BIODIVERSITY STUDIES

Biodiversty Studies (BiSt)
2023, 2(1): 37-47
https://doi.org/10.56494/bist.2023.13

RESEARCH PAPER

Current status and threats to fish biodiversity of Pailati *beel*, Bangladesh

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How to cite: Ferdous, J., Sultana, A., Mitu, S. J., Shrabon, A. R., Rahman, Z., & Mia, R. (2023.). Current status and threats to fish biodiversity of Pailati beel, Bangladesh. *Biodiversity Studies (BiSt), 2*(1), 37-47.

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Article History:
Received: 10.05.2023
Accepted: 17.07.2023
First online: 31.07.2023

Keywords
Biodiversity, Pailati *beel,* Conservation

Abstract

To evaluate the current status of fish biodiversity, a study was carried out in the Pailati *beel*. It was carried out using key informant interviews (KII), focus group discussions (FGD), questionnaire interviews (QI) of fishermen, and secondary data collection. This water body comprised a total of 55 species, 23 families, and 10 orders, with 20% of the species being abundantly available, 40% of the species being commonly available, 29.09% of the species being moderately available, and 10.90% of the species being rarely available. Barbs and minnows (20%) were discovered to be the most common species, followed by carps (16.36%), catfishes (14.36%), and perches (14.55%). The most dominant order was the cypriniformes (38.18%), followed by the perciformes (20%) and the siluriformes (16.36%). Synbranchiformes, Clupeiformes, Osteoglossiformes, Beloniformes, Decapoda, and Anabantiformes made up the remaining seven classes. The values of the indices for Simpson dominance (C), Pielou's evenness (J'), Shannon-Weaver diversity (H), and Margalef's richness (d) in December, January, and February, respectively, were 0.91, 0.443, 3.25, 5.81, 0.94, 0.451, 3.29, and 5.95. Therefore, the results could be used to design and put into action plans that help to maintain the wetlands in a sustainable way.

INTRODUCTION

Bangladesh is enriched with diverse fisheries resources, that make the country the most productive and dynamic sectors with substantial potential for future economic growth (Shamsuzzaman et al. 2020). Bangladesh is a realm of wetland with diverse inland and marine fisheries resources (Pandit et al., 2021), while approximately 4.24 million hectares of inland water are supported by haor basins, rivers, beels, flood plains and estuaries (DoF 2022). The nation has a diverse range of aquatic life, including approximately 260 types of freshwater fish and 730 types of marine fish, as well as other forms of aquatic organisms. IUCN Bangladesh only assessed 253 native fish species, of which 36 were migratory and 113 were found in floodplains and rivers (Pandit el al., 2021). Bangladesh has gained increasing international recognition as a major fish producer, having achieved self-sufficiency in fish production. The country now ranks 3rd globally for inland fish production, following China and India, and holds the 5th position for aquaculture production and the 11th for marine fish production (FAO, 2020, Samsuzzaman et al. 2020). The fisheries industry

makes up 3.57% of the overall Gross Domestic Product (GDP) of the nation, contributes 25.30% to the agricultural GDP, and generates over 2.0% of the total earnings from exports. In addition to meeting around 60% of the daily dietary requirement for animal protein, the target of fish production in the fiscal year 2020-21 was exceeded by producing 4.621 million metric tons (DoF 2022). Therefore, the role of fisheries sector is very vital in the socio-economic upliftment, poverty alleviation, manpower development, and food and nutrition security of the agriculture-dependent Bangladesh.

Wetlands, which are among the most crucial natural resources, support some of the most productive ecosystems on Earth. An ecosystem refers to the entire range of living organisms, encompassing genetic variation and diverse habitats within a particular ecosystem (Islam et al., 2015). A "beel" is a low-lying depression that resembles a lake in a wetland or floodplain, which is regarded as one of the preferred natural habitats for Bangladesh's indigenous fish species and contribute 2.3% of the nation's annual fish production. These permanent wetlands, covering an area of around 114,161 ha (DoF 2022, Pandit et al., 2021) are used by indigenous fish as a natural habitat for food and shelter (Rahman et al., 2019). Beels plays an important role in inland fish production and fishermen's livelihoods, while fish stocks fully or partially support fishermen's livelihoods (Islam et al., 2018). Hence, fish diversity of wetlands is an indicator of conservation status, ecosystem services and distribution pattern of diversified aquatic species in inland water fisheries.

