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Research Article

Fish Biodiversity at Haor Wetland of Bangladesh: A Comprehensive Review

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Abstract

Wetland environments in Bangladesh, such as rivers, lakes, ponds, beel, baor, and haor, are critical for the feeding, spawning, breeding, and nursing of at least 253 fish species, as well as a variety of freshwater fish and prawns. In addition, they support a number of rural people and provide habitat for a multitude of migrating birds. Bangladesh's wetlands are classified as freshwater wetlands, saltwater wetlands, and artificial wetlands, with haors belonging to the freshwater wetlands group. Haor is a marshy wetland area that looks like a bowl or saucer. It is inundated for seven to eight months during the wet season, similar to a massive inland sea, and then divides into beels during the dry season. Apart from giving migratory fish and bird species breeding, nursing, and feeding habitats, it boasts around 154 native fish species from 35 families and 12 orders. The biodiversity of fish in haor wetlands has been experiencing a decline due to factors such as overexploitation, environmental degradation, and the persistent challenges posed by climate change. To effectively manage the haor wetland ecosystem, it is strongly recommended that an ecosystem-based co-management approach be adopted. This should involve the active participation of the local community, the establishment of sustainable fishing practices, and the promotion of alternative livelihoods for deprived harvesters who are heavily reliant on these resources. This review paper proposes a simple and practical approach to studying the haor wetlands, the current state of fish biodiversity in the various haor ecosystems of Bangladesh, and related challenges.

Introduction

Bangladesh has abundant and varied coastal and inland water resources and is an agro-based nation [1,2]. With a diverse fish fauna and abundant water resources, the country boasts one of the most abundant and varied inland aquatic ecosystems in the world. It is a floodplain delta of the Brahmaputra, Ganges, and Meghna rivers [3-6]. Over 6.7 million hectares of inland water make up its total area, of which 94% is devoted to open-water capture fisheries and 6% to closed-water aquaculture [7]. Wetlands in Bangladesh have the most significant impact on sociodemographic, environmental, and development issues [8]. Fish, the second most valued crop in Bangladesh, is essential to millions of people's lives and means of subsistence [9,10]. Bangladesh produced 4.5 million Metric Tons (MT) of fish in 2019–20, making it one of the top fish-producing nations in the world [11]. At the same time, it ranked third in the world for inland open-water capture fisheries production [12]. However, Bangladesh has a variety of wetland types, including rivers, lakes, ponds, lake, beel, baor, and haor. Additionally, these freshwater bodies, also known as wetlands, are vital areas for feeding, spawning, breeding, and nursing at least 253 fish species, various freshwater fish species, and prawns. They also cover approximately 4.64 million hectares of land [13], serve as habitat for hundreds of thousands of migratory birds, and provide food for millions of rural households [14,15].

Bangladeshi wetlands are divided into three groups: freshwater wetlands, saltwater wetlands, and artificial wetlands. Nonetheless, Bangladesh's haors fall under the

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category of freshwater wetlands [16]. In Bangladesh, the term "Haor" describes a bowl- or saucer-shaped marshy wetland habitat that is flooded for about seven to eight months during the rainy season, resembling a vast inland sea, and then separates into beels during the dry season [17-21]. According to Salauddin and Islam [22], the Haor Basin is an ecosystem that is essential to the commercial and ecological production of fish. Additionally, it provides residents and migratory fish species with breeding, nursing, and feeding. The haor wetlands are home to over 154 native fish species from 35 families and 12 orders [21]. The haor region produced 108,880 MT of fish overall in 2018–19, with a productivity of 433 kg/ha [23]. Furthermore, during FY 2017–18 and FY 2018–19, the haor region's fish production increased at a rate of 12.11% [23], inhabitants as well as fish species that migrate.

