Fish biodiversity and livelihood of fishermen at an Oxbow lake of South-West Bangladesh

Jamil1, B.M. Newaz Sharif2, Lirong Yu Abit3, Md. Idris Miah1* and Md. Shahjahan1

1Department of Fisheries Management, Faculty of Fisheries, Bangladesh Agricultural University, Mymensingh, 2202, Bangladesh
2Research and Development Department, Fishtech Hatchery Limited, Dhaka, Bangladesh
3Department of Animal Science and Fishery, Faculty of Agricultural and Forestry Sciences, Universiti Putra Malaysia Bintulu Sarawak Campus, Jalan Nyabau 97008, Bintulu, Sarawak, Malaysia

*Corresponding author: Md. Idris Miah, Department of Fisheries Management, Faculty of Fisheries, Bangladesh Agricultural University, Mymensingh, 2202, Bangladesh. E-mail: pdridris952@gmail.com

Received: 20 August 2022/Accepted: 21 September 2022/Published: 27 September 2022

Copyright © 2022 Jamil et al. This is an open access article distributed under the Creative Commons Attribution 4.0 International License (https://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Abstract: The present study was conducted to know the biodiversity status and assess the existing livelihood conditions of the fishers of Habullah Baor at Bagherpara upazila, Jashore district from November 2017 to April 2018. Sixty fishermen were randomly selected for collecting data through a semi structured questionnaire. The current study discovered that there were 11 different fish species from six orders and seven families in the Habullah baor. All of the sampled fishermen were Hindu. About 25% of the fishermen was young aged, majority was middle aged and 25% was old aged group. A total of 75% of the fishermen had nuclear family and 25% families lived in joint family. Among the fishermen 85% had a few decimal of cultivable land and 15% were truly landless. Annual income of the respondents varied from 30,000 to 70,000 BDT with an average of 42,833 BDT. All fishers had access to drinking water from tube wells. Most of the fishers lived in katcha houses. About 15% of the fishers enjoyed electricity facilities in their home. Among the fishermen investigated, majority had earthen latrine, 20% used tin shed latrine, 8% used concrete latrine and a few of them 10% had no latrine. There were no modern medical facilities in the villages. The respondents had no alternate income sources during the dry season and at the time of ban period. The fishers as a whole are leading measurable life due to great financial hardship. Proper conservation and management measures can be taken to enhance the availability of fish fauna in Habullah baor, so that, the fishermen can harvest ample fish on sustainable basis.

Keywords: fish biodiversity; fishing gears; livelihood of fishermen; training; education

1. Introduction

A baor or ox-bow lake is an u-shaped body of water that forms when a wide meander from the main stream of a river is cut off creating a free standing body of water (Baker et al., 1991; Cantonati et al., 2020). Habullah Baor is of the oxbow lakes, which found abandoned meander isolated or cut off from the main stream channel by depressing and filled with water in south-west Bangladesh. The bulk of oxbow lakes were discovered in south-western Bangladesh, but research on these lakes’ biodiversity, ecology, population characteristics of the species that were present, taxonomy, and other factors was still insufficient (Azad et al., 2020; Biswas et al., 2009; Halim et al., 2018; Sharif et al., 2016).
The biodiversity is often used as a measurement of the health of biological system (Aerts et al., 2018; Vyas et al., 2009). The biodiversity of a water body also act as an ecological indicator and measurement of pollution for instance (Parmar et al., 2016; Sui et al., 2020; Zaghoul et al., 2020). Several biodiversity assessment studies were conducted in different water bodies in south-western Bangladesh, including small indigenous species (Samad et al., 2013), river ecosystem (Leela et al., 2018), plankton community in an oxbow lake (Raju et al., 2018), fish biodiversity (Ahamed et al., 2019; Biswas et al., 2021), aquatic weed diversity in different ecosystems (Adhikary et al., 2018; Islam et al., 2017b). A sustainable livelihood found based on the development to improve the progress in poverty elimination by assessing the appropriate objectives, scope and priorities (Adhikary et al., 2018; Gilling et al., 2001; Islam et al., 2014; Islam et al., 2015; Singh and Chudasama, 2020; Yu and Huang, 2021). Socio-economic status is typically broken into three categories, high SES, middle SES, and low SES to describe the a family or an individual (Bradley, 2016; Darin-Mattsson et al., 2017). When categorizing a family or an individual into one of these groups, it was necessary to evaluate four or all three of the criteria (income, education, and occupation) (Avvisati, 2020; Chowdhury and Chakraborty, 2017; Hällsten and Thaning, 2022). For sustainable development and poverty alleviation, five different approaches had been adopted and the sustainable livelihood approach had been gradually expanded with its own core and principles for poverty focused development activities (Rahman et al., 2012; Stacey et al., 2021; Voumik, 2014). Biodiversity plays an important role for the future sustainability of marine and fresh water natural resources that include commercial fisheries (Hiddink et al., 2008; Hossain, 2019; Hussain, 2010; Shamsuzzaman et al., 2017; Apon et al., 2019). Due to a variety of factors, some fish populations are declining despite the fact that fish is an essential traditional food item in Bangladeshi diets (Aziz et al., 2021; Hoque and Myrland, 2022; Rahman and Islam, 2020). A vital step in preventing the extinction of many species is to examine the biodiversity of various vulnerable fish species (Aziz et al., 2021; Miranda et al., 2022).

It is critical to possess in-depth knowledge of the linked population's livelihood patterns and the biodiversity state of any environment in order to improve the fisheries sector (Islam et al., 2014; Lynch et al., 2016). The state of the people's livelihoods serves as an illustration of their current position, lifestyle, and financial situation (Scoones, 2009). However, few studies on socio-economic conditions of fishermen were carried out by Al-Asif and Habib (2018), Islam et al. (2014), Hossain et al. (2016), Vaumik et al. (2017), Islam et al. (2021) and Razeim et al. (2017) but all these efforts lack specific information of livelihood like access to organizations, livelihood vulnerabilities and outcomes. Therefore, the present study was undertaken to determine the fish biodiversity status and livelihood of the fishermen of Habullah baor. This study will be the first baseline study on Habullah ox-bow Lake while it might be helpful for understanding the current fish biodiversity status and the livelihood status of fishers.

