FISH-DIVERSITY IN THE KURA RIVER OF BANGLADESH: PATTERNS AND THREATS

SANZIB KUMAR BARMAN[1#], MRITYUNJOY KUNDA[1], SABUJ KANTI MAZUMDER[2*],
MD. NAHIDUZZAMAN[3], PARTHO PROTIM BARMAN[4,5] and SIMON KUMAR DAS[6]

*[1]Aquatic Resource Management, Faculty of Fisheries,
Sylhet Agricultural University, Sylhet 3100, Bangladesh*
*[2]Genetics and Fish Breeding, Bangabandhu Sheikh Mujibur Rahman Agricultural University,
Gazipur 1706, Bangladesh*
[3]WorldFish, Bangladesh and South Asia, Dhaka 1213, Bangladesh
[4]Coastal and Marine Fisheries, Sylhet Agricultural University, Sylhet 3100, Bangladesh
[5]College of Fisheries, Ocean University of China, Qingdao 266003, China
*[6]Department of Earth Sciences and Environmental, Faculty of Science and Technology,
Universiti Kebangsaan Malaysia, 43600 UKM Bangi Selangor, D.E., Malaysia*
*[#]Current address: Department of Fishery Resources Conservation & Management,
Faculty of Fisheries & Ocean Sciences, Khulna Agricultural University, Khulna-9100*
[*]E-mail: sabujgfb@bsmrau.edu.bd

ABSTRACT

The study was aimed to investigate the current status and threats of fisheries resources in the Kura River, Bangladesh. Monthly fish catch surveys were carried out from December 2015 to November 2016 in four catchment areas at Hasinarghat, Kandir-dor, Pulertol, and Barartok. In addition, questionnaire interviews and focus group discussions (FGD) were done to clarify perceptions about the Kura River fishery status. A total of 59 fish species from 22 families were documented and of which 27% were threatened. The values of diversity (H), richness (D), and evenness (J') were calculated at 3.599, 4.345, and 0.921 respectively. The highest catch volume was recorded 19800±7722.71 kg in November 2016 at the Kandir-dor and the lowest 225±110.65 kg in March 2016 at the Barartok ($p<0.05$). The upstream blockage (man-made dam) in the Kura River was identified as the main cause of fish habitat change, decrease fish biodiversity, and production of this River. Therefore, the findings of this study exposed that the conservation of fish has become urgent. In this regard, the baseline scenario of the Kura River biodiversity and threats will help to make awareness to take necessary conservation strategy as well as the need for further in-depth study.

Key words: Catch volume, fish diversity, fishing gears, habitat degradation, threats

INTRODUCTION

Bangladesh is blessed with voluminous rivers and canals making it a riverine country. The Kura River is one of the most important rivers in the northeast part of Bangladesh in terms of fish production and income generation of more than thousands of surrounding fishermen (Banglapedia, 2015). The Kura River is an interconnecting waterway between two important water bodies named Erali Beel upstream and Damri haor the downstream. The Erali Beel is also connected with the river Surma and Damri haor

is connected with the river Kushiyara formed two major rivers of Sylhet district in Bangladesh. As an interconnecting water body, the Kura River is rich in fisheries biodiversity. During the winter period (December to March), water flow reduces (average depth becomes 5-6 m) and it acts as a reserve for diversified aquatic species, useful for the next year's breeding. Also, there are many important fishing grounds which locally called Dor, as Fokir marar dor, Senapotir dor, Kunimurar dor, Udorulir dor, Gonar dor, Lalmatir dor, Koikhanir dor, and Laiatokir dor, Pulertol, Botertol, Khaler mukh, Barartok, Solimsah ghat, and Hasinar ghat. Approximately more than 3000 households are living in this area whose

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livelihoods, culture, and daily activities are mainly relying on this aquatic environment (Banglapedia, 2015).

In recent decades, man-made threats such as upstream dam construction, overfishing, use of illegal fishing gears, destruction of fish sanctuaries, and siltation have caused gradual degradation of ordinary habitats as well as decreasing aquatic diversity, a vital problem in Bangladesh (Islam *et al*., 2015; Pandit *et al*., 2015a). Studies have indicated the need for detailed biodiversity studies to assess the present status and sustainable management of such water bodies (Chaki *et al*., 2014; Mohsin *et al*., 2014; Pandit *et al*., 2015a; Mazumder *et al*., 2018). In addition, several studies have been conducted on fish faunal biodiversity in different water bodies of Bangladesh (Galib *et al*., 2013; Imteazzaman & Galib, 2013), while no study has been reported on fisheries biodiversity of the Kura River in Sylhet, Bangladesh. Therefore, this study is the first attempt to comprehend the current status, current production, and threats of fisheries diversity in the Kura River.

MATERIALS AND METHODS

Study area

The study was conducted in the Kura River at Golapganj upazila (located in between 24°41' and 24°55' north latitudes and in between 91°55' and 92°06' east longitudes) in Sylhet district, Bangladesh. The total length of the Kura River is about 15 km with surrounding localities. Field surveys were undertaken at four adjacent villages of Kura River, named Masura, Uttar Gaon, Dakhin Gaon, and Sitessor under Bhadeshwar union of Golapganj upazila. Two criteria for the selection of the study area were suitable geographical coverage for a wide variety of biodiversity and the number of fishermen depending on fishing activities for their livelihood in this area (Figure 1).

Data collection

Fish sampling was done from all sampling points on monthly basis to study the biodiversity and status of Kura River fisheries. Also, data were collected from interviews and focus group discussions (discussions with a small group of people, generally 12-15 in numbers have a common interest) with stakeholders to understand the previous scenario of the Kura River fishery. For interview and FGD, semi-structured and structured questionnaires were developed, pretested, and adopted to addressed key issues included present status and causes of fisheries diversity loss with their possible mitigation measures. A total of 284 stakeholders including fishermen, aratdar (acts as a middleman between fisherman and customers), fish traders, housewives, local leaders, Upazila Fisheries Officers (UFO), and District Fisheries Officer participated in this survey. A total of 80 fishermen, 20 fish traders, and 20 aratdars were randomly selected for the questionnaire interview. In each of the four villages, two FGDs were conducted in which FGD1 had 12 and FGD2 had 15 participants (Table 1).

