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Original Article

Assessment of fish fauna in relation to biodiversity indices of Chalan Beel, Bangladesh

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Abstract: The research was carried out to enlist the fish species diversity along with diversity indices of existing fish species of Chalan *Beel*, Bangladesh. During the study, a total of 78 fish species including 69 native and 9 exotic fish species were recorded belonging 10 orders and 26 families. The values of Shannon-Weiner diversity index (*H*) indicated a good spread of fish population in Chalan *Beel* although the number of species was not found satisfactory. The degradation of water quality due to domestic discharges, jute rotting, excessive usage of agro-chemicals, indiscriminate fishing activity etc. were revealed as the causes of declining the fish diversity of this *Beel*. The Margalef's richness index (*d*) expressed the species richness of Chalan *Beel* that started in July by joining new fish population with the existing fish species and reached gradually highest in November after breeding. Pielou's index (*J*) showed the equal distribution pattern of fish species throughout the sampling area indicating a stable but incompatible habitat for existing fish species. The assessment of the study revealed the number of species was not found in expected level in view of the overall fish biodiversity of the country. Considering the observations, it is recommended for stopping water pollution, ensuring normal water flow and developing awareness of fishermen to retrieve the fish diversity of the study area. Besides, an inclusive management and conservation scheme is crying need for the *Beel* fishery to enrich the fish species diversity of the Chalan *Beel* as well as the country.

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Introduction

A *Beel* is a term for a lake-like wetland with static water in the Ganges-Brahmaputra flood plains of the Eastern Indian states of West Bengal and Asam; and in the country of Bangladesh. A number of *Beels* is existing Northwest regions of Bangladesh. The Chalan *Beel* is one of the largest inland depressions of marshy character and also one of the richest wetland areas of this country. It was originated about 2000 years ago when the Brahmaputra diverted its water into the new channel of the Jamuna (Banglapedia, 2006). Several decades ago, this *Beel* was abundant with variety of fishes but in recent years like other water bodies of Bangladesh, aquatic resources from this water body is decreasing to a large extent due to uncontrolled fishing and highly destructive devices of fish capture in *Beel* deplete fisheries resources and are followed by great economic distress (Karim, 2003). A number of research works have been done on different aspects of fisheries species diversity of Chalan *Beel*. Hoq (2006) recorded 121 Small Indigenous fish Species (SIS), including 41 riverine, 29 migratory and 51 flood plain fish species; Galib et al. (2009) found a total of 81 fish species, including 72 indigenous fish species and 9 exotic fish species; Mostafa et al. (2009) recorded a total of 114 fish species; Gillespie (2011) found 129 fish species and Kostori et al. (2011) recorded a total of 82 SIS fish species from Chalan *Beel*. The variation in number of species in the previous works noticeably ranged from 81 to 129 during the period from 2006 to 2011. And diversity in the two research works in 2009, a far difference is observed in the species between Galib et al. (2009) and Mostafa et al. (2009). That is why the research work is aimed to enlist the fish species diversity

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along with diversity indices of existing fish species of Chalan *Beel* to make some recommendations for its proper management and conservation.

Materials and Methods

Duration and location of the study: The study was conducted from January 2015 to December 2015 to enlist fish species diversity and to calculate fish species diversity indices based on four main Sampling Areas of Chalan *Beel*. The biodiversity indices were calculated based on the fishing duration and fishing activity of the *Beel* from July to December. The geographical positions of the four Sampling Areas are mentioned here as Sampling Area-1 (24°28'N, 89°14'E), Sampling Area-2 (24°39'N, 88°49'E), Sampling Area-3 (24°10'N, 89°20'E) and Sampling Area-4 (24°36'N, 89°37'E) (Fig. 1).

Sampling procedure: Both field and fish landing center based survey was carried out for collecting and enlisting fish species diversity fortnightly. Fish species were collected from fishermen who use traditional fishing gear, nets and traps such as seine net (length, width and mesh size was 12.20 m, 1.25 m and 0.5 cm), lift net (length, width and mesh size was 45 cm, 5 m and 0.5 cm), Bitti (length, width and height was 45 cm, 15 cm and 35 cm) and Dohair (length, width and height was 45 cm, 25 cm and 40 cm) for sampling the biodiversity indices. The fishing nets operation time was considered for the morning (4.00 to 6.30 AM) where one attempt of fishing was counted one sampling for seine net and 10 hauls counted as a one sampling for lift net. Traps (Bitti and Dohair) were set up for overnight which counted one sampling.

