Assessment of fishing gear efficiency, species diversity, and socioeconomic impacts on fishermen along the Jamuna River, Bangladesh

Syed Ariful Haque [1,*], Saud M. Al Jufaili [2], Md. Sabit Hasan[3], Asma Jaman[4], Md. Fakhrul Islam[5]

[1,2] Department of Marine Science and Fisheries, Sultan Qaboos University, P.O Box 34, Al-khood 123, Muscat, Oman. https://orcid.org/0000-0002-2378-2995[1], https://orcid.org/0000-0002-0930-5754[2]
[1,3,5]Department of Fisheries, Bangamata Sheikh Fojilatunnesa Mujib Science and Technology University, Melandah, Jamalpur-2012, Bangladesh. https://orcid.org/0000-0001-6076-2312[3]
[4]Bangladesh Fisheries Research Institute, Mymensingh-2201, Bangladesh. https://orcid.org/0000-0001-5681-6023[4]
[5]Institute of Hydrobiology, Chinese Academy of Sciences, Wuhan, China.
[5]University of Chinese Academy of Sciences, Beijing, China. https://orcid.org/0000-0002-0059-4967[5]

***Corresponding Author:** Syed Ariful Haque
Department of Marine Science and Fisheries, Sultan Qaboos University, Al-khood 123, Muscat, Oman
E-mail addresses: s143174@student.squ.edu.om ; sahaque@bsfmstu.ac.bd

Acceptance Date: 02/01/2024 **Published Date:** 08/01/2024

Abstract
The Jamuna River in Bangladesh is a vital source of freshwater aquatic resources and a natural breeding habitat for freshwater fish. However, recent declines in gear efficiency and species variety have significantly impacted the economic situation of fishermen. A study was conducted on 117 fishermen in Sariakandi upazilla, Bogra district, Bangladesh, from July 2022 to June 2023. The data was collected through direct visits, group discussions, and in-person interviews. The study identified 18 fishing gears and found that the seine net was the most effective gear for 8 months, with Cypriniformes being the most dominant fish order. The highest species abundance was recorded in September, while the lowest was in February. Only two types of fishing crafts were recorded during this period. The socioeconomic conditions of the fishermen were documented, with 71% being professionals and the rest being occasional. Most were over 40 years old, experienced, and had a large family. Their homes were kacha dwellings, with only 6% missing sanitary facilities and 76% using kacha latrines. Annual earnings ranged from 12500 to 169000 Tk, with 41% relying primarily on fishing and the remainder on other activities. A total of 59% of the fishermen borrowed loans from non-governmental organizations. This study shows that diminishing species diversity and total catch significantly impact fishermen's socioeconomic conditions. The government should take proper steps to protect the natural ecosystem of the Jamuna River and enhance the living needs of fishing communities in the study area.

Keywords: Fishing gears, Fishing crafts, Species abundance, Socioeconomic status, Jamuna river

1. Introduction

Bangladesh is a riverine country with various types of rivers running through it. Bangladesh is the world's third-largest producer of freshwater fish (FAO, 2018). Rivers are vital in the lives of people in a country, particularly fishermen. The fish industry is valued for its ability to generate low-cost protein, jobs, food safety, export earnings, and societal progress. Bangladesh has 250 to 266 freshwater fish species (Rahman 2005; Siddiqui 2007). The total fish production in the fiscal year 2021-22 is 4.759 Million MT, with the Jamuna River contributing 6202 MT (DoF, 2022). Rivers contribute significantly to Bangladesh's fishing economy. In the 2020-21 fiscal year, the GDP growth of the fisheries sector is 2.08%, while the whole agriculture sector is 21.83% (DoF, 2022).

Bangladesh is a riverine country. It possesses a huge number of fishing resources and fish are caught from different sources (Haque et al., 2021). Bangladesh's major rivers include the Padma, Meghna, Jamuna, and Brahmaputra. The Jamuna River exhibits a dynamic environment with diverse fish species and incredible biodiversity. The Jamuna River is important in Bangladesh due to its abundant and rich aquatic biodiversity (Haque et al., 2023). Bangladesh's largest sand-bed meandering river flows from north to south throughout the country (Rahman, M. R., 2023). This river has a significant contribution to the economy of Bangladesh. Mondol et al. (2015) discovered 49 fish species in this river, representing 8 orders and 8 families. Despite this river being a suitable breeding habitat for freshwater fish, the diversity of fish in Bangladesh's environment has rapidly decreased in recent years (Haque et al., 2023).

The river's natural breeding ground has been diminished due to harmful fishing gear, illegal activities, and overfishing. There used to be a diverse range of fish in the river, but natural and anthropogenic influences have drastically reduced

fish availability (Rahman et al., 2014). Various fishing gears are used to catch fish in the Jamuna River. In general, freshwater fishing in Bangladesh employs seine nets, gill nets, cast nets, lift nets, fixed nets, dragged nets, hooks and lines, and various types of traps. In different parts of Bangladesh, several types of fishing vessels are employed. The variety and use of fishing gear may have a substantial impact on fish population sustainability as well as fisheries effectiveness. The Jamuna River has two types of fishing vessels: non-engine and engine. Selectivity of gear and species is critical for effective fishing.

River fishing relies heavily on the economic and social stability of its fishermen. Income, lifestyle, and ease of access to resources and markets are all considered. The economic and social stability of these people and their families is frequently strongly related to the resilience and long-term survival of the river's fish population. Livelihood encompasses several essential attributes pertaining to individuals who are directly connected to their sources of income, earning patterns, and occupations, which are influenced by factors such as age, health, education, assets, technical considerations, food and nutrition, sanitation, access to credit, and affiliation with social organizations. The fishing industry in Bangladesh has a substantial impact on the livelihoods of its citizens through the provision of sustenance, the generation of employment opportunities, and the age of foreign exchange revenues. Many riverine fishermen rely heavily on the Jamuna River fisheries for their subsistence and livelihood. However, the current crisis of declining fish populations and species has a devastating effect on fishermen. Currently, Bangladeshi fishermen are among the most vulnerable people in the world. The majority of fishermen are impoverished and cannot access the available services. They are impoverished by any measure, and the fishermen's financial situation has deteriorated over time (Siddiq et al., 2013).

Several studies were conducted based on specific objectives in different rivers of Bangladesh. Some researchers focused on fish biodiversity studies, while others conducted fishing gear surveys and socioeconomic studies in different parts of Bangladesh. Saha et al. (2022) investigated the relationship between salinity and fish diversity in the Meghna River; Islam et al. (2021) studied the socioeconomic status of fisher communities in Dengar beel; Islam et al. (2015) focused on the status and current implications of fish diversity in the Payra river; the selectivity of fishing gear and its impact on the diversity of fisheries in the Rabnabad channel of Patuakhali were investigated by Rahman et al. (2015); Siddiq et al. (2013) studied on fishing gears of the Meghna river estuary of Chandpur region; Sayeed et al. (2014) evaluated the fishing gear efficiency in Chalan Beel; Mohsin et al. (2014) studied fish fauna on the Andharmanik river.

Different studies are conducted on the Jamuna River based on specific objectives and regions. Haque et al. (2023) studied seasonal fish diversity in the Jamuna River; Paul et al. (2021) focused on fish biodiversity and conservation status in the Jamuna River; Rahmatullah et al. (2015) studied the socioeconomic study of the Jamuna River under Jamalpur district; Rahman et al. (2014) investigated on a socioeconomic survey of Jamuna river under Shirajgonj district. However, there are no specific studies on fishing gear's impact on annual species abundance, and no research has been conducted yet on the socioeconomic status of fishermen in the Sariakandi region, Bogura district, Bangladesh. Further, it is probably the first combined study on fishing gears and crafts study, species abundance, total catch, and socioeconomic status of the fisher's community in any region of Bangladesh.

Therefore, it is crucial to underline the need for more profound research in this region for policymakers to give attention to ensuring sustainable fishing and improving the living standards of the fishing community. For this, our study aims to assess the fishing gear impact, current status of species distribution, total fish catch and socioeconomic conditions of the fisher's community in the Jamuna river at Sarikandi region, Bogura district, Bangladesh.

2. Materials and Methods

2.1. Study area and duration

The study was conducted in Kalitola Ghat (Station 1), Mothurapara Ghat (Station 2), and Kutubpur Bazar (Station 3) in the Sariakandi region, in the district of Bogura, Bangladesh (Fig.1). The data on fishing gear, fishing craft, species abundance, total catch and socioeconomic conditions of fisher communities in the Jamuna river were collected from July 2022 to June 2023.