2. Materials and Methods
2.1. Study location and periods
This study was conducted on Habullah baor (oxbow lake) at Bagherpara Upazila under Jashore district, Bangladesh from November 2017 to April 2018 (Figure 1).

2.2. Sample population and data collection
Sixty fishermen from Habullah baor area were interviewed during the survey.

2.2.1. Primary data
First-hand information was gathered through questionnaire interviews with fishermen from Habullah baor area. For this study, one of the PRA tool such as Focus Group Discussion (FGD) was conducted in baor area.

2.2.2. Crosschecked interviews
After collecting the data through questionnaire interviews and FGD, crosscheck interviews were conducted with Upazila Fisheries Officer, Assistant Fisheries Officer, relevant NGO workers from the study area.

2.2.3. Secondary data
Secondary source of information consist of published material such as journals (for example, Islam et al. (2017c), textbooks, university thesis (up to post-graduate level), newspaper and other sources. Moreover, appropriate government and non-government organizations reports were also taken into consideration for gathering information. The information regarding fish biodiversity was collected from fishermen and the nearest fish market.
2.3. Data processing and preparation map
The data were analyzed using tabular and descriptive statistical techniques. The summary tables were prepared in accordance to the objective of the study. Data collected from various sources was entered into a database system using Microsoft office Software. The graphical presentation of data were conducted using OriginLab 2022 and the map was prepared using QGIS Version 3.26.3 (QGIS Development Team, 2019).

3. Results
3.1. Fish biodiversity and fishing gears used in Habullah baor
The current study discovered that there were 11 different fish species from six orders and seven families in the Habullah baor, some of which were seasonal and the majority of which were year-round (Table 1). Ten of the fish species identified in Habullah Bay were determined to be of least concern, while one species was determined to be vulnerable based on the IUCN Red List status. This study also found that, eight species of fishes were available all the year while three species could be found in a particular season.

Table 1. Fish biodiversity in Habullah baor.

| Order          | Family    | Scientific Name                  | Local name | IUCN status | Availability |
|----------------|-----------|----------------------------------|------------|-------------|--------------|
| Anabantiformes | Channidae | *Channa marulius*                | Gozar      | LC          | +            |
|                |           | *Channa orientalis*              | Cheng      | VU          | -            |
| Beloniformes   | Nandidae  | *Nandus nandus*                  | Bheda      | LC          | -            |
| Cypriniformes  | Belonidae | *Xenentodon cancila*             | Kakila     | LC          | +            |
| Cypriniformes  | Cyprinidae| *Pethia ticto*                   | Punti      | LC          | -            |
|                |           | *Amblypharyngodon mola*          | Maya       | LC          | +            |
|                |           | *Osteobrama cotto*               | Dhela      | LC          | +            |
| Ovalentaria    | Ambassidae| *Chanda nama*                    | Chanda     | LC          | +            |
| Siluriformes   | Bagridae  | *Sperata aer*                    | Air        | LC          | +            |
| Synbranchiformes| Mastacembelidae | *Mastacembelus armatus* | Baim      | LC          | +            |

* Least Concern (LC); Vulnerable (VU); Y=available year round; S=seasonally available species
Various types of fishing gears were found to be operated in the Habullah baor for catching fishes. It was observed that, most of fishermen used borsi (33.33%) followed by castnet (30%), current jal (20%), thelajal (10%), and dharmajal (6.67%) for harvesting fishes (Table 2).

Table 2. Fishing gears used in Habullah baor.

| Name of gears | Number of respondents | Percentage (%) |
|---------------|-----------------------|----------------|
| Cast net      | 18                    | 30             |
| Thela jal     | 6                     | 10             |
| Dharma jal    | 4                     | 6.67           |
| Current jal   | 12                    | 20             |
| Borshi        | 20                    | 33.33          |

3.2. Livelihood and socio-economic status of the fishermen at Habullah baor

3.2.1. Family type
The current study found that, most of the fishermen had nuclear family (75%), while rest were joint type of family (25%) (Table 3).

Table 3. Family type of fishermen at Habullah baor.

| Family Type | Number of respondents | Percentage (%) |
|-------------|-----------------------|----------------|
| Nuclear     | 45                    | 75             |
| Joint       | 15                    | 25             |

3.2.2. Family size
It was found that, about 50% of the fishermen had small family with 3 to 4 members, followed by medium family (33.33%) and large family (16.67%) (Figure 2).

3.2.3. Age group distribution
The present study found, majority (50%) of the fishermen were middle aged, followed by young aged (25%) and old aged (25%) (Figure 3).
Figure 3. Distribution of the fishermen according to their age (young=15-30 years; middle= 31-45 years; old= 46 years and above).

3.2.4. Income sources
In the study area, majority of income came from baor fishing activity (58.33%), while rest of the fishermen were involved in others occupation such as agricultural activity, labors and tea stall business (41.67%) (Table 4).

| Income sources | Number of respondents | Percentage (%) |
|----------------|-----------------------|----------------|
| Primary        | 35                    | 58.33          |
| Secondary      | 25                    | 41.67          |

Table 4. Income sources of fishermen.

3.2.5. Educational status
This study found that, majority of fishermen had no institutional education (33.33%) while 25% of them could write their names only; followed by primary level (16.67%), secondary level (11.67%), S.S.C level (8.33%) and H.S.C level (5%) (Figure 4).

Figure 4. Educational status of fishermen.
3.2.6. Education of the children
The current study found that, most of the fishermen’s children used to go to school (75%) while rest of the children did not go to school (25%) (Figure 5).

![Figure 5. Educational status of fishermen’s children.](image)

3.2.7. Religious status
Current study found that, 100% fishermen was Hindu and we did not find any fishermen from other religions (Table 5).

