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Fish diversity assessment of Beels in Chandpur District, Bangladesh

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Abstract

The present investigation was carried out to observe fish biodiversity of Guptir beel, Satbaria beel and Dogger beel under Faridganj, Chandpur Sadar and Hajiganj Upazila respectively in Chandpur district, Bangladesh. A field study was conducted for five months from September, 2021 to January, 2022. During the study period, a total of 46 species of fish were reported belonging to 10 orders and 20 families were documented from three beels of Chandpur district. Cypriniformes and Siluriformes were filed as leading group in the fish fauna community that comprises 36% and 18% of total species, respectively. According to IUCN conservation 2015, the study revealed that (70%) of the species were of Least Concern followed by Near Threatened (15%), Endangered (7%), Vulnerable (6%) and Data Deficient (2%). Population indices, viz. Shannon-Weaver diversity index (H'), Margalef species richness (d) and Pielou's evenness index (J') were applied to demonstrate the species diversity, richness and evenness of fish. The highest and lowest mean value of Shannon-Weaver diversity (H') index were 3.68±0.079 and 3.55±0.08 in Dogger beel and Guptir beel, respectively. Margalef Richness Index (d) was recorded as 4.33 to 6.15. The mean value of Richness (d) index 5.41±0.51 and 4.81±0.40 were found in Guptir and Satbaria beel, respectively. The highest mean value of evenness index was 0.966±0.015 in Satbaria beel, whereas the tiniest mean value was 0.968±0.009 in Guptir beel. Prudent planning for sustainable management and conservation Schemes are essential for beel fishery to enrich the fish species diversity of three beels in Chandpur district.

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Introduction

Bangladesh is absolutely rich with fresh water and marine water resources. The water bodies of our country are also considered as the habitation of fish (FRSS, 2020). Freshwater and marine water resources of Bangladesh are abundant with large varieties of species counting 260 species of freshwater fish, 24 species of prawn in the inland water bodies, 475 species of marine species, 36 species of shrimp and 12 species of exotic fishes (Ahammed *et al.*, 2015). Fisheries sector plays necessary role in national economy, fulfill the protein uptake of human and development of poor people livelihood (FRSS 2018). In the fiscal year 2018-2019.

The total production of fish was 43.84 lakh metric tons. Now, Bangladesh is able to fulfill about 60% of daily protein uptake of the people.

By exporting almost 73.17 thousand metric tons of fish and fishery products, Bangladesh earns BDT 425031.00 lakhs in 2018-19 (DOF, 2018). According to FAO report, Bangladesh ranked 3rd in inland water capture production and 5th in world aquaculture production (FAO, 2018).

Recently, fisheries sector contributes 3.50% to the national GDP and more than one-fourth (25.72%) to the agricultural GDP and 12% of the total population of Bangladesh depend on fisheries and aquaculture sectors for their livelihoods (FRSS, 2020).

Beel is defined as lake-like wetland with relatively large surface, static water body as opposed to moving water in rivers, canals- typically called khals (Banglapedia, 2015). It is a low-lying depression on a wetland or floodplain, sometimes drying up in the dry season. Sometimes, it contains water around the whole year (Majumder *et al.,* 2017).

Beels are generally rich in fishes than compare to rivers in Bangladesh (Siddiq *et al.,* 2013). Bangladesh has a total of 6,300 beels covering an area of about 114161 ha and overall production of fish in beels is about 99890 MT and productivity is only about 875kg/ha (FRSS, 2020).

Chadpur is a district in Chittagong division and in the east-central part of Bangladesh (Banglapedia, 2021). In Chadpur district, Guptir beel is situated in Faridgong upazila, Satbaria beel in Chandpur Sadar and Dogger beel in Hajiganj upazila. In 2018-19, Annual fish production of beels in Chandpur district was near about 278 MT from 361 ha water area ((FRSS, 2020).

Bangladesh is very abundant with fish biodiversity (Joadder, 2012) and several researchers conducted their studies on fish biodiversity in different water bodies such as khanom *et al.* (2018) in Uthrail beel of Noagong district, Paul *et al* (2018) in Jamuna river Bangladesh, Chakraborti *et al.* (2007) in Gharia beel of Bangladesh, Mojumder *et al.* (2017) in Shorupdah beel, Jashore etc.

But there is no sufficient information about these three beels of chandpur district, so our present study was conducted to know the present condition of fish biodiversity of these beels. Major causes of fish species loss are overfishing, environmental pollution, habitat modification, fragmentation, destruction, invasive species, climate change and human activities. Among them human activities is the most important factor for the loss of fish species in our country.

