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ASSESSMENT OF FISH BIODIVERSITY IN THE DHOLAI RIVER UNDER COMPANIGONJ UPAZILA OF SYLHET, BANGLADESH

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Abstract

This research aimed to assess the fish biodiversity and present status of the Dholai river in Companigonj Upazila under Sylhet district. A semi-structured questionnaire survey was used to gather the relevant information from 64 fishers from November 2019 to April 2020. This research identified 56 fish species under 21 families and ten orders. The most dominant order was Cypriniformes 32.14%, following Siluriformes 28.57%, Perciformes 14.28%, Channiformes 7.14%, Synbranchiformes 5.36%. The species availability status was observed in four categories and achieved as 17 species of commonly available (30.36%), 14 species of moderately available (25%), 17 species of less available (30.36%), and eight species of fishes were rarely found available (14.28%). A total number of five nets, one trap, one hook, and a line were recorded. The peak amount of mean Catch per Unit effort (CPUE) in the current jal was 3.67±1.50 kg/day, and the lowest was in borshi at 0.09±0.01kg/day. The highest diversity index value was 2.55 in January, and the lowest was 1.21 in April, with a mean value of 1.98±0.05. The peak richness index value was 2.76 in January, and the lowest was 1.79 in April, with a mean value of 2.36±0.1. The peak evenness value was 0.73 in January, and the lowest value was 0.41 in April, with the mean evenness value 0.61±0.05. The peck amount of fish production was in January as 478±70 kg/day, and less value was in March at 109±12 kg/day. The local fishermen identified several threats to fish biodiversity, fish habitat, and fish production of the Dholai river. The establishment of the fish sanctuary, control of river pollution, minimizing exploitation of sand and rock, conservation of angling gears ever, and maintaining fisheries rules and regulations will be effective for the conservation of fish biodiversity of the Dholai River.

Keywords: Fish biodiversity, Assessment, Dholai river, Bangladesh.

Introduction

Fish and fisheries were performing an essential role in the nutrition, economy, employment, and culture of Bangladesh people. Fish is the second essential food after rice in Bangladesh (FAO, 2005). Bangladesh is enhanced by its aquatic biodiversity containing 260 species of indigenous freshwater finfish belonging to 55 families and 150 species of waterfowls, 50 species of reptiles, 24 species of mammals, 19 species of amphibians, and 63 species of Palaemonidae and prawns (Ali, 1991; World Bank, 1991). A total of 253 fish species were identified in Bangladesh. Among them, nine species contained as Critically Endangered, 30 species contained as Endangered, and 25 species contained as Vulnerable, 27 species of fish were calculated as Near Threatened (NT), 122 species contained as Least Concern (LC), and the rest 40 species were considered Data Deficient (DD) (IUCN, 2015). Additionally, 700 rivers in Bangladesh have their own geographical, hydrological, sedimentary, and biological characteristics (Alam *et al.,* 2013). These rivers donated a lot to upsurge the open water fish production and to declare socio-economic security of the fishermen (Rahman *et al.,* 2015; Islam *et al.,* 2015, 2016; Barman *et al.,* 2021).

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The Dholai river is one of the most important water bodies in the North-Eastern part of Bangladesh regarding fish production and income generation of many fishers surrounding the water body. This River is about 13 km long and rich in biodiversity due to continuous water flow; thus, fish production is high around the year. This River considers a vital spawning and feeding ground for riverine fish species. However, riverine ecosystems have suffered from a passionate human intervention that results in habitat losses and degradation of aquatic ecosystems; as a result, fish production is decreasing rapidly in Bangladesh, and the Dholai river is not an exception. Habitat loss produced by massive siltation, infrastructure development, drying up of water bodies, dewatering, converting wetlands, overfishing, and aquatic pollution are the major causes of Bangladesh's fish population decline (IUCN, 2015; Barman *et al.*, 2014; Pandit *et al.*, 2015; Arefin *et al.*, 2018; Islam *et al.*, 2019; Akter *et al.*, 2020). Recent studies on biodiversity loss and its implications for ecosystem services have uncovered only species losses at global and regional levels (Dulvy *et al.*, 2003, Baille *et al.*, 2004). So the assessment of fish biodiversity is necessary to conserve the riverine natural biodiversity. The present study would add some new information about fish production, biodiversity status, and causes of destruction of fish diversity of the Dholai river. The outcome of this study would also help to take necessary management initiatives and development policies by the competent authorities to conserve the fish biodiversity in the Dholai river.

