Article

Indigenous Freshwater Ichthyofauna in the Dhanu River and Surrounding Wetlands of Bangladesh: Species Diversity, Availability, and Conservation Perspectives

Debasish Pandit ^{1,*} , Shuva Saha ² , Mrityunjoy Kunda ¹ and Ahmed Harun-Al-Rashid ¹

¹ Department of Aquatic Resource Management, Sylhet Agricultural University, Sylhet 3100, Bangladesh; kunda.sau@gmail.com (M.K.); russel.sau@gmail.com (A.H.-A.-R.)

² Department of Fish Biology and Genetics, Sylhet Agricultural University, Sylhet 3100, Bangladesh; shuvasahasau@gmail.com

* Correspondence: dpandit.sau@gmail.com; Tel.: +880-1724868478

Abstract: A checklist of the native fishes of the Dhanu River and adjacent waters at Mithamain Upazila under the Kishoreganj district of Bangladesh is prepared with details on their availability, conservation status, habitat preferences, population trends, and threats. Data were collected monthly by field survey, focus group discussions, and personal interviews by using a semi-structured questionnaire and a pictorial check list of fish species. A total of 91 indigenous fish species of 59 genera belonging to 29 families under 11 orders were documented where 17.6%, 27.5%, 31.9%, and 23.1% species were abundantly available, commonly available, moderately available, and rarely available, respectively. Among those, 24 fish species (26.4%) were under the threatened category (3 critically endangered, 11 endangered, and 10 vulnerable) according to the IUCN Bangladesh. Notably, the globally threatened *Cirrhinus cirrhosus*, *Channa orientalis*, and *Wallago attu* were available in the study area. Fish population trends of 24.2% and 59.3% of the entire fish species were found in decreasing trends at the global and national level, respectively. The leading threats to the fish diversity were indiscriminate overfishing followed by fishing by dewatering of wetlands, the *katha* fishing method, the use of deprecated fishing gears, etc. Minimizing anthropogenic impacts, enacting fishing laws, installing and managing fish sanctuaries, and raising public awareness can be effective for the conservation of existing fisheries resources.

Keywords: *beel*; management; fish diversity; IUCN; native fishes

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1. Introduction

Bangladesh is a realm of wetlands with a diversified area of open water fisheries resources comprising inland and marine fisheries [1]. The inland share of these resources has an irrevocable contribution in the economy and food habits of the Bangladeshi citizens [2,3]. By position, the country ranked third in inland open water capture fisheries production and attained the fifth position in aquaculture production in the whole world [4]. Fish constitutes the major source of protein, consisting of about 60% of the available animal protein in the Bangladeshi people's diet [1]. Fish, the most consumed fisheries resource, has a wide range of species variation in Bangladesh, and the numbers of fish species in the wetlands differ from each other because of the distinct ecologies of those wetlands [5]. Rahman [5] recorded 265 indigenous freshwater fish species in Bangladesh, which were under 154 genera and 55 families. However, only 253 indigenous fish species were assessed by IUCN Bangladesh [6], where 113 species were floodplain inhabitants, 104 were riverine, and 36 were migratory species (travel floodplains and rivers) [6].

Haors are saucer or bowl-shaped shallow depressions distributed along the north-eastern part of Bangladesh, which include irrigation canals, large seasonally inundating agricultural lands, and the coalescence of hundreds of inter-affiliated *beels* [1,4,7–9]. *Beels*

are permanent wetlands and constitute a major habitat for fish production (869 kg ha^{-1}) in Bangladesh. The total area of *beel* in Bangladesh is nearly 114,161 ha, which is a contributor of 2.3% fish of the country's yearly fish production [1]. About 700 rivers, from large stretches to small tributaries, are distributed in the country and shape a waterway with a total length of about 24,140 km [6,10]. These rivers are the main perennial freshwater wetlands of Bangladesh which provide habitats for feeding, breeding, and dry season shelter to various fish species [6], but there is a clear lack of information on the fish diversity of rivers in Bangladesh [11].

The Dhanu River, with its lower portion called the Ghorautra River, is a tributary of the Meghna River. It is navigable throughout the year and makes its way towards the south from the Sunamganj district and flows along the eastern part of the Netrakona and Kishoreganj districts [12,13]. The river is also enriched with diversified aquatic resources and provides habitat for aquatic organisms including fishes and other aquatic fauna and flora [13]. Fishers with different fishing boats and gears capture an uncountable number of fishes from this river every day. Thus, this river has a great impact on the overall economy of this region [13].