Table 1. Categorization of key stakeholder groups and their roles in the study (DFO = district fisheries officer, UFO = upazilla fisheries officer, FGD = focus group discussion)

| Stakeholder	Number	Stakeholder role	Involvement in the Study
Fishers	200	Depend on Kura River for livelihood	Interview and FGD
DFO	1	Implement fish acts and monitoring of the overall fishing activities; encourages the fishermen to conserve the habitat considering its great importance	Interview
UFO	1	Implement fish acts; involvement in the leasing process, and motivating people for fish conservation and habitat restoration to increase fish production	Interview
Local Leaders	10	Proclamation on conservation, conflict resolution, and policy involvement at the local level	Interview and FGD
Housewives	32	Assist fishers by net making	FGD
Fish Traders	20	Invest in the fishing business, promote fish transportation	Interview
Aratders	20	Collects fish from fishers and sell it to other parties; acts as a middleman	Interview
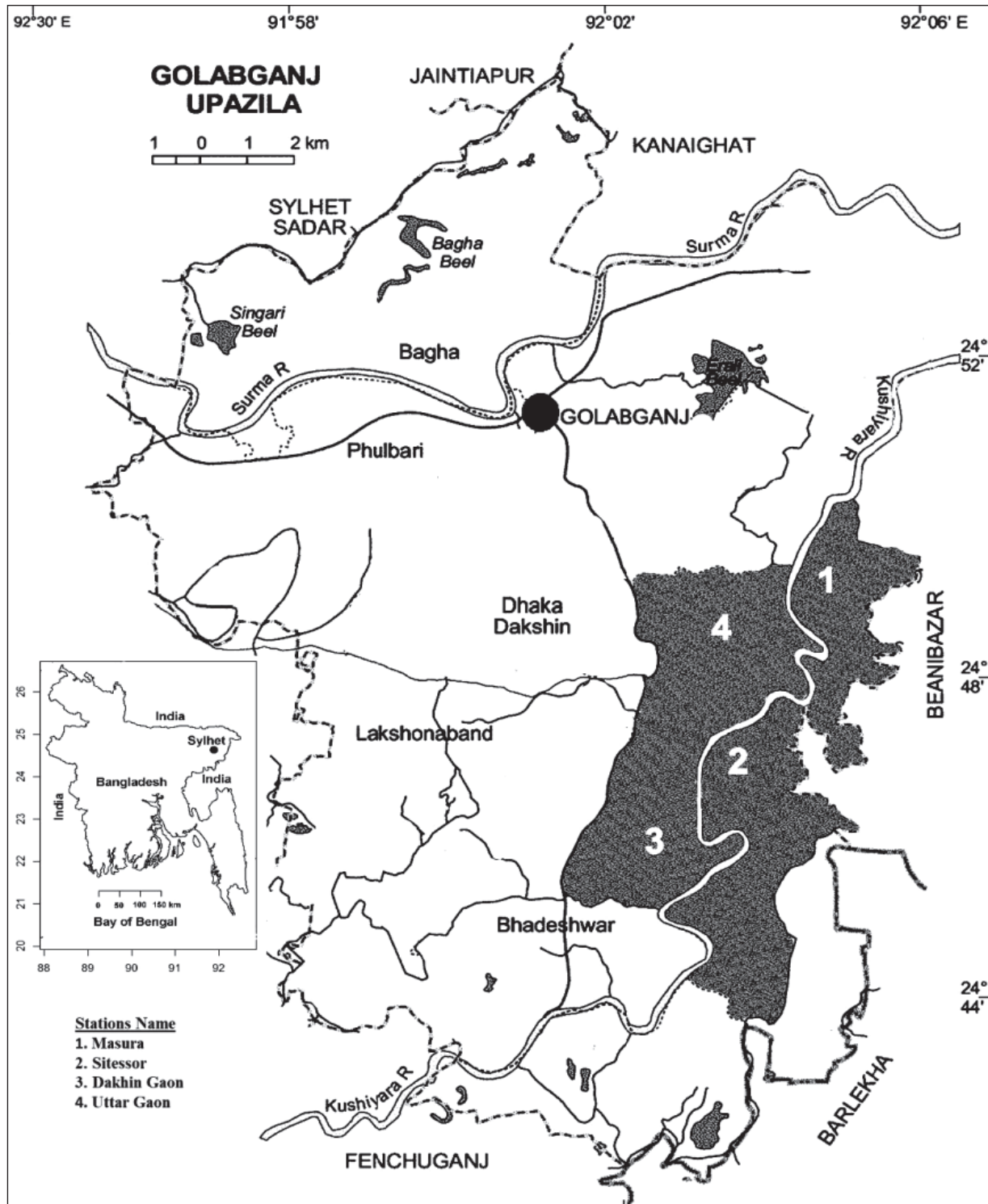
Fig. 1. Map depicting the location of the study area, Golapganj, Sylhet, Bangladesh.

Catch assessment sampling

Catch assessment surveys were performed at four main fishing grounds of the study area named Hasinar ghat, Kandir dor, Pulertol, and Barartok (Figure 1). Fish samples were directly collected from the fishing spots where sampling was performed 3 times at the same location in a week. Set bag nets (Suti jal) were deployed to capture all types and sizes of fish, with minimum selectivity, to assess species composition. When possible, fish were identified, counted, weighed *in-situ,* and then released onsite. Otherwise, they were preserved in 10% formalin in plastic jars for laboratory assessment. The collected fish were identified according to the description by Jhingran and Talwar (1991), Froese and Pauly (2007), and Rahman (2005). To estimate fishing gear

efficiency, fish sampling was conducted with a set bag net, seine net, gill net, cast net, and fish traps. Each of these gears was sampled in triplicate at the same sample sites. The month-wise fish production at the four fishing grounds in the Kura River was calculated by the catch assessment method.

Fish categorization and grouping

Based on the interview and recording of the fishermen, and availability during the study period the fishes were further characterized and evaluated as commonly available (CA), moderately available (MA) and less available (LA). For the valuation of abundance and biodiversity status, the identified fishes were characterized as vulnerable (VU), endangered (EN), critically endangered (CR), and near threatened (NT) according to International Union for Conservation of Nature Red List (Mazumder *et al*., 2016). There were also some species evaluated but not considered as a threatened species and these were recorded as least concern (LC) fish species according to the IUCN (Table 2).

