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ORIGINAL RESEARCH ARTICLE

Freshwater icthyo-faunal checklist of Roktodaho Beel in Bangladesh: Threats and conservation

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ABSTRACT

A checklist of the native fishes of the Roktodaho *beel* of Adamdighi and Raninagar Upazila under the Bogura and Naogaon districts of Bangladesh, where 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 from a professional fishing boat caught by different nets, traps, and hooks from July 2021 to June 2022. A total of 36 species under 8 orders belonging to 19 families were recorded, of which 29%, 28%, 25%, and 8% were available, seasonal, rare, and very rare, respectively. Among those, 8 fish species (22.22%) were in the threatened category (1 critically endangered, 2 endangered, and 5 vulnerable), according to the IUCN Bangladesh. Notably, the globally threatened *Channa orientalis* and *Wallago attu* were available in the study area. According to their place of residence, 24 (66.67%) of the fish were floodplain residents except *Glossogobius giuris*, which is a mixed residence (reverine, estuarine, and floodplain) species. This residence status of fish indicates that the species have chosen their ideal environment. Dewatering, *katha* fishing, and the use of unlicensed technology were the main dangers. Creating and maintaining fish sanctuaries, reducing human effects, passing fishing regulations, and increasing consciousness may all help to preserve the current supply of fish. Strategies for restoration must be performed in the Roktodaho *beel* to preserve the fish range.

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INTRODUCTION

As a result of an unprecedented decrease in biodiversity, our world is seeing a rapid decline in the number of species (Barnosky *et al*., 2011; Cowie *et al*., 2022). In freshwater environments, this decrease is the most serious as well (Sala *et al*., 2000; Harrison *et al*., 2018; Reid *et al*., 2019). With 260 freshwater species of fish (DoF, 2022), Bangladesh is a self-sufficient country ranked third in inland open-water capture production, fifth in world aquaculture production, and fourth in world tilapia production (FAO, 2022), supplying a total output of 46.21 lakh metric tons per year (DoF, 2022). The fisheries sector contributes up to 60% of animal protein consumption in Bangladesh (Sufian *et al*., 2017; DoF, 2022), and fish is consumed by most people as their main source of protein (Haque *et al*., 2015). This country has an extensive number of unique watercourses, including rivers, lakes, floodplains, estuaries, canals, *beel*s, *haor*s, and *baor*s (Suravi *et al*., 2017). For their daily needs and farming endeavors, the bulk of agrarian populations on floodplains depend on genuine reserves of water (Pandit *et al*., 2022). There are numerous *beel*s with bowl-shaped areas and a distinct environment in floodplains. This environment is a mixture of arid and moist regions, with both shallow and deep regions present at the same time. With 4,500 *beel*s overall and an area of 1,14,161 hectares, Bangladesh produces 2.27% of global output (DoF, 2022). *Beel* can be produced at an average yearly rate of 919 kg/ha, meaning it's a bit modest (DoF, 2022). One of the biggest *beel*s in the Bogura and Naogaon districts of

Bangladesh, Roktodaho *beel* occupies a khas (government) territory of 105 ha and may swell to 1000 ha during the wet season (Aminul *et al*., 2014). It is a wetland of significant financial and ecological significance. The plethora of this authentic fish range and output were earlier plentiful with many small indigenous species (SIS), which had enormous socioeconomic opportunities in Bangladesh (Haque *et al*., 2023). However, these days, these factors, along with degradation of habitat, overfishing, haphazard construction, changes in the environment, the emergence of disruptive alien species, contamination of water, and others, are progressively decreasing the quantity of this open natural fish variance and generation (Sayeed, 2010; Khan *et al*., 2018; Sultana *et al*., 2021; Pandit *et al*., 2021, 2023b; Das *et al*., 2022; Mia *et al*., 2022), except for certain fingerling stocked and co-managed water bodies (Aziz *et al*., 2021; Talukder *et al*., 2021; Kunda *et al*., 2022; Kamal *et al*., 2022; Pandit *et al*., 2023a). A few real-life forms are becoming extinct in specific water sources (Pandit *et al*., 2015). A diverse range of types of fish is pivotal to the biogeochemistry and long-term effectiveness of the alluvial plains (Prakash and Verma, 2019; Prakash *et al*., 2020). However, the Roktodaho *beel* has a pleasant water environment and can sustain a wide range of aquatic species, but its fish biodiversity is in danger of becoming extinct. On the current state of the Roktodaho *beel*'s fish and wildlife's richness, however, there is not enough information accessible. The present research is intended to examine the current condition of fish fauna richness in the Roktodaho *beel*, as well as establish their resilience rating and provide an action plan for their sustainability, in order to address some of the knowledge shortages.

