



RESEARCH PAPER

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Fish biodiversity and conservation status of the lower streams of the Dhepa river of Dinajpur, Bangladesh

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Abstract

The impacts of the establishment of fish sanctuary at the upstream of the Dhepa river in Birganj, Dinajpur, Bangladesh were investigated from January to December 2016. Monthly samples were collected from 3 sites of the river, the Kantonagor (25°42'13.9"N; 88°38'05.8"E), Karnai (25°47'08.2"N; 88°40'24.6"E) and Bangibacha ghat (25°39'08.9"N; 88°37'48.2"E). The collected fish were transferred to the laboratory and preserved in 10% formalin. The fishes were identified using the taxonomic key. The biodiversity status, abundance and distribution were described by the Shannon-Weiner diversity index, Margalef's index, Simpson's dominance and evenness index which were determined using PAST software (version 3.11). A total of 61 fish species belonging to 8 orders, 18 families were identified. Based on the updated list of IUCN Bangladesh, the conservation status of the fishes were 6 vulnerable, 11 endangered, 2 critically endangered, 23 least concern, 8 near threatened, 11 not threatened. Out of 25 threatened fish species 10 species were abundantly available where 15 were rarely available. Among the studied sites of the river, Bangibacha ghat site was found fish biodiversity rich area based on the Shannon-Weiner diversity, Margalef's and evenness index (3.56, 7.62 and 0.62 respectively). On the other hand, Simpson's dominance index was found highest (0.11) at the Karnai area and the lowest (0.04) at the Bangibacha Bridge area. The fishes of studied sites were found at the risk of extinction due to the habitat destruction and over exploitation. To protect the fish from the being extinction, establishment of another fish sanctuary at Bangibacha ghat sites are highly required.

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Introduction

Inland water bodies of Bangladesh are comprised of small and large rivers, seasonal floodplains, perennial saucer-shaped natural depressions (beel), oxbow-lakes (haor), and canals. About 230 rivers including tributaries flow through the country constituting a waterway of total length around 24,140 km. A fairly large number of big rivers with their tributaries and branches criss-cross the country. About 54 rivers are shared with India. Dinajpur district is situated in the northwest part of Bangladesh which criss-crossed with several rivers including the Atrai, the Dhepa, the Choto Jamuna etc. Among these, Dhepa River is an offshoot of the Karatoya-Atrai (Buri Tista) river. The total length of the river is about 40 km. The Dhepa is totally free from tidal influence.

The Dhepa River flows at full speed only in the rainy season. Every year large quantities of fishes are caught from this river. The Dhepa river is believed to be an important spawning and feeding ground for riverine fish species of northwestern Bangladesh. A large number of people depend on fishing in the river and other fishery-related activities for their livelihood. By doing so there is a continuous loss of biodiversity due to decreasing fish stocks. Fish biodiversity is reduced in the rivers due to siltation, over exploitation, use of destructive gears, river obstruction and abstraction of water for winter agriculture (Hasan, 2007). Among the 260 freshwater fish species 54 are threatened in Bangladesh (IUCN, 2000). The biodiversity of these fishes are categorized under different levels of extinction under the current circumstances.

The biodiversity of these fish are categorized under different levels of threat such as, vulnerable (VU), endangered (EN) and critically endangered (CR) and so on. Such categories of threat levels provide an assessment of the likelihood of extinction under the current circumstances. IUCN-Bangladesh (2016) categorized 234 fish species in Bangladesh, of which 9 are critically endangered, 30 are endangered and 25 are vulnerable, 27 are near threatened, 40 are data deficient and 112 are least concern. It is estimated

that freshwater fishes make up more than 6% of the world's annual animal protein supplies for humans (FAO, 2002). But some fish are become decreasing due to various reasons. So they are become threatened. Biodiversity of different threatened fish species is very important to determine their diversity that helps from the extinction of indefinite species. So it is important to first identify these threatened fish species then the diversity of these fish species to be measured to control their extinction by knowing their distribution, abundance and the status spawning grounds in the river. This knowledge would be highly required for the conservation of the gene pool of the threatened fishes of Bangladesh.

For this reason, this study was design to know the distribution and abundance of fishes of the Dhepa river, to identify the threatened fishes, determine the conservation status based on IUCN Bangladesh (2016) as well as to suggest the potential sites for conservation for increase the native fish production.

Material and methods

The study was conducted through fish collection from the experimental sites, interviewing the fishermen from the sites and using the secondary data.

Study area and period

The study was conducted for a period of eight month from January to December 2016 in the Department of Fisheries Biology and Genetics of Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur. Three sites of the Dhepa river were selected for the sampling; Kantonagor (site 1), Karnai (site 2), Bangibacha Bridge (site 3) (Table 1 and Fig. 1). The monthly fish samples were collected where total of 36 sampling done from 3 sampling sites.

Fish sample collection, identification and preservation of fishes

To record the fish biodiversity of the Dhepa River, monthly fish samples were collected with the help of fishermen by using different types of fishing gears such as Ber jal, Dharma jal, Thela jal, Jhaki jal, Current jal etc at the time of catching and brought to

the Fisheries Biology and Genetics Laboratory of Hajee Mohammad Danesh Science and Technology University for further identification. The collected fish samples were identified to species level using

standard taxonomic literature, Freshwater Fishes of Bangladesh (Rahman, 2005) and Encyclopedia of Flora and Fauna of Bangladesh and Fishbase (www.fishbase.org).