Materials and Methods

Selection and description of study areas

The selection of the study site is significant for conducting any research work. The study was conducted in the Dholai river at Companigonj Upazila in Sylhet district. Data collection was done from fishing spots, fish markets, and landing centers of Bholaganj, Tuker Bazer, and Thana Bazer around the Dholai river. The River originates from Meghalaya, India, and it is one of the rivers of the northwest region of the Sylhet district of Bangladesh. Its water flow connects the Katagang river. This River is about 13 km long and 50 m wide.

Table 1. Locations name with latitude and longitude of study areas

Spots	Site name	Latitude (N)	Longitude (E)
Spot-1	Bholaganj	25°15’94”	91°74’29”
Spot-2	Tuker bazar	25° 11’03”	91° 76’11”
Spot-3	Thana bazar	24° 91’02”	91° 89’52”

Study design

According to the objectives, the fishermen, wholesalers/brothers, and retailers in the study were interviewed. Then the questionnaire was confirmed after necessary changes and modifications as per the stakeholders' opinions during the pre-testing trial. Questions related to species availability, critically endangered and endangered fish species abundance, seasonal variation, and peak harvesting season were included in the survey questionnaire. Fish biodiversity was a significant portion of the questionnaire survey from 40 fishers, 20 retailers, and 4 arotders in the study area.

Data collection

Local name, short-lived notes on the nature of periodic availability, place of occurrence, upbringing season etc., and information were recorded at the spot of sample collection. Secondary information such as systematic position, availability in the local area, synonyms, fish classification, and the red list of IUCN 2015 status was collected from KII, Local leaders, UFO and DFO, books, and relevant thesis. Cross-checking discussions were attended with strategic resource persons such as Upazila Fisheries Officers (UFO), District Fisheries Officer (DFO), and local leaders. The strategic information interviews of the respondents were shown in their offices for 60 minutes.