MATERIALS AND METHODS

Study area

The study was conducted on Roktodaho *beel* from July 2021 to June 2022, which is a "U"-shaped *beel* situated on Adamdighi upazila of Bogura district and Raninagar upazila of Naogaon district with an area of 900 acres, located between 24°52"N to 89°22" E (Figure 1). The experimental area was divided into three sites (Tebaria, Kashipur, and Khagra), from which monthly data was collected.

Preparation of the questionnaire

The objectives of the research were made sure to be satisfied by creating an initial questionnaire and pre-testing it with a focus group discussion with a small sample of respondents. The draft questionnaire was carefully pre-tested to ensure that it included any further data that wasn't supposed to be collected and filled out. In accordance with prior testing input, the questionnaire was revised, modified, and rearranged.

Data collection procedure

To collect primary data, in-depth interviews with nearby residents, vendors, and fishermen were undertaken. Interviewing the upazila (sub-district) fisheries officer of the Adamdighi and Raninagar upazilas served as a means of extend-checking. An informal survey was used in several focus group sessions. Monthly catch assessment surveys were carried out during the study period from July 2021 to June 2022 at each of the sample locations.

According to Rahman (2005), and Talwar and Jhingran (1991), the captures were recorded species-by-species and by the quantity of individuals. Fish species were discovered and categorized into four categories depending on public perception and incidence harmonics (the proportion of surveys where the scientist documented the specific species). The categories are listed below: Commonly Available (CA): Species seen frequently but in small numbers throughout the year Abundantly Available (AA): Species seen on a regular basis throughout the year Moderately Available (MA): Species found occasionally in the research zone and Rarely Available (RA): Species seen only infrequently and in small numbers (updated from Pandit *et al*., 2020, 2021).

Data processing and analysis

The gathered information was summarized, encoded, and prepared for analysis. The IUCN Bangladesh database was used to evaluate the state of conservation (IUCN, 2015). Microsoft Office Excel 2015 has been used to examine the acquired data. The data was analyzed and represented using tables, pie charts, column diagrams, cylinder diagrams, etc.