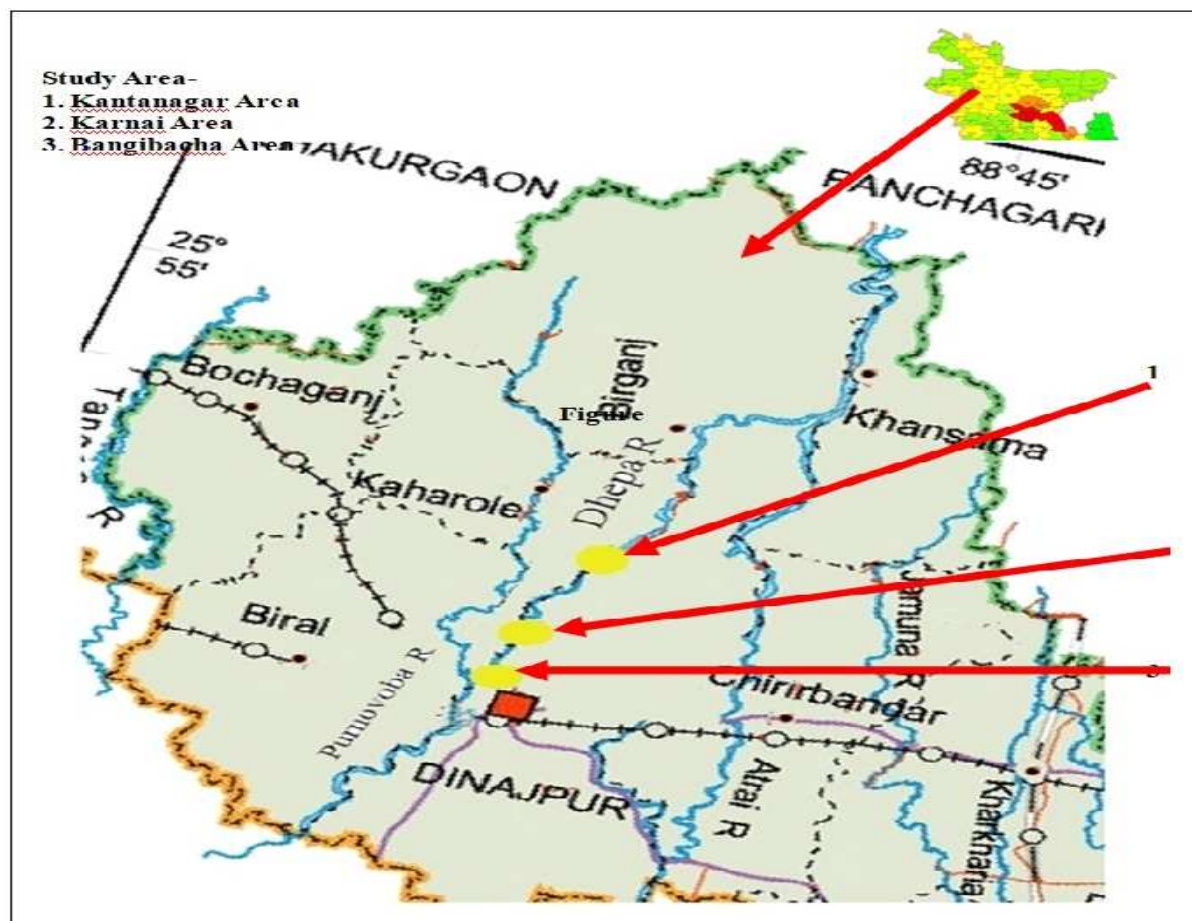


Fig. 1. Map of study area (Source: Google Map).

The photographs of different fishes were taken by using digital camera. Finally, identification of threatened fish species was done by using IUCN-Bangladesh red list (2016). The samples were preserved in 10% formalin in the plastic jars and labeled properly with the local name, scientific name. Some large fish were not collected and preserved during the survey because those species were costly and most common fish species as well as easily identified.

Identification of potential risks associated with threatening of fish species

A total of 48 fishermen were interviewed with semi structured questionnaires to know the potential risks associated with the threatening of the fish species at

every month (September 2015 to April 2016). Six fishermen were interviewed per month from each study area. Questionnaire was prepared for data collection from fishermen. Seasonal availability, place of occurrence, breeding seasons of fishes was recorded at the sites of sample collection. Data on fishing gear and reason of decreasing fish diversity were also recorded during data collection from fishermen. Secondary data like systematic position, synonyms, fish base name, IUCN, red list status were recorded from the books and online based literature.

Data processing, analysis and presentation

The collected data were summarized and processed for analysis. For processing and analysis MS Excel was used. Tables, pie-charts, histogram etc. were used

for data presentation. Paleontological Statistics (PAST) version 3.11 a software package was used for the determination of Shannon-wiener index, Margalef's index, Simpson's dominance index and evenness. Past is free software for scientific data analysis, with functions for data manipulation, plotting, univariate and multivariate statistics, ecological analysis, time series and spatial analysis.