Abundance and fish biodiversity

To estimate the fish biodiversity, the Shannon-Weaver diversity index (H), Margalef's richness index (D), and Pielou's evenness index (J') were calculated as $H = -\Sigma Pi\ lnPi$ (Shannon & Weaver, 1949); $D = S-1 / ln\ N$ (Margalef, 1958) and $J' = H / ln\ S$ (Pielou, 1966). Where Pi is the relative abundance (s/N), s is the number of individuals of one species and N is the total number of individuals in the sample, S is the total number of species, and ln is the natural logarithm.

Statistical analysis

There were no significant differences among the replicated samples means ($p>0.05$), and the data for the different replicates were therefore averaged. Before the statistical analysis, all data were tested for normality and homogeneity of variance among the different groups using a Kolmogornov-Smirnov (K-S) test on residuals and Bartlett's test for homogeneity of variance (Sokal & Rohlf, 1995). The month-wise fish production was compared using the one-way ANOVA technique (Zar, 1996). All results were expressed as means ± standard error (S.E). The differences in diversity indices (diversity H, richness D, and evenness J') were analyzed using Past version 3.0 (Hammer *et al*., 2001) and all other statistical analyses were performed using Origin™ Version 9.0 and Minitab version 17 computer software (Mazumder *et al*., 2016), and the differences were significant at *p*-values of less than 5%.

RESULTS AND DISCUSSION

Fish biodiversity

According to direct catch observations and information provided by the local fishermen, a total of 59 fish species under 22 families were recorded from the study area. A similar study has been reported by Rahman *et al*. (2015) also recorded a total of 56 species under 21 families from the Talma River of Bangladesh while only 53 fish species belonging to 28 families were recorded from the Andharmanik River of Bangladesh (Mohsin *et al*., 2014). These differences in fish diversity at different rivers may occur due to different geographical and physicochemical characteristics of that water body. Moreover, the health of any aquatic ecosystem depends on the abiotic characteristics of water and the biological diversity of that ecosystem, which is measured in the form of physicochemical properties. In addition, the fish diversity of any aquatic ecosystem, especially the numbers and geographical distribution depends on the physicochemical properties of that waterbody (Ingole *et al*., 2010; Sharma & Shingh, 2013). However, it is exceptionally difficult to stick point one or two single factors, but several factors are interrelated for changing any aquatic biodiversity status (Raveendar *et al*., 2018). The present study results also exposed the Cyprinidae family as the leading fish family amongst the 22 families consisting of 29% of the total fish species composition (Figure 2). These findings are also parallel to the similar observations made by Joadder *et al*. (2015) in the River Padma and Galib (2015) in the River Choto Jamuna, in which the Cyprinidae family was recorded as the dominating fish family. Fishes under the Cyprinidae family were also found as the dominant fish family (consisting of 22.71% of the total fish species) in the Shari-Goyain River of Sylhet district (Talukder *et al*., 2021). In this regard, the recorded total number of fishes in different families, present status, and IUCN status are described in Table 2. According to respondents' survey and catch assessment period, 10 most abundant fish species were identified (Figure 3) and 21 species were recognized as commonly available throughout the year.

Taking into account all the samples collected in this study, the values of H, D, and J' were 3.599, 4.345, and 0.921, respectively. The value of H ranged from 3.454 (April 2016) to 3.681 (October 2016), D varied from 3.404 (March 2016) to 4.889 (September 2016) and J' ranged from 0.904 (June & September 2016) to 0.952 (March 2016). The number of fish species diversity recorded in April 2016 was

Table 2. Fish species occurrence in the studied area with their IUCN status (CA = commonly available, MA = moderately available, LA = less available, CR= critically endangered, EN= endangered, VU= vulnerable, NT= near threatened, and LC= least concern)

