FISH SPECIES USING THE FISH PASSAGE BETWEEN JAMUNA AND BANGALI RIVER AT SARIAKANDI, BOGRA

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Abstract

Sariakandi fish pass is unique connecting Jamuna and Bangali rivers through an engineered channel. A study was conducted on the fish pass aiming to improve fish diversity in north-west Bangladesh. Sampling at the fish pass, market census, interviewing the locals and focus group discussion were done to collect data from the study area. A total of 69 fish species under 9 orders and 26 families were recorded. Cypriniformes (22 species) was the most dominant order followed by Siluriformes (21 species), Perciformes (13 species), Clupeiformes (4 species), Synbranchiformes (4 species), Osteoglossiformes (2 species), Mugiliformes (1 species), Anguilliformes (1 species) and Tetraodontiformes (1 species). In total 30 threatened species in Bangladesh and globally recognized 9 species were recorded. This fish pass is not working during the dry or winter seasons but helps in the diversified fish migration diversity of Bengali and Jamuna river system during the flood time of Bangladesh. The present study recommends establishing effective fish passages in flood protection structures or dams in Bangladesh to retain the connectivity of fish migration routes and the improving of fish diversity.

Key words: Fish diversity; Fish pass; Threatened fishes; Bangali River; Jamuna River.

INTRODUCTION

Sariakandi Fish pass is the largest fish pass of Bangladesh constructed between 1999-2001 connecting the Jamuna river (west bank) and the Bengali river (east bank) at Debdanga of Kutubpur union of Sariakandi Upazilla, Bogra. The fish pass facilities was created by construction of 6 km embankment to join the Kalitola Groyne with the river bank protection works at Mathurapara. The construction of Brahmaputra-Jamuna right embankment (BRE) in the late 1960 affected the flooding pattern and fish production in the Bangali river and to overcome the effects later structure was built (IUCN 2002). The flood had a major impact on the geography of rivers in the northern region of Bangladesh. The Jamuna and the Teesta were created after a massive flood in 1787. It is speculated that the Bangali River (Fig 1) was born out of the changes of the Jamuna and the Teesta (Chowdhury 2012). The Jamuna and the Bangali River had good numbers of freshwater fishes before implementation of the Brahmaputra right embankment project. After the construction of BRE, fish production in the Bangali river was reduced drastically due to the disruption of the natural fish migration routes between these two rivers. After construction of the fish pass, the water volume and fish species of the Bangali River is increased (Moumita *et al.* 2011, Zaman *et al.* 2018).

A fish pass is a hydraulic structure that enables fishes to overcome obstructions in the passage to the spawning grounds and other upstream migration habitats (Bell 1986, Clay 1961). The concept of fish pass was introduced in Bangladesh in the 1990s and since then four fish friendly structures and fish passes have been built (IUCN 2002, Kabir 2010, Zaman *et al*. 2019). At present, reduction in the abundance of fish species from the inland waters is a burning issue in Bangladesh. The river fisheries of Bangladesh is being deteriorated day by day due to over fishing, construction of flood protection dams, destruction of natural breeding and feeding grounds, use of fertilizer, insecticides and manures etc. Therefore area basis study is required to identify the present status and causes of destruction of faunal diversity in different rivers of Bangladesh. The study was conducted to identify the present status of migratory fishes using the fish passes in flood season from the Bangali to the Jamuna river system.

