Exploring Fish Biodiversity and the Socioeconomic Status of Fishers in the Karatoya River, Sadar Upazila, Panchagarh District, Bangladesh

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Original Research Article

ABSTRACT

These studies were carried out to study species diversity of fishes and socio-economic conditions of the fishers of Karatoya River at Sadar upazila in Panchagarh district Bangladesh. Pertinent information was collected from 65 fishermen, who were directly engaged in catching fish around the

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study area for six months from December 2022 to June 2023. The results demonstrated that 41 fish species belonging to 8 orders and 15 families were found in the Karatoya River. Cypriniformes was found as the most dominant order, constituting 50.6% of the total fish population, considering species abundance, and Siluriformes constituting 12.7% and Perciformes constituting 12.0%, which were occupied the second and third position in abundance. The order Channiformes, Clupeiformes, Mastacembeliformes and Tetraodontifomres were constituted 6.6%, 6.0%, 4.8%, and 4.2%, respectively. Beloniformes constituted the lowest number of species (30%). It was observed that many fish species in the Karatoya River were severely impacted by the environmental and human-induced hazards. However, the age of the fishermen was ranged from 22 to 65 years. The Hindus (70%) were featured to be the highest percentage than the Muslims (30%), while no Christians and Buddhists were found. Various levels of education were documented in the study area, where majority of the fishermen were illiterate (69%), up to primary 18%, up to secondary 8% and the small portion (5%) were above secondary. The fishermen's housing status was predominated by kaccha (66%), followed by semi pacca (23%) and pacca (11%). Majority of the fishers were landless (39%), whereas 15% fishers had 1-10 decimal (dec.) lands, 18% had 11-20 dec., 11% had 21-30 dec., 14% had 31-40 dec. and badly 3% of them had possessed >40 dec. lands. Among the fishermen, 45% of them were found to be involved in fishing activities, 40% in agriculture and 15% in sand business as day-to-day labour. There were 4 types of nets, 3 types of traps, 4 types of spears and 2 types of line fishing operated in this area. The study revealed that the fisheries production was not sufficient according to the demand. The reasons behind this might be due to the fact that the fishers around the Karatoya River were mainly poor, illiterate, lack of proper training and also nonexistence of consciousness of their sanitary and health care facilities. Therefore, it is very important to provide the required Organizational and Institutional help, support and extension facilities for the enhancement of fish biodiversity as well as development of sustainable livelihood of fishers in the Karatoya River as well.

1. INTRODUCTION

Bangladesh is fortunate enough to have significant potential of capture fishery and aquaculture potential due to having a wide area of inland water bodies including rivers, canals, haors, beels, reservoirs, Kaptai lake, Ox-bow lakes, ponds, tanks, floodplains areas and the Bay of Bengal, and almost all of these water bodies are very much suitable for aquaculture and fish production (Zerin et al., 2023). The advantageous geographical location of the country arises with huge numbers of aquatic animals and gives abundant bioresources to sustenance fisheries management (Shamsuzzaman et al., 2017). Rice and fish are the popular components in our everyday life, as mentioned by an age-old proverb "Maache-bhate Bengali" ("A Bengali is composed of fish and rice")) (Ghose, 2014 and Shamsuzzaman et al., 2017). The fisheries of Bangladesh can be divided into three categories, viz., inland capture fisheries, inland aquaculture and marine fisheries (Shamsuzzaman et al., 2017). The rivers are providing enormous scopes and facilities for enhancing fish production and socioeconomic security of the peoples, living around the area (Zerin et al., 2023). Furthermore, the fisheries

sector is a vital contributor to the country's economy, not only fulfilling the substantial amount of the nation's food need but also generating considerable revenue (Zerin et al., 2023), (Shamsuzzaman et al., 2023), (Hossan, 2023). In terms of fisheries resource management, Bangladesh was ranked third position internationally during the fiscal year 2020-21, harvesting about 20 million tons of fish and contributing 3.57% to the country's GDP (DoF, 2020-21), (Zerin, 2023), (Hossan, 2023). In addition, the country has been exporting bony fish, shellfish and other fish-related products to >50 nations worldwide as well as receiving $533 million in 2021-2022, which is >1% of the nation's total export revenues (Hossan, 2023).

Being one of the riverine countries, Bangladesh is blessed with vast water resources in the forms of 3 mighty Rivers: the Padma, the Meghna and the Jamuna that contributes to an enormous prospect for both the freshwater and brackishwater fisheries (Shamsuzzaman et al., 2017), (Hossan, 2023). Along with many ponds, rivers, canals, lakes, estuaries and floodplains all over Bangladesh, the Bay of Bengal situates at the end of the southern part in the country (DoF, 2020-21), (Hossan, 2023). These huge water

areas have been recognized as the habitats for a large number of fish species, which are easy to rear, capture and digest and thus, considering them as principal foods for the peoples of Bangladesh. Based on the State of World Fisheries and Aquaculture Report 2022 by FAO, Bangladesh ranks the third position internationally for fish harvesting from open waterbodies as well as fifth position for fish production through aquaculture (DoF, 2020-21), (FAO, 2022). Besides, the country ranks fourth position globally and third position in Asian countries or the production of tilapia. Moreover, Bangladesh's greatest noteworthy success is that it secured the highest position among the eleven countries that produce hilsa fishery, which is regarded as the national fish and accounted for >12% of the entire fish production in the country (DoF, 2020-21), (Hossan, 2023).

Fish production of Bangladesh has been increased to six folds in the past 3 decades. The country produced 7.54 lakh mt of fish during the fiscal year 1983-1984, while this production surpassed 46.21 mt in 2020-2021 (DoF, 2020-21), (Hossan, 2023). Actually, the vision 2021 of Bangladesh Government was to produce 45.52 lakh mt, which has already been exceeded in 2020-2021 (DoF, 2020-21), (Hossan, 2023). Nevertheless, over 57% of the production arises from aquaculture systems including inland close water culture, inland open water capture and the sea, i.e., the Bay of Bengal (DoF, 2020-21).

