

Article

Cut off from River, but rich in biodiversity: fish biodiversity and livelihood of fishermen in Jhapa baor, Jashore, Bangladesh

Fahmida Sultana Rimi¹, Subrata Mondal^{1*}, B.M. Newaz Sharif², Jamil³ and Md. Barkot Hasan¹

¹Department of Fisheries and Marine Bioscience, Faculty of Biological Science and Technology, Jashore University of Science and Technology, Jashore – 7408, Bangladesh

²Research and Development Department, Fishtech Hatchery Limited, Dhaka, Bangladesh

³Department of Fisheries Management, Faculty of Fisheries, Bangladesh Agricultural University, Mymensingh, 2202, Bangladesh

*Corresponding author: Subrata Mondal, Department of Fisheries and Marine Bioscience, Faculty of Biological Science and Technology, Jashore University of Science and Technology, Jashore – 7408, Bangladesh. E-mail: s.mondal@just.edu.bd

Received: 02 October 2022/Accepted: 04 November 2022/ Published: 18 November 2022

Copyright © 2022 Fahmida Sultana Rimi *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: Oxbow lake is one of the significant freshwater fisheries assets in Bangladesh, which supports livelihood of fishermen community. This study was conducted to assess the fish biodiversity and socio-economic conditions of fishermen in Jhapa baor (oxbow lake) at Manirampur upazilla in Jashore district from July to September 2019. This investigation used primary data, collected through household interviews, key informant or cross-checked interviews, Focus Group Discussion (FGDs) as well as secondary data. Fish fauna were identified based on their morphometric and meristic characters. After identification, fish species were systematically classified. A total of 43 species belonged to 11 orders and 17 families were identified from the baor. A total of five types of nets, three types of fish traps and four types of wounding gears were found during the survey. Furthermore, results of this study didn't show improved socio-economic conditions of the baor fisheries dependent families. Their income was less than the national average. Almost 50% of the households had up to 4 family members. Most family had single earning member. Most didn't have land aside from residence and their houses were earthen made. Although most of them had access to safe drinking water, few had access to quality health services and sanitary latrine. Their education levels were low about 70% fishers had no or beneath primary level education. Although currently the majority of their children were school going (72%) and the percentage is increasing gradually. Almost 65% of fishing community was involved with credit organization. This study will provide the baseline information about biodiversity and livelihood status of fishermen in Jhapa baor.

Keywords: oxbow lake; biodiversity; seasonal availability; fishing gears; co-operative organization

1. Introduction

Bangladesh produces 4.4 million metric tons of fish every year in which aquaculture contributes the most (56.76% of the total production) followed by inland waters capture-based fisheries (28.19% of total production) affiliating 3rd in inland open water capture production and 5th in world aquaculture production (FRSS, 2019). As the rank of capture fishery reducing gradually, the aquaculture sector got a jackpot and became the second largest producer just after mainland China (Al-Asif *et al.*, 2021b). Over one third of total fish habitat in

Bangladesh is occupied by inland water-bodies, which support some 260 fish species (Shamsuzzaman *et al.*, 2017).

Since fishing is frequently available in distant and rural locations with few other economic activities, it may be a significant source of economic growth and livelihood in rural areas (Al-Asif and Habib, 2017; Islam *et al.*, 2017a; Islam *et al.*, 2014; Shamsuzzaman *et al.*, 2020). In addition to direct reliance, fisheries support various economic activities made possible by the availability of fish, including as processing, packaging, manufacturing, transport, and distributions (Chwakravorty *et al.*, 2019; Hossain *et al.*, 2015; Islam *et al.*, 2017b; Leela *et al.*, 2018; Sharif and Al-Asif, 2015; Rahaman *et al.*, 2015). Additionally, it offers auxiliary activities such boat building, net and gear making, engine manufacture and repair, ice production and supply, supply of services to fisherman and fuel to fishing boats (Zhao and Jia, 2020).

Although the country's fisheries industry plays a significant part in the economy, it is in danger of being extinct (Brander, 2007; Hossain, 2014). The primary causes of the decline in fisheries are believed to be overexploitation, pollution, degradation of the riverine environment, and irresponsible human intervention (Aziz *et al.*, 2021; Hussain, 2010; Miah *et al.*, 2021). Besides, lack of awareness about the river water or open water fishes convert the poor situation to worst (Islam *et al.*, 2017c; Samad *et al.*, 2013).

It is apparent that, finding out the current biodiversity state of the open water fisheries is necessary for the conservation of the fisheries resources (Abu Hena *et al.*, 2022; Al-Asif *et al.*, 2021a; Kalimuthu *et al.*, 2022). There has been very little or no study discovered in Bangladesh, and further research is needed to conserve these fisheries resources (Islam *et al.*, 2017c; Jamil *et al.*, 2022). Numerous studies have been conducted globally to evaluate the variety of fishes (Aziz *et al.*, 2021; Hossain *et al.*, 2012; Lévêque *et al.*, 2008; Toussaint *et al.*, 2016).

Baors were one of the significant fishing sectors in Bangladesh's inland water resources (Hasan *et al.*, 2021; Shamsuzzaman *et al.*, 2017). The oxbow lakes in the south-west of Bangladesh are the most effective example of culture-based fisheries that have been accomplished there (Abdul Halim *et al.*, 2018; Al Mamun and Brook, 2015; Jamil *et al.*, 2022). The Ganges delta's sluggish Oxbow Lake is a semi-closed body of water that is occupied by river channels that have dried up (Jamil *et al.*, 2022).

Baors have a significant role in the production of inland fish as well as the life of fishermen (Ahamed *et al.*, 2019; Jamil *et al.*, 2022; Sharif *et al.*, 2016). Baor fisheries resources either entirely or partially supported the livelihood of baor fishers (Islam *et al.*, 2018; Jamil *et al.*, 2022). An accurate assessment of the current situation, the chances and hazards of future changes, and the potential for reducing adverse effects on the quality of human existence are all dependent on regional socioeconomic analysis (Bodrud-Doza *et al.*, 2020; Mondal *et al.*, 2018b; Rahaman *et al.*, 2020; Rashed *et al.*, 2017; Salam *et al.*, 2020; Uddin *et al.*, 2022).

With its abundant biological and water resources, the baor area in the Jashore district contributes significantly to the nation's economy (Azad *et al.*, 2020; Jamil *et al.*, 2022). For marine and freshwater natural resources, including commercial fisheries, to be sustained in the future, biodiversity management is crucial (Abu Hena *et al.*, 2022; Al-Asif *et al.*, 2022; Elliott *et al.*, 2022; Jahan *et al.*, 2018). Inland water bodies have seen extensive human interference over the past century, which has led to habitat loss and degradation; as a result, several fish species have become critically endangered, globally (Abu Hena *et al.*, 2022; Neogi *et al.*, 2017). Considering the knowledge gap in biodiversity and livelihood condition of fishermen in south-western oxbow lake fishery, this study was conducted to assess the fish biodiversity and socio-economic conditions of fishermen of the Jhapa baor.

2. Materials and Methods

2.1. Study site and periods

The study was conducted in Jhapa baor (22°59'1.34"N, 89° 9'36.39"E, 22°59'1.34"N) at Manirampur upazilla in Jashore district (Figure 1). The oxbow lake is surrounded by six villages belongs to three unions. Total area of this baor is 605 acres, which found one of the biggest water bodies of this area. Water remains almost all the year round but in rainy season, the area increases. More than 3000 peoples directly or indirectly depends on this baor such as in fish culture, fishing, fish business, fish marketing, agriculture, transport, and other occupation. This study was conducted from July 2019 to September 2019.

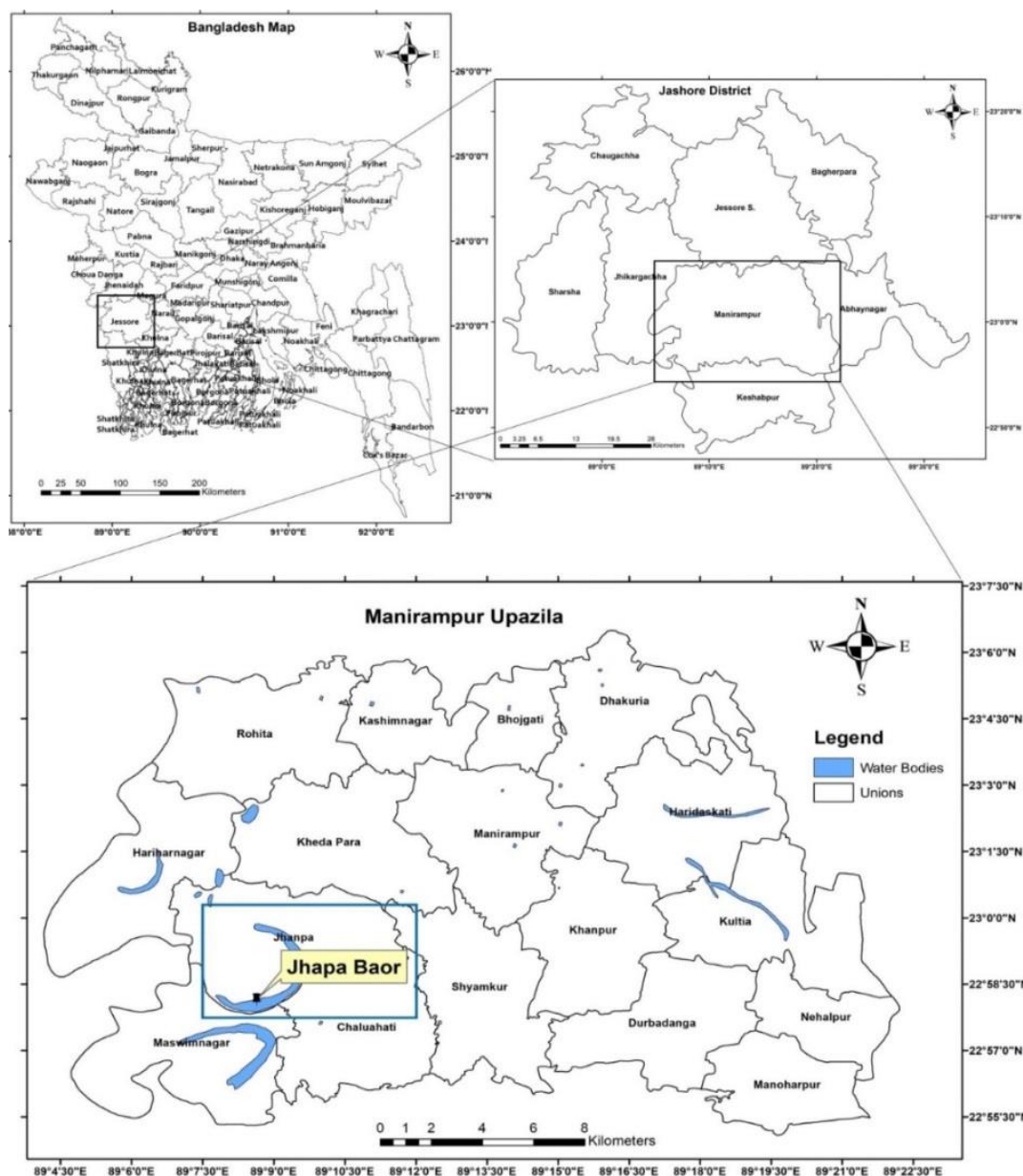


Figure 1. Map showing the study area.