For future development and conservation of fisheries resources, some research works would necessary for biological management of Guptir beel, Satbaria beel and Dogger beel at Hajiganj, Chandpur Sadar and Faridganj Upazila respectively in Chandpur district. So, a research work was documented to know the status of fish diversity in this three beels and to conserve their fish biodiversity by calculating diversity index, evenness and richness.

Materials and methods

Study Area and Duration

The research study was conveyed to three beels expressly, Guptir beel, Satbaria beel and Dogger beel at Hajiganj, Chandpur Sadar and Faridganj Upazila, respectively in Chandpur district (Fig 1).This experiment was operated from September, 2021 to January, 2022.

Fig 1. Map indicates the location of three beels in Chandpur district. Dense star marked denotes the sampling site (Satbaria beel: Chandpur Sadar, Guptir beel: Faridganj, and Dogger beel: Hajiganj).

Data Collection
Preliminary questionnaire was advanced to collect primary and secondary data. The questionnaire interview and Focus Group Discussion (FGD) were conducted for the research study. Collected data were approved by discussion with DOF and concerned Upazila Fisheries Officer (UFO).

Analysis of Biodiversity
Biodiversity of fish species was estimated through the medium of Shannon-Weaver index (H′), species richness by Margalef index (d) and evenness by Pielou's index (J′) according to the following equations:
Diversity index was determined by following formula followed by Rahman *et al.* (2019) as below:
Shannon-Weaver diversity index ($H′$) = $-\sum p_i \times ln\,(p_i)$
Richness index was calculated using the following formula used by khanom *et al.* (2018) as below:
Margalef species richness (d) = (S-1)/ Log (n)
Evenness index was calculated according to the following formula used by Galib *et al.* (2013) as beneath:

Pielou's evenness index (J′) = H′ / H′ (max), where H′ (max) = lnS

Statistical analysis
Collected data and information were compiled for analyzing the fish biodiversity status of the selected three beels in Chandpur district. Simple descriptive analysis and graphical presentation were carried out using Microsoft excel (Version 2013) for better understanding.

Result and discussion
IUCN conservation status
During the investigation period, a total of 46 species of fishes including 10 orders and 20 families were documented from three beels of Chandpur district (Table 1). In the research study, Thirty two species (70%) were filed as Least Concern and seven species (15%) were recommended as Near Threatened. Among the observed fishes, 7% and 6% species were considered as Endangered and Vulnerable respectively (Fig. 2) based on IUCN Red List (2015).

Hossain *et al.* (2021) revealed that the highest percentage was Least Concern (67%), followed by Near Threatened (14%), Vulnerable (11%) and Endangered (8%) in Daduria beel, Faridpur. Rahman *et al.* (2019) observed that 57.89%, 10.53%, 2.63% of species were Least Concern, Vulnerable and Endangered, respectively in Basuakhali beel, Khulna. Rahman *et al.* (2017) reported 12% species were Vulnerable and Endangered out of 66 fish species in Chalan beel. Out of 56 species in Bhawal beel, 5 and 7 species were recommended as Endengered and Vulnerable respectively by Sultana *et al.* (2017). Galib *et al.* (2013) recorded 15.87% species were Endengered and 15.87% species were as Vulnerable in Choto Jamuna river.

Table 1. Fish fauna of three beels with their conservation status in Chandpur district.

SL	Order	Family	Scientific name	Local name	Status*
1	Clupeiformes	Clupeidae	*Corica soborna*	Kachki	LC
2	Clupeiformes	Clupeidae	*Gudusia chapra*	Chapila	VU
3	Cypriniformes	Cyprinidae	*Cyprinus carpio*	Common carp	LC
4	Cypriniformes	Cyprinidae	*Labeo rohita*	Rui	LC
5	Cypriniformes	Cyprinidae	*Labeo gonius*	Sada gonia	NT
6	Cypriniformes	Cyprinidae	*Chirrhinus cirrosus*	Mrigal	NT
7	Cypriniformes	Cyprinidae	*Catla catla*	Catla	LC