| Family Name	Local Name	Common/ English Name	Scientific Name	Present Status	IUCN Status
Cyprinidae	Punti/Jat punti	Punti barb	*Puntius sophore*	CA	LC
	Tit punti	Ticto barb	*Puntius ticto*	CA	LC
	Sarputi	Olive barb	*Puntius sarana*	CA	LC
	Gonia	Kuria labeo	*Labeo gonius*	CA	NT
	Kalira/Kalibaus	Black rohu	*Labeo calbasu*	CA	LC
	Bata/Bhangon bata	Bata labeo	*Labeo bata*	CA	LC
	Rui	Rohu carp	*Labeo rohita*	MA	LC
	Mola	Mola carplet	*Amblypharyngodon mola*	LA	LC
	Boro Chela/Chelabaiya	Gora chela	*Securicula gora*	MA	NT
	Silver carp	Silver carp	*Hypophthalmichthys molitrix*	MA	LC
	Grass carp	Grass carp	*Ctenopharyngodon idella*	MA	LC
	Mrigel/Mirka	Mrigel	*Cirrhinus cirrhosus*	LA	NT
	Dhela/Gilacaki	Cotio	*Osteobrama cotio*	LA	NT
	Catla	Catla	*Catla catla*	LA	LC
	Carpu/Carpio	Common carp	*Cyprinus carpio* var. *Communis*	LA	LC
	Darki/Darkina	Flying barb	*Esomus danricus*	LA	LC
	Chela pata/Chela	Silver hatchet chela	*Chela cachius*	LA	VU
Bagridae	Rita	Rita	*Rita rita*	MA	EN
	Kalo bujuri	Tengara mystus	*Mystus tengara*	MA	LC
	Ayre	Long whiskered catfish	*Sperata aor*	MA	VU
	Guizza/Guizza ayer	Giant river catfish	*Sperata seenghala*	LA	VU
	Tengra	Striped dwarf catfish	*Mystus vittatus*	CA	LC
	Golsha	Day's mystus	*Mystus bleekeri*	CA	LC
	Batashi	Tista batasio	*Batasio batasio*	LA	NT
Siluridae	Kani pabda	Butter catfish	*Ompok bimaculatus*	LA	EN
	Boal	Freshwater shark	*Wallago attu*	CA	VU
	Pabda	Pabo catfish	*Ompok pabo*	CA	CR
	Modhu pabda	Pabdah catfish	*Ompok pabda*	MA	EN
Channidae	Shol	Banded snakehead	*Channa striatus*	MA	LC
	Lata/Taki	Spotted snakehead	*Channa punctatus*	CA	LC
	Gozar	Giant snakehead	*Channa marulius*	LA	EN
Mastacembelidae	Guchi baim	Striped spiny eel	*Mastacembelus pancalus*	CA	LC
	Tara baim	Spiny eel	*Macrognathus aculeatus*	CA	LC
	Boro baim/Sal baim	Tire-track spiny eel	*Mastacembelus armatus*	MA	EN
Anabantidae	Boro Khalisa	Giant gourami	*Colisa fasciatus*	CA	LC
	Koi	Climbing perch	*Anabas testudineus*	MA	LC
	Lal Khalisa	Dwarf gourami	*Colisa lalius*	CA	LC
Clupeidae	Chapila	Indian river shad	*Gudusia chapra*	LA	VU
	Kachki/Guramach	Ganga river-sprat	*Corica soborna*	MA	LC
	Ilish	Hilsa shad	*Tenualosa ilisha*	LA	LC
Cobitidae	Bou/Rani	Necktie loach	*Botia dario*	MA	EN
	Gutom/Puiya	Guntea loach	*Lepidocephalus guntea*	CA	LC
Notopteridae	Foli	Grey featherback	*Notopterus notopterus*	MA	VU
	Chital	Humped featherback	*Chitala chitala*	LA	EN
Schilbeidae	Garua	Schilbid catfish	*Clupisoma garua*	MA	EN
	Bacha	Batchwa vacha	*Eutropiichthys vacha*	LA	LC
Palaemonidae	Sada chingri	Prawn	*Macrobrachium* sp.	CA	LC
	Golda	Prawn	*Macrobrachium rosenbergii*	CA	LC
Sisoridae	Bagair/Bagmach	Gangetic goonch	*Bagarius bagarius*	LA	CR
Nandidae	Meni/Bheda	Mud perch	*Nandus nandus*	LA	NT
Heteropneustidae	Shing	Stinging catfish	*Heteropneustes fossilis*	CA	LC
Clariidae	Magur	Walking catfish	*Clarias batrachus*	CA	LC
Gobiidae	Bele/Bailla	Tank goby	*Glossogobius giuris*	MA	LC
Centropomidae	Lomba chanda	Elongated Glass	*Chanda nama*	MA	LC
Hemiramphidae	EkThota/Ek Thuita	Congaturi halfbeak	*Hyporhamphus limbatus*	LA	LC
Belonidae	Kakila/Kakla	Frashwater garfish	*Xenentodon cancila*	LA	LC
Ambassidae	Gol Chanda	Indian Glass Fish	*Parambassis ranga*	CA	LC
Ariidae	Gagla/Ghagot	Gagora catfish	*Arius gagora*	MA	LC
Sciaenidae	Berkol/Koitor poa	Coitor croaker	*Johnius coitor*	LA	LC
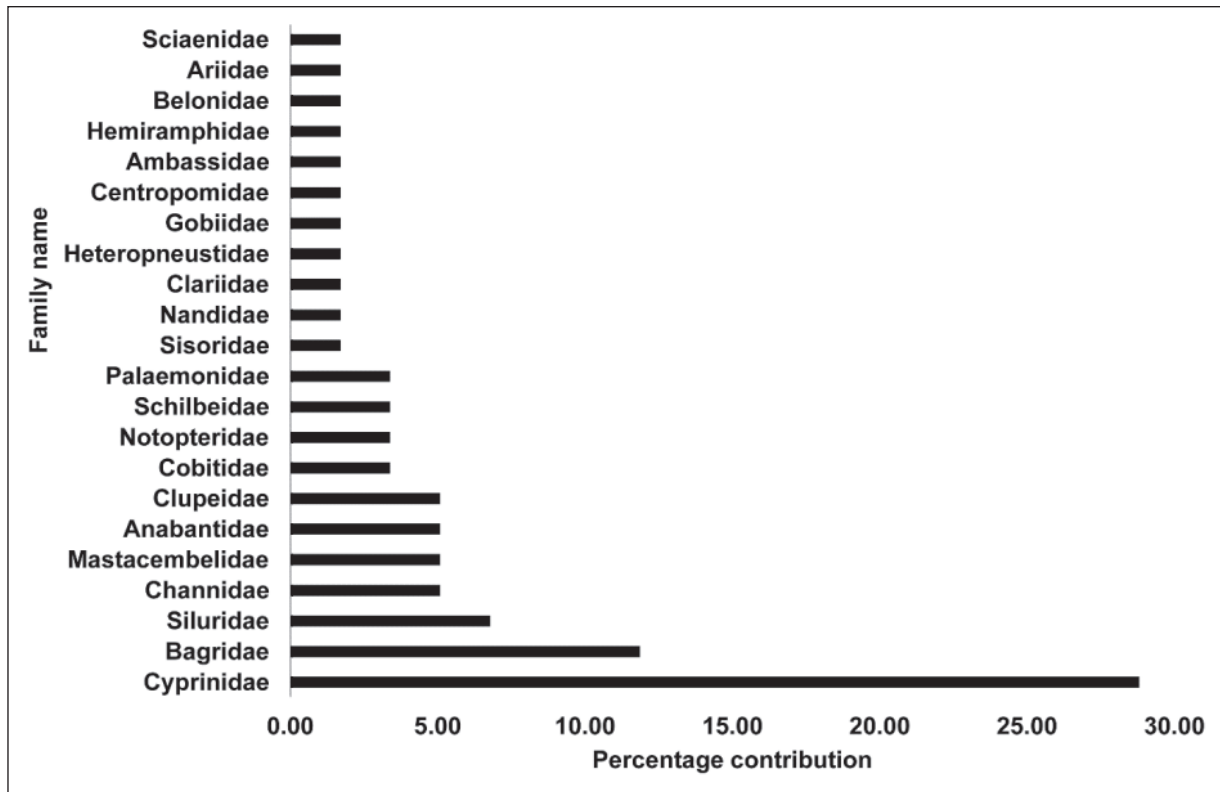
Fig. 2. Percentage of fish species diversity under different families recorded in the Kura River, Bangladesh.
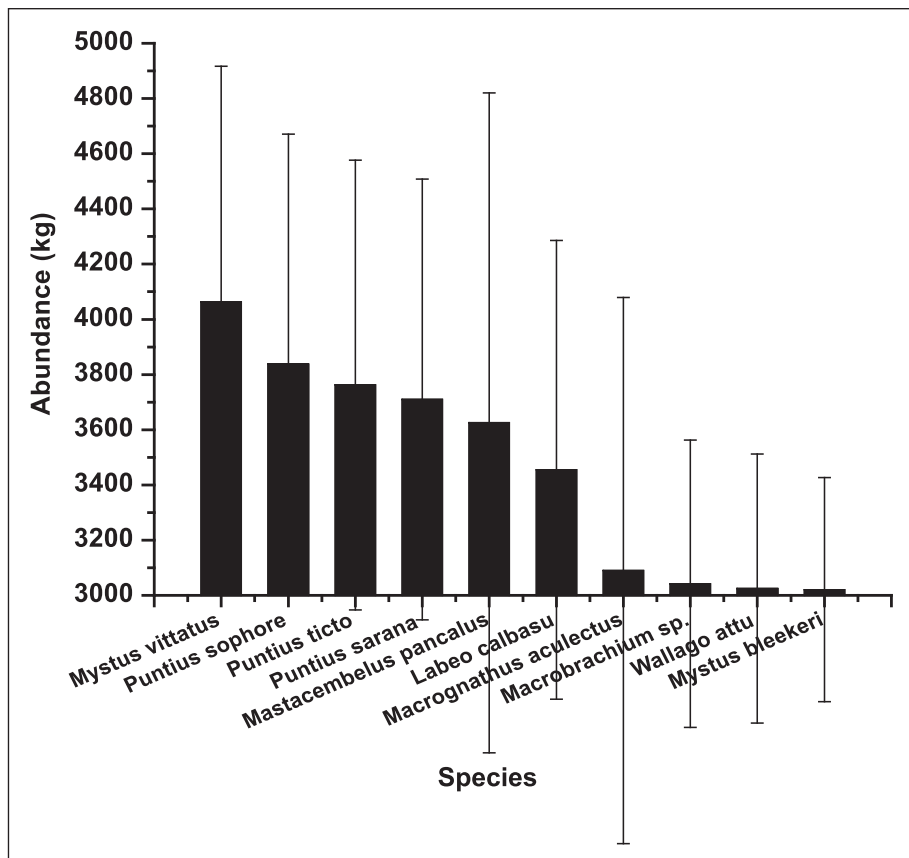