Fish species collection and identification: Specimens of recorded fish were collected from study areas and then identified based on the morphometric and meristics characteristics following Talwar and Jhingran (1991) and Rahman (2005). Identified species were preserved in 10% buffered formalin solution in leveled plastic jars. The abundance (VC=Very Common, C=Common, R=Rare and VR= Very Rare) and seasonal availability status of fish

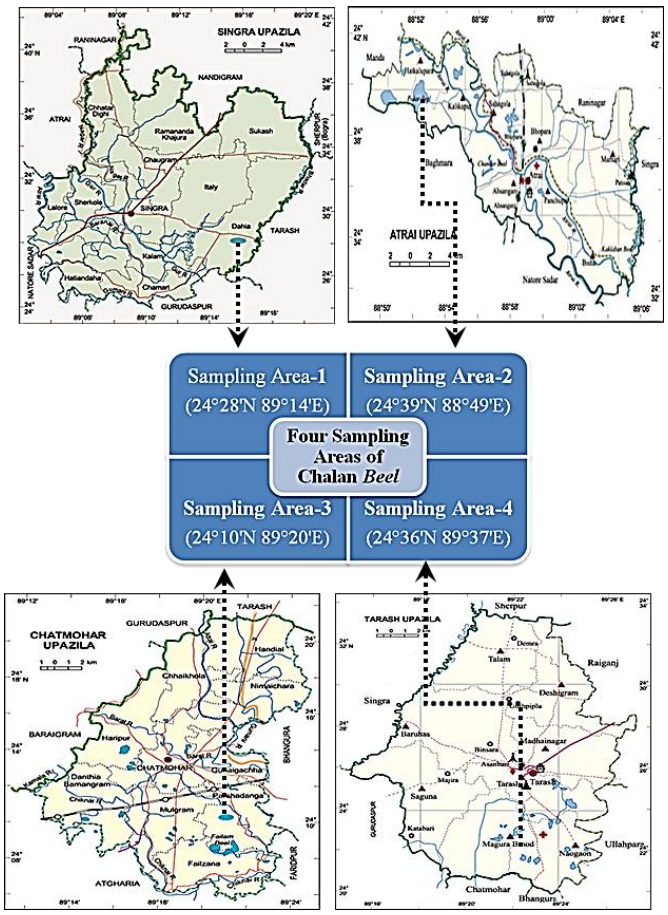

Figure 1. The four sampling areas of Chalan *Beel*.

species (M=Monsoon, PM=Post Monsoon, W= Winter and AS=All Season) were categorized based on the catch records and interview of 336 fishermen from studied areas.

Fish species diversity indices: In the present study, the biodeversity indices *viz.* diversity index (H') by Shannon-Weiner (1949), species richness index (d) by Margalef (1968) and species evenness index (J') by Pielou (1966) were calculated as follows:

$$H' = -\text{Sum}\,[pi \times \log(pi)],$$

Where, H'=Shannon-Weiner index, pi=ni/N, ni= no. of indivduals of a species, and N=Total number of individuals.

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

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

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

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.

Analysis of data: Descriptive analysis and graphical presentation of data were carried out using Microsoft Excel (version 2010). Biodiversity indices were calculated using PAST (Paleontological Statistics) and SPSS (Statistical Analysis for Social Sciences, version 20) software.

Results and Discussion

Status of fish fauna in Chalan Beel: During the study period, a total of 78 fish species including 69 native fish species belonging 10 orders and 26 families and 9 exotic fish species belonging 2 orders and 2 families recorded from Chalan *Beel*. The order and family based abundance and seasonal availability of each species are shown in the Table 1. The findings are very much similar to the findings of Galib et al. (2009) and Kostori et al. (2011) who recorded 81 and 82 fish species respectively from Chalan *Beel*. But the findings varied with Hossain et al. (2009) who reported a total of 114 fish species from Chalan *Beel*.