With over 260 freshwater native fish species, inland fisheries, including haors, are primarily in charge of boosting Bangladesh's fish production [6,11,24]. Because Haor has more resources than other water reservoirs in the nation, it is very important for the national economy, nutrition, and rural livelihoods [25]. However, the proportion of inland capture fisheries to total fish production had steadily declined from 62.59% in 1983-84 to 28% in 2013-14 due to overexploitation, habitat fragmentation, siltation of freshwater bodies, and environmental pollution from industries and agricultural chemicals [23,26]. In order to boost fish productivity, leaseholders of some Haor beels typically raise carp fingerlings in their beels as part of aquaculture. The loss of biodiversity, especially species diversity, is a major issue in the country. For a variety of natural and man-made reasons, the number of endemic fish species in different inland water bodies is declining annually [18-21,27-31]. Although Haor is important to its residents from a socioeconomic, environmental, and geoecological perspective, there isn't yet a thorough overview study, analysis, or adequate data on the current state of fish biodiversity in Bangladesh's various haor ecosystems. This review paper is therefore an initial effort to identify research gaps from earlier studies, the present state of fish biodiversity in Bangladesh's various haor ecosystems, and related challenges.

Methodology

In accordance with Liberati's (2009) principles [32], a systematic review of the literature was done. Concerning fish biodiversity, wetland ecosystems, fishery management, fishermen's livelihood management, and issues related to fish population decline, a significant amount of research has been conducted. We primarily focused on peer-reviewed journal articles and studies, PhD and Master's theses, and scientific reports about Haor and fish production that were written in English and published online in order to identify research gaps from earlier works, the current status of fish biodiversity of various haor ecosystems in Bangladesh, and related issues. The databases of Web of Science, Scopus, and Google Scholar were searched for a thorough evaluation because they are academic publications. A total of 119 peer-reviewed articles from Google Scholar, Web of Science, and Scopus were searched. Following an initial title sorting, 42 papers were eliminated, leaving 77 papers for abstract sorting. Then, out of 77 research articles, we eliminated 38 after sorting by abstract. The remaining 39 research articles undergo a thorough review procedure, after which 13 are eliminated. Ultimately, 26 research articles are accepted for the present manuscript. Table 1 illustrates the evaluation process's methodical approach.

Haors of Bangladesh

In Bangladesh, horas can be classified into three categories based on their physical characteristics: floodplain areas, extensively flooded horas, and foothill and near-hill horas. Geographically, the most notable haors are Tanguar, Hakaluki, Dekar, Kawadighi, Medir, Naluar, Karcher, Hail, and Sonir. In addition, there are numerous tiny haors remains in Sylhet and Mymensingh regions. Sylhet and Mymensingh regions are abundant in terms of natural resources, including fish, aquatic fruits, swamp forests, livestock, medicinal plants, and water storage facilities. These districts contain 373 haors, each covering around 858,460 hectares, or almost 43% of the districts' total area. The Indian hills of Meghalaya to the north, Manipur to the east, and Tripura and Mizoram to the south enclose the Haor areas.

Tanguar Haor

One of Bangladesh's six Ecologically Essential Areas (ECAs), Tanguar Haor is a wetland that is known across the world as the Ramsar site [33,34]. It covers more than 10,000 hectares and serves at least 60,000 people in Sunamganj District's two upazilas, Tahirpur and Dharmapasha [35]. Between 25°12'10.572" and 25°5'47.969" north latitude and 90°58'49.426" and 91°10'0.018" east longitude, this haor is situated in the northeastern region of Bangladesh. The haor's whole area is roughly 114 km^2. The Surma, Jadukata, and Dhanu Baulai Rivers have an impact on the Haor Wetland. Numerous hill streams pour into the Haor Basin from the Meghalayan Hills of India, which are located at the country's far northern tip [36].

Fish biodiversity of Tanguar Haor: Tanguar Haor is known for its diverse fish, aquatic plants, amphibian, reptilian, avian, and mammal species, which are all part of its floral and faunal compositions [37]. The region has one of the six "Mother Fish Stocks" in the nation in terms of fish species diversity [37]. According to [38-40], it is home to roughly 141–143 freshwater fish species (135–137 native and 6 exotic) belonging to 35 families and 12 orders (Figure 1 and 2). Almost half of Bangladesh's 260 freshwater fish species are represented

Table 1: The step-by-step approach to the review process.