Natural resources are limited, and their sustainable use is very important for human being. Therefore, biodiversity conservation and its sustainable management are considered as major moves [10]. However, wild fish populations are disappearing gradually from the rivers, *haors*, *beels*, floodplains, and other wetlands of Bangladesh and around the world due to the degradation and loss of their natural habitats, overexploitation, climate change, man-made fibers, microplastic pollution, and other manmade and natural causes [6,8,9,14–19]. However, the Dhanu River has a favorable water quality that supports a variety of aquatic lives [13], but the fish biodiversity of this river and adjacent *beels* are at risk of disappearance. Many of the fishes may have done so already amid the vulnerable, endangered, and critically endangered categories, which are unknown due to lack of published materials on the fish biodiversity of this river. Worldwide events of unprecedented extinction of variety of species have come to light with the help of the study on biodiversity [20]. Pandit et al. [8] and Huda et al. [21] mentioned that the biodiversity of fish should be known before applying any management tool to the fishery of a waterbody, which intimates the necessity of a profound research on fish biodiversity of these wetlands. In this circumstance, research work aspires to obtain a narrated overview with an updated list of existing fish species of the Dhanu River and its adjacent waters for planning subsequent steps for the effective management of these resources and their conservation as well. However, the specific objective of this study was to prepare a checklist of indigenous fish species including their present availability status in the Dhanu River and adjacent wetlands in relation to the national and global conservation status, habitat preferences, population trends and intimidations. Notably, this is the first checklist of indigenous freshwater fishes in this area.

2. Materials and Methods

2.1. Study Area

The current study was conducted in the Dhanu River and surrounding *beels* of Mithamain Upazila (sub-district) under the Kishoreganj district of Bangladesh. Mithamain is located between $24^{\circ}49'$ and $25^{\circ}06'$ north latitudes and $91^{\circ}27'$ and $91^{\circ}49'$ east longitudes (Figure 1). To collect primary data on fish availability, the study area was divided into 8 sampling sites (4 sites in the Dhanu River and 4 sites in 4 *beels* named Farua, Nikla, Khunkhuni, and Deodhuri *beels*) (Figure 1), and data were collected from each site from July 2016 to June 2018.

Figure 1. The inset showing the location of Bangladesh. In the enlarged map (bottom), sampled river sites (RS) are indicated by red circles, *beel* sites (BS) by black ovals, and minor rivers are shown as blue lines. The water flow direction is shown by black arrows on the Dhanu River (yellow line) (Google Earth Pro).

2.2. Data Collection Framework

The data were gathered monthly from the study area by field survey and specimen collection [8,9,22]. Information about present condition of existing fishes were collected by means of personal interview with fishers, fishing vessel owners, fish traders, native people, riverside residents, and other forthcoming people from the sampling areas. Focus group discussions were also performed in fish landing centers and fishers' villages near those selected sampling sites with a pictorial check list of indigenous fish species and a semi-structured questionnaire.

Samples of different fish species were collected directly from the catch of fishers, fish landing stations of the selected sites and from retail markets as well. The collected fish samples were identified in the field to the species level by the examination of the morpho-

metric and meristic attributes, following some previously published literatures [5,6,23,24]. The fish samples, which were found difficult to identify in the field, were preserved in 10% buffered formalin and transported to the laboratory of the Department of Aquatic Resource Management, Sylhet Agricultural University, Sylhet, for appropriate identification. Identified species of fish were grouped into 4 categories based on people's perceptions and frequency of occurrence (percent of surveys in which respective species were documented by the researcher) modified from Myers et al. [25] and Jadhav et al. [26]. The categories are as follows: abundantly available (AA): species plentifully observed throughout the year (frequency of occurrence: 76–100%); commonly available (CA): species generally observed throughout the year but in small numbers (frequency of occurrence: 51–75%); moderately available (MA): species observed infrequently in the study area (frequency of occurrence: 26–50%); and rarely available (RA): species observed occasionally in very small numbers (frequency of occurrence: 1–25%). The national and global conservation status and population trends were determined by following IUCN Bangladesh [6] and IUCN [27].

3. Results and Discussion

3.1. Diversity of Fish Species

In total, 8 sampling sites represented the existence of 91 indigenous fish species, which were under 59 genera, 29 families, and 11 orders (Table 1).

Table 1. List of recorded fish species in the Dhanu River and surrounding *beels* (BD = Bangladesh; Present status: AA = Abundantly Available, CA = Commonly Available, MA = Moderately Available, RA = Rarely Available; Conservation status: NE = Not Evaluated, NT = Near Threatened, LC = Least Concerned, VU = Vulnerable, EN = Endangered, DD = Data Deficient, CR = Critically Endangered; Habitat: B = *Beel*, R = River; Population trend: IN = Increasing, ST = Stable, DE = Decreasing, UN = Unknown).