2.2. Identification of the fishes

Fish fauna collected from the study area were identified based on their morphometric and meristics characters following Akter *et al.* (2016), Talwar and Jhingran (1991), Hossain *et al.* (2016a). After identification, fish species were systematically classified according to Kalimuthu *et al.* (2022).

2.3. Distribution of respondents

Interviews were conducted with respondents in the baor area and most of the respondents were from Jhapa (30%), followed by Komolpur (21.7%), Rajbari (20%), Mobarakpur (15%), Rampur (10%) and Hanuair (3.30%) from six villages (Figure 2).

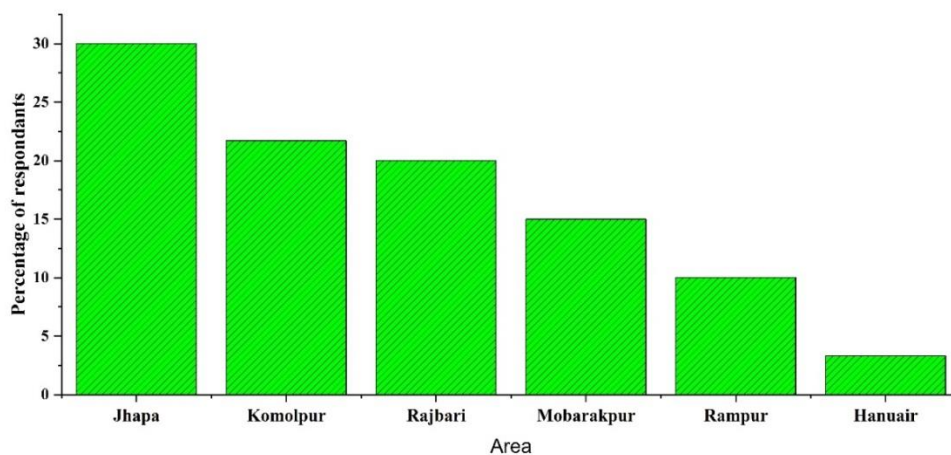


Figure 2. Respondent distribution in baor fishermen community.

2.4. Data collection

2.4.1. Primary data collection

Primary data were collected using face-to-face semi-structured interviews, focus group discussions (FGDs) and key informant interviews with the fishermen. Questions were related to fish species availability, fishing gear used, fishers family size, age status, religious status, earning members, educational status, income, income from baor, land ownership status, house type, diseases status, food intake, loan/credit status etc.

2.4.2. Secondary data collection

Secondary data were collected by literature review, commune’s annual reports and different research paper etc.

2.5. Data processing and analysis

All of the information was compiled, thoroughly examined, and documented. Using OriginLab 2022, the data were shown graphically. The map of the research region was presented using GIS software.

3. Results

3.1. Fish Biodiversity of Jhapa Baor

3.1.1. Fishing gears operated in Jhapa Baor

A total of five types of nets (gill net, seine net, cast net, dip net, push net), three types of fish traps (vair, bitte, ghuni) and four types of wounding gears (chip borshi, wheel borshi, teta/kala thurkuj, Koach) were found for catching fishes in Jhapa baor (Table 1, Figure 3).

Table 1. Fishing gears operated in Jhapa Baor

Group name	Gear type	Local name	Species caught
Nets	Gill net	Current jal	Chapila, Pangus, Tengra, Puti, Taki
		Fash jal	Puti, Taki, Shing, Bele, Kunchu chingri
	Seine net	Ber jal	Rui, Catla, Tit puti, Pungus
	Cast net	Khepla jal	Silver carp, Rui, Catla, Bata, Boal, Gozar, Ayre
	Dip net	Chuni	Boal, Grass carp, Mrigal, Shing
	Push net	Thela jal	Puti, Taki, Bele, Chapila
	Drug net	Tana jal	Bele, Taki, Puti
Fish traps	-	Charo/vair	Rui, Catla, Boal, Gozar, Shol, Baim, Taki
	-	Bitte	Tit puti, Kunchu chingri, Tengra, Chanda
	-	Ghuni/ Kholsun	Baim, Tit puti, Kunchu chingri, Tengra, Chanda, Koi, Chapila
Wounding gears	Hook and line	Chip borshi	Tit puti, Taki, Boal, Rui, Catla, Shol
		Wheel borshi	Tit puti, Taki, Boal, Rui
	-	Teta/Kala thurkuj	Taki, Boal, Shol, Bele
	-	Koach	Rui, Catla, Shol, Gozar

*For scientific name of fishes, please see Table 2.



Figure 3. Different type of nets, traps and wounding gears (a) current jal, (b) fash jal, (c) ber jal, (d) khepla jal, (e) chuni, (f) thela jal/chitki, (g) charo, (h) vair, (i) ghuni, (j) chip borshi, (k) wheel borshi, (l) teta/kala thurkuj, (m) koach.

This study also found that, among the fishing gears majority of fishermen (46.16%) preferred nets, 23.07% used fish traps and 30.77% wounding gears were used by the fishermen (Figure 4).

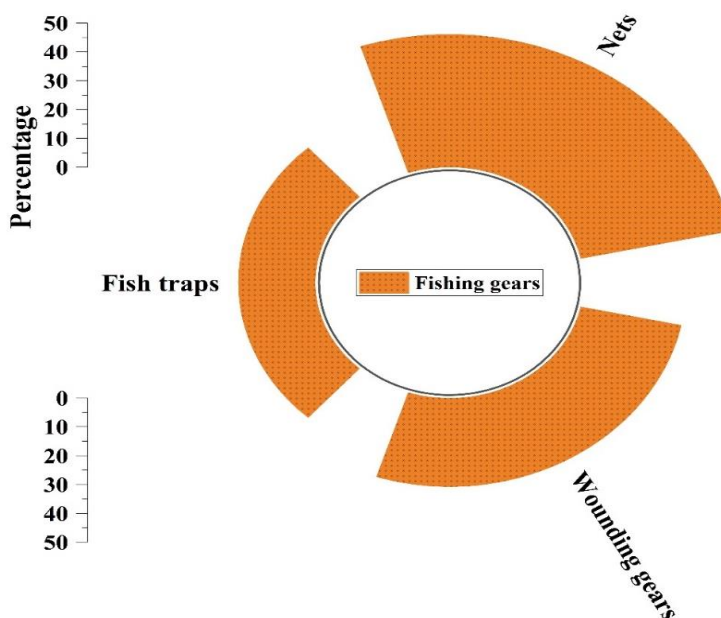


Figure 4. Percentage of fishing gears used.

3.1.2. Fish biodiversity in Jhapa Baor

A total of 43 fish species belonged to 11 orders and 17 families were found in Jhapa baor (Table 2). A total of 17 common groups of fishes were identified in the baor. While the majority of fish were determined to be year-round, and certain species were seasonal.

Table 2. List of recorded fish species with biodiversity status

Order	Family	Scientific Name	Local Name	IUCN status	Availability	
					Y	S
Anabantiformes	Anabantidae	<i>Anabas testudineus</i>	Koi	LC	-	+
		Channidae	<i>Channa punctata</i>	Taki	LC	+
	<i>Channa marulius</i>		Gazar	LC	+	-
	<i>Channa striata</i>		Shol	LC	+	-
	<i>Channa orientalis</i>	Cheng	VU	-	+	
	Nandidae	<i>Nandus nandus</i>	Bheda	LC	-	+
Beloniformes	Belonidae	<i>Xenentodon cancila</i>	Kakila	LC	+	-
Cichliformes	Cichlidae	<i>Oreochromis mossambicus</i>	Tilapia	VU	+	-
		<i>Oreochromis niloticus</i>	Nilotica	LC	+	-
Clupeiformes	Clupeidae	<i>Corica soborna</i>	Kachki	LC	+	-
		<i>Gudusia chapra</i>	Chapila	LC	+	-
Cypriniformes	Cyprinidae	<i>Salmostoma phulo</i>	Chela	LC	+	-
		<i>Labeo rohita</i>	Rui	LC	+	-
		<i>Catla catla</i>	Catla	LC	+	-
		<i>Cirrhinus mrigala</i>	Mrigal	LC	+	-
		<i>Labeo calbasu</i>	Kalbaush	LC	+	-
		<i>Labeo bata</i>	Bata	LC	+	-
		<i>Hypophthalmichthys molitrix</i>	Silver carp	NT	+	-
		<i>Ctenopharyngodon idella</i>	Grass carp	LC	+	-
		<i>Cyprinus carpio</i>	Common carp	VU	+	-
		<i>Mylopharyngodon piceus</i>	Black carp	LC	+	-
		<i>Aristichthys nobilies</i>	Bighead carp	DD	+	-
		<i>Cirrhinus reba</i>	Bhangan	LC	-	+
		<i>Pethia ticto</i>	Tit punti	LC	+	-
		<i>Puntius sophore</i>	Jat punti	LC	+	-
		<i>Systemus sarana</i>	Sharpunti	LC	+	-
		<i>Barbonymus gonionotus</i>	Thai sharpunti	LC	-	+
		<i>Amblypharyngodon mola</i>	Mola	LC	+	-
<i>Osteobrama cotio</i>	Dhela	LC	+	-		
Decapoda	Palaemonidae	<i>Macrobrachium lamarrei</i>	Kuncho chingri	LC	+	-
Gobiiformes	Gobiidae	<i>Glossogobius giuris</i>	Bele	LC	-	+
Osteoglossiformes	Notopteridae	<i>Notopterus notopterus</i>	Foli	LC	-	+
		<i>Chitala chitala</i>	Chital	NT	-	+
Ovalentaria	Ambassidae	<i>Chanda nama</i>	Lomba chanda	LC	+	-
Siluriformes	Bagridae	<i>Mystus vittatus</i>	Tengra	LC	-	+
		<i>Sperata aor</i>	Ayre	LC	+	-
	Clariidae	<i>Clarias batrachus</i>	Magur	LC	+	-
	Heteropneustidae	<i>Heteropneustes fossilis</i>	Shing	LC	+	-
	Pangasiidae	<i>Pangasianodon hypophthalmus</i>	Pangus	EN	+	-
	Siluridae	<i>Wallago attu</i>	Boal	VU	-	+
		<i>Ompok pabda</i>	Pabda	NT	-	+
Synbranchiformes	Mastacembelidae	<i>Mastacembelus armatus</i>	Baim	LC	+	-
		<i>Macragnathus aral</i>	Tara baim	LC	+	-