Sources of Databases	Steps	Approaches	No of Article		
			Total	Excluded	Retained
Peer-reviewed journal articles and studies, PhD and Master's theses, and scientific reports	Steps -1	Total number of articles found	119	-	-
	Steps -2	Eligibility test by title	119	42	77
	Steps -3	Eligibility test by abstract	77	38	39
	Steps -4	Eligibility test by full paper read	39	13	26
	Steps -5	Final Review	26	-	-

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in this group [41-43]. The total fish stock of Tanguar Haor was estimated to be 6701 tons [37] and this huge fisheries asset's economic value added to the GDP of the country each year [44]. There were 137 native fish species, of which 8 were critically endangered, 20 endangered, 17 vulnerable, 20 near threatened, and 62 endangered [38-40,45-47]. However, [37] also noted that a significant number of fish species that have been classified as threatened nationwide were determined to be endangered, with 23 of the 55 vulnerable fish taxa being found in Tanguar Haor alone.

According to [39], out of the 141 species of fish in the natural ecosystem of Tanguar Haor, only 41% (58 species) were present throughout the winter season. The remaining 59% (83 species) either vanished or were lost from this body of water, which is exceedingly concerning. 12 fish (20.68%) were classified as Less Available Species (LAS), 12 fish (20.68%) as Rarely Available Species (RAS), 18 fish (31.08%) as Moderately Available Species (MAS), and 16 fish (28%) as Commonly Available Species (CAS) out of the 58 species [39]. The same evidence was presented by [48,49] that the lack of water in the haor causes problems in fish breeding, particularly for small indigenous fish species (Figures 2,3), and results in a decline in the fish population from the end of February to the first week of March. Furthermore, the erratic rainfall and scarcity of water in the nearby rivers and canals prevent the brood fish from arriving at the haor's breeding grounds in time [50]. According to [36], fish biodiversity has been influenced by climate vulnerability brought on by pH, temperature, and erratic rainfall.

Hakaluki Haor

The complex ecosystem that is known as the Hakaluki Haor is made up of about 238 interconnected beels, or Jalmohals [47,50,51]. More than 18,000 hectares are covered by the haor during the rainy season, which spans five Upazila (subdistricts) in the districts of Sylhet and Moulvibazar: The Fenchuganj and Golapganj in Sylhet, and the Barlekha, Juri, and Kulaura in Moulvibazar [52,53]. In contrast, during the dry season, the total area of beels decreases to about 4600 ha and stays underwater for as long as five or six months [2]. The Hakaluki haor is situated in the northeastern region of Bangladesh, between latitudes 24°35' N and 24°45' N and longitudes 92°00' E and 92°08' E [51]. Since 1999, this wetland has been designated as an "Ecologically Critical Area" (ECA) in accordance with the Bangladesh Environment Conservation Act 1995 [51,52].

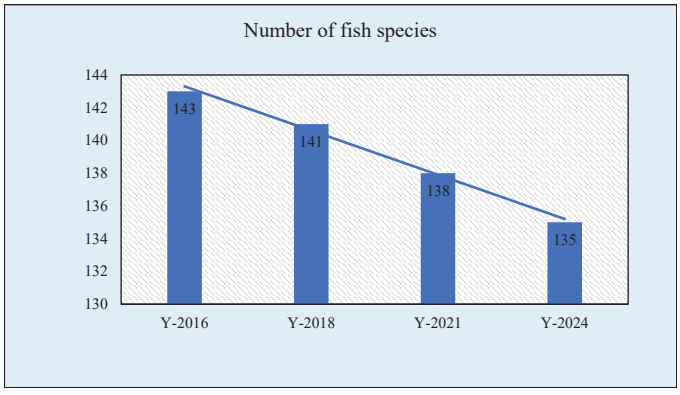

Figure 1: Number of fish species existing at Tanguar Haor in the last 10 years.