| SL	Order	Family	Scientific name	Local name	Status*
8	Cypriniformes	Danoinidae	*Amblypharyngodon mola*	Mola	LC
9	Cypriniformes	Cyprinidae	*Hypophthalmichthys molitrix*	Silver carp	LC
10	Cypriniformes	Cyprinidae	*Ctenopharyngodon idella*	Grass carp	LC
11	Cypriniformes	Cyprinidae	*Puntius sarana*	Sharpunti	NT
12	Cypriniformes	Cyprinidae	*Labeo calbasu*	kalibaus	LC
13	Cypriniformes	Danoinidae	*Puntius sophore*	Bhadi punti	LC
14	Cypriniformes	Cyprinidae	*Puntius ticto*	Tit punti	VU
15	Cypriniformes	Danoinidae	*Esomus danricus*	Darkina	LC
16	Cypriniformes	Danoinidae	*Rohtee cotio*	Dhela	NT
17	Cypriniformes	Cyprinidae	*Chela laubuca*	Chela	LC
18	Cypriniformes	Cobitidae	*Lepidocephalus guntea*	Gutum	LC
19	Siluriformes	Bagridae	*Mystus vittatus*	Tengra	LC
20	Siluriformes	Bagridae	*Mystus bleekeri*	Gulsha tengra	LC
21	Siluriformes	Siluridae	*Wallago attu*	Boal	LC
22	Siluriformes	Siluridae	*Ompok pabda*	Madhu pabda	EN
23	Siluriformes	Claridae	*Clarias batrachus*	Magur	LC
24	Siluriformes	Heteropneustidae	*Heteropneustes fossilis*	Shing	LC
25	Siluriformes	Bagridae	*Mystus tengara*	Bajari tengra	LC
26	Siluriformes	Pungasidae	*Pangasius pangasius*	Pangus	EN
27	Perciformes	Ambassidae	*Pseudambassis baculis*	Chewa	NT
28	Perciformes	Nandidae	*Nandus nandus*	Meni	NT
29	Perciformes	Channidae	*Channa striatus*	Shol	LC
30	Perciformes	Channidae	*Channa marulius*	Gozar	LC
31	Perciformes	Channidae	*Channa punctata*	Taki	LC
32	Perciformes	Ambassidae	*Chanda nema*	Lamba chanda	LC
33	Perciformes	Anabantidae	*Anabas testudineus*	Koi	LC
34	Synbranchyformes	Mastcembelidae	*Masacembelus armatus*	Baim	EN
35	Synbranchyformes	Mastcembelidae	*Macrognathus aculeatus*	Tara baim	DD
36	Synbranchyformes	Mastcembelidae	*Mastacembelus puncalus*	Pankal baim	LC
37	Osteoglossiformes	Notopteridae	*Notopterus chitala*	Chital	LC
39	Osteoglossiformes	Notopteridae	*Notopterus notopterus*	Foli	LC
40	Anabantiformes	Osphornemidae	*Colisa fasciatus*	Khoilsa	LC
41	Anabantiformes	Badidae	*Badis badis*	Badis	NT
42	Cichliformes	Cichlidae	*Tilapia mussambicus*	Tilapia	LC
43	Cichliformes	Cichlidae	*Oreochromis niloticus*	Nilotika	LC
44	Decapoda	Palaemonidae	*Macrobrachium rosenbergii*	Chingri	LC
45	Decapoda	Palaemonidae	*Macrobrachium malcomsonii*	Chingri	LC
46	Gobiformes	Gobidae	*Glossogobius giuris*	Bele	VU
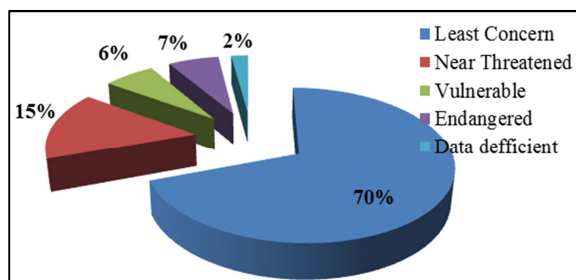
Fig 2. IUCN conservation status of beels in Chandpur district.

Order and Family based fish species availability

The dominant order was Cypriniformes comprising 36%. Other dominant order were Siluriformes, Perciformes and Synbranchiformes constituting 18%, 16% and 7% of species filed, respectively (Fig. 3). The most prominent family was Cyprinidae compost of 23.91% of the total fish species caught. Other diversified family was Danoinidae (8.69% species), Channidae, Bagridae, Mastacembelidae (6.52% species each) are shown in Fig. 4.