Biodiversity parameters

Shannon-Wiener Index

Shannon-Weiner index is a index that is commonly used to characterize species diversity in a community considered both the number of species and the distribution of individuals among species (Shannon-Weaver, 1963; Ramos *et al.*, 2006). Shannon-Weiner diversity index was calculated as

$$H' = - \sum p_i \ln(p_i)$$

Where, $P_i = S/N$

S= Number of individuals of one species

N= Total number of all individuals in the sample

ln = natural logarithm

Margalef's index

Margalef's diversity index was used to measure species richness (Margalef's, 1968). Margalef's diversity index was calculated by using following formula:

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

Where,

d= Margalef's diversity index

S= is number of species

N= is number of individuals

Simpson's Dominance Index

Simpson's Dominance Index is a measure of diversity. it is often used to quantify the biodiversity of a habitat and it takes into account the number of species present, as well as the abundance of each species (Vijaylaxmi *et al.*, 2010). Simpson's dominance index was calculated by following formula:

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

Where,

D = Simpson's Dominance index

n = the total number of organisms of a particular species

N = the total number of organisms of all species

Evenness

Evenness is a measure of the relative abundance of the different species making up the richness of an area. Buzas Gibson's evenness (Harper, 1999) is measured by using the following formula: $E = eH/S$ Where, S = the total number of species and E = the evenness value.

Result and discussion

Fish biodiversity of the Dhepa river

A total 61 species of fishes under 11 groups, 8 orders and 18 families were recorded. Fish orders, family, local names and scientific names were represented in Table 2. The percentage compositions of the orders are shown in the Fig. 2. Cypriniformes was the dominant fish order which constitute 51% of the total fishes found in the Dhepa River.

Table 1. Geographical location (Longitude and Latitude) of study sites across the Dhepa river of Dinajpur.

Study Area	Study sites	Longitude	Latitude
Dinajpur	Site -1: Kantonagor Area	25°42'13.9"N	88°38'05.8"E
	Site-2: Karnai Area	25°47'08.2"N	88°40'24.6"E
	Site-3: Bangibacha ghat	25°39'08.9"N	88°37'48.2"E

The percentage compositions of the families are showed in the Fig. 3. The highest numbers of fishes was from Cyprinidae family (43%). Comparing to three study sites (Fig. 4), the Kantonagor was less diversified (29%) region for fish fauna. On the other

hand, 41 out of 61 species were identified from Kantonagor site and Beloniformes order was least. The Karnai area showed moderate diversification of fish species (45) comprising 32% of all the number of species recorded and Tetraodontiformes and

Beloniformes were least. On the other hand, the maximum numbers (55) of fish species were identified from the Bangibacha bridge area comprising 39% and Beloniformes order was least (Fig. 4). Cypriniformes order was dominant in all

three sites. Similar findings were also reported by Galib *et al.* (2009), Mohsin and Haque (2009) and Imteazzaman and Galib (2013). Carp was the most diversified fish group among 11 groups of fish and catfish is second diversified fish group (Fig. 5).

Table 2. Available fish species in the Dhepa river.

Order	Family	Local name	Scientific name
Cypriniformes	Cyprinidae	Rui	<i>Labeo rohita</i>
		Bata	<i>Labeo bata</i>
		Kalibaus	<i>Labeo calbasu</i>
		Gonia	<i>Labeo gonius</i>
		Boga	<i>Labeo boga</i>
		Catla	<i>Gibelion catla</i>
		Mrigal	<i>Cirrhinus mrigala</i>
		Khorki	<i>Cirrhinus reba</i>
		Silver carp	<i>Ctenopharyngodon idella</i>
		Grass carp	<i>Hypophthalmichthys molitrix</i>
		Carpio	<i>Cyprinus carpio</i> var. <i>communis</i>
		Ghol	<i>Chagunius chagunius</i>
		Cheli	<i>Salmostoma bacaila</i>
		Morar	<i>Aspidoparia morar</i>
		Mola	<i>Amblypharyngodon mola</i>
		Jatputi	<i>Puntius sophore</i>
		Titputi	<i>Pethia ticto</i>
		Sharpiti	<i>Systemus sarana</i>
		Chola Punt	<i>Puntius chola</i>
		Darkina	<i>Esomus danricus</i>
		Joiy	<i>Barilius bendalensis</i>
		Pathar Chata	<i>Barilius telio</i>
		Khaksa	<i>Barilius barna</i>
		Bhol	<i>Raiamas bola</i>
	Cobitidae	Gutum	<i>Lepidocephalichthys guntea</i>
		Rani	<i>Botia dario</i>
		Balichata	<i>Acanthocobotis botia</i>
		Lohachata	<i>Botia lohachata</i>
		Poia	<i>Canthophrys gongota</i>
Siluriformes	Bagridae	Gulsha tengra	<i>Mystus cavasius</i>
		Choto Tengra	<i>Mystus tengra</i>
		Tengra	<i>Mystus vittatus</i>
		Air	<i>Sperata aor</i>
	Sisoridae	Rita	<i>Rita rita</i>
	Clarridae	Magur	<i>Clarias batrachus</i>
	Heteropneustidae	Shing	<i>Heteropneustes fossilis</i>
	Siluridae	Boal	<i>Wallago attu</i>
		Pabda	<i>Ompok pabda</i>
	Gobiidae	Balia	<i>Glossogobius giuris</i>
	Sisoridae	Conta	<i>Conta conta</i>
	Schilbeidae	Bashpata	<i>Ailia coilia</i>
Perciformes	Cichlidae	Tilapia	<i>Oreochromis niloticus</i>
	Ambassidae	Chanda	<i>Chanda nama</i>
		Lal Chanda	<i>Chanda ranga</i>
		Koi	<i>Anabas testudineus</i>
		Kholisha	<i>Colisa fasciatus</i>
	Channidae	Shol	<i>Channa striata</i>