ID	Order/Family	Species	English Name	Bengali Name	Present Status	Conservation Status		Habitat	Population Trends	
						BD	Global		BD	Global
1	Anguilliformes Anguillidae	<i>Anguilla bengalensis</i> (Gray, 1831)	Indian mottled eel	Bamosh	RA	VU	NT	R	DE	UN
2	Beloniformes Belonidae	<i>Xenentodon cancila</i> (Hamilton, 1822)	Freshwater garfish	Kakila	CA	LC	LC	B	UN	UN
3	Hemiramphidae	<i>Hyporhamphus limbatus</i> (Valenciennes, 1847)	Congaturi halfbeak	Ekthote	MA	LC	LC	R	UN	ST
4	Clupeiformes Clupeidae	<i>Corica soborna</i> Hamilton, 1822	The Ganges river sprat	Kachki	CA	LC	LC	R	UN	UN
5		<i>Tenualosa ilisha</i> (Hamilton, 1822)	Hilsa	Ilish	RA	LC	LC	R	IN	DE
6		<i>Gudusia chapra</i> (Hamilton, 1822)	Indian river shad	Chapila	AA	VU	LC	R	DE	DE
7	Engraulidae	<i>Setipinna phasa</i> (Hamilton, 1822)	Gangetic hairfin anchovy	Phasa	RA	LC	LC	R	DE	UN
8	Cypriniformes Cyprinidae	<i>Amblypharyngodon mola</i> (Hamilton, 1822)	Mola carplet	Mola	MA	LC	LC	B	DE	ST
9		<i>Chela cachius</i> (Hamilton, 1822)	Silver hatchlet barb	Chhep chela	MA	VU	LC	R	DE	UN
10		<i>Esomus danricus</i> (Hamilton, 1822)	Flying barb	Darkina	MA	LC	LC	B	DE	ST
11		<i>Osteobrama cotio</i> (Hamilton, 1822)	Cotio	Dhela	RA	NT	LC	R	DE	UN
12		<i>Rasbora daniconius</i> (Hamilton, 1822)	Slender barb	Darkina	RA	LC	LC	B	DE	UN
13		<i>Rasbora rasbora</i> (Hamilton, 1822)	Gangetic scissortail rasbora	Darkina	MA	NT	LC	B	DE	UN

Table 1. Cont.

