

Full Length Research Paper

Needs for conservation for Fish variety of the River Choto Jamuna, Bangladesh

Monjurul Xafri, Chakra Arafat and Saminul Farzana

Department of Fisheries Technology, Faculty of Fisheries, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh.

Accepted 31 July 2013

River Choto Jamuna is an important and well-known river in north-west Bangladesh in terms of fish production and source of income for many fishermen living beside where this study has been conducted from January to December, 2012. This study revealed the existing fish species and their composition along with diversity, richness and evenness indices. A total of 63 species of fishes have been recorded belonging to 41 genera, 23 families and 9 orders. Cypriniformes was recorded as the most diversified fish group in terms of both number of species and individuals observed. Of all the fishes found, 41.27% species were threatened in Bangladesh including 15.87% vulnerable, 15.87% endangered and 9.52% critically endangered species. Overall values of diversity, richness and evenness indices were found to be 3.717, 6.954 and 0.897, respectively. Finally, considering all the findings, the establishment of fish sanctuaries to conserve available fish species, both threatened and non-threatened, naturally is recommended.

Key words: Fish diversity, Choto Jamuna, biodiversity, Shannon-weaver diversity, Margalef's richness, Pielou's evenness, Bangladesh.

INTRODUCTION

Bangladesh is exclusively endowed with extremely rich and extensive inland and marine water resources. The freshwater bodies of Bangladesh are considered a home to at least 265 species of fin fishes (Rahman, 2005). River Choto Jamuna is one of the major distributaries of River Atrai, one of the major rivers in Bangladesh. The river is an important and well-known river in north-west Bangladesh in terms of fish production and source of income for many fishermen living beside it. But, at present time, reduction in the abundance and fish species from the inland waters of Bangladesh is a burning issue in the country (Galib et al., 2009; Imteazzaman and Galib, 2013).

Throughout the last century, riverine ecosystems have suffered from intense human intervention resulting in

habitat loss and degradation and as a consequence, many fish species have become highly endangered, particularly in rivers where heavy demand is placed on freshwaters (Rahman et al., 2012). However, a total of 54 fish species of Bangladesh have been declared threatened by IUCN (IUCN Bangladesh, 2000) but most of the wild populations have seriously declined in rivers and streams of Bangladesh due to over exploitation augmented by various ecological changes and degradation of the natural habitats (Hossain et al., 2012b). All these findings clearly indicate the need for water body specific detailed biodiversity studies which is essential to assess the present status and for the sustainable management of a body of water (Imteazzaman and Galib, 2013).

Though several studies on the biodiversity of fishes

*Corresponding author. E-mail: jurul_m@gmail.com

have been conducted throughout the world (Goswami et al., 2012; Shinde et al., 2009a, b; Raghavan et al., 2008) but in Bangladesh, such studies are much limited in number and conducted by Shahjahan et al. (2001), Saha et al. (2002), Ahmed et al. (2004), Zafar et al. (2007), Galib et al. (2009), Hossain et al. (2009), Mohsin and Haque (2009), Mohsin et al. (2009), Hossain et al. (2012a,b), Rahman et al. (2012) and Imteazzaman and Galib (2013). But, all these research efforts in Bangladesh except Hossain et al. (2012a) are lacking analyses of diversity indices, in which many research works have been completed in different parts of the world (Penczak et al., 1994; Yisa et al., 2011; Innocent et al., 2012; Nunoo et al., 2012; Nyanti et al., 2012). In order to preserve biodiversity in a given area, we need to be able to understand how diversity is impacted by different management strategies. Because diversity indices provide more information than simply the number of species present (that is, they account for some species being rare and others being common), they serve as valuable tools that provide important information on rarity and commonness of species in a community. The ability to quantify diversity in this way is an important tool for biologists trying to understand community structure (Beals et al., 2000).

To the best knowledge of the authors, no biodiversity indices-based research effort on fish fauna was carried out in Bangladesh except that of Hossain et al. (2012a) and this is the second attempt on measuring fish fauna of the Choto Jamuna River. Subsequently, the aim of the present paper was to carry out the first comprehensive biodiversity indices-based description of fish fauna in the river Choto Jamuna, Bangladesh.