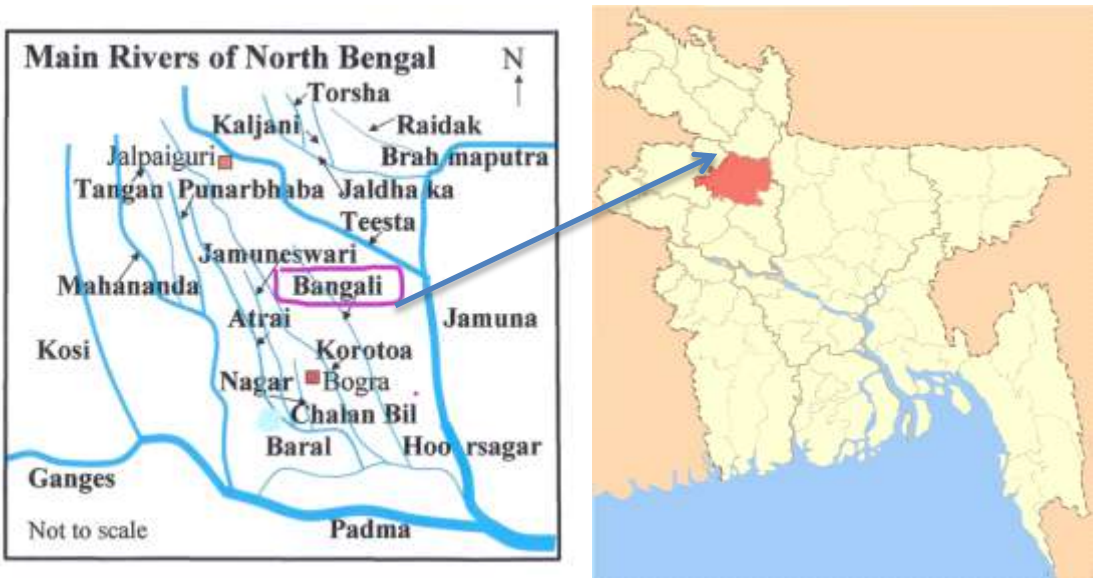

Fig. 1. Map of the Bangali River in Sariakandi, Bogra, Bangladesh.

MATERIAL AND METHODS

Study area

The field study was conducted in the Bangali river and the Jamuna river Sariakandi Fishpass at Sariakandi Upazilla, Bogra District, Bangladesh. Located between 24°'44' and 25°03' N latitudes and between 89°30' and 89°45' E longitudes (Fig 2a). Sariakandi fish pass is the most recent and modern, vertical slot type of fish pass (Fig. 2b), rectangular in shape, length 92.4 m and width is 15m. There are 3 separate and parallel passages in the pass (IUCN 2002).

a **b**

Fig. 2. View of the study site: **a**. Aerial view; **b**. Vertical slot type fish pass.

Data collection

Data collection was conducted from May to August 2015. It was attempted with a view to assessing the availability of fishes using the fish pass during migration period. The data collection was made in respect to the fish fauna increase or decline causes created by the fish pass. For this study sampling at the fish pass, local market census, interviewing the inhabitants and focus group discussion were

considered as the procedural methods. Fish samples were collected from fishermen when on fishing. Fishermen used lift net, cast net, seine net, fish traps dharma jal, khepla jal and ber jal for the catch. Threatened fish samples were collected from the site, preserved in 7-10% buffered formalin solution for the identification and further study at Bergen Laboratory, Department of Zoology, University of Dhaka.

a **b**

Fig. 3. Activities of a fisherman in the fish pass: **a**. Fisherman on fishing; and **b**. Using net to catch fish.

To collect data with questionnaire interviews, random sampling method was followed in 50 fishermen from nearby villages adjacent to fish pass. The interview of fishermen was made at home or on fish pass site during fishing (Fig. 3a and 3b). Local market also surveyed for fishes which were available round the year. Focus group discussions (FGD) for fishermen and cross-check interviews with key informants were used. A total of five FGDs were conducted. Each group size of the FGD was 7 to 10 fishermen. Cross-check interviews were made with key person as Upazilla Fisheries Officer. Water quality parameter data were collected by using Oxygen Meter (Lutron portable dissolved oxygen meter, model no. DO 5509) for oxygen detection, pH meter (Orion Laboratories, model 210A) for pH and TDS meter (Ultrapen^{TM} PT1) used to detect temperature and TDS.

a **b** **c**

Fig. 4. Fish passes in different countries: **a**. Richelieu River, Quebec, Canada; **b**. Elbe River, Germany; and **c**. Millville, California, USA.

Methodology of fish migration study

Fish passes have been developed mainly in North America and Europe for a very limited number of target species, mainly salmonids and clupeids. In these cases, the data is gathered from control station monitoring, trapping or surveillance or some marking, recapture and telemetry methods (Welcomme

1985). Thiem *et al.* (2011) made reports on spawning migrations of sturgeon affected by the construction of dams on Richelieu River, Quebec, Canada (Fig. 4a). They found barriers to migration to the imperilment of the sturgeon. Myers *et al.* (2001) studied ocean distribution and migration patterns of Yukon river chinook salmon. Direct information from high seas tagging studies indicates that Yukon river chinook salmon are concentrated in the Bering Sea. Fish pass designed for Eel and Elver in UK and Europe (Fig. 4b). The aim of the study was to produce design criteria and best practice designs for Eel and Elver passes (Solomon *et al.* 2004). The Coastal Conservancy (2004) reported inventory of barriers to fish passage in California's coastal watersheds (Fig. 4c), California's salmon, steelhead and other species are vitally dependent on the ecological integrity of dozens of streams and rivers. By following and on understanding the above literature the present attempt has been proceeded to observe the fish migration in the Jamuna river and Bangali river.