Endangered (EN), Vulnerable (VU), Near threatened (NT), Least concern (LC), Data deficient (DD).

The IUCN red list status of fishes available in Jhapa Baor suggested that, majority of fishes comprised Least Concern (LC) (34 species), followed by Vulnerable (VU) (four species), Near Threatened (NT) (three species), Endangered (EN) (one species), Data deficient (DD) (one species) (Figure 5).

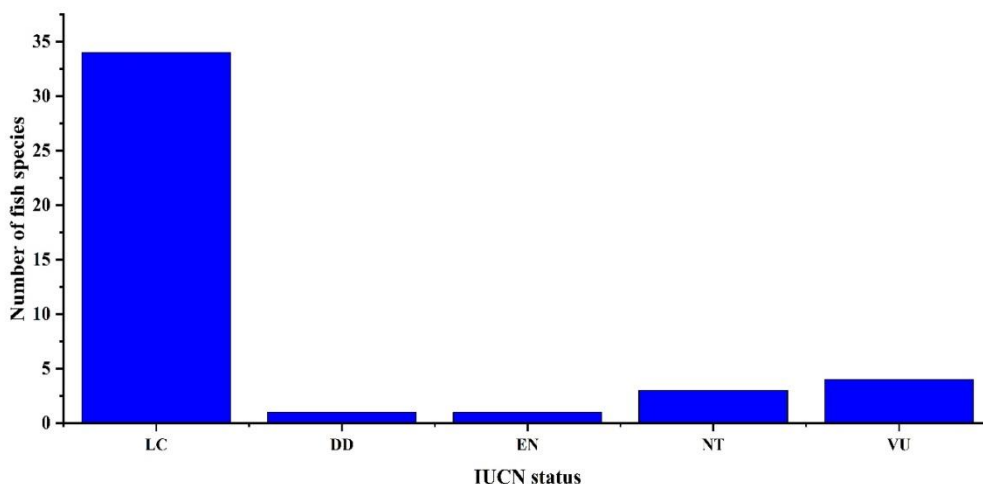


Figure 5. Present status of fish species in Jhapa baor, based on IUCN Bangladesh (Endangered (EN), Vulnerable (VU), Near Threatened (NT), Least Concern (LC), Data deficient (DD))

Among the fish species found in the ox-bow lake majority was carp (26%), while 16% fishes were catfish, followed by perch like (9.4%), barb and snake head (both 9.3%), molacarplet (5%), featherback (5%), spiny eel (5%), rivershad (5%); while mullet, climbing perch, small prawn, freshwater garfish, and elongate perchlet comprised 2% each (Figure 6).

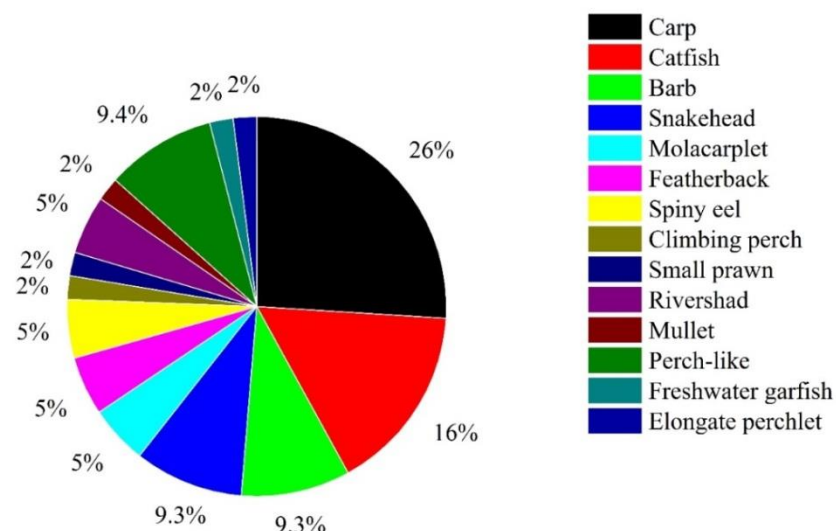


Figure 6. Percentage of different fish groups in Jhapa baor.

Majority of fishes among 43 species were found from Cypriniformes (41.9%) order, followed by Siluriformes (16.3%), Anabantiformes (14%), Cichliformes (4.7%), Clupeiformes (4.7%), Osteoglossiformes (4.7%), Synbranchiformes (4.7%), Beloniformes, Decapoda, Gobiiformes, Ovalentaria (2.3% each) (Figure 7).

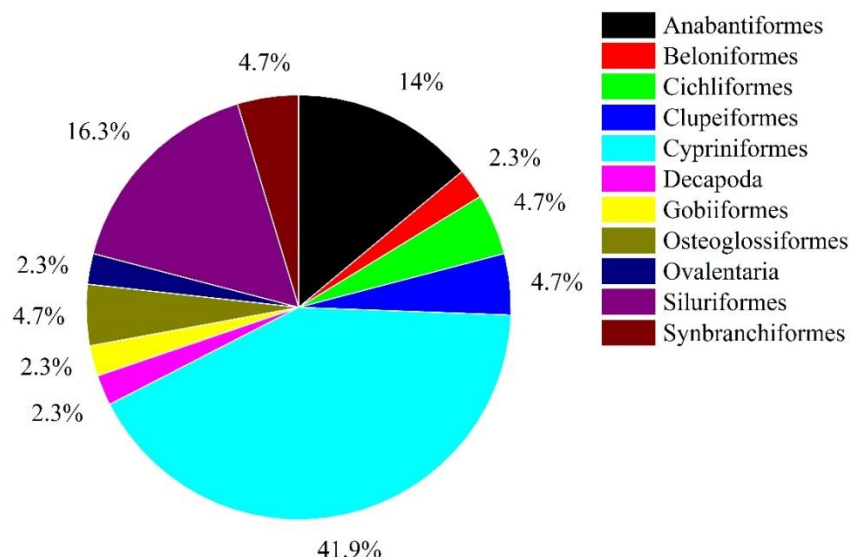


Figure 7. Order based fish species diversity of Jhapa baor.

3.2. Socio-economic conditions of fishermen of the Jhapa baor

3.2.1. Age distribution

The age ranges of fishers were between 23 to 70 years. It was found that, 15% of fishermen’s age were below 30 years, 40% were 31-40 years, 25% were 41-50 years and 17% were 51-60 years and 3% had more than 60 years (Figure 8).

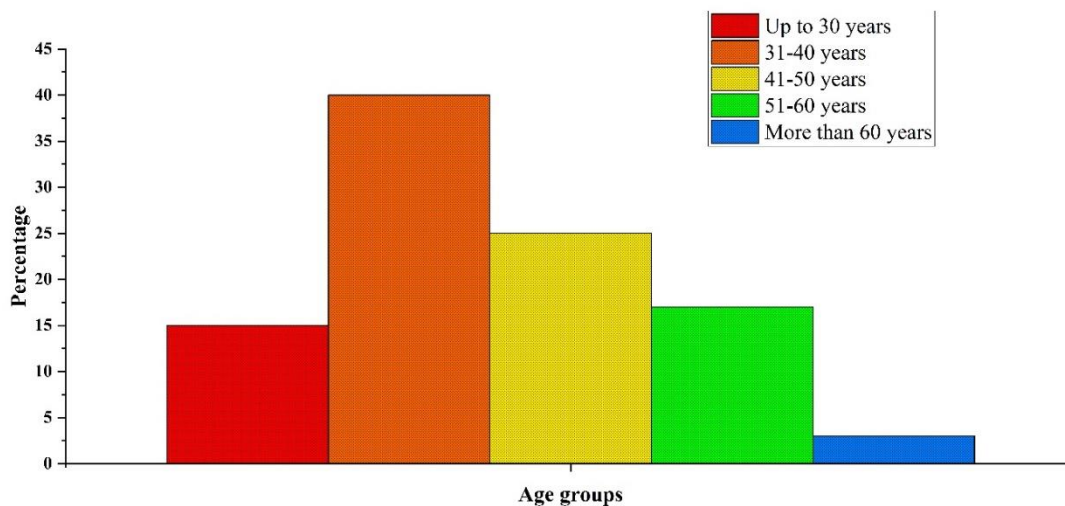


Figure 8. Age distribution of fishermen.

3.2.2. Religion status

Most of the fishers belonged to Hindu community (69%) and 31% Muslim fishermen were benefited from the boar (Figure 9).