Table 5. Religious status of fishermen.

| Religion  | Number of respondents | Percentage (%) |
|-----------|------------------------|----------------|
| Hindu     | 60                     | 100            |
| Muslim    | 0                      | 0              |

3.2.8. Household land holding
Most of the fishermen (85%) had at least few decimals of land (2-12 decimals) and a small segment of the fishermen (15%) were found landless and they owned the government khas land (Figure 6).

![Figure 6. Household land holding status of fisher’s community.](image)
3.2.9. Housing conditions
The current study indicated that, majority of fishermen had katcha house (72%) made of shon, paddy straw, bamboo and wood timbers, while we found some houses were tin shed (24%) and pucca buildings (4%) (Figure 7).

![Figure 7. Housing condition of the fishermen.](image)

3.2.10. Sanitation facilities
The current study observed that, majority of latrines of the fishermen were earthen (60%), while some tinshed (20%) and concrete latrines (8%) were also found in the fishermen community. We also found a small portion (10%) of fishermen house had no latrine (Figure 8).

![Figure 8. Sanitation facilities in fishermen community.](image)

3.2.11. Household water facilities
This study found that, most of the fishermen had no tube-wells (80%) while they collect water from nearby places and 20% of fishermen had own tube wells (Table 6).

| Household water facilities       | Number of respondents | Percentage (%) |
|----------------------------------|-----------------------|----------------|
| Own tube-well                    | 12                    | 20             |
| Share neighbors tube-well        | 48                    | 80             |
3.2.12. Electricity facility
This study revealed that, majority of houses of fishermen has no electricity (85%), while 15% had access to electricity facility (Figure 9).

![Electricity facility in fishermen community.](image)

3.2.13. Medical facilities
The result suggested that, majority of fishermen and their families visited village doctors (66.67%) in case of any illness, while some used to visit government health complex (20%), and rest were treated by MBBS doctor (13.33%) (Table 7).

| Medical service          | No. of fishermen (n=60) | Percentage (%) |
|--------------------------|-------------------------|----------------|
| Village doctors          | 40                      | 66.67          |
| Upazila health complex   | 12                      | 20             |
| MBBS doctors             | 8                       | 13.33          |

3.2.14. Bank account holder
It was observed that 58.33% fishermen had bank account and rest of 41.33% fishermen had no bank account (Table 8).

| Account holder   | Number of respondents | Percentage (%) |
|------------------|-----------------------|----------------|
| Bank account     | 35                    | 58.33          |
| Non-bank account | 25                    | 41.67          |

3.2.15. Annual income of the fishermen
The current findings suggested that, majority (33.33%) of fishermen had yearly income range of 35000–40000 BDT, while 28.33% of them received income range of 40000–45000 BDT. The highest range of income 45000–70000 BDT were receive by 13.33% fishermen. This data revealed that, the average income of fishermen community of Habullah baor were 42,833 BDT/year and 3,569 BDT/month (Table 9).
Table 9. Annual incomes of the sampled fishermen in the surveyed areas.

| Income range     | No of fishermen | Annual income (BDT) | Percentage of fishermen | Average income         |
|------------------|-----------------|---------------------|------------------------|------------------------|
| Tk 30000-35000   | 15              | 525000              | 25                     |                        |
| Tk 35000-40000   | 20              | 800000              | 33.33                  | 42,833 Tk/yr           |
| Tk 40000-45000   | 17              | 765000              | 28.33                  | 3,569 Tk/month         |
| Tk 45000-70000   | 8               | 480000              | 13.33                  |                        |
| Total            | 60              | 2570000             |                        |                        |

3.2.16. Involvement of fishers in economic activities
The study area’s primary source of income was fishing, and a sizeable portion of the local population still participates in fishing and activities linked to the fisheries. In the research region, there were around 5,950 persons who had a direct connection to fishing. Nearly every one of them worked as fisherman in a boat. All of the fishermen were capable of net mending, and some were involved in net manufacture. The fishermen were recognized and divided into two categories: boat owner-fishers and worker fishers, depending on their participation in various fishing and fisheries-related activities (Table 10).

Table 10. Classification of fishers in study area.

| Categories of fishers | Characteristics |
|-----------------------|-----------------|
| Boat owner-fisher     | The fisher have own fishing boat and fishing equipment or accessories, and accommodate about 8-10 laborer fishers per boat for fishing. |
| Laborer fisher        | The laborer fishers do not have own boat but join with a boat owner fisher on catch sharing basis. |

3.2.17. Annual savings of fisher community
The present study suggested that, majority of fishermen (30%) had an annual savings of 1000-5000 BDT, followed by 5000-10000 BDT (25%), 10000-15000 BDT (20%), 15000-20000 (16.67%) and 20000-25000 (8.33%) (Table 11).

Table 11. Annual savings of the sampled fishermen.

| Annual savings range (BDT) | No. of fishermen (n=60) | Percentage (%) |
|-----------------------------|-------------------------|----------------|
| 1000-5000                   | 18                      | 30             |
| 5000-10000                  | 15                      | 25             |
| 10000-15000                 | 12                      | 20             |
| 15000-20000                 | 10                      | 16.67          |
| 20000-25000                 | 5                       | 8.33           |

3.2.18. Livelihood outcome
It was found that, 41.67% fishermen improved their livelihood status while 58.33% of fishermen failed to improve their livelihood status through fishing (Table 12).

Table 12. Livelihood outcome of fishermen.

| Improve | Number of respondents | Percentage (%) |
|---------|-----------------------|----------------|
| Yes     | 25                    | 41.67          |
| No      | 35                    | 58.33          |

3.2.19. Training
It was found that, minor portion of fishermen (33.33%) received training and rest of 66.67% did not receive any training related with fisheries activities (Table 13).
Table 13. Training facilities of fishermen.

| Receiving of training | Number of respondents | Percentage (%) |
|-----------------------|-----------------------|----------------|
| Yes                   | 20                    | 33.33          |
| No                    | 40                    | 66.67          |

3.2.20. Credit access and private sectors
The current study suggested that, majority of fishermen (80%) borrowed money from NGOs, while 8% from relatives and 12% fishers did not borrow any money from out sources (Figure 10).