MATERIALS AND METHODS

Study area and duration

The present study was conducted in River Choto Jamuna at Badalgachi subdistrict (approximately 24°58' N latitude; 88°55' E longitude) of Naogaon district, north-west Bangladesh (Figure 1), for a period of one year from January to December 2012. The River Choto Jamuna is one of the major distributaries of River Atrai, one of the major rivers in Bangladesh.

Sampling framework

Fish sampling were done monthly with the help of traditional fishing nets viz. cast nets, gill nets, lift nets and fishing traps locally known as Dohair, Britti and Kholsun. All these fishing gears were operated at the same spot within 0.5 km area to ensure harvesting of maximum species of study site in the catch. Gill net and fishing traps were set in late afternoon and left overnight to be checked in the morning. When cast and lift nets were employed, twenty throws and fifteen hauls were made for cast and lifts net, respectively. Immediately after harvesting, the fishes were counted on the spot. In this way, a total of 7449 individuals of recorded fish species were counted and categorized during the period of study. However, species that seemed difficult to identify on spot were preserved in 7 to 10% buffered formalin solution and transported to the Aquatic

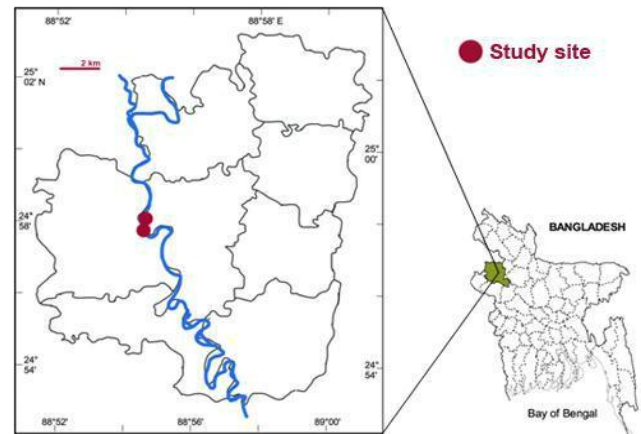


Figure 1. Map of River Choto Jamuna including the study area.

Biodiversity Laboratory of the Department of Fisheries, University of Rajshahi, Rajshahi, Bangladesh for identification and further study. These species were identified after analyzing their morphometric and meristics characters under laboratory situation.

Identification of the fishes

Fish fauna harvested from the study area were identified based on their morphometric and meristics characters following Bhuiyan (1964), Rahman (1989, 2005) and Talwar and Jhingran (1991). After identification, fish species were systematically classified according to Nelson (2006).

Biodiversity parameters

To understand the seasonal diversity of fishes in the study area, month-wise data were collected. In this study, the diversity, evenness and richness indices were calculated for understanding the status of diversity using the following formulas:

Shannon-Weaver diversity index, $H = - \sum P_i \ln P_i$ (Shannon and Weaver, 1949)

Margalef's richness index, $D = \frac{S-1}{\ln N}$ (Margalef, 1968)

Evenness index, $e = \frac{H}{\ln S}$ (Pielou, 1966)

where H is the diversity index, P_i is the relative abundance (s/N), s is the number of individual for each species, N is total number of individuals, D is the richness index, S is the total number of species, e is the similarity or evenness index and \ln is the natural logarithm.

RESULTS

Composition of fish fauna

Fish orders, families, species, English name, local name(s), their status in Bangladesh and percentage in total catch are given in Table 1.

A total of 63 species of fishes have been recorded from the study site belonging to 41 genera, 23 families and 9

Table 1. Fish fauna of River Choto Jamuna with their status and percentage in total catch in Bangladesh.