Perennial and seasonal ponds, haors, baors, pens, enclosures, floodplains, and cages are mostly used for cultivation of inland fisheries. More than 26.38 lakh mt of fish were cultured in around 8.43 lakh ha of inland water bodies during the fiscal year 2020-2021, which is accounted for 57% of total fish production of Bangladesh (DoF, 2020-21), (Hossan, 2023). However, around 19.82 lakh mt fish were obtained from the inland water bodies (viz., rivers and canals), whereas the remainder is supported by the sea, and over 12% population of the country has directly or indirectly been engaged in fisheries activities for their source of income and livelihood (Hossan, 2023). The fisheries sector nowadays is considered to be one of the important employment-producing areas and also plays a significant role in socio-economics development and foreign-exchange earnings of Bangladesh (DoF, 2020-21). It is to mention here further that fish and fisheries are an essential part of this country since the time extending beyond the memory (Kabir, 2012).

However, both the rivers and traditional fishing societies are broadly and geographically distributed throughout Bangladesh, and most of the fishermen are vulnerable as well as facing problems in catching fish through traditional fishing practices, and due to low income, they are living with hand to mouth (Ali, 2014). Fishermen, locally referred as 'Jele' or 'Jaila", a group of peoples in Bangladesh, who are living by catching and selling fishes (Rahman, 2019). They are usually considered to be the most susceptible and disadvantaged peoples in the society due their earnings situate below the marginal level of income (Kabir, 2012), (BBS, 2017). In addition, their livelihood mostly depends upon the riverine-fishery resources (Alam and Bashar, 1995), (Khan, 2013), (Hossan, 2014), Shamsuzzaman, 2017), (Hossan, 2023). Fish is the main source of animal protein in the diet of Bangladeshi people, constituting 60% of the total protein intakes with per person consumption reaching 62.58 g, the value of which is higher than their daily protein requirement of 60 g (BBS, 2017). Nevertheless, appropriate production of fish depends upon technological advancements, sustainable management practices, and socio-economics features of fishing communities, which justifies an aspect of interests for the fisheries scientists directing to identify the limitations as well as to advance the existing circumstances (Kabir, 2012), (Ali et al., 2014), (Mia et al., 2015), (DoF, 2020-21), (Hossan, 2023).

The Karatoya is one of the main river systems of the Sadar Upazila in Panchagarh district of Bangladesh and has significant effects on biodiversity of fishes as well as the socio-economic conditions of fishing communities. In order to maintain their livelihood, majority of the families are directly engaged in fishing and getting money to maintain their livelihood in the year-round. For appropriate advancement of the fishing communities, it is deemed indispensable to know the baseline information of the exact progressive phases and improve the livelihood patterns of the fishers. Still now, there have been no adequate evidences available regarding the means of support to the fishers around the northern most parts of Bangladesh. However, few studies on assessment of fish diversity, livelihood status and socioeconomic conditions of fishermen were carried out but all of the efforts lack exact evidences. Therefore, the present research has been undertaken to investigate the fish diversity, fishing gears used, socioeconomic condition of fishermen and livelihood development in the Karatoya River.

2. MATERIALS AND METHODS

These researches were conducted through the collection of primary data by field survey from the Karatoya River at Panchagarh sadar in Panchagarh district. The design and steps followed during the present study are depicted in Fig. 1.

2.1 Research Site

The present research was carried out in Karatoya River around Sadar upazila (sub-district) in Panchagarh district under Rangpur division, the northern Bangladesh. Karatoya River has an area of 6.0 km, and situated at 26°07´07″N and 88°45´33″E (Fig. 2). Panchagarh sadar upazila has different types of natural water resources, the partial view of which are given in Fig. 3.

2.2 Preparation of Interview Schedules

In order to collect data from different sources, a well-structured interview schedule was prepared. At first, a draft schedule was prepared on the basis of the research objectives before making the final one. It was then pretested to authenticate the consistency and accuracy. After the necessary adjustments, a final survey schedule was developed. In the present study, the standards applied to measure the efficacy of the marketing system of fish were as follows:

- Diversity of fishes
- Socio-economic conditions of fishermen
- Financial supports of fishermen
- Fishing gears
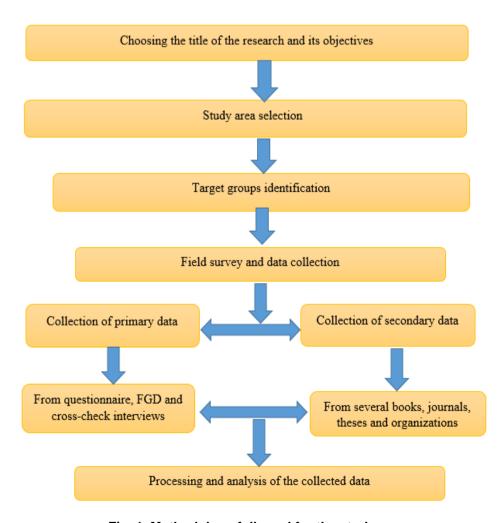- Problems encountered by the fishing communities

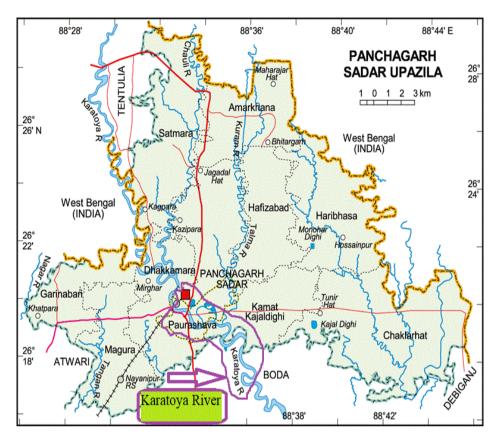**Fig. 1. Methodology followed for the study**

Fig. 2. Map and location of the study area in Karatoya River at Sadar upazila, Panchagarh district, Bangladesh
(Source: Google)

Fig. 3. Partial view of the study area at Sadar upazila in Panchagarh district

2.3 Data Collection Period

Different types of qualitative and quantitative data were collected from the Karatoya River through the field surveys for six (6) months between December, 2022 and June, 2023.

2.4 Target Groups

Sixty-five fishermen were randomly selected for data collection. All the fishermen were found to be lived nearer to the River Karatoya in Sadar upazila of Panchagarh district and captured fishes to supplement their family livelihood and income.

2.5 Data Collection

For data collection, a set of interview schedule was designed in this study. Both the open and close forms of questionnaire were designed for this study, and the required information were collected from various reliable sources. Three steps, viz., questionnaire interviews with the fishermen, FGD with the fishermen and cross-check interviews with the key informants were used during the data collection (Fig. 4).