Figure 10. Sources of credit facilities for fishermen.

3.2.21. Occupational status
The current study suggested, majority (86.67%) of fishermen were engaged in fish selling and working as day labor as their main occupational activity, while a small proportion of the fishermen (13.33%) were found involved in boat driving and net making activities (Table 14).

Table 14. Occupational status of studied fishermen.

| Type                               | Number of respondents | Percentage (%) |
|------------------------------------|-----------------------|----------------|
| Fishermen (fish seller and catcher)| 52                    | 86.67          |
| Fishermen (boat driver and net maker) | 8                     | 13.33          |

3.2.22. Social assets
The current study found that, almost all fishermen (100%) had low social status. There was no (0%) local leader, and member of school committee among the fishermen community (Table 15).

Table 15. Social status of fishers.

| Social status of fishers | Number of fishers (n=60) | Percentage (%) |
|--------------------------|---------------------------|----------------|
| Ordinary person          | 60                        | 100            |
| Local leaders/member of school committee | 0                     | 0              |

3.2.23. Feed analysis of fishermen community
It was found that, during dry season, fishermen were mostly depended on vegetables and their fish consumption used to reduce to 2-3day/week from 5-6 days/week (Table 16).
Table 16. Food menu of fisher community.

| Food items                  | Wet season        | Dry season        |
|-----------------------------|-------------------|-------------------|
| Rice                        | Daily             | Daily             |
| Fish                        | 5-6 days/week     | 2-3 days/week     |
| Vegetables                  | 4-5 days/week     | 6-7 days/week     |
| Meat/egg/milk               | Once or twice in every month | Rarely        |
| Muri/chira/panthabhath      | 6-7 days/week     | 5-6 days/week     |

4. Discussion

4.1. Biodiversity status of fish species

The current study found 11 different fish species from six orders and seven families in the Habullah oxbow lake, while some species had seasonal availability and most of them were available in whole year. The IUCN red list status of the fish species were assessed and found majority of the species were not in critical condition. The study of Islam et al. (2017c) found 39 species from Bhairab River and this study covered most of ecological and biodiversity status of some parts of that river. Different studies from Chalan beel found 114 fish species (Hossain et al., 2009), 38 fish species belonging to 24 Genus, 17 families and 8 orders (Karim et al., 2020), 78 fish species (Siddique et al., 2016) and 28 fish species belonging to 8 orders, 16 families (Khanom et al., 2018).

Another study from Kumira, Chittagong found amount of kilogram fishes caught by different fishermen and the catch composition (Mondal et al., 2018); however it could be suggested that, the future studies might be focused on the catch composition with the amount of fishes caught by fisher. This study focused on the common fish biodiversity of Habullah oxbow lake and found most of the fishes were small indigenous species; previous study of Mondal et al. (2020b) and Mondal et al. (2020a) one of the common species Amblypharyngodon mola. On the other hand, some similar studies also focused on the IUCN red list status of available biodiversity in different regions of Bangladesh and other countries (Abu Hena et al., 2022; Kalimuthu et al., 2022; Pramanik et al., 2017; Roy et al., 2022). The current study found, different fishing gears were used for catching fish from the Habullah baor including borsi, castnet, current jal, thelajal, and dharmajal. However the study of Ali et al. (2015) suggested that, fisheremen were used gill net, cast net, fixed purse net, seine net, dip net, lift net and drag/push net for fishing activity in Lohalia River in Patuakhali. Some other studies were also found similar types of fishing gears, for instance, Bay of Bengal (Haque et al., 2021), Surma River, Sylhet district (Mia et al., 2018), Ashura beel, Dinajpur (Ferdoushi et al., 2018), and Hatiya Island (Azam et al., 2014). During monsoon when water level increased the use of all types of gears was also increased simultaneously. Due to the presence of water current, traps were widely used in canal and adjacent shallow water up to October and then reduced gradually with the decreased in water level during rest of months. At the same time, number of nets used was also decreased, but the use of wounding gears increased which were generally used by the subsistence fishermen. These findings indicate that the use of different types of gear varies with the seasonal variation of water level in the beel.

4.2. Livelihood and socio-economic condition of fishermen

The current study found that, most of the fishermen had nuclear family, while rest were joint type of family. The study of Al-Asif and Habib, (2017) found that, around 66% fish farmers lived in joint families and 34% lived with separated families, while Sharif et al. (2015) showed, 86% of farmer and trader had nuclear family and rest of 14% had joint family in fishermen or fish trader of Jashore district. The current study found that, about 50% of the fishermen had small family with 3 to 4 members, followed by medium family and large family. Al-Asif and Habib (2017) found around 26% families had four members, 18% families had five members, 32% families had six members and 24% families had seven or more members in their family in Jashore district. This study found majority of the fisheremen were middle aged, followed by young aged and old aged, while the study of Islam et al. (2017a) from Meherpur district suggested that, most of the fishermen were in the age group of 31-40 years. This statement was also supported by the study of Mondal et al. (2018) from two coastal villages, namely Kumira and Kattoli, Chittagong.

The current study found that, majority of income came from baor fishing activity, while rest of the fishermen were involved in others occupation such as agricultural activity, labors and tea stall business. The study of Adhikary et al. (2018) suggested, majority of fisher used to engaged with agriculture in Noakhali district as they had their own lands. The study of Vaumik et al. (2017) also found the similar result from Lalmonirhat district. This study found that, majority of fishermen had no institutional education followed by could write their names only, primary level, secondary level, S.S.C level and H.S.C level. The study of Al-Asif and Habib (2017) found
majority of fishermen had highest secondary level of education, while Al-Asif et al. (2015) found in Jashore district that, majority of fish fingerling traders had no experience of education, coincident with the current findings. As government made mandatory primary education for every children of the country, the current study found that, most of the fishermen’s children used to go to school while rest of the children did not go to school. This result were supported by Adhikary et al. (2018), and Al-Asif and Habib (2017).