2.2. Data Collection

This study was conducted using a combination of primary and secondary sources of information. Prior to collecting primary data, a prototype questionnaire was developed and pre-tested with a small group of fishermen, with information added or rejected as needed (Hossain et al., 2015). The final questionnaire was improved, rearranged, and adjusted in light of the insights gained through pre-testing. All fishing gear, crafts, and fish species data were collected directly from the fishermen at the fishing spots or their houses. For identifying the socioeconomic status of fishermen in the study area, the final questionnaire included questions about occupational status, age, fishing experience, educational status, family size, housing condition, health facilities, sanitary facilities, annual income, alternative occupations, and credit facilities. Primary data from 117 fishermen were collected using questionnaires, interviews, and Rural Appraisal (PRA) procedures such as Focus Group Discussions (FGD) and Crosscheck Interviews (CI) with key informants. The fishermen were interviewed at their houses or fishing spots (Bhuyan and Islam et al., 2016).

2.3. Fish Sampling
Fish caught by different fishing gears from specific locations by local fishermen were identified and counted. The fish species were identified based on their morphometric and meristic traits, according to Quddus et al. (1988), Talwar and Jhingran (1991), and Rahman (2005).

2.4. Fishing gear survey
In-person interviews with fishermen were used to compile data on fishing gear, such as mesh size, length, width, and construction costs. According to Ahmed (1971), fishing gear was put into several main groups.

2.5. Data Analysis
All of the acquired data was coded, inputted, and subjected to analysis using Microsoft Excel 2019. The data was then presented in textual, tabular, and graphical formats to assist readers in understanding the fish population, fishing methods, and current economic status of the fishermen in the research area.

3. Results
3.1. Fishing gear survey
Different fishing gears are used in the Jamuna River to catch fish and other related aquatic organisms. In this survey, we identified 18 fishing gears from 3 groups: nets, wounding gears and traps. There were 13 types of fishing nets, which consist of 6 types (Table 1) such as seine nets (Ber Jal, Kochal Jal, Ghurni ber Jal), gill nets (Current Jal, Fash Jal, Okal Jal, Sursuri Jal), dragged net (Thela Jal, Moi Jal), cast Net (Jhaki Jal), lift Net (Dharma Jal), fixed Net (Panti Jal, China Jal), etc. Maximum (25-30 cm) and minimum (0.5 cm) mesh sizes were found in the case of Fash Jal, Okal Jal, and Ber Jal, Kochal Jal under the groups of gill and seine net, respectively. The highest construction cost was observed for Fash Jal (100000-150000 BDT/net), and the lowest was for Thela Jal (200-500 BDT/net). The study location identified 2 types of wounding gears, Borshi ,Hazari borshi, and 3 types of traps, Darke, Kate, and Polo (Table 1).

A total of 47 species were recorded during the harvesting of 3 major groups of fishing gears, consisting of 18 types of gear in the study locations. The fish species caught per gear per day varies from one to another gear. The highest number of species are caught by the seine nets group, whereas the lowest by traps. Among all the types of gear, 37 species were caught by Kochal Jal, which was the highest individually (Table 2). However, only 1 species were caught by Kate in the study locations.

The Seine net demonstrates the most effective fishing gear year-round (Fig.2). It was the most productive in total catch. It captured the widest range of species and yielded over 30% of the total catch. Traps were the least productive in terms of species diversity as well as annual catch. With 38 species captured, the Seine net had the most significant yearly catch at 1196 kg. Gill net comes next, catching 21 species annually with a yield of 661 kg. With 11 species, Dragged Net produced 346 kg of fish annually. The 14 species were collected annually with a catch of 441 kg, by Cast Net. With 10 species, Lift Net produced 315 kg of fish annually. Fixed Net had an annual yield of 409 kg, and were 13 different species. The 14 species captured using hooks and lines have a catching of fish 441 kg annually, equivalent to cast nets. With 9 species captured and 283 kg of catch annually, traps have the most negligible impact.

3.2. Species distribution
Throughout the observation period, 47 fish species belonging to 9 orders (Fig.3) and 20 families (Fig.4) from the three selected stations were recorded. Among the orders, Cypriniformes was the most abundant, accounting for 36.17 % of all species. Siluriformes constituted 25.53 % of all fish species. With a ratio of 17.02%, Perciformes was likewise well represented. More moderate levels of representation were found in the orders Synbranchiformes and Clupeiformes (6.38% and 4.26 %, respectively). Osteoglossiformes had the same frequency as Clupeiformes, at 4.26 %. The families of Anguilliformes, Decapoda, and Tetraodontiformes accounted for 2.13 % of the total, making them the least common. Cypriniformes, Siluriformes, and Perciformes were the most frequent or abundant orders in the stated locations. In contrast, the other orders were less common or had fewer species overall.

The family Cyprinidae, which has 29.79% of the species, had the highest representation among the families (Fig.4). The Ophichthidae, Gobiidae, Ambassidae, Nandidae, Belonidae, Siluridae, Pangasiidae, Synbranchidae, Palaemonidae, and Tetraodontidae families all shared the lowest proportion (2.13%). The families Cobitidae, Channidae, Bagridae, and Schilbeidae comprised 6.38 % of the total. The Clupeidae and Notopteridae each accounted for 4.26 % of families. Most listed families have fewer than 10% of the species, showing a relatively uniform distribution.

3.3. Total catch and species abundance
The month-wise fish catch of 3 sampling sites of the Jamuna River was recorded using survey techniques. A total of 4093 kg of fish was caught annually by combining all fishing gears; the entire species were 47. Among the species, the highest 42 number of fish species were found in September, where the total catch was 550 kg/year (Fig.5). The most significant

abundances of both species and total yield in September suggest that this month occurred with a period of high production or seasonal abundance in the ecosystem. The lowest abundances of both species (25) and catch (155) were observed in May, indicating the lowest and lowest productivity in the selected locations. The Jamuna River fluctuates all year long, reaching its maximum levels during the monsoon season (which in this location is usually from August to September). Towards the end of the dry season, which typically lasts from March to June, are the lowest levels. The river's ecology may be impacted by seasonal variations, which could lead to this pattern. Further, overfishing, harvesting brood fishes, and catching all sizes and types of fish reduce fish abundance in the Jamuna River. Highways, dams, barriers, and human settlements block migratory pathways and harm the ecosystem of the Jamuna River.

3.4 Fishing Craft

Different types of fishing crafts are used in Bangladesh. In the Jamuna River, we recorded two types of fishing crafts during the study period: Dinghi Nauka and Trawler. The dinghies are comparatively small boats with round bottoms. The fore and find parts of boats are high above the water level. The stern and bow are long and pointed. Its dimensions are 6 to 9 m long, 2.5 to 3 m wide, and 1.5 to 2.5 m tall. This boat's construction will cost between 12,000 to 22,000 BDT (Table 3). The boat's front and back parts are elevated above the water. Stern and bow parts are long and pointed. Smaller boats have no deck, but larger ones typically have one. When the deck is present, the hood is generally absent and situated in the back of the boat. Most dinghies do not carry a sail, but if one is used, it is encouraged by bamboo poles that are joined diagonally and are composed of relatively thin material.

A trawler is a more powerful mechanized boat than a boat. This boat's construction cost is between 30,000 and 60,000 BDT. This boat is 10 to 13 meters long, 3.5 to 5 meters wide, and 3 to 4 meters in height (Table 3). Either flat or pubescent shapes can be found at the bottom. This style of boat is typically used for fishing by 8 to 10 fishermen. It is employed in long-haul and distance fishing. Different types of nets are used in this craft.

3.5 Socioeconomic status of fishermen

For the livelihood characteristics of the fishermen, an in-depth evaluation was made on the subsequent parameters and provided in the following segments.

3.5.1 Occupational Status

In our present study, 76.07% of fishermen were engaged in fishing as professionals, whereas 23.93% were occasional fishermen. It depends on the season and fish availability.

3.5.2 Fishermen Age

Different classes of age groups below 20, 20-29, 30-39, 40-49, 50-59, and above 60 were considered to have a look at the age structure. In our present study, the highest 33.33 % of fishermen are aged 40-49 (Fig. 7).

3.5.3 Fishing Experience

Based on their fishing experience, fishermen were divided into 3 classes: 0-10 years, 11-20 years, and >20. 41% of fishers had fishing experiences of 11- 20 years (Fig. 8).

3.5.4 Educational condition

In the current study, the fishermen were divided into 4 groups based primarily on their level of education (Fig. 9). The majority of the fishermen were illiterate (29%), followed by those with primary level education (35%), those with secondary education (24%) and those with only a small amount of higher secondary education (12%). Most fishermen were uneducated and had to depend on fishing as a source of income from a young age due to their parents' financial circumstances.

3.5.5 Family pattern

There were different types of family patterns. Four of these groups of family members had undergone research (Fig. 10). Only 11.96% of families had more than 10 members. The majority of households only had (41.03%) members 4-5, (17.95%) members 6–9, and (29.06%) members under 4 (small family).