Synbranchiformes	Mastacembelidae	Taki	<i>Channa punctatus</i>
		Cheng	<i>Channa orientalis</i>
		Guchi Baim	<i>Macrognathus pancalus</i>
		Tara baim	<i>Mastacembelus aculeatus</i>
		Lal baim	<i>Mastacembelus armatus</i>
Clupeiformes	Sybranchidae	Cuchia	<i>Monopterusuchia</i>
	Clupeidae	Kachki	<i>Corica soborna</i>
		Chapila	<i>Gaduasias chapra</i>
Osteoglossiformes	Notoperidae	Chital	<i>Chitala chitala</i>
		Foli	<i>Notopterus notopterus</i>
Beloniformes	Belonidae	Kakila	<i>Xenentodon cancila</i>
Tetraodontiformes	Tetraodontidae	Potka	<i>Tetraodon cutcutia</i>
Decapoda	Palaemonidae	Golda chingri	<i>Macrobrachium rosenbergii</i>
		Gura chingri	<i>Macrobrachium lumarre</i>

The recorded fish species was much lower than some other rivers of Bangladesh (Bhuiyan *et al.* 2008; Rahman *et al.* 2012) but presence of similar number of fish species was also reported in Mahananda river

(Mohsin and Haque, 2009). Galib *et al.* (2013) reported a total of 63 species of fishes belonging to 41 genera, 23 families and 9 orders in the Choto Jamuna river.

Table 3. The availability of fishes according to sites of the Dhepa river.

Sl. No.	Name of the species	Site-1	Site-2	Site-3
1	<i>Labeo rohita</i>	+	+	+
2	<i>Labeo bata</i>	+	+	+
3	<i>Labeo calbasu</i>	+	+	+
4	<i>Labeo gonius</i>	—	—	+
5	<i>Labeo boga</i>	—	—	+
6	<i>Gebilion catla</i>	+	+	+
7	<i>Cirrhinus mrigala</i>	+	—	+
8	<i>Cirrhinus reba</i>	+	+	+
9	<i>Ctenopharyngodon idella</i>	+	—	+
10	<i>Hypophthalmichthys molitrix</i>	—	+	—
11	<i>Cyprinus carpio</i> var. <i>communis</i>	+	+	+
12	<i>Chagunius chagunius</i>	—	—	+
13	<i>Salcostoma bacaila</i>	+	+	+
14	<i>Aspidoparia morar</i>	—	—	+
15	<i>Amblypharyngodon mola</i>	+	+	+
16	<i>Puntius sophore</i>	+	+	+
17	<i>Pethia ticto</i>	+	+	+
18	<i>Systemus sarana</i>	+	+	+
19	<i>Puntius chola</i>	—	+	+
20	<i>Esomus danricus</i>	+	+	+
21	<i>Barilius bendalensis</i>	+	—	+
22	<i>Barilius telio</i>	—	—	+
23	<i>Barilius barna</i>	+	+	+
24	<i>Raiamas bola</i>	—	—	+

25	<i>Lepidocephalichthys guntea</i>	+	—	+
26	<i>Botia dario</i>	+	+	+
27	<i>Acanthocobotis botia</i>	+	+	—
28	<i>Botia lohachata</i>	+	+	—
29	<i>Canthophrys gongota</i>	—	—	+
30	<i>Mystus cavasius</i>	+	—	—
31	<i>Mystus tengra</i>	+	+	+
32	<i>Mystus vittatus</i>	+	+	+
33	<i>Sperata aor</i>	—	+	+
34	<i>Rita rita</i>	+	—	+
35	<i>Clarias batrachus</i>	—	+	—
36	<i>Heteropneustes fossilis</i>	+	+	+
37	<i>Wallago attu</i>	+	+	+
38	<i>Ompok pabda</i>	—	+	+
39	<i>Glossogobius giuris</i>	+	+	+
40	<i>Conta conta</i>	—	+	+
41	<i>Ailia coilia</i>	—	+	+
42	<i>Oreochromis niloticus</i>	+	+	+
43	<i>Chanda nama</i>	+	+	+
44	<i>Chanda ranga</i>	+	—	+
45	<i>Anabas testudineus</i>	+	+	+
46	<i>Colisa fasciatus</i>	+	+	+
47	<i>Channa striatus</i>	+	+	+
48	<i>Channa punctatus</i>	+	+	+
49	<i>Channa orientalis</i>	+	+	+
50	<i>Macrognathus pancalus</i>	+	+	+
51	<i>Mastacembelus aculeatus</i>	+	—	+
52	<i>Mastacembelus armatus</i>	+	+	+
53	<i>Corica soborna</i>	—	+	+
54	<i>Gaduasias chapra</i>	—	+	+
55	<i>Monopterusuchia</i>	—	+	+
56	<i>Chitala chitala</i>	—	—	+
57	<i>Notopterus notopterus</i>	—	+	+
58	<i>Xenentodon cancila</i>	+	+	+
59	<i>Tetraodon cutcutia</i>	—	+	—
60	<i>Macrobrachium rosenbergii</i>	+	+	+
61	<i>Macrobrachium lumarre</i>	+	+	+
Total		41	45	55

On the other hand, Parvez *et al.* (2014) identified 84 species of 21 families from several rivers of Dinajpur districts which were much higher than this investigation. It's occurred due to inclusion of different river in Dinajpur district. Two exotic species were, grass carp (*Ctenopharyngodon idella*) and

silver carp (*Hypophthalmichthys molitrix*) also reported in the study area. These two species are extremely popular in aquaculture of Bangladesh, and most probably, they escaped from adjacent aquaculture ponds during heavy flood. Establishment of silver carp into natural waters of Bangladesh was

reported by several researchers (Galib and Mohsin, 2011). Parvez *et al.*, 2014 were also identified 12 exotic species in three river of Dinajpur. These species can pose threat to native ichthyofauna (Mukherjee *et al.* 2002). So, consideration should be given to these non-indigenous species in order to avoid potential

negative impacts. Similar comments were also made by several researchers (Rixon *et al.*, 2005; Imteazzaman and Galib, 2013). However, all these researchers concluded with gradual loss of biodiversity in their studied rivers. In that sense, this is also true for the Dhepa river.