According to Islam et al., 2015, one of Bangladesh's most urgent problems right now is the decline in the variety and richness of fish species from the country's inland waters or wetlands. Over the past few years, fisheries have been confronted with a range of difficulties arising from both natural and human activities, including climate change, environmental disasters, industrialization, pollution, overfishing, harmful fishing practices, and the use of pesticides and agricultural chemicals (Pandit et al. 2021; Rimi et al., 2022; Akter et al., 2020, Sunny et al., 2022). Because of the substantial threats posed by all of these activities to the aquatic life that makes up the beel ecosystem, a number of fish species are now globally considered to be critically endangered. As a result, detailed analyses of the biodiversity of individual water bodies, their preservation, and their sustainable management are seen as key step (Islam et al., 2015; Pandit et al., 2022).

Therefore, it is essential to take pragmatist management measures in order to improve the biodiversity status of the beel, upon which local communities rely. National programs and biological management technologies have been developed to boost fish production and manage open water resources in order to prevent the depletion of aquatic resources. Prior to implementation, it is essential to understand the state and trend of a management strategy; yet, there are few published publications that deal with this problem. There have been numerous studies on the status of the fish biodiversity in wetlands, rivers, estuaries, and beels (Pandit et al., 2021; Rimi et al., 2022; but no such work has been done on the Pailati beel. In light of the aforementioned fact, the current study was conducted in order to ascertain the state, trend, and hazards to the aquatic biodiversity of the Pailati beel.

MATERIALS and METHODS

Study Area

Mohanganj and Pailati *Beel* are separated by a distance of approximately 10 kilometers. The *beel* encompasses an area of 12 acres and is surrounded by three villages, namely Pailati, Palgao, and Kulputa. The southern boundary of the *beel* is marked by the Khagra River. Unfortunately, no sanctuary or Katari has been established in the area. The water level in the *beel* is known to dry up periodically. To catch fish, the fishermen employ three different types of nets: sceine net, khewa net, and khana net. Even though there are challenges associated with fishing in the bill, the local fishermen continue to utilize this resource to support their families.

Data collection methods

The information was gathered with regard to the fish diversity and the reasons for the *beel* population decrease. Focus group discussions (FGD) for fishermen were used as a Participatory Rural Appraisal (PRA) method in this research, along with cross-check interviews with important informants. Sixty (60) fishermen from four communities in the Pailati *beel* were randomly

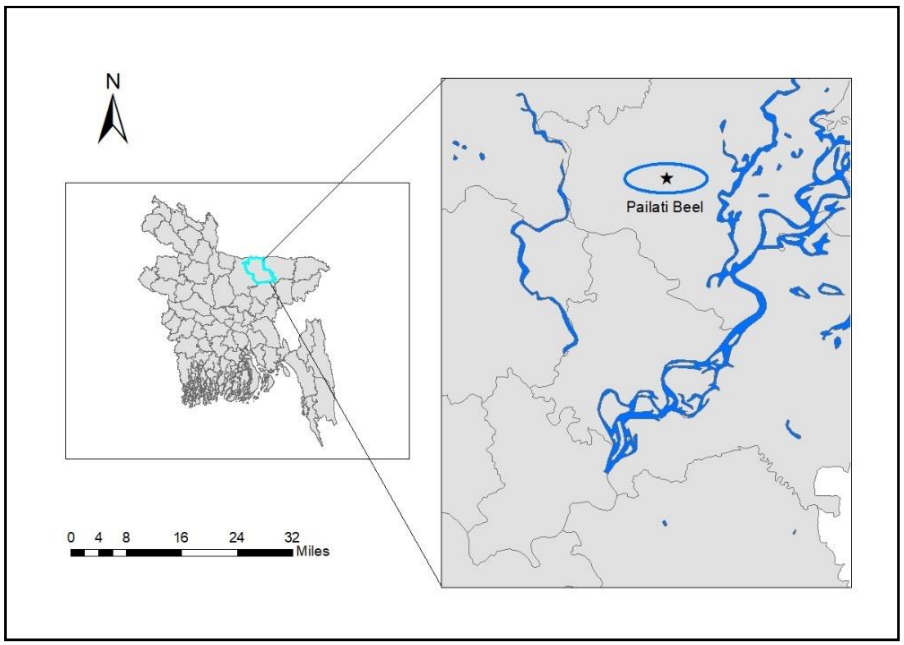

Figure 1. Study area (Pailati beel)

selected to participate in questionnaire interviews for the purpose of gathering data. Interviews with fishers were conducted at their homes or on their fishing grounds. Five FGDs total, with 15 to 20 fishermen in each group, were performed in the *beel* area. Where information was contradictory or requested for, cross-check interviews were performed with important individuals like the Upazila Fisheries Officer (UFO), teachers, local leaders, and NGO workers.

