2.18%), Heteropnuestidae (2.18%), Nandidae (2.18%), Anabantidae (2.18%), Synbranchidae (2.18%), and Soleceridae (2.18%) showing in Figure 6. Study on *beel* fisheries in Bangladesh is very few, assessment of fish biodiversity in Basuakhali *beel* at Khulna district was recorded [35]. Likewise this experiment, cypriniforms order was recorded as the most dominant with 12 species in Gorai River [36]. Also fish biodiversity research on various location of Bangladesh reported presence of similar fish species but varying numbers, for example, a total 57 species of fish from the Old Brahmaputra river [37], 106 species of fish which belongs to 31 families in Chalan *beel* [38], 92 species of fish from Sylhet-Mymensingh sub-basins [39].

Although the Bamui *beel* is the habitat of an extensive array of aquatic organisms, there are significant issues about the existence and survival of aquatic diversification because of an assortment of human and ecological phenomena that are lowering richness in the *beel* region. Various biodiversity based fish research is going to make a clear concept on fish species existence. The Cyprinidae family contained the most fish species which was about 54 species in Charar *beel* [40]. Cyprinidae family contributed 17 species, which made it the most abundant family in the Bhawal *beel* [41]. Jat punti (*Puntius sophore*) has been reported as the most available and dominant species at the Hatil *beel* of Bangladesh [42]. Availability of low sediment and pure water in Bamui *beel* made it a suitable place for fish to reproduce. As per report, over half of the total fish population (53.36%) in Bangladesh fell under the "Least Concern (LC)" category [43]. Additionally, around 14.55% and 10.90% of the overall fish species were classified as near-threatened and vulnerable in the same study, respectively. Natural vegetation offers a natural biological balance for sheltering other broodfish, while emergent and submerged vegetation is an excellent home for small and medium-sized fishes. Similar research was conducted on many rivers of Bangladesh such as the Tista River [25], the Padma River [44], the Mahananda river [45] and the Choto Jamuna River [42].

All fish species in Bamui *beel* were negatively impacted by scorching *beels*, high precipitation, over exploitation, land subsidence, usage of hazardous gears to catch fishes, tem-

Table 2. List of freshwater species with their availability and conservation status found in Bamui beel during experiment

Order	Family	Scientific name	English name	Commo n name	Present status	Conservation status	
						BD	Global
Cypriniformes	Cyprinidae	*Labeo rohita* (Hamilton, 1822)	Rohu	Rui	MA	LC	LC
		Cirrhinus reba (Hamilton, 1822)	Reba Carp	Lachu	CR	NT	LC
		Labeo calbasu (Hamilton, 1822)	Orange Fin Labeo	Kalbasu	MA	LC	LC
		Cyprinus carpio (Hamilton, 1822)	Common Carp	Carpio	MA	NT	VU
		Ctenopharyngodon idella (Hamilton, 1822)	Ray-Finned Fishes	Grass Carp	MA	NT	NE
		Labeo gonius (Hamilton, 1822)	Kuria Labeo	Gonia	MA	NT	LC
		Esomus danricus (Hamilton, 1822)	Stripped Flying Barb	Darkina	CR	DD	NE
		Puntius ticto (Hamilton, 1822)	Ticto Barb	Tit Punti	AA	VU	LC
		Puntius sophore (Hamilton, 1822)	Spotfin Swamp Barb	Jat Punti	AA	LC	LC
		Puntius guganio (Hamilton, 1822)	Glass Barb	Mola Punti	AA	LC	LC
		Puntius chola (Hamilton, 1822)	Chola Barb	Chola Punti	MA	LC	LC
		Amblypharyngodon mola (Hamilton, 1822)	Mola Carplet	Mola	AA	LC	LC
		Osteobrama cotio (Hamilton, 1822)	Cotio	Dhela	RA	NT	LC
		Securicula gora (Hamilton, 1822)	Chela Gora	Ghora Chela	MA	NT	LC
		Salmostoma acinaces (Valenciennes, 1844)	Silver Razorbelly Minnow	Chela	CR	DD	LC
		Barbodes sarana (Hamilton, 1822)	Olive Barb	Shorputi	MA	NT	LC
	Cobitidae	*Lepidocephalus guntea* (Hamilton, 1822)	Guntea Loach	Gutum	CR	LC	LC
		Botia dario (Hamilton, 1822)	Bengal Loach	Bou Rani	CR	EN	LC
Siluriformes	Siluridae	*Wallago attu* (Linnaeus, 1758)	Freshwater Shark	Boal	CR	VU	VU
		Ompok pabo (Hamilton, 1822)	Pabo Catfish	Pabda	CR	CR	NT
	Clariidae	*Clarias batrachus* (Hamilton, 1822)	Walking Catfish	Magur	MA	LC	LC
	Heteropneustidae	*Heteropneustes fossilis* (Bloch & Schneider, 1801)	Asian Stinging Catfish	Shing	CR	LC	LC
	Schilbeida	*Pseudeutropius atherinoides* (Bloch, 1794)	Indian Potasi	Batashi	AA	LC	NE
	Bagridae	*Sperata aor* (Hamilton, 1822)	Long-Whiskered Catfish	Air	CR	VU	LC
		Mystus bleekeri (Day, 1877)	Bleeker's Mystus	Gulsha Tengra	AA	LC	LC
		Mystus vittatus (Hamilton, 1822)	Asian Striped Catfish	Tengra	AA	LC	LC
Perciformes	Ambassidae	*Chanda lala* (Hamilton, 1822)	Highfin Glassy Perchlet	Lal Chanda	MA	LC	NE
		Chanda nama (Hamilton, 1822)	Elongate Glass Perchlet	Lamba Chanda	MA	LC	LC
	Nymphalidae	*Chanda beculis* (Hamilton, 1822)	Dewelled Nawab	Chanda	CR	EN	NE