3.5.6 Housing condition

The housing circumstances of the fishermen are proven in this study (Fig.11). Most of the fishermen had tin shed houses (59%) (walls and floors constructed with cement and bricks and roofs with tin). Only 18 % of the fishermen's houses were semi-paka, 23% used kacha, and 0% used Paka houses. Most of the Kacha houses were made of wood straw, bamboo, jute sticks, etc.

3.5.7 Health amenities

The health facilities of the fishermen were not satisfactory. Fishermen face fitness issues; initially, most of them go to the village medical doctor (64.10 %) and Kobiraj (11.97 %). If the inconvenience is excessive, they visit the Upazila health complex (23.93 %) (Fig. 12).

3.5.8 Sanitary Convenience

The sanitary circumstances of the fishermen in the studied location were impoverished. The lavatories used by the fishermen had been dominated by 76% Kacha (made of bamboo with leaf and inadequate drainage system) and 18 % semi-paka (made of tin or wood with an inadequate drainage system). Only 6 % of fishermen had no sanitary facilities (Fig 13).

3.5.9 Annual earnings

Earnings are the most important factor in determining the socioeconomic position of a fisherman. Fishermen's average yearly earnings ranged from BDT 125000 to BDT 169000 (Fig. 14). The fishermen's wages were poor. The fisherman was in a challenging situation due to the BDT irritation. These professions were compelled to quite due to the severe economic crisis.

3.5.10 Substitutional income sources

In the study area, fishermen were involved in other income sources besides fishing due to the economic crisis. Only 41 % of fishermen depended solely on fishing (Fig 15). In the present situation, they can't address the increase in charge of each day's essential commodity, so they are involved in secondary occupations like fishing and agriculture (35%), fishing and day labour (18%), and others (6%), etc. (Fig 15).

3.5.11 Lend facilities

The fishermen of the study area obtained loans from distinct NGOs (ASHA, GRAMEEN BANK, and BRAC), neighbors, and relatives for buying fishing equipments and boats. According to our findings, 59% of fishermen received loans from NGOs, 18% didn't get hold of loans, 13% acquired loans from neighbors, and 10% received loans from relatives (Fig. 16).

4. Discussion

4.1 Fishing gear

Fishing gear is the leading equipment for catching fish. Generally, fishing gear is equipment for capturing aquatic resources, mainly fish (Rahman et al., 2016). A total of 18 types of fishing gear, which were divided into 3 major categories, were identified from 3 locations: 3 seine nets, 4 gill nets, 2 dragged nets, 1 cast net, 1 lift net, 2 fixed nets, 2 wounding gears and 3 traps. However, Islam et al. (2015) identified just 12 varieties of fishing gear from the Rupsha River, which were divided into four categories: fish nets, fish traps, hook and line, and wounded gear. Islam et al. (2016) identified 11 types of fishing nets under 5 significant groups: gill net, dragged Net, cast net, hook and line, and seine net. The maximum and minimum mesh sizes were 25-30 cm for Fash jal and Okla jal and 0.5 cm for Ber/kochal/china jal, which is more or less similar to Rahman et al. (2015). Islam et al. (2016) found 10 species were caught by Ber Jal, 3 by Moiya Jal, 5 by Thela Jal, 7 by Jhaki Jal, 7 by Barshi, and 3 by Hazari Barshi, which is more or less similar to the present study. Sultana et al. (2016) identified 18 different kinds of gear, including 5 gill nets, 1 seine, 2 fixed purse nets, 1 lift net, 1 cast net, 2 push/drag nets, 2 traps, 2 hooks and lines, and 2 wounding gears. A total number of 19 fishing gears were documented in the Old Brahmaputra River, Mymensingh, where the Seine net exhibited the maximum catch per unit effort, which closely matches our present findings (Sultana et al., 2016)

4.2 Species distribution

During the observation period, 47 fish species belonging to 9 orders and 20 families from three selected stations were identified. Cypriniformes emerged as the highest order, whereas Siluriformes and Perciformes were the more abundant orders than others. The other orders were less familiar or had fewer species overall. Cyprinidae, which has 29.79% of the species, had the highest representation among the families. The Ophichthidae, Gobiidae, Ambassidae, Nandidae, Belonidae, Siluridae, Pangasiidae, Synbranchidae, Palaemonidae, and Tetraodontidae families shared the lowest proportion (2.13%). Cobitidae, Channidae, Bagridae, and Schilbeidae comprised 6.38 %of the total. The Clupeidae and Notopteridae each accounted for 4.26 %. Most listed families had fewer than 10% of the species, showing a relatively uniform distribution. Jamuna River has an enriched fish diversity. Sultana et al. (2016) identified 41 fish species in the old Brahmaputra River, Mymensingh. Mondol et al. (2015) found 49 fish species in this river at separate locations, representing 8 orders and 8 families, which is more or less similar to our present findings. There were 55 species found at different areas of the River Jamuna, belonging to 44 genera and 28 families where the Cyprinidae had the most 10 species and 7genera followed by the 4 Schilbeidae 3 and the Osphronemidae (Islam et al., 2016) which is closely associated to our findings. Paul et al. (2021) found 55 fish species from the Jamuna River in the Sirajganj area, representing 6 orders, 20 families, and 41 genera matching our study. Similar findings were also reported by Galib et al. (2009), Galib et al. (2013), Sultana et al. (2018), Jewel et al. (2018), and Akhi et al. (2020). The production and abundance of various fish species were closely related to the monsoon season's flooding pattern (Ahmed et al., 1991). When pre-monsoon flooding starts, fish from the Jamuna River begin their upstream migration. Many indigenous fish species have a great feeding and nursing habitat in the Jamuna River.

4.3 Total catch and species abundance

A total of 4093 kg of fish were caught annually by combining all fishing gears documented in the different locations, representing 47 other species. The fish catch data revealed that September had the most incredible abundance, with 42 species and a capture of 550 kg/year. The lowest levels of abundance were exhibited in May, suggesting a corresponding decrease in productivity. Sultana et al. (2016) estimated the total weight of fish captured by fishing gear in the old Brahmaputra River throughout the year was 4170 kg, with the highest catch with combined gear being 490.5 kg in June, and the lowest of 252 kg in January which is more or less similar to our findings.

4.3 Fishing Craft

There were two types of crafts in the Jamuna River: dingi nauka and trawlers. Sultana et al. (2016) documented 3 types of fishing crafts: Kosha, Dinghi, and Trawler Payra River, Bangladesh. The Dinghi was round, whereas the trawler was flat or round. This style of boat is typically used for fishing by fishermen. (Banglapedia, 2015; Sultana et al., 2016). Diverse crafts are also necessary to ensure quality and success in fishing. The boats and equipment used for freshwater fishing are historical designs that have been used for a long time. The study region exhibits the same findings or observations. After a given amount of use, most fishing equipment must stop working to rest and be renovated. (Khanna et al., 1989; Sultana et al., 2016).

4.4 Socioeconomic status of fishermen

The socioeconomic conditions of fishermen were studied based on types of fishermen, age, experience, educational background, family members, housing conditions, health amenities, sanitary convenience, annual earnings, substitutional occupations, lending facilities, etc. The overall scenario of socioeconomic conditions was not satisfactory. There were two types of fishermen, 76.07% were professional, and 23.93% were occasional. According to Alam et al. (2009), fishermen's primary earnings source is fishing. Different classes of ages fishermen were observed; among them, the highest 33.33 % age group was 40-49 years. This finding indicates that most fishermen were old, supported by the study of Islam et al. (2021) where 47% were over 45 years old. Regarding educational qualifications, 35% of fishermen were at the primary level, and 29% were illiterate. Kabir et al. (2012) stated that many fishermen lack literacy skills. The family size of the fishermen was diverse. The majority family size was 41.3%, consisting of 4 to 5 members, and the minimum was 11.5%, which belongs to more than 10 members. Islam et al. (2017) studied on the local fishing population at the Sirajganj Sadar fish departure point found that 32% of families were tiny (2-4 people), 48% were medium (5-6 people), and 18% were significant (7-10 people), which is consistent with our findings. The house status of the fishermen was not satisfactory. The Maximum (59%) fishermen's house was a tin shed with no paka house. Islam et al. *(*2022) reported that about 81% of fishermen had kacha houses while 12% had semi-paka houses, similar to the present findings. The health facilities of the fishermen were in the very worst situation. Only 24% go to the Upazila Health Complex, where the maximum percent of fishers (64%) go to the village doctor. The present study findings were similar to those of Ali et al. (2009), Kabir et al. (2012), and Khan et al. (2013). The level of sanitation in the study area was unsatisfactory because of low income and a lack of knowledge. There was no sanitary latrine facility for 6% of fishermen, and 76% only used the kacha latrine. Sharker et al. (2012) recorded that, of the people, about 76% used kacha latrines, the rest 17 % used semi-paka, and 7% of the fishermen were paka ltrines, which was more or less similar to the present findings. The annual earnings of the study area fishermen indicated that the maximum fishermen were very poor and the range was BDT 125000-169000 annually, similar to the findings of Islam et al. (2021). Fishermen were forced to leave their primary source of income fishing due to the lower catch of fish species. The primary income source of the fishermen was converting to the other types of sources, which were 69%. This finding closely matches the findings of Rahman et al. (2021). Maximum fishermen (59%) lend money from NGO's with high rates of interest in our study area.