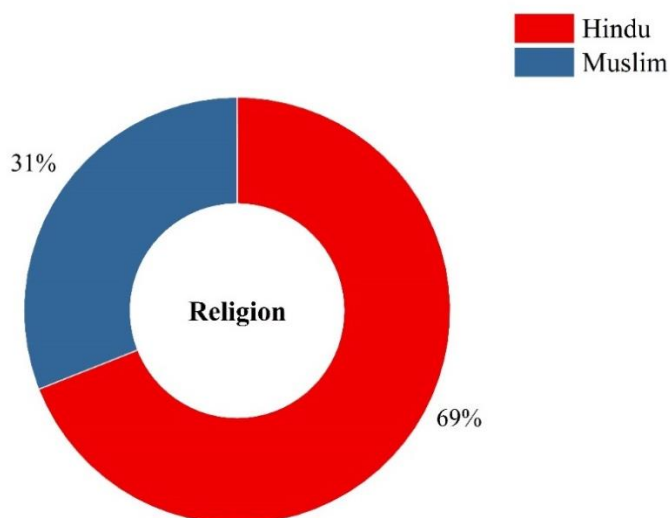


Figure 9. Religion status of fishermen.

3.2.3. Educational status

In Jhapa baor, majority (43%) fishermen were found illiterate, 36% fishers have knowledge of primary level and 21% fishers have knowledge of secondary level (Figure 10).

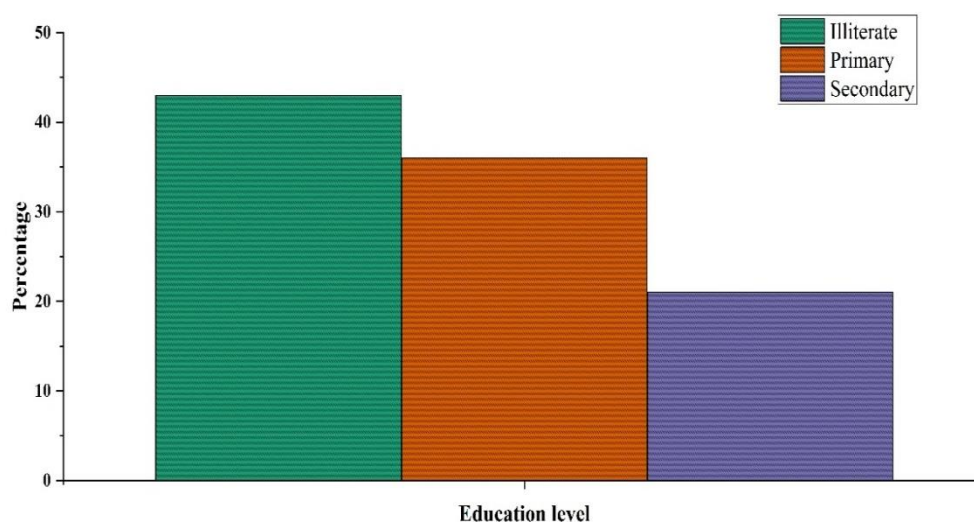


Figure 10. Educational status of fishermen.

3.2.4. Family members of fishermen

It was found that, 50% of the households had up to four members, 48% households comprised 5-8 members, and 2% household had more than eight members (Figure 11).

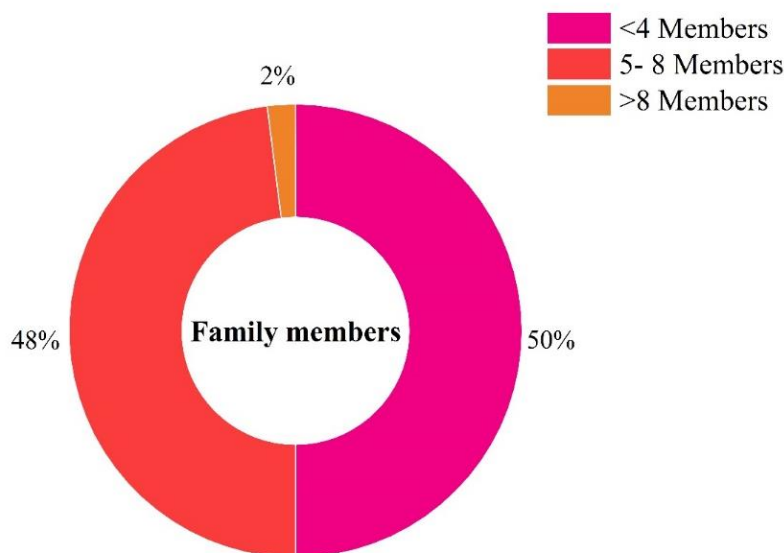


Figure 11. Household members of fishermen.

3.2.5. Earning members in family

Majority of family (85%) had single earning member, while 10% family had at least two earning members in the family and 5% family comprised more than two earning members (Figure 12).

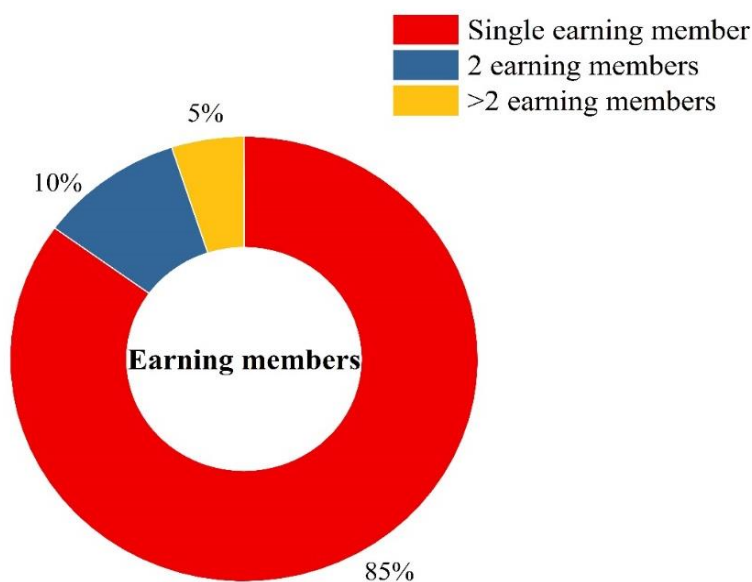


Figure 12. Household earning members of fishermen.

3.2.6. Monthly income

Majority of fishermen (65%) had a monthly income of 5,000-10,000 BDT, while 23% fishermen had a monthly income of more than 10000 BDT and 12% fishermen earned less than 5000 BDT (Figure 13).

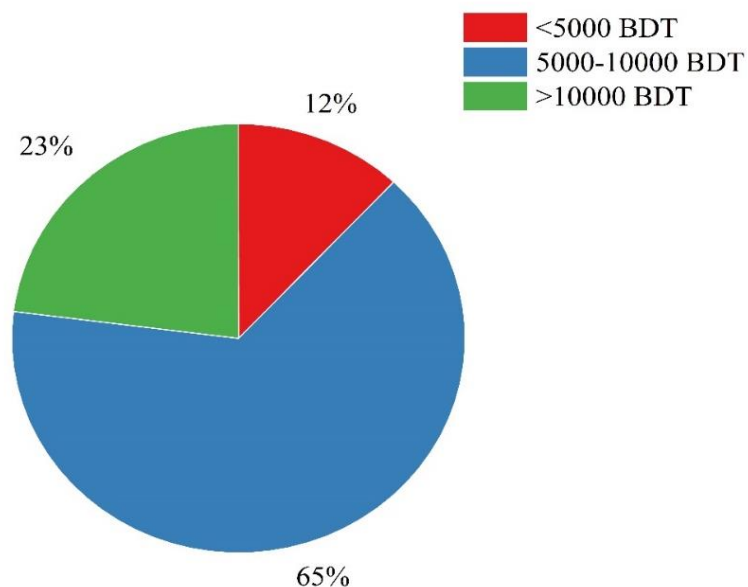


Figure 13. Household income of fishermen.

3.2.7. Household income of fishers from baor

In Jhapa baor total 73.11% household income of fishers came from the baor which was very significant for their livelihood (Figure 14).

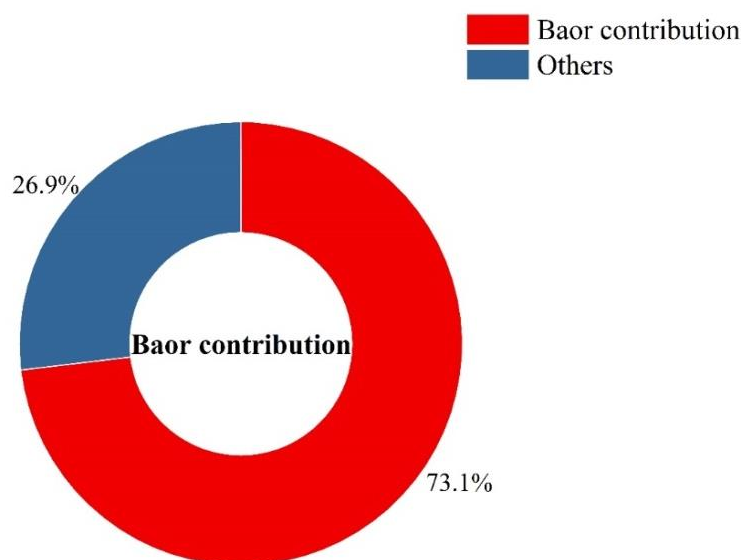


Figure 14. Baor contribution in household income of fishermen.

3.2.8. Land ownership status

All of the fishermen have own homestead area, 50% have agricultural land and only 2% have own pond (Figure 15).

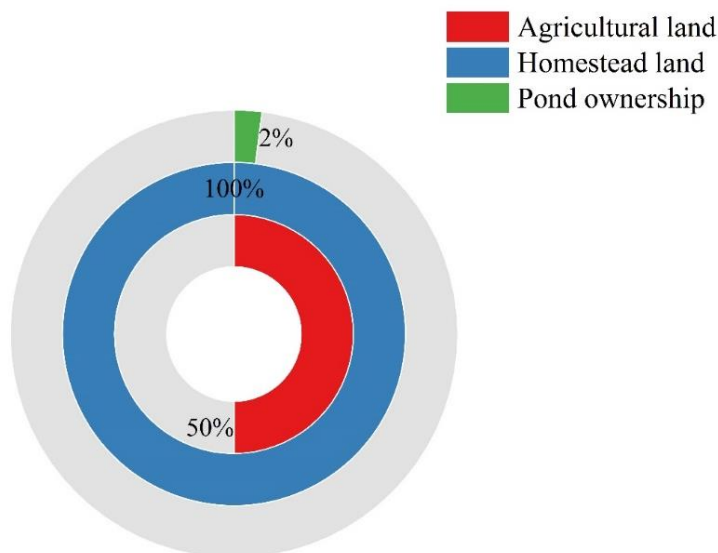


Figure 15. Land ownership status of fishermen.