2.6 Questionnaire Interview

Interviews with the questionnaire were conducted at the selected sites as well as other different suitable sites. Prior to start a real interview, the objectives of the research were explained to the fisher groups and guaranteed them that all the information will be kept in secret. The questionnaire was simple and inquired thoroughly for their easy understanding. The times necessary for each scheduled interview was not beyond than an hour.

2.6.1 Focus group discussion

During this study, Participatory Rural Appraisal (PRA) tool, viz., FGD (Focus Group Discussion) meeting was performed with the target group fishermen, where they discussed about the preferred aspects, viz., current fish culture techniques, problems associated with production of fish, socioeconomic conditions of fishers etc. In total, six (6) FGD group meetings was carried out, wherein each session was consisting of 6-10 fishers. All the FGD sessions were conducted on river banks, in the houses of fishermen, underneath large trees and in front of village-shops, where spontaneous assembly of peoples were observed (Fig. 5). The primary data, viz,

availability of fish, fishing gears and crafts were taken from the fish farmers, fishing groups and knowledgeable peoples.

2.6.2 Crosscheck interviews with key informers

Crosscheck interviews were performed with the key informers, viz., local leaders, teachers, District Fisheries Officer, Senior Upazila Fisheries Officer and related NGO employees, where evidences were inconsistent or asked for more evaluations. The key informers are specifically experienced persons on certain areas and are anticipated for being capable of answering the questions and quarries in a comparatively worthwhile manner.

2.7 Data Collection by Direct Observation

The data collected from the research site by the direct monitoring and observation were as follows:

➤ Species of fish captured.
➤ Various kinds of gears and crafts utilized.
➤ Several kinds of nets and associated fishing components used.

2.8 Problems Encountered during Data Collection

A number of difficulties were encountered by the fishing communities throughout the interview sessions. These were (but not limited to): fishermen were keeping so busy with fishing that they were not being able to talk, as they also afraid that the researchers are the Government Officials from the Tax or other Departments, data taken in traditional measuring units, linguistic difficulties etc. These difficulties were resolved by the researchers through providing additional care and conversation. Clarification of local terms and traditional units were received from the key informers through the crosscheck interviews.

2.9 Data Processing and Analyses

All the field-collected data were thoroughly checked to remove the errors and contradictions. Before entering the data in the computer, the traditional values were transformed into the international units. Initial data-sheets were compared with the original questionnaire and result-sheets to confirm the accurateness of the data entry. A Computerized Software (MS Excel 2023) were finally used to process and analyze the data.
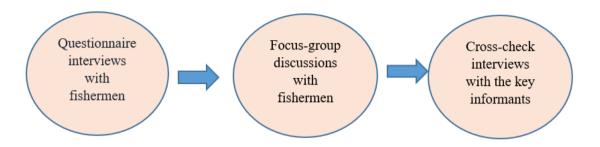
Fig. 4. Steps of data collection method

Fig. 5. Questionnaire interview and Focus Group Discussion (FGD) with a local fisherman in the study area

3. RESULTS

3.1 Fish Species Diversity

In total, 41 species of fishes belonging to 8 orders and 15 families were found in Karatoya River throughout the present study (Table 1 and Table 2). The Cypriniformes family was found to be the most dominant and leading order, comprising 50.6% of the total fish population by constituting major species abundance, and Siluriformes comprising 12.7% and Perciformes comprising 12%, constituted the 2nd and 3rd position in abundance, followed by Channiformes constituting 6.6%, Clupeiformes constituting 6.0%, Mastacembeliformes constituting 4.8% and Tetraodontifomres constituting 4.2% in this order (Fig. 6). The lowest abundance of species comprising 3.0% was enumerated for the order Beloniformes and only one species of fish was

found for each order throughout the entire investigations. Those were *Xenentodon cancila* and *Tetraodon cutcutio* belonged to the family Belonidae and Tetraodintidae, respectively (Fig. 6). The identified species availability during the study is summarized in Table 1, while order-wise fish diversity is given in Table 2.

3.2 Problems for Declining Fish Diversity

3.2.1 Declining of open water resources

The study area in the Karatoya River was found to be reduced gradually due to siltation and agricultural pollution. Human intervention due to construction of dams, roads etc. also reduced the area of open water, which was directly affect the fish diversity. As a result, production of fish from the water body that is captured fishery has been declined day by day.

Table 1. Fish species in Karatoya River

Order	Family	Sl. No.	Local name	Scientific name
Cypriniformes	Cyprinidae	1.	Katla	*Catla catla*
		2.	Rui	*Labeo rohita*
		3.	Mrigel	*Cirrhinus mrigala*
		4.	Grass carp	*Hypophthalmichthys molitrix*
		5.	Silver carp	*Ctenopharyngodon idella*
		6.	Kalibaus	*Labeo calbasu*
		7.	Punti	*Puntius sophore*
		8.	Sarpunti	*Puntius sarana*
		9.	Mola	*Amblypharyngodon mola*
		10.	Dhela	*Rohtee cotio*
		11.	Chela	*Salmostoma phula*
		12.	Nilotica	*Oreochromis niloticus*
		13.	Common	*Cyprinus carpiova*
		14.	carp	*Esomus danricus*
		15.	Darkina	*Cyprinus carpiovar.*
		16.	Miror carp	*Oreochromis mossambicus*
		17.	Tilapia	*Labeo bata*
		18.	Bata	*Aristichthys nobilis*
			Bighead carp	
Channiformes	Channidae	19.	Shol	*Channa striata*
		20.	Chang	*Channa orientalis*
		21.	Taki	*Channa punctatus*
Tenaodontiformes	Tetraodontidae	22.	Tepa, Potka	*Tetraodon cutcutio*
Beloniformes	Belonidae	23.	Kakila	*Xenentodon cancila*
Perciformes	Anabantidae	24.	Khalisha	*Colisa fasciata*
		25.	Lalkhalisha	*Colisa lalius*
		26.	Koi	*Anabas testudineus*
Perciformes	Centropomidae	27.	Chanda	*Chanda nama*
		28.	Lalchanda	*Chanda ranga*
Perciformes	Gobiidae	29.	Bele	*Glossogobius giuris*
Mastacembeliformes	Mastacembelidae	30.	Tara baim	*Macrognathus aculeatus*
		31.	Guchi baim	*Mastacembelus pancalus*
Clupiformes	Notopteridae	32.	Foli	*Notopteru notopterus*
		33.	Chital	*Notopterus chitala*
Clupiformes	Clupeidae	34.	Kaski	*Corica soborna*
Sliuriforme	Bagridae	35.	Gulsha	*Mystus cavasius*
		36.	Ayre	*Mystus aor*
Sliuriforme	Bagridae	37.	Tengra	*Mystus tengara*
Sliuriforme	Pangasiidae	38.	Pangus	*Pangasius sutchi*
Sliuriforme	Siluridae	39.	Boal	*Wallago attu*
Sliuriforme	Claridae	40.	Magur	*Clarius batrachus*
Sliuriforme	Heteropneustidae	41.	Shing	*Heteropneustes fossilis*

3.2.2 Over fishing

Excessive and indiscriminate harvest of fish had declined the sustainable fish population in the Karatoya River. Brood fish and fry were also taken unintentionally, which caused havoc to the fish biodiversity in this river ecosystem.

