Article

Haor-Based Floodplain-Rich Freshwater Ichthyofauna in Sylhet Division, Bangladesh: Species Availability, Diversity, and Conservation Perspectives

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Abstract: Biodiversity assessment is important for evaluating community conservation status. The *haor* basin in Sylhet Division represents a transitional zone with high species availability, rare occurrences and endemism. As a result, this study aims to describe the *haor*-based freshwater fish composition, including habitat, trophic ecology, availability and conservation status. Semi-structured questionnaires were used to collect data on fish samples through focus group discussions, field surveys, and interviews with fisheries stakeholders on a monthly basis. We identified 188 morphospecies, of which 176 were finfish and 12 shellfish, distributed into 15 orders and 42 families where 29%, 42%, 15%, and 14% species were commonly available, moderately available, abundantly available, and rarely available, respectively. Cypriniformes was the dominant order in both total species and small indigenous species identified. Approximately 45.34% of species were riverine, 31.58% floodplain residents, 12.55% estuarine, 2.83% migratory, and 7.69% were exclusively hill stream residents. Carnivores and omnivores were the most dominant trophic groups. A total of 87.76% species were used as food, 12.23% as ornamental and 6.91% as sport fish. Approximately 50 species were threatened (7 critically endangered, 23 endangered and 20 vulnerable) at the national level, most of them belonging to Cypriniformes and Siluriformes. Based on endemism, 16 species were endemic of which Sygnathidae, Cobitidae, Olyridae, Cyprinidae and Balitoridae fell under the threatened category. Minimizing intense fishing efforts, banning indiscriminate fishing and destructive fishing gear, initiating fish sanctuaries and *beel* nurseries, and implementing eco-friendly modern fishing technology are suggested to conserve the threatened species. This study represents a guideline for assessing the availability and conservation of freshwater fish in the Sylhet belt and serves as a reference for decision-makers in order to allow for the sustainable exploitation of fisheries resources within an ecosystem-based framework.

Keywords: *haor*; biodiversity; freshwater fish conservation evaluation; threatened species

1. Introduction

Basic knowledge of species ordination patterns and existence images is important to accurately describe the structure and dynamics of an ecosystem [1]. Moreover, this information supports the fruitful management of natural resources and reduces possible anthropogenic effects [2,3]. Equatorial freshwater fish are highly diverse and not easily characterized by any specific features. Scientists distinguish freshwater fish into three major groups in terms of saltwater tolerance and the presumed ability to spread by overcoming maritime barriers: [4] fish that are strictly intolerant of saltwater (primary division), rarely capable of crossing narrow marine boundaries (secondary division), and representatives of marine families colonizing inland water from the sea (peripheral division). Fish

Base (http://www.fishbase.org (accessed on 7 December 2016) adapts a slightly different salient feature of freshwater and brackish water fish species into three groups: (1) entirely freshwater, (2) fresh and brackish water, and (3) fresh, brackish and seawater.

Globally, freshwater and brackish water fish species belong to 207 families and 2513 genera, of which 11,952 are strictly freshwater species [5] and 15,062 inhabit fresh and brackish waters [6]. Notably, the number assessed to be 13,000 ichthyofauna found in freshwater reservoirs covers only 1% of the earth's surface. Freshwater fish species and the stability of their existing ecosystem are seriously threatened and are the world's most endangered group of animals after amphibians [7–9].

Bangladesh is blessed with highly diverse and rich natural aquatic resources in the form of rivers, streams, estuaries, mangroves, floodplains, *haors* (seasonal wetlands), *baors* (oxbow lakes), *beels* (perennial water bodies), canals and artificial reservoir ponds. A total of 253 fish species were assessed where 104 were riverine, 113 floodplain inhabitants and 36 migratory species [10]. The freshwater fish species are not limited to freshwater; 62 species live in estuaries and numerous fish species migrate upstream from the Bay of Bengal [11]. Among the assessed fish species, 64 species were listed as threatened, comprising 25.3% of the total species assessed, while 9 species were Critically Endangered (CR), 30 species were Endangered (EN) and 25 species were Vulnerable (VU). In addition, 27 species were listed as Near Threatened (NT), 122 species as Least Concern (LC), and the remaining 40 species were considered Data Deficient (DD). No fish were found to be Extinct or Regionally Extinct [10]. In the last few decades, freshwater fish faced adverse impacts due to anthropogenic environmental degradation such as urbanization, construction of dams, diversion of water for irrigation and power generation and pollution. Unfortunately, the country's biodiversity is under threat due to the recent growing population and excessive extraction and use of natural resources [10].

Sylhet Division covers 12,558 square kilometers (with 217 *haors* covering 16,154.51 ha; 663 floodplains covering 174,824.17 ha; 3167 *beels* covering 40,946.18 ha; 116,850 ponds covering 15,129.09 ha and 20 fish sanctuaries) and is comprised of four districts (Sylhet, Sunamganj, Moulvibazar, and Hobiganj). It is the most important breeding, nursery and grazing habitats for freshwater fish species with near 0.26 million metric tons (MT) total production and a surplus of 55.85 thousand metric tons [12]. Approximately 0.152 million registered fishers are engaged in fishing and depend on natural waters for livelihood. Fishers with diverse fishing crafts and apparatuses seize a massive number of different fish species in the *haors*, rivers, and *beels* every day except during times when fishing is definitely prohibited. Indiscriminate killing, over-exploitation, use of destructive fishing gear and techniques, pollution and lack of proper management have put the fish biodiversity of Sylhet division at extreme risk. As a result, many fish have become vulnerable, endangered and critically endangered over time. The extinction of fish species at the global and local levels seriously threatens biodiversity and ecosystem balance [13]. Some research studies have been conducted on fish biodiversity in Sylhet Division, but a complete list of existing ichthyofauna with up-to-date conservation status is lacking. Therefore, it is very challenging to comprehend the present status of fish in Sylhet Division. Detailed survey work with a logical inventory of fish species is highly required to undertake necessary management for conservation of fish biodiversity of Sylhet division.

Although there are a few relevant publications on diversity and conservation status in this region, to date there is no compilation of the complete list of freshwater fish of the entire Sylhet division and information on their potential threat level. Considering this scenario, the aim of the study was to (a) prepare an updated checklist of floodplain rich freshwater fish species composition, availability status, habitat and trophic status, and national and global conservation status, and (b) propose recommendations to develop the existing conservation position of threatened fish in Bangladesh.