ID	Order/Family	Species	English Name	Bengali Name	Present Status	Conservation Status		Habitat	Population Trends	
						BD	Global		BD	Global
14		<i>Salmostoma argentea</i> (Day, 1867)	Silver razorbelly minnow	Chela	RA	DD	LC	R	DE	UN
15		<i>Salmostoma bacaila</i> (Hamilton, 1822)	Large razorbelly minnow	Katari chela	MA	LC	LC	R	DE	ST
16		<i>Salmostoma phulo</i> (Hamilton, 1822)	Finescale razorbelly minnow	Fulchela	CA	NT	LC	R	DE	UN
17		<i>Gibelion catla</i> (Hamilton, 1822)	Catla	Catla	RA	LC	LC	R	DE	UN
18		<i>Cirrhinus cirrhosus</i> (Bloch, 1795)	Mrigal carp	Mrigal	MA	NT	VU	R	DE	DE
19		<i>Cirrhinus reba</i> (Hamilton, 1822)	Reba carp	Laccho	CA	NT	LC	R	DE	ST
20		<i>Devario devario</i> (Hamilton, 1822)	Sind danio	Chapchela	MA	LC	LC	B	DE	UN
21		<i>Labeo bata</i> (Hamilton, 1822)	Bata labeo	Bata	RA	LC	LC	R	UN	UN
22		<i>Labeo boga</i> (Hamilton, 1822)	Boga labeo	Bhangan	RA	CR	LC	R	UN	UN
23		<i>Labeo calbasu</i> (Hamilton, 1822)	Black rohu	Kalibaosh	CA	LC	LC	R	IN	UN
24		<i>Labeo gonius</i> (Hamilton, 1822)	Kuria labeo	Gonia	CA	NT	LC	R	DE	UN
25		<i>Labeo pangusia</i> (Hamilton, 1822)	Pangusia labeo	Ghora maach	RA	EN	NT	R	DE	DE
26		<i>Labeo rohita</i> (Hamilton, 1822)	Rohu	Rui	MA	LC	LC	R	DE	UN
27		<i>Puntius chola</i> (Hamilton, 1822)	Chola barb	Chola punti	MA	LC	LC	B	UN	UN
28		<i>Pethia conchonius</i> (Hamilton, 1822)	Rosy barb	Kanchan punti	MA	LC	LC	B	UN	UN
29		<i>Pethia gelius</i> (Hamilton, 1822)	Golden dwarf barb	Gili punti	MA	NT	LC	B	UN	UN
30		<i>Pethia guganio</i> (Hamilton, 1822)	Glass barb	Mola punti	MA	LC	LC	B	UN	UN
31		<i>Pethia phutunio</i> (Hamilton, 1822)	Spottedsail barb	Phutani punti	RA	LC	LC	B	UN	UN
32		<i>Systemus sarana</i> (Hamilton, 1822)	Olive barb	Sarpunti	AA	NT	LC	B	DE	UN
33		<i>Puntius sophore</i> (Hamilton, 1822)	Spotfin swamp barb	Jat punti	AA	LC	LC	B	UN	UN
34		<i>Puntius terio</i> (Hamilton, 1822)	One spot barb	Teri punti	RA	LC	LC	B	UN	UN
35		<i>Pethia ticto</i> (Hamilton, 1822)	Ticto barb	Tit punti	CA	VU	LC	B	DE	UN
36		<i>Securicula gora</i> (Hamilton, 1822)	Chela gora	Ghora chela	CA	NT	LC	B	DE	UN
37		<i>Salmostoma acinaces</i> (Valenciennes, 1844)	Silver razorbelly minnow	Chela	RA	LC	LC	R	UN	UN
38	Cobitidae	<i>Botia dario</i> (Hamilton, 1822)	Queen loach	Rani mach	MA	EN	LC	B	UN	UN
39		<i>Lepidocephalichthys annandalei</i> Chaudhuri, 1912	Annaldale loach		RA	VU	LC	B	DE	UN
40		<i>Lepidocephalichthys guntea</i> (Hamilton, 1822)	Guntea loach	Gutum	CA	LC	LC	B	DE	ST
41		<i>Canthophrys gongota</i> (Hamilton, 1822)	Gongota loach	Ghora gutum	MA	NT	LC	R	DE	UN

Table 1. Cont.

ID	Order/Family	Species	English Name	Bengali Name	Present Status	Conservation Status		Habitat	Population Trends	
						BD	Global		BD	Global
42	Cyprinodontiformes Aplocheilidae	<i>Aplocheilus panchax</i> (Hamilton, 1822)	Blue panchax	Kanpona	CA	LC	LC	B	UN	UN
43	Mugiliformes Mugilidae	<i>Rhinomugil corsula</i> (Hamilton, 1822)	Corsula	Corsula	MA	LC	LC	R	UN	UN
44	Osteoglossiformes Notopteridae	<i>Chitala chitala</i> (Hamilton, 1822)	Humped featherback	Chital	RA	EN	NT	R	DE	DE
45		<i>Notopterus notopterus</i> (Pallas, 1769)	Grey featherback	Kanla	MA	VU	LC	B	DE	ST
46	Perciformes Gobiidae	<i>Glossogobius giurus</i> (Hamilton, 1822)	Bareye goby	Baila	CA	LC	LC	R	UN	UN
47	Channidae	<i>Channa marulius</i> (Hamilton, 1822)	Giant snakehead	Gazar	AA	EN	LC	B	DE	UN
48		<i>Channa orientalis</i> Block & Schneider, 1801	Smooth-breasted snakehead	Raga	CA	LC	VU	B	DE	DE
49		<i>Channa punctata</i> (Bloch, 1793)	Spotted snakehead	Lati	CA	LC	LC	B	DE	ST
50		<i>Channa striata</i> (Bloch, 1793)	snakehead murrel	Shol	AA	LC	LC	B	DE	ST
51	Badidae	<i>Badis badis</i> (Hamilton, 1822)	Blue perch	Napit koi	CA	NT	LC	B	UN	UN
52	Ambassidae	<i>Chanda nama</i> Hamilton, 1822	Elongate glass perchlet	Lomba chanda	AA	LC	LC	B	DE	DE
53		<i>Parambassis baculis</i> (Hamilton, 1822)	Himalayan glassy perchlet	Kata chanda	RA	NT	LC	B	DE	DE
54		<i>Parambassis lala</i> (Hamilton, 1822)	Highfin glassy perchlet	Ranga chanda	MA	LC	NE	B	UN	DE
55		<i>Pseudambassis ranga</i> (Hamilton, 1822)	Indian glassy fish	Gol chanda	AA	LC	LC	B	UN	ST
56	Sciaenidae	<i>Johnius coitor</i> (Hamilton, 1822)	Big-eyed jewfish	Poa	MA	LC	LC	R	UN	ST
57	Nandidae	<i>Nandus nandus</i> (Hamilton, 1822)	Mud perch	Bheda	MA	NT	LC	B	DE	UN
58	Anabantidae	<i>Anabas testudineus</i> (Bloch, 1792)	Climbing perch	Koi	MA	LC	LC	B	UN	ST
59	Osphronemidae	<i>Trichogaster fasciata</i> Bloch & Schneider, 1801	Banded gourami	Bara khail-sha	CA	LC	LC	B	UN	UN
60		<i>Trichogaster labiosa</i> Day, 1877	Thick-lipped gourami	Khalisha	AA	LC	LC	B	UN	UN
61		<i>Trichogaster lalius</i> (Hamilton, 1822)	Red gourami	Lal khail-sha	RA	LC	LC	B	UN	UN
62		<i>Ctenops nobilis</i> McClelland, 1845	Indian paradise fish	Napit khai- isha	RA	LC	NT	B	UN	DE
63	Siluriformes Schilbeidae	<i>Trichogaster chuna</i> (Hamilton, 1822)	Honey gourami	Boicha	AA	LC	LC	B	UN	UN
64		<i>Eutropiichthys vacha</i> (Hamilton, 1822)	Batchwa vacha	Bacha	MA	LC	LC	R	DE	DE
65		<i>Pachypterus atherinoides</i> (Bloch, 1794)	Indian potasi	Batasi	AA	LC	LC	R	DE	UN
66		<i>Silonia silondia</i> (Hamilton, 1822)	Silond catfish	Shilong	RA	LC	LC	R	DE	UN
67		<i>Ailia coila</i> (Hamilton, 1822)	Gangetic ailia	Kajuli	CA	LC	NT	R	UN	DE
68		<i>Clupisoma garua</i> (Hamilton, 1822)	Garua bacha	Ghaura	MA	EN	LC	R	DE	DE