Fig. 3. Ten most abundant species were found in the study area (mean ± SE).

significantly lowest with H value of 3.454 as compared to other months ($p<0.05$). However, the H value was not significant between March and May 2016 ($p>0.05$). The highest recorded value of H (October 2016) was significantly different i.e. the number of recorded fish species was comparatively high from most of the months except December 2015, January 2016, September 2016, and November 2016 ($p<0.05$). This is because of the high availability of fishes especially during the post-monsoon period (October to November) at the Kura River ecosystem. In addition, the fishing effort (per day), as well as the increasing pressure of fishing gear during the post-monsoon period, were also responsible for the high catch value (Table 4). Moreover, the higher H value indicates the lowest degree of pollution with the high species diversity at any aquatic ecosystem, which also supports the present findings (Biligrami, 1988; Raveendar *et al.*, 2018). On the other hand, the lowest value of D (March 2016) was significantly different from other months except April 2016 ($p<0.05$). Also, the highest value of D (September 2016) was significantly different from other months except October 2016 ($p>0.05$). This finding also indicates the high species richness during the late monsoon period due to the high species diversity as well as the slightly low polluted waterbody of Kura River (Biligrami, 1988; Raveendar *et al.*, 2018). However, there was no significant difference for J value throughout the study period except the highest (March 2016) J value ($p>0.05$). This finding indicates the maximum dominance of different fish species during the month of winter (March 2016) as well as

the even distribution of fish diversity (Raveendar *et al.*, 2018). This is also because of the low water pollution of the Kura River or favorable condition for fish, which is supported by the explanation of Biligrami (1988). Biligrami (1988) has studied biodiversity index and given the degrees of pollution level of water-body based on the ranges of Shannon-weaver species diversity as, slight pollution (species diversity 3.0-4.5), light pollution (species diversity 2.0-3.0), moderate pollution (species diversity 1.0-2.0) and heavy pollution (species diversity 0.0-1.0), respectively. The current study results also showed values ranging from 3.454-3.681 in all the seasons, representing slight pollution based on the findings of Biligrami (1988). The results signifying the overall condition of the Kura River were found to be good with species diversity richness. However, the month-wise calculated values of Shannon-Weaver diversity (H), Margalef's richness (D), and Pielou's evenness (J') were presented in Table 3.

Threatened fish species

Out of the recorded 59 fish species, 37 species were the least concern, and 6 species were near threatened (NT). Among the remaining 16 fish species (27%), 6 species were ranked as vulnerable (10%), 8 as endangered (14%), and 2 as critically endangered (3%) recorded in the study area (Figure 4 & 5) (International Union for Conservation of Nature, 2015). However, according to the respondents' feedback, these species were abundant in previous decades but now recorded as threatened because of increasing fishing pressure, gradually

Table 3. Diversity index of fish assemblages from all the sampling points of the Kura River

Month	Number of species (S)	Total Number of individuals (N)	Diversity, H	Richness, D	Evenness, J'
July,16	55	87102	3.630	4.747	0.906
August,16	55	87084	3.631	4.747	0.906
September,16	57	94210	3.656	4.889	0.904
Monsoon					
October,16	57	99966	3.681	4.864	0.910
November,16	56	100652	3.673	4.775	0.912
Post-monsoon					
December,15	55	93911	3.680	4.716	0.918
January,16	50	77467	3.662	4.353	0.936
February,16	46	73472	3.619	4.016	0.945
March,16	39	70580	3.489	3.404	0.952
Winter					
April,16	40	75313	3.454	3.473	0.936
May,16	44	78476	3.478	3.815	0.919
June,16	50	80042	3.536	4.340	0.904
Summer					
Average	59	1018275	3.599	4.345	0.921