3.2.3 Management problem

There were no fish sanctuaries and no-take zones found in the study area for fish conservation and stock enhancement. Lack of credit facilities and training activities were also observed to be other causes for the decreasing trends of fish biodiversity and production in the Karatoya River.

3.3 Livelihood Conception

3.3.1 Age structure

The age of the fishermen in the research area was ranged between 22 and 65 years. They

were categorized into 4 age groups, viz., below 18 years, 18-30 years and above 50 years (Fig. 7) were considered to study the structures of their age. It seemed likely that among the age groups, 31-50 years aged fishermen were the highest (46%).

3.3.2 Religious status

The religious status of fishermen was investigated during the study and found that the Hindus fishermen featured the highest majority (70%), followed by the Muslims (30%) with no Buddhists or Christians (Fig. 8).

3.3.3 Family type and family size

Families are typically classified into two categories in the rural Bangladesh. These are: 1). Nuclear Family: consisting of married couples and children and 2). Joint Family: comprising of a group of people allied by bloods and laws. In the research aera, it had been observed that 60% families were joint family, while 40% families were nuclear (Fig. 9). During the field survey, family sizes of fishermen were classified as 2-4 members, 5-7 members and above 7 members. Throughout the period of investigation, 2-4 members constituted 20%, 5-7 members constituted 55% and above 7 constituted 25% of the total surveyed fishermen (Fig. 10).

3.3.4 Educational status

Education has been considered to be the most important determining factor towards maintaining the lifestyle and status in a society as well as facilitating economic mobilities. In our study area, the highest number of fishermen were illiterate (69%), followed by primary (18%), secondary (8%) and small portion of them were above secondary (5%) (Fig. 11).

Table 2. Order of fish in Karatoya River

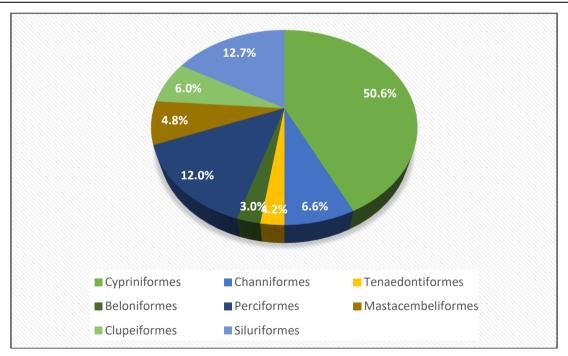| Day	Cyprinifor-mes	Sliurifor-mes	Percifor-mes	Channifor-mes	Clupifor-mes	Mastacem-beliformes	Tenaodon-tiformes	Belonifor-mes
1	17.0	3.0	3.0	2.0	2.0	2.0	1.0	1.0
2	16.0	4.0	4.0	2.0	1.0	1.0	2.0	1.0
3	18.0	7.0	5.0	3.0	4.0	2.0	1.0	1.0
4	17.0	3.0	5.0	3.0	1.0	2.0	2.0	1.0
5	16.0	4.0	3.0	1.0	2.0	1.0	1.0	1.0
Mean	16.8	4.2	4.0	2.2	2.0	1.6	1.4	1.0
%	50.6	12.7	12.0	6.6	6.0	4.8	4.2	3.0

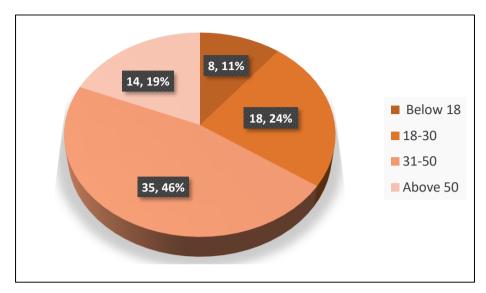**Fig. 6. Order of fish in Karatoya River**

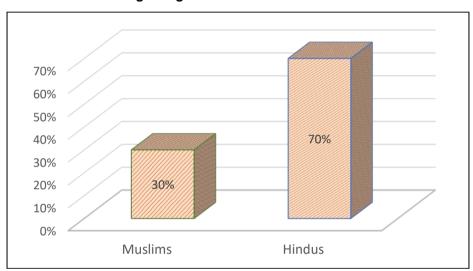**Fig. 7. Age distribution of fishermen**

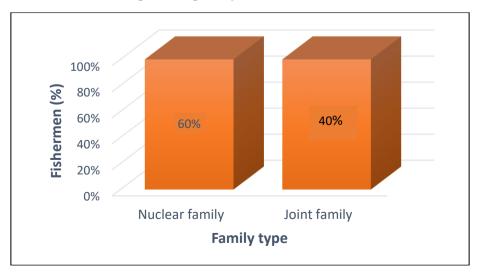**Fig. 8. Religious profile of fishermen**

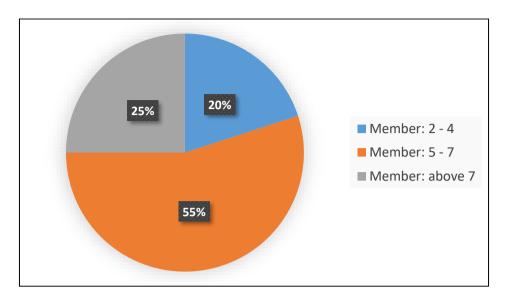**Fig. 9. Distribution of fishermen according to their family type**

Fig. 10. Classification of fishermen based on the sizes of their family
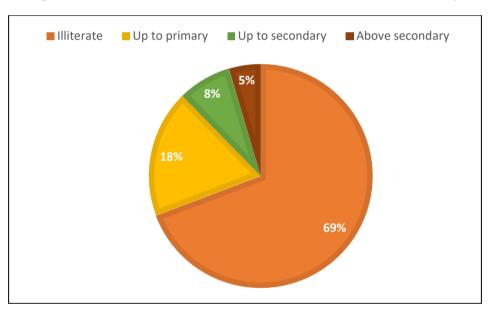

Fig. 11. Distribution of fishermen in the study area according to their educational status

3.4 Physical Properties Status

3.4.1 Housing conditions

The fishermen's housing conditions amid the research sites of Karatoya River were mainly of three types, viz., kaccha, pacca and semi-pacca. Housing conditions of the fishermen were found to be dominated by kaccha (66%), followed by semi pacca (23%) and pacca (11%) in this order (Fig. 12).