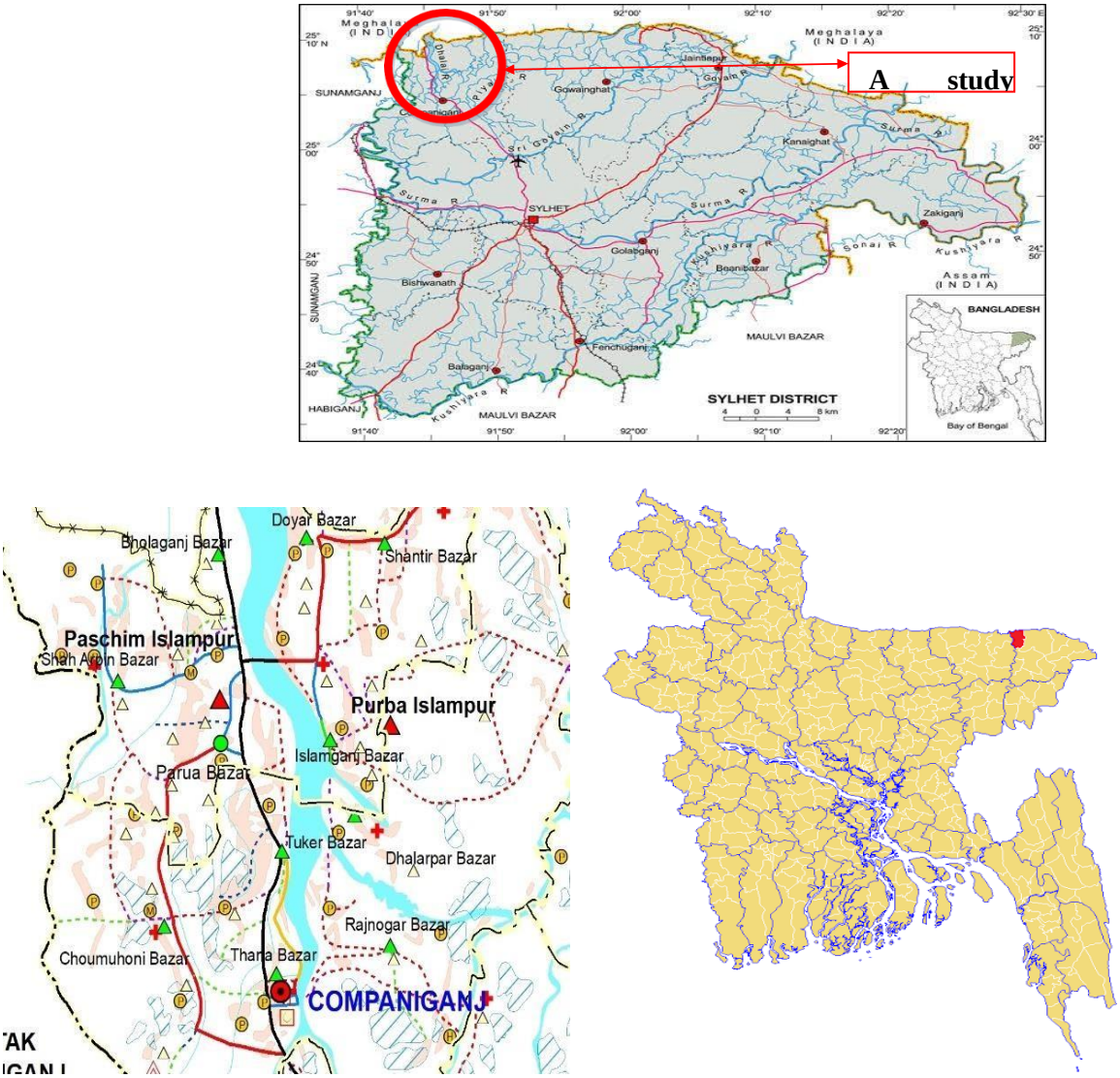

Fig. 1. Map showing the location of the Dholai river (Source: Banglapedia, 2015)

Measurement of abundance and fish biodiversity status

In the study, the diversity of fish was appraised by the Shannon Weaver index (H′) (Shannon and Weaver, 1949); species richness by Margalef index (d) (Margalef, 1968), and evenness by Pielou"s index (J′) (Pielou, 1966) through the following formula:

a) The Shannon-Weaver diversity index, $H' = -\sum P_i * \ln P_i$

b) Margalef's richness index, $d = S-1 / \ln N$

c) Pielou's evenness index, $J' = H / \ln S$

Where n_i = no. of individuals of a species, $P_i = n_i/N$, N = Total number of individuals in the sample, ln = Returns the natural logarithm of the number, S = Total species number, and H = Shannon-Weaver index. This index is a popular diversity index in the ecological literature.

Data analysis

After data collection, all data were adorned in a sequential form and documented on a computer. Data were analyzed depending on the collected data according to the questionnaire. Then the documented data were confirmed to omit all possible mistakes and contradictions. Several forms of the tabular method were applied to process the data by using some statistical implementations. Finally, data were evaluated by using Microsoft Office Excel 2007 software. For the presentation of the analyzed data, manifold tables, pie charts, and graphical figures were used in the primary documents of the thesis.

Results and Discussion

Species composition and abundance

Fifty-six fish species under ten orders and 21 families were recorded from direct catch observation and market visits. The recorded total number of fishes with their order and family details status were described in Table 2. The most contributing family was Cyprinidae (28.57%) contributed to 18 species. The second most dominated family was Bagridae, about six species (10.71%), Channidae, and Schilbeidea, where each family contributed 7.14% and four species. The Mastacembelidae, and Ambassidae families contributed 5.36% and three species by each. Also, Cobitidae, Osphronemidae, Siluridae, and Notopteridae contributed two species (3.57%), while other families contributed 1.79% (Figure 2). Similar results were found by Barman et al. (2021), who recorded a total of 59 fish species in the Surma River; Mohsin et al. (2014) found a total of 53 species found in the Andharmanik river, and Mohsin and Haque (2009) found overall 56 species in the Mahananda river. A total of 18 species was identified from Cypriniformes order. Among them, nine were commonly available, three were moderately available, three were less available, and three were rarely available in the study area. The findings are also supported by Galib et al. (2009), Mohsin and Haque (2009), Chowdhury et al. (2019), and Imteazzaman and Galib (2013).