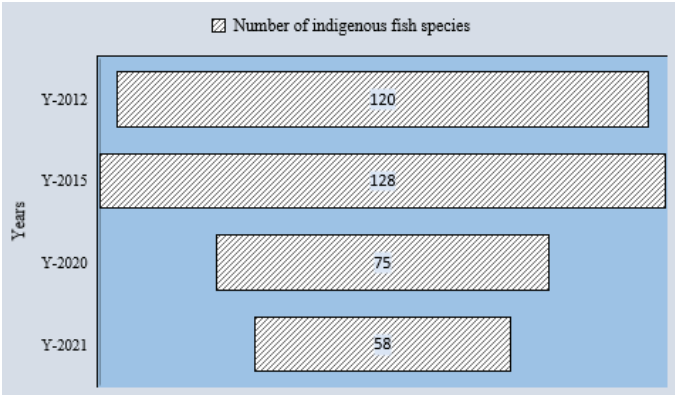

Figure 2: Number of indigenous fish that exist at Tanguar Haor.

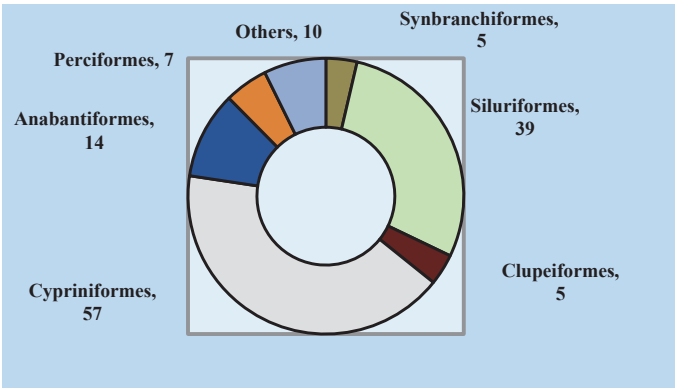

Figure 3: Number of fish species based on order.

Fish biodiversity: The Hakaluki Haor is home to numerous commercially significant species, including carp, six species of giant catfish, numerous small catfishes, and numerous other fish species. This haor's fish diversity is enhanced by the presence of both giant freshwater prawns (*Macrobrachium rosenbergii*) and little prawns [53,54]. The Hakaluki haor produced 28,000 tons of fish on average during the fiscal year 2022-2023, compared to 53,109 tonnes for the national wetland average [55]. Iqbal [2] used a participatory rural appraisal approach to identify 83 fish species in Hakaluki Haor, belonging to 55 genera, 28 families, and 10 taxonomic orders, while local fishermen reported 57 species across 42 genera, 23 families, and 7 taxonomic orders [21]. According to various research, the Hakaluki Haor is home to 75 and 82 fish species from 9 and 10 taxonomic groups, respectively [56-58]. By comparison, a survey conducted in 1993 found 107 species of fish in Hakaluki; however, by 2009, that number had dropped to 75 [57]. Among the fish species identified, Cypriniformes accounted for 35.08% of the total, with Perciformes (26.32%), Siluriformes (21.05%), Synbranchiformes (7.01%), Clupeiformes (5.26%), Osteoglossiformes (3.50%), and Anguiliiformes (1.75%) following closely behind [3-5]. Additionally, it was discovered that the most dominating family was Cyprinidae, which includes

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16 fish species and accounts for 28.07% of all documented species. Cyprinidae is the largest family, with five species (8.77%), followed by Bagridae. Ambassidae (3.50%), Cobitidae (3.50%), Notopteridae (3.50%), Osphronemidae (5.26%), Siluridae (5.26%), Channidae (7.01%), Clupeidae (5.26%), Mastacembelidae (5.26%), and Schilbeidae (3.50%) were the other families that underwent divergence. Furthermore, according to [46-48], only one species was a member of the following families: Anabantidae, Anguillidae, Aplocheilidae, Badidae, Balitoridae, Belontidae, Centropomidae, Clariidae, Gobiidae, Heteropneustidae, Nandidae, and Synbranchidae (Figure 3).