Table 4. Variation of Shannon-Weiner index (H), Simpson's Dominance Index (D), Margalef's Index (M) and Evenness (E) according in studied sites of Dhepa river.

Study Area	Total number of species	Total number of individuals	Shannon-Weiner index (H)	Simpson's dominance index (D)	Margalef's index (d)	Evenness (E)
Karnai	47	2830	2.84	0.11	5.79	0.37
Kantonagor	43	1311	3.19	0.06	5.85	0.57
Bangibacha Bridge	57	1552	3.56	0.04	7.62	0.62

Table 5. The threatened fish species available from the Dhepa river during study period (IUCN-Bangladesh, 2016).

Threatened categories	Local name	Scientific name	Status of threatened fishes of the Dhepa river	
			Available	Rarely available
Critically Endangered	Boga	<i>Labeo boga</i>		✓
	Lal Chanda	<i>Chanda ranga</i>		✓
Endangered	Joiy	<i>Barilius bendalensis</i>	✓	
	Pathar Chata	<i>Barilius tileo</i>		✓
	Khaksa	<i>Barilius barna</i>	✓	
	Chital	<i>Notopterus chitala</i>		✓
	Bhol	<i>Raiamas bola</i>		✓
	Rani	<i>Botia dario</i>	✓	
	Lohachata	<i>Botia lohachata</i>		✓
	Modhu Pabda	<i>Ompok pabda</i>		✓
	Baim	<i>Mastacembelus armatus</i>	✓	
	Pabda	<i>Ompok pabda</i>		✓
Vulnerable	Ghol	<i>Chagunius chagunius</i>		✓
	Cheli	<i>Salmotoma bacaila</i>		✓
	Morar	<i>Aspidoparia morar</i>	✓	
	Boal	<i>Wallago attu</i>		✓
	Cuchia	<i>Monopterusuchia</i>		✓
	Foli	<i>Notopterus notopterus</i>		✓
Near Threatened	Goinna	<i>Labeo goniis</i>		✓
	Mrigal	<i>Cirrhinus mrigala</i>	✓	
	Reba	<i>Cirrhinus reba</i>	✓	
	Gulsha tengra	<i>Mystus cavasius</i>		✓
	Choto Tengra	<i>Mystus tengra</i>	✓	
	Tengra	<i>Mystus vittatus</i>	✓	
	Conta	<i>Conta conta</i>		✓
	Tara baim	<i>Mastacembelus aculeatus</i>	✓	
Least	Rui	<i>Labeo rohita</i>	✓	

Concern	Kalibaus	<i>Labeo calbasu</i>	✓
	Catla	<i>Catla catla</i>	✓
	Bata	<i>Labeo bata</i>	✓
	Mola	<i>Amblypharyngodon mola</i>	✓
	Jatputi	<i>Puntius sophore</i>	✓
	Titputi	<i>Pethia ticto</i>	✓
	Chola Punti	<i>Puntius chola</i>	✓
	Darkina	<i>Esomus danricus</i>	✓
	Gutum	<i>Lepidocephalichthys guntea</i>	✓
	Magur	<i>Clarias batrachus</i>	✓
	Shing	<i>Heteropneustes fossilis</i>	✓
	Balia	<i>Glossogobius giuris</i>	✓
	Bashpata	<i>Ailia coilia</i>	✓
	Chanda	<i>Chanda nama</i>	✓
	Koi	<i>Anabas testudineus</i>	✓
	Shol	<i>Channa striatus</i>	✓
	Taki	<i>Channa punctatus</i>	✓
	Cheng	<i>Channa orientalis</i>	✓
	Guchi Baim	<i>Macrogathus pancalus</i>	✓
	Kachki	<i>Corica soborna</i>	✓
	Kakila	<i>Xenentodon cancila</i>	✓
	Potka	<i>Tetraodon cutcutia</i>	✓

If a species becomes established, its eradication is challenging if not impossible (Myers and Hinrichs, 2000).

In this regard, continuous monitoring is essential for this purpose because it is crucial to take necessary measures against non-native species in time. In the

previous year (2015), our studies identified 55 freshwater fishes where 48 were indigenous and 7 were exotic from the fish sanctuary established at the upper stream of the Dhepa river basin in Dinajpur district of Bangladesh to protect the threatened fishes (Parvez *et al.*, 2017).

Table 6. Potential risks associated with the threatening of fish species.

Sl. No.	Potential risks	respondents (fishermen)	Percentage (%)
01.	Indiscriminate fishing all the year round	45	19.31%
02.	Fishing of brood fish and fry during breeding season	40	17.17%
03.	Fish poisoning	38	16.31%
04.	Use of kata fishing method	35	15.02%
05.	Use of prohibited nets such as current jal and other destructive fishing gears	30	12.88%
06.	Fertilizers and pesticides used in agricultural land around the river are polluting the water	27	11.59%
07.	Environmental and water pollution	20	8.58%

The similar number of fish species were identified from the site 3 (Bangibecha ghat area) of this present study though total number of species from three sites were slightly increased that the previous study. The establishment of sanctuary at the upper stream of the Dhepa river may working in conservation and

management of the fish species of the river. Another sanctuary at the lower stream area mostly in the site 3 of the present studies is highly required for natural propagation and management of the native fishes of this northwest region of Bangladesh.