Table 2 (cont). List of freshwater species with their availability and conservation status found in Bamui beel during experiment

Order	Family	Scientific name	English name	Commo n name	Present status	Conservation status	
						BD	Global
	Nandidae	*Nandus nandus* (Hamilton, 1822)	Gangetic Leaf Fish	Meni	CR	NT	LC
	Channidae	*Channa marulius* (Hamilton, 1822)	Giant Snakehead	Gozar	RA	EN	LC
		Channa striata (Bloch, 1793)	Snakehead Murrel	Shol	MA	LC	LC
		Channa punctate (Bloch, 1793)	Spotted Snakehead	Taki	CR	LC	LC
		Channa orientalis (Bloch & Schneider, 1801)	Asiatic Snakehead	Cheng	CR	LC	LC
Anabantiformes	Anabantidae	*Anabas testudineus* (Bloch, 1793)	Climbing Perch	Koi	MA	LC	LC
		Trichogaster fasciata (Bloch & Schneider, 1801)	Banded Gourami	Baro Kholisha	CR	LC	LC
Synbranchiformes	Osphronemidae	*Trichogaster lalius* (Hamilton, 1822)	Red Gourami	Lal Kholisha	CR	LC	LC
	Mastacembel idae	*Macrognathus aral* (Bloch & Schneider, 1801)	One-Stripe Spiny Eel	Tara Baim	MA	DD	LC
		Mastacembelus pancalus (Hamilton, 1822)	Striped Spiny Eel	Guchi Baim	RA	LC	LC
		Mastacembelus armatus (Lecepede, 1800)	Tire-Track Spinyeel	Baim	MA	EN	NE
	Synbranchidae	*Monopterus cuchia* (Hamilton, 1822)	Gangetic Mudee	Kuchia	RA	VU	VU
Clupeiformes	Clupeidae	*Gudusia chapra* (Hamilton, 1822)	Indian River Shad	Chapila	RA	VU	LC
		Corica soborna (Hamilton, 1822)	The Ganges River Sprat	Kachki	CR	LC	LC
Osteoglossiformes	Notopteridae	*Notopterus notopterus* (Pallas,1769)	Bronze Featherback	Foli	MA	VU	LC
		Chitala chitala (Hamilton, 1822)	Humped Featherback	Chitol	MA	EN	NT
Decapoda	Soleniceridae	*Solenocera crassicornis* (H. Milne Edwards,1837)	Red Prawn	Gura Chingri	CR	LC	NE

NE: Not Evaluated; DD: Data deficient; LC: Least concern; NT: Near threatened; VU: Vulnerable; EN: Endangered; RA: Rarely available; MA: Moderately available; CR: Critically endangered; BD: Bangladesh.