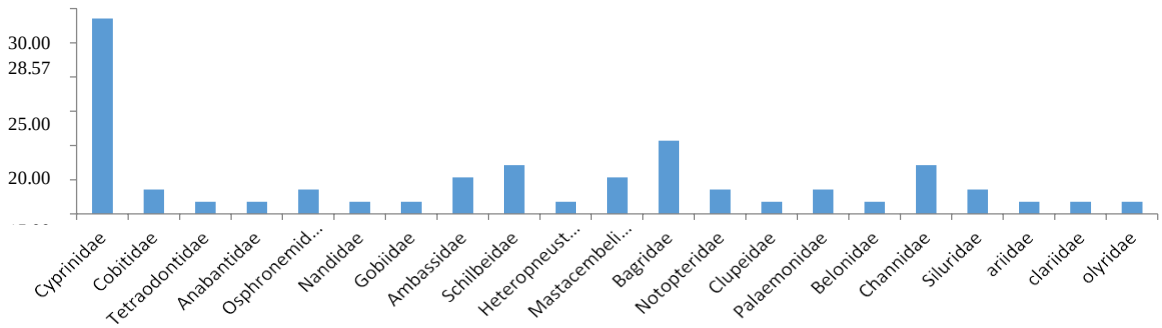

Figure 2. Percentage of fish species diversity under different families recorded in the Dholai river

The species availability status was observed in four categories and reported that 30.36% (17 out of 56) fish species were commonly available, 25% (14 species) fish species were moderately available, 30.36% (17 species) fish species were less available, and 14.28% (8 species were rarely available (Figure 3). According to the IUCN 2015 status, 36 species were least concerned, six were near threatened, and 7 were vulnerable and endangered; critically endangered was absent in the study area (Figure 4). Joadder et al. (2015) found that nearly one-third (72%) of the total species belonged to the least concerned group of Global conservation status. Kamrujjaman and Nabi (2015) found an almost similar effect in 52.08% of threatened species in the Bangshi River, in which vulnerable, endangered, and critically endangered were 20%, 36%, and 44%, separately. Chaki et al. (2014) branded 30 nearby vulnerable species amongst them vulnerable 13.51%, endangered 18.92%, and critically endangered 8.11% were detailed on the Atrai river.