Table 4. Type of fishing gears and period of operation in the Kura River, Bangladesh (*All- all types of large and small fish; Carnivore- mainly catfish (boal, pabda), snakeheads and eels; Big fish- fish > 25 cm total length; Sep- September; Oct- October; Nov- November; Dec- December; Jan- January)

| Category	Type of gear	Local Name of gear	Construction cost (BDT/Net)	Mesh size (cm)	Target species	Fisherman needed for operation	Fishing effort/day	Season/Period	Main Fishing Habitat	Durability
Fishnets	Set bag net	Chonga/Behundi jal	10000-15000	0.5-3.0	All	1-2	Full day	July-Oct	The lower end of the Kura River	5-7 years
	Seine net	Ber/Moshari/Kapri jal	40000-50000	0.3-1.0	All	8-10	3-4 time	Oct-Nov	All over the Kura River	4-5 years
		Utar jal	15000-16000	0.5-1.5	All	2-3	12-15 time	July-Nov	Hasinar Ghat & Kandir Dor	4-5 years
	Gillnet	Current jal	400-500	0.5-3.0	All	1-2	8-10 time	Year round	All over the Kura River	3-4 month
		Bauyai jal	30000-40000	2.0-4.0	Big fish	8	12-14 time	Oct-Dec	All over the Kura River	7-8 years
		Leuya jal	500-1000	5.0-20.0	Big fish	1-2	8-10 time	July-Sep	All over the Kura River	10-15 years
		Suta vasar jal/ Fash jal	1800-2000	4.5-15.0	Big fish	1-2	8-10 time	July-Oct	Hasinar Ghat	4-5 years
	Cast net	Jhaki jal	4500-5000	≥1	All	1	15-20 time	Year-round	All over the Kura River	5-6 years
	Lift net	Dharma/Afa/Kura jal	1500-2000	0.5-1.2	All	1-2	20-25 time	July-Oct	All over the Kura River	5-7 years
		Bel jal	5000-6000	0.5-2.0	All	1-2	15-20 time	July-Nov	All over the Kura River	5-7 years
Hook and line		Chip borshi	200-250	0	Carnivores	1	8-10 time	July-Dec	Pulertol and Kandir Dor	2-3 month
		Boro borshi	400-500	0	Carnivores	1-2	6-8 time	July-Dec	Pulertol and Kandir Dor	5-6 month
Fish aggregating device		Katha	500-600	0	All	10-12	4-5 time	Nov-Jan	All over the Kura River	2-3 months
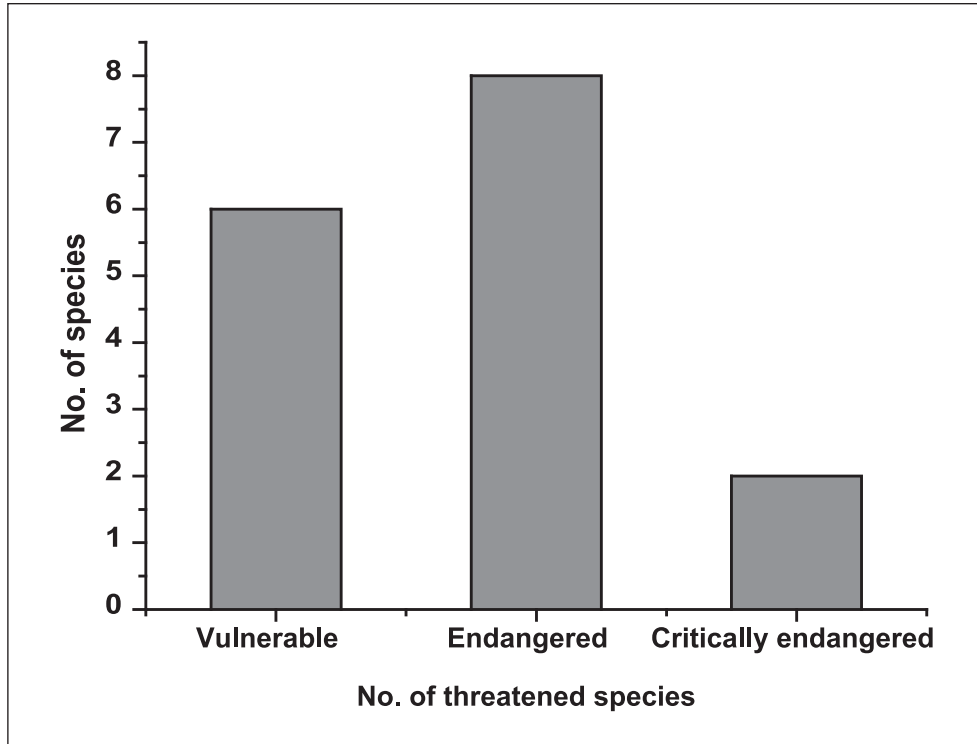
Fig. 4. Threatened fish species found in the study area according to the International Union for Conservation of Nature (IUCN 2015).
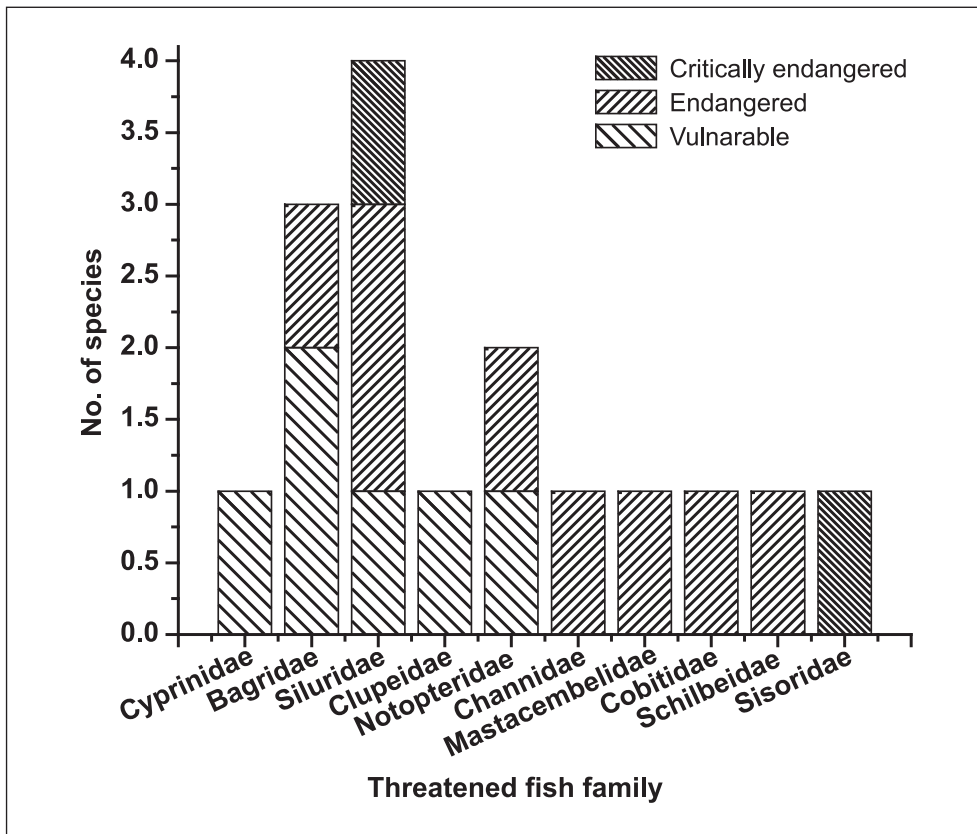