Current study found that, all of the fishermen was Hindu, however study of Al-Asif and Habib (2017) found 12% Hindu population among fisher in Jashore district. While result of Sharif et al. (2015) suggested that, all the fisher were Muslim as the area was populated by Muslim community. Most of the fishermen had at least few decimals of land (2-12 decimals) and a small segment of the fishermen were found landless and they owned the government khas land. The study of Al-Asif and Habib (2017) suggested that, majority of fisher had at least some decimal of own land, which supported the present study. On the other hand a study from Sundarban mangrove forest suggested that most (78%) of the fry collectors were landless (Islam et al., 2015). The current study indicated that, majority of fishermen had katcha house made of shon, paddy straw, bamboo and wood timbers, which were supported the result of Al-Asif and Habib (2017), Adhikary et al. (2018), Al-Asif et al. (2015), Sharif et al. (2015), Islam et al. (2014), and Hossain et al. (2016). The current study observed that, majority of latrines of the fisher were earthen, while some tinshed and concrete latrines were also found. The study of Al-Asif and Habib (2017) found a total of 100% of fishermen good sanitation facilities, however as this area of the baor was underprivileged area, the sanitation facilities were not so good at this area. This study found that, most of the fishermen had no tube-wells while they collect water from nearby places and minor portion of fisher had own tube wells. The study of Al-Asif and Habib (2017) that the all fishermen community had good water supply facilities, while the study from Noakhali district suggested that, majority of fishermen had their own tube-well (Adhikary et al., 2018). This study found that, majority of houses of fisher has no electricity, while some had access to electricity facility while the study of Vaumik et al. (2017) found majority of the fisher had electricity facilities in Lalmonirhat district, which was found opposite with the present study. In Noakhali district it was also found that majority of fisher had electricity in their home or business institution (Adhikary et al., 2018).

The current result suggested that, majority of fisher and their families visited village doctors in case of any illness, while some used to visit government health complex, and to MBBS doctors. The study of Al-Asif and Habib (2017) found almost all of the fisher visited to the MBBS doctor for their sickness, while in Noakhali most of the fisher used to visit to local kabiraj (Adhikary et al., 2018). Al-Asif et al. (2015) found that, majority of the fisher visited to government health complex for their sickness in Jashore district. On the other hand, Sharif et al. (2015) found majority of fisher visited to the quack doctors. The present study observed that, majority of fishermen had bank account, which were found similar with the studies of Al-Asif and Habib (2017), Al-Asif et al. (2015), Sharif et al. (2015), Islam et al. (2014). The current findings suggested that, majority of fishermen had yearly income range of 35000–40000 BDT, while 28.33% of them received income range of 40000–45000 BDT. The highest range of income 45000–70000 BDT were receive by 13.33% fishermen. Studies of Al-Asif and Habib (2017), Vaumik et al. (2017), and Adhikary et al. (2018) discussed about the annual income of fishermen but however, the ranges were far higher than the current study, which could be due to the underprivileged area of Jashore district. The study area’s primary source of income was fishing, and a sizeable portion of the local population still participates in fishing and activities linked to the fisheries. In the research region, there were around 5,950 persons who had a direct connection to fishing. Nearly every one of them worked as fisherman in a boat. All of the fishermen were capable of net mending, and some were involved in net manufacture. The fisher were recognized and divided into two categories: boat owner-fishers and worker fishers, depending on their participation in various fishing and fisheries-related activities. The present study suggested that, majority of fishermen had an annual savings of 1000–5000 BDT, followed by 5000–10000 BDT, 10000–15000 BDT, 15000–20000 and 20000–25000. The study of Mozahid et al. (2018) suggested that majority of fishermen in Sunamganj district had no savings for their future. The current study found that, minor portion of fishermen received training from different organizations including the government agencies (DoF, BFRI, University, etc.), however study of Sultana et al. (2015) emphasized on the training for farm women, while some other studies also revealed that, fishermen used to receive training from different organizations (Al-Asif and Habib, 2017; Vaumik et al., 2017).

The current study suggested that, majority of fishermen borrowed money from NGOs, while some used to take money from relatives. Al-Asif and Habib (2017) found, fishermen used their own money for investing in any projects while some taken loan from bank and NGOs. The similar findings were also reported by Vaumik et al. (2017) and Sharif et al. (2015). The current study suggested, majority of fishermen were engaged in fish selling and working as day labor as their main occupational activity, while a small proportion of the fishermen were
found involved in boat driving and net making activities. The study of Adhikary et al. (2018) suggested, majority of fisher used to engaged with agriculture in Noakhali district as they had their own lands. The study of Vaumik et al. (2017) also found the similar result from Lalmonirhat district. The current study found that, almost all fishermen had low social status. It was also found that, during dry season, fishermen were mostly depended on vegetables and their fish consumption used to reduce to 2-3day/week from 5-6 days/week. One study from Noakhali district found that, before fish farming 64% fish farmer taken 2 times meal per day, 24% fish farmer taken 1 time meal per day and only 12% farmer taken 3 times meal per day (Adhikary et al., 2018).

5. Conclusions
The biodiversity and livelihood status of fishermen of Habullah Baor came out with the study. The IUCN red list status of available fish species in Habullah Baor was accessed. Livelihood conditions of the fishermen in Bagherpara upazila were not satisfactory. In the study area, fishermen were deprived of many facilities. The education level of the fishermen was not good. Lack of awareness as well as the poor income, the fishermen have to take loan from Mohajan at high interest.

Acknowledgements
The research team would like to acknowledge the logistic and technical support of the Department of Fisheries Management, Bangladesh Agricultural University. No financial support was received for conducting the study.

Data availability
The data of this current investigation will be available upon valid request by any authority from the corresponding author.

Conflict of interest
None to declare.