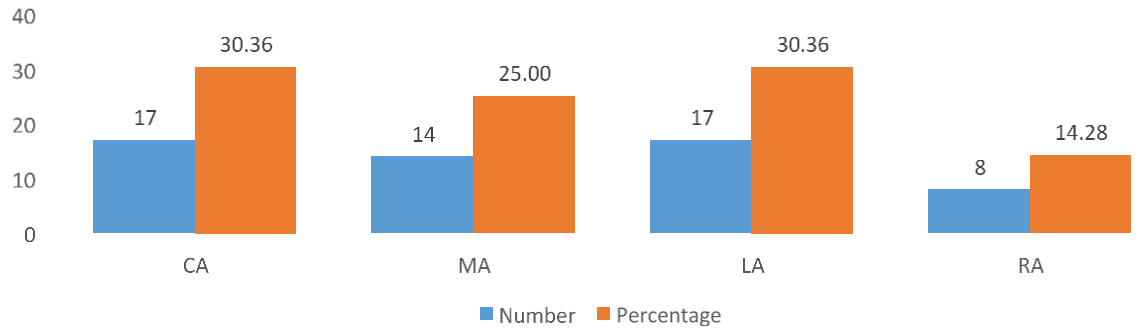

Fig. 3. Availability and percentage of fish biodiversity in the area of study

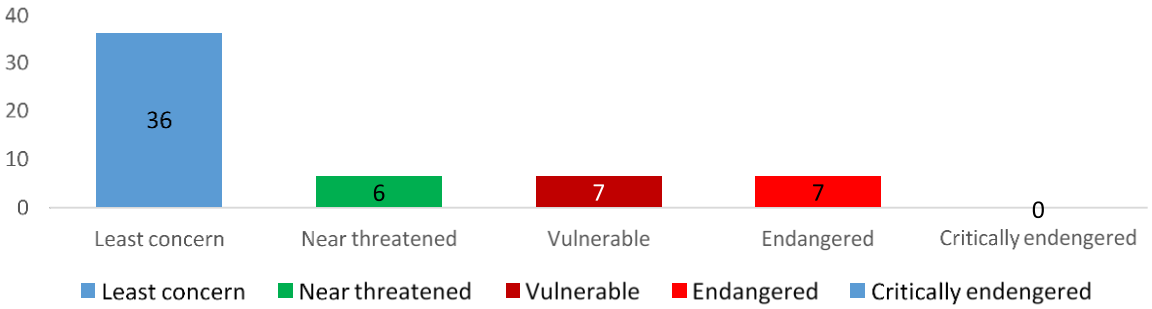

Figure 4. The number of fishes according to IUCN status

Gear composition and CPUE

The fishermen used a variety of fishing gears in the Dholai river to catch fish. Five nets, one trap, one hook, and one line were recorded in the Dholai river during the survey period (Table 3). Siddiq et al. (2013) acknowledged 13 different varieties of fishing gears under five major groups in the Dogger beel. Saha et al. (2005) categorized into seven different types of gear into 3 types (nets, traps, and wounding gears) used by two categorized fishers in the beel.

Table 2. The fishermen of Dhola River use different categories of fishing gear

Types	Group name	Local name	Englishname	Meshsize (cm)	Narrative ofgears the	Period (month)
Nets	Seine net	Ber jal	Surrounding net	0.25-1	It has 2 lines of borders with rectangular size and also attachedin float and sinkers.	December to January
	Lieft net	Dharmajal	Hand lift net	0.5-1	Nets can be flat shaped like a bag/rectangular/ pyramid/cone.	November
	Fallingnet	Jhaki jal	Cast net	0.5-1	Oval shape made with nylon fibers.	Year around
		Thela jal	Push net	0.25-1	Triangle shapemade of bamboo and nylon fibers.	Novemberto March

	Gill net	Currentjal	Fixed net	.5-2.5	A beg shape net made of mono filaments nylon fibers.	Year around
Traps	Fishing traps	Dhoar	-	-	Made of bamboo.	January to March
Hook and lines	Angling gear	Boallah Borshi	Barbed iron hook	-	Bamboo nylon with fiber and hook	Year around

Fish catch per unit effort (CPUE) is an index of the richness and level of management of fishery resources. It regulates the quantity of fishing gear that a given fishery might maintain in a sustainable custom. The CPUE (kg gear^{-1}haul^{-1}) can also be used to examine the softness of fish capture in aggregation with the estimated total harvest (Chowdhury *et al.*, 2019). A total of 7 types of fishing gears were documented from the study spots as Ber Jal, Current jal, Dharma jal, Jhaki jal, Thala jal, Dhoar, Boallah Borshi. The mean CPUE of Current jal, the peak amount was 3.67±1.50 kg^{-1}day$^{-1,}$ and the lowest Boallah borshi was at 0.09±0.01 kg^{-1}day^{-1}. The mean CPUE in amount in addition to present fishing gear as: Ber jal- 3.51±1.50 kg^{-1}day^{-1}, Dharma jal- 0.75±0.01 kg^{-1}day^{-1}, Jhaki jal- 0.74±0.01 kg^{-1}day^{-1}, Thela jal 0.38±0.01 kg^{-1}day^{-1} and Dhoar trap (fish trap)-0.06±0.01 kg^{-1}day^{-1}. Azadi et al. (2013) conducted a biodiversity study in the Halda River and documented that the mean CPUE for all the gears was 2.247±0.265 kg gear^{-1}day^{-1} for 2007 and 2.697±0.355 kg gear^{-1}day^{-1} for 2008. Total 8 gears were recorded in the Halda River, and among them, bag nets yielded the highest CPUE during 2007 as 5.957±0.704 kg gear^{-1}day^{-1} and seine nets during 2008 at 7.288±1.477 kg gear^{-1}day^{-1}.

Table 3. Catch per unit effort of fishing gear pick and less production with months

CPUE	Pick amount and month	Less amount and month
Ber jal	7.85 kg, December	0.65 kg, April
Current jal	9.62 kg, November	3.75 kg, March
Dharma jal	1.30 kg, January	0.003 kg, November
Jhaki jal	2.10 kg, December	0.029 kg, February
Thela jal	0.87 kg, February	0.002 kg, April
Dhoar	0.03 kg, February	0.009 kg, April
Boallah borshi	0.29 kg, November	0.003 kg, March