RESULTS AND DISCUSSION

Fish Movement

Information on fish movement through fish pass was acquired primarily by the fishermen fishing in the study area and secondarily from visual observations. Generally fish species take shelter in the Bangali river during flood recession period. During sampling period presence of these fish species migrating from Bangali river to Jamuna river were collected. The major type of fish species, which moves through the Sariakandi fish pass are listed in the Table 1.

Table 1. Number of collected fishes from the study area

No. of Orders	No. of Families	No. of Genus	No. of Species	No. of fishes observed passing fish pass		No. of fishes not observed passing fish pass	
				Genus	Species	Genus	Species
9	26	52	69	31	35	27	34

Type of fishes

A total of 69 species of fish belonging to 26 families of nine orders were recorded. Observation states that 51 genera contain the examined 69 species. Among them 35 fish species under 31 genera were observed crossing the fish pass. Fishermen catch showed some threatened fishes.

Table 2. Present status of fish biodiversity in Bangali River after establishment of fish pass

Order	Family	Scientific name	Local name	Status in BD	Global Status
Cypriniformes	Cyprinidae	*Amblypharyngodon mola*	Mola, Moa	LC	NE
		Amblypharyngodon microlepis	Mola, Molangi	LC	LC
		Systomus sarana	Sarputi	NT	LC
		Puntius chola	Chola puti	LC	LC
		Pethia conchonius	Kanchan puti	LC	LC
		Pethia ticto	Tit-punti	VU	LC
		Puntius sophore	Jat punti, Jati punti	LC	LC
		Aspidoparia morar	Piyali	VU	NE
		Labeo rohita	Rui, Rohu	LC	LC
		Labeo calbasu	Kalibaus	LC	LC
		Labeo bata	Bata	LC	LC
		Labeo boga	Bhangon, Bata	CR	LC
		Gibelion catla	Katla, Katol	LC	NE
		Cirrhinus cirrhosus	Mrigel, Mirka	NT	VU
		Cirrhinus reba	Tatkini, Bata	NT	LC
		Chela laubuca	Chhep Chela	LC	NE
		Rasbora daniconius	Darkina	LC	LC
		Osteobrama cotio	Dhela	NT	LC