Order	Family	Species	English name	Local name	Status*	%**
Beloniformes	Belontiidae	<i>Xenentodon cancila</i>	Freshwater garfish	Kakila	NO	1.87
Clupeiformes	Clupeidae	<i>Gudusia chapra</i>	Indian river shad	Chapila	NO	1.83
	Engraulidae	<i>Setipinna phasa</i>	Gangetic hairfin anchovy	Phasa	NO	1.05
Cypriniformes	Cyprinidae	<i>Amblypharyngodon mola</i>	Mola carplet	Mola, Moa	NO	5.17
		<i>Aspidoparia morar</i>	Aspidoparia	Pioly	DD	2.91
		<i>Catla catla</i>	Catla	Catal, Catla	NO	1.24
		<i>Cirrhinus mrigala</i>	Mrigal carp	Mrigel, Mirka	NO	1.19
		<i>Cirrhinus reba</i>	Reba	Raik	VU	1.89
		<i>Ctenopharyngodon idella</i>	Grass carp	Glass/grass carp	EX	0.05
		<i>Esomous danricus</i>	Flying barb	Darkina, Darka	DD	6.26
		<i>Hypophthalmichthys molitrix</i>	Silver carp	Silver carp	EX	0.12
		<i>Labeo bata</i>	Bata	Bata	EN	2.40
		<i>Labeo calbasu</i>	Orange-fin labeo	Calbaus	EN	0.66
		<i>Labeo rohita</i>	Roho labeo	Rui	NO	0.95
		<i>Puntius chola</i>	Swamp barb	Chola puti	NO	1.29
		<i>Puntius phutunio</i>	Spottedsail barb	Phutani puti	NO	1.33
		<i>Puntius sarana</i>	Olive barb	Sarputi	CR	2.46
		<i>Puntius sophore</i>	Pool barb	Jatputi	NO	5.32
		<i>Puntius ticto</i>	Ticto barb	Titputi	VU	1.30
		<i>Salmostoma bacaila</i>	Large razorbelly minnow	Chela	NO	5.73
		<i>Salmostoma phulo</i>	Finescale razorbelly minnow	Chela	NO	4.64
	Cobitidae	<i>Botia dario</i>	Bengal loach	Rani, Bou	EN	0.67
		<i>Botia lohachata</i>	Reticulate/Y-loach	Rani, Bou	EN	1.21
		<i>Lepidocephalus guntia</i>	Guntea loach	Gutum	NO	2.07
		<i>Somileptus gongota</i>	Gongota loach	Pahari gutum	NO	0.58
Cyprinodontiformes	Aplocheilidae	<i>Aplocheilus panchax</i>	Blue panchax	Pach chok	NO	0.15
Perciformes	Ambassidae	<i>Chanda lala</i>	Highfin glassy perchlet	Choto chanda	NE	0.93
		<i>Chanda nama</i>	Elongate glass-perchlet	Nama chanda	VU	5.29
		<i>Chanda ranga</i>	Indian glass-perchlet	Lal chanda	VU	3.15
	Anabantidae	<i>Anabus testudineus</i>	Climbing perch	Koi	NO	0.26
	Channidae	<i>Channa marulius</i>	Great snakehead	Gozar	EN	0.13
		<i>Channa orientalis</i>	Walking snakehead	Cheng	VU	0.21
		<i>Channa punctata</i>	Spotted snakehead	Taki	NO	0.89
		<i>Channa striata</i>	Snakehead murrel	Shol	NO	0.21
	Gobiidae	<i>Glossogobius giurisi</i>	Tank goby	Bele, Baila	NO	1.69
	Mugilidae	<i>Rhinomugil corsula</i>	Corsula mullet	Ural, Korsula	NO	0.50
	Osphronemidae	<i>Colisa fasciata</i>	Banded gourami	Boro kholisha	NO	3.69
		<i>Colisa lalia</i>	Dwarf gourami	Lal kholisa	NO	0.93
Siluriformes	Bagridae	<i>Mystus aor</i>	Long whiskered catfish	Ayre	VU	1.18
		<i>Mystus cavasius</i>	Gangetic mystus	Gulsa tengra	VU	4.20
		<i>Mystus seenghala</i>	Giant river catfish	Guizza ayre	EN	2.99
		<i>Mystus tengana</i>	Tengara catfish	Choto tengra	NO	1.06
		<i>Mystus vitatus</i>	Stripped dwarf catfish	Tengra	NO	1.60
		<i>Rita rita</i>	Rita	Rita	CR	0.45
	Clariidae	<i>Clarias batrachus</i>	Walking catfish	Magur	NO	0.16
	Heteropneustidae	<i>Heteropneustes fossilis</i>	Stinging catfish	Shing, Kanos	NO	0.20
	Pangasiidae	<i>Pangasius pangasius</i>	Pungas	Pangus	CR	0.12

Table 1. Contd.