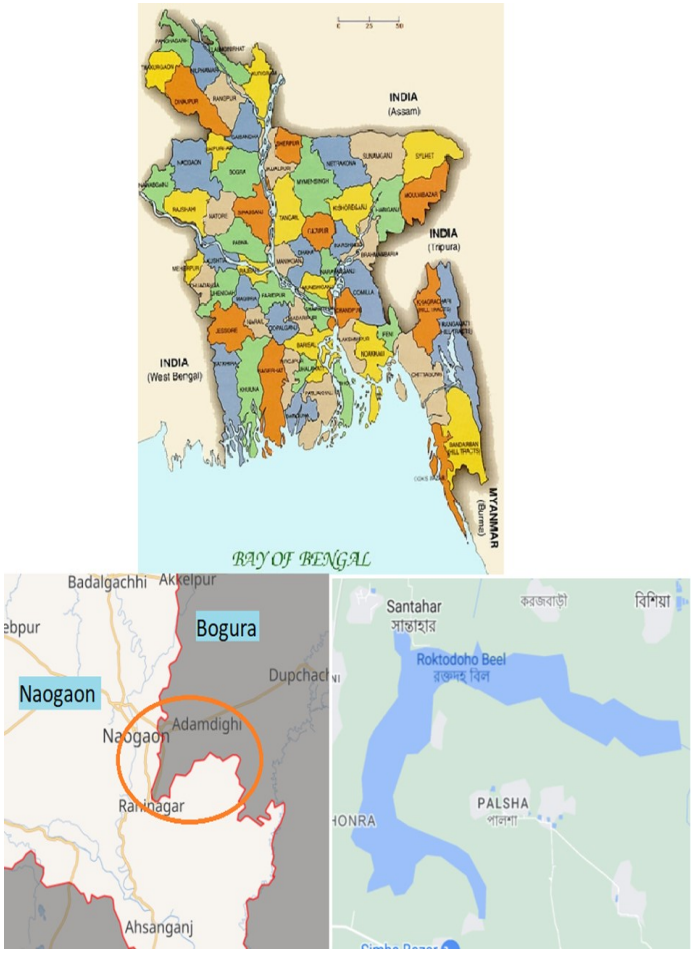

Figure 1. *Map depicting study area.*

RESULTS AND DISCUSSION

Numerous kinds of wild fish spawn, nurse, and depend on the Roktodaho *Beel*. A total of 36 species of wild ichthyofauna belonging to eight orders and 19 families were found in this *beel* (Table 1). Many more research studies have had such a pleasant stay since gauging the fish biodiversity in multiple wetlands in Bangladesh (Kamrujjaman and Halder, 2022; Ferdoushi *et al*., 2022; Khanom *et al*., 2018; Hossain *et al*., 2021; Mia *et al*., 2017; Suravi *et al*., 2017; Talukder *et al*., 2021). Ehshan and Bhuiyan (2014) found 46 species of fish, of which eight were exotic. This indicates that the diversity of fish is declining compared to previous years. Ferdoushi *et al*. (2022) recorded 35 species of fish belonging to 7 orders and 17 families in the Ashura *beel* of Dinajpur; Kamrujjaman and Halder (2022) reported a total of 34 species under 24 genera, 16 families, and 7 orders from the Bahadurpur *beel* of Madaripur district; Khanom *et al*. (2018) reported 28 fish species under 8 orders and 16 families from the Uthrail *beel* of Naogaon district. The above-mentioned observations are lower than those of the present expedition. Hossain *et al*. (2021) recorded a total of 37 species of fish in Daduria *beel*, which is near the present expedition. Pandit *et al*. (2021) recorded a total of 91 indigenous fish species belonging to 29 families under 11 orders in the Dhanu River and its adjacent *beel* areas. Despite being far fewer than those in other rivers in northeastern Bangladesh, the fish variety identified in the current research was nonetheless significant. This *beel*'s tiny area (100 hectares) and lack of a distinct inlet or outflow might be blamed for it. In comparison with the mentioned *beel*s and rivers, this wetland's diversity is declining day by day. These studies indicated the Roktodaho *beel*'s faunal assemblage is under threat. In this study, in the case of orders, Cypriniformes was found to be the most diversified fish group regarding both number of species and individuals, with 10 species, followed by Siluriformes (9), Anabantiformes (7), Synbranchiformes (4), and Ovalentaria (3), with the rest of the orders like Gobiiformes, Cyprinodontiformes, and Osteoglossiformes having each one (1) (Figure 2). Since there hasn't been any prior study on the orders discovered in the Roktodaho *beel*, contrasting the results of the present information is challenging. Numerous investigators in Bangladesh have evaluated the fish biodiversity in different wetlands and reported identical results.

Table 1. Present status of fish species of Roktodaho *Beel*.