		Hypopthalmichthys molitrix	Silver carp	EXOTIC SP.	
	Cobitidae	*Botia dario*	Rani	EN	LC
		Lepidocephalichthys guntea	Puiya, Poa	LC	LC
		Canthophrys gongota	Gutum	NT	LC
Clupeiformes	Clupeidae	*Gudusia chapra*	Chapila	VU	LC
		Corica soborna	Kachki	LC	LC
		Tenualosa ilisha	Ilish (Juvenile)	LC	LC
	Engraulidae	*Setipinna phasa*	Phaisha	LC	LC
Siluriformes	Siluridae	*Wallago attu*	Boal	VU	NT
		Ompok pabda	Pabda	EN	NT
		Ompok bimaculatus	Kani pabda	EN	NT
	Pangasidae	*Pangasius pangasius*	Pangus	EN	LC
	Heteropneustidae	*Heteropneustes fossilis*	Shing	LC	LC
	Claridae	*Clarius batrachus*	Magur	LC	LC
	Schilbeidae	*Clupisoma garua*	Ghaura, Muribacha	EN	NE
		Pseudeutropius atherinoides	Batasi	LC	LC
		Ailia coila	Kajuli	LC	NT
		Ailia punctata	Banshpata	LC	NE
		Eutropiichthys vacha	Bacha	LC	LC
	Erethistidae	*Conta conta*	Bot Tengara	NT	NE
	Bagridae	*Sperata aor*	Guji ayr	VU	LC
		Sperata seenghala	Taila ayr	VU	LC
		Mystus tengara	Bujuri tengra	LC	LC
		Mystus vittatus	Tengra	LC	LC
		Mystus cavasius	Kabshi tengra	NT	LC
		Rita rita	Rita	EN	LC
	Amblycipitidae	*Amblyceps laticeps*	Chhota Shingi	VU	LC
	Sisoridae	*Bagarius bagarius*	Bagha ayr	CR	NT
		Hara hara	Kutakanti	LC	LC
Osteoglossiformes	Notopteridae	*Notopterus notopterus*	Pholi	VU	LC
		Chitala chitala	Chital	EN	NT
Mugiliformes	Mugulidae	*Rhinomugil corsula*	Urol	LC	LC
Perciformes	Belonidae	*Xenentodon cancila*	Kaikka, Kakila	LC	NE
	Channidae	*Channa punctatus*	Taki	LC	LC
		Channa marulius	Gojar	EN	LC
		Channa striatus	Shol	LC	LC
		Channa orientalis	Gachua	LC	LC
	Ambassidae	*Chanda nama*	Chanda	LC	LC
		Pseudambassis baculis	Phopha chanda	NT	LC
		Pseudambassis ranga	Lal chanda	LC	LC
	Nandidae	*Nandus nandus*	Bheda	NT	LC
	Anabantidae	*Anabas testudineus*	Koi	DD	DD
	Osphronemidae	*Trichogaster fasciata*	Kholisha	LC	LC
		Pseudophromenus cupanus	Koi bandi	LC	LC
	Gobiidae	*Glossogobius giuris*	Baila, Bele	LC	NE
Synbranchiformes	Mastacembelidae	*Mastacembelus armatus*	Baim, Gonti	EN	NE
		Mastacembelus pancalus	Guchi baim	LC	LC
		Macrognathus aral	Tara baim	DD	LC
	Synbranchidae	*Monopoterus cuchia*	Kuchia	VU	VU
Anguilliformes	Ophichthidae	*Pisodonophis boro*	Bamosh, Kharu	LC	LC
Tetraodontiformes	Tetraodontidae	*Leiodon cutcutia*	Potka,Tepa	LC	LC

Green marked fishes found using the fish pass for migration; The status of Bangladesh is taken from IUCN Red-list (2015); NT=Near Threatened, EN= Endangered, VU= Vulnerable, CR= Critically Endangered, DD=Data Deficient, LC= Least Concern, NE= Not Evaluated.

Observation of fish migration

Observation of fish movement from Bangali to Jamuna river was the main objective of Sariakandi fish pass study. Migratory fish species included carps, catfishes, eels, gobies, knife fish, perches, miscellaneous species and prawns. The local fishes categorized into whitefish (carp fish) and blackfishes (catfishes) based on their migratory movements. The white fishes are Rui, Catla, Mrigel, Kalbaush, Gonia, Sarputi etc. of which Rui, Mirgel, Kalbaush are more dominant species than other species. In black fishes are Boal, Pabda, Tengra, Magur, Rita, Ayr, Koi, Shingi, Gulsha, Chital etc. Among them Chital, Gulsha and Rita were more dominant species than other species (Kumar 2016). Scientific names of the fishes are shown in the Tables (Table 2, 3 and 4). Fish fingerling, juvenile and adult movement was observed. From the abundance of species in the catch and the catch frequency related that the Carp fishes (Rui and Catla) are dominant species in the study area, of which Cypriniforme (22 species), Siluriformes (21species), Perciformes (13species), Clupeiformes(4species), Synbranchiformes (4species), Osteoglossiformes(2species), Mugiliformes(1species), Anguilliformes(1species) and Tetraodontiformes (1 species) (Table 2, Fig. 5). Among the recorded families Cyprinidae was the most dominant family with 19 species recorded. In Siluriformes 21 species found from 9 different families.

Threatened fish status

About 69 species were found using fish pass where 30 are threatened (2 critically endangered, 10 endangered, 9 vulnerable and 9 near threatened) (IUCN BD/IOIS status) in Bangladesh. In global perspective 9 species found of which 2 vulnerable, 1 endangered and 6 near threatened fishes. A good number (30) of vulnerable and endangered fishes (Fig. 5) found to be using the fish pass (Table 3).