According to Bhattacharjee, et al. [59], *Labeo* spp. (14.67%), *Wallago attu* (11.34%), *Mystus* spp. (8.33%), *Puntius* spp. (5.84%), *Cirrhinus cirrhosus* (4.58%), *Sperata* spp. (3.77%), *Notopterus notopterus* (2.65%), and small prawns (6.61%) made up the majority of the average catch composition in the Hakaluki haor. In contrast, [37] reported that the dominant species catches in the Hakaluki haor were *Hypophthalmichthys molitrix* (5.8%), *Wallago attu* (11.10%), *Nandus nandus* (10.20%), *Gudusia chapra* (8.40%), *Glossogobius giuris* (5.2%), *Puntius sophore* (5.1%), *P. sarana* (4.30%), *Labeo rohita* (3.5%), and small prawns (15.10%).

Additionally, of the species that were identified, nine fish species (15.79%) were classified as Commonly Available Species (CAS), fifteen fish species (26.32%) as Moderately Available Species (MAS), twenty-one fish species (36.84%) as Less Available Species (LAS), and twelve fish species (21.05%) as Rarely Available Species (RAS) (Figure 4) [5,24-26]. Furthermore, according to Hossain & Rabby (2020), 66.66% of all fish species were classified as "Least Concern (LC)," with 10.52% being Near Threatened (NT), Vulnerable (VU), Endangered (EN) endangered, and 1.75 percent critically endangered (CR). This is in contrast to the fact that 22.80% of all species have been classified as Threatened [5,26]. In contrast, [2] identified 41 fish species in Hakaluki Haor that were threatened, of which 12 were vulnerable, 18 were endangered, and 11 were highly endangered. Anthropogenic, socioeconomic, and climatic factors are the three main categories into which these variations in findings could be divided [5,7,21].

Dekhar haor

Dekhar Haor is located between latitudes 24°34´N and 25°12´N and longitudes 90°56´E and 91°49´E. It encompasses

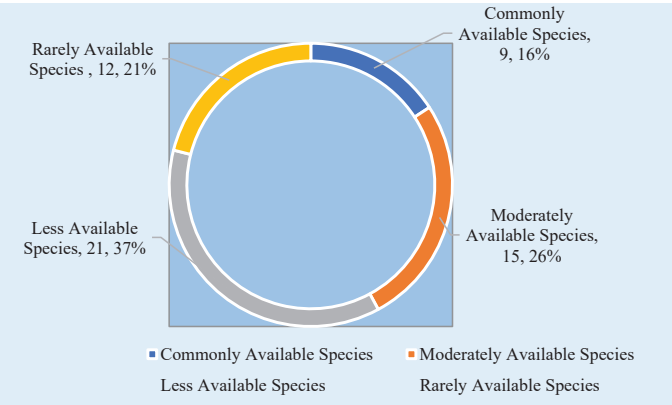

Figure 4: Available species of fish in different categories at Hakaluki Haor.

11514.6 hectares in total, with 36 small, medium, and big interconnected beels, canals, rivers, and croplands [34,35]. While the haor appears to be an inland sea during the monsoon season, it is nearly dry throughout the dry season, with the exception of a few deeper beels [25,34].