ID	Order/ Family	Scientific name	English name	Bengali name	Habitat	Present Status	Conservation Status	
							BD	World
1	Anabantiformes Osphronemidae	*Trichogaster fasciata* (Bloch & Schneider, 1801)	Stripped gourami	Boro khoilsa	FP	A	LC	LC
2	Anabantidae	*Anabas testudineus* (Bloch, 1792)	Climbing perch	Koi	FP	S	LC	LC
3	Nandidae	*Nandus nandus* (Hamilton, 1822)	Gangetic leaffish	Meni	FP	S	NT	LC
4	Badidae	*Badis badis* (Hamilton, 1822)	Blue perch	Napit	FP, HS	R	NT	LC
5	Channidae	*Channa striata* (Bloch, 1793)	Snakehead murrel	Shol	FP	S	LC	LC
6		*C. punctata* (Bloch, 1793)	Taki	Taki	FP	S	LC	LC
7		*C. orientalis* (Bloch & Schneider, 1801)	Smooth-breasted snakehead	Cheng	FP	A	LC	VU
8	Gobiiformes Gobiidae	*Glossogobius giuris* (Hamilton, 1822)	Bareyed goby	Baila	R, FP, ET	S	LC	LC
9	Ovalentaria Ambassidae	*Pseudumbassis ranga* (Hamilton, 1822)	Indian glassy fish	Gol chanda	FP	A	LC	LC
10		*Chanda nama* (Hamilton, 1822)	Elongate glass perchlet	Lomba chanda	FP	A	LC	LC
11		*Parambassis baculis* (Hamilton, 1822)	Himalayan glassy perchlet	Kata chanda	FP	S	LC	LC
12	Synbranchiformes Mastacembelidae	*Macrognathus aculeatus* (Bloch, 1786)	One-stripe spiny eel	Tara baim	R	A	NT	LC
13		*Mastacembelus armatus* (Lacepède, 1800)	Tire-track Spinyeel	Boro baim	R	S	EN	LC
14		*M. pancalus* (Hamilton,1822)	Stripped spiny eel	Chirka baim	FP	S	LC	LC
15	Synbranchidae	*Monopterus cuchia* (Hamilton, 1822)	Gangetic mudeel	Kuchia	FP	R	VU	LC
16	Cypriniformes Danionidae	*Esomus danricus* (Hamilton, 1822)	Flying barb	Darkina	FP	A	LC	LC
17		*Amblypharyngodon mola* (Hamilton, 1822)	Mola carplet	Mola	FP, R	A	LC	LC
18		*Securicula bacaila* (Hamilton, 1822)	Silver razorbelly minnow	Chela	R	R	NT	LC
19	Cyprinidae	*Cirrhinus reba* (Hamilton, 1822)	Reba carp	Lachu	R, FP	R	NT	LC
20		*Pethia ticto* (Hamilton, 1822)	Ticto barb	Titpunti	FP, HS	A	VU	LC
21		*Puntius sophore* (Hamilton, 1822)	Spotfin swamp barb	Jatpunti	FP	A	LC	LC

Table 1. *Contd.....*

22		*P. chola* (Hamilton, 1822)	Chola barb	Punti	FP	A	LC	LC
23		*Labeo calbasu* (Hamilton, 1822)	Black rohu	Kalibaus	R, FP	VR	LC	NT
24	Cobitidae	*Lepidocephalichthys guntea* (Hamilton, 1822)	Guntea loach	Gutum	FP	R	LC	LC
25		*Botia dario* (Hamilton, 1822)	Queen loach	Rani	FP	R	EN	LC
26	Siluriformes Clariidae	*Clarias batrachus* (Linnaeus , 1758)	Walking catfish	Magur	FP	S	LC	LC
27	Siluridae	*Wallago attu* (Bloch & Schneider, 1801)	Freshwater shark	Boal	R, M	R	VU	VU
28		*Ompok pabo* (Hamilton, 1822)	Pabo catfish	Pabda	FP	VR	CR	NT
29	Heteropneustidae	*Heteropneustes fossilis* (Bloch, 1994)	Stinging catfish	Shingi	FP	S	LC	LC
30	Bagridae	*Mystus tengara* (Hamilton, 1822)	Tengara mystus	Buzuri tengra	FP	R	LC	LC
31		*Sperata aor* (Hamilton, 1822)	Long-whiskered catfish	Air	R	VR	VU	LC
32		*Mystus bleekeri* (Day, 1877)	Bleeker's mystus	Gulsha	FP	S	LC	LC
33		*Mystus vittatus* (Bloch, 1794)	Asian Striped Catfis	Tengra	FP	A	LC	LC
34	Horabagridae	*Pachypterus atherinoides* (Bloch, 1794)	Indian potashi	Batashi	R, FP	R	LC	LC
35	Osteoglossiformes Notopteridae	*Notopterus notopterus* (Pallas, 1769)	Grey featherback	Foli	FP	R	VU	LC
36	Cyprinodontiformes Aplocheilidae	*Aplocheilus panchax* (Hamilton, 1822)	Blue panchax	Kanpona	FP	A	LC	LC

BD: Bangladesh, A: available, S: seasonal, R: rare, VR: very rare, CR: critically endangered, EN: endangered, VU: vulnerable, NT: near threatened, LC: least concern and EX: exotic species, NE = Not Evaluated, DD = Data Deficient, FP=Floodplain, R=River, ET=Estuarine, HS=Hill Stream, M=Migratory.