Authors’ contribution
Jamil: conceptualization, methodology, analysis and manuscript writing; B.M. Newaz Sharif: reviewing and editing; Lirong Yu Abit: data analysis, interpretation, graphical presentation and map preparation, reviewing and editing; Md. Idris Miah and Md. Shahjahan: Supervision, conceptualization, methodology, reviewing and editing. All authors have read and approved the final manuscript.

References
Abu Hena MK, A Sinden, MH Idris, A Al-Asif, H Hamli, N Musa, RM Piah, MEA Wahid, RA Lah, NW Rasdi, MH Abualreesh, KA Bhuiyan and AM Shahabuddin, 2022. Diversity of fisheries in Sarawak, Northwest Borneo: present status and conservation issues. Borneo J. Res. Sci. Tech., 12: 32–51.
Adhikary RK, S Alam and A Al-Asif, 2018. Aquatic weeds diversity of Fatki River in Magura district, Bangladesh. Asian Australas. J. Biosci. Biotechnol., 3: 201–207.
Adhikary RK, S Kar, A Faruk, A Hossain, MNM Bhuiyan and A Al-Asif, 2018. Contribution of aquaculture on livelihood development of fish farmer at Noakhali, Bangladesh. Asian Australas. J. Biosci. Biotechnol., 3: 106–121.
Aerts R, Honnay O and A Van Nieuwenhyusse, 2018. Biodiversity and human health: Mechanisms and evidence of the positive health effects of diversity in nature and green spaces. British Med. Bull., 127: 5–22.
Ahamed GS, T Alam, KS Mazumder, M Islam, A Rashid and T Dey, 2019. Present status of oxbow lake fisheries: Cases from south-western Bangladesh. Int. J. Fish. Aqua. Stud., 7: 451–458.
Al-Asif A and MAB Habib, 2017. Socio-economic condition of fish farmers of Jhikargachha upazila in Jessore district, Bangladesh. Asian J. Med. Biol. Res., 3: 462–475.
Al-Asif A, MA Samad, MH Rahman, MA Farid, SM Yeasmin and BMS Rahman, 2015. Socio-economic condition of fish fry and fingerling traders in greater Jessore region, Bangladesh. Int. J. Fish. Aqua. Stud., 2: 290–293.
Ali M, B Das, S Islam, M Masud and M Rahman, 2015. Fishing gears and crafts used by the fishers at Lohalia River in Patuakhali. J. Env. Sci. Nat. Res., 7: 169–175.
Apon AH, A Hossain, S Islam, H Rahman, A Al-Asif, JA Mirza and MM Billah, 2019. Impact of stocking common carp (Cyprinus carpio) on production in some selected Beels in Gazipur district, Bangladesh. Int. J. Exc. Inno. Dev., 2: 41–55.
Avvisati F, 2020. The measure of socio-economic status in PISA: a review and some suggested improvements. Large-Sca. Ass. Educ., 8: 1-37.

Azad KN, S Akter and KN Azad, 2020. Fish species availability and socio-economic conditions of fishermen of the Bergobindopur baor, Jashore, Bangladesh. Bangladesh J. Fish., 32: 199–206.

Azam AKMS, D Saha, M Asadujjaman, KR Mahbub and MH Minar, 2014. Fishing gears and crafts commonly used at Hatiya Island: A coastal region of Bangladesh. Asian J. Agri. Res., 8: 51–58.

Aziz MSB, NA Hasan, MMR Mondol, MM Alam and MM Haque, 2021. Decline in fish species diversity due to climatic and anthropogenic factors in Hakaluki Haor, an ecologically critical wetland in northeast Bangladesh. Heliyon, 7: e05861.

Baker JA, KJ Killgore and RL Kasul, 1991. Aquatic habitats and fish communities in the lower Mississippi River. Rev. Aqua. Sci., 3: 313–356.

Biswas A, JK Tripti, MA Farid, MH Rahman and S Ghosh, 2021. Present status of fish biodiversity and socio-economic conditions of fishermen of the Kannayadaha baor, Jashore, Bangladesh. Int. J. Biosci., 18: 120–126.

Biswas MMR, MF Islam, MM Rahman, MA Kawsar and SK Barman, 2009. Fisheries management scenarios of two Baors in the district of Chuadanga, Bangladesh. J. Inno. Dev. Str., 3: 11–15.

Bradley RH, 2016. Socioeconomic status. In: Encyclopedia of mental health. Edited by: Bradley RH, Elsevier, pp. 196–210.

Cantonati M, S Poikane, CM Pringle, LE Stevens, E Turak, J Heino, JS Richardson, R Bolpagni, A Borrini, N Cid, Tvrtilková M, DMP Galassi, M Hájek, I Hawes, Z Levkov, L Naselli-Flores, AA Saber, MD Cicco, B Fiasca and P Znachor, 2020. Characteristics, main impacts, and stewardship of natural and artificial freshwater environments: Consequences for biodiversity conservation. Water, 12: 1-85.

Chowdhury S and P Chakraborty, 2017. Universal health coverage—There is more to it than meets the eye. J. Fam. Med. Pri. Car, 6: 169–170.

Darín-Mattsson A, S Fors and I Kärreholt, 2017. Different indicators of socioeconomic status and their relative importance as determinants of health in old age. Int. J. Equ. Heal., 16: 1–11.

Ferdoushi Z, M Rana, N Gupta, Y Ara and A Hossain, 2018. Fishing gears and their targeted species of Ashura beel in Dinajpur. J. Sci. Tech., 16: 9–23.

Gilling J, S Jones and A Duncan, 2001. Sector approaches, sustainable livelihoods and rural poverty reduction. Dev. Pol. Rev., 19: 303–319.

Halim A, S Islam, DK Mondal, S Rana, HMH Rahman and N Mohammad, 2018. Fish production in baors environment of Bangladesh, present status and challenges: a review. J. Entom. Zool. Stud., 6: 163–167.

Hälsten M and M Thaning, 2022. Wealth as one of the “Big Four” SES dimensions in intergenerational transmissions. Soe. For., 100: 1533–1560.