Table 1. Fishing gears classification with their length, width, mesh size, and construction cost in Jamuna River

Gear Name			Length (m)	Width (m)	Mesh Size (cm)	Construction Cost (BDT/net)
Types	**English Name**	**Local Name**				
1. Nets	Seine Net	Ber Jal	180-200	10-12	0.5	40000-100000
		Kochal Jal	180-210	10-12	0.5	60000-150000
		Ghurni ber jal	50-55	10-12	0.5	40000-50000
	Gill Net	Current Jal	135-140	1.5-2	1.5-3	3000-5000
		Fash Jal	600-700	10-15	25-30	100000-150000
		Okal Jal	550-650	16-18	25-30	80000-120000
		Sursuri Jal	45-55	4.5-5	1.5	18000-25000
	Dragged Net	Thela Jal	2-2.5	1-1.5	0.5	200-500
		Moi Jal	4.5-5	2.5	2-5	10000-15000
	Cast Net	Jhaki Jal	3	3.5	1-3	2500-4000
	Lift Net	Dharma Jal	3.5-4	3.5-4	0.5-3	3000-5000
	Fixed Net	Panti Jal	40-45	1.5-2	0.5	8000-10000
		China Jal	300-400	0.45	0.5	3000-6000
2. Wounding gear (Hooks and lines)		Borshi	-	-	-	Depending on length
		Hazari Borshi	-	-	-	Depending on size and length
		Darki	1	0.45	0.70	250-300

3. Traps	Kate	0.70	0.25	0.50	120-150
	Polo	0.5-1	0.25-0.5	0.6	100-150

m= Meter, cm= Centimeter, BDT= Bangladesh Currency

Table 2. Species caught by fishing gears in Jamuna River

Gear Name	No. of operating person	Major species caught	No. of Species	Fishing Period
Ber Jal	10-12	1. Bacha (*Eutropiichthys vacha*) 2. Sorili (*Aspidoparia jaya*) 3. Bele (*Glossogobius giuris*) 4. Ghaura (*Clupisoma garua*) 5. Chingri (*Macrobrachium tenuipes*) 6. Tengra (*Mystus vittatus*) 7. Gulsha (*Mystus bleekeri*) 8. Kayakata (*Botia lohachata*) 9. Bou (*Botia Dario*) 10. Bashpata (*Ailia coila*) 11. Ilish (*Tenualosa ilisha*) 12. Pabda (*Ompok pabda*) 13. Punti (*Puntius sophore*) 14. Chanda (*Chanda nama*) 15. Mola (*Amblypharyngodon mola*) 16. Dhela (*Rohtee cotio*) 17. Foli (*Notopterus notopterus*) 18. Bhola (*Johnius coitor*) 19. Rui (*Labeo rohita*) 20. Katal (*Catla catla*) 21. Chital (*Notopterus chitala*) 22. Pangas (*Pangasius pangasius*) 23. Kalibaus (*Labeo calbasu*) 24. Boal (*Wallago attu*) 25. Rita (*Rita rita*) 26. Mrigel (*Cirrhinus mrigala*) 27. Taki (*Channa punctata*) 28. Puti (*Puntius ticto*) 29. Sar Puti (*Puntius sarana*) 30. Bata (*Labeo bata*) 31. Darkina (*Esomous danricus*) 32. Chapila (*Gudusia chapra*) 33. Shol (*Channa striata*) 34. Potka (*Tetraodon cutcutia*)	34	Sep to Apr

Kochal Jal	12-15	1. Bacha (*Eutropiichthys vacha*) 2. Sorili (*Aspidoparia jaya*) 3. Bele (*Glossogobius giuris*) 4. Ghaura (*Clupisoma garua*) 5. Chingri (*Macrobrachium tenuipes*) 6. Tengra (*Mystus vittatus*) 7. Gulsha (*Mystus bleekeri*) 8. Kayakata (*Botia lohachata*) 9. Bou (*Botia Dario*) 10. Bashpata (*Ailia coila*) 11. Ilish (*Tenualosa ilisha*) 12. Pabda (*Ompok pabda*) 13. Punti (*Puntius sophore*) 14. Chanda (*Chanda nama*) 15. Mola (*Amblypharyngodon mola*) 16. Dhela (*Rohtee cotio*) 17. Foli (*Notopterus notoperus*) 18. Bhola (*Johnius coitor)* 19. Rui (*Labeo rohita*) 20. Katal (*Catla catla*) 21. Chital (*Notopterus chitala*) 22. Pangas (*Pangasius pangasius*) 23. Kalibaus (*Labeo calbasu*) 24. Boal (*Wallago attu*) 25. Rita (*Rita rita*) 26. Mrigel (*Cirrhinus mrigala*) 27. Taki (*Channa punctata*) 28. Puti (*Puntius ticto*) 29. Sar Puti (*Puntius sarana*) 30. Bata (*Labeo bata*) 31. Gojar (*Channa marulius*) 32. Bamush (*Ophisternon bengalense*) 33. Chapila (*Gudusia chapra*) 34. Shol (*Channa striata*) 35. Potka (*Tetraodon cutcutia*) 36. Baril (*Barilius barila*) 37. Bheda (*Nandus nandus*)	37	Sep to Apr
Ghurni Ber Jal	5-7	1. Puti (*Puntius ticto*) 2. Pabda (*Ompok pabda*) 3. Bele (*Glossogobius giuris*) 4. Ghaura (*Clupisoma garua*) 5. Chingri(*Macrobrachium tenuipes*) 6. Tengra (*Mystus vittatus*) 7. Gulsha (*Mystus bleekeri*) 8. Kayakata (*Botia lohachata*) 9. Bou (*Botia Dario*) 10. Bashpata (*Ailia coila*) 11. Ilish (*Tenualosa ilisha*) 12. Sorili (*Aspidoparia jaya*) 13. Punti (*Puntius sophore*) 14. Chanda (*Chanda nama*) 15. Mola (*Amblypharyngodon mola*) 16. Dhela (*Rohtee cotio*) 17. Foli (*Notopterus notopterus*) 18. Bhola (*Johnius coitor*) 19. Rui (*Labeo rohita*) 20. Katal (*Catla catla*) 21. Chital (*Notopterus chitala*)	30	Sep to Apr

		22. Pangas (*Pangasius pangasius*) 23. Kalibaus (*Labeo calbasu*) 24. Boal (*Wallago attu*) 25. Rita (*Rita rita*) 26. Mrigel (*Cirrhinus mrigala*) 27. Taki (*Channa punctata*) 28. Bacha (*Eutropiichthys vacha*) 29. Darkina (*Esomous danricus*) 30. Bamush (*Ophisternon bengalense*)		
Current Jal	1	1. Sorili (*Aspidoparia jaya*) 2. Tengra (*Mystus vittatus*) 3. Gulsha (*Mystus bleekeri*) 4. Puti (*Puntius ticto*) 5. Sar Puti (*Puntius sarana*) 6. Bata (*Labeo bata*) 7. Gojar (*Channa marulius*) 8. Pabda (*Ompok pabda*) 9. Bhola (*Johnius coitor*) 10. Taki (*Channa punctata*) 11. Potka (*Tetraodon cutcutia*)	11	Jun to Dec
Fash Jal	3	1. Ayre (*Mystus aor)* 2. Bagha-ayre (*Bagarius bagarius*) 3. Rui (*Labeo rohita*) 4. Katal (*Catla catla*) 5. Chital (*Notopterus chitala*) 6. Pangas (*Pangasius pangasius*) 7. Boal (*Wallago attu*) 8. Rita (*Rita rita*)	8	Jun to Dec
Okal Jal	3	1. Boal (*Wallago attu*) 2. Bagha-ayre (*Bagarius bagarius*) 3. Rui (*Labeo rohita*) 4. Katal (*Catla catla*) 5. Chital (*Notopterus chitala*) 6. Pangas (*Pangasius pangasius*) 7. Ayre (*Mystus aor)* 8. Rita (*Rita rita*) 9. Veush (*Sperata seenghala*)	9	Jun to Dec
Sursuri Jal	2-3	1. Sorili (*Aspidoparia jaya*) 2. Tengra (*Mystus vittatus*) 3. Gulsha (*Mystus bleekeri*) 4. Puti (*Puntius ticto*) 5. Sar Puti (*Puntius sarana*) 6. Bata (*Labeo bata*) 7. Gojar (*Channa marulius*) 8. Pabda (*Ompok pabda*) 9. Bhola (*Johnius coitor*) 10. Taki (*Channa punctata*) 11. *Chapila (Gudusia chapra)*	11	Jun to Dec
Thela Jal	1	1. Punti (*Puntius sophore*) 2. Bele (*Glossogobius giuris*) 3. Chingri (*Macrobrachium tenuipes*) 4. Tengra (*Mystus vittatus*) 5. Gulsha (*Mystus bleekeri*)	11	Jul to Nov