Order based distribution of fish fauna: In the present study, the dominant order considering the species number found as Cypriniformes which contribute 34.78% of the total orders and then followed by Siluriformes (30.43%), Perciformes (18.84%), Channiformes (5.80%), Oteoglosiformes (2.90%) and the rest of the orders are occupied 1.45% (Fig. 2). Among the recorded families, the Cyprinidae was the most diversified with 16 species and followed by Bagridae (7) and Schilbeidae (5). This finding is strongly agreed with the findings of Kostori et al. (2011) and Galib (2015). Therefore, the present findings indicate that the Chalan *Beel* area is suitable habitat for minnows, barbs and Catfishes.

Table 1. Status of order and family based fish species abundance in the Chalan *Beel* area including seasonal availability.

Order	Family	Species Name	Abundance	Seasonal Availability
Native Fish Species				
Beloniformes	**Belonidae**	*Xenentodon cancila* (Hamilton, 1822)	C	W
Clupeiformes	**Clupeidae**	*Gudusia chapra* (Hamilton, 1822)	C	AS
Cypriniformes	**Cyprinidae**	*Amblypharyngodon mola* (Hamilton, 1822)	VC	M
		Catla catla (Hamilton, 1822)	C	AS
		Cirrhinus mrigala (Day, 1878)	VC	AS
		Cirrhinus reba (Day, 1878)	R	M
		Labeo bata (Hamilton, 1822)	C	AS
		Labeo boga (Hamilton, 1822)	R	AS
		Labeo calbasu (Hamilton, 1822)	VR	AS
		Labeo rohita (Hamilton, 1822)	C	M
		Puntius chola (Hamilton, 1822)	VC	W
		Puntius conchonius (Hamilton, 1822)	VR	PM
		Puntius phutunio (Hamilton, 1822)	VC	AS
		Puntius sophore (Hamilton, 1822)	VC	AS
		Puntius ticto (Hamilton, 1822)	C	PM
		Puntius sarana (Hamilton, 1822)	C	PM
		Rohtee cotio (Hamilton, 1822)	VR	PM
		Salmostoma bacaila (Hamilton, 1822)	C	PM
	Rasborinae	*Danio devario* (Day, 1878)	VC	PM
		Esomous danricus (Hamilton, 1822)	C	PM
	Cobitidae	*Botia Dario* (Hamilton, 1822)	C	M
		Botia lohachata (Chaudhuri, 1912)	R	AS
		Lepidocephalus berdmorei (Blyth, 1860)	VC	AS
		Lepidocephalus guntia (Hamilton, 1822)	R	M
	Balitoridae	*Acanthocobities botia* (Hamilton, 1822)	R	W
		Somileptus gongota (Hamilton, 1822)	VR	M
Cypridontiformes	**Aplocheilidae**	*Aplocheilus panchax* (Hamilton, 1822)	C	PM

Table 1. To be continued.