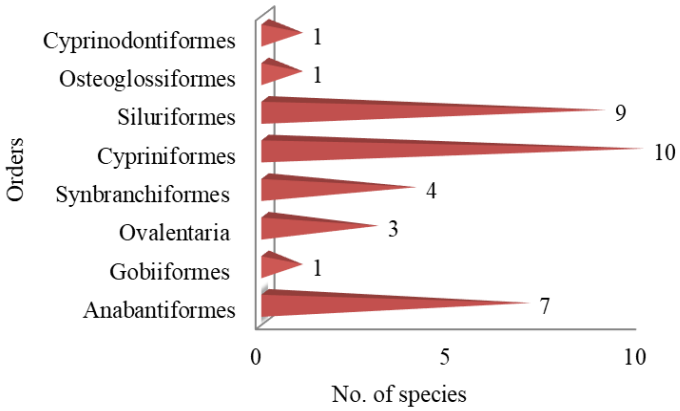

Figure 2. *Fish species of different orders recognized from Roktodaho beel.*

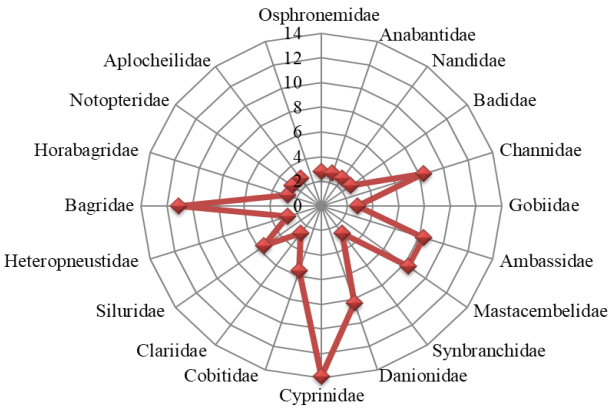

Figure 3. *Contribution of families (%) fish population of Roktodaho beel.*

Khanom *et al.* (2018) recorded a similar result in dominancy of orders in the Uthrail *beel* of Naogaon, where Cypriniformes was recorded as the dominant order, contributing 40.62%, and the rest 7 orders, Perciformes, Siluriformes, Synbranchiformes, Channiformes, Beloniformes, Tetraodontiformes, and Osteoglossiformes, contributing 26.31%, 12.4%, 9.77%, 7.59%, 2.90%, 0.22%, 0.22%, and 0.10%, respectively. Many other researchers (Ferdoushi *et al.*, 2022; Kamrujjaman & Halder, 2022; Pandit *et al.*, 2021, 2023a; Mia *et al.*, 2017) also got similar results regarding the dominancy of the Cypriniformes order in Bangladesh's wetlands.

The majority of fish in this *beel* belonged to the Cyprinidae family (13.88%), then Bagridae (11.11%), Channidae, Ambassidae, Danionidae, and Mastacembelidae (8.33%), Siluridae, and Cobitidae (5.55%), in that order. The contributions of Osphronemidae, Anabantidae, Nandidae, Badidae, Gobiidae, Synbranchidae, Clariidae, Heteropneustidae, Horabagridae, Notopteridae, Gecarcinucidae, and Ampullariida constituted 2.78% each (Figure 3). Similar results were recorded by Ferdoshi *et al.*, 2022, in the Asura *beel* of Dinajpur and also by Kamrujjaman & Halder, 2022, in the Bahadurpur *beel* of Dinajpur; Pandit *et al.*, 2021, in the Dhanu river; Talukder *et al.*, 2021, in the Shari Goyain river; Mia *et al.*, 2017; and Suravi *et al.*, 2017 in Dekar *haor*. Rahman (2005) described the copiousness of all freshwater fish families in Bangladesh. However, there are differences in the species richness within the Cyprinidae family's supremacy in multiple bodies of water in Bangladesh, which may be related to the rivers' varying environments and physical locations.