Table 1. Cont.

ID	Order/Family	Species	English Name	Bengali Name	Present Status	Conservation Status		Habitat	Population Trends	
						BD	Global		BD	Global
69	Bagridae	<i>Hemibagrus menoda</i> (Hamilton, 1822)	Menoda catfish	Ghagla	CA	NT	LC	R	DE	UN
70		<i>Mystus bleekeri</i> (Day, 1877)	Bleeker's mystus	Gulsha tengra	CA	LC	LC	B	UN	UN
71		<i>Mystus cavasius</i> (Hamilton, 1822)	Gangetic mystus	Golsha	CA	NT	LC	R	DE	DE
72		<i>Mystus tengara</i> (Hamilton, 1822)	Tengara mystus	Bujuri tengra	AA	LC	LC	B	UN	UN
73		<i>Mystus vittatus</i> (Bloch, 1794)	Asian striped catfish	Tengra	CA	LC	LC	B	UN	DE
74		<i>Rita rita</i> (Hamilton, 1822)	Rita	Rita	MA	EN	LC	R	DE	DE
75		<i>Sperata aor</i> (Hamilton, 1822)	Long-whiskered catfish	Ayre	AA	VU	LC	R	DE	ST
76		<i>Sperata seenghala</i> (Sykes, 1839)	Giant river-catfish	Guijja ayre	CA	VU	LC	R	DE	UN
77	Siluridae	<i>Ompok bimaculatus</i> (Bloch, 1794)	Butter catfish	Kani pabda	MA	EN	NT	B	DE	UN
78		<i>Ompok pabda</i> (Hamilton, 1822)	Two stripe gulper catfish	Madhu pabda	CA	EN	NT	B	DE	DE
79		<i>Ompok pabo</i> (Hamilton, 1822)	Pabo catfish	Pabda	RA	CR	NT	B	DE	DE
80		<i>Wallago attu</i> (Bloch & Schneider, 1801)	Freshwater shark	Boal	AA	VU	VU	R	DE	DE
81	Sisoridae	<i>Bagarius bagarius</i> (Hamilton, 1822)	Gangetic goonch	Baghair	MA	CR	NT	R	DE	DE
82	Pangasiidae	<i>Pangasius pangasius</i> (Hamilton, 1822)	Yellowtail catfish	Pangas	RA	EN	LC	R	DE	DE
83	Clariidae	<i>Clarias batrachus</i> (Linnaeus, 1758)	Walking catfish	Magur	CA	LC	LC	B	DE	ST
84	Heteropneustidae	<i>Heteropneustes fossilis</i> (Bloch, 1794)	Stinging catfish	Shing	AA	LC	LC	B	UN	ST
85	Chacidae	<i>Chaca chaca</i> (Hamilton, 1822)	Squarehead catfish	Chaka	MA	EN	LC	B	DE	DE
86	Synbranchiformes Synbranchidae	<i>Monopterus albus</i> (Hamilton, 1822)	Gangetic mud eel	Kuchia	MA	VU	LC	B	DE	UN
87	Mastacembelidae	<i>Macrognathus aral</i> (Bloch & Schneider, 1801)	One-stripe spiny eel	Tara baim	MA	DD	LC	B	UN	ST
88		<i>Macrognathus aculeatus</i> (Bloch, 1786)	One-stripe spiny eel	Tara baim	AA	NT	NE	R	UN	UN
89		<i>Mastacembelus armatus</i> (Lacepède, 1800)	Spiny eel	Sal baim	CA	EN	LC	R	DE	ST
90		<i>Macrognathus pancalus</i> Hamilton, 1822	Stripped spiny eel	Chikra baim	AA	LC	LC	B	DE	UN
91	Tetraodontiformes Tetraodontidae	<i>Leiodon cutcutia</i> (Hamilton, 1822)	Ocellated puffer fish	Potka	CA	LC	LC	B	UN	UN