		6. Chanda (*Chanda nama*) 7. Kholisha (*Colisa fasciata*) 8. Mola (*Amblypharyngodon mola*) 9. Dhela (*Rohtee cotio*) 10. Kakila (*Xenentodon cancila*) 11. Darkina (*Esomous danricus*)		
Moi Jal	2	1. Chingri (*Macrobrachium tenuipes*) 2. Darkina (*Esomous danricus*)	2	Jul to Nov
Jhaki Jal	1	1. Bashpata (*Ailia coila*) 2. Bele (*Glossogobius giuris*) 3. Chingri (*Macrobrachium tenuipes*) 4. Tengra (*Mystus vittatus*) 5. Gulsha (*Mystus bleekeri*) 6. Chanda (*Chanda nama*) 7. Kholisha (*Colisa fasciata*) 8. Mola (*Amblypharyngodon mola*) 9. Dhela (*Rohtee cotio*) 10. Kakila (*Xenentodon cancila*) 11. Boal (*Wallago attu*) 12. Katal (*Catla catla*) 13. Punti (*Puntius sophore*) 14. Darkina (*Esomous danricus*)	14	Jul to Nov
Dharma Jal	1	1. Chingri (*Macrobrachium tenuipes*) 2. Tengra (*Mystus vittatus*) 3. Gulsha (*Mystus bleekeri*) 4. Chanda (*Chanda nama*) 5. Kholisha (*Colisa fasciata*) 6. Mola (*Amblypharyngodon mola*) 7. Dhela (*Rohtee cotio*) 8. Kakila (*Xenentodon cancila*) 9. Punti (*Puntius sophore*) 10. Darkina (*Esomous danricus*)	10	Feb to Sep
Panti Jal	2	1. Sorili (*Aspidoparia jaya*) 2. Chela (*Salmostoma bacaila*) 3. Mola (*Amblypharyngodon mola*) 4. Dhela (*Rohtee cotio*) 5. Darkina (*Esomous danricus*)	5	Jul to Oct
China Jal	1	1. Chingri (*Macrobrachium tenuipes*) 2. Tengra (*Mystus vittatus*) 3. Gulsha (*Mystus bleekeri*) 4. Baim (*Macrognathus aculeatus*) 5. Gochi (*Macrognathus pancalus*) 6. Bele (*Glossogobius giuris*) 7. Kuchia (*Monopterus cuchia*) 8. Rita (*Rita rita*)	8	Jul to Oct
Borshi	1	1. Chingri (*Macrobrachium tenuipes*) 2. Tengra (*Mystus vittatus*) 3. Gulsha (*Mystus bleekeri*) 4. Punti (*Puntius sophore*) 5. Ayre (*Mystus aor)* 6. Bele (*Glossogobius giuris*) 7. Rui (*Labeo rohita*)	13	Sep to Mar

		8. Ritha (*Rita rita*) 9. Boal (*Wallago attu*) 10. Katal (*Catla catla*) 11. Punti (*Puntius sophore*) 12. Shol (*Channa striata*) 13. Bamush (*Ophisternon bengalense*)		
Hazari Borshi	2	1. Ghaura (*Clupisoma garua*) 2. Boal (*Wallago attu*) 3. Veush (*Sperata seenghala*) 4. Ayre (*Mystus aor)* 5. Rita (*Rita rita*) 6. Bagha-ayre (*Bagarius bagarius*) 7. Bamush (*Ophisternon bengalense*)	7	Sep to Mar
Darki	-	1. Chingri (*Macrobrachium tenuipes*) 2. Tengra (*Mystus vittatus*) 3. Gulsha (*Mystus bleekeri*) 4. Bele (*Glossogobius giuris*) 5. Baim (*Macrognathus aculeatus*) 6. Gochi (*Macrognathus pancalus*) 7. Kuchia (*Monopterus cuchia*) 8. Darkina (*Esomous danricus)*	8	Jul to Oct
Kate	-	1. Chingri (*Macrobrachium tenuipes*)	1	Jul to Oct
Polo	-	2. Taki (*Channa punctata*) 3. Gochi (*Macrognathus pancalus*) 4. Bele (*Glossogobius giuris*)	3	Jul to Oct

Table 3. Fishing crafts used in Jamuna River

Craft name	Cost (BDT/ Boat)	Length (m)	Width (m)	Height (m)	The shape of the bottom	Persons need to operate	Durability (years)
Dinghi nauka	12000-22000	6-9	2.5-3	1.5-2.5	Rounded	1-2	4-6
Trawler	30000-60000	10-13	3.5-5	3-4	Flat/Rounded	8-10	5-7