3.2.9. Housing condition

In Jhapa baor area 63% fishermen’s house were earthen and followed by semi-concrete house 35% and 2% lived in concrete house (Figure 16).

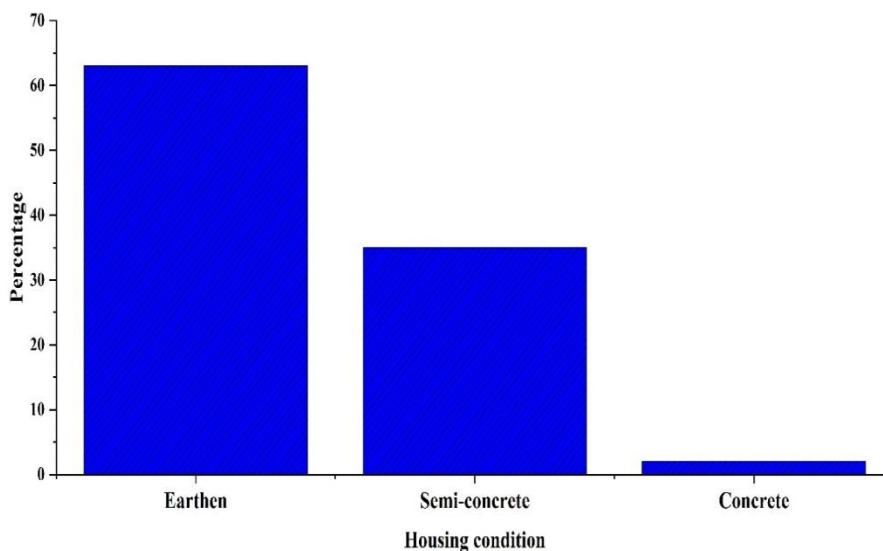


Figure 16. Housing condition of fishermen.

3.2.10. Drinking water or other water facilities

Majority of fishermen (62%) household used deep tube-well water and 38% used shallow tube-well in Jhapa baor area (Figure 17).

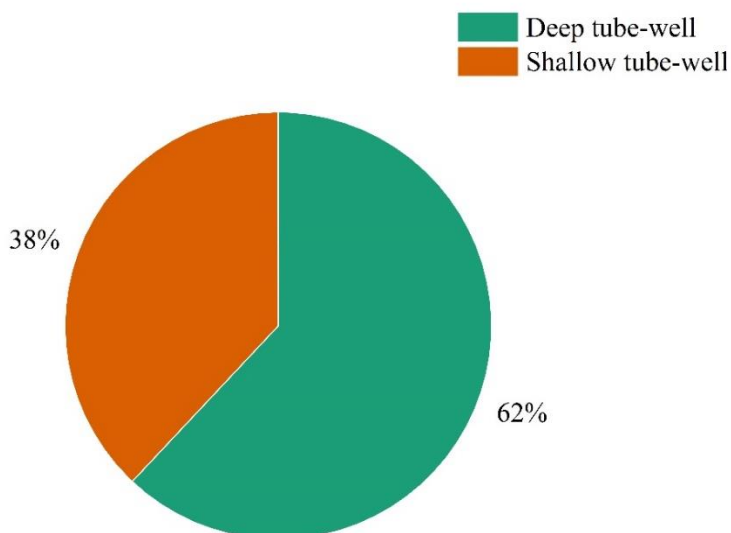


Figure 17. Drinking water or other water facilities of fishermen.

3.2.11. Sanitary facilities

It was found that, 50% of toilets were semi-concreted, followed by earthen toilets (36%) and concrete (14%) (Figure 18).

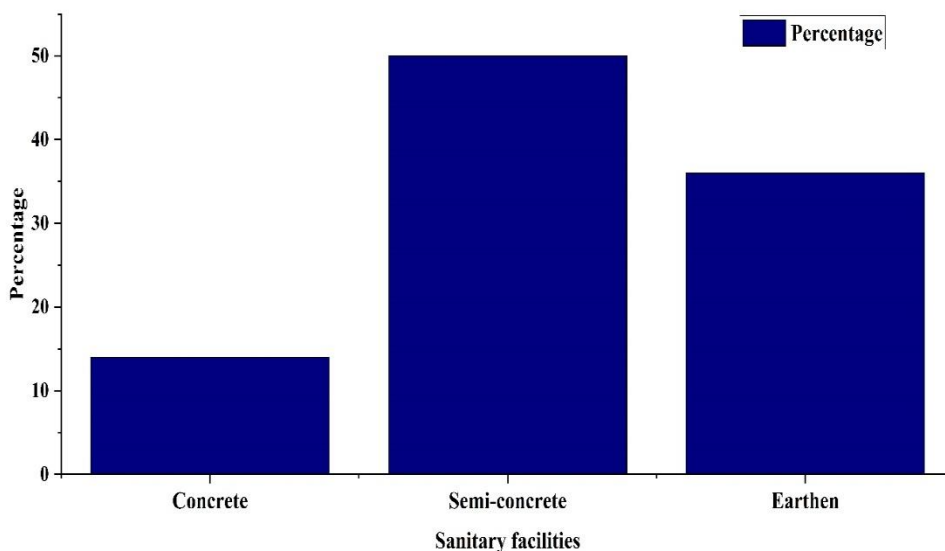


Figure 18. Sanitary facilities of fishermen.

3.2.12. Food and nutrition intake

It was recorded that, maximum 70% fishermen took fish and only 2% took milk (Figure 19).

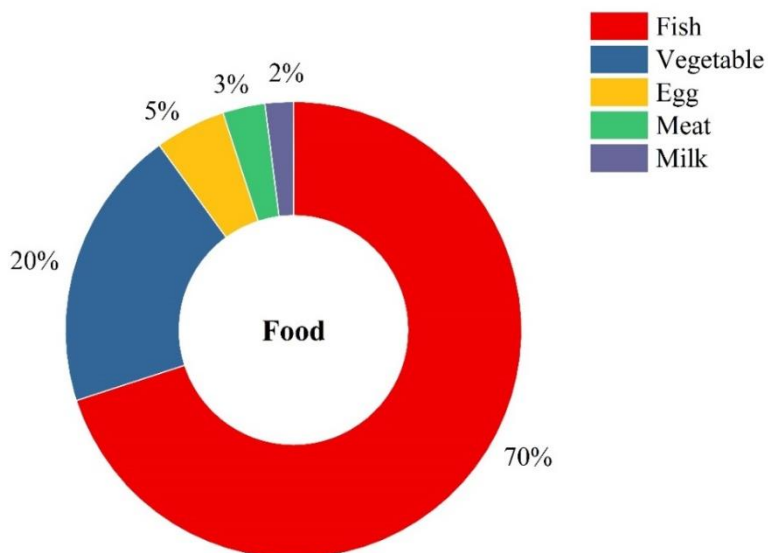


Figure 19. Food and nutrition intake status.

3.2.13. Children educational status

It was found that, 72% household children used to go to school while a small portion of children (28%) were deprived from education (Figure 20).

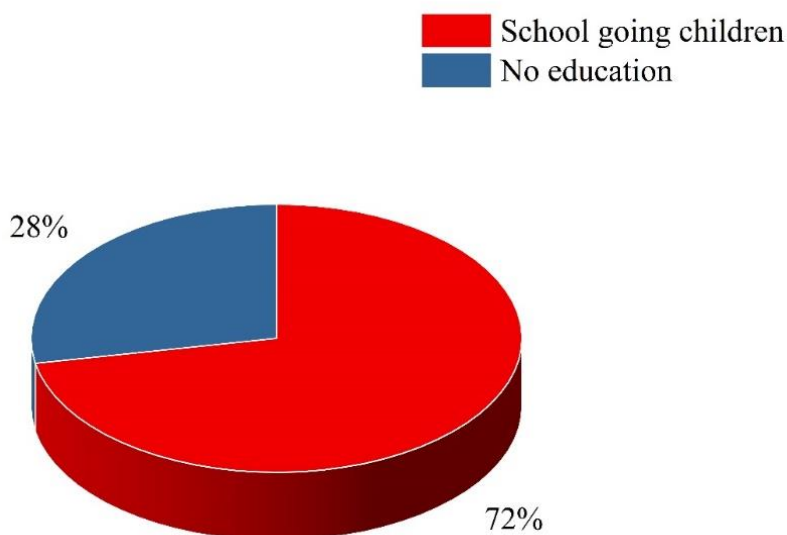


Figure 20. Fishers children educational status.

3.2.14. Health facilities

The highest proportion (92%) of fishermen of the baor area depended upon local village doctors and rest took service both from local village doctor and upazilla health complex (Figure 21).

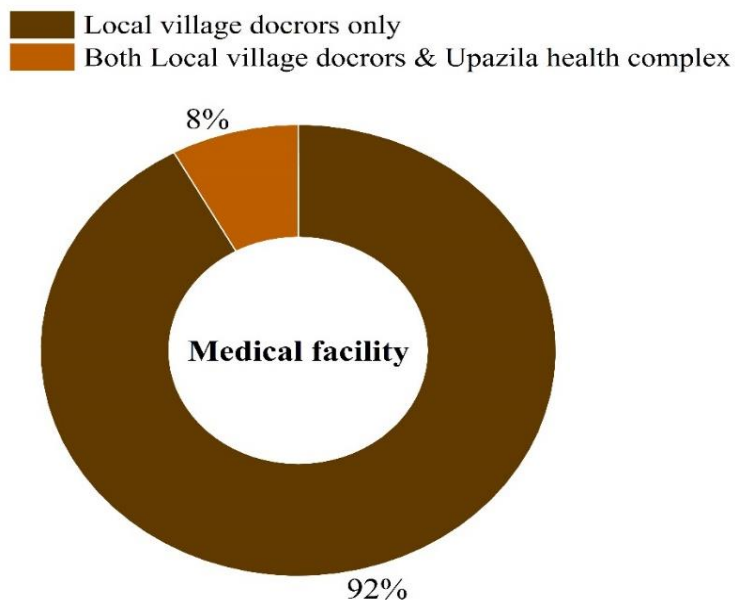


Figure 21. Health facilities of fishermen.