Since no research work on fish biodiversity of the Dhanu River has been done, it deters any kind of comparison of the current findings. A similar limitation was also confronted by several other scientists while assessing fish diversity in different wetlands of Bangladesh [14,15,22,28]. However, the present study can be compared with other rivers of Bangladesh. Almost similar findings were documented by Gain et al. [29], and they reported 95 fish species under 14 orders, 45 families, and 77 genera from the Passur River. The number of species was higher in the Passur River than the Dhanu River because the Passur River is situated in the intertidal coastal region where both freshwater and marine

fishes were available. On the other hand, Joadder et al. [30] reported 71 fish species from the Padma River, those were under 10 orders, 26 families, and 54 genera. Arefin et al. [10] found 62 fish species under 23 families after investigating the Rupsa River; Islam et al. [31] recorded 75 fish species under 25 families from the Juri River in the *haor* basin of the Sylhet district. All the above studies showed lower fish diversity compared to the present study. The possible reasons behind the availability of fish species in higher numbers in the present study areas may be the suitable water quality [13], the geographical location of wetlands in the *haor* basin, and being a tributary of the biodiversity-rich Meghna River [12]. Pramanik et al. [32] found 107 fish species searching the Meghna River, which are under 36 families and 13 orders. However, Mahalder & Mustafa [33] obtained a better finding in fish species combination, which was 126 fish species contributing to 39 families from the *haor* region of the Sunamganj district.

In this study, the most dominant order was Cypriniformes that covered 37.4% fish species, followed by Siluriformes (24.2%), Perciformes (19.8%), Synbranchiformes (5.5%), Clupeiformes (4.4%), Osteoglossiformes (2.2%), and Beloniformes (2.2%). Meanwhile, Anguilliformes, Cyprinodontiformes, Mugiliformes, and Tetraodontiformes were represented by 1.1% of species each (Figure 2). Galib [15] recorded similar results from the Brahmaputra River, where the highest 21 fish species made the Cypriniformes order dominant over Siluriformes (19 species), Perciformes (15 species), Clupeiformes (3 species), Osteoglossiformes (2 species), Beloniformes, Tetraodontiformes, and Synbranchiformes (1 species each). Hanif et al. [34] and Sultana et al. [35] also recorded Cypriniformes as the dominant order in the Gorai River and the wetlands of Chhatak, respectively.

Figure 2. Fish species percentage by orders in the study area.

In this investigation Cyprinidae was found to be the richest family with 30 species (33.0%), followed by Bagridae (8.8%); Osphronemidae and Schilbeidae (5.5% each); Ambassidae, Channidae, Cobitidae, Mastacembelidae, and Siluridae (4.4% each); Clupeidae (3.3%); and Notopteridae (2.2%). All remaining families were represented by 1.1% species each (Figure 3). Cyprinidae was documented as the dominant family by Galib [15] in the Brahmaputra River, Joadder et al. [30] and Mohsin et al. [28] in the Padma River, and Chaki et al. [36] in the Atrai River. Rahman [5] found the Cyprinidae family to be the most populous over all freshwater fish families of Bangladesh. However, there are variations in the species dominance within Cyprinidae family in different water bodies of Bangladesh, which might be due to the geographical and environmental disparities of those rivers.