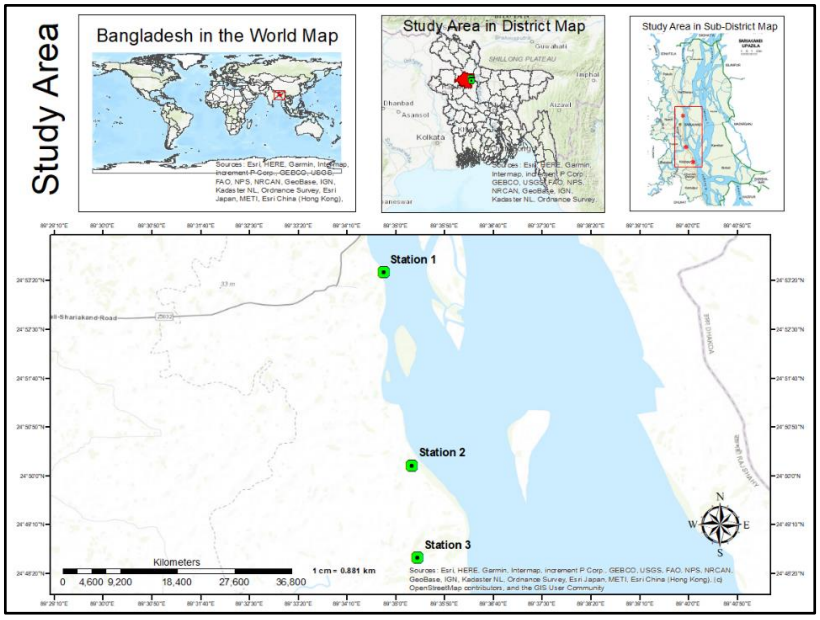

Fig.1. Location of the sampling sites in Jamuna River

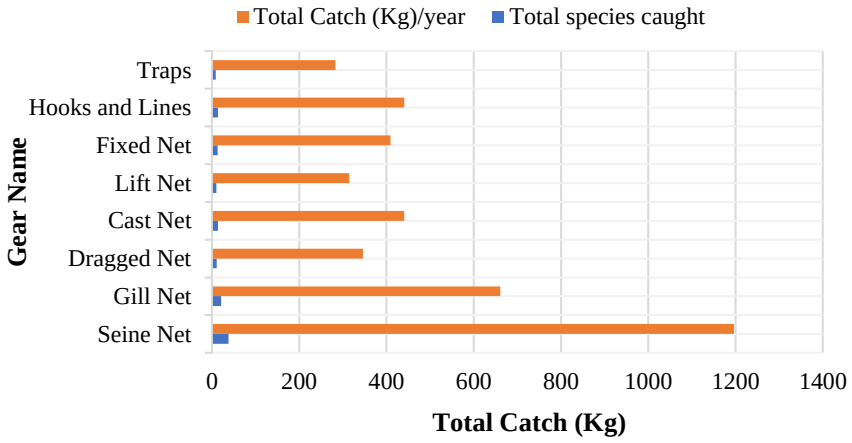

Fig.2. Total fish caught by different fishing gears annually in Jamuna River

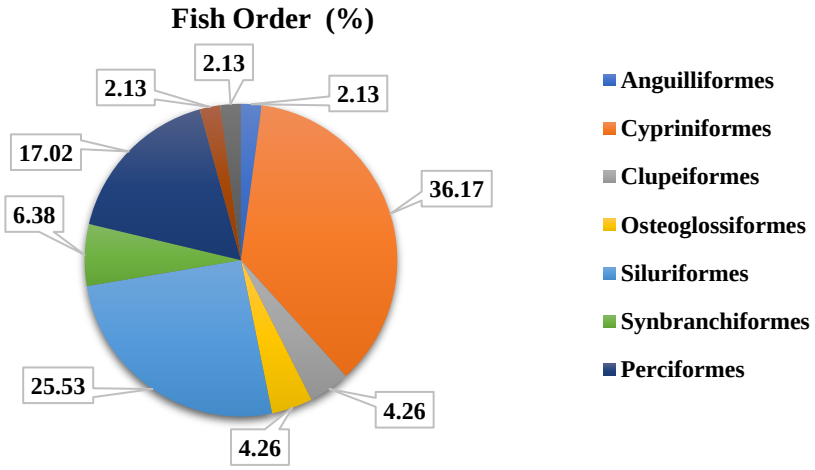

Fig.3. Fish order (%) caught by different fishing gears annually in Jamuna River

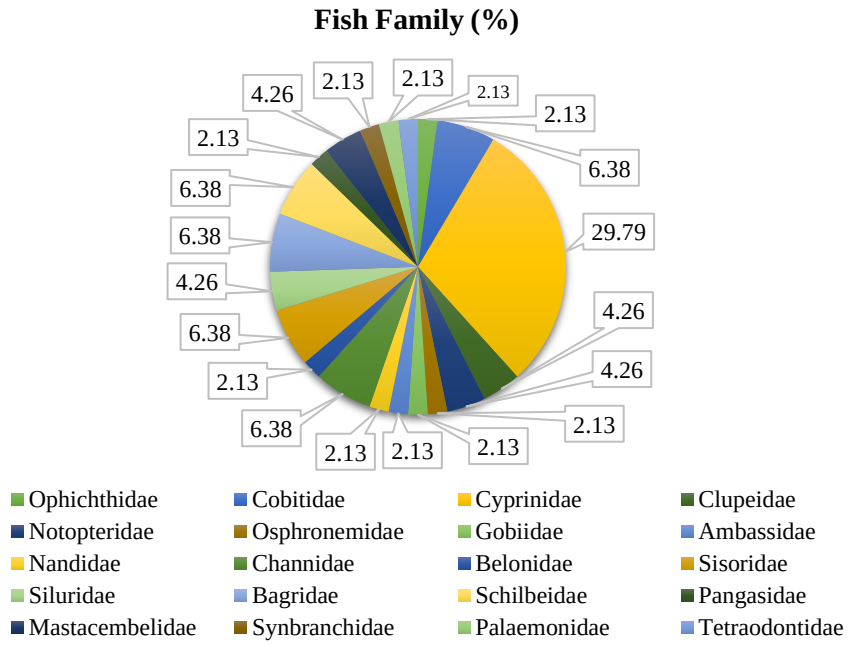

Fig.4. Fish family (%) caught by different fishing gears annually in Jamuna River