2. Materials and Methods

2.1. Study Area

Sylhet division lies between latitudes 23°58′ and 25°12′ north and longitudes 90°56′ and 92°30′ east. It is bordered by Meghalaya to the north, Tripura to the south, Assam to the east and Netrokona and Kishoreganj districts to the west. The study was conducted at 43 sampling sites (10 sites in fish *arat*/wholesale fish markets, 16 sites in retail fish markets, and 17 sites in fishing spots/areas) across Sylhet division (Figure 1). The study sites were selected to consider their unique geographic locations and incredible species diversity. The GPS reading of sampling spots was taken using Android GPS Test Software (version 1.6.3). A map of the sampling sites was created using ArcMap 10.7 [14].
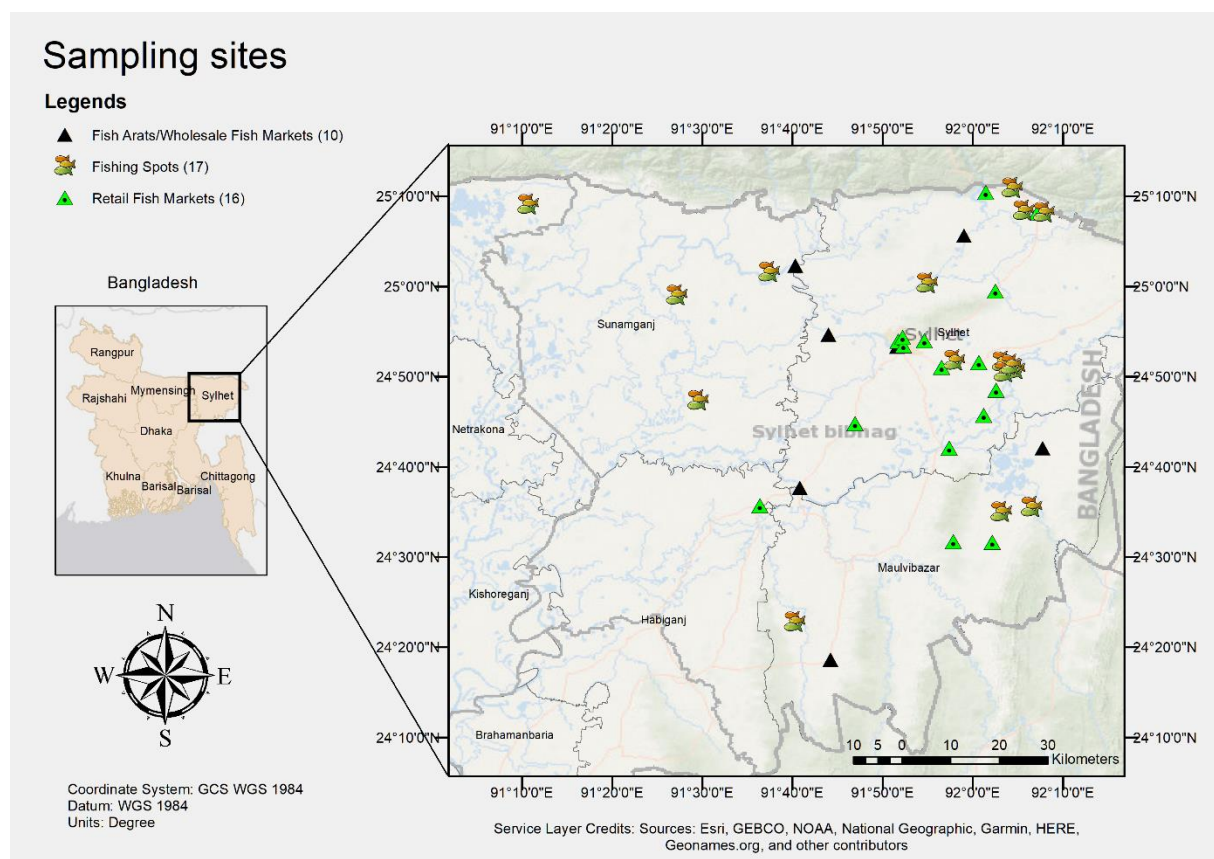

Figure 1. Location of the sampling sites.

2.2. Data Collection Framework and Species Identification

An eight-month study was conducted from September 2017 to April 2018. Focus group discussions (FGDs) with commercial fishing vessel owners, fish retailers, fish traders, locals, fishermen, sport anglers, riverbank colonials, and other people who came forward were used to obtain information regarding the feasibility of sampling existing fish species. In addition, a semi-structured questionnaire was used to conduct consultations at fish markets, fish landing centers, and fishing villages.

Fish samples were collected in both live and fresh conditions. Samples of live and fresh fish were collected directly from fishermen at fishing spots, *aratders*/wholesalers at *arat*/wholesale fish markets, and retailers at retail fish markets. For capturing live fish samples, fishing nets (seine net, gillnet, cast net, drag net, pull net, push net, and lift net) and fishing traps were used (*Doair*, *Bair*, *Chai*, *Bana*, *Bamboo pipe*, *Hogra*), and the ethical procedure approved by the 'Ethical Approval Committee of Bangladesh Agricultural University Research System (BAURES)' was followed. During sampling, photos of each fish

species were taken with a digital camera. The collected fish samples were acknowledged by examining their biometric features in accordance with published articles [6,10,11,15].

Trophic category and habitat groups were determined by following IUCN Bangladesh [10] and the Web-based related database [6]. When data were unavailable on IUCN Bangladesh and Fishbase, information was gathered from various articles published earlier [12,16–24]. As precise information on fish trophic levels is absent in the study area, the food items for each species were reviewed to explain the feeding mode according to the literature found for each taxon. The identified fish species were categorized into functional groups based on feeding mode (omnivores, carnivores, planktivores, herbivores, larvivores, and insectivores). The ecological structure was categorized into five groups, namely, riverine, hill stream, migratory, estuarine, and floodplain residents. To identify the commercial value of fish, each species was evaluated based on specific criteria for food (showed adequate growth in unit time and attained maximum size), sport (the preference of anglers), or ornamentation (based on diversified ornamental criteria *viz.* beautiful color, shape and size, banding pattern, hardiness, transparent body, calm behavior, and adhesive suckers). Endemic species were identified based on their distribution restricted to *haor* basins in Sylhet [12]. In addition, identified fish were categorized into four groups based on respondent perceptions, namely, abundantly available (AA): available in abundance all year round (frequency of occurrence: 76–100%), commonly available (CA): usually found in small numbers all year round (frequency of occurrence: 51–75%), moderately available (MA): rarely found in the study area (frequency of occurrence: 26–50%), and rarely available (RA): found infrequently in very small numbers (frequency of occurrence: 1–25%) [4,25]. The conservation status of each species was listed in accordance with the IUCN Red List of Bangladesh [10] and Threatened Species of Global Red List [16].

2.3. Data Analysis

To detect the most frequent freshwater fish orders, families, trophic categories, habitat group endemicity, commercial fish value, and existing conservation status, the contribution (frequency of occurrence) of each group was assessed by following equation: $F_0 = (N/n) \times 100$, where F_0 is % contributor or frequency of occurrence, N is the category to be calculated (order, family, or conservation status) and n is the total number of species in each group.

3. Results

3.1. Fauna Composition

The present study on freshwater fish species in the Sylhet division revealed one hundred eighty-eight (188) species, distributed into 15 orders and 42 families, detected from 43 sampling spots. The identified fish included 176 finfish (166 indigenous and the rest 10 were exotic) followed by 12 shellfish (freshwater prawn) (Table 1).