3.4.2 Drinking water facilities

It could be seen from Fig. 13 that all the households of the fishing communities (100%) used tube well water for drinking purpose.

However, amongst them, 75% fishers used own tube well, 20% used Government (shared) tube well and the lowest (5%) took drinking water from the tube well owned by their neighbors (Fig. 13).

3.4.3 Sanitary facilities

It was observed that 48% toilets in the research area were kaccha, 15% were semi-pacca, 5% were pacca, while 32% of the fishermen had no sanitary facilities (Fig. 14).

3.4.4 Health services

In the study area, the existing health services were classified into 4 groups such as Village quack doctors, Kabiraj (Ayurvedic physicians),

Upazila health complex and MBBS doctors. However, substantial numbers of fishermen were relied on Village doctors (60%), who really do not have any knowledges and experiences on medical treatments. Around 25% fishermen received health facilities from Ayurvedic kabiraj, 10% from Upazila health complex, and 5% from the outdoor chamber of MBBS doctors (Fig. 15).

3.4.5 Electricity conveniences

It was discovered that majority of the fishers (90%) in the research area had enjoyed the electricity conveniences, while only 10% of them did not have any electricity facilities in their houses (Fig. 16).

3.5 Financial Condition

3.5.1 Land assets

During this field survey, most of the fishermen were found to be very poor. The fishermen were divided into several groups based on the land ownership patterns. The highest number of fishermen were landless (39%), while 15% had 1-10 decimal lands, 18% had 11-20 decimal, 11% had 21-30 decimal 11% had 21-30 decimal, 14% had 31-40 decimal and the lowest (3%) fishermen had more than 40 decimal lands (Fig. 17).

3.5.2 Professional status

The results demonstrated that around 45% fishermen had been involved in fishing, 40% in agricultural activities, and 15% as day-to-day labour in the business of sands and rocks. (Fig. 18).

3.5.3 Income of fishermen

On the basis of yearly income, the fishermen were classified into 3 groups, then it was observed that 55% fishermen had yearly income of BDT 20000-30000, 25% had BDT 30001-40000 and 20% fishermen had more than BDT 40000 (Fig. 19).

3.5.4 Credit facilities

The organized poor fisher communities usually receive some sorts of credit facilities from the Government Organization (GO) and Non-government Organizations (NGOs) such as Bangladesh Rural Advancement Committee (BRAC) and Grameen Bank (GB) for the procurement of fishing crafts (small boats) and gears. In the area of present investigation, around 65% fishers did not require to get the credit money; however, 20% received credit facility from their relatives, whereas 35% obtained credit from several NGOs and 10% fishers took loan from Co-operatives for their fishing and fish marketing activities (Fig. 20).

3.6 Fishing Operations and Biodiversity Implications

3.6.1 Usage of gears in Karatoya River

Different kinds of gears were found to be used for catching fish in the Karatoya River at Panchagarh sadar upazila. Selection of various gear types were performed on the basis of: 1) Target species, 2) Water bodies, 3) Intensity of labors, 4) Costs, 5) Materials and Resource availability, and 6) Profits. For fishing operations, usually gill nets, lift nets, cast nets and spears were used in both days and nights. Nevertheless, the traps were found to be operated solely at night times, whereas seine nets and push nets were practiced at daytimes only. Moreover, lift nets and spears were found to be seasonal as well as operated during the wet season only.

3.6.2 Operation of nets

Various kinds of nets were operated by the fishermen for catching fishes from the study area. Both the quality of fiber and mesh size were equally crucial for operating the nets. During the current research, different types of nets were operated in the Karatoya River, the details of which are summarized in Table 3 and depicted in Fig. 21.

3.6.3 Operation of traps

Various kinds of traps have long been used for catching fish by the professional and non-professional fishermen in Bangladesh. Using these traps, only small fishes are caught by allowing them to enter into it, but prohibited to come out. These are generally made of bamboo-splits and tied strongly with ropes. During our investigation, numerous types of traps were observed to be used for catching fish in the Karatoya River, which are thoroughly described in Table 4 and depicted in (Fig. 22).
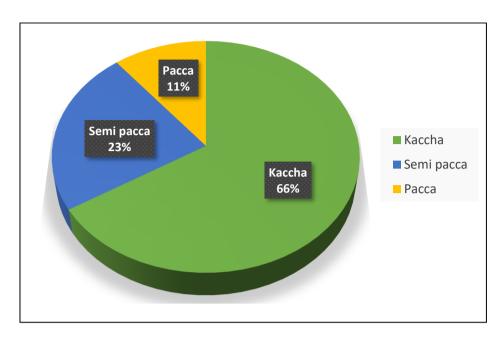
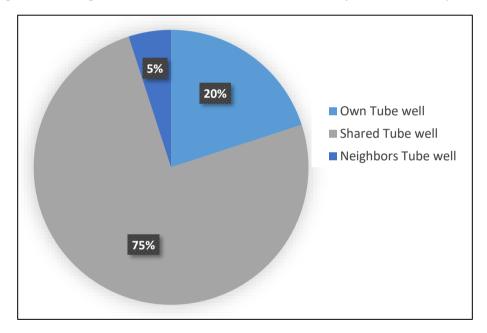**Fig. 12. Housing conditions of the fishermen in the study area of Karatoya River**

Fig. 13. Drinking water facilities of fishermen in the study area

3.6.4 Use of hooks and lines

Hooks and baits are the basic requirements for line-fishing. The rule in line-fishing is to provide actual or artificial baits to lure the targeted fishes, which are not being able to get release from the baits and afterwords, they are lifted from the waterbody. The metallic-hooks of different sizes and shapes are usually utilized for this fishing operation. Throughout the field survey, four kinds of lines and hooks were observed to be used by the fishing communities. Descriptions of the various types of lines and hooks are summarized in Table 5, and the pictures are shown in (Fig. 23).