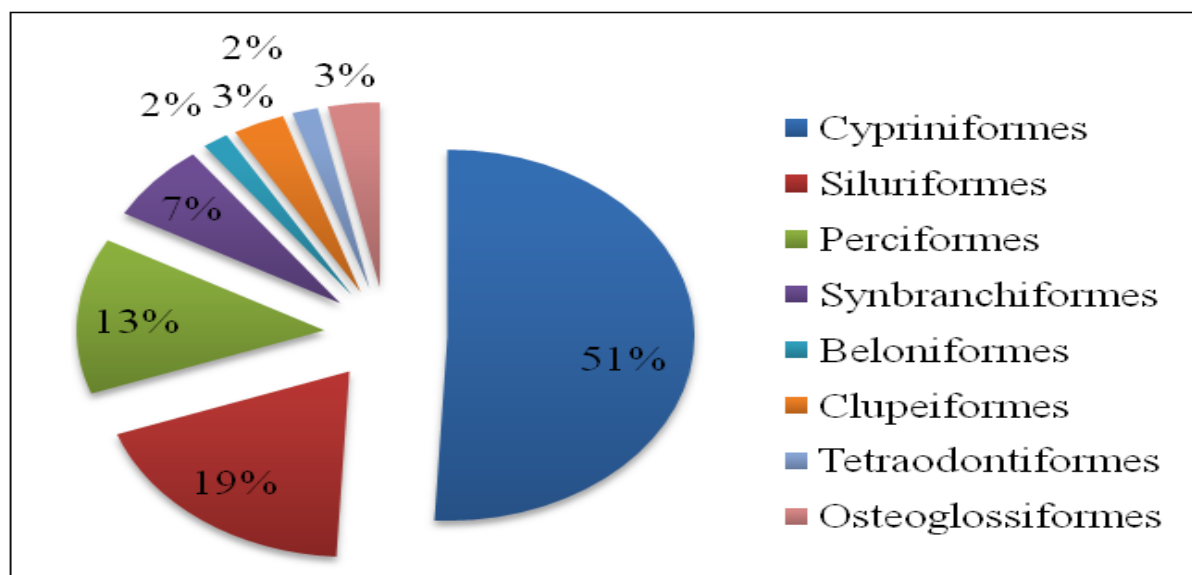


Fig. 2. Order- wise fish biodiversity of the Dhepa river.

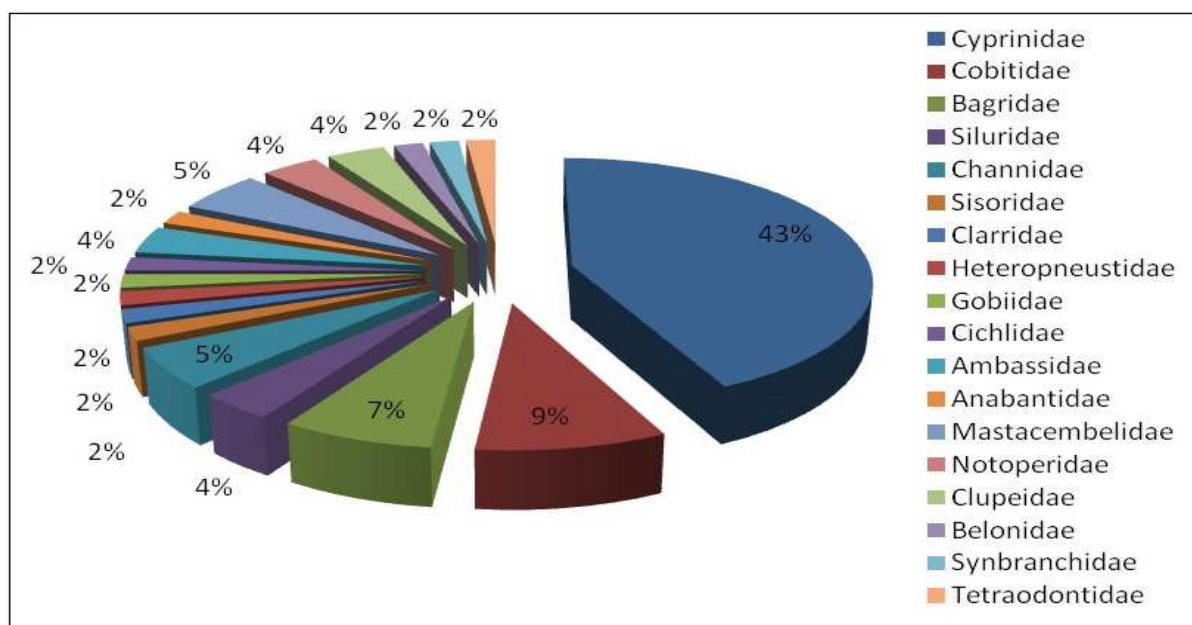


Fig. 3. Family-wise fish biodiversity of the Dhepa river.

Biodiversity indices of the Dhepa river

Several biodiversity indices (Shannon-Wiener diversity index, Simpson's dominance index, Margalef's index and Evenness) were calculated to estimate the fish biodiversity status of the Dhepa

river. The value of Shannon -Wiener index (H'), Simpson's dominance index (D), Margalef's index (M) and Evenness (E) were calculated according to sites (Table 4). The Highest Shannon Wiener index was found 3.56 at Bangibacha Bridge area followed by

3.19 at Kantonagor area and 2.84 at Karnai area (Table 4). The main causes of the differences occurring in the biodiversity indices are seasonal variations of nutrients), atmospheric air currents and environmental conditions (Keskin and Unsal, 1998), and seasonal fish migrations (Ryer and Orth, 1987).