Table 1. Freshwater fish species recorded in Sylhet division of Bangladesh. CA—Commonly available; MA—Moderately available; AA—Abundantly available; RA—Rarely available; FP—Flood plain; HS—Hill streams; Et—Estuarine; R—River; Mgt—Migratory; NE—Not Evaluated; DD—Data Deficient; LC—Least Concern; NT—Near Threatened; VU—Vulnerable; EN—Endangered; CR—Critically Endangered; BD—National conservation status; IUCN—Global conservation status.

Taxon	Common Name	Local Name	Present Status	Habitat	Trophic Group	Conservation Status	
						BD	IUCN
Order Perciformes							
Family Anabantidae							
Anabas testudineus [†]	Climbing Perch	Koi	CA	FP	I	LC	DD

Table 1. *Cont.*

Taxon	Common Name	Local Name	Present Status	Habitat	Trophic Group	Conservation Status BD	IUCN
Family Ambassidae							
Pseudambassis ranga [†, ‡]	Indian Glassy Fish	Ranga Chanda	MA	FP	C	LC	LC
Chanda nama [†, ‡]	Elongate Glass-Perchlet	Lomba Chanda	MA	FP	C	LC	LC
Pseudambassis lala [†, ‡]	High-Fin Glassy Perchlet	Lal Chanda	CA	FP	C	LC	NE
Parambassis thomassi [†, ‡]	Western Ghat Glassy Perchlet	Dhipali Chanda	MA	FP	C	NE	LC
Parambassis baculis [†, ‡]	Himalayan Glassy Perchlet	Bokul Chanda	MA	FP	C	NT	LC
Family Badidae							
Badis badis [‡]	Dwarf Chameleon Fish	Napit Koi	CA	FP, HS	C	NT	LC
Family Gobiidae							
Glossogobius giuris [†, ‡]	Tank Goby	Bele	MA	R, FP, Et	O	LC	LC
Brachygobius nunus [†]	Bumblebee Goby	Baligora	CA	Et, Mgt	C	LC	NE
Gobiopterus chuno [†]	Gobius Chuno	Chuno	CA	R, Et	C	LC	DD
Family Nandidae							
Nandus nandus [†, ‡]	Mottled Nandus	Veda	CA	FP, R	C	NT	LC
Family Osphronemidae							
Colisa fasciata [†, ‡]	Giant Gourami	Khalisha	MA	FP	O	LC	LC
Trichogaster lalius [†, ‡]	Red/Dwarf Gourami	Lal/Boicha Khalisha	CA	FP	O	LC	LC
Trichogaster chuna [†, ‡]	Sunset Gourami	Chuna Khalisha	CA	FP	O	LC	LC
Trichogaster labiosus [†, ‡]	Thick-Lipped Gourami	Thoatmota Kholisha	MA	FP	O	LC	LC
Ctenops nobilis [‡]	Indian Paradise Fish	Mohua	RA	FP	C	LC	NT
Pseudosphromenus cupanus [‡]	Spike Tail Paradise Fish	Pot Koi	MA	FP	I	LC	LC
Family Sciaenidae							
Johinus coitor [†]	Coitor Croaker	Koitor Puma	MA	Et, R, FP	C	LC	LC
Otolithoides pama [†]	Pama Croaker	Crocker Puma	MA	Et, R	P	LC	NE
Panna microdon [†]	Panna Croaker	Panna Puma	MA	Et	P	NE	LC
Family Cichlidae							
Oreochromis niloticus [*, †]	Nile Tilapia	Nilotica	MA	FP	O	NE	LC
Family Channidae							
Channa striatus [†]	Striped Snakehead	Shol	CA	FP	C	LC	LC
Channa marulius [†]	Giant Snakehead	Gajar	MA	FP	C	EN	LC
Channa punctatus [†]	Spotted Snakehead	Taki	AA	FP	C	LC	LC
Channa orientalis [†, ‡]	Walking Snakehead	Cheng	AA	FP	C	LC	NE
Order Siluriformes							
Family Amblycipitidae							
Amblyceps mangois [a, ‡]	Indian Torrent Catfish	Amu/Khudi Magur	RA	HS	C	LC	LC
Family Bagridae							
Batasio batasio [†, ‡]	Tista Batasio	Batasi	CA	R	C	NT	LC
Batasio tengana [†, ‡]	Assamese/Dwarf Catfish	Tengra Batasi	MA	R	C	EN	LC
Mystus tengara [†, ‡]	Pearl Catfish	Bujuri Tengra	CA	FP	C	LC	LC
Mystus vittatus [†, ‡]	Asian Striped Catfish	Vita Tengra	AA	FP	C	LC	LC
Mystus bleekeri [†, ‡]	Day's Mystus	Golsha Tengra	AA	R, FP	C	LC	LC
Mystus cavasius [†, ‡]	Gangetic Mystus	Kabashi Tengra	MA	R	C	NT	LC

Table 1. *Cont.*

Taxon	Common Name	Local Name	Present Status	Habitat	Trophic Group	Conservation Status	
						BD	IUCN
Rama chandramara [†, ‡]	Asian Cory	Futki Bujuri	MA	FP	O	LC	LC
Mystus keletius [†, ‡]	Keletius Mystus	Kele Tengra	MA	R	O	NE	LC
Mystus armatus [a, †]	Kerala Mystus	Armi Tengra	MA	R	C	DD	LC
Rita rita [†, ‡]	Rita	Rita	CA	R	C	LC	EN
Hemibagrus menoda [†]	Menoda Catfish	Ram Tengra	MA	R	C	NT	LC
Sperata aor [†, $]	Long Whiskered Catfish	Guji Ayre	AA	R	C	VU	LC
Sperata seenghala [†, $]	Giant River-Catfish	Tolla/Guijja Ayre	AA	R	C	VU	LC
Family Chacidae							
Chaca chaca [‡]	Square-Head Catfish	Chaka	MA	FP	C	EN	LC
Family Clariidae							
Clarias batrachus [†]	Air Breathing Catfish	Magur	CA	FP	O	LC	LC
Family Erethistidae							
Conta conta [‡]	Conta Catfish	Konta Kutakanti	CA	R	C	NT	NE
Family Heteropneustidae							
Heteropneustes fossilis [†]	Stinging Catfish	Shing	CA	FP	O	LC	LC
Family Olyridae							
Olyra longicaudata [a, ‡]	Longtail Catfish	Vot Shingi	RA	HS	C	EN	LC
Family Pangasiidae							
Pangasius pangasius [†, $]	Yellowtail Catfish	Pangas	RA	R, Et	O	EN	LC
Pangasianodon hypophthalmus [*, †]	Thailand Catfish	Thai Pangas	AA	R	O	NE	CR
Family Schilbeidae							
Ailia coila [†, ‡]	Gangetic Ailia	Kajoli	CA	R, FP	C	LC	NT
Ailia punctata [†]	Jamuna Ailia	Bashpata	CA	R, FP	H	LC	DD
Clupisoma garua [†, $]	Garua Bacha	Ghoura Bacha	CA	R	C	EN	NE
Eutropiichthys murius [†]	Murius Vacha	Muri Bacha	CA	R	C	LC	LC
Eutropiichthys vacha [†]	Batchwa Vacha	Bacha	CA	R	C	LC	LC
Neotropius atherinoides [†]	Indian Potasi	Patasi	MA	R, FP	P	LC	LC
Silonia silondia [†, $]	Silond Catfish	Silon	MA	R, Et	C	LC	LC
Family Siluridae							
Ompok bimaculatus [†]	Butter Catfish	Boali Pabda	AA	FP	O	EN	NT
Ompok pabda [†]	Pabda Catfish	Modhu Pabda	CA	FP	O	EN	NT
Ompok pabo [†]	Pabo Catfish	Kala Pabda	MA	FP	O	CR	NT
Wallago attu [†, $]	Freshwater Shark	Boal	AA	R, Mgt	C	VU	NT
Family Sisoridae							
Bagarius bagarius [†, $]	Gangetic Goonch.	Bagair	CA	R	C	CR	NT
Gagata cenia [†]	Indian Gagata	Kawa Tengra	MA	R	O	LC	LC
Gogangra viridescens [a, †, ‡]	Huddah Nangra.	Totamukh Gang Tengra	MA	R	C	LC	LC
Gagata sexualis [a, †, ‡]	Koel Gagata	Modna Gang Tengra	MA	R, Et	C	NE	LC
Glyptothorax cavia [†, ‡]	Painted Catfish	Kaviar Pathor Chata	MA	R, FP	C	DD	LC
Glyptothorax platypogonoides [‡]	White Catfish	Sada Dag Pathor Chata	MA	R	C	NE	LC