Order	Family	Species Name	Abundance	Seasonal Availability
Perciformes	**Ambassidae**	*Chanda lala* (Hamilton, 1822)	VC	PM
		Chanda nama (Hamilton, 1822)	C	PM
		Chanda ranga (Hamilton, 1822)	C	W
	Anabantidae	*Anabus testudineus* (Bloch, 1792)	C	M
	Gobidae	*Glossogobius giuris* (Hamilton, 1822)	C	W
	Osphronemidae	*Colisa fasciata* (Bloch and Schneider, 1801)	C	W
		Colisa lalia (Hamilton, 1822)	C	W
		Trichogaster chuna (Hamilton, 1822)	R	W
	Nandidae	*Nandus nandus* (Hamilton, 1822)	C	M
	Mastacembelidae	*Mastacembelus armatus* (Lacepede, 1800)	VC	M
		Mastacembelus pancalus (Hamilton-Buchanan,	C	M
		Macrognathus aculeatus (Bloch, 1786)	R	PM
	Pristolepidae	*Badis badis* (Hamilton, 1822)	C	W
Channiformes	**Channidae**	*Channa orientalis* (Bloch and Schneider, 1801)	R	W
		Channa marulius (Hamilton, 1822)	VC	W
		Channa punctata (Bloch, 1793)	C	W
		Channa striata (Bloch, 1793)	C	AS
Siluriformes	**Bagridae**	*Chandramara chandramara* (Hamilton, 1822)	VR	AS
		Mystus aor (Hamilton, 1822)	VR	AS
		Mystus cavasius (Hamilton, 1822)	R	AS
		Mystus menoda (Hamilton, 1822)	R	AS
		Mystus seenghala (Sykes, 1839)	VC	AS
		Mystus tengara (Hamilton, 1822)	C	W
		Rita rita (Hamilton, 1822)	C	W
	Claridae	*Clarias batrachus* (Linnaeus, 1758)	C	M
	Heteropneustidae	*Heteropneustes fossilis* (Bloch, 1794)	C	M
	Pangasiidae	*Pangasius pangasius* (Hamilton, 1822)	VR	W
	Schilbeidae	*Ailia coila* (Hamilton, 1822)	VR	W
		Ailia punctata (Day, 1871)	R	M
		Clupisoma garua (Hamilton, 1822)	VR	M
		Eutropiichthys vacha (Hamilton, 1822)	C	W
		Pseudeutropius atherinoides (Bloch, 1794)	VR	W
	Chacidae	*Chaca chaca* (Hamilton, 1822)	C	AS
	Siluridae	*Ompok pabda* (Hamilton, 1822)	R	AS
		Ompok bimaculatus (Bloch, 1794)	VC	W
		Wallago attu (Bloch and Schneider, 1801)	R	W
	Sisoridae	*Gagata cenia* (Hamilton, 1822)	R	PM
		Glyptothorax telchitta (Hamilton, 1822)	VR	PM
Synbranchiformes	**Synbranchidae**	*Monopterus cuchia* (Hamilton, 1822)	VR	W
Osteoglossiformes	**Notopteridae**	*Notopterus chitala* (Hamilton-Buchanan, 1822)	C	W
		Notopterus notopterus (Pallas, 1769)	VR	P M
Tetradontiformes	**Tetradontidae**	*Tetradon cutcutia* (Hamilton, 1822)	C	AS
Exotic Fish Species				
Cypriniformes	**Cyprinidae**	*Aristichthys nobilis*	C	AS
		Ctenopharyngodon idella	C	AS
		Cyprinus carpio var. communis	C	AS
		Cyprinus carpio var. specularis	C	AS
		Hypopthalmichthys molitrix	C	AS
		Oreochromis mossambicus	C	AS
		Oreochromis niloticus	C	AS
		Puntius goninotus	C	AS
Siluriformes	**Pangasiidae**	*Pangasius hypophthalmus*	C	W

Abundance and seasonal availability status: The abundance of native fish species were categorized into four statuses which observed as very common (17.39%), common (43.48%), rare (20.29%) and very rare (18.84%) (Fig. 3a). The study focusing the declining trend of the existing fish population considering the percentage of rare and very rare species. Flowra et al. (2013) observed a total of 60 species in Baral River which has direct linkage with Chalan *Beel* and also found 45% available, 33.33% less available, 13.33% rare and 8.33% very rare fish species from this river. But, herein between two findings the percentage of rare and very rare species differed noticeably. The findings indicated some probable factors or barriers that are responsible for this abundance status.