	Schilbeidae	<i>Ailia coila</i>	Gangetic alia	Baspata	NO	2.39
		<i>Clupisoma garua</i>	Garua bacha	Gang gaira	CR	0.35
		<i>Eutropiichthys vacha</i>	Batchwa vacha	Bacha	CR	1.56
		<i>Pseudeutropius atherinoides</i>	Potasi	Batashi	NO	1.19
	Siluridae	<i>Ompok bimaculatus</i>	Butter catfish	Boili pabda	EN	3.13
		<i>Ompok pabda</i>	Pabdah catfish	Pabda	EN	0.99
		<i>Wallago attu</i>	Freshwater shark	Boal	NO	0.50
	Sisoridae	<i>Bagarius bagarius</i>	Gangetic goonch	Bagair	CR	0.28
		<i>Gagata cenia</i>	Indian gagata	Jungla magur	NO	0.12
Synbranchiformes	Mastacembelidae	<i>Macrognathus aculeatus</i>	Lesser spiny eel	Tara baim	VU	0.70
		<i>Mastacembelus armatus</i>	Zig-zag eel	Sal baim , baim	EN	1.37
		<i>Mastacembelus pancalus</i>	Barred spiny eel	Guchi	NO	1.01
	Synbranchidae	<i>Monopterusuchia</i>	Mud eel	Kuchia	VU	0.30
Osteoglossiformes	Notopteridae	<i>Notopterus chitala</i>	Clown knifefish	Chital	EN	0.25
		<i>Notopterus notopterus</i>	Bronze featherback	Foli	VU	1.44
Tetraodontiformes	Tetraodontidae	<i>Tetraodon cutcutia</i>	Ocellated pufferfish	Potka	NO	0.24

*Status DD, CR, EN, NT and VU are based on IUCN Bangladesh (2000); **percentage of total catch; CR, critically endangered; DD, data deficient; EN, endangered; EX, exotic; NE, not evaluated; NO, not threatened; VU, vulnerable.

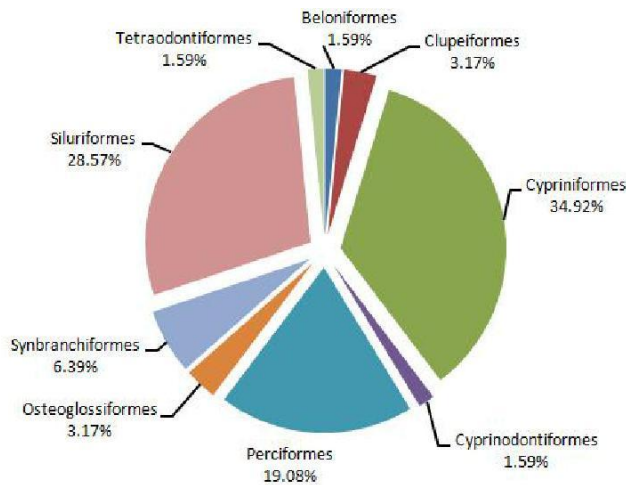


Figure 2. Order-based fish species diversity in River Choto Jamuna, Bangladesh.

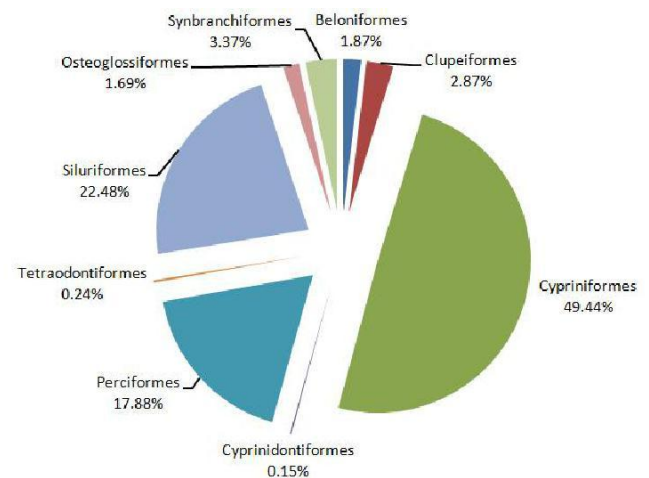


Figure 3. Order-based percentage of fish species in River Choto Jamuna, Bangladesh.