Simpson's dominance index is a measure of both the richness and proportion of each species.

It is the measure of the chance that if two organisms are taken from the environment they will be members of the same species.

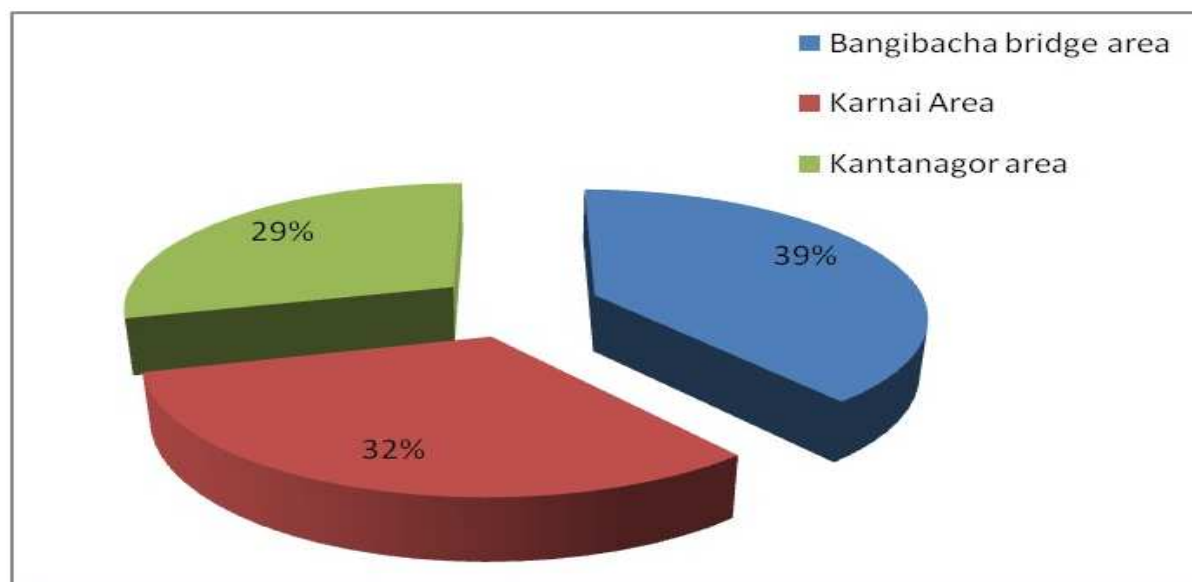


Fig. 4. Fish biodiversity of the Dhepa river according to study sites.

The maximum value of Simpson's dominance index (D) was observed 0.11 at Karnai area followed by 0.06 at Kantonagor area and 0.04 at Bangibacha Bridge area. According to the months, higher D value was found during March (0.23), followed by April (0.08), December (0.06) and September, October, November, January, February (0.05). The Margalef's index (M) is a measure for the total number of the species in a community.

The maximum Margalef's index (M) value was observed 7.62 at Bangibacha Bridge area followed by 5.85 at Kantonagor area and 5.79 at Karnai area. According to the months, the highest M value was found during September (8.38) followed by November (8.07), October (7.83), December (7.20), January (7.11), March (7.07), February (6.80) and April (6.54). Evenness is a measure of the relative abundance of the different species making up the richness of the area. The maximum Evenness (E) value was observed 0.62 at Bangibacha Bridge area followed by 0.57 at Kantonagor area and 0.37 at

Karnai area (Table 3). According to the months, the highest E value was found during both January and February (0.61) followed by October (0.60), September (0.58), November (0.57), December (0.54), April (0.39) and 0.19 during March.

There is positive correlation found between Margalef's index and Evenness index similar to Nair *et al.* (1989) as their study has shown same relationship of fish species diversity in the Nair River of the Western Ghats of India. On the other hand a negative relation was observed between Shannon–Weiner and Dominance index in this study which is similar to the study of Naaf river estuary by Chowdhury *et al.* (2010). In Shannon (H), Evenness (E), Dominance index (D) and Margalef's (M) diversity there was no significant difference observed. Diversity and richness indices showed that diversity of fish fauna was higher in the winter months (mainly November to February) than other months. The maximum number of fish species was also recorded during this time.