Table 1. *Cont.*

Taxon	Common Name	Local Name	Present Status	Habitat	Trophic Group	Conservation Status	
						BD	IUCN
Glyptothorax telchitta [†, ‡]	Copper Catfish	Telichita Pathor Chata	MA	R	C	VU	LC
Hara hara [‡]	Kosi Hara	Teen Kata Hara	AA	R, FP	C	LC	LC
Hara jerdoni [‡]	Sylhet Hara	Kutakanti	AA	R, FP	C	LC	LC
Erethistes pusillus [‡]	Giant Moth Catfish	Teen Kata Pushil	CA	R, HS	C	LC	LC
Pseudolaguvia shawi [‡]	Shawi Stone Catfish	Teen Kata Shabi	MA	R	C	DD	LC
Pseudecheneis sulcata [‡]	Sucker Throat Catfish	Vot Magur	RA	R	C	DD	LC
Sisor rabdophorus [‡]	Sisor Catfish	Sisor	RA	R	C	CR	LC
Family Loricariidae							
Hypostomus Plecostomus [†, ‡]	Armored Catfish	Sucker mouth Catfish	CA	R, Et	O	NE	NE
Order Anguilliformes							
Family Anguillidae							
Anguilla bengalensis [†]	Giant Mottled Eel	Bamosh	RA	R	C	VU	NT
Family Moringuidae							
Morigua raitaborua [‡]	Purple Spaghetti Eel	Rata baura	CA	FP	O	NE	NE
Family Ophichthidae							
Pisodonophis boro [†]	Rice-Paddy Eel	Boro Balachata	CA	Et, R	C	LC	LC
Lamnostoma orientalis [†]	Oriental Sand Eelhara	Chotku Balachata	CA	Et, R	C	NE	LC
Pisodonophis cancrivorus [†]	Long-Fin Snake Eel	Motku Balachata	CA	ET	C	LC	NE
Order Cyprinodontiformes							
Family Aplocheilidae							
Aplocheilus panchax [‡]	Blue Panchax	Teen Chokha	CA	FP	L	LC	LC
Order Beloniformes							
Family Belonidae							
Xenentodon cancila [†, ‡]	Needle Fish	Kakila	CA	FP	C	LC	NE
Family Adrianichthyidae							
Oryzias melastigma [‡]	Estuarine Rice-Fish	Kanpona	CA	Et, FP	L	LC	LC
Family Hemiramphidae							
Hyporhamphus limbatus [†]	Congaturi Halfbeak	Ekthuta	MA	R, Et	C	LC	NE
Dermogenys pusillus [†]	Wrestling Halfbeak	Gollez Ekthuti	RA	R, Et	C	LC	NE
Order Pleuronectiformes							
Family Soleidae							
Pseudorhombus arsius [‡]	Large Tooth Flounder	Kathal Pata	MA	Et	C	NE	NE
Order Cypriniformes							
Family Cobitidae							
Lepidocephalichthys guntea [†, ‡]	Guntea Loach	Gutum	AA	FP	L	LC	LC
Lepidocephalus thermalis [†, ‡]	Malabar Loach	Gormi Puiya	MA	R	C	NE	LC
Canthophrys gongota [†, ‡]	Gongota Loach	Pahari Gutum	MA	R	O	NT	LC
Lepidocephalichthys irrorate [†, ‡]	Loktak Loach	Chuccha Puiya	CA	R, FP	C	VU	LC
Lepidocephalichthyes annandalei [a, †, ‡]	Annandale Loach	Annon Puiya	MA	FP	O	VU	LC
Oreonectes evezardi [†, ‡]	Poona Loach	Kuti Puiya	MA	R	P	NE	LC
Pangio pangia [‡]	Pangia Coolie-Loach	Panga	RA	R	C	LC	LC