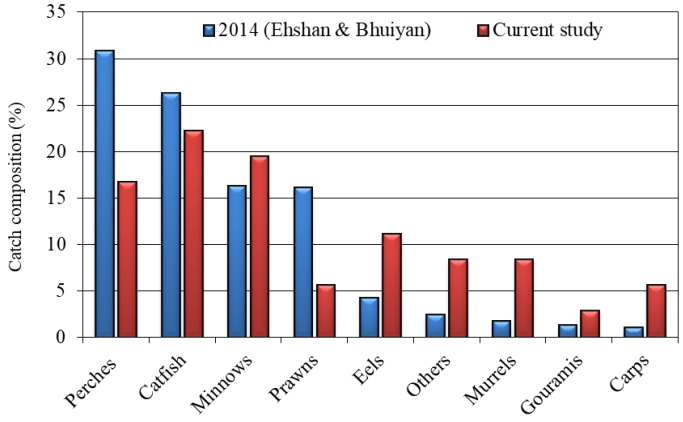

Figure 4. *Comparative analysis of the Roktodaho beel's catch composition (%) with earlier discoveries.*

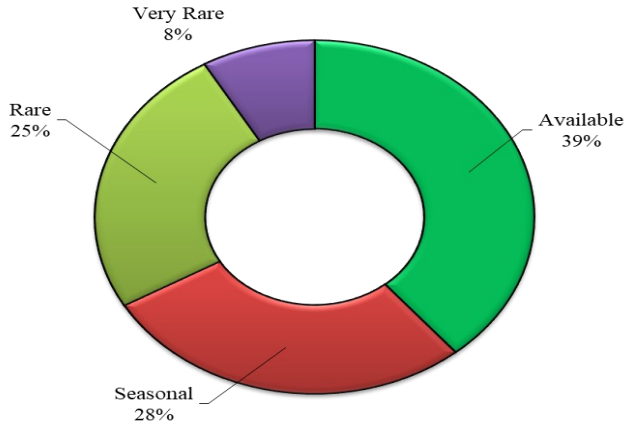

Figure 5. *Present status of fish biodiversity in study area during July 2021-June 2022.*

Table 2. Habitat diversity of different fishes of Roktodaho *beel*.

Habitat	No. of species
Only Floodplain	24
River + Migratory	1
River	4
Floodplain + Hill Stream	2
River + Floodplain + Estuary	1
Floodplain + River	4

This investigation identified nine often occurring fish groups, with catfish (22.22%) emerging as the dominant category in the Roktodaho *beel*, followed by minnows (19.44%), perches (16.67%), eels (11.11%), murrels and others (8.33%), carps and prawns (5.56%), and gouramies (2.78%). Our study revealed that perches, catfish, and prawns decreased in the catch composition (%); however, minnows (mola, darkina, dhela, sarpunti, jatipunti, titpunti, and chela), carps, eels, murrels, gouramies, and others showed an increased catch rate when compared to the past findings (Ehshan and Bhuiyan, 2014) (Figure 4). Here we observed that major groups' catch, viz. perches, catfish, and minnows, has declined inordinately, while minor groups' species count has increased a lot. This declination may be due to an increase in fishing pressure by those groups in that area, and the increase may be due to the establishment of a fish sanctuary by the Department of Fisheries in that *area*.