All gears' highest average gear efficiency was documented during November as 0.962 kg gear $^{-1}$ person $^{-1}$ hour $^{-1,}$ and the lowest average gear efficiency was documented throughout April as 0.0001 kg gear $^{-1}$ person $^{-1}$ hour $^{-1}$. The gear efficiency (kg gear $^{-1}$ person $^{-1}$ hour $^{-1}$) was recorded from 3 different sites of the Dholai River. The gear efficiency of Ber jal was estimated as 0.21±0.01 kg in spot-1, 0.19±0.01 kg spot-2, and 3.49±1.5 kg spot-3. In the case of the Current jal, the gear efficiency was documented as 0.28±0.01 kg in spot-1, 0.26±0.01 kg in spot-2, and 0.29±0.02 kg in spot-3. On account of Dharma jal, the gear efficiency was estimated by 0.143±0.001 kg, 0.139±0.01 kg, and 0.144±0.03 kg from spot-1, spot-2, and spot-3, respectively. In the case of the gear efficiency of Jhaki jal was estimated by means of 0.052±0.01 kg from spot-1, 0.049±0.01 kg from spot-2, and 0.053±0.01 kg from spot-3. In Thela jal, the gear efficiency recorded in the study time was 0.021±0.01 kg in spot-1, 0.018±0.01 kg in spot-2, and 0.02±0.01 kg in spot-3. In Dhoar fishing traps, the gear efficiency was varied as 0.005±0.01 kg in spot-1, 0.003±0.01 kg in spot-2, and 0.006±0.01 kg in spot-3. In Boallah Borshi, the gear

efficiency was recorded in study time as 0.0072±0.01 kg in spot-1, 0.0069±0.01 kg in spot-2, and 0.007±0.01 kg in spot-3.

Diversity index of fish species

The month-wise diversity of Shannon-Weaver diversity (H'), Margalef's richness (D), and Pielou's evenness (J') index were presented in Table 5.

Table 4. The number of calculated species and individuals with particular principles of Shannon-Weaver diversity, Margalef's richness, and evenness used in the index sampling month

Month	Number of species (S)	Number of individuals (N)	Diversity (H')	Richness (d)	Evenness(J')
Nov, 2019	27	35438	1.37±0.02	2.67±0.15	0.42±0.15
Dec, 2019	30	56890	2.46±0.07	2.65±0.21	0.72±0.01
Jan, 2020	32	76891	2.55±0.06	2.76±0.01	0.73±0.02
Feb, 2020	26	36783	2.32±0.02	2.38±0.11	0.71±0.03
Mar, 2020	20	26782	1.98±0.09	1.89±0.08	0.66±0.01
Apr, 2020	19	23075	1.21±0.04	1.79±0.05	0.41±0.05
Average	25.66	42643	1.98±0.05	2.36±0.10	0.61±0.05

The mean Shannon-Weiver diversity index (H') was estimated to range from 1.21 to 2.55. The mean value of the Shannon-Weaver diversity index (H') was documented as 1.98±0.05. The peak diversity index value was 2.55 in January, and the lowest value was 1.21 in April. Barman *et al.* (2021) estimated H´ value between 3.454 to 3.861. The recent study's findings are slightly different from the above findings because of the different geographical locations of the study area (Barman *et al.*, 2021).

The degree of pollution was measured and discovered along with values based on the collection of the Shannon-Weiver diversity index as suggested by Biligrami (1988). All the Months showed values ranging from 1.21to 2.55, representing moderate to less pollution. This suggests that the whole condition of the water bodies of the Dholai River was found to be good. Though, Government and different NGOs intervention for protecting these endangered fish species in the area will be very helpful for the use of future generations. A similar result was also reported by Nath and Deka (2012), who recorded the richest fish diversity in winter. The lowest number of species was recorded in the month of June; The value of the diversity and richness index in this study was found to be greater than that of Yisa et al. (2011) and Innocent et al. (2012), indicating comparatively highest biodiversity area. The Peak Richness index value was 2.76 in January and the less value was 1.79 in April. The mean value of the Richness index (H') was recorded as 2.34±0. The peak evenness value 0.73 was estimated in January and less value 0.41 in April. The mean evenness value was found as 0.61±0.05.