Collection of fish sample

Fish samples were taken during the catch from nearby fish landing sites and fishermen who had been informed earlier. Local fishermen use a variety of fishing gear in the study area, which varies in terms of target species, size, and performance (e.g., seine nets, gill nets, cast nets, hooks, and traps). Every sampling month used the same gathering techniques.

Identification of collected fish samples

Fish collected were arranged according to their main physical characteristics. The species that were challenging to recognize on-site were transferred to the Fisheries Biology and Genetics laboratory, Sylhet Agricultural University, where they were kept in a buffered formalin solution of 5–10%. Then the species were identified by analyzing their morphometric and meristic characteristics. The taxonomic analysis was completed in accordance with IUCN Bangladesh (2015). According to Nelson (2006), the fish species were categorized after identification.

Fish species diversity indices

The researchers used several indices to calculate the diversity, species richness, evenness, and dominance of fishes in their study. Specifically, they utilized the Shannon-Weaver diversity index (H') developed by Shannon and Weaver in (1949) to measure diversity. They also used the Margalef index (d) developed by Margalef in (1968) to measure species richness, Pielou's index (J') developed by Pielou in (1966) to measure evenness, and the Simpson index to measure dominance. The equations used to calculate these indices were as follows.:

Simpson dominance index (C)= $\sum_{i-1}^{s}\left(\frac{ni}{N}\right)^2$

Where,

ni = number of individuals in the 'each' species

N = total number of individuals

S = total number of species

Shannon-Weiner diversity index (H):

H =-Sum [pi × log(pi)]

Where, H'=Shannon-Weiner index,

pi=ni/N, ni= no. of indivduals of a species, and N=Total number of individuals.

Margalef's species richness index (d):

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

Where, S = Total species, N = Total individuals.

Pielou's evenness index (J'):

J' = H(s)/H(max)

Where, H(s)=The Shannon-Weiner diversity index, and H(max)=The theoretical maximum value for H(s) if all species in the sample were equally abundant.

Statistical analysis

Data input, pre-processing, and analysis of the collected information were done using SPSS software version 25.0, which stands for Statistical Package for the Social Sciences. The evaluation of biodiversity indices was done using PAST (Paleontological Statistics) version 2.16. ArcGIS 10.0 software was used to map the research area with the assistance of a GPS. (GPS). Analyses were conducted both qualitatively and quantitatively.

RESULTS and DISCUSSION

In the Pailati *beel*, a total of 55 species of fish and prawns were found, which belonged to 10 different orders, 23 families, and 13 groups. Within these species, there were 53 types of fish and 2 types of prawns. (Table 1). Because the fish diversity of this *beel* had never been investigated before, this study's findings could not be evaluated in comparison to those of other studies. The Medha *Beel* is home to a diverse range of aquatic life, including 70 types of wild fish, four types of prawns, one type of crab, one type of snail, and four types of turtles. These species belong to 23 different families and 50 different genera (Chakraborty et al., 2009). According to Galib et al. (2009), a study conducted on Chalan *beel* reported the presence of a total of 81 fish species. These included 72 species that were native to the area, and 9 species that were non-native or exotic. The fish belonged to 12 different orders, 27 families, and 59 genera. (Kumar, 2011) found a total number of 93 aquatic species from bogjan *beel* which was higher than the present findings. Saha & Hossain (2002) reported that there were 40 fish species in Saldu beel. However, the number of fish species identified in the present study is higher than what they reported. In contrast to the current study, Chakraborty et al., (2021) listed a total of 91 species from 65 genera that were found in the Charia *beel*. Compared to the current study, Rahman et al., (2019) only counted 33 fish species from 6 orders in the Basurabad *beel*. According to Siddique et al., (2013), 58 fish species from 21 families and 9 orders were found in the dogger *beel*. From Bhawal *beel*, Bangladesh, Sultana et al., (2019) recorded 56 species of fish, including prawn, in 10 orders and 23 families. Joadder et al., (2016) found a total of 52 species of fish from Kumari *beel* which were similar to the present study.

According to their availability, the observed species were classified into four statuses: Abundantly available (AA) 20%, commonly available (CA) 40%, moderately available (MA) 29.09%, and rarely available (RA) 10.90% (Figure 2). Pandit et al., (2020) observed the highest number of fish species in Gurukchi River was RA (29.82%), followed by CA (28.07%), MA (22.81%), and AA (19.30%). Galib et al., (2009) enlisted CA (23%), AA (17%) and RA (19%) in challan *beel*. Sultana et al., (2019) recorded 44.65% available, 19.64% seasonal and 16.08% rare in Bhawal *beel*.