Figure 3. Fish species percentage by families in the study area.

3.2. Present Status of Indigenous Fish Fauna

The current research showed 16 abundantly available (AA), 25 commonly available (CA), 29 moderately available (MA), and 21 rarely available (RA) fish species in the area of investigation (Figure 4). It is indicated almost a quarter of fish species was in the rarely available category, whose occurrences were sporadic. By observing their declining population trends, local fishers opined that RA species might be disappeared from the river in future.

Figure 4. Present fish diversity status of the study area.

3.3. Habitat Based Status of Fish Fauna

In Bangladesh there are three well known categories of freshwater fishes based on their residential status, such as riverine, migratory, and floodplain resident species. For instance, during the dry season when the water levels of the floodplains reach their nadir, several floodplain-dwelling species take shelter in nearby perennial water bodies such as rivers and deeper *beels* [6], which makes their categorization more complex. However, the maximum lifespan of freshwater fishes is spent in rivers and/or perennial *beels*. Hence, in the present survey, the total existing fish species were categorized in to two categories where 54.9% were *beel* residents and the remaining 45.1% were riverine resident species (Figure 5). Their availability status showed that the highest portion of riverine resident species (31.7%) was found under the rarely available category (Figure 6).

Figure 5. Habitat preference of the freshwater fishes in the study area.

Figure 6. Present availability status of *beel* and riverine resident species.

3.4. Global and National Conservation Status of Fish Species

In Figure 7 pursuant to the global conservation status, the highest percentage fish species was occupied by the least concern category (84.6%) followed by near threatened (9.9%), vulnerable (3.3%), and not evaluated (2.2%). It might be notable that globally vulnerable fish species, namely, *Cirrhinus cirrhosus* (Bloch, 1795), *Channa orientalis* Block & Schneider, 1801, and *Wallago attu* (Bloch & Schneider, 1801), were found to be MA, CA, and AA, respectively, in the study area. Similar results were found by Galib [15] in the Brahmaputra River, where a majority of the indigenous fish species (82.0%) were under least concern followed by the near threatened (9.0%), not evaluated (5.0%), vulnerable (2.0%), and data deficient (2.0%).

Figure 7. Global conservation status of fish species.

Comparing with the national conservation status, the highest position was occupied by the least concern category with 49 species (53.8%), followed by near threatened (17.6%), endangered (12.1%), vulnerable (11.0%), critically endangered (3.3%), and data deficient (2.2%) (Table 2). Notably, 26.4% of the fish species in the present study were under the threatened category of IUCN Bangladesh [6]. Pramanik et al. [32] found 20.0% of the total identified species in the threatened condition in the Meghna River, where 2.0% species were critically endangered, 7.5% were endangered, and 10.3% were in the vulnerable condition.

Table 2. National conservation status of fish species.

Status	IUCN, BD 2015 Status	Present Study	
		No. of Species	Species Presence (%) Comparing IUCN Status
CR	9	3	33.3
EN	30	11	36.7
VU	25	10	40.0
NT	27	16	59.3
LC	122	49	40.2
DD	40	2	5.0
Total	253	91	36.0

3.5. Global Fish Population Trend

According to the global population trends, the highest percentage of the fish species of the present study was in the unknown category (57.1%), followed by decreasing (24.2%) and stable (18.7%) (Figure 8). A similar trend was found in the Brahmaputra River by Galib [15], where the highest percentage of the fish species was in the unknown category (57.0%) followed by decreasing (25.0%), stable (13.0%), and not evaluated (5.0%). Joadder et al. [30] mentioned the population trend of 51.0% fish species of the Padma River as unknown, and almost 24.0% were of declining status.

Figure 8. Global fish population trend.

3.6. National Fish Population Trend

The population trend of over half (59.3%) of fish species found in the present study was in decreasing trend at the national level assessed by IUCN Bangladesh [6], and only 2.2% were found to be increasing (Figure 9). Galib [15] found that the population trend of more than two-thirds of the total native fishes in the Brahmaputra River were showing a decreasing trend. A decreasing trend was recorded for the fish species in the Padma River, too [28].

Figure 9. National fish population trend.