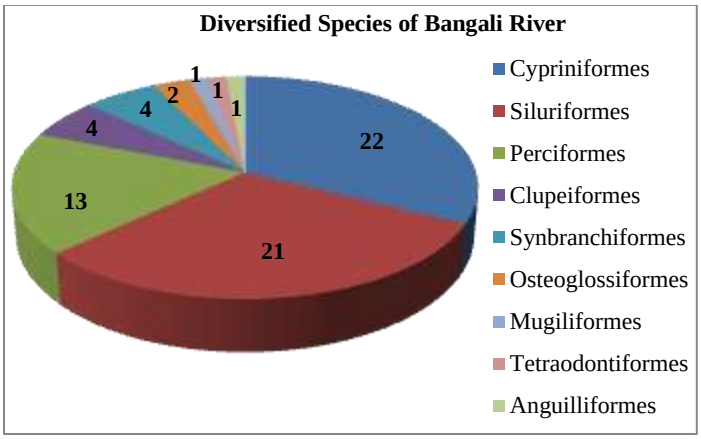

Fig. 5. Composition of diversified species under different orders in the study area

Table 3. Status of threatened fishes using fish pass in Sariakandi, Bogra

Status	Species found in Bangladesh	Globally found Species
Vulnerable (VU)	*Pethia ticto, Aspidoparia morar, Amblyceps laticeps, Gudusia chapra, Wallago attu, Sperata aor, Sperata seenghala, Notopterus notopterus, Monopterus cuchia,*	*Cirrhinus cirrhosis, Monopterus cuchia*
Endangered (EN)	*Botia dario, Chela laubuca, Ompok pabda, Ompok bimaculatus, Pangasius pangasius, Clupisoma garua, Rita rita, Chitala chitala, Channa marulius, Mastacembelus armatus*	*Conta conta*
Near Threatened (NT)	*Systomus sarana, Cirrhinus cirrhosus, Cirrhina reba, Osteobrama cotio, Canthophrys gongota, Mystus cavasius, Pseudambassis baculis, Nandus nandus, Conta conta*	*Wallago attu, Ompok pabda, Ompok bimaculatus, Bagarius bagarius, Chitala chitala, Ailia coila*
Critically Endangered (CR)	*Labeo boga, Bagarius bagarius*	

Green marked fishes found using the fish pass for migration

Physico-chemical factors in the fish pass

Fish passage success influenced by physico-chemical factors. Field study conducted in Sariakandi at 26.3 to 28.1^{0}C temperature, pH found 8.66 in upstream and 8.50 in downstream. Dissolved oxygen (DO) found to be 5.7-8.13 mg/L in upstream and 4.9-5.2 mg/L in downstream of the water. TDS found ton be 43-46 ppm. Water depth, velocity and flow condition found favorable for fish migration in study site (Biswas 2007).

Table 4. Collected sample fishes habitat and feeding behaviour

Fish	Maximum Length (cm)	Sample length (cm)	Habitat, abundance, seasonal availability	Feeding habit
Rani (*Botia dario*)	15.1	3.1	North Bengal rivers, hill streams of Chittagong	Snail, worm, small shrimp
Lal chanda (*Pseudambassis ranga*)	8	3	Freshwater streams, rivers. Abundant in rainy season	Zoobenthus, worm, benthic crustaceans
Batashi (*Pseudeutropius atherinoides*)	8	4.1	Amphidromous, breed in mid-May to July, abundant in Oct-Dec	Algae, plant material, debris
Kholisha (*Trichogaster fasciata*)	10	4.3	Freshwater areas, beels, flood plains, breed several times on stagnant water of paddy field during monsoon	Omnivore, feed on insect larvae.
Kaikka (*Xenentodon cancila*)	40	8	Canal, beel, large and medium size rivers, slow flowing pools.	Predator, live feeder, feeds on live fish, tadpoles.
Koi Bandi (*Pseudophromenus cupanus*)	7	4	Benthopelagic, shallow water, paddy field, beels.	Insects, zooplankton
Bot tengara (*Conta conta*)	7.8	5	Rivers of North Bengal, torrential habitat.	Mud and benthic organism
Potka (*Leiodon cutcutia*)	13.2	3.5	River, beel, canals and pond	Shells of molluscs and crustaceans
Silver carp (*Hypopthalmichthys molitrix*)	105	15	Culture fish, naturally occurs in river system	Phytoplankton, zooplankton
Rui (*Labeo rohita*)	61	9.3	Beels, floodplains, clear sluggish streams, inundated paddy field. Spawn on May-July in shallow water or rivers.	Column feeder of mid water, algae, protozoans, higher plants, insect larvae, crustaceans
Chhep Chela (*Chela laubuca)*	6.7	5.1	Rivers, canal, ponds. Spawn in shallow water	Larvivorous, insects, stem and leaf tissue
Kutakanti (*Hara hara*)	6.2	4.5	Muddy river bed (Dinajpur, Sylhet, Mymensign)	Benthic organisms
Bamosh (*Pisodonophis boro*)	66	9	Shallow beels, mud holes.	Small fishes, tadpole, aquatic insects
Chhota Shingi (*Amblyceps laticeps*)	8.5	6	Dahuki river near Sylhet, Rangpur, Netrokona	Shells of molluscs and crustaceans
Kajoli (*Ailia coila*)	15.4	5.4	Major freshwater rivers and connected waters	Carnivore, but occasionally feed algae, debris.
Dhela (*Osteobrama cotio*)	10.8	4	Rivers, canals, beels. Abundance reduced. Breeding starts early monsoon, continue till September.	Omnivore, surface feeder. Algae, protozoan, crustaceans, aquatic insects