Conservation status of fish

According to the Red List of Freshwater Fishes released by IUCN Bangladesh in 2015, more than ½ of the fish (63.89%) were least concerned species: near-threatened 13.89%, vulnerable 13.89%, endangered 5.56%, and critically endangered 2.78% (Table 1). In the research region, it was discovered that 29% of the overall fish composition of the Roktodaho *beel* was available, 28% was seasonal, 25% was rare, and 8% was a very rare fish species (Figure 5 and Table 1). The nearby fishing community believes that this is a result of demographic patterns that are diminishing. Similar results were also recorded for several other *beels* in Bangladesh, including Bhawal *beel*'s recording of available (44.64%), seasonal (19.64%), uncommon (16.08%), and extremely rare (19.64%) *beel* types in 2017. Ichanoi *beel* was determined to be available (46.77%), seasonal (8.06%), uncommon (6.45%), and very rare (38.71%) by Akhtaruzzaman & Alam (2014). According to data collected by Suravi *et al.* (2017) from Dekar Haor, there were 51 fish species, of which 23 were abundant, 10 were common, and 18 were uncommon. According to the worldwide conservation status, the least concern group made up the largest majority of fish species (86%), followed by near threatened (6%), and vulnerable (8%). It may be noteworthy that the research region revealed the internationally threatened fish species *Wallago attu* (Bloch & Schneider, 1801) and *Channa orientalis* (Block & Schneider, 1801) to be available and rare, respectively.

Habitat status of fishes

According to their place of residence, freshwater fish in Bangladesh may be divided into five well-known distinct groups: riverine (R), estuary (ET), migratory (M), hill stream (HS), and floodplain (FP) resident species (IUCN, 2015). For instance, numerous floodplain-dwelling animals seek refuge in neighboring perpetual water sources like rivers and deeper *beels* during the dry season, when the floodplains' water levels are at their lowest (IUCN, 2015), complicating the classification of these species. Freshwater fish spend the majority of their lives in rivers or persistent *beels*, however. Thus, the results of the current study are shown in Table 2, where 24 (66.67%) of the 36 species are found in floodplains, indicating that the species have chosen their ideal environment.

Threats to the fish diversity

Participants were questioned about potential dangers to the Roktodaho *beel*'s array of fish throughout the data gathering process. Wide-ranging menaces were offered, including inadequate water flow, water contamination from rice mills, ash, dredging, trapping of fry and brood fish, haphazard drilling and deposits, faulty drainage and sluice gates, failure to establish legitimate *beel* management techniques for fish sanctuaries, use of herbicides and pesticides, and natural phenomena like drought, siltation, and water diversion, as well as irresponsible fishing practices (overexploitation, brood and juvenile fish exploitation According to many studies (Khanom *et al.*, 2018; Ferdoushi *et al.*, 2022; Pandit *et al.*, 2021, 2023a; Mia *et al.*, 2017; Suravi *et al.*, 2017), these factors are also thought to be contributing to the loss of fish variety in different regions of Bangladesh.

The present research makes a number of recommendations on the basis of the research and firsthand knowledge for the protection and improved control of the fishery resources of the Roktodaho *beel*. The recommended actions include locating fish spawning areas, banning destructive fishing only during the breeding season, raising endangered fish species, discouraging the use of fine-mesh nets, proving fish-restricted areas, alleviating water pollution by limiting attainable sand and gravel pursuit, pushing the river to improve its water storage and flow, setting up education initiatives and ways to earn a living for the affected people, and Future studies should concentrate on the artificial breeding methods and life cycle characteristics of the aforementioned vulnerable fish species.

Conclusion

Despite the fact that the Roktodaho *beel* is a tiny *beel* in northern Bangladesh, it can be deduced from the study's results that the aquatic assemblage is rich in many fish species. From previous reports, it has been seen that the *beel* has a rich biodiversity. This research showed how many anthropogenic stressors have an impact on *beel* fish and suggested a number of conservation methods. Additionally, coordination between governmental and nongovernmental groups, as well as financial assistance, are necessary for doing additional research, monitoring, and educating the populace about the need for improved management and protection of the Roktodaho *beel*'s fishing resources. An administrative enhancement must be extended via the typical holding of fingerlings with an ensemble of local executive communities in order to improve conducting and set aside a stash of water-dependent variation in this *beel*.

Conflict of interest

The researchers acknowledge that they have no conflicts of interest.

Ethics committee approval

All procedures used in experiments involving humans and animals (fish) were following the ethical standards of the "Bangladesh Fisheries Research Institute, Mymensingh" Ethical Committee. All survey participants provided informed consent.

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