Table 1. *Cont.*

Taxon	Common Name	Local Name	Present Status	Habitat	Trophic Group	Conservation Status	
						BD	**IUCN**
Botia dario [†,‡]	Bengal Loach	Rani Mach	AA	FP	C	EN	LC
Botia lohachata [†,‡]	Y-Loach	Lohachata Rani	RA	R	C	EN	NE
Botia dayi [†,‡]	Hora Loach	Dayo Rani	MA	R	O	EN	NE
Family Balitoridae							
Schistura scaturigina [†,‡]	Scaturigina Loach	Kathuri Puiya	MA	HS	O	EN	LC
Schistura corica [†,‡]	Corica Loach	Korica Puiya	MA	HS	O	CR	LC
Acanthocobitis botia [†,‡]	Sand Loach	Balichata	RA	FP	O	LC	LC
Acanthocobitis zonalternans [†,‡]	Dwarf Zipper Loach	Thuta Puiya	MA	FP, R	O	VU	LC
Schistura sikmaiensis [a,†,‡]	River Loach	Sikim Puiya	MA	HS	C	EN	LC
Syncrossus hymenophysa [a,†,‡]	Green Tiger Loach	Bagha Puyia	MA	HS	O	NE	LC
Family Cyprinidae							
Labeo rohita [†,$]	Rohu	Rui	AA	R, Mgt	H	LC	LC
Gebelion catla [†,$]	Catla	Catla	AA	R, Mgt	H	LC	NE
Cirrhinus cirrhosus [†,$]	Mrigal Carp	Mrigal	AA	R	O	NT	LC
Labeo gonius [†]	Kuria Labeo	Gonia	AA	R	H	NT	LC
Cirrhinus reba [†,‡]	Reba Carp	Tatkini	CA	R, FP	P	NT	LC
Labeo calbasu [†,$]	Black Rohu	Kalibaus	AA	R, FP	H	LC	LC
Labeo bata [†]	Bata Labeo	Bhangon Bata	MA	R	H	LC	LC
Labeo boggut [†]	Boggut Labeo	Ghoria	MA	R	P	VU	LC
Labeo boga [†]	Boga Labeo	Boga Bata	MA	R	H	CR	LC
Labeo angra [†]	Angra Labeo	Angra Rui	RA	R	H	VU	LC
Labeo ariza [a,†]	Ariza Labeo	Ariza Rui	RA	R	P	NT	LC
Labeo dero [†]	Kusha Labeo	Kusha Rui	RA	R	H	DD	LC
Chagunius chagunio [†]	Jerruah/Chaguni	Chaguni	RA	R	O	VU	LC
Labeo nandina [†]	Nandina Labeo	Nandia Rui	RA	R	O	CR	NT
Labeo pangusia [†]	Pangusia Labeo	Ghora Mokho Rui	CA	R	H	EN	NT
Labeo dyocheilus [†]	Brahmaputra Labeo	Ghora Maach	RA	R	H	DD	LC
Tor tor [†,‡,$]	Tor Mahseer	Mohashol	RA	R	O	CR	DD
Garra gotyla [†,‡]	Sucker Head	Ghar Poia	MA	HS	H	EN	LC
Puntius sarana [†,‡]	Olive Barb	Sarpunti	CA	FP	O	NT	LC
Puntius ticto [†,‡]	Ticto Barb	Tit Punti	AA	FP, HS	O	VU	LC
Puntius sophore [†,‡]	Pool Barb	Jat Punti	AA	FP	O	LC	LC
Puntius chola [†,‡]	Swamp Barb	Chola Punti	CA	FP	O	LC	LC
Puntius guganio [†,‡]	Glass Barb	Mola Punti	MA	FP	O	LC	LC
Puntius gelius [‡]	Golden Barb	Jelly Punti	MA	FP	O	NT	LC
Pethia phutunio [†]	Dwarb Barb	Phutoni Punti	MA	FP	C	LC	LC
Oreichthys cosuatis [†,‡]	Cosuatis Barb	Kosha Punti	RA	FP	C	EN	NE
Puntius conchonius [†,‡]	Rosy Barb	Kanchon Punti	MA	FP	O	LC	LC
Puntius terio [†]	One-Spot Barb	Teri Punti	MA	FP, HS	O	LC	LC
Puntius parrah [†]	Parrah Barb	Para Punti	CA	FP	O	NE	LC
Aspidoparia jaya [†]	Carplet	Jaya	MA	R	O	LC	NE
Aspidoparia morar [a,†]	Aspidoparia	Morari	MA	R	O	VU	NE

Table 1. *Cont.*

Taxon	Common Name	Local Name	Present Status	Habitat	Trophic Group	Conservation Status	
						BD	**IUCN**
Chela cachius [†]	Silver Hatchet Chela	Kechi Chela	MA	R, FP	P	VU	LC
Salmostoma phulo [†]	Fine-Scale Razor Belly Minnow	Phul Chela	CA	R, FP	P	NT	LC
Salmostoma bacaila [†]	Large Razor Belly Minnow	Narkeli Chela	MA	R	O	LC	LC
Securicula gora [†]	Gora Chela	Ghora Chela	CA	FP	C	NT	LC
Amblypharyngodon mola [†]	Mola Carplet	Mola	AA	FP, R	P	LC	LC
Amblypharyngodon microlepis [†]	Indian Carplet	Boro Mola	MA	FP, R	P	LC	EN
Osteobrama cotio [†,‡]	Cunma Osteobrama	Dhela	MA	R, FP	O	NT	LC
Danio devario [†]	Sind Danio	Chap Chela	CA	FP	C	LC	LC
Danio rerio [†,‡]	Zebra Danio	Anju	RA	HS	O	NT	LC
Rasbora daniconius [†,‡]	Blackline Rasbora	Dankina	MA	FP	O	LC	LC
Bengala elanga [†,‡]	Bengala Barb	Elang	MA	R	O	EN	LC
Esomus danricus [†,‡]	Flying Barb	Darkina	CA	FP	O	LC	NE
Barilius tileo [a,†,‡]	Tileo Baril	Tila Borali	RA	R	O	EN	LC
Barilius bendelisis [a,†,‡]	Hamilton's Barila	Hiralu Borali	RA	R, HS	O	EN	LC
Barilius barila [a,†,‡]	Barred Baril	Borali	MA	R	C	EN	LC
Barilius vagra [a,†,‡]	Vagra Baril	Vagra Borali	RA	R, HS	O	EN	LC
Barilius dogarsinghi [a,†,‡]	Manipur Baril	Dogarsingh Borali	MA	HS, R	O	NE	VU
Puntius gonionotus [*,†,‡]	Silver Barb	Thai Sarpunti	AA	R	O	NE	LC
Hypopthalmichthys molitrix [*,†]	Silver Carp	Silver	AA	R	P	NE	NT
Hypopthalmichthys nobilis [*,†]	Bighead Carp	Bighead Carp	AA	R	P	NE	DD
Cyprinus carpio [*,†]	Common Carp	Carpio	AA	R	O	NE	VU
Cyprinus carpio var. communis [*,†]	Common Carp	Carpio	AA	R	O	NE	DD
Cyprinus carpio var. specularis [*,†]	Mirror Carp	Mirror Carp	AA	R	O	NE	DD
Ctenopharyngodon Idella [*,†]	Grass Carp	Grass Carp	AA	R	H	NE	NE
Mylopharyngodon piceus [*,†]	Black Carp	Black Carp	MA	R	C	NE	DD
Family Psilorhynchidae							
Psilorhynchus balitora [†]	Balitora Minnow	Balitora	MA	HS	P	LC	LC
Order Clupeiformes							
Family Clupeidae							
Tenualosa ilisha [†]	Hilsa Shad/River Shad	Ilish	MA	R, Mgt	P	LC	LC
Gudusia chapra [†]	Indian River Shad	Chapila	AA	FP	O	VU	LC
Gonialosa manmina [†]	Ganges River Gizzard Shad	Mukh Chukka Chapila	RA	R, Et	P	LC	LC
Corica soborna [†]	Ganges River Sprat	Kachki	CA	R, FP	P	LC	LC
Ilisha melastoma [†]	Indian Ilisha	Khorchuna	MA	Mgt, Et	P	DD	LC
Family Engraulidae							
Setipinna phasa [†]	Gangetic Hairfin Anchovy	Phasa	MA	R, Et	O	LC	LC
Order Rajiformes							
Family Dasyatidae							