Table 3. Species compositions (%), productivity (kg/ha) and production (MT) of different groups observed in the *beel*

Group name	Species compositions (%)	Productivity (kg/ha)	Total production in the beel (MT)
Small indigenous species	63.4	256.25	3.672
Large indigenous group	21.67	146.77	1.876
Exotic fishes	13.26	94.63	1.232
Prawn	1.61	17.48	0.243
Total	100		7.023

Table 4. Causes of diversity degradation mentioned by local ordinary people, fishermen and landowners (n=357)

Causes of affecting species diversity	No. of respondents (%)
Drying beel each year	91.67
Excessive fish catch	90.45
Usage of harmful fishing equipment	88.72
Extensive agricultural practices	72.26
Building lane and elevation near the beel	66.32
Usage of insecticides	61.48
Soil erosion	56.15
Building a blockade	44.42
Government negligence	30.64
Draught	23.71

perature inversions, and the addition of inorganic supplement to capture fishes. Every year, those who rent the *beel*, dewater the entire water body (generally using a powerful pump) before subletting them to the other groups, who also repeat the same scenario once again since some water is left in the *beels* just after primary dehydration. Identical issues were discovered which were engaged to involve biodiversity degradation. The main reasons behind the reduction in the biodiversity of Bamui *beel* are mainly drying *beel* every year (91.67%), overfishing (90.45%), usage of harmful fishing equipment (88.72%), and extensive agricultural practices (72.26%), building lane and elevation near the *beel* (66.32%), usage of insecticides (61.48%), soil erosion (56.15%), building a blockade (44.42%), government negligence (30.64%), draught (23.71%) (Table 4).

Biodiversity Index Status

Biodiversity index of the Bamui *beel* during different seasons (post-monsoon, monsoon and pre-monsoon) are shown in Figure 7. The highest Evenness score of 0.247 during pre-monsoon was suggested a relatively balanced distribution of species abundance. This could mean that no single species was dominating the ecosystem, and various species coexist in similar numbers. In contrast, the lower Evenness score of 0.213 during the monsoon implied a more uneven distribution, with some species possibly becoming more dominant. The range of values between 1.992 and 2.114 indicated a moderate level of diversity in Bamui *beel*. A higher index generally suggests a more diverse ecosystem [5]. The slight variation across seasons could signify changes in the composition or abundance of species, contributing to the overall diversity. The maximum Simpson's dominance index of 0.883 in pre-monsoon was suggested a relatively high dominance of certain species during that period. As the dominance decreased to a minimum of 0.852 in the monsoon, it implied a reduction in the influence of dominant species, leading to a more evenly distributed community. Similar pattern of Simpson's dominance index (0.325 in monsoon and 0.893 in pre-monsoon) was observed in Bangladesh's Dhaleshwari River [46]. Shannon Weaver diversity index (H') considered both the number of species and the distribution of individuals among species of the Bamui *beel*. For observational data, the Shannon-Weaver diversity index (H') normally varied from 1.5 to 3.5, it seldom exceeded 4.0 and could rise over 5.0 only when samples contained one million organisms [47]. The value of Shannon-Weaver diversity index (H') was the highest in pre-monsoon (2.114), whereas the value was the lowest in monsoon (1.992). Similarly, Shannon-Weaver diversity index (H') also demonstrated that the higher availability of species in pre-monsoon compared to monsoon and post-monsoon. Analogous result ranging from 0.95 to 2.62 for the Shannon-Weaver diversity index (H') was also observed in the Bakkhali River estuary [48]. Pielou's evenness index (J') in Bamui *beel* was the highest during pre-monsoon (0.247) and the lowest during monsoon (0.213). The Richness index in Hakaluki Haor was exhibited a range between 3.889 (in November) and 8.679 (in January) [49]. Correspondingly, Pielou's evenness index (J') values varied from 0.4879 (in September) to 0.8252 (in May), while Simpson's dominance index values spanned from 0.625 (in September) to 0.9423 (in May). The Shannon-Weaver diversity index (H') was showed fluctuations from 1.726 (in November) to 3.406 (in May) [49]. In the Shari Goyain river, Simpson's dominance index (D) was ranged from 3.430 (in December) to 2.325 (in March) and Pielou's evenness index (J') values was ranged from 0.508 (in November) to 0.561 (in March) [50].

Stakeholder's Perception on Bamui *Beel* Fisheries

Regarding fishery productivity and ecology, each factor had favorable and unfavorable effects. 357 people involving fish related work (property owners, fishers, and ordinary people) took part in the questionnaire and provided their meaningful thoughts on their meaningful thoughts and experience on Bamui *beel* fisheries (Fig. 8). The main question was *beel* fisheries should be permitted 62.36% of