Fig. 5. Several threatened fishes under different families were recorded from the study area (Kura River), Golapganj, Bangladesh.

reducing water flow due to upstream barrier, increased pressure of destructive fishing gears, etc. However, several parallel studies by Joadder *et al.* (2015) at the River Padma and Talukder *et al.* (2021) at the Srari-Goyain River of Sylhet district of Bangladesh have found 28 and 19 fish species as threatened, respectively. Therefore, the suitability of feeding, breeding, and nursing ground of different water bodies may cause different calculations and identification of threatened fish species at different Rivers and underline the necessity of fast improved conservation management (Talukder *et al.*, 2021).

Fishing gears

Kura River is considered rich in fish diversity and so as fishing gear. A total of thirteen (13) diversified fishing gears under three main categories- fishnets, hook and lines, and fish aggregating devices were identified and documented from the study area (Table 4). Set bag net, seine nets, gill nets, cast nets and different types of hooks and lines were used as the major fishing gears by the fishers in the study area. Several parallel studies with similar findings have also been reported by Siddiq *et al.* (2013) at Dogger Beel and Islam *et al.* (2016) at Jamuna River, who identified also thirteen (13) fishing gears but mostly under 5 major groups (due to locally made different fishing gear type), namely, fish nets, fish traps, hooks and lines, spears/wounding gears and khata/zag. Most of the recorded fishing gears were used during the monsoon to the post-monsoon period (July to January), except the gill net (current jal) and cast net (jhaki jal) which were identified as year-round using gear in the study area, respectively. A similar observation was reported by Siddiq *et al.* (2013) in which the current jal was used around the year to catch most of the species at Dogger Beel. In contrast, the present findings identified another two types of gear- gill net (leuya jal) and lift net (dharma jal) were recorded only been used during the monsoon period, but the fish aggregating device (Katha fishing) were especially used and recorded during the post-monsoon period (November to January), respectively. The present study also identified many special types of fishing gears from different fishing grounds, such as- seine net (uttar jal) from Hasinar ghat and Kandir dor, gill net (suta vasar jal) in Hasinar ghat, chip borshi, and boro borshi used especially in Pulertol and Kandir dor fishing ground. The present study identified the seasonal variability for using different fishing gears at Kura River. The use of different fishing gears and the operational time mostly depends on the habitat or fishing grounds type, water level, an abundance of species, etc. (Siddiq *et al.*, 2013). Additionally, the catch composition of different fish species varies with season and so varies with fishing gears. The significant differences in species composition and richness between different sampling gears depend on habitat or fishing ground type, which supports the present study findings (Siddiq *et al.*, 2013; Paiva de Affonso *et al.*, 2016). The high abundance with increased catch value of fishes is highly responsible for increasing fishing activities during the monsoon and post-monsoon periods were observed in the present study. Higher fishing activities were reported by Dewan and Mazid (1994) using different fishing techniques in Bangladesh during the monsoon and post-monsoon period.

Fish production

The catch assessment method was applied to calculate the fish production from four fishing grounds in the Kura River. The highest fish production (19800±7722.71 kg) was recorded in November 2016 at the Kandir Dor fishing ground, which was significantly higher than all other months ($p<0.05$). The Kandir Dor is comparatively deeper than all other fishing ground, may cause of the high species abundance. During the post-monsoon period (October-November), high fishing activities were performed in the Kura river and Kandir Dor as well supposed to high catch composition and highest fish production.