Haque MA, MI Hossain, SJ Hasan and PK Dey, 2021. Diversity of fishing gears and crafts used for harvesting the Asian seabass, Lates calcarifer along the Bay of Bengal, Bangladesh coast. Bangladesh J. Fish., 33: 147–155.

Hiddink JG, BR MacKenzie, A Rijnsdorp, NK Dulvy, EE Nielsen, D Bekkevold, M Heino, P Lorance and H Ojaveer, 2008. Importance of fish biodiversity for the management of fisheries and ecosystems. Fish. Res., 90: 6–8.

Hoque MZ and Ø Myrland, 2022. Consumer preference for fish safety inspection in Bangladesh. Aquaculture, 551: 737911

Hossain MAR, M Nahiduzzaman, MA Sayeed, ME Azim, MA Wahab and PG Olin, 2009. The Chalan beel in Bangladesh: Habitat and biodiversity degradation, and implications for future management. Lak. Reserv. Res. Man., 14: 3–19.

Hossain MM, 2019. Future importance of healthy oceans: Ecosystem functions and biodiversity, marine pollution, carbon sequestration, ecosystem goods and services. J. Oce. Coas. Econ., 6: 1–32.

Hossain MZ, A Pal, MA Hasan, MS Parvej, N Nahar and A Al-Asif, 2016. Nutritional status and socio-demographic characteristics of the people of south-west coastal region in Bangladesh. Asian Australas. J. Biosci. Biotechnol., 1: 323–332.

Hussain MG, 2010. Freshwater fishes of bangladesh: Fisheries, biodiversity and habitat. Aqua. Ecosys. Heal. Man., 13: 85–93.

Islam FMK, A Al-Asif, M Ahmed, MS Islam, B Sarker, MA Zafar and M Rahman, 2017a. Performances of resource poor households in aquaculture practices in sadar upazila, Meherpur, Bangladesh. Int. J. Fish. Aqua. Stud., 5: 281–288.
Islam MD, SM Rahmatullah, M Ahmed, A Al-Asif, A Satter, B Sarker, A Hosain and S Mojumder, 2017b. Aquatic weeds diversity of Bangladesh Agricultural University Campus, Mymensingh, Bangladesh. Asian Australas. J. Biosci. Biotechnol., 2: 181–192.

Islam MF, SA Haque, MS Islam, PS Das and M Rahman, 2021. Socio-economic status of fisher communities in Dengar beel under Melandah Upazila, Jamalpur, Bangladesh. Asian J. Med. Biol. Res., 7: 164–173.

Islam MM, A Al-Asif, S Vaumik, MA Zafar, BMN Sharif, MH Rahman and S Shahriyar, 2015. Socio economic status of fry collectors at Sundarban region. Int. J. Fish. Aqua. Stud., 3: 89–94.

Islam MM, S Sallu, K Hubacek and J Paavola, 2014. Vulnerability of fishery-based livelihoods to the impacts of climate variability and change: insights from coastal Bangladesh. Reg. Env. Chan., 14: 281–294.

Islam MA, A Al-Asif, MA Samad, BMS Rahman, MH Rahman, A Nima and SM Yeasmin, 2014. Socio-economic conditions of the fish farmers in Jessore, Bangladesh. Int. J. Bus. Soc. Sci. Res., 2: 153–160.

Islam MA, A Al-Asif, MA Samad, B Sarker, M Ahmed, A Satter and A Hossain, 2017c. A comparative study on fish biodiversity with conservation measures of the Bhairabriver, Jessore, Bangladesh. Asian J. Med. Biol. Res., 3: 357–367.

Kalimuthu K, H Hamli, MT Engan, JB Rasidi, M Rabullah, J Ismail, A Al-Asif and GI Gerusus, 2022. Diversity of fish and macrobenthos at the coastal area of Tanjung Kidurong Power Plant (TKPP: Sarawak, Malaysia. Egyptian J. Aqua. Biol. Fish., 26: 585–607.

Karim SR, KA Halim, MA Uddin, MF Yeasmin and K Hasanuzzaman, 2020. Investigation on species composition in Chalan beel of Bangladesh. Int. J. Fish. Aqua. Stud., 8: 88–91.

Khanom DA, MR Akhtar and A Jewel, 2018. Fish biodiversity and conservation status in Uthrail Beel of Naogaon district, Bangladesh. Univ. J. Zool. Rajshahi Univ., 37: 28–34.

Leela M, MFU Zaman, A Al-Asif and MA Hossain 2018. Availability of fish species in fish markets and fish marketing in Noakhali district , Bangladesh. J. Entom. Zool. Stud., 6: 1332–1344.

Lynch AJ, SJ Cooke, AM Deines, SD Bower, DB Bunnell, IG Cowx, VM Nguyen, J Nohner, K Phouthavong, B Riley, MW Rogers, WW Taylor, W Woelmer, SJ Youn and TD Beard, 2016. The social, economic, and environmental importance of inland fish and fisheries. Env. Rev., 24: 115–121.

Mia MR, ASM Arif, PR Das, R Islam and MA Hossen 2018. Fishing gears and crafts of the Surma River in Sylhet district , Bangladesh. Int. J. Fish. Aqua. Stud., 6: 399–407.

Miranda R, I Miqueleiz, W Darwall, C Sayer, NK Dulvy, KE Carpenter, B Polidoro, N Dewhurst-Richman, C Pollock, C Hilton-Taylor, R Freeman, B Collen and M Böhm, 2022. Monitoring extinction risk and threats of the world’s fishes based on the Sampled Red List Index. Rev. Fish Biol. Fish., 32: 975–991.

Mondal MAI, MA Kader, AH Choudhury, G Mustafa, RU Nabi, MM Billah, A Al-Asif and AAM Siddiqui, 2018. Socio-economic uplifting analysis of ESBN fishery of the coastal villages, Kumira and Kattoli, Chittagong, Bangladesh. Int. J. Res. Gran., 6: 248–263.