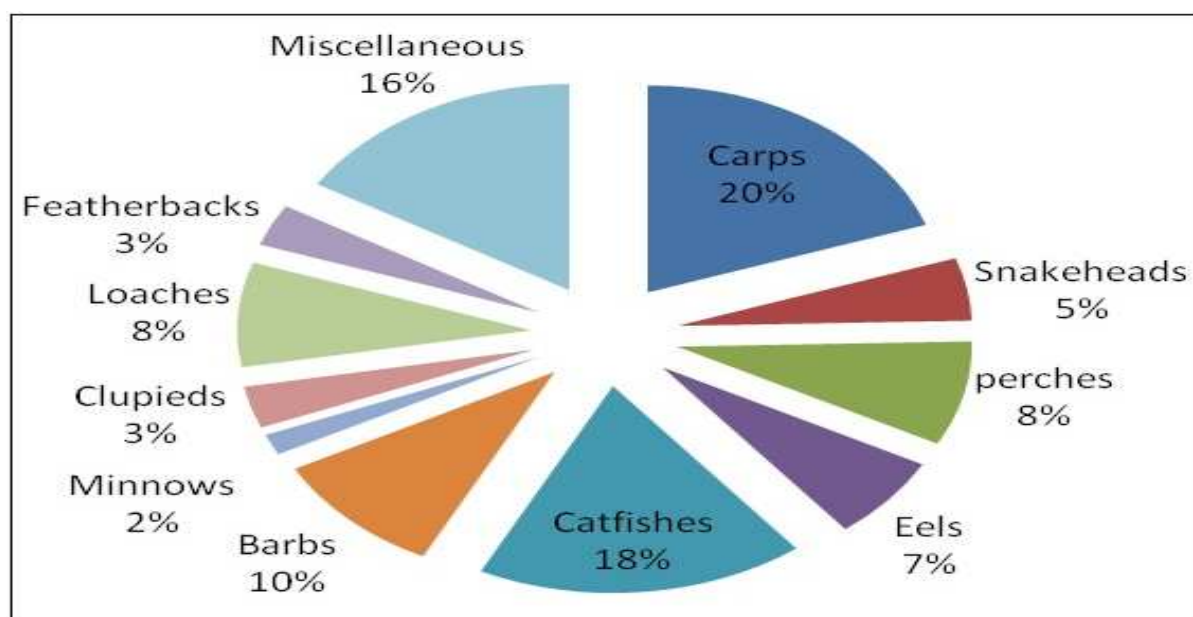


Fig. 5. Major groups of fishes from the Dhepa river.

This is because, water depth reduced to minimum due to lack of sufficient rainfall this time allowing fishermen to employ their fishing gears more effectively. Similar result was also reported by Nath and Deka (2012) who have recorded the richest fish diversity in winter. Therefore, it may be concluded that the seasonal difference in species diversity is a common phenomenon in the studied area.

Conservation status of the fish species from the Dhepa river

During the study period, a total of 50 red listed fish species (According to IUCN 2016) were identified from the Dhepa river that indicates the availability of threatened fish species (Table 5). Among 50 threatened fish species, 23 species (*Labeo rohita*, *Labeo calbasu*, *Catla catla*, *Labeo bata*, *Amblypharyngodon mola*, *Puntius sophore*, *Pethia ticto*, *Puntius chola*, *Esomus danricus*, *Lepidocephalichthys guntea*, *Clarias batrachus*, *Heteropneustes fossilis*, *Glossogobius giuris*, *Ailia coilia*, *Chanda nama*, *Anabas testudineus*, *Channa striatus*, *Channa punctatus*, *Channa orientalis*, *Macrognathus pancalus*, *Corica soborna*, *Xenentodon cancila* and *Tetraodon cutcutia*) were least concern, 11 species (*Barilius bendalensis*, *Barilius tileo*, *Barilius barna*, *Notopterus chitala*, *Raiamas bola*, *Botia dario*, *Botia lohachata*, *Ompok*

pabda, *Mastacembelus armatus* and *Ompok pabda*) were endangered, 8 species (*Labeo gonius*, *Cirrhinus mrigala*, *Cirrhinus reba*, *Mystus cavasius*, *Mystus tengra*, *Mystus vittatus*, *Conta conta*, and *Mastacembelus aculeatus*) were near threatened, 6 species were (*Chagunius chagunius*, *Salmostoma bacaila*, *Aspidoparia morar*, *Wallago attu*, *Monopterus cuchia*, and *Notopterus notopterus*) vulnerable, 2 species were (*Labeo boga* and *Chanda ranga*) critically endangered and 11 species were not categorized. Among 200 IUCN- Bangladesh (2016) categorized fish species, 50 species were found in the Dhepa river. Among 50 species, 25 species were found available and 25 species were rarely available. According to IUCN (2000), *Systemus sarana* is critically endangered but it is moderately abundant in the study area. Alam (2004) recorded a total of 73 species of fish belonging to 47 genera, 25 families, two species of prawn and 1 species of dolphin from Kaptai Lake. He also found 4 extinct and 5 threatened fish species.

Potential risks associated with the threatening of fishes of the Dhepa river

Potential risks associated with the threatening of the fish species of the Dhepa river were identified (Table 6). Indiscriminate fishing all the year round (19.31%) was the dominant risk where environmental and

water pollution (8.58%) was least and followed by fishing of brood fish and fry during breeding season (17.17%), fish poisoning was 16.31%, use of kata fishing method was 15.02%, use of prohibited net such as current Jal and other destructive fishing gear (12.88) and fertilizers and pesticides used in the low-land agriculture around the river are polluting the water (11.59%). Rolph and David (2004) studied the environmental characteristics and situation of aquatic habitats and communities and reported that aquatic habitats and communities have been degraded, as their biodiversity becomes affected by overfishing and pollution.

Conclusion

A total of 61 species of fish including prawn were recorded in the Dhepa river under 8 orders, 11 groups and 18 families. Cypriniformes was the dominant fish order and carp was dominant group in Dhepa river. From the Dhepa River total of 50 threatened fish species, among 50 red listed fish species, 25 species were found available and 25 species were rarely available. Finally the present study represents a rich fish biodiversity of Dhepa river. Based on findings, the following recommendations can be made for overall enhancement of fish biodiversity of the Dhepa River. Use of illegal fishing gear like current Jal should be stopped. Fish act should be implemented properly. During breeding season fishermen should be kept away from catching fish by providing them with alternate livelihood support. Fishing by poisoning should be stopped. Fishing by using kata should be stopped.

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