The recorded fish species' order basis percentage analysis based on availability revealed the highest amount from cypriniformes (38.18%) followed by perciformes (20%) and siluriformes (16.36%). Other seven orders were constituted by Synbranchiformes, Clupeiformes, Osteoglossiformes, Beloniformes, Decapoda, Anabantiformes, and Tetraodontiformes. Sultana et al., (2019) observed highest number of fish species from cypriniformes (33.93%) followed by siluriformes (21.43%) and perciformes (19.65%). Akter et al., (2020) recorded the order based peccetage where highest came from cypriniformes (31.25%) followed by siluriformes (28.13%) and perciformes (14.06%) in Khiru River, Bangladesh. From Halti *Beel*, Bangladesh, Imteazzaman and Galib (2013) discovered that Cypriniformes (41.27%) was the dominant order, followed by Siluriformes (22.22%) and Perciformes (20.63%) which supports the present result (Figure 3).

The most prevalent family was listed as Cyprinidae (36.37%), followed by Channidae (7.27%), Bagridae (5.46%), and so on (Figure 4).

Table 1: Recorded fish species from the Pailati *beel*

SL. No.	Order	Family	Scientic Name	English Name	Common Name	Group Name	Present Status	Conservation Status	
								BD	Global
1	Cypriniformes	Cyprinidae	*Labeo rohita*	Rohu	Rui	Carps	MA	LC	LC
2	Cypriniformes	Cyprinidae	Catla Catla	South Asian carp	Catla	Carps	AA	LC	NE
3	Cypriniformes	Cyprinidae	*Cirrhinus reba*	Reba carp	Lachu	Carps	CA	NT	LC
4	Cypriniformes	Cyprinidae	*Labeo calbasu*	Orange Fin Labeo	Kalibaus	Carps	MA	LC	LC
5	Cypriniformes	Cyprinidae	*Cyprinus carpio*	Common carp	Carpio	Carps	MA	NT	VU
6	Cypriniformes	Cyprinidae	*Hypophthalmic hthys molitrix*	Freshwater cyp rinid fish	Silver carp	Carps	RA	LC	NT
7	Cypriniformes	Cyprinidae	*Ctenopharyngo don idella*	Ray-finned fishes	Grass carp	Carps	MA	NT	NE
8	Cypriniformes	Cyprinidae	*Pethia ticto*	Ticto barb	Tit punti	barbs and minnows	AA	VU	LC
9	Cypriniformes	Cyprinidae	*Puntius sophore*	Spotfin swamp barb	Jat punti	barbs and minnows	AA	LC	LC
10	Cypriniformes	Cyprinidae	*Puntius conchonius*		Kanchon punti	barbs and minnows	MA	LC	LC
11	Cypriniformes	Cyprinidae	*Puntius guganio*	Glass-barb	Mola punti	barbs and minnows	MA	LC	LC
12	Cypriniformes	Cyprinidae	*Pethia phutunio*	Spottedsail barb	Phutanio punti	barbs and minnows	MA	LC	LC
13	Cypriniformes	Cyprinidae	*Puntius chola*	Chola barb	Chola punti	barbs and minnows	AA	LC	LC
14	Cypriniformes	Cyprinidae	*Systomus sarana*	Olive barb	Shorputi	barbs and minnows	MA	NT	LC
15	Cypriniformes	Cyprinidae	*Amblypharyngo don mola*	Mola carplet	Mola	barbs and minnows	AA	LC	LC
16	Cypriniformes	Cyprinidae	*Osteobrama cotio*	Cotio	Dhela	barbs and minnows	RA	NT	LC
17	Cypriniformes	Cyprinidae	*Securicula gora*	Chela gora	Ghora chela	barbs and minnows	CA	NT	LC
18	Cypriniformes	Cyprinidae	*Salmostoma acinaces*	Silver razor belly minnow	Chela	barbs and minnows	MA	DD	LC
19	Cypriniformes	Cobitidae	*Lepidocephalich thys guntea*	Guntea loach	Gutum	Loaches	MA	LC	LC
20	Perciformes	Cobitidae	Botia dario	Bengal Loach	Bou rani	Loaches	CA	EN	LC
21	Clupeiformes	Clupeidae	*Gudusia chapra*	Indian river shad	Chapila	Clupeids	CA	VU	LC
22	Clupeiformes	Clupeidae	*Corica soborna*	The Ganges River sprat	Kachki	Clupeids	AA	LC	LC
23	Perciformes	Channidae	*Channa marulius*	Giant snakehead	Gozar	Snakeheads	RA	EN	LC
24	Perciformes	Channidae	*Channa striata*	Snakehead murrel	Shol	Snakeheads	CA	LC	LC
25	Perciformes	Channidae	*Channa punctatus*	Spotted Snakehead	Taki	Snakeheads	CA	LC	LC
26	Perciformes	Channidae	*Channa orientalis*	Asiatic snakehead	Cheng	Snakeheads	CA	LC	LC
27	Perciformes	Nandidae	*Nandus nandus*	Gangetic leaffish	Meni	Perches	CA	NT	LC
28	Perciformes	Anabantidae	*Anabas testudineus*	Climbing perch	Koi	Perches	MA	LC	LC
29	Anabantiformes	Osphronemidae	*Colisa fasciata*	Banded gourami	Baro kholisha	Perches	CA	LC	LC

Table 1 (continued).