In contrast, the fish production (225±110.65 kg) at Barartok fishing ground in March 2016 was significantly lower than in all other study months ($p<0.05$; Figure 6). Hence, the Barartok fishing ground is reported as the lowest depth of all other fishing grounds of the Kura River. Also, the lowest species abundance, richness, and catch composition were estimated in March during the winter season (December-March). However, the total fish production (kg/ha) from January to December, has been recorded at 41153.85 kg/ha, 32548.57 kg/ha, 29374.76 kg/ha, and 21814.83 kg/ha, respectively, from Kandir Dor, Hasinar Ghat, Pulertol and Barartok fishing grounds. The depth, water quality, and catch composition of the four fishing grounds of Kura River made different from each other. Moreover, the geo-morphological parameter such as depth/altitudes is considered as the most significant character than physicochemical parameters of any water body, which may affect different fish production at four fishing grounds of Kura River (Welcomme *et al.*, 2006; Suvarnaraksha *et al.*, 2012). Therefore, the richness and production of fish species are firmly bound to the inundating pattern during the monsoon period (Ahmed 1991), in which the fish production of the Kura River has been recognized higher at monsoon (July to September) and post-monsoon (October to December) period as well.
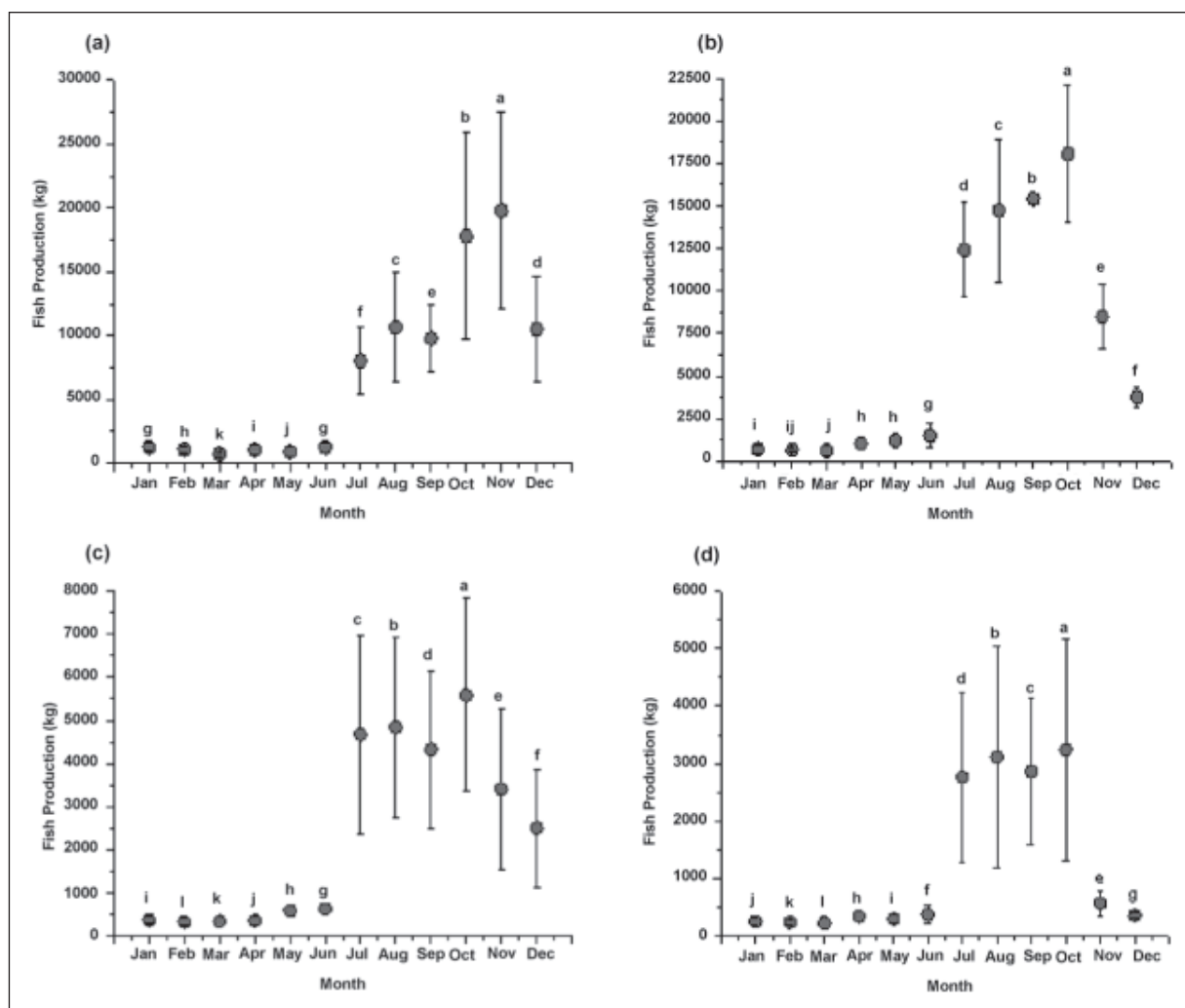
Fig. 6. Month-wise total fish production (kg) at four fishing grounds in the Kura River, (a) Kandir Dor; (b) Hasinar Ghat; (c) Pulertol; and (d) Barartok. Values are presented as mean ± standard error (S.E). Different letters indicate significant differences by month ($p<0.05$).

Table 5. Factors/reasons for fish habitat change in the Kura River, Bangladesh

SL. No.	Reasons	No. of respondents	Percentage of respondents
1.	Blockage of the upstream connecting channel (khal) of the river that might be disturbed in fish migration	70	87.5%
2.	Use of illegal/destructive fishing gears (Chonga/Behundi jal and current jal)	65	81.25%
3.	Decreasing water depth and current, increasing siltation	62	77.5%
4.	Increasing fisherman and fishing pressure	60	75.0%
5.	Catching of juvenile and brood fishes	38	47.5%
6.	Use as navigational route resulting fishes were disturbed their breeding and migration purposes	28	35.0%
7.	Bottom fishing by illegal gears (Ber jal) that damage bottom and surrounding habitat	16	20.0%
8.	High rate of katha fishing	10	12.5%

Reasons for fish habitat change

Loss of fish habitat degradation is an alarming issue for decreasing fish diversity in any aquatic ecosystem. Due to the high level of anthropogenic pressure (dam construction, pollution, land erosion, overexploitation, etc.), the freshwater fish population facing serious threats around the world (Magurran, 2009; Arthington *et al*., 2016; Guo *et al*., 2018). Thus, the present study results were identified several threats for reducing fish biodiversity and habitat degradation of the Kura River fishery, presented in Table 5. Undisturbed fish habitat is an essential part of maintaining healthy fish populations, although the upstream blockage was declared as the prime cause of habitat change in the Kura River followed by the use of illegal fishing gears, siltation, an increase of fishing pressure, catching of juvenile and brood fishes, local navigational route, high rate of katha fishing (aggregation of fishes by using aggregating devices such as- making bush of tree branches, aquatic weeds, etc. for attracting fish and then catching all the fishes by using seine net). Alteration of river flow due to dam construction is considered as one of the strongest threats for directly damaging and reducing river habitat (Vörösmarty *et al*., 2010). Furthermore, overexploitation and year-round use of destructive fishing gears (illegal fishing gears) are also considered as the principal cause of fish habitat destruction as well as declining fish diversity (Guo *et al*., 2018; Jahan *et al*., 2020). Similar results were also observed by Pandit *et al*. (2015b) at Soma Nadi Jalmohal and Rahman *et al*. (2015) at Talma River of Bangladesh, who stated that the exploitation, siltation, flooding, drought, construction of obstacles for fish migration as the key causes of decline fish habitat and biodiversity in Bangladesh, respectively. Thus, all the clear destructive factors respond with the sustainability of fish diversity habitat loss at any river ecosystem (Guo *et al*., 2018; Jahan *et al*., 2020). Therefore, the management strategy and the conservation process of fish diversity at Kura River have become more important.

CONCLUSION

The present study has documented the baseline scenario of the Kura River wherein the current fish biodiversity status, as well as the main threats to fish biodiversity, have been figure out. Cyprinidae family was recorded as the dominating fish family. During the post-monsoon season (October-November), the Kura River provided the highest fish biodiversity and catch. The present study identified 6 vulnerable, 8 endangered and 2 critically endangered species while the respondents' evaluation reported the number of threatened species is increasing. Blockage of the upstream connecting channel (khal), use of illegal/destructive fishing gears (e.g. Chonga/Behundi jal & current jal), decreasing water depth, and increasing fishing pressure was identified as serious threats to the Kura River, which affects the overall fish production of this resourceful ecosystem. Therefore, the findings of this study exposed that the conservation of fishes has become urgent, more hotspots should be identified as nature reserves, and an integrated management plan should, therefore, be developed and implemented effectively.

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