Md. Arifur Rahman *et al.* (2019) explored that Basurabad beel, overall 33 species were recorded among them Perciformes (39.40%) was the prominent order followed by Cypriniformes (18.20%), Decapoda (18.20%), Siluriformes (12.10%) and Synbranchiformes (9.10%). In Uthrail beel a total of 28 fish species were recorded and comprising of 8 orders, 16 families among these Cypriniformes (40.62%) was considered as dominant order which revealed by khanom *et al.* (2018). Overall 68 fish species were recorded and comprising of 9 orders, 22 families among these Cypriniformes was considered as dominant order which revealed by Miah *et al.* (2017). Joaddar *et al.* (2016) reported 52 species in kumara beel, 20 were belonging to the family Cyprinidae followed by Channidae (4 species) and Ambasidae, Cobitidae, Bagridae and Mastacembelidae (each with 3 species). 22 species of fishes under 6 orders and 10 families were recorded by Biswas *et al.* (2021) in the konnyadaha Boar.
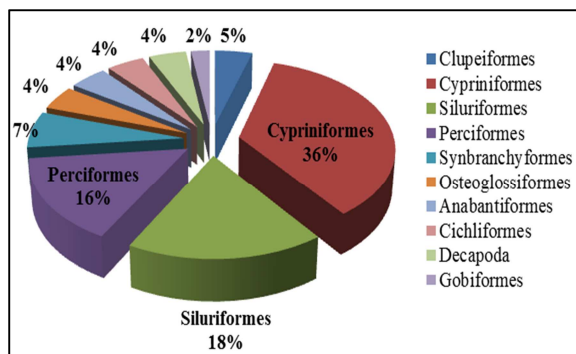
Fig 3. Order basis percentage composition of recorded fish species in the study area.
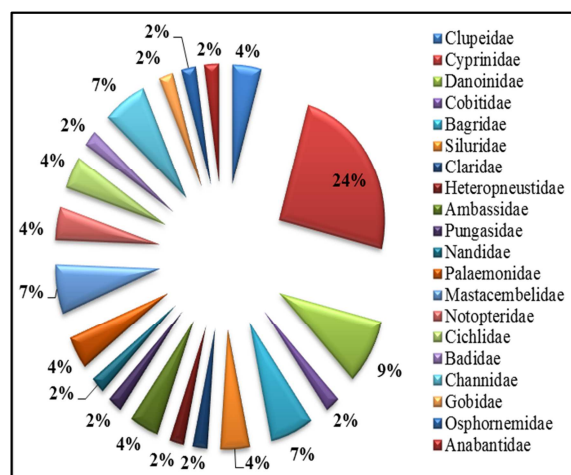

Fig 4. Family basis percentage composition of recorded fish species in the study area.

Catch Composition

Considering the number of individuals caught, the most abundant fish species *Tilapia mussambicus* (4.64%), *Pseudambassis baculis* (3.86%) *and Amblypharyngodon mola* (5.38%) were in Dogger beel, and Satbaria Beel, respectively. Whereas, the least abundant fish species *Puntius sophore* (0.93%), *Notopterus notopterus* (1%) and *Wallago attu* (0.17%) were found in Dogger beel, Guptir beel and Satbaria Beel, respectively (Table 2).

Gallib *et al.* (2013) revealed that the most abundant fish species was *Esomus danricus* comprising 6.26% of the total catch followed by *Salmostoma bacalia* (5.73%), *Puntius sophore* (5.32%), *Chanda nema* (5.29%) *and Amblypharyngodon mola* (5.21%) in Choto Jamuna River.

In Kumari beel, Joaddar *et al.* (2016) modeled that the most abundant fish species was *Mystus tengara* comprising 9.75% of total catch.

Khanom *at el.* (2018) reported that *Puntius chola* was the most abundant (30.8%) fish species, whereas, *Monopterus cuchia* was the least abundant (0.05%) fish species in Uthrail beel of Naogaon District.

Table 2. Fish Fauna of three beels of Chandpur district with percentage in total catch.

Local name	Dogger beel (%)	Guptir beel (%)	Satbaria beel (%)
Kachki	2.34	3.02	4.88
Chapila	2.09	2.14	4.28
Common carp	2.29	2.23	1.95
Rui	2.56	2.59	2.11
Sada gonia	1.61	1.24	0.00
Mrigal	1.82	2.21	1.61
Catla	2.34	2.52	1.68
Mola	3.29	2.89	5.38
Silver carp	2.37	2.59	1.97
Grass carp	2.36	3.69	0.63
Sharpunti	3.08	4.31	3.14
kalibaus	2.44	1.05	0.74
Bhadi punti	0.93	1.05	2.35
Tit punti	1.85	1.29	4.83
Darkina	1.81	1.48	5.07
Dhela	3.18	3.54	4.79
Chela	2.62	2.52	0.00
Gutum	2.36	3.02	4.94
Tengra	2.29	3.55	4.34
Gulsha tengra	1.47	1.57	0.00
Boal	1.27	0.89	0.17
Madhu pabda	2.22	1.55	3.55
Magur	2.34	2.66	1.68