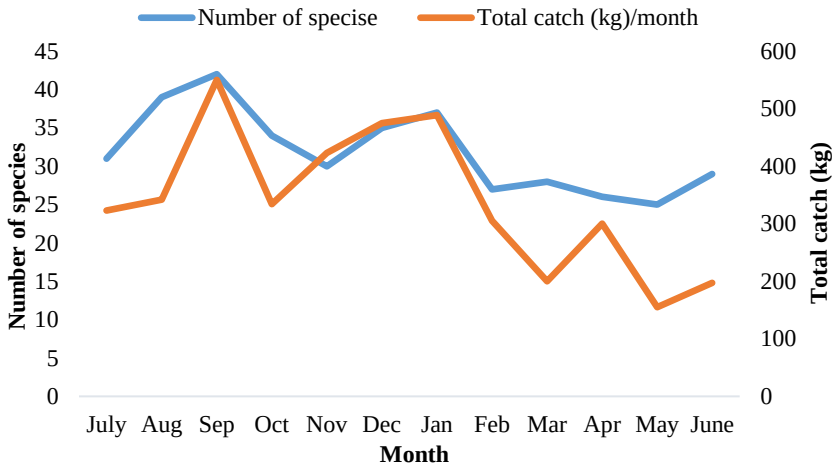

Fig.5. Species abundance in terms of total catch in Jamuna River

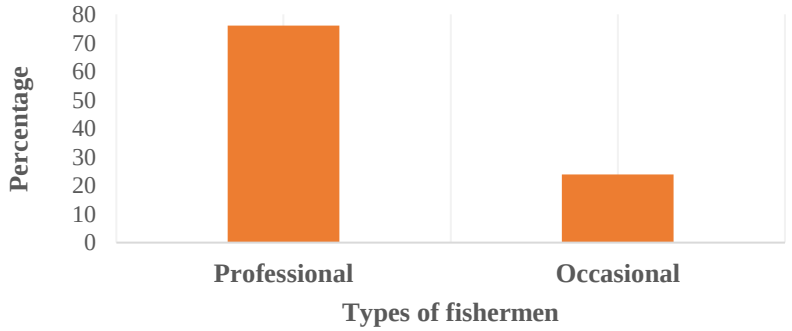

Fig.6. Fishermen's occupation in Jamuna River

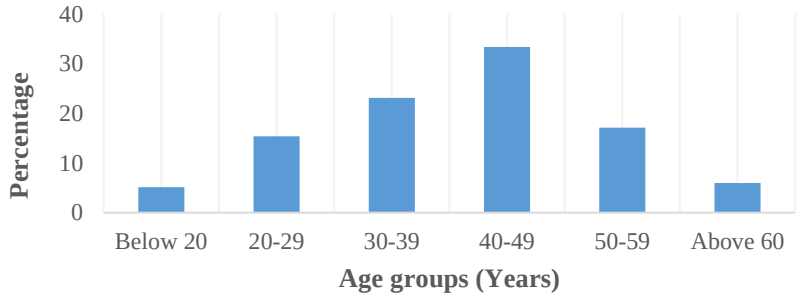

Fig.7. Age of the fishermen in Jamuna River

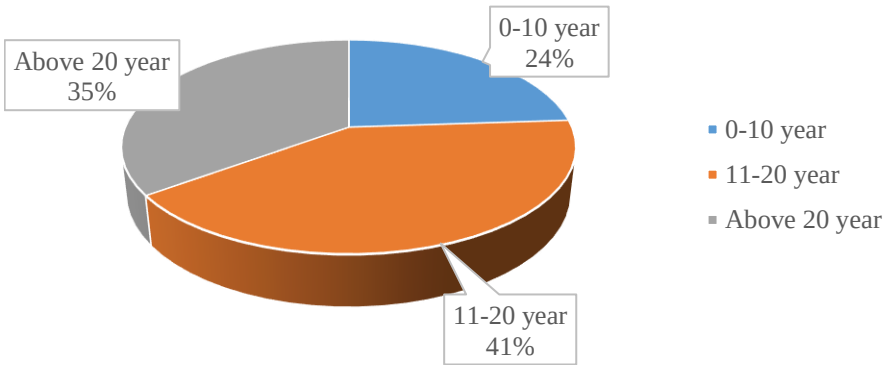

Fig.8. Fishing experience of fishermen in Jamuna River

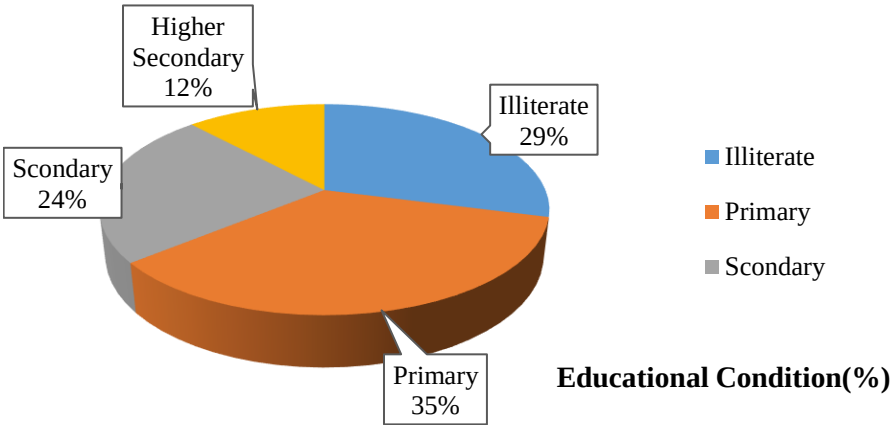

Fig.9. Educational condition of the fishermen in Jamuna River

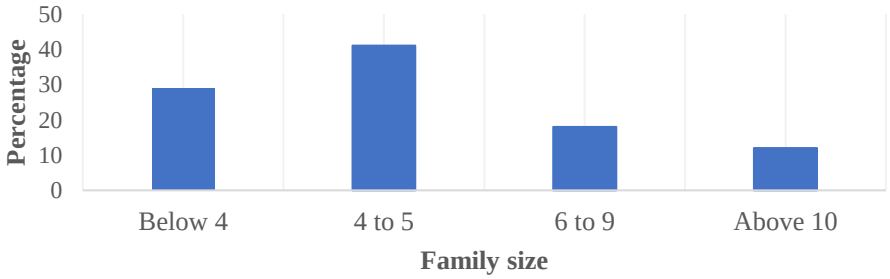

Fig. 10. Family pattern of the fisherman in Jamuna River

Fig.11. Housing condition of fishermen in Jamuna River

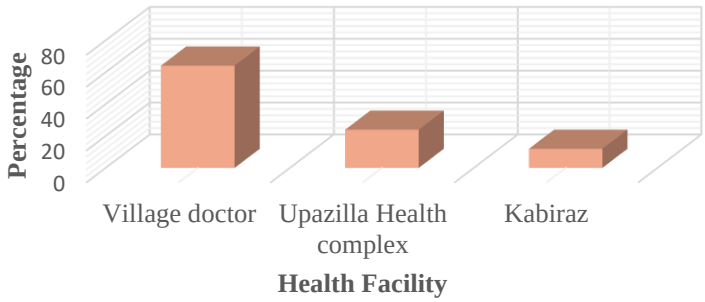

Fig.12. Health amenities of fishermen in Jamuna River

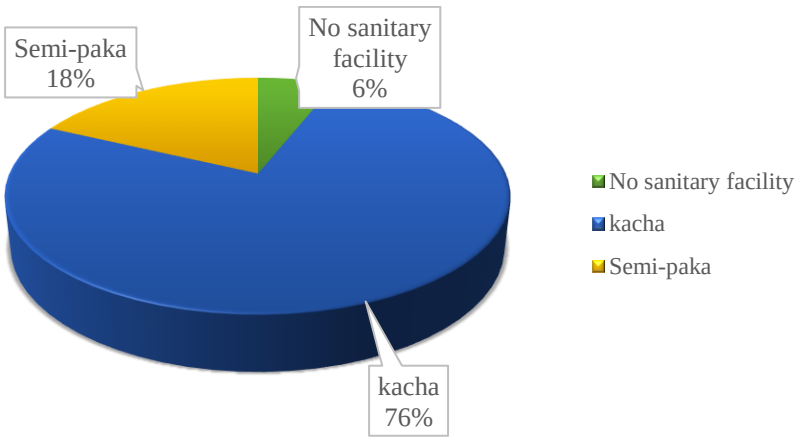

Fig.13. Sanitary convenience of fishermen in Jamuna River

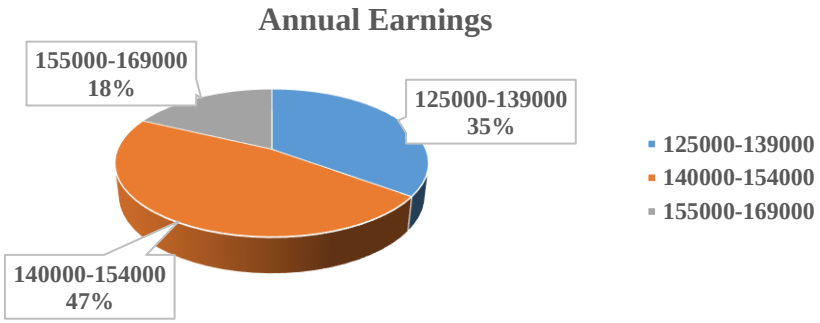

Fig 14: Annual earnings of the fishermen in Jamuna River

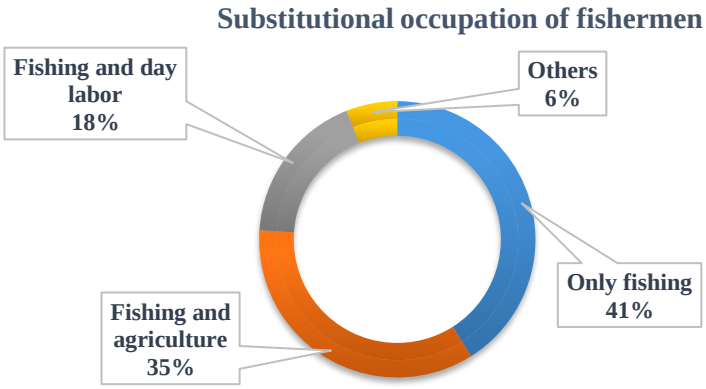

Fig.15. Substitutional occupation of fishermen in Jamuna River

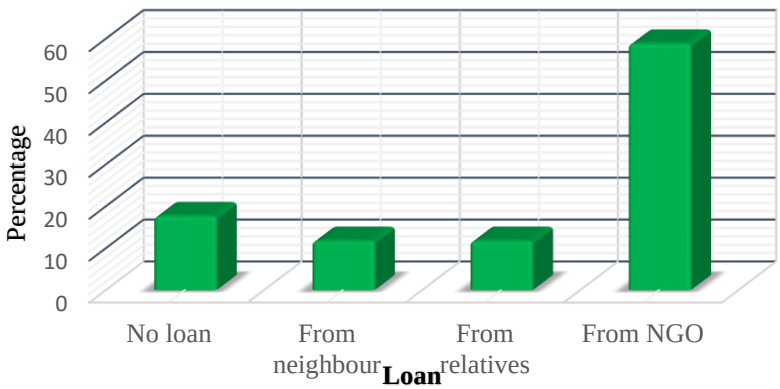

Fig.16. Lend facilities of fishermen in Jamuna River

5. Conclusion

The Jamuna River is vital for conserving and restoring fishery resources. However, recent years have seen a fall in the availability of fish species and compositions. For this reason, the efficiency of fishing gear is heavily affected. In a whole day of fishing, fishermen get very little fish. This phenomenon has created a heavy socioeconomic crisis in the fishermen's lives. During fishing season, fishermen are faced with a lack of necessary fishing equipment like gear and crafts due to money problems. Further, they lend money from NGOs with a high-interest rate, which causes a severe burden on their lives for recovery. Moreover, due to a lack of amenities such as education, sanitization, decent housing, health facilities, insufficient income, and other means of subsistence, the socioeconomic status of the Jamuna River fishermen in the Bogura district areas is terrible. Fishermen have left their main occupation and are engaging in other professions. It is high time for policymakers to take immediate steps for the conservation of the fish population of the Jamuna River and take necessary measures to increase the socioeconomic conditions of fishermen. It is high time for policymakers to take immediate steps for conservation, increase the fish stock of the Jamuna River and take necessary measures to improve the socioeconomic conditions of fishermen. Otherwise, our significant natural fish breeding ground source, the Jamuna River, will be destroyed soon, and endless sorrows will descend upon the fishermen who rely on it for their livelihood. Thus, maintaining and conserving the Jamuna River's fishery resources has become essential, and a management plan for fishermen should be established and implemented as quickly as feasible.