orders. The dominant order was Cypriniformes (minnows and carps) comprising 34.92% of all the number of species recorded. Next to Cypriniformes, other dominant orders were Siluriformes, Perciformes and Synbranchiformes constituting 28.57, 19.05 and 6.35% of species recorded, respectively (Figure 2). The dominant family was Cyprinidae comprising 28.57% of the total number of species caught. Other diversified families were Bagridae (9.52% species), Cobitidae, Channidae and Schilbeidae (6.35% species each). Of the recorded species, 2 exotic fish species, *Hypophthalmichthys molitrix*

and *Ctenopharyngodon idella* belonging to family Cypriniformes were recorded. Furthermore, order Cypriniformes was found as the most dominant fish group in terms of total number of individual observed (Figure 3).

Maximum of 59 species were recorded in the month of February, November and December and the lowest (45 species) were recorded in the month of June (Table 2). Considering the number of individuals caught, the most dominant species was *Esomus darricus* comprising 6.26% of the total catch followed by *Salmostoma bacaila* (5.73%), *Puntius sophore* (5.32%), *Chanda nama* (5.29%),

Table 2. Total species and specimens recorded and studied with values of Shannon-Weaver diversity (H), richness (M) and evenness (e) indices in each sampling month.

Month	Number of species	Number of individual	Diversity (H)	Richness (D)	Evenness (e)
January	58	755	3.781	8.602	0.931
February	59	748	3.786	8.765	0.929
March	57	617	3.748	8.716	0.927
April	54	646	3.642	8.191	0.913
May	48	602	3.482	7.343	0.899
June	45	550	3.427	6.973	0.900
July	48	554	3.449	7.440	0.891
August	48	514	3.497	7.529	0.903
September	51	500	3.528	8.046	0.897
October	56	543	3.653	8.734	0.908
November	59	661	3.753	8.932	0.920
December	59	759	3.818	8.745	0.936
All	63	7449	3.717	6.954	0.897

Amblypharyngodon mola (5.21%) and so on (Table 1).

Among the found fishes, 41.27% species were considered threatened in Bangladesh, which was 48.19% of the total number of threatened fish species of the country; according to IUCN Bangladesh (2000). These include 15.87% vulnerable, 15.87% endangered and 9.52% critically endangered species. All the species belonging to Osteoglossiformes, 75% species under Synbranchiformes, 55.56% species under Siluriformes, 33.33% species under Perciformes and 31.82% species under Cypriniformes were threatened (Figure 4). In the study area, 38.68% of the total individuals were threatened fish species (Table 1).

Diversity, richness and evenness indices

The month-wise values of Shannon-Weaver diversity (H), Margalef's richness (D) and Pielou's (e) evenness indices are shown in Table 2. However, considering all the specimens studied during the period of study, the values of H , D and e were found to be 3.717, 6.954, and 0.897, respectively. The value of diversity index ranged from 3.427 (June) to 3.818 (December), richness index ranged from 6.973 (June) to 8.932 (November), and evenness index ranged from 0.891 (July) to 0.936 (December) (Table 2).

DISCUSSION

This maiden study on fish fauna of River Choto Jamuna, Bangladesh recorded a total of 63 fish species including 61 indigenous and 2 exotic species. No previous statistics of fish fauna in the River Choto Jamuna was found and thus comparison of the present findings with previous one was not possible. This problem seemed not new in Bangladesh while working with fish diversity (Mohsin and Haque, 2009; Imteazzaman and Galib,

2013) and indicates the need for water-body specific fish diversity study in Bangladesh. 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). However, all these researchers concluded with gradual loss of biodiversity in their studied rivers. In that sense, this is also true for River Choto Jamuna. Order Cypriniformes was found to be the most diversified fish group in terms of both number of species and individuals followed by Siluriformes and Perciformes. Similar findings were also reported by Galib et al. (2009), Mohsin and Haque (2009), Mohsin et al. (2009) and Imteazzaman and Galib (2013). This is because these three groups are the most dominant groups in freshwater bodies of Bangladesh (Rahman, 1989, 2005).