4. DISCUSSION

Being a riverine country, Bangladesh is bestowed enough to have the vast open water resources and the richest species diversity. The country is also rich with aquatic biodiversity, encompassing around 260 species of freshwater

fishes (DoF, 2018). However, owing to the degrading and declining states of aquatic resources of wetlands, the inland capture fisheries have been reduced dramatically in the recently past decade (Zerin et al., 2023).

In total, 41 fish species belonging to 8 orders and 15 families were found in the Karatoya River throughout the research. Among the orders investigated, Cypriniformes was observed to be the foremost order comprising 50.6% of the whole fish populations, followed by Siluriformes (12.7%) and Perciformes (12.0%) in this order. On the other hand, Channiformes

constituting (6.6%), Clupeiformes (6.0%), Mastacembeliformes (4.8%), Tetradontiformes (4.2%) and Beloniformes were the least numerous orders constituting only 3.0% of the total fish population, which was similar to the study of (Joadder et al.,2021). Altogether, 80 different fish species belonging to the 9 orders and 24 families were found in the River Padma throughout their investigation, in which Cypriniformes was noticed to be the highest dominating order comprising 35% of the entire population of fish (Rahman et al., 2012). However, these values were greater than those obtained during our present investigation.
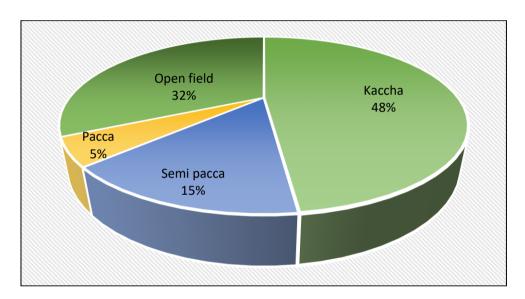

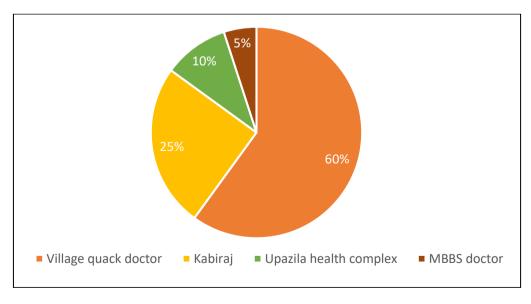**Fig. 14. Sanitary facilities of fishermen in the research area**

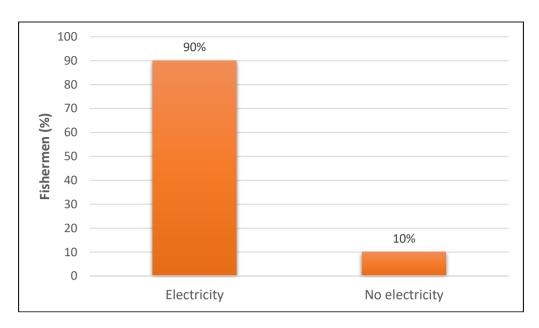**Fig. 15. Health services of the fishermen in the research area**

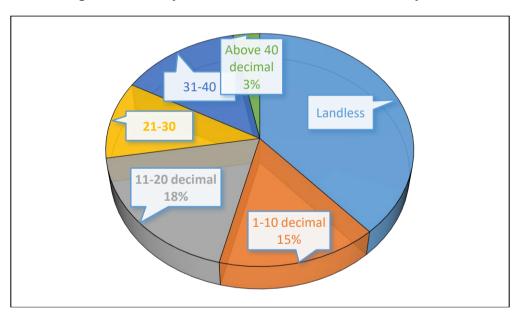**Fig. 16. Electricity facilities of the fishermen in the study area**

Fig. 17. Distribution of fishermen according to their land properties

The result revealed that that the biodiversity of fish was declining in Karatoya river due to natural and man-made hazards including habitat destruction, natural calamities, over-exploitation, unstrained fishing, insecticides, water contaminations and aquatic pollutions, outbreak of diseases, unrestrained inclusions of exotic fish species, demolition of spawning areas, sedimentation and siltation, frequent environmental alterations in natural ecosystems, and deficiency in appropriate management. While planning water resources development projects, comprehensive studies on different ecological aspects of fish species should be undertaken so that a meaningful understanding of the needs for fish and other aquatic animals emerges.

In the research area, the fishermen's age was ranged between 22 and 65 years and it appeared that 31-50 years aged fishermen were the highest (46%). The finding was dissimilar with Ahmed (1996) and Ahmed (1999), who stated that about 66% and 70% fishermen were below the age of 40 years in Tangail and coastal areas, respectively.
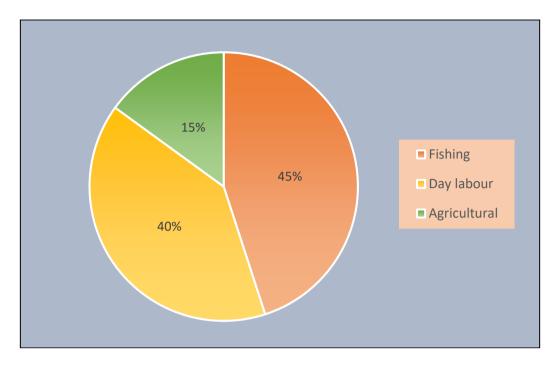
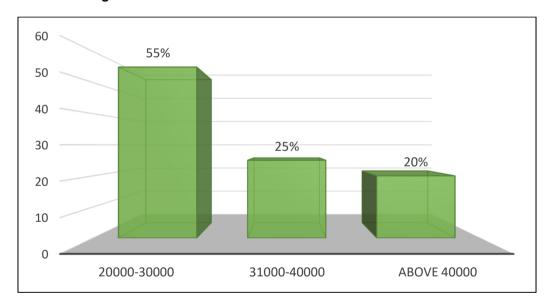**Fig. 18. Profession status of fishermen in the research area**

Fig. 19. Yearly income of fishermen in the study area

Religions perform the key functions of providing solidarity in the society or modify the social changes and also can play a vital role in the socio-economic-cultural activities of peoples in a certain area. In the area of our present work, it was observed that the Muslim fishermen were the highest majority (75%), followed by Hindus (25%), while no Christians and Buddhists were found. Similar results were also obtained by Joadder et al. (2021), who found that Hindus featured the highest majority (70%), followed by Muslims (30%) with no Buddhists or Christians in the other parts of Karatoya river in Panchagarh district. These results were relatively identical to those of our present research.