30	Anabantiformes	Osphronemidae	*Colisa lalia*	Honey gourami	Lal kholisha	Perches	CA	LC	LC
31	Perciformes	Gobiidae	*Glossogobius giuris*	Tank goby	Bele	Mudskippers	CA	LC	LC
32	Perciformes	Ambassidae	*Pseudambassis lala*	Highfin glassy perchlet	Lal chanda	Perches	MA	LC	LC
33	Perciformes	Nymphalidae	*Chanda beculis*	Dewelled Nawab	Chanda	Perches	CA	EN	NE
34	Perciformes	Ambassidae	*Chanda nama*	Elongate glass perchlet	Lamba chanda	Perches	CA	LC	LC
35	Beloniformes	Belonidae	*Xenentodon cancila*	Freshwater garfish	Kankila	Gars	CA	LC	LC
36	Siluriformes	Siluridae	*Wallago attu*	Freshwater shark	Boal	Catfishes	CA	VU	VU
37	Siluriformes	Siluridae	*Ompok pabo*	Pabo catfish	Pabda	Catfishes	CA	CR	NT
38	Siluriformes	Clariidae	*Clarius batrachus*	Walking catfish	Magur	Catfishes	MA	LC	LC
39	Siluriformes	Heteropneustidae	*Heteropneustes fossilis*	Stinging catfish	Shing	Catfishes	CA	LC	LC
40	Siluriformes	Schilbeidae	*Neotropius atherinoides*	Indian potasi	Batashi	Catfishes	AA	LC	NE
41	Siluriformes	Bagridae	*Sperata aor*	Long-whiskered catfish	Air	Catfishes	CA	VU	LC
42	Siluriformes	Sisoridae	*Bagarius bagarius*	Gangetic Goonch	Baga air	Catfishes	AA	CR	NT
43	Siluriformes	Bagridae	*Mystus bleekeri*	Bleeker's mystus	Gulsha tengra	Catfishes	AA	LC	LC
44	Siluriformes	Bagridae	*Mystus vittatus*	Asian striped catfish	Tengra	Catfishes	AA	LC	LC
45	Synbranchiformes	Mastacembelidae	*Mastacembelus aculentus*	Elephant trunk fish	Tara baim	Eels	MA	DD	LC
46	Synbranchiformes	Mastacembelidae	*Mastacembelus pancalus*	Striped spiny eel	Guchi baim	Eels	RA	LC	LC
47	Synbranchiformes	Mastacembelidae	*Mastacembelus armatus*	Zig-zag eel	Baim	Eels	MA	EN	NE
48	Synbranchiformes	Synbranchidae	*Monopterus cuchia*	Gangetic mudee	Kuchia	Eels	RA	VU	VU
49	Osteoglossiformes	Notopteridae	*Notopterus notopterus*	Bronze featherback	Foli	Feathes backs	CA	VU	LC
50	Osteoglossiformes	Notopteridae	*Chitla chitla*	Clown knifefish	Chitol	Feathes backs	RA	EN	NT
51	Tetraodontiformes	Tetraodontidae	*Leiodon cutcutia*	Ocellated puffer fish	Potka	Puffer fishes	CA	LC	LC
52	Decapoda	Soleniceridae	*Solenocera crassicornis*	Red prawn	Gura chingri	Prawn	AA	LC	NE
53	Decapoda	Palaeomonidae	*Macrobrachium rosenbergii*	Giant river prawn	Golda	Prawn	CA	LC	LC
54	Cypriniformes	Cyprinidae	*Ctenopharyngodon idella*	Ray-finned fishes	Gonia	Carps	MA	NT	LC
55	Cypriniformes	Cyprinidae	*Esomus lineatus*	Stripped Flying Barb	Darkina	Carps	CA	DD	NE