Table 1. *Cont.*

Taxon	Common Name	Local Name	Present Status	Habitat	Trophic Group	Conservation Status	
						BD	IUCN
Himantura bleekeri [†]	White Nose/Dwarf Whipray	Sankush	MA	Mgt	C	NE	VU
Order Mugiliformes							
Family Mugilidae							
Rhinomugil corsula [†,‡]	Corsula Mullet	Khorsula	MA	R, Et	O	LC	LC
Order Osteoglossiformes							
Family Notopteridae							
Chitala chitala [†,‡,$]	Clown Knife Fish	Chital	CA	R	C	EN	NT
Notopterus notopterus [†,‡]	Bronze Featherback	Foli	CA	FP	C	VU	LC
Order Sygnathiformes							
Family Sygnathidae							
Microphis cuncalus [‡]	Crocodile-Tooth Pipefish	Kona Kumirer Khil	MA	R, Et	C	VU	LC
Microphis deocata [a,‡]	Deocata Pipefish	Kota Kumirer Khil	MA	R, Et	C	VU	NT
Order Synbranchiformes							
Family Synbranchidae							
Monopterus cuchia [†]	Gangetic Mud Eel.	Kuchia	CA	FP	C	VU	VU
Ophisternon bengalense [†]	Bengal Eel	Boush	RA	Et, R	C	VU	LC
Family Mastacembelidae							
Mastacembelus armatus [†,‡]	Tire-Track Spiny Eel	Shal Baim	CA	R	C	EN	NE
Macrognathus aculeatus [†,‡]	Lesser Spiny Eel	Tara Baim	CA	R	C	NT	NE
Macrognathus aral [†,‡]	One-Stripe Spiny Eel	Holdey Dora Tara Baim	RA	FP	C	DD	LC
Macrognathus pancalus [†]	Striped spiny eel	Pakal	MA	FP	C	LC	LC
Mastacembelus oatesii [†]	Inlelake Spiny Eel	Chokra Baim	CA	FP	C	NE	EN
Order Tetraodontiformes							
Family Tetraodontidae							
Tetraodon cutcutia [‡]	Ocellated Puffer Fish	Potka	CA	FP	C	LC	LC
Tetraodon nigroviridis [‡]	Spotted Green Pufferfish	Bish Potka	MA	FP	C	NE	NE
Order Decapoda							
Family Palaemonidae							
Macrobrachium rosenbergii [†]	Giant Freshwater Prawn	Golda Chingri	CA	R. Et	O	LC	LC
Macrobrachium malcolmsonii [†]	Monsoon River Prawn	Chatka Chingri	CA	R, Et	O	LC	LC
Macrobrachium rude [†]	Hairy River Prawn	Paitta Chingri	CA	R, Et	O	LC	LC
Nematopalaemon tenuipes [†]	Spider Prawn	Gura Chingri	CA	Et	O	DD	NE
Macrobrachium dolichodactylus [†]	Ghoda River Prawn	Gada Icha	CA	R, Et	O	LC	NE
Macrobrachium Idella [†]	Slender River Prawn	Chikna Icha	MA	R	O	DD	LC
Macrobrachium villosimanus [†]	Dimua River Prawn	Dimua Icha	MA	R	O	LC	LC
Macrobrachium lamarrei [†]	Kuncho River Prawn	Kunchu Icha	MA	R, Et	O	LC	LC
Macrobrachium birmanicum [†]	Birma River Prawn	Thengua Icha	MA	R, Et	O	LC	LC
Macrobrachium lar [†]	Tahitian Prawn	Chora Icha	MA	R, Et	O	DD	LC
Macrobrachium dayanus [†]	Kaira River Prawn	Ghoda Icha/Beel Icha	MA	R	O	LC	NE
Macrobrachium equidens [†]	Rough River Prawn	Goda Icha	MA	R, Et	O	DD	LC

* Exotic species, [a] Endemic species, [†] Food fish, [‡] Ornamental fish, [$] Sportfish.

Table 2 summarizes a comparison of recorded fish species and their presence (%) to the national and global levels. Compared with nationwide levels, Synbranchiformes showed the highest prevalence (116.67%) followed by Osteoglossiformes (100%), Cyprinodontiformes (100%), Siluriformes (83.64%) and Cypriniformes (79.35%). Compared with worldwide levels, the highest presence was occupied by Anguilliformes (83.33%), followed by Tetraodontiformes (16.67%), Mugiliformes (12.5%) and Pleuronectiformes (10%). The rest were less than 10% compared with global prevalence.

Table 2. Status of freshwater fish species in Sylhet division compared with national (BD) and global level.

Class	Order	Number of Freshwater Fish Species			Species Presence (%) Compared to National and Global Levels	
		National	**Global**	**Present Study**	**National**	**Global**
Actinopterygii	Cypriniformes	92 [b]	2662 [a]	73	79.35	2.74
	Siluriformes	55 [b]	2280 [a]	46	83.64	2.02
	Perciformes	56 [b]	1922 [a]	25	44.64	1.3
	Clupeiformes	17 [b]	79 [a]	6	35.29	7.59
	Anguilliformes	8 [h]	6 [a]	5	62.5	83.33
	Beloniformes	6 [b]	98 [a]	4	66.67	4.08
	Sygnathiformes	3 [b]	81 [d]	2	66.67	2.47
	Synbranchiformes	6 [h]	94 [a]	7	116.67	7.45
	Tetraodontiformes	3 [h]	12 [a]	2	66.67	16.67
	Osteoglossiformes	2 [b]	244 [a]	2	100	0.82
	Cyprinodontiformes	1 [b]	996 [a]	1	100	0.1
	Pleuronectiformes	4 [b]	10 [a]	1	25	10
	Mugiliformes	6 [b]	8 [e]	1	16.67	12.5
Elasmobranchii	Rajiformes	5 [c]	59 [d]	1	20	1.69
Malacostraca	Decapoda	24 [f]	800 [g]	12	50	1.5

[a] = Nelson et al. [26]; [b] = IUCN Bangladesh [10]; [c] = Froese and Pauly [6]; [d] = Eschmeyer [27]; [e] = Nelson [5]; [f] = Ahmed et al. [28]; [g] = De Grave et al. [29]; [h] = Hossain and Wahab [30].

Cypriniformes was the dominant order (39.04%) followed by Siluriformes (24.6%) and Perciformes (13.37%). The rest of the faunal orders contributed approximately 23.53% of the total species found (Table 3). Cyprinidae was the leading family, accounting for 29.95% (56 species) of all families identified, followed by Bagridae with 6.95% (13 species), Sisoridae with 6.95% (13 species), Palaemonidae with 6.42% (12 species), and Cobitidae with 5.35% (10 species).