6. Reference:

1. Ahmed, M., 1991. A model to determine benefits obtainable from the management of riverine fisheries of Bangladesh. *ICLARM Tec. Rep*. 28, Manila, Philippines, 2013: 133.
2. Ahmed, N., 1971. Government of East Pakistan Directories of Fisheries: Fishing Gear of East Pakistan. *East Pakistan Fishery Department, East Pakistan*.
3. Akhi, M. M., Jewel, M. A. S., Haque, M. A., et al., 2020. Multivariate approaches to determine the relationship between fish assemblage structure and environmental variables in Karatoya River, Bangladesh. *Community Ecology*, 21, 171–181. (3), 160–165.
4. Alam, M. S., Sarker, I. C., Salam, M. A., Ali, H., & Mollah, M. O. U., 2009. Water loading for live fish transportation and socioeconomic status of water loading station owners in three upazilla of Mymensingh district. *J. Environ. Sci. & Natural Resources*, *2*(1), 73-76.
5. Ali, H., Azad, M. A. K., Anisuzzaman, M., Chowdhury, M. M. R., Hoque, M., & Sharful, M. I., 2009. Livelihood status of the fish farmers in some selected areas of Tarakanda upazila of Mymensingh district. *J. Agrofor. Environ*, *3*(2), 85-89.
6. Banglapedia., 2015. Fishing Craft, National Encyclopedia of Bangladesh. Asiatic Society of Bangladesh, Dhaka.
7. Bhuyan, S., & Islam, S., 2016. Present status of socioeconomic conditions of the fishing community of the Meghna River adjacent to Narsingdi district. *Bangladesh. J. Fish. Livest. Prod*, *4*(4), 1-5.
8. DoF., 2022. *Yearbook of fisheries Statictis of Bangladesh 2021-2022.* Fisheries Resources Survey System (FRSS), department of Fisheries. Bangladesh: Director General, DoF, 2022 Volume **39**:p.139.
9. FAO., 2018. *The State of World Fisheries and Aquaculture 2018*. Meeting the sustainable development goals. Rome, Italy.
10. Galib, S. M., Naser, S. M. A., & Mohsin, A. B. M., 2013. Fish biodiversity of river chotoJamuna, Bangladesh: Present status and conservation needs. *International Journal of Biodiversity and Conservation*, 5(6), 389–395.
11. Galib, S. M., Samad, M. A., Kamal, M. M., Haque, M. A., & Hasan, M. M., 2009. A study on fishing gears and methods in the Chalan Beel of north-west Bangladesh. *Journal of Environmental Science & Natural Resources*, *2*(2), 213-218.
12. Haque, S. A., Islam, M. F., Rahman, M. C., Islam, M. S., & Rahman, M. M., 2021. Supply Chain and Logistics of Fish: A Case Study of Jamalpur District Markets in Bangladesh. *Asian Journal of Agricultural Extension, Economics & Sociology*, 39(7), 8–27. https://doi.org/10.9734/ajaees/2021/v39i730604
13. Haque, S. A., Jaman, A., & Hasan, M. S., 2023. Environmental impacts on seasonal fish diversity in Jamuna River, Bangladesh. *Journal of Survey in Fisheries Sciences*, 3019-3030.
14. Islam, M. A., Al Asif, A., Samad, M. A., Sarker, B., Ahmed, M., Satter, A., & Hossain, A., 2017. A comparative study on fish biodiversity with conservation measures of the Bhairabriver, Jessore, Bangladesh. *Asian Journal of Medical and Biological Research*, *3*(3), 357-367.
15. Islam, M. F., Haque, S. A., Islam, M. S., Das, P. S. and Rahman, M., 2021. Socioeconomic status of fisher communities in Dengar beel under Melandah Upazila, Jamalpur, Bangladesh. *Asian J. Med. Biol. Res*, *7*(2), 164-173., https://doi.org/i: 10.3329/ajmbr. v7i2.54996
16. Islam, M. K., Ahmad-Al-Nahid, S., Khan, M. S. R., Ahsan, M. E., Habib, K. A., & Ali, M. M., 2015. Fishing gears used by the fishers at Rupsha River in Khulna district, Bangladesh. *International Journal of Fisheries and Aquatic Studies*, *4*(1), 29-33.
17. Islam, M.F., Ali, M. F., Rahman, M. S., Haque, S. A., & Juthi, R. A., 2022. Assessing socioeconomic patterns and trends of livelihoods of fisher's community of the Old Brahmaputra River: A case study in Jamalpur, Bangladesh. *Archives of Agriculture and Environmental Science*, 7(4), 611-617,

18. Islam, S. M., Rahman, M. B., Alam, M. R., Mithun, B. D., Bal, A., Azam, M., & Ruma, M., 2016. A case study on fishing gears, fish species composition and fisher folk community at Jamuna river of sirajganj sadar fish landing site. *Journal of Aquatic Science*, *4*(1), 11-19.
19. Jewel, M. A. S., Haque, M. A., Khatun, R., & Rahman, M. S., 2018. A comparative study of fish assemblage and diversity indices in Bangladesh's aquatic habitats: Lakhandaha wetland and Atari River. *Jordan Journal of Biological Sciences*, 11(4), 427–434.
20. Kabir, K. R., Adhikary, R. K., Hossain, M. B., & Minar, M. H., 2012. Livelihood status of fishermen of the old Brahmaputra River, Bangladesh. *World Applied Sciences Journal*, *16*(6), 869-873.
21. Khan, M. R., Miah, M. I., Hossain, M. B., Begum, A. F. R. O. Z. A., Minar, M. H., & Karim, R., 2013. Fish biodiversity and livelihood status of fishing community of Tista River, Bangladesh. *Global Veterinaria*, *10*(4), 417-423.
22. Khanna, S.S., 1989. An introduction to fishes. Published by central book dept. Allahabad. 2 ed. pp: 486.
23. Mohsin, A. B. M., Yeasmin, F., Galib, S. M., Alam, B., & Haque, S. M. M., 2014. Fish fauna of the Andharmanik river in Patuakhali, Bangladesh. *Middle-East Journal of Scientific Research*, *21*(5), 802-807.
24. Mondol, M. M. R., Hossain, M. Y., & Rahman, M. M., 2015. Check-list of Fish availability in the Karatoya River, Bangladesh. *World Journal of Zoology*, *10*(1), 17-21.
25. Paul, S. I., Majumdar, B. C., Hasan, M., Sarker, A. K., Baidya, A., & Hakim, M. A., 2021. Fish Biodiversity, Threat Status and Conservation Significance of the Jamuna River, Bangladesh. *Croatian Journal of Fisheries*, *79*(4), 173-186.
26. Quddus, M. M. A., Sarker, M. N., & Banerjee, A. K. (1988). Studies of the Chondrichthyes Fauna (sharks, skates and rays) of the Bay of Bengal. *The Journal of Noami*, 5(2), 19-23.
27. Rahman, A. K. A., 2005. *Freshwater fishes of Bangladesh* (2nd ed.). Dhaka: Zoological Society of Bangladesh, Department of Zoology, University of Dhaka.
28. Rahman, K. M. M., Nahar, M., Adhikary, R. K., Khan, N. S., Rahman, M. M., Asadujjaman, M., & Rahman, M. A., 2014. Socioeconomic condition and occupation migration of fisherman of the Jamuna river under Shirajgonj district in Bangladesh. *Middle-East J. Sci. Res*, *22*, 633-638.
29. Rahman, M. B., Hoque, M. S., & Hasan, M. M., 2015. Selectivity of fishing gears and their effects on fisheries diversity of Rabnabad channel of Patuakhali district in Bangladesh. *Academic Research International*, *6*(6), 184-196.
30. Rahman, M. M., Motin, M. A., Islam, M. S., Haque, S. A., Islam, M. F., & Rahman, M., 2021. Assessing livelihood and socioeconomic status of fishermen community adjacent to Chalan beel area in Faridpur upazila, Pabna, Bangladesh. *Journal of Bioscience and Agriculture Research*, *28*(01), 2324-2334.
31. Rahman, M. M., Rahman, M. B., Rithu, M. N. A., & Hoque, M. S., 2016. Observation on selectivity of fishing gears and ichthyofaunal diversity in the Paira River of Southern Bangladesh. *International Journal of Fisheries and Aquatic Studies*, *4*(1), 95-100.
32. Rahman, M. R., 2023. River dynamics–a geospatial analysis of Jamuna (Brahmaputra) River in Bangladesh during 1973–2019 using Landsat satellite remote sensing data and GIS. *Environmental Monitoring and Assessment*, *195*(1), 96.
33. Rahmatullah, D. S., Aziz, A., Rahman, M., Bari, M. R., & Alam, M. A., 2015. Socioeconomic Status of Fishermen of the Jamuna River in Bangladesh. *IOSR Journal of Humanities and Social Science*, *20*(10), 63-66.
34. Sayeed, M. A., Hashem, S., Salam, M. A., Hossain, M. A. R., & Wahab, M. A,. 2014. Efficiency of fishing gears and their effects on fish biodiversity and production in the Chalan Beel of Bangladesh. *European Scientific Journal*, *10*(30).
35. Shaha, D. C., Ahmed, S., Hasan, J., Kundu, S. R., Haque, F., Rahman, M. J., ... & Wahab, M. A., 2022. Fish diversity in relation to salinity gradient in the Meghna river estuary, Bangladesh. *Conservation*, *2*(3), 414-434.
36. Sharker, M. R., Mahmud, S., Siddik, M. A. B., Alam, M. J., & Alam, M. R., 2015. Livelihood status of hilsha fishers around Mohipur Fish Landing site, Bangladesh. *World Journal of Fish and Marine Sciences*, *7*(2), 77-81.
37. Siddiq, M. A., Miah, M. I., Ahmed, Z. F., & Asadujjaman, M., 2013. Present status of fish, fishers and fisheries of Dogger Beel in Hajigonj Upazila, Chandpur, Bangladesh. *Journal of Aquatic Science*, *1*(2), 39-45.
38. Siddiqui, K. U., 2007. *Encyclopedia of Flora and Fauna of Bangladesh: Freshwater Fishes*. Asiatic Society of Bangladesh.
39. Sultana, M. A., Mazumder, S. K., & Kunda, M., 2016. Fishing gears and crafts used in Payra River, Bangladesh. *European Journal of Applied Sciences*, *8*(6), 337-346.
40. Sultana, M.A., Mazumder, S.K., Kunda, M., 2018. Diversity of fish fauna and fishing gears used in the River Banar, Mymensingh, Bangladesh. *Bangladesh J. Fish*. 30 (2), 229–240.
41. Talwar, P. K., & Jhingran, A. G., 1991. *Inland fishes of India and adjacent countries* (Vol. 2). CRC press.