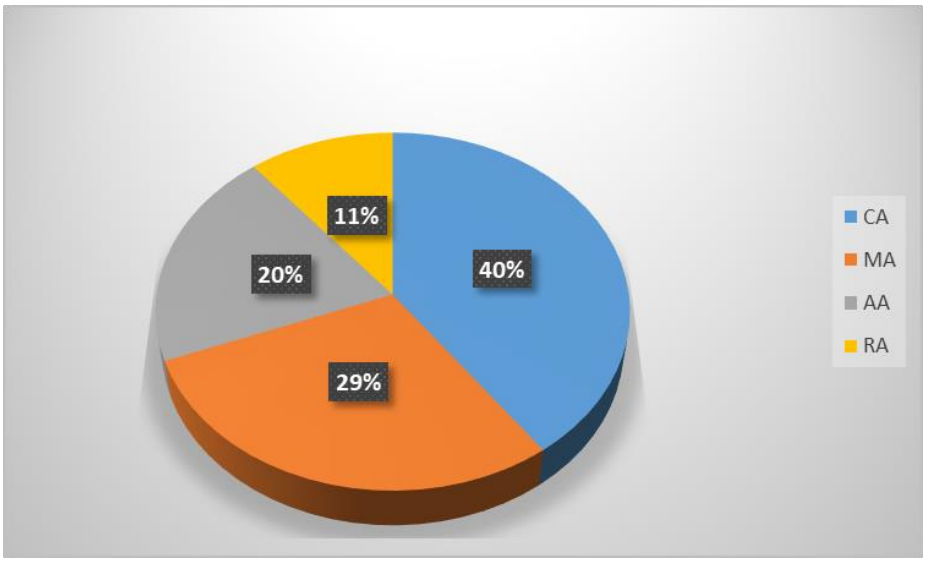

Figure 2. Present status of fish biodiversity of Pailati *beel.*

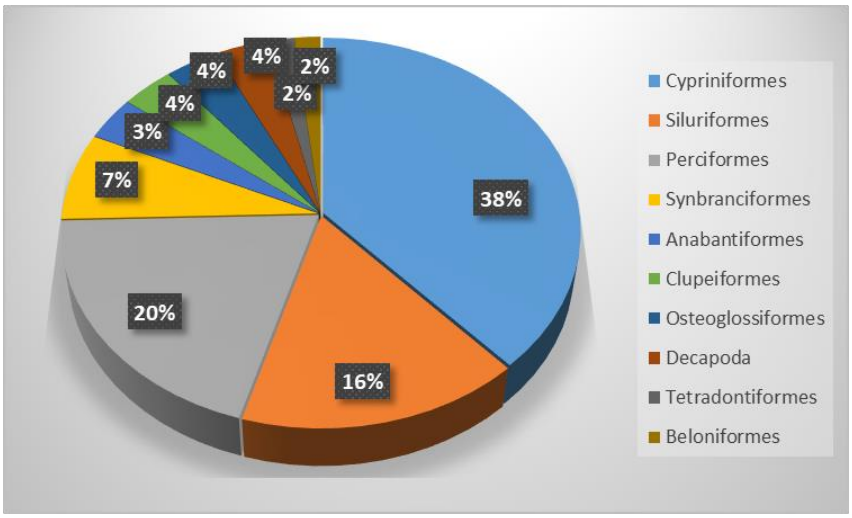

Figure 3. The variety of fish species found in Pailati *beel* are categorized under various orders.

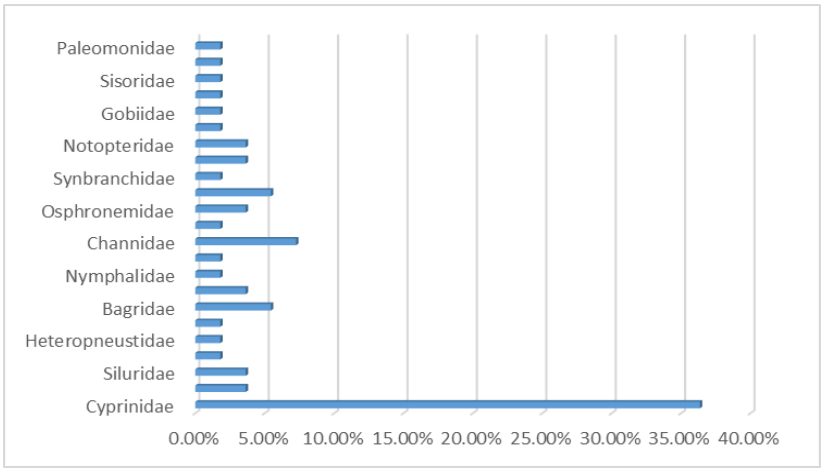

Figure 4. The families of fish found in Pailati *beel* and their respective species compositions

The Cyprinidae Family contained the most fish species, out of 54 species from charar beel (Raushon et al., 2019). According to Sultana et al. (2019), the Cyprinidae family contributed 17 species, which makes it the most abundant family in the Bhawal beel. Most fish species (16) from the cyprinidae family were seen from the Dogger beel (Siddiq et al., 2013) which is similar to the current study.