The fish recorded in this study were categorized into 17 major groups: perch, snakeheads, catfish, eels, tooth carp, needlefish, flatfish, barbs and minnows, carp, clupeids, stingrays, mullets, feather backs, pipefish, pufferfish, prawns, and loach (Figure 2). Catfish contributed the most, accounting for 25% of the total groups, followed by barbs and minnows (17%), carp (13%), perch fish (11%), loach (8%), prawns (6%) and eels (6%). The remaining groups contributed a considerably smaller percentage (14%). Small indigenous species (SIS) comprised 140 species distributed into 12 orders, of which Cypriniformes (56 species), Siluriformes (39 species) and Perciformes (22 species) were dominant, representing approximately 83.57% (Figure 3).
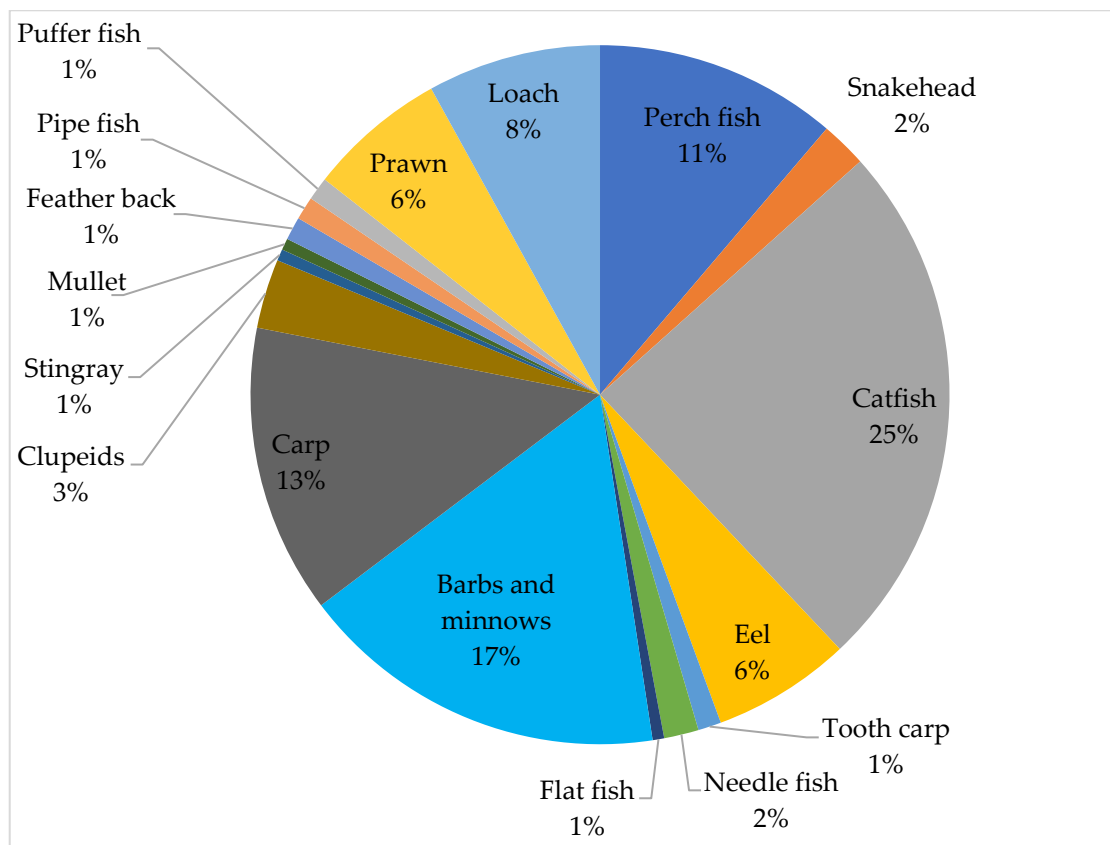
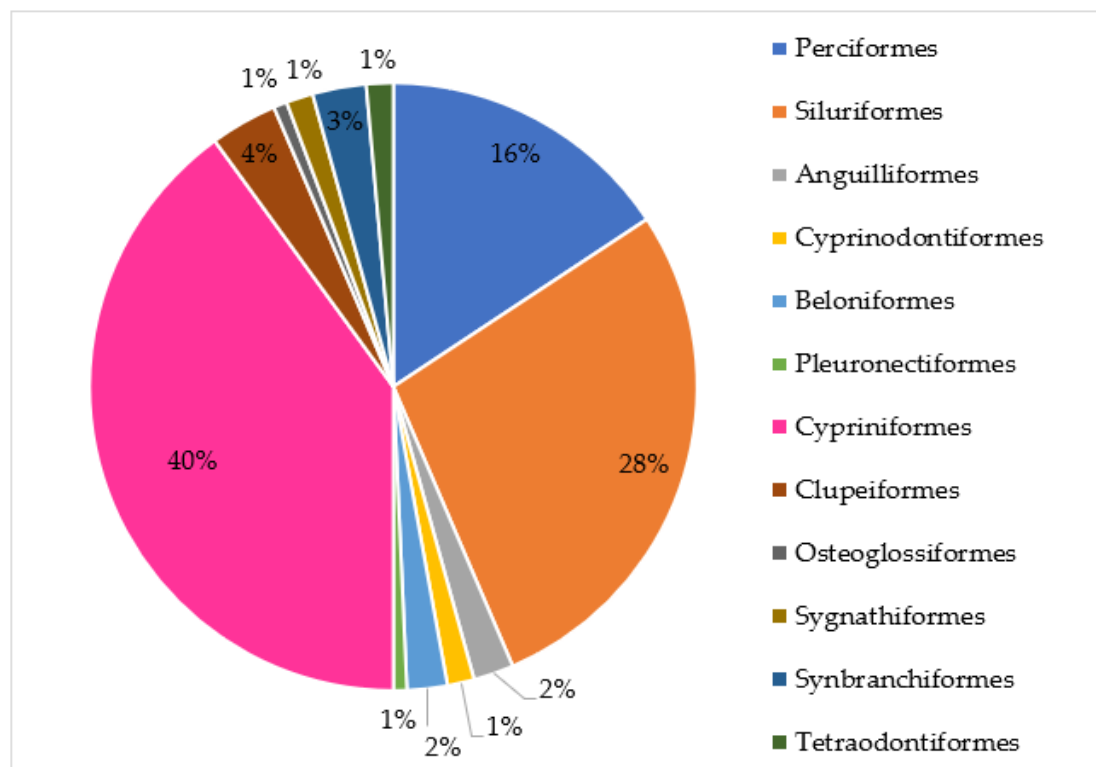**Figure 2.** Major groups of freshwater fish in Sylhet division.

Figure 3. Composition of small indigenous fish species (based on order) from the study area.

Table 3. Number and frequency of occurrence (FO) of orders and families of fish in Sylhet division, Bangladesh.