Threatened fish samples were collected from the site, preserved for identification in laboratory (Table 4, Fig. 6). This maiden study of fish fauna recorded a total 69 species including 68 species indigenous and 1 exotic. Fish hatching, juvenile and adult movements were observed in fish pass but maximum fishes were juvenile in size. Fishes were caught when they using fish pass from Bangali River to Jamuna river. The fish size and fish catch indicates that the juvenile species migrates from Bangali

river to Jamuna mostly. Exotic species (*Hypopthalmichthys molitrix)* were adult in size, which is popular in Bangladesh, probably escaped from adjacent aquaculture pond during heavy flood. Abundance of threatened fish species among the total catch strongly reflecting its potentiality to be an excellent site for natural conservation. Mass awareness is required for the fishermen to save the threatened fish fauna of the rivers. There should be a strong implementation of conservation laws and acts to make free from illegal catch in fish pass area.

Fig. 6. Fishes found using the fish pass: a. Rani (*Botia Dario*); b. Chanda (*Pseudambassis ranga*); c. Batashi (*Pseudeutropius atherinoides*); d. Kholisha (*Trichogaster fasciata*); e. Kaikka (*Xenentodon cancila*); f. Koi Bandi (*Pseudophromenus cupanus*); g. Bot Tengara (*Conta conta*); h. Potka (*Leiodon cutcutia*) i. Silver carp (*Hypopthalmichthys molitrix*) and Rui (*Labeo rohita*); j. Chhep Chela (*Chela laubuca*); k. Kutakanti (*Hara hara*); l. Bamosh (*Pisodonophis boro*); m. Chhota Shingi (*Amblyceps laticeps*) n. Kajoli (*Ailia coila*) o. Chingri (Insects); and p. Dhela (*Osteobrama cotio*)

A range of studies have been documented that their efficiency of fish passes can be highly variable (Marmulla and Larinier 2011). Sturgeon spawning migration on Richelieu river, Quebec, Canada fishway resulted 82.2% (88 of 107) fishes passing through fish pass. The remaining individuals either

made no attempt. Which indicate successful ascension occurred (Thiem *et al.* 2011).Restoring connection of riverine systems that have been fragmented by dams is a critical step towards rebuilding fish population and preventing extinction. Fish ways are regarded as potential strategy for mitigating the installation of barriers.

Fish pass between Jamuna and Bangali river study shows that fish way has a positive impact on fish migration. Resulting an improved livelihood of the rural people living at the adjacent villages around the fish pass. After construction of the fish pass, the water volume and fish species of the Bengali River is increased along with the fish diversity and fish biomass. Study showed a good number of threatened species taking the fish pass which indicates faunal exchange between the rivers through fish pass. Water parameters, depth, velocity and flow were also favourable for fishes. Study showed in 69 species, 30 threatened species (IUCN, BD 2015) passing fish pass where 9 species are globally threatened, which may extinct in near future due to improper management. From this study it is evident that fish pass aided in improving the fish diversity in Jamuna river by adding fish from Bangali river system. Further study on the aspect could enlight more information of fish migration habits.

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