Fish biodiversity: Fish in the Dekhar Haor Biodiversity vary in size, shape, color, habitat, and how they eat and breed. It has been reported [60,61] that 51 fish species were available throughout the year, but [62] reported that 74 fish species were still present in Dekhar Haor. Twelve of the 56 species were scarcely available (21%), 18 were moderately available (32%), and 26 were widely available (47%). According to [63] of the 56 species, 8 were carps, 12 were catfish, 9 were barbs and minnows, 4 were snakeheads, 4 were eels, 10 were perches, 3 were loaches, and 6 were miscellaneous, including 3 prawn species. Trina [62] and [63] report that out of 74 fish species, 54 were threatened, with 12 of those threatened species being critically endangered (CR), 28 being endangered (EN), and 14 being vulnerable (VU). Furthermore, considering the viewpoint of fishermen, all fish were divided into four main groups based on their availability. These are: Abundantly available (AA), Frequently available (FA), Rarely available (RA), and very uncommon (VR) [62]. Ten common groups were also created from the fishes. Ten prevalent groups-carps, barbs and minnows, loaches, clupeids, snakeheads, perches, catfish, eels and mud eels, featherbacks, and miscellaneous were identified in the research area out of the 74 species. The greatest rate is 24% for catfishes. The percentages for perches, carps, barbs, and minnows are 18%, 16%, and 15%, respectively, indicating a very intimate association. Clupeids and loaches each make up 3%, while snakeheads make up 8%. Feather backs and miscellaneous contribute 4% each, whereas eels and mud eels contribute 5% [64].

Medir haor

The Medir haor (MH), also called Medinir haor, is located in the Nasirnagar upazila of Brahmanbaria district of the Chattogram division of Bangladesh (Upazila: an administrative subdivision of Bangladesh). It occupies an area of approximately 3628 hectares [65]. Austogram, Bajitpur, Sarail, Brahmanbaria Sadar, Madhabpur, and Lakhai are the six upazilas that border the Nasirnagar upazila [65]. Two or more dispersed little haor-basins come together to form this haor. In particular, Medir haor finishes at Lakhai Upazila after beginning on the north side of Nasirnagar Sadar. The Medir haor's land uses fall into three main categories: a) agri-lands, which are areas used for farming, cultivation, and crop production; b) beels, which are the haor's deepest section; and c) kandas, which are the outer sections of the haor that are close to the nearby communities [65].

Fish biodiversity: In the Medir Haor wetland, 31 fish species were identified (Table 2), with 6 of those species expected to be catfish [66]. Compared to the Tanguar haor wetland ecosystems, [38] documented, the Medir haor wetland's fish resource richness was somewhat lower. According to other researchers, the Ratargul Freshwater marsh also has a number of mollusks and crustaceans, such as *Sartoriana spinigera* [67].

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Table 2: Identified fish species of Medir Haor.

SL. No.	Scientific Name	Fish Species
1	*Ailiichthys punctate*	Kajuli
2	*Amblypharyngodon mola*	Mola
3	*Batasio batasio*	Tengra
4	*Catla catla*	Katol
5	*Channa marulius*	Gozar
6	*Channa punctate*	Taki
7	*Channa striata*	Shoul
8	*Chitala chitala*	Chital
9	*Cirrhinus cirrhosis*	Mrigel
10	*Clarias batrachus*	Koi
11	*Clarias gariepinus*	Magur
12	*Corica soborna*	Kechhki
13	*Gagata youssoufi*	Shing
14	*Glossogobius giuris*	Bele
15	*Gudusia chapra*	Chapila
16	*Labeo bata*	Bata
17	*Labeo boggut*	Ghonia
18	*Labeo calbasu*	Kalibaus
19	*Labeo dyocheilus*	Ghora mach
20	*Labeo rohita*	Ruhi
21	*Lepidocephalichthys annandalei*	Gutum
22	*Mastacembelus armatus*	Baim
23	*Mystus vittatus*	Tengra
24	*Neotropius atherinoides*	Batasi
25	*Ompok pabo*	Pabda
26	*Pangasius pangasius*	Pangash
27	*Plotosus canius*	Gang-magur
28	*Puntius puntio*	Punti
29	*Puntius sarana*	Shorpunti
30	*Wallago attu*	Boal
31	*Xenentodon cancila*	Kakila

*Source: [67]

Kawadighi Haor

Once a mother fishery, the Kawadighi Haor is now a multifunctional (FCDI) sector covering 22700 hectares. It is bordered to the north by the Kushiyara River, to the south and west by the Monu River, and to the east by the base of the Bhatera hills. About 12,295 hectares make up the Haor, which is situated in the Rajnagar upazila of the Moulvibazar district and has 63 beels and linking canals. Koradoyer Khal (canal) connects the Haor to the Kushiara River.