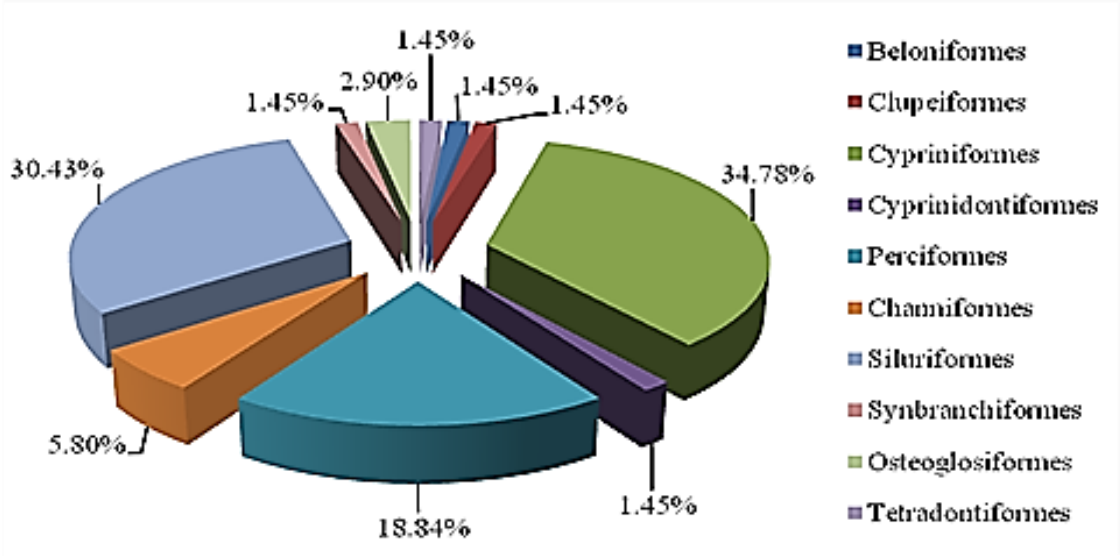

Figure 2. Order based percentage distribution of native fish species of Chalan *Beel*.

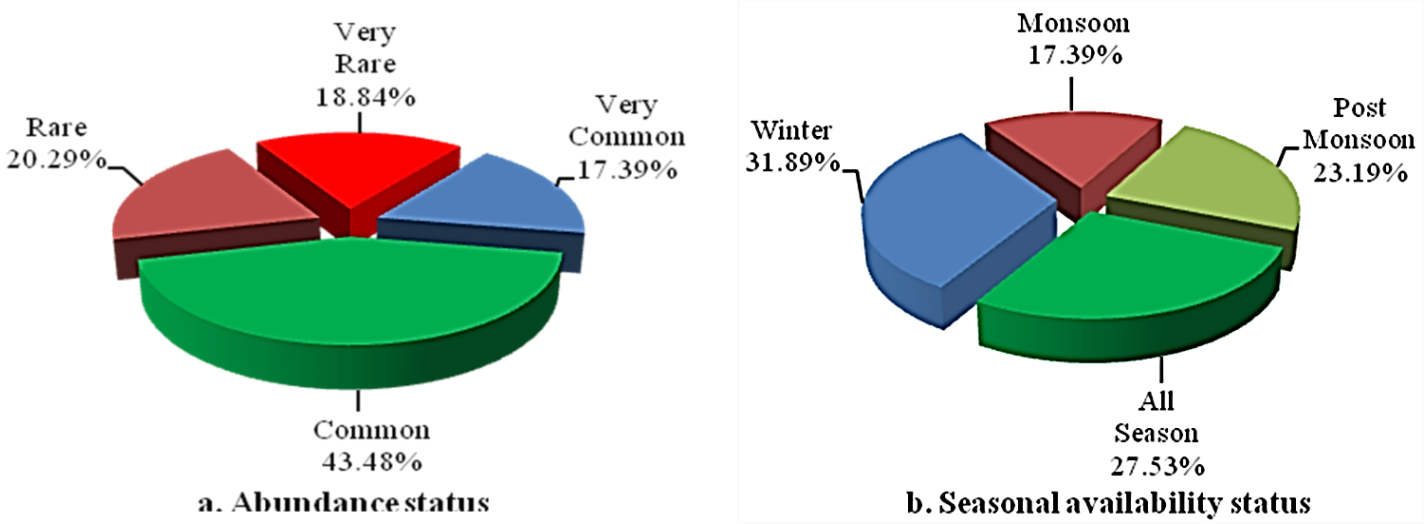

Figure 3. Abundance and seasonal availability status of indigenous fish species of Chalan *Beel*.

During the study period the highest number (31.43%) of fish species were found in winter (November-December) season (Fig. 3b), because success of *Beel* fishery mainly depends on the water volume of the habitat and the fishermen can easily catch the fish by netting, trapping and even dewatering. The highest catch of Chalan *Beel* was found in December where Kostori et al. (2011) observed in September-October and Karim (2003) reported maximum abundance in monsoon period.

Fish diversity indices: The diversity index indicates correlation with overall species richness and

evenness across the sampling areas and could be utilized by the biodiversity conservation managers for prioritization of study areas of conservation and habitat restoration.