Local name	Dogger beel (%)	Guptir beel (%)	Satbaria beel (%)
Shing	1.77	2.05	2.04
Bajari tengra	1.68	1.24	2.26
Pangus	2.79	0.00	0.00
Chewa	3.86	4.45	0.00
Meni	1.76	1.47	2.04
Shol	1.14	1.36	1.42
Gozar	1.46	1.48	0.12
Taki	3.2	2.5	2.14
Lamba chanda	2.06	3	2.95
Koi	2.4	3.88	2.42
Baim	2.31	3.18	2.95
Tara baim	1.36	3.05	1.97
Pankal baim	1.1	0.00	0.00
Chital	2.29	2.12	0.89
Foli	1.09	1	0.33
Khoilsa	3.5	4.33	3.26
Badis	0.96	0.88	0.00
Tilapia	3.03	4.64	3.31
Nilotika	1.65	2.33	2.52
Chingri	2.91	0.00	3.44
Chingri	2.28	3.05	0.00
Bele	2.39	1.67	3.38
Kakila	1.16	0.00	0.00

*Shannon-Weaver diversity index (*H´*)*

The month-wise values of Shannon-Weaver diversity index ($H´$) are shown in Table 3. During the study period, the highest and lowest mean value of Shannon-Weaver diversity ($H´$) index were 3.68±0.079 and 3.55±0.08 in Dogger beel and Guptirbeel respectively. In Satbaria beel, the highest value 3.94 was documented in December and the lowest value 3.34 reported in October.

Rahman *et al.* (2019) found the highest value of diversity index ($H´$) was 1.19±0.41 in Fultola beel and the lowest value was 0.68±0.17 in Kishmath-Fultola. Khanom *et al.* (2018) observed the average value of diversity index was 2.23±0.14 in Uthrail beel of Naogaon district.

The diversity index ($H´$) of Jamuna river ranged from 1.28 to 1.48 that studied by Paul *et al* (2021).

Table 3. Month wise and Average Shannon-Weaver diversity index ($H´$) value with standard deviation.

Beel name	Name of the Month					Average ± SD
	September	October	November	December	January	
Guptir beel	3.59	3.41	3.57	3.62	3.57	3.55±0.08
Satbaria beel	3.51	3.34	3.39	3.45	3.44	3.43±0.06
Dogger beel	3.76	3.69	3.65	3.56	3.75	3.68±0.079

Table 4. Month wise and Average Margalef Richness Index (d) value with standard deviation.

Beel name	Name of the Month					Average± SD
	September	October	November	December	January	
Guptir beel	5.70	4.63	5.75	5.83	5.15	5.41±0.51
Satbaria beel	5.30	4.88	4.48	5.08	4.33	4.81±0.40
Dogger beel	6.15	5.70	5.41	4.96	5.89	5.62±0.46

Table 5. Month wise and Average Pielou's evenness index (J´) value with standard deviation.

Beel name	Name of the Month					Average± SD
	September	October	November	December	January	
Guptir beel	0.968	0.976	0.955	0.969	0.981	0.968±0.009
Satbaria beel	0.963	0.942	0.972	0.970	0.983	0.966±0.015
Dogger beel	0.983	0.983	0.983	0.985	0.99	0.984±0.003

Margalef Richness Index (d)

In the study period, Margalef Richness Index (d) was recorded as 5.89 to 6.15 and the average value was 5.62±0.46 in Dogger beel. The mean value of Richness (d) index 5.41±0.51 and 4.81±0.40 were found in Guptir and Satbaria beel respectively (Table 4). Galib *et al.* (2013) mentioned the richness index ranged from 6.973 to 8.932 in Choto Jamuna River, Bangladesh. Islam and Yasmin (2018) evaluated the richness index value was 4.79 to 7.43 in Dhaleshawri river. In Upper Halda River, Alam *et al.* (2013) reported the richness index value was 6.60 to 7.91.

Pielou's evenness index (J´)

In the research observation, the highest mean value of evenness index was 0.966±0.015 in Satbaria beel, whereas the tiniest mean value was 0.968±0.009 in Guptir beel (Table 5). Paul *et al.* (2021) investigated the highest value was 0.86 and the lowest value was 0.77 in Jamuna river, Bangladesh.

Conclusion

Fish diversity is considered as boundless aquatic resources for human food but now-a-days the fish diversity of the world is absolutely undergoing complex stage then the previous years. During the study period, it was found that the fish diversity of these three beels in Chandpur district is declining at an alarming rate. Fishing pressure, environmental pollution, habitat modification, use of destructive nets, fragmentation, climate change and human activities etc. are the major threats for fish diversity of these three beels. Management initiatives should be adopted to protect the threatened species and achieve the sustainable production of those beels. Government Organizations, NGO's, and researchers should take necessary steps to conserve the fish biodiversity of beels.

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