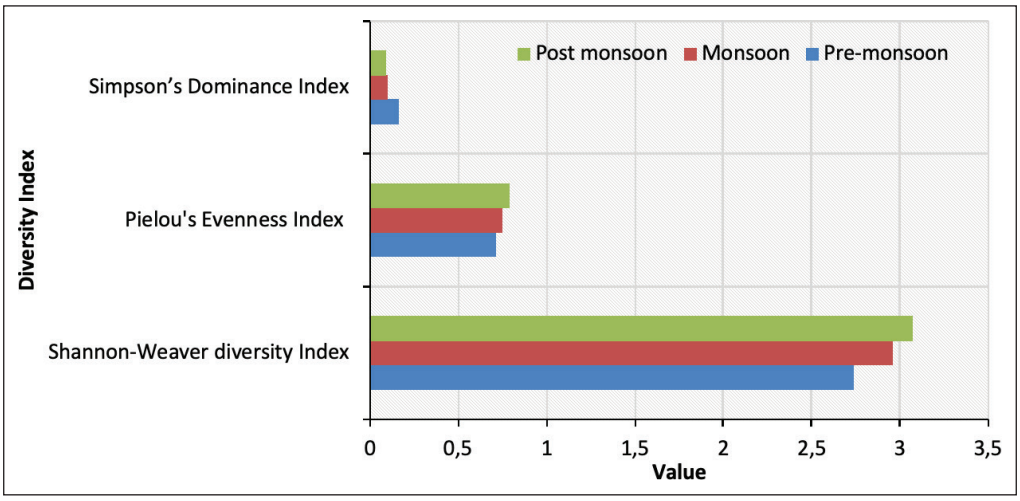

Figure 7. Biodiversity index of Bamui *beel* during three seasons (post-monsoon, monsoon and pre-monsoon).

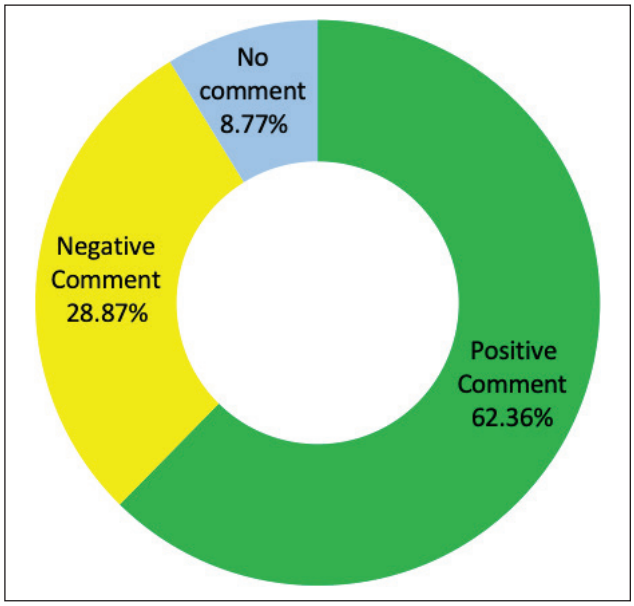

Figure 8. Stakeholder's (n=357) opinion from the study area.

total participants agreed about permitting the *beel* fisheries, while negative feedback was given by 28.87%, and 8.77% was not sure or didn't share their opinion (Fig. 8). All negatively participants responded that they didn't have total access to harvest fishes in the *beel* region during the whole year. Once questioned that there was a potentiality of effective fish reproduction (specially the threatened species) to keep the sustainable balance for the future generation, all the respondents replied affirmatively. Additionally, the respondents also expressed that dewatering the water bodies was degrading the habitat of fishes. Statement given above, inferred that fish production would increase the productivity and thus could maintain a sustainable biodiversity in the Bamui *beel*.

In essence, the initial biodiversity and conservation assessment of Bamui *Beel* not only contributes to our scientific understanding of this unique ecosystem but also provides a foundation for concrete conservation actions. By recognizing its importance and addressing the threats it faces, we can work towards ensuring the long-term health and resilience of the Bamui *beel* for future generations.

CONCLUSION

In assumption, the inaugural biodiversity and conservation assessment of the Bamui *beel* in Bangladesh has provided valuable insights into the current status and approaching threats facing this ecosystem. About 46 fish species were found that was under the 18 taxonomical families and 8 orders, within these species 37% were commonly available and 11% were abundantly available in terms of biodiversity status. The comprehensive examination of biodiversity has unveiled a nuanced understanding of the ecological dynamics, with a particular focus on the diverse array of species inhabiting the Bamui *beel*. The identification of threats serves as a crucial foundation for informed conservation efforts. The findings of the study were underscored that the urgency of implementing strategic conservation measures to mitigate the identified threats and preserve the biodiversity of the Bamui *beel*.

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DATA AVAILABILITY STATEMENT

The author confirm that the data that supports the findings of this study are available within the article. Raw data that support the finding of this study are available from the corresponding author, upon reasonable request.

CONFLICT OF INTEREST

The author declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

ETHICS

In the present study, fish were handled according to the guidelines as described the Animal Ethics Committee of Sylhet Agricultural University (Memo: SAU/AEC/FOF/ARM-102).

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