Out of the 13 identified groups in the beel, barbs and minnows (20%) were found to be the most prevalent, followed by carps (16.36%), catfishes, and perches (14.55%). Clupeids, loaches, prawns, and featherbacks were estimated to make up roughly (3.64%) of the total fish population, followed by snakeheads and eels (7.27%) (Figure 5). Trina et al., (2016) obseeved the highest percentage in catfishes, at 24%. The percentages for perches, carps, barbs, and minnows are 18%, 16%, and 15%, respectively, demonstrating their strong association. When Clupeids and Loaches are individually accounted for at 3%, Snakeheads make up 8%. Featherbacks and Miscellaneous both contribute 4%, while Eels and Mud Eels contribute 5% which supports the present result.

According to the IUCN Bangladesh report from 2015, more than half of the entire fish population (53.36%) was categorized as "least concern" (LC). Approximately 14.55% and 10.90% of the total available fish species were belong to near threatened and vulnerable category respectively in IUCN Bangladesh (2015). The conservation status of fish species from Pailati beel was evaluated globally, and it was found that most of the listed species (74.55%) were categorized as being of least concern (LC). The remaining species were either not evaluated (NE) (12.73%), not threatened (NT) (7.27%) and vulnerable (VU) (5.46%). (Figure 6).

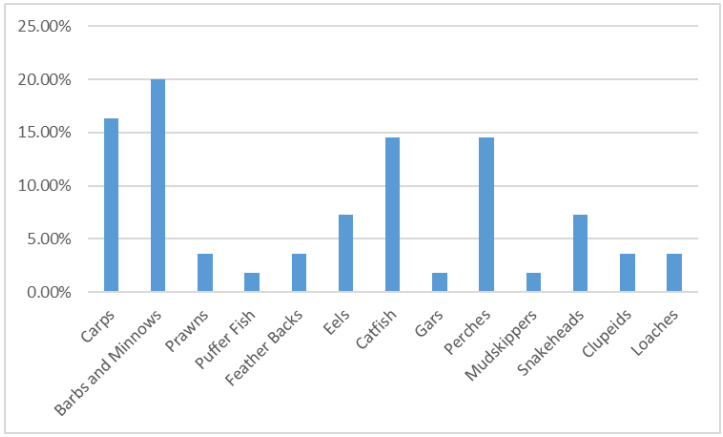

Figure 5. Distribution of fish groups that are commonly found in the Pailati *Beel*.

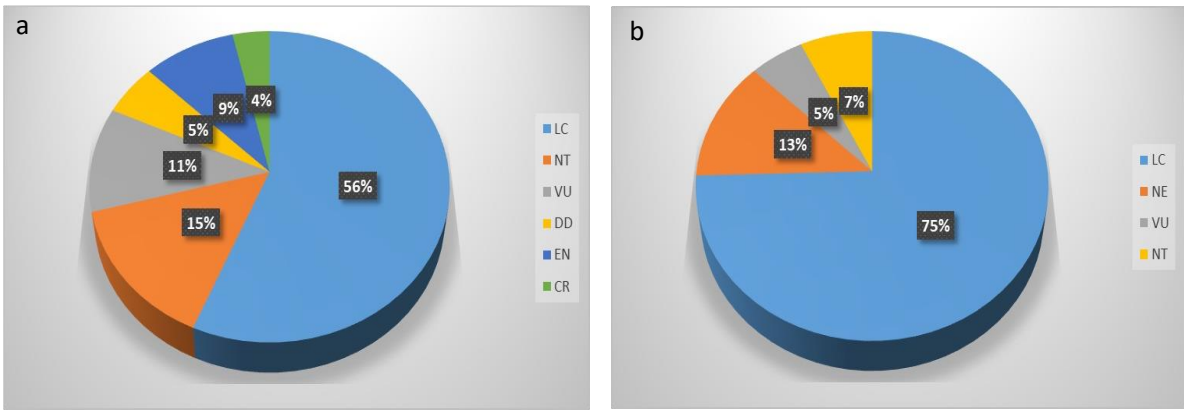

Figure 6. Conservation status of the fish species that have been documented (a, according to Bangladesh); (b, according to global status) in Pailati *beel* (IUCN Bangladesh, 2015).