Table 5. Shannon-Weiver diversity index (H') and pollution level

Shannon-Weaver diversity index (H')	Pollution level	Values found (Range)
3.0 - 4.5	Slight	
2.0 – 3.0	Less	1.21 – 2.55

1.0 – 2.0	Moderate
0.0 – 1.0	Heavy

Fish production

Fish productions changed in different months in the Dholai river. The peak value of fish production was estimated in January as 478±70 kg /day and less value were recorded in March as 109±12 kg/day. Fish production was calculated as 121±50 kg/day, 154±55 kg/day, 127±66 kg/day and 132±39 kg/day, respectively in November, December, February and April. The average fish production was found in spot-3, spots-2, and spots-1 as 201.7±.81 kg/day, 196.5±40.03 kg/day, and 186.58±61.30 kg/day, respectively. The highest average fish production was recorded in spot-3 as 201.7±.81 kg/day and the lowest average were found in spot-1 at 186.58±61.30 kg/day. More or less similar result was originated by Hossain et al. (2009) displayed gradual reduction in fish production in the Chalan beel and recounted a total of 12,217 tons of annual fish production during the 2005-2006 economic years, which was partial of the production experiment in 1982. The main reasons for declining biodiversity and overall availability of fishes, according to a questionnaire survey and data collected, were shown in Table 7.

Table 6. Causes for degradation in fish biodiversity of the Dholai river

Threats to fish diversity	No. of Respondents	Percentage of Respondents
Use of unwanted fishing gear, e.g. Current jal,Ber jal.	77	49.28%
Siltation and sedimentation.	79	50.56%
Exploration sand and rock	75	48%
Turbidity	70	44.8%
Excess navigation	70	44.8%
Overfishing and undiscriminating fishing on account of proper knowledge was absent.	68	43.52%
Catching of brood fish, fry, fingerlings andjuvenile fish.	65	41.6%
Low water depth and current	62	39.68%
Drought in summer season	60	38.4%
Over doses of insecticides and pesticides inagricultural land	54	34.56%
To make agricultural land by filling the river	38	24.32%
Use of river water for irrigation	60	38.4%
Use of chemical fertilizers like urea, triplesuper phosphate etc in land area	70	44.8%
Poor implementation of fishing rules andregulations	22	14.08%

The findings of this present study are supported by Islam *et al.* (2015) and Barman *et al.* (2021). However, more or less similar work was found by Islam et *al.* (2017) they displayed that fish biodiversity of the Bhairab River has been deteriorating day by day due to fishing heaviness and terminated fishing were answerable for virtually 38% damage and pollution and siltation produced about 27% damage of ecosystem. Around 21% and 14% of damage to the ecosystem was produced by urbanization, human encroachment, and recreational happenings. Almost parallel results by Rahman et *al.* (2015) recorded that the fish biodiversity of the Talma river has dropped little due to overexploitation, natural causes (such as siltation, flooding, drought, and calamities), and trade problems for fish migration and lack of public consciousness.

Conclusion

The Dholai river is a major source of indigenous fish species and has shown good indication of rich biodiversity as 56 species of fishes belong to 21 families under ten orders. The most contributing family was Cyprinidae (28.57%) followed by Bagridae (10.71%), Channidae, Schilbeidea, Mastacembelidae, Ambassidae, Cobitidae, Osphronemidae, Siluridae, and Notopteridae. A total of seven types of fishing gears were documented from the study spots as Ber Jal, Current jal, Dharma jal, Jhaki jal, Thala jal, Dhoar, and Boallah Borshi. The maximum mean CPUE was reported for Current jal (3.67 ± 1.50 $kg^{-1}day^{-1}$), and the minimum was reported for Boallah borshi (0.09 ± 0.01 $kg^{-1}day^{-1}$). Fish diversity and production (478 ± 70 kg/day) were recorded high in January, while low diversity in April and low production (109 ± 12 kg/day) in March in the Dholai river. However, fish production of the Dholai river is decreasing day by day due to unwanted fishing gear, siltation and sedimentation, overfishing and indiscriminating fishing. So, a proper management system needs to be taken to control the fish biodiversity of the Dholai river. The establishment of the fish sanctuary, control of river pollution, minimizing exploitation of sand and rock, conservation of angling gears ever, and maintaining fisheries rules and regulations will be effective for the conservation of fish biodiversity of the Dholai river. For the safety of fish biodiversity of the Dholai river, the Community Based Fisheries Management (CBFM) system and sustainable fisheries management should be adopted amongst the fishermen.

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