3.2.15. Electricity facilities

Majority of fishermen (85.71%) used electricity during the study and other 14.29% fishermen used kerosene as light or other power source (Figure 22).

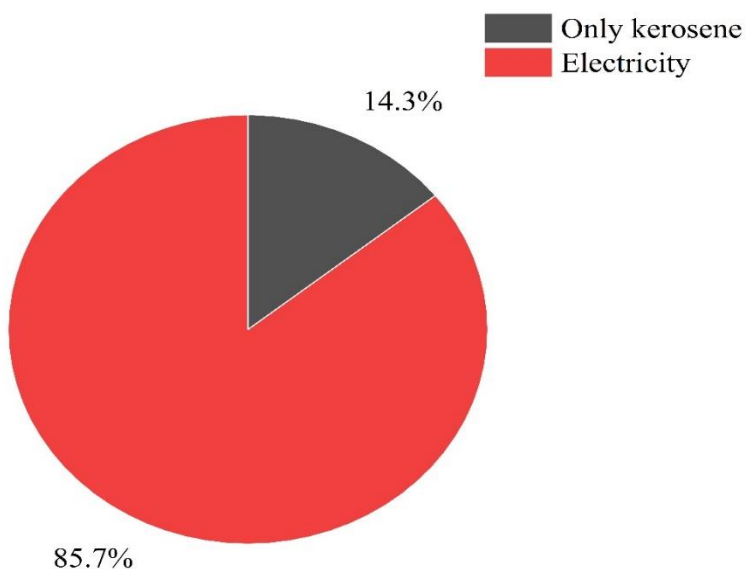


Figure 22. Fishers light/energy source facilities.

3.2.16. Loan or credit and savings

It was found 29% of fishermen were found involved with BRAC, followed by with Grameen Bank (20%), Samadhan (16%), Jagoroni Chakra (13%), ASHA (11%), GO (7%) and SUS (4%) (Figure 23).

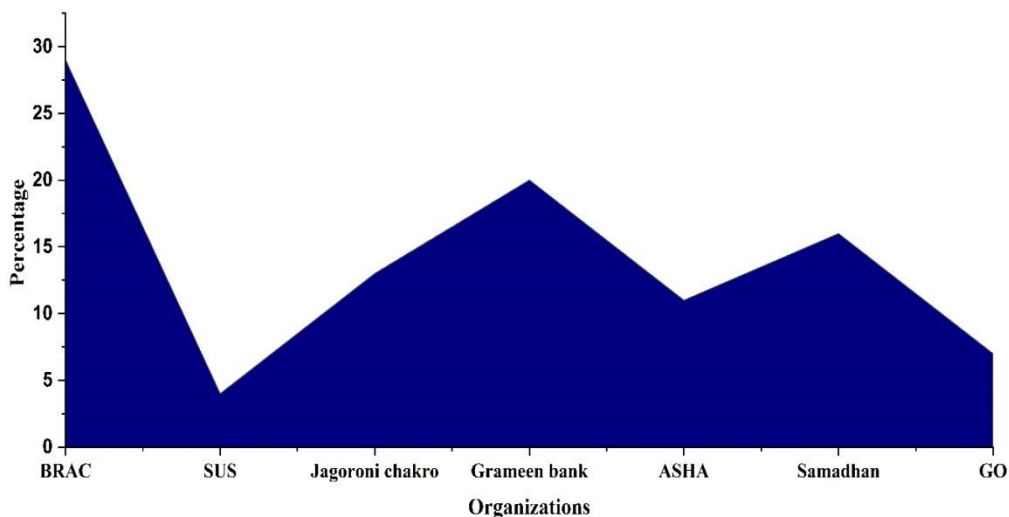


Figure 23. Fishers Loan or credit and savings status.

3.2.17. Membership in fishermen co-operative organization

Among the respondents in Jhapa baor area 48.3% fishers were member of Matshajibi Somobai Somiti Ltd., while we found 51.7% if fishermen did not involve with any co-operative organization (Figure 24).

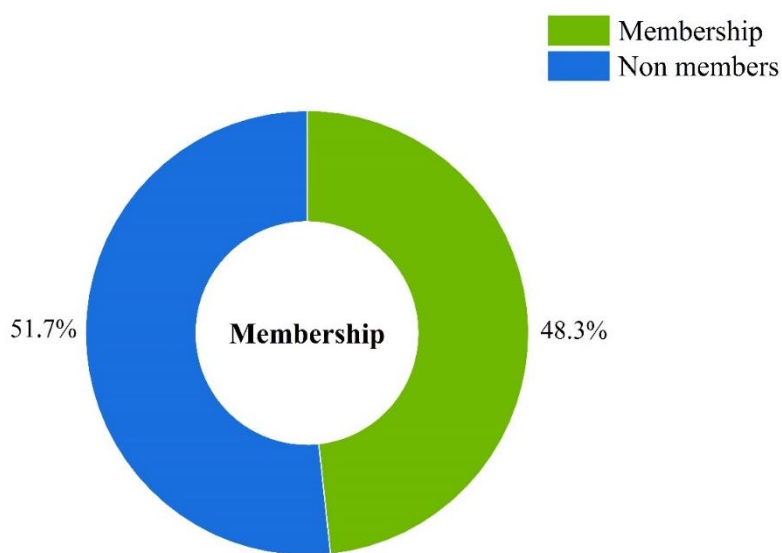


Figure 24. Fishers membership status in fisher’s co-operative organization.

3.2.18. Ownership of boat

In Jhapa baor area, 75% fishers had own boat, while a small portion of them did not have own boat (Figure 25).

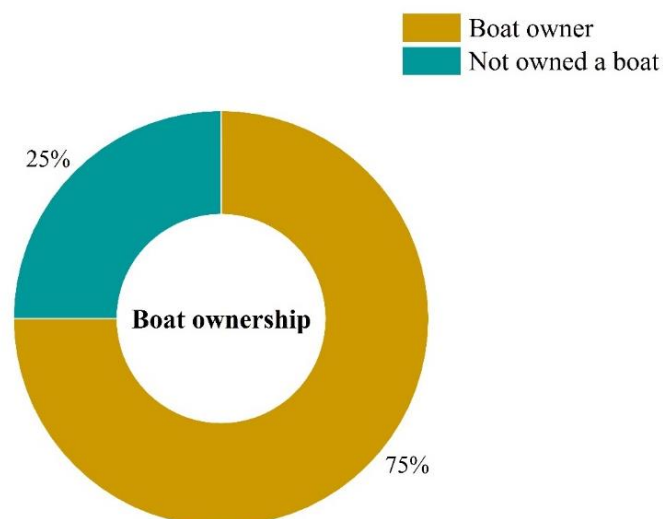


Figure 25. Boat ownership status at study area.

4. Discussion

4.1. Fish Biodiversity and fishing gears used in Jhapa Baor

Bangladesh's wetland ecology, which is home to some 260 native freshwater species, is significant on a worldwide scale (Shamsuzzaman *et al.*, 2017). The current study found five types of nets, three types of fish traps and four types of wounding gears were used by the fishermen in the Jhapa baor. The study of Mia *et al.* (2018) discovered 16 types of fishing gears from Surma River Sylhet, some other studies such as, 30 fishing gears from Chalan Beel (Sultana and Islam, 2016), 28 fishing gears from Ashura beel, Dinajpur (Ferdoushi *et al.*, 2018) were identified for catching fishes. Whereas 10 fishing gears were used to catch Asian seabass at the coastal area of Bangladesh (Haque *et al.*, 2021).

During the study period a total of 43 fish species from 11 orders and 17 families were recorded in the Jhapa baor. A total of 39 species were identified in the Bhairab River investigation of Islam *et al.* (2017c), which also covered the majority of the river's ecological and biological conditions. Other studies such as Hossain *et al.* (2009) found 114 fish species, 38 fish species (Karim *et al.*, 2020), 78 fish species (Siddique *et al.*, 2016), 28 fish species (Khanom *et al.*, 2018) from Chalan beel. Another research from Kumira, Chittagong, determined the weight of fish captured by various fishermen and the make-up of the catch (Mondal *et al.*, 2018a).

The IUCN red list status of fishes available in Jhapa Baor suggested that, majority of fishes comprised Least Concerned status, while some were found vulnerable, near threatened, endangered, data deficient. The study of Parvez *et al.* (2019) showed similar IUCN red list status for assessing the threat level of fish species. Similar studies assessed fishes and benthos fauna from Malaysia which showed the IUCN red list status of any organisms might be important indicator for their conservation initiatives (Abu Hena *et al.*, 2022; Al-Asif *et al.*, 2020; Al-Asif *et al.*, 2021a).

Among the fish species found in the ox-bow lake majority was carp, while some were catfish, perch like, barb, snakehead, molacarp, featherback, spiny eel, rivershad, mullet, climbing perch, small prawn, freshwater garfish, and elongate perchlet. While majority of fishes were from order Cypriniformes, followed by Siluriformes, Anabantiformes, Cichliformes, Clupeiformes, Osteoglossiformes, Synbranchiformes, Beloniformes, Decapoda, Gobiiformes, and Ovalentaria. The study of Parvez *et al.* (2019) assessed the group of fishes available in Dhepa, Punarbhaha, and Atrai rivers, Bangladesh. This study examined the variety of common fish in the Jhapa Oxbow Lake and discovered that, the majority of the fish were small indigenous species, previous study of Mondal *et al.* (2020a) and Mondal *et al.* (2020b) suggested that, one of the common species was *Amblypharyngodon mola*. The study of Samad *et al.* (2013) revealed the availability of small indigenous species (SIS) from the South-Western Region of Bangladesh.