In the present study, the values of H varied from 3.25 (December) to 3.34 (February), d varied from 5.67 (February) to 5.95 (January), J' varied from 0.443 (December) to 0.462 (February), and C varied from 0.91 (December) to 0.97. (February) The results for H, J', and C indicated that February was the month with the highest amount of fish fauna. During this time, the most fish species were identified. In December, the number of species recorded was lowest. According to Rahman et al., 2015, the Talma River showed variations in H, D, and e values throughout the year. The H values ranged from 1.06 in June to 1.51 in October, while the D values ranged from 5.34 in July to 7.41 in October. Additionally, the e values varied from 0.65 in May to 0.73 in October. Richness index values ranged from 3.889 (November) to 8.679 (January), evenness index values varied from 0.4879 (September) to 0.8252 (May), dominance index values ranged from 0.625 (September) to 0.9423 and diversity index value varied from 1.726 (November) to 3.406 (May) in Hakaluki Haor (Iqbal et al., 2015). Das et al., (2022) recorded d varied from 3.430 (December) to 2.325 (March), J value ranged from 0.508 (November) to 0.561 (March) and C varied from 0.244 (January) to 0.294 (November) in Shari-Goyain River. The highest value of H observed 3.49 and lowest was 3.29, the maximum value of C recorded 0.06 and minimum was 0.05, the value D varied from 7.91 to 6.60 and the value J ranged from 0.50 to 0.61 which are similar to our result

Reason for Declining of Fish Diversity:

1. Unregulated fishing practices
2. Fishing by dewatering and using poison
3. Altering the natural water flow
4. catch juvenile and small fish, disrupting fish growth and reproduction
5. Harvesting brood fish and fry during the breeding season
6. The excessive use of fertilizers, insecticides, and pesticides on agricultural land
7. Siltation caused by human activities such as mining and deforestation
8. Construction of developmental infrastructure
9. Water pollution from human activities such as industrial discharge, sewage, and oil spills

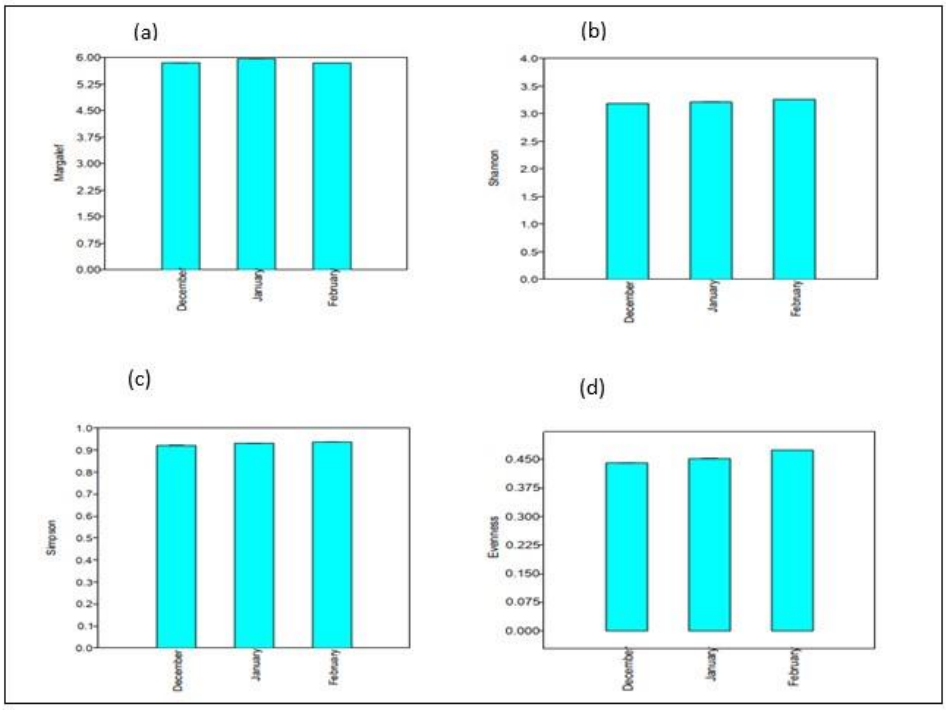

Figure 7. Biodiversity indices of Pailati *beel.* a) Margalef b) Shannon c) Simpson d) Evenness.

CONCLUSION

The Pailati *beel* comprised a wide variety of fish, according to the current study. The Pailati *beel's* fish species diversity has never been studied, and the study's primary goal was to compile a list of all potential native and non-native fish and prawn species. Due to anthropogenic factors (overfishing, habitat destruction, destructive fishing gear, building of dams, embankments, and siltation, among other things) as well as some natural factors (high drought prone area and changing the river route), the number of fish species in this beel was declining day by day. However, this research will serve as a baseline for future planning on fish diversity regulate and conservation in the Pailati *beel*.

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