Two exotic species were, grass carp (*C. idella*) and silver carp (*H. molitrix*). 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 (Rahman et al., 2007; Galib and Mohsin, 2011). 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). 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. Similar recommendation was also made by Önsöy et al. (2011) and Imteazzaman and Galib (2013). However, the study area seemed less contaminated by the exotic species than some other

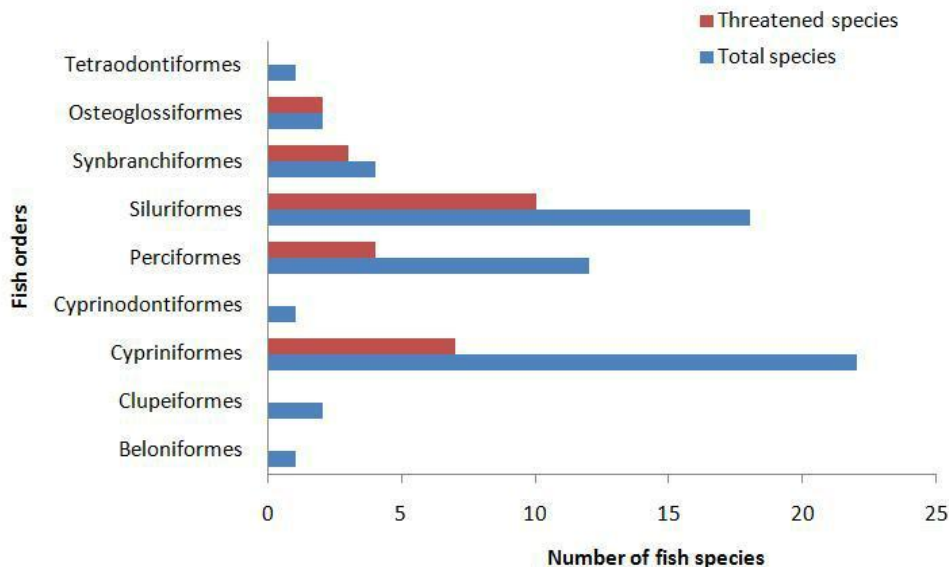


Figure 4. Diversity of fish species including the threatened species in River Choto Jamuna, Bangladesh.

water bodies of Bangladesh as 9, 8, and 5 non-native fish species have been recorded in Chalan Beel, Haldi Beel and Bookbhara Baor, respectively (Galib et al., 2009; Imteazzaman and Galib, 2013; Mohsin et al., 2009).

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. 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. The lowest number of species was recorded in the month of June; this is due to heavy rain during this time which makes fishing very difficult as water level reached its maximum. The value of diversity and richness index in this study was found to be greater than that of Yisa et al. (2011) and Innocent et al. (2012), indicating comparatively richer biodiversity in the study area.

At present, loss of biodiversity is an alarming threat but the earliest effective management is essential to deal with this issue. According to Lakra (2010), conservation of fish diversity is essential to maintain ecological/nutritional and socio-economic equilibrium. A major portion (41.72%) of the total fish species recorded from the river Choto Jamuna were found threatened in Bangladesh. However, several reasons including degradation of natural habitats, excess exploitation using illegal fishing gears, use of toxins in aquaculture ponds are responsible for this loss of fish diversity in Bangladesh (IUCN Bangladesh, 2000; Galib et al., 2009, 2010). Threatened species present in the study area was 48.19% of the total threatened fish species of Bangladesh. Abundance of

threatened fish species among the total catch (38.68%) strongly reflecting its potentiality to be an excellent site for natural conservation. Establishment of perennial and seasonal (during breeding seasons) fish sanctuaries may serve this purpose.