In this research area, we observed that the highest portion of families was joint family (60%), followed by nuclear family (40%). More or less similar findings were obtained by Uddin et al. (2021) during their studies in Kharingcha Baor at Chaugachha Upazilla, Jashore, Bangladesh. During the period of investigation, 2 to 4 members constituted 20%, 5 to 7 members

constituted 55% and above 7 constituted 25% of the total fishers investigated. During this survey work, the size of family was smaller than those were found in other places and societies of Bangladesh. Joadder et al. (2021) categorized the family sizes, such as: a) Small family (2-4 members), b) Medium family (5-7 members), and c) Large family (>7 members). They further reported that the constitutions of small, medium and large families were 20%, 50% and 30%, respectively, among the total fishermen surveyed accordingly. Similar results were also obtained during our present investigation.
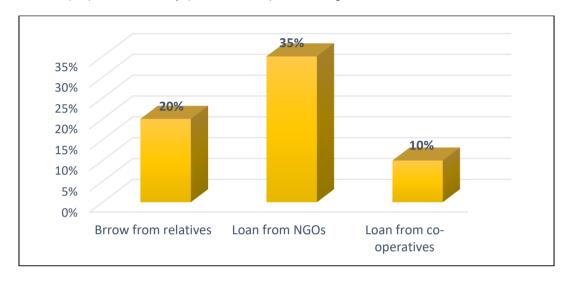

Fig. 20. Distribution of fishermen according to their credit access

Table 3. Various kinds of nets operated in the Karatoya River at Panchagarh upazila

Name of gears	Traditional Bengalee name	Use of the main gears and their types	Effects of gears on fish biodiversity
Cast net	Torajal, Jhakijal, Kheplajal	Old types and the commonly used net throughout Bangladesh, used by a people from the banks, in shallow waterbodies or in the open waterbodies from the boats.	Low: Generally, not harmful for fish and their biodiversity conservation.
Gill net	Fashjal, Patajal, Current jal	Usually monofilament nets; highly operational in harvesting small fishes	High: Used very often and highly detrimental in maintaining fish diversity.
Seine net	Jagatberjal, Berjal, Katha berjal	Large number of fishes are harvested by this net compared to other basic methods. Mesh size of seine nets can be big, intermediate or too small.	High / Moderate: Impacts depend upon the mesh sizes. Seine nets with small mesh size are severely detrimental compared to the nets with small mesh.
Push net	Thelajal, Dharmojal	Smaller nets are usually mounted by supporting ropes on triangular bamboo frames. Mostly operated in the dry and late monsoons.	Moderate: Destructive throughout the post-breeding seasons.

Toira jal

Jhaki jal

Thela jal

Kochal jal

Fig. 21. Various kinds of nets operated for fishing in the River Karatoya around Panchagarh sadar upazila

Table 4. Various kinds of traps operated in Karatoya River in Panchagarh sadar upazila

Name of Traps	Physical structure and using materials	Common caught species	Impact on Biodiversity
Jhupi	Bell shaped, made of spilt bamboo	Mainly caught large species of fishes	Low: generally, not harmful
Polo	Bell shaped, made of spilt bamboo	Mainly caught large species of fishes	Low: generally, not harmful
Dohair	Basket shaped made of spilt bamboo with two or three traps door	Punti, Mola, Tengra Taki	Low: generally, not harmful

Jhupi   Polo   Dohair

Fig. 22. Various kinds of traps operated for catching fish from Karotoya River

Table 5. Various kinds of lines and hooks operated for catching fish in Karatoya River

Types of gear	Names of gear	Number of hooks	Common species caught
Hook and line	Daunbarshi	5-50	Bele, Boal, Shol, Gojar, Taki etc.
	Chip barshi	1-2	Rui, Catla, Tilapia, Puti, Tengra etc.
	Wheel barshi and Patabarshi	1-2 1-2	Boal, Foli, Chital, Pabda Magur etc.

Chip Barshi   **Patabarshi**
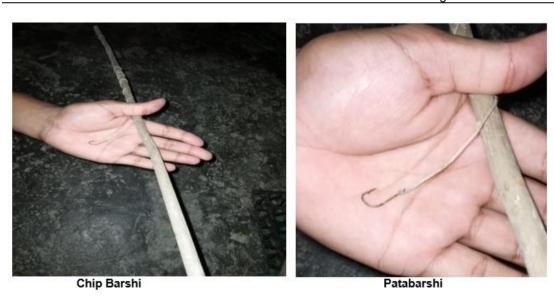
Fig. 23. Various kinds of lines and hooks operated for catching fish in the research area

During the present research, the highest proportion of fishermen were found to be illiterate (69%), followed by primary (18%), secondary (8%) and the lowest position of them were above the secondary level (5%). This was similar with the finding of Joadder et al. (2021) in Karatoya river at Debiganj upazila in Panchadarh district. Also, the finding was relatively identical with Uddin et al. (2020) who found that most of the fishermen were illiterate (48%), 32% could be

able to make sign only, 13% had up to primary level education, and the lowest (7%) was up to the secondary level education in Gomti river.

Housing was found to be dominated by kaccha (66%), followed by semi pacca (23%) and pacca (11%). Abdullah-Bin-Farid et al. (2013) found in their study that housing condition was dominated by kaccha (74%), whereas Kabir et al. (2013) observed that most of the fishermen (83%) in the Old Brahmaputra River had kaccha house, while 17% of them had semi-pakka house.

During the present study, it was observed that all the fishermen households (100%) utilized the tube-well water for drinking purposes and among them, 75% households had utilized their own tube-well, 20% utilized government tube-well and the remaining households (5%) took the drinking water from their neighbor's tube-wells. Similar results were obtained by Joadder et al. (2021), while they were conducting the field survey research in Karatoya River at Debiganj upazila in Panchadarh district. Islam (2012) worked in Tangon River and also observed that 100% of the fishers' community had utilized tube-well water for drinking, which is strongly supported by the findings of our present research.

The sanitary situations of the fishing communities were observed to be too bad. The fishermen used four kinds of toilets such as kaccha, semi-kaccha, open field and pacca. The present findings revealed that among the toilets, 48% were kaccha, 15% were semi-pacca, 5% were pacca and 32% of the fishers did not have any sanitary opportunities. The finding was dissimilar with Joadder et al. (2021), who found in their study that 62% of the toilets were kacha, 23% were semi pacca, while 15% of the fishermen did not have any sanitary facilities. No pacca sanitation system was used by the fishermen in Karatoya River at Debigonj Upazila in Panchadarh District. This finding was also dissimilar with Islam (2009), who reported that 7.5% fishers had constructed toilets, 42.5% had semi-constructed ones and 50% had non-constructed toilets in the River Kali.