***Shannon-Weiner diversity indices* (*H'*):** Shannon-Weiner diversity (*H'*) index considers both the number of species and the distribution of individuals among species of Chalan *Beel*. This index takes into account the number of individuals as well as number of taxa. The value of *H'* usually falls between the values 1.5 to 3.5 and it rarely surpasses the value of 4.5. A value near 4.6 would indicate that the numbers of individuals are evenly distributed between all the species. During the study period, the highest value of *H'* was found as 3.15 (December) in Sampling Area-2 and the lowest value was found as 2.54 (July) in Sampling Area-4 (Fig. 4). In each case of the highest Shannon-Weiner, diversity index is involved with high individuals and the lowest diversity involved with low number of individuals. The main causes of the findings occurring in the biodiversity indexes are seasonal variations of nutrients, effectiveness of breeding activities, affecting the coexistence of many fish species, atmospheric air currents, environmental conditions and seasonal fish migrations. The average highest *H'* value of Chalan *Beel* was found as 3.05 in December and lowest was found as 2.74 in July and August as a whole. This finding is closely related with the findings of Iqbal et al. (2015) who recorded *H'* value from 2.90 to 3.12 in Konoskhaihaor in Sunamgonj. Murugan and Prabaharan (2012) recommended that low diversity (*H'*) occurs in pre monsoon due to shrinkage of water spread of the water body and the highest diversity occurs in post monsoon due to sufficient water and ample food in resources. Therefore, these findings strongly agreed with the present findings and also expressed that the recorded value of *H'* both monthly and every sampling area indicates a good spread of species diversity in Chalan *Beel*. But, Biligrami (1988) recommended better condition of water body for fish diversity when *H'* index ranged from 3.0-4.5. This mean Chalan *Beel* is slightly degraded which has negative impact on decline the fish diversity.

***Margalef's richness index* (*d*):** Margalef's richness is the simplest measure of biodiversity and is simply a count of the number of different species in a given area. This measure is strongly dependent on sampling size and effort. In this study, the lowest and highest Margalef richness index value was observed as 4.03 in July and 9.58 in December at Sampling Area-2 respectively (Fig. 5). The average highest and lowest richness (*d*) value in the entire Chalan *Beel* was recorded as 8.39 in December and 4.53 in July respectively. Most of fish species start their breed from July when the monsoon begin in Bangladesh which may be the reason behind the lowest and highest richness value during July and December. As a result, numbers of new individuals joined the fish stocks increased the species richness up to December. Galib et al. (2013) calculated fish species richness value in the Choto Jamuna River of Bangladesh and found values varied from 6.973 (June) to 8.932 (November). The Margalef's index may deviate from actual diversity value to some extent because it does not confound the evenness and species richness value properly and it is depend on sample size (Nair et al., 1989). This may occur as a result of reduced water depth due to lack of rainfall, which disturbed fishermen to employ their fishing gears more effectively (Iqbal et al., 2015). In addition, ecological conditions also have an effect on the distribution of the fish species.

Equitability or Pielou's evenness index (J): Equitability is an evenness measure index which measures the evenness which individuals are divided among the taxa present. During the study period, the recorded highest evenness (*J*) value was found in July as 0.69 in Sampling Area-1 and the lowest as 0.25 (November) in Sampling Area-2 (Fig. 6) whereas the average highest and lowest value was recorded as 0.62 in July and 0.29 in November in the whole Chalan *Beel* (Fig. 7). Therefore, the species equitability index among the sampling area and in the different months reveals that the distribution of species or fish population of Chalan *Beel* is equally distributed. The values are also close to those reported by Emmanuel and Modupe (2010) for River

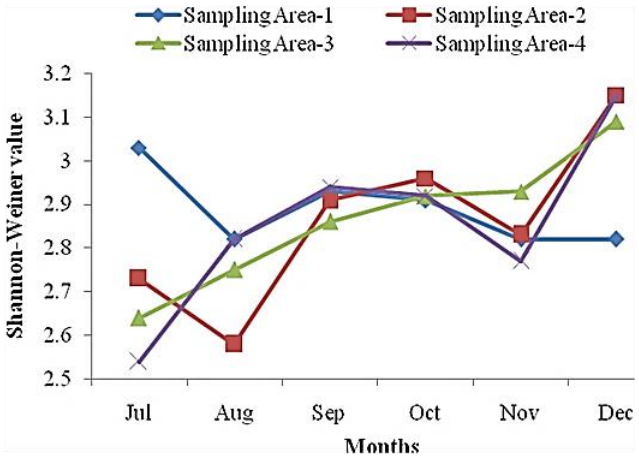

Figure 4. Sampling area based Shannon-Weiner indices.