Fish biodiversity: In the Kawadighi Haor, 87 fish and freshwater prawn species from 30 families under 14 orders were identified [67,68]. Of them, 78 were native fish, 6 were foreign fish, and 3 were prawn species. Ailiidae (3), Clupeidae (3), Mastacembelidae (3), Palaemonidae (3), Botiidae (2), Cobitidae (2), Bagridae (7), Ambassidae (4), Channidae (4), Osphronemidae (4), Siluridae (4), and Ambassidae (4) were the most numerous of the families, with 20 species each. The families contain one species are: Heteropneustidae, Gobiidae, Horabagridae, Mugilidae, Nandidae, Pangasiidae, Synbranchidae, Sisoridae, Tetraodontidae, Badidae, Anguillidae, Belonidae, Chacidae, Clariidae, and Horabagridae. According to [67], the order Cypriniformes had the most species (34), followed by Siluriformes (20), Anabantiformes (11), Ovalentaria (4), Synbranchiformes (4), Clupeiformes (3), Decapoda (3), Osteoglossiformes (2), Anguilliformes (1), Beloniformes (1), Cyprinodontiformes (1), Gobiiformes (1), Mugiliformes (1), and Tetraodontiformes (1). Numerous other studies saw a similar situation when evaluating the fish biodiversity in different Bangladeshi wetlands [68-70]. In Beel Kumari and Hilna Beel in Northwestern Bangladesh, 2 prawn species and 93 bony fish species from eight orders were discovered [70]. In the Sylhet-Mymensingh basin, 92 distinct species of fish and prawns were identified [14].

Possible reasons for the decline of fish biodiversity in haors

i. Both natural and man-made factors, such as exploitation, environmental degradation, and the ongoing phenomenon of climate change, contributed to the decline in fish biodiversity in wetlands [71,72]. The following are the main causes listed:**Overfishing:** Thousands of endangered species are destroyed by uncontrolled and excessive fishing, which eventually affects the food and nutrition security of hundreds of millions of people worldwide [72]. However, overfishing through the use of illegal and prohibited nets, gear, etc., harmed the native fish species' spawning, feeding, and nursery grounds inside the wetland environment [39]. Overfishing, which is caused by a lack of sources of income and extreme poverty, is threatening to wipe out approximately 32 fish species in Hakaluki Haor which poses a serious threat to fish stocks [73,74]. Additionally, 190,000 residents in the surrounding areas use the natural resources of the haors year-round, which contributes to the decrease of wetlands [75].

ii. **Indiscriminate catching:** Fish conservation was found to be seriously threatened by local fishermen's indiscriminate fishing of fry/fingerlings, juveniles, gravid fish, and small fish, as well as their disruption of fish growth and reproduction during the breeding season and ban period [39,74].

iii. **Climate:** Various extreme weather conditions, such as drought, temperature swings, river erosion, and unpredictable rainfall, may contribute to the decline of biodiversity [45,71]. Fish productivity and diversity in natural waterbodies are particularly vulnerable to climatic changes because a broad range of weather and water quality parameters affect feeding, migratory, spawning, and other biological processes [35,75]. The length of the rainy season can vary, occurring in the early summer or early winter [40].

iv. **Dewatering:** The most destructive method for harvesting fish of all sizes, including fry, juveniles,

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and adults, is fishing by dewatering or completely drying the beel ditches [39,42]. Breeding activity, larval development, and fish diversity are all impacted by the brood fish migration from the deep-water shelter to the breeding grounds, which is hampered by the haor's connected rivers and beels' insufficient water supply due to intermittent rainfall [31,39].