Majority of fishermen in the research area had health facilities. However, a substantial portion of fishers (60%) had depended on Village-doctors, who really do not have any scientific knowledge and experiences on medical treatments. Around 25% fishermen received health-related services from Village-kabiraj, 10% from Upazila Health Complex, while a few (5%) took health -benefits from the experienced MBBS doctors. Pravakar et al. (2013) stated that health services of the fishing community at Shahrasti Upazila were not good, and around 70% fishers were solely reliant on Village-doctors, whereas 20% and 10% of them received health services from Upazila Health Complex and MBBS doctors in this order.

Almost all the fishers (90%) in the Karatoya River had access to electricity facility. The same finding was obtained by Momotaz (2009), where 90% fishers did have electricity facilities, while 10% of them had no such conveniences at the 3 Villages, viz., Jamaira, Garakhola and Chatiani in Phultula Upazila, Khulna. Shamima (2000) reported that only 20% of the fishing community got electricity facilities in the Gallamari area of Khulna.

Inside the research area, most of the fishing communities were found to be below the level of subsistence and among them, 39% were landless, while 15% possessed 1-10 decimal (dec.) lands, 18% possessed 11-20 dec., 11% possessed 21-30 dec., 14% possessed 31-40 dec., while the only 3% fishers had above 40 dec. lands. Generally, the fishermen who did not have any lands were found to live on the Khas (Government) land as their income was so low to purchase the land. The finding was dissimilar with Joadder et al. (2021), who found in their study that 45% fishermen possessed 1-10 dec. lands, whereas 5% of them had no lands, 17.5% possessed 11-20 dec., 12.5% possessed 21-30 dec., 5% possessed 31-30 dec., and 15% possessed above 40 dec. lands. Islam et al. (2013) found 2% of the fishermen was landless, however, those who possessed the lands, had an area of 0.02 to 1.57 ha at Monirampur Upazila in Jashore District, Bangladesh.

The findings exposed that majority of the fishermen (45%) were actively involved in fishing activities, 40% in agriculture, while 15% were engaged in sand business as daily labors. The finding was dissimilar with Joadder et al. (2021), who found in their study that 45% of fishermen were engaged in fishing, 40% in agriculture and 15% in sand business as daily labors in the Karatoya River at Debiganj upazila in Panchadarh district, Bangladesh. Rahman et al. (2015) reported that around 76% of the fishermen in Talma River was engaged in fishing activities as their prime job, 16% in agriculture, and 8% was involved as day-to-day labour.

Based on the annual income, the fishermen were classified into 4 groups and the results revealed that 55% of the fishers had annual income between BDT 20,000 and 30,000, 25% had BDT 30,001-40,000 and only 20% fishers had above BDT 40,000. The finding was similar with Joadder et al. (2013), who observed in their study that 50% fishermen had annual income from BDT 20,000 to 30,000, 20% had income from BDT 30,001 to 40,000 and 12.5% had annual income of above BDT 50,0000. Kabir et al. (2013) reported that around 60% of the fishing communities had the annual income from BDT 24,000 to 35,000 and 30% fishermen had annual income between BDT 35,000 and 45,000 around the study site of the River Old Brahmaputra.

Among the fishermen, about 65% of them did not require to lend money for their fishing activities, while 20% borrowed money from their friends and relatives, 35% from NGOs, and 10% from some cooperatives. Kabir at el. (2013) found that around 40% fiashers were self-solvent and thus, no monetary assistance was required, however, around 14% of them borrowed money from neighbors, 18% from relatives, 22% from NGOs as well as 6% from cooperatives for their fishing activities around the research area of the Old Brahmaputra River system.

During our present investigation, various kinds of fishing gear were found to operate in the Karatoya River. However, the types of gears were differed based on the fish species targeted, types of waterbodies, intensities of labors, costs, availabilities of materials and profits. The gears such as cast, lift and gill nets, and spears were used for fishing at days and nights. Nevertheless, traps were operated at night only, whereas seine and push nets were operated solely at daytimes. However, the usages of lift nets and spear units were seasonal as well as restricted to the wet seasons only. The finding was similar to Joadder et al. (2021), who observed that various kinds of gears were operated in both day and night times for catching fish in Karatoya River at Debiganj upazila in Panchadarh district, Bangladesh.

During the present study, many kinds of traps, lines and hooks were used by the fishermen in the River Karatoya. This finding was similar with Joadder et al. (2021), who found that many types of traps were used for fishing. Afroze (2014) found that around 93.3% fishermen had operated boats, while only 6.7% used jhaki jal thela jal, and chai without boats for catching fish. In addition, they also used tuni jal as well as various kinds of traps, bairs, hooks and lines. Ali (2013) found eight types of fishing gear, which were used by the fishermen in the Atrai River. These were jhaki jal, ber jal, current jal, thella jal, khara jal, daun, bair, and borshi. In his study, Islam (2012) mentioned that 8 kinds of gears including current jal, jhaki jal, ber jal, thela jal, khara jal, chandi bar, other bairs and borshi were operated for fishing in the River Tangon, situated at the northwest part of Bangladesh.

5. CONCLUSION

Ecologically, Karatoya River is highly productive in our country. Comparing the present research with the past research findings, it can be concluded that the fisheries diversity of Karatoya River at Panchagarh upazila was undergoing critical stage than earlier time. The present socio-economic condition of this river was not satisfactory. Most of the peoples around the river were poor and solely depended on fishing for their livelihood. However, improved and appropriate actions from both the Government and Non-government Organizations might come forward towards the speedy advancement of the socioeconomic situations in the study area. Nevertheless, the current research could afford a vital starting point towards the biodiversity conservation, sustainable management and effective utilization, of the fisheries resources. Utilization of appropriate fishing gears and crafts would not only facilitate to reduce the IUU (Illegal, Unprotected and Unregulated) fishing but could help to safeguard the target-species, thus, decrease the losses of fish diversity to a greater extent.

DISCLAIMER(ARTIFICIAL INTELLIEGENCE)

We, the authors are hereby declaring that no propagative AI-technology, viz., Large Language Models (ChatGPT, Gemini, Copilot etc.) and Text-to-image Generators have been used throughout preparing and editing this article.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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