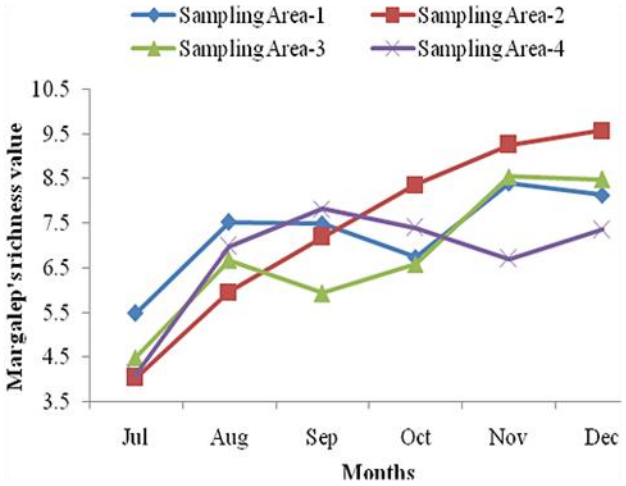

Figure 5. Sampling area based Margalef's richness indices.

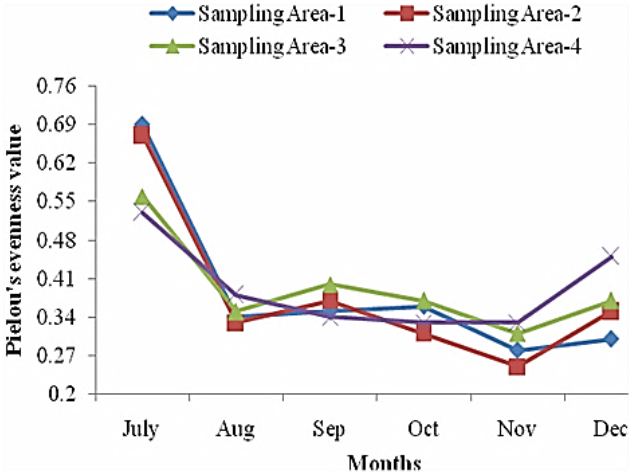

Figure 6. Sampling area based Pielus's evenness indices.

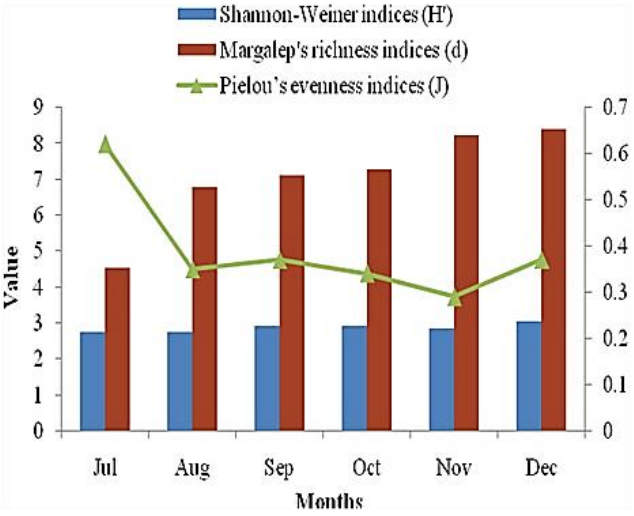

Figure 7. The average biodiversity indices of Chalan *Beel*.

Ore, hence, the category of water body is different. Murugan and Prabharan (2012) found highest evenness value (0.99) in late monsoon indicating on evenly distributed and rich fauna in the monsoon and post monsoon.

Conclusion: Bangladesh is one of the diversified countries with respect to freshwater fish species (260) in the world. As only 69 native fish species were recorded from Chalan *Beel* which representing the overall fish biodiversity status of Chalan *Beel* indicating a question mark in respect of number of total species. The value of *H'* indicating good spread of fish population in entire Chalan *Beel* as well as poor water quality that may cause by the domestic discharge, excessive uses of insecticides and pesticides in cultivation of the *Beel* and adjacent lands. On the other hand, indiscriminate and excessive fishing is one of the major causes for declining the native fish species from this *Beel*. A good management and conservation scheme is badly recommended to enrich the species diversity of this prominent waterbody of the country.

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