4.2. Livelihood conditions of fishermen at Jhapa baor

The age ranges of fishers were between 23 to 70 years. It was found that, majority of fishermen were from the age group of 31-40 years (40%) while some other groups made a small portion of the fishermen. According to Islam *et al.* (2017a) from the Meherpur area, the majority of fisherman were between the ages of 31 and 40.

This claim was further corroborated by a study conducted by Mondal *et al.* (2018b) in two coastal communities in Chittagong, namely Kumira and Kattoli. Most of the fishers belonged to Hindu community and some Muslim fishermen were also found during the study. However, a 2017 survey by Al-Asif and Habib (2017) discovered 12% of fishermen in the Jashore district to be Hindu. Sharif *et al.* (2015) found that, all of the fishermen were Muslims because they were the majority in the region. Adhikary *et al.* (2018a) suggested majority of fishermen were muslim in the Jashore region.

In Jhapa baor, majority fishermen were found illiterate, some fishermen had knowledge of primary level and secondary level. According to Al-Asif and Habib (2017), the majority of fishermen had completed at least a high school, but another study of Al-Asif *et al.* (2015) found that, the majority of fish fingerling traders in the Jashore district lacked any formal education, which is consistent with the current findings. It was found that, majority of the households had up to 4 members, while some had 5-8 members and more than 8 members contained in only 2% household. In the Jashore district, according to Al-Asif and Habib (2017), around 26% of households had four people, 18% had five, 32% had six, and 24% had seven or more individuals. Majority of family had single earning member, while 10% family had at least two earning members in the family and 5% family comprised more than two earning members. Current study revealed this kind of information for the first time in Bangladesh. Majority of fishermen had a monthly income of 5,000-10,000 BDT, while 23% fishermen had a monthly income of more than 10000 BDT and 12% fishermen earned less than 5000 BDT. Study of Jamil *et al.* (2022) covered the yearly income, while converting to the monthly income this income range might be compatible to the current study. The yearly income of fishermen were explored in studies of Al-Asif and Habib (2017), Vaumik *et al.* (2017), and Adhikary *et al.* (2018b), but the ranges were much higher than those in the current study. In Jhapa baor total majority household income of fishermen came from the baor which was very significant for their livelihood which is found similar with the study of Jamil *et al.* (2022). All of the fishermen have own homestead area, 50% have agricultural land and only 2% have own pond. According to the study by Adhikary *et al.* (2018b), the majority of fishermen in the Noakhali district used to work in agriculture since they had their own land. Similar findings from the Lalmonirhat district were also discovered in the study conducted by Vaumik *et al.* (2017), while study of Jamil *et al.* (2022) suggested majority of income came from baor fishing activity which is relevant with the present findings. In Jhapa baor area majority of fishermen's house were earthen and followed by semi-concrete house and concrete house, which were supported the results of Hossain *et al.* (2016b), Sharif *et al.* (2015), Adhikary *et al.* (2018b), Al-Asif and Habib (2017), Al-Asif *et al.* (2015) and Islam *et al.* (2014). Majority of fishermen household used deep tube-well water and 38% used shallow tube-well in Jhapa baor area. Al-Asif and Habib (2017) found that, all fishing communities had excellent water supply infrastructure, however in the Noakhali district study found that, the majority of fishermen had their own tube wells (Adhikary *et al.*, 2018b). It was found that, majority of toilets were semi-concreted, followed by earthen toilets and concrete. In the research by Al-Asif and Habib (2017), 100% of fishermen had access to decent sanitation facilities; however, because this region of the bay was underdeveloped, the sanitation facilities there were not as good. It was recorded that, maximum majority fishermen took fish and only 2% took milk, however, the study of Jamil *et al.* (2022) suggested, during dry season, fishermen were mostly depended on vegetables and their fish consumption used to reduce. It was found that, majority household children used to go to school while a small portion of children were deprived from education. The government mandated that, all children in the nation receive a basic education, however the studies of Adhikary *et al.* (2018b) and Al-Asif and Habib (2017) both provided support for this current finding. The highest proportion of fishermen of the baor area depended upon local village doctors and rest took service both from local village doctor and upazilla health complex. In contrast to Noakhali, where the majority of fishermen used to attend the local kabiraj for medical attention (Adhikary *et al.*, 2018b), the research by Al-Asif and Habib (2017) revealed that, practically all fishermen sought medical attention from MBBS doctors. According to Al-Asif *et al.* (2015), the majority of fishermen in the Jashore district used to visit government health facilities for their illnesses. However, Sharif *et al.* (2015) discovered that, the majority of fishermen attended quack. Majority of fishermen used electricity during the study and other fishermen used kerosene as light or other power source, in contrast to the findings of the present study, Vaumik *et al.* (2017), revealed that, the majority of fishers in the Lalmonirhat district had access to electricity. Additionally, it was discovered that, most fishermen in the Noakhali district had electricity in their residences or places of business (Adhikary *et al.*, 2018b). It was found majority of fishermen were found involved with BRAC, followed by with Grameen Bank, Samadhan, Jagoroni Chakra, ASHA, GO and SUS; while Al-Asif and Habib (2017) discovered that, while some fishermen borrowed money from banks and NGOs, the majority of fishermen invested their own money in initiatives. Both Vaumik *et al.* (2017), and Sharif *et al.* (2015) reported findings that were comparable to the present findings. Among the respondents in Jhapa baor area, majority of fishermen were member of Matshajibi

Somobai Somiti Ltd., while we found 51.7% if fishermen did not involve with any co-operative organization. In Jhapa baor area, majority of fishermen had own boat, while a small portion of them did not have own boat. Similar type of socioeconomic studies were conducted elsewhere in Bangladesh, while very limited studies might be found to determine the livelihood status and biodiversity of oxbow lake fishermen (Table 3).

Table 3. Previous studies conducted in different habitats of Bangladesh.

Location	Habitat	References
Jhapa Baor, Jashore	Baor	Present study
Habullah Baor, Jashore	Baor	Jamil <i>et al.</i> (2022)
Padma river, Munshiganj	River	Ema <i>et al.</i> (2021)
Dengar beel, Jamalpur	Beel	Islam <i>et al.</i> (2021)
Meghna, Laukhati and Galachipa river	River	Rahaman <i>et al.</i> (2020)
Kishoregonj	Haor	Islam <i>et al.</i> (2020)
Nijhum Dwip	Coast	Siam <i>et al.</i> (2020)
Three beels, Noagaon	Beel	Salam <i>et al.</i> (2020)
Belai beel, Gazipur	Beel	Jahan <i>et al.</i> (2018)
Coastal area of Chittagong, Bangladesh	Coast	Mondal <i>et al.</i> (2018b)

5. Conclusions

This study revealed the fish diversity, fishing gears used by fishermen in Jhapa Baor, Jashore. While the socio-economic status of fishermen also came with this study which might be considered as the baseline information for the further studies in this oxbow lake habitat. Future research on the seasonal fisheries catch composition, water quality parameters and other aspects might be helpful for sustainable management of this habitat. This research will assist government, research and educational institutions for understanding the current status of the fish biodiversity and livelihood condition of fishermen in Jhapa Baor, Jashore.

Acknowledgements

The research team would like to acknowledge the logistic and technical support of the Department of Fisheries and Marine Bioscience, Jashore University of Science and Technology. We would also like to mention the support of Dr. Abdulla-Al-Asif from Universiti Putra Malaysia during the processing of this article.

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

Fahmida Sultana Rimi: conceptualization, methodology, graphical presentation and map preparation, analysis and manuscript writing; Subrata Mondal: supervision, conceptualization, methodology, reviewing and editing; B.M. Newaz Sharif: data analysis, interpretation, reviewing and editing; Jamil and Md. Barkot Hasan: reviewing and editing. All authors have read and approved the final manuscript.

References

- Abdul Halim M, MS Islam, S Sharmin, MM Haque, MS Rahman, MCA Halim, S Sharmin and HH Rahman 2018. Assessment of water quality parameters in baor environment, Bangladesh: A review. *Int. J. Fish. Aqua. Stud.*, 6: 259–263.
- 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 MR, A Rahman, A Al-Asif and RK Adhikary, 2018. Socio-economic status of fish retailers in Jashore sadar, Bangladesh. *Asian Australas. J. Food Saf. Secur.*, 2: 100–108.
- 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.