REFERENCES

- Ahmed K KU, Hasan RR, Ahamed SU, Ahmed T, Mustafa G (2004). Ecology of Shakla beel (Brahmanbaria), Bangladesh. *Bangladesh J. Fish. Res.* 8(2):101-111.
- Beals M, Gross L, Harrell S (2000). Diversity Indices: Shannon's *H* and *E*. <http://www.tiem.utk.edu/~gross/bioed/bealsmodules/shannonDI>. Accessed on January 10, 2013.
- Bhuiyan AL (1964). Fishes of Dacca, *Asiat. Soc. Pakistan, Pub.* 1, No. 13, Dacca (Dhaka), Bangladesh, p.148.
- Bhuiyan SS, Joadder MAR, Bhuiyan AS (2008). Occurrence of fishes and non-fin fishes of the River Padma near Rajshahi, Bangladesh. *Univ. J. Zool. Rajshahi Univ.* 27:99-100.
- Galib SM, Mohsin ABM (2011). *Cultured and Ornamental Exotic Fishes of Bangladesh*. Lambert Academic Publishing, Germany, p.176.
- Galib SM, Samad MA, Hossain MA, Mohsin ABM, Haque SMM (2010). Small Indigenous Species of Fishes (SISF) in Chalan Beel with Reference to their Harvesting and Marketing. *Bangladesh J. Prog. Sci. Tech.* 8(2):251-254.
- Galib SM, Samad MA, Mohsin ABM, Flowra FA, Alam MT (2009). Present Status of Fishes in the Chalan Beel- the Largest Beel (Wetland) of Bangladesh. *Int. J. Ani. Fish. Sci.* 2(3):214-218.
- Goswami UC, Basistha SK, Bora D, Shyamkumar K, Saikia B, Changsan K (2012). Fish diversity of North East India, inclusive of the Himalayan and Indo Burma biodiversity hotspots zones: A checklist on their taxonomic status, economic importance, geographical distribution, present status and prevailing threats. *Int. J. Biodivers. Conserv.* 4(15):592-613. DOI: 10.5897/IJBC11.228.
- Hossain MAR, Nahiduzzaman M, Sayeed MA, Azim ME, Wahab MA, Olin PG (2009). The Chalan beel in Bangladesh: Habitat and biodiversity degradation, and implications for future management. *Lakes & Reservoirs: Research and Management* 14:3-19. DOI: 10.1111/j.1440-1770.2009.00387.x