Mondal MAI, M Kader, MRU Nabi, AAM Siddiqui, MM Billah and A Al-Asif, 2018. Bio-economic analysis of ESBN fishery of Kumira, the coastal area of Chittagong, Bangladesh. Asian J. Med. Biol. Res., 4: 315–322.

Mondal S, A Wahab, BK Barman and A Al-Asif, 2020a. Breeding biology of mola carplet, (Amblypharyngodon mola, Hamilton, 1822) in semi-natural condition. Asian J. Anim. Sci., 14: 111–120.

Mondal S, A Wahab, BK Barman and A Al-Asif, 2020b. Enhance the contribution of small indigenous fish production: Emphasis mola (Amblypharyngodon mola) with carps in North-West of Bangladesh. Singapore J. Sci. Res., 10: 308–316.

Mozahid MN, JU Ahmed, M Mannaf and S Akter, 2018. Role of small scale fishing on the livelihood improvement of Haor fishermen: An empirical evidence from Bangladesh. American J. Econ. Bus. Admin., 10: 1–10.

Parmar TK, D Rawtani and YK Agrawal, 2016. Bioindicators: the natural indicator of environmental pollution. Front. Life Sci., 9: 110–118.

Pramanik MMH, MM Hasan, SM Bishhas, A Hossain, AA Hossain and TK Biswas, 2017. Fish biodiversity and their present conservation status in the Meghna River of Bangladesh. J. Entom. Zool. Stud., 5: 446–455.

QGIS Development Team, 2019. QGIS geographic information system, GNU GPLv2. Open Source Geospatial Foundation Project.

Rahman MN and ARMT Islam, 2020. Consumer fish consumption preferences and contributing factors: empirical evidence from Rangpur city corporation, Bangladesh. Heliyon, 6: e05864.

Rahman M, MF Tazim, SC Dey, AKMS Azam and MR Islam, 2012. Alternative livelihood options of fishermen of Nijhum Dwip under Hatia Upazila of Noakhali district in Bangladesh. Asian J. Rur. Dev., 2: 24–31.
Raju RH, MA Samad, A Al-Asif, MM Billah and MA Ali, 2018. Variation in the plankton abundance, biomass and diversity of municipal pond and Bukvorabaor at Jashore district, Bangladesh. Res. Rev. J. Bioinfo., 5: 1–14.

Razeim MA, MG Farouque, MA Sarker, A Al-Asif and M Ahmed, 2017. Attitude of farmers towards Pangas farming for their livelihood improvement. Asian Australas. J. Biosci. Biotechnol., 2: 106–119.

Roy D, NB Didar, S Sarker, MAR Khan and GA Latifa, 2022. Appraisal of different attributes of fish community in Andharmanik River of coastal Bangladesh and socio-economic conditions of fishermen. Heltyon, 8: e09825.

Samad MA, BS Rahman, A Al-Asif and RK Audhikary, 2013. Availability and potentiality of small indigenous species of fish throughout the year in South-Western region of Bangladesh. African J. Bas. App. Sci., 5: 167–173.

Scoones I, 2009. Livelihoods perspectives and rural development. J. Peas. Stud., 36: 171–196.

Shamsuzzaman MM, MM Islam, NJ Tania, AM Al-Mamun, PP Barman and X Xu, 2017. Fisheries resources of Bangladesh: Present status and future direction. Aqua. Fish., 2: 145–156.

Sharif BMN, R Hassan, MM Islam, MM Rahaman, SK Das, MI Miah and MR Amin, 2016. A study on fishery management of Bergobindapur baor at Chaugachha upazila under Jessore district, Bangladesh. Asian Australas. J. Biosci. Biotechnol., 1: 291–296.

Sharif BMN, A Al-Asif, S Vaumik, MA Zafar, MM Islam and MA Samad, 2015. Socio-economic condition of fish farmer and trader at the village of Pitamborpur in Chaugachha Upazilla in Jessore, Bangladesh. Int. J. Fish. Aqua. Stud., 3: 212–217.

Siddique AB, MA Hussain, FA Flowra and MM Alam, 2016. Assessment of fish fauna in relation to biodiversity indices of Chalan Beel, Bangladesh. Int. J. Aqua. Biol., 4: 345–352.

Singh PK and H Chudasama, 2020. Political will and development priorities effects on infrastructure investment for resilience and poverty alleviation. PLoS ONE, 15: e0227176.

Stacey N, E Gibson, NR Loneragan, C Warren, B Wiryawan, DS Adhuri, DJ Steenbergen and R Fitriana, 2021. Developing sustainable small-scale fisheries livelihoods in Indonesia: Trends, enabling and constraining factors, and future opportunities. Mar. Pol., 132: 104654.

Sui H, J Wang, Z Li, Q Zeng, X Liu, L Ren, C Liu, Y Zhu, L Lv, Q Che and X Liu, 2020. Screening of ecological impact assessment indicators in urban water body restoration process title. Ecol. Indi., 113: 106198.

Sultana N, A Al-Asif, MMI Dihider, SM Ahsan and FS Maraj, 2015. Usefulness of farm women training programmes in livelihood security. Int. J. Bus. Soc. Sci. Res., 4: 13–24.

Vaumik S, SK Sarker, MS Uddin, MT Alam, A Satter and A Al-Asif, 2017. Constraints and prospects of fish farming in Lalmonirhat district. Int. J. Bus. Soc. Sci. Res., 5: 201–210.

Voumik LC, 2014. A green economy in the context of sustainable development and poverty eradication: What are the implications for Bangladesh? J. Econ. Sust. Dev., 5: 119–131.

Vyas V, V Parashar and D Damde, 2009. Fish biodiversity and preferential habitats of fishes in selected stretch of Narmada River. Nat. Env. Poll. Tech., 8: 81–89.

Yu Y and J Huang, 2021. Poverty reduction of sustainable development goals in the 21st century: A bibliometric analysis. Fron. Comm., 6: 754181.

Zaghloul A, M Saber, S Gadow and F Awad, 2020. Biological indicators for pollution detection in terrestrial and aquatic ecosystems. Bull. Nat. Res. Cen., 44: 127.