v. **Harmful fishing gears:** Higher rates of brush fishing during the mating season are depleting the populations of juvenile and gravid fish in various haor wetland areas [39] and fishing across sluice gates, canals, rivers, or other waterways using bamboo fencing or nets with fixed fishing equipment like synthetic gill nets (current jal) and seine nets (ber jal) may be a significant factor in the Haors' declining fish biodiversity [39].

vi. **Unplanned construction:** The construction of roads, bridges, embankments, and crop dams around the haor to divide the shallow water area from the deeper area of the wetland adjacent to the rivers in order to prevent fish migration routes and interfere with regular water flows [17-21]. Road, bridge, culvert, and other construction projects are also interfering with migratory paths and influencing natural recruitment [74].

vii. **Use of harmful and toxic pesticides:** The overuse of pesticides, fertilizers, and other hazardous chemicals on agricultural land and on agricultural lands near wetlands has resulted in significant pollution of wetland waters and the destruction of fish habitats [21,39].

viii. **Deforestation:** Fish biological diversity and habitat degradation have been found to be mostly caused by direct and indirect resource exploitation as well as deforestation [76,77]. A sizable portion of the population depends entirely or in part on the floral resources-more especially, the non-wood forest products of the MH wetland ecosystems-for fuel, thatching materials, firewood, and fodder.

ix. iX) **Haphazard leasing and illegal pressure:** Fisheries resources have been made worse by poor governance with top-down policy implications, an inappropriate Jalmohal leasing system, and corrupted socio-political management [74,75]. The Haor area's political officials are solely responsible for the leasing system, which discourages regular fishermen from fishing and promotes illegal fishing [77].

Recommendations/Way Forward

For the appropriate management of hoar, a few particular things are highly advised here. The following are the suggestions:

- The prohibition of damaging gear and illegal fishing nets, such as seine and monofilament nets, should be enforced.
- To lessen the damage caused by unexpected floods, the Haor Basin should establish an early warning system for flash floods.
- Trees (ecosystem friendly) should be planted and restored to preserve the biological balance of the area and safeguard homestead areas.
- Creation of a comprehensive strategy for managing the Haors that covers all water resources and bodies, forests, fisheries, wetland management, and the distribution of Khas land.
- To preserve the brood and juvenile fishes, a sanctuary needs to be created at the Haor Basin.
- During the busiest breeding season, the fish harvest ban period should be observed.
- Special task groups incorporating Upazila Fisheries personnel are required to control harbor and high-speed vehicles and equipment.
- More research on the Haor economy and ecology is necessary, with a focus on identifying issues from multiple angles and investigating opportunities in the pertinent fields for immediate and practical policy implications.
- In light of sustainable harbor management, government policy and interdepartmental links should be updated and representative in order to lessen the negative consequences of ecotourism, which is hardly acknowledged due to its undesired influence.

Conclusion

The study indicates that the country's haors are home to the most productive ecosystems that support extensive food webs and a wide diversity of species, as well as a wide variety of fish, wildlife, and other water bodies. They also contribute significantly to Bangladesh's economy and ecology by providing a variety of commodities and services that sustain livelihoods and life. However, it is concerning because the biodiversity of these natural wetlands is being gravely threatened by their gradual disappearance. It has been revealed that a number of anthropogenic, socioeconomic, and climatic factors have a significant detrimental effect on fish genetic resources, making them the primary threats to the ecological viability and productivity of this rich, unique environment. Therefore, community-based activity, nongovernmental organizations, government policy and strategy, and social recognition are all essential for the preservation of haor biodiversity. A range of stakeholders, including the fishing community, local managers, lawmakers, and haor management authorities, were expected to benefit from the review's conclusions. Additionally, before haor suffers irreversible harm, we would want to urge the national and international communities to conduct comprehensive surveys to assess its relevance.

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