- Hossain MS, Das NG, Sarker S, Rahaman MZ (2012a). Fish diversity and habitat relationship with environmental variables at Meghna river estuary, Bangladesh. *Egypt. J. Aquatic Res.* 38:213-226. DOI: <http://dx.doi.org/10.1016/j.ejar.2012.12.006>
- Hossain MY, Rahman MM, Fulanda B, Jewel MAS, Ahamed F, Ohtomi J (2012b). Length-weight and length-length relationships of the five threatened fishes from the Jamuna (Brahmaputra River distributary) River, Northern Bangladesh. *J. Appl. Ichthyol.* 28(2):275-277.
- Imteazzaman AM, Galib SM (2013). Fish Fauna of Haldi Beel, Bangladesh. *Inter. J. Curr. Res.* 5(1):287-290.
- Innocent BX, Karuthapandi M, Fathima MSA (2012). Fish Faunal Diversity of Suthamalli Pond, Tirunelveli District, Tamilnadu. *Int. J. Adv. Lif. Sci.* 1:73-79.
- IUCN Bangladesh (2000). Red book of threatened fishes of Bangladesh, IUCN- The world conservation union. pp.12-116.
- Lakra WS (2010). Fish Biodiversity of Uttar Pradesh: Issues of Livelihood Security, Threats and Conservation. National Conference on Biodiversity, Development and Poverty Alleviation. Uttar Pradesh State Biodiversity Board, India. pp. 40-45.
- Margalef R (1968). *Perspectives in Ecological Theory*. Chicago: University of Chicago Press.
- Meyer L, Hinrichs D (2000). Microhabitat preferences and movements of the weatherfish, *Misgurnus fossilis*, in a drainage channel. *Environ. Biol. Fish.* 58:297-306.
- Mohsin ABM, Haque ME (2009). Diversity of Fishes of Mahananda River at Chapai Nawabganj District. *Res. J. Biol. Sci.* 4(7):828-831.
- Mohsin ABM, Hasan MM, Galib SM (2009). Fish Diversity of Community Based Fisheries Managed Oxbow Lake (Bookbhara Baor) in Jessore, Bangladesh. *J. Sci. Foundation* 7(1):121-125.
- Mukherjee M, Praharaj A, Das S (2002). Conservation of endangered fish stocks through artificial propagation and larval rearing technique in West Bengal, India. *Aquaculture Asia* 7(2):8-11.
- Nath B, Deca C (2012). A Study on Fish Diversity, Conservation Status and Anthropogenic Stress of Chandubi Tectonic Lake, Assam, India. *J. Bio. Innov.* 1(6):148-155.
- Nelson JS (2006). *Fishes of the World*, fourth edition. John Wiley & Sons, Inc. p.601.
- Nunoo J, Agbo N, Ackah M (2012). Fish fauna of the Owabi Dam Reservoir in Ghana. *Proceedings of the Inter. Acad. Ecol. Environ. Sci.* 2(1):21-26.
- Nyanti L, Nur 'Asikin R, Ling TY, Jongkar G (2012). Fish Diversity and Water Quality during Flood Migration Works at Semariang Mangrove Area, Kuching, Sarawak, Malaysia. *Sains Malaysiana*, 41(12):1517-1525.
- Önsoy B, Filiz H, Tarkan AS, Bilge G, Tarkan AN (2011). Occurrence of Non-Native Fishes in a Small Man-Made Lake (Lake Ula, Muğla): Past, Present, Future Perspectives. *Turk. J. Fish. Aquat. Sci.* 11: 209-215. DOI: 10.4194/trjfas.2011.0205.
- Penczak T, Agostinho AA, Okada EK (1994). Fish Diversity and Community Structure in Two Small Tributaries of the Parana River, Parana State, Brazil. *Hydrobiologia* 294:243-251.
- Pielou EC (1966). Species diversity and pattern diversity in the study of ecological succession. *J. Theoret. Biol.* 13:131-144.
- Raghavan R, Prasad G, Ali PHA, Pereira B (2008). Fish fauna of Chalakudy River, part of Western Ghats biodiversity hotspot, Kerala, India: patterns of distribution, threats and conservation needs. *Biodivers. Conserv.* 17:3119-3131. DOI 10.1007/s10531-007-9293-0
- Rahman AKA (1989). *Freshwater Fishes of Bangladesh*, first edition, Zoological Society of Bangladesh, University of Dhaka, Dhaka, Bangladesh, p.364.
- Rahman AKA (2005). *Freshwater Fishes of Bangladesh*, second edition. Zoological Society of Bangladesh, University of Dhaka, Dhaka, Bangladesh, p. 263.
- Rahman AKA (2007). Exotic fishes and their impact on environment. 16th Annual General Meeting and National Conference 2007, Zoological Society of Bangladesh, 30 March, Dhaka, Bangladesh, pp.26-39.
- Rahman MM, Hossain MY, Ahamed F, Fatematuazzhura Subba BR, Abdallah EM, Ohtomi J (2012). Biodiversity in the Padma Distributary of the Ganges River, Northwestern Bangladesh: Recommendations for Conservation. *World J. Zool.* 7(4): 328-337.
- Rixon CAM, Duggan IC, Bergeron NMN, Ricciardi A, Macisaac H (2005). Invasion risks posed by the aquarium trade and live fish markets on the Laurentian Great Lakes. *Biodivers. Conserv.* 14:1365-1381. DOI 10.1007/s10531-004-9663-9
- Saha BK, Hossain MA (2002). Saldu Beel fishery of Tangail. *Bang. J. Zool.* 30(2):187-194.
- Shahjahan M, Miah MI, Haque MM (2001). Present Status of Fisheries in Jamuna River. *Pakistan J. Biol. Sci.* 4(9):1173-1176.
- Shannon CE, Weaver W (1949). *The Mathematical Theory of Communication*. Urbana, IL: University of Illinois Press.
- Shinde SE, Pathan TS, Bhandare RY, Sonawane SL (2009a). Ichthyofaunal Diversity of Harsool Savangi Dam, District Aurangabad, (M.S.) India. *World J. Fish Marine Sci.* 1(3):141-143.
- Shinde SE, Pathan TS, Raut KS, Bhandare RY, Sonawane SI (2009b). Fish Biodiversity of Pravara River at Pravara Sangam District Ahmednagar, (M.S.) India. *World J. Zool.* 4(3):176-179.
- Talwar PK, Jhingran AG (1991). *Inland Fishes of India and Adjacent Countries*, Vol. 1 and 2, Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi-Calcutta, p.1158.
- Yisa TA, Adeyemi RA, Ibrahim I (2011). Evaluation of Diversity Index of Fish Fauna in a Lowland Rice Field in Southern Guinea Savannah of Northern Nigeria. *I.J.S.N.* 2(4):809-812.
- Zafar MS, Amin MN, Iqbal MJ (2007). Biodiversity of fisheries organisms in the Pagla river of Bangladesh. *Bangladesh J. Fish. (Special Issue)* 30:165-175.