- 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.
- Akter S, MFU Zaman, MHU Jaman, IN Sithi, D Yesmin and A Al-Asif, 2016. Morphometric study of banded gourami (*Colisa fasciata*) in Jessore, Bangladesh. *Asian J. Med. Biol. Res.*, 2: 113–120.
- Al-Asif A, MK Abu Hena, H Hamli, MH Idris, GJ Gerusu, J Ismail, MKA Bhuiyan, MH Abualreesh, N Musa, MEA Wahid and M Mishra, 2022. Status, biodiversity, and ecosystem services of seagrass habitats within the Coral Triangle in the Western Pacific Ocean. *Ocean Sci. J.*, 57: 147–173.
- 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, H Hamli, MK Abu Hena, MH Idris, GJ Gerusu, JB Ismail and NU Karim, 2020. Benthic macrofaunal assemblage in seagrass-mangrove complex and adjacent ecosystems of Punang-Sari Estuary, Lawas, Sarawak, Malaysia. *Biodiversitas*, 21: 4606–4615.
- Al-Asif A, H Hamli, MK Abu Hena, MH Idris, GJ Gerusu, J Ismail and MH Abualreesh, 2021a. Bivalves (Bivalvia) in Malaysian Borneo: status and threats. *J. Threat. Taxa*, 13: 19553–19565.
- Al-Asif A, A Hossain, H Hamli, S Islam and SL Kabir, 2021b. Research trends of aqua medicines, drugs and chemicals (AMDC) in Bangladesh: the last decade's (2011-2020) story to tell. *Asian J. Med. Biol. Res.*, 7: 90–106.
- 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.
- Al Mamun A and RK Brook, 2015. Evaluating local rules and practices for avoiding tragedies in small-scale fisheries of oxbow lakes, Southern Bangladesh. *Int. J. Com.*, 9: 772–807.
- Azad KN, Akter S, and Azad KN 2020. Fish species availability and socio-economic conditions of fishermen of the Bergobindopur baor, Jashore, Bangladesh. *Bangladesh J. Fish.*, 32: 199–206.
- 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.
- Bodrud-Doza M, M Shammi, L Bahlman, ARMT Islam and MM Rahman, 2020. Psychosocial and socio-economic crisis in Bangladesh due to COVID-19 pandemic: A perception-based assessment. *Front. Pub. Heal.*, 8: 341.
- Brander KM, 2007. Global fish production and climate change. *Proc. Nat. Aca. Sci. USA*, 104:19709–19714.
- Chwakravorty P, P Paul, A Hossain, S Islam, M Rahman and A Al-Asif, 2019. Post-harvest handling and quality loss of Indian major carps in the distribution channel of Noakhali district, Bangladesh. *Res. Rev. J. Bioinfo.*, 6: 9–19.
- Elliott VL, AJ Lynch, SC Phang, SJ Cooke, IG Cowx, JE Claussen, J Dalton, W Darwall, I Harrison, KJ Murchie, EA Steel and GL Stokes, 2022. A Future for the inland fish and fisheries hidden within the Sustainable Development Goals. *Front. Env. Sci.*, 10: 756045.
- Ema NS, MS Hossain, MN Uddin, MM Rahman and Z Hossain, 2021. Study of the climate change impact on fishers' livelihood near the Padma river in Munshiganj, Bangladesh. *Asian J. Med. Biol. Res.*, 6:777–784.
- Ferdoushi Z, M Rana, N Gupta, Y Ara and A Hossain, 2018. Fishing gears and their targeted species of Ashura beel in Dinajpur. *Journal of Science and Technology*, 16: 9–23.
- FRSS, 2019. Yearbook of fisheries statistics of department of fisheries Bangladesh. In *Fisheries Resources Survey System (FRSS)*.
- 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.
- Hasan J, RA Lima, and DC Shaha, 2021. Fisheries resources of Bangladesh: A review. *Int. J. Fish. Aqua. Stud.*, 9: 131–138.
- Hossain AM, A Al-Asif, AM Zafar, TM Hossain, SM Alam and AM Islam, 2015. Marketing of fish and fishery products in Dinajpur and livelihoods of the fish retailers. *Int. J. Fish. Aqua. Stud.*, 3: 86–92.
- Hossain MS, DN Gopal, S Sarker and MZ Rahaman, 2012. Fish diversity and habitat relationship with environmental variables at Meghna river estuary, Bangladesh. *Egyptian J. Aqua. Res.*, 38: 213–226.
- Hossain MY, MA Hossen, MM Islam, PMN Uddin, F Nawer, AK Paul, HHM Adnan, MM Rahman, G Kaushik and S Bardoloi, 2016a. Biometric indices and size at first sexual maturity of eight alien fish species from Bangladesh. *Egyptian J. Aqua. Res.*, 42: 331–339.

- Hossain MZ, A Pal, MA Hasan, MS Parvej, N Nahar and A Al-Asif, 2016b. Nutritional status and socio-demographic characteristics of the people of south-west coastal region in Bangladesh. *Asian Australas. J. Biosci. Biotechnol.*, 1: 323–332.
- 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. *Lake Reserv. Res. Man.*, 14: 3–19.
- Hossain MAR, 2014. An overview of fisheries sector of Bangladesh. *Res. Agri. Live. Fish.*, 1: 109–126.
- Hussain MG, 2010. Freshwater fishes of Bangladesh: Fisheries, biodiversity and habitat. *Aqua.Eco. Heal. Man.*, 13: 85–93.
- Islam A, MS Hossain and Z Hossain, 2020. Impacts of climate change on fishers' livelihood in Kishoregonj haor region, Bangladesh. *Asian J. Med. Biol. Res.*, 6: 408–417.
- Islam FK, 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 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, C Kar, GK Kundu, G Mondal and MS Khan, 2018. Current status and barriers to fisheries comanagement: Evidences from an Oxbow lake of Bangladesh. *Bangladesh J. Zool.*, 46:105–116.
- Islam MS, A Al-Asif, B Sarker, A Satter, M Ahmed, M Rahman, MA Zafar and S Rahmatullah, 2017b. Fry production and its marketing system of North-West fisheries extension project at Parbatipur, Dinajpur, Bangladesh. *Asian J. Med. Biol. Res.*, 3: 368–378.
- Islam MA, A Al-Asif, MA Samad, BMS Rahman, MH Rahman, A Nima and SM Yeasmi, 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 Bhairabr river, Jessore, Bangladesh. *Asian J. Med. Biol. Res.*, 3: 357–367.
- Jahan MI, MS Alam, MS Karim, N Sultana, M Mamun and S Rafiquzzaman, 2018. Assessment of fish diversity and socio-economic condition of fishermen in Bangladesh. *Asian J. Med. Biol. Res.*, 4: 69–76.
- Jamil, BMN Sharif, LY Abit, I Miah and M Shahjahan, 2022. Fish biodiversity and livelihood of fishermen at an Oxbow lake of South-West Bangladesh. *Asian J. Med. Biol. Res.*, 8: 165–180.
- Kalimuthu K, H Hamli, MT Engan, JB Rasidi, M Rabullah, J Ismail, A Al-Asif and GJ Gerusu, 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 Aktar and 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.
- Lévêque C, T Oberdorff, D Paugy, MLJ Stiassny and PA Tedesco, 2008. Global diversity of fish (Pisces) in freshwater. *Hydrobiologia*, 595: 545–567.
- 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.
- Miah MY, MM Hossain, P Schneider, MMH Mozumder, SJ Mitu and MM Shamsuzzaman, 2021. Assessment of ecosystem services and their drivers of change under human-dominated pressure—the Meghna River estuary of Bangladesh. *Sustainability*, 13: 4458.
- Mondal AI, MA Kader, AH Choudhury, G Mustafa, RU Nabi, M Billah, A Al-Asif and AAM Siddiqui, 2018a. Socio-economic uplifting analysis of ESNB fishery of the coastal villages, Kumira and Kattoli, Chittagong, Bangladesh. *Int. J. Res. Granth.*, 6: 248–263.
- Mondal MAI, M Kader, MRU Nabi, AAM Siddiqui, MM Billah and A Al-Asif, 2018b. Bio-economic analysis of ESNB 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.
- Neogi SB, M Dey, SL Kabir, SJH Masum, G Kopprio, S Yamasaki and R Lara, 2017. Sundarban mangroves: diversity, ecosystem services and climate change impacts. Asian J. Med. Biol. Res., 2: 488–507.
- Parvez I, MA Alam, MM Hassan, Y Ara, I Hoshan and ASM Kibria, 2019. A checklist of fish species from three rivers in northwestern Bangladesh based on a seven-year survey. J. Threat. Tax., 11: 13786–13794.
- Rahaman MJ, MS Hossain, MM Rahman and Z Hossain, 2020. Impacts of climate change on livelihood of the fishers' at the Meghna, Laukhati and Galachipa river in Bangladesh. Asian J. Med. Biol. Res., 6:81–92.
- Rahaman MM, MA Zafar, BN Sharif, P Paul, A Al-Asif, MM Islam and MI Hossain, 2015. Tilapia (*Oreochromis mossambicus*) marketing system in greater Jessore region, Bangladesh. Int. J. Fish. Aqua. Stud., 3:95–103.
- Rashed M, MA Hossain and MM Rahman, 2017. A case study of the gears and craft used for artisanal fishing in Chittagong Patharghata Fishery Ghat, Bangladesh and socio-economic condition of the fishermen. Asian J. Med. Biol. Res., 2: 712–726.
- Salam M, KS Rana and MT Rahman, 2020. Impact of beel encroachment on aquatic biodiversity and vulnerability of poor fishermen in Noagaon district, Bangladesh. Asian J. Med. Biol. Res., 6: 244–254.
- Samad MA, BS Rahman, A Al-Asif and RK Audhikary, 2013. Availability and potentiality of small indigenous species of fish throughout the tear in South-Western region of Bangladesh. African J. Bas. App. Sci., 5: 167–173.
- Shamsuzzaman MM, MMM Hoque, SJ Mitu, AF Ahamad and MS Bhyuian, 2020. The economic contribution of fish and fish trade in Bangladesh. Aquaculture and Fisheries, 5: 174–181.
- Shamsuzzaman MM, MM Islam, NJ Tania, AMM Abdullah, PP Barman and X Xu, 2017. Fisheries resources of Bangladesh: Present status and future direction. Aquaculture and Fisheries, 2: 145–156.
- Sharif BMN and A Al-Asif, 2015. Present status of fish hatchlings and fry production management in greater Jessore, Bangladesh. Int. J. Fish. Aqua. Stud., 2: 123–127.
- Sharif BN, 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.
- Sharif BN, MY Ali, MK Saha, MA Ahmad, MA Islam and MR Amin, 2016. Economic analysis of the fishery activities of Bergobindapur baor at Chaugachha upazila under Jessore district of Bangladesh. Asian J. Med. Biol. Res., 2: 436–441.
- Siam HS, MR Hasan and T Sultana, 2020. Socio-economic status of fisher community at Nijhum Dwip. Asian J. Med. Biol. Res., 6: 351–358.
- 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.
- Sultana N and MN Islam, 2016. Fishing gears and methods in the Chalan Beel, Bangladesh. J. Fish., 4: 377.
- Talwar PK and AG Jhingran, 1991. Inland fishes of India and adjacent countries. Oxford-IBH Publishing Co. Pvt. Ltd.
- Toussaint A, N Charpin, S Brosse and S Villéger, 2016. Global functional diversity of freshwater fish is concentrated in the Neotropics while functional vulnerability is widespread. Scientific Reports, 6: 1–9.
- Uddin MN, TK Saha, MR Hossain, SF Islam and Z Hossain, 2022. Constraints to climate change adaptation and livelihood challenges: perspectives from the Sundarbans fishers' community in Bangladesh. Asian J. Med. Biol. Res., 8: 103–114.
- 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(2), 201–210.
- Zhao X and P Jia, 2020. Towards sustainable small-scale fisheries in China: A case study of Hainan. Marine Policy, 121: 103935.