3.7. Threats to the Fish Diversity

Despite the fact that the Dhanu River and adjacent *beels* are rich in fish species, there are concerns regarding the fish biodiversity's long-term sustainability due to several man-made and natural drivers that are responsible for destroying fish biodiversity and habitats (breeding, feeding, and nursing grounds) of the river and adjacent *beels*. The leading intimidations to the fish diversity of the studied wetlands were indiscriminate overfishing (92.2%), followed by fishing by dewatering of wetlands (87.8%), the *katha* fishing method (86.7%), the use of deprecated fishing gears (78.9%), climate change impacts (75.6%), siltation and sedimentation (72.2%), intensification of agricultural farming (67.8%), natural drought in winter and summer seasons (66.7%), construction of development and communication infrastructures (58.9%), and water pollution (51.1%) (Table 3). In addition, the conversion of wetlands to human settlement, lack of alternative income-generating activities of fishers, navigation, tourism, non-native fish species, and revenue-oriented leasing systems have direct or indirect impacts on fish diversity. Notably, non-native fish species might have devastating impacts on native species, causing extinctions and affecting natural ecosystems, which were unexplored due to poor knowledge of fishers. However, 10 non-native fish species, *Barbonymus gonionotus* (Bleeker, 1849), *Clarias gariepinus* (Burchell, 1822), *Ctenopharyngodon idella* (Valenciennes, 1844), *Cyprinus carpio* Linnaeus, 1758, *Hypophthalmichthys nobilis* (Richardson, 1845), *Hypophthalmichthys molitrix* (Valenciennes, 1844), *Oreochromis mossambicus* (Peters, 1852), *Oreochromis niloticus* (Linnaeus, 1758), *Pangasianodon hypophthalmus* (Sauvage, 1878), and *Pterygoplichthys pardalis* (Castelnau, 1855), were recorded in the Dhanu River and the surrounding floodplains. Talukder et al. [22] found similar threats to the fish diversity of the Shari-Goyain River in northeastern Bangladesh. Overfishing, lack of water flow in the winter season, water pollution, siltation, indiscriminate harvesting of brood and juvenile fishes, catching fish with destructive fine-meshed nets, the *katha* fishing method, and habitat destruction have negative effects on all aquatic fauna, particularly fish [22]. According to local fishers of the Rupsa River, water depth reduction by siltation and sedimentation (91.0%), overfishing and navigation (90.0%), the use of illegal fishing gear (86.0%), waste pollution (72.5%), urbanization (64.0%), temperature fluctuation (61.8%), and turbidity (56.0%) are the main causes for fish diversity reduction in the Rupsa River [10]. Flowra et al. [37], Pandit et al. [8], Sultana et al. [35], and Islam et al. [31] found similar types of causes responsible for species reduction in the different inland waters of Bangladesh. Based on surveys and direct observations, the current study suggested different measures for conserving fish diversity

by minimizing the threats to these wetlands. The reduction of anthropogenic impacts, enactments of fishing laws, installation and management of fish sanctuaries, and raising public awareness can be effective for the conservation of existing fisheries resources in the natural waters of Bangladesh.

Table 3. Major threats to the fish biodiversity in the study area.

Serial Number	Drivers Affecting Fish Diversity	No. of Respondents (%)
1	Indiscriminate overfishing	92.2
2	Fishing by dewatering of wetlands	87.8
3	<i>Katha</i> fishing method	86.7
4	Use of deprecated fishing gears	78.9
5	Climate change impacts (irregular rainfall, temperature rise, flash floods, etc.)	75.6
6	Siltation and sedimentation	72.2
7	Intensification of agricultural farming	67.8
8	Natural drought in winter and summer seasons	66.7
9	Construction of development and communication infrastructures	58.9
10	Water pollution	51.1

Due to a lack of funding, the current study contains several minor drawbacks, especially the collection of fish samples from the fishers and fish traders rather than direct sampling through fishing by hired fishers. As a result, the sample size was limited, with the only purpose being proper identification. In addition, threats were recorded based on stakeholder perceptions via a survey and researchers' observations. Therefore, a more in-depth study is required in the future for more specific information in order to develop better management strategies for the wetlands.

4. Conclusions

This is the first attempt at looking into the fish species diversity of the Dhanu River, and the study focused primarily on documenting the available native (and implicitly to non-native) fish species of the river and adjacent *beels*. Fish species richness is a good allusion of healthy fish diversity in the waters, which could be conserved. On the contrary, the poor availability status and decreasing trend of many fish species intimates the alarming present situation of the fisheries resources. Furthermore, the current study also observed that the freshwater fish species are affected by a range of anthropogenic and natural threats, and it suggested a number of conservation solutions. Moreover, ecosystem-based fisheries management with local community participation is highly recommended for these water bodies to conserve fish diversity and to prevent any kind of catastrophes in the future.

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