Taxon	N	FO (%)	Taxon	N	FO (%)
Order Perciformes	25	13.37	Order Clupeiformes	6	3.21
Family Anabantidae	1	0.53	Family Clupeidae	5	2.67
Family Ambassidae	5	2.67	Family Engraulidae	1	0.53
Family Badidae	1	0.53	Order Cypriniformes	73	39.04
Family Nandidae	1	0.53	Family Cobitidae	10	5.35
Family Osphronemidae	6	3.21	Family Balitoridae	6	3.21
Family Gobiidae	3	1.60	Family Cyprinidae	56	29.95
Family Sciaenidae	3	1.60	Family Psilorhynchidae	1	0.53
Family Cichlidae	1	0.53	Order Rajiformes	1	0.53
Family Channidae	4	2.14	Family Dasyatidae	1	0.53
Order Siluriformes	46	24.60	Order Osteoglossiformes	2	1.07
Family Amblycipitidae	1	0.53	Family Notopteridae	2	1.07
Family Bagridae	13	6.95	Order Mugiliformes	1	0.53
Family Chacidae	1	0.53	Family Mugilidae	1	0.53
Family Clariidae	1	0.53	Order Sygnathiformes	2	1.07
Family Erethistidae	1	0.53	Family Sygnathidae	2	1.07
Family Heteropneustidae	1	0.53	Order Anguilliformes	5	2.67
Family Olyridae	1	0.53	Family Anguillidae	1	0.53
Family Pangasiidae	2	1.07	Family Moringuidae	1	0.53
Family Schilbeidae	7	3.74	Family Ophichthidae	3	1.60
Family Siluridae	4	2.14	Order Synbranchiformes	7	3.74
Family Sisoridae	13	6.95	Family Synbranchidae	2	1.07
Family Loricariidae	1	0.53	Family Mastacembelidae	5	2.67
Order Beloniformes	4	2.18	Order Tetraodontiformes	2	1.07
Family Belonidae	1	0.53	Family Tetraodontidae	2	1.07
Family Hemiramphidae	2	1.07	Order Cyprinodontiformes	1	0.53
Family Adrianichthyidae	1	0.53	Family Aplocheilidae	1	0.53
Order Pleuronectiformes	1	0.53	Order Decapoda	12	6.42
Family Soleidae	1	0.53	Family Palaemonidae	12	6.42

3.2. Habitat Status and Trophic Ecology of Fish Fauna

Figure 4 reveals that 45.34% of the species were riverine, 31.58% floodplain residents, 12.55% estuarine, 2.83% migratory (traveled to floodplains and other habitats for feeding and spawning during monsoon) and 7.69% were exclusively hill stream inhabitants. Figure 4 also demonstrates that carnivorous and omnivorous species were the leading trophic groups, accounting for 43.62% and 37.23%, respectively, followed by planktivorous with 9.57%, herbivorous with 6.91%, larvivorous with 1.6%, and insectivorous with 1.06%.
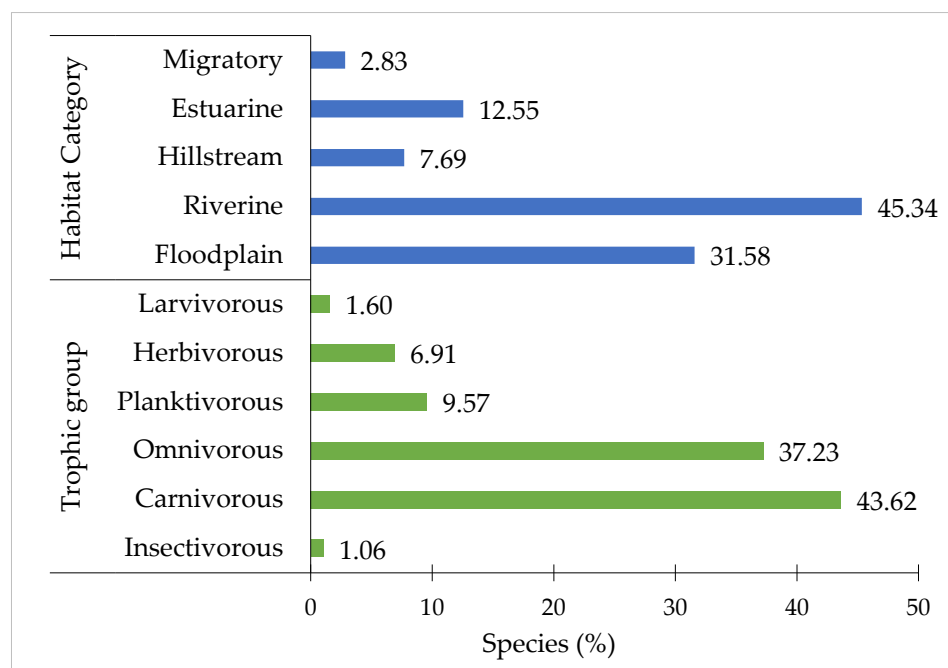
Figure 4. Habitat structure and trophic groups of freshwater fish recorded in Sylhet division.

3.3. Endemic Status of Fish

Figure 5 summarizes the species-rich group of endemic species from the study area. A total of sixteen (16) endemic species were identified, distributed across three orders and eight families, accounting for 8% of the total species found. Cyprinidae was the leading endemic species-rich family (seven species—*Labeo ariza*; *Aspidoparia morar*; *Barilius tileo*; *Barilius bendelisis*; *B. barila*; *B. vagra*; *B. dogarsinghi*) with 44% of total endemic species found, followed by Balitoridae with 13% (two species—*Schistura sikmaiensis*; *Syncrossus hymenophysa*) and Sisoridae with 13% (two species—*Gogangra viridescens*; *Gagata sexualis*). The rest contributed 30% (one species of each family) to the total endemic species found.

3.4. Commercial Utilization Status of Fish

The utilization of commercial fish revealed that 87.76% (165 species) were consumed as food, with 43.03% also having ornamental value (71 sp.). Approximately 12.23% (23 species) were only of ornamental value, while 6.91% (13 species) were considered sport fish with food value. *Tor tor* and *Chitala chitala* were considered to be food, ornamental, and sport fish (Table 1). All species belonging to Decapoda, Rajiformes, and Clupeiformes were found to have food value, while Tetraodontiformes, Pleuronectiformes, Cyprinodontiformes, and Sygnathiformes had ornamental value. Cypriniformes, Osteoglossiformes, and Siluriformes were shown to have food, ornamental, and sport fish value, with food value being more prevalent (62.28%) compared to the other groups (40% and 52.17% respectively) (Figure 6).

3.5. Present Status of Identified Fish Species

The current study revealed that approximately 42% of fish were moderately available, followed by 29% commonly available, 15% abundantly available and 14% rarely available (Figure 7a). Figure 7b summarizes the present status of species according to order. The results showed that moderately available, rarely available and abundantly available species were highest in Cypriniformes (39.24%, 57.69% and 58.62% respectively) whereas commonly available species were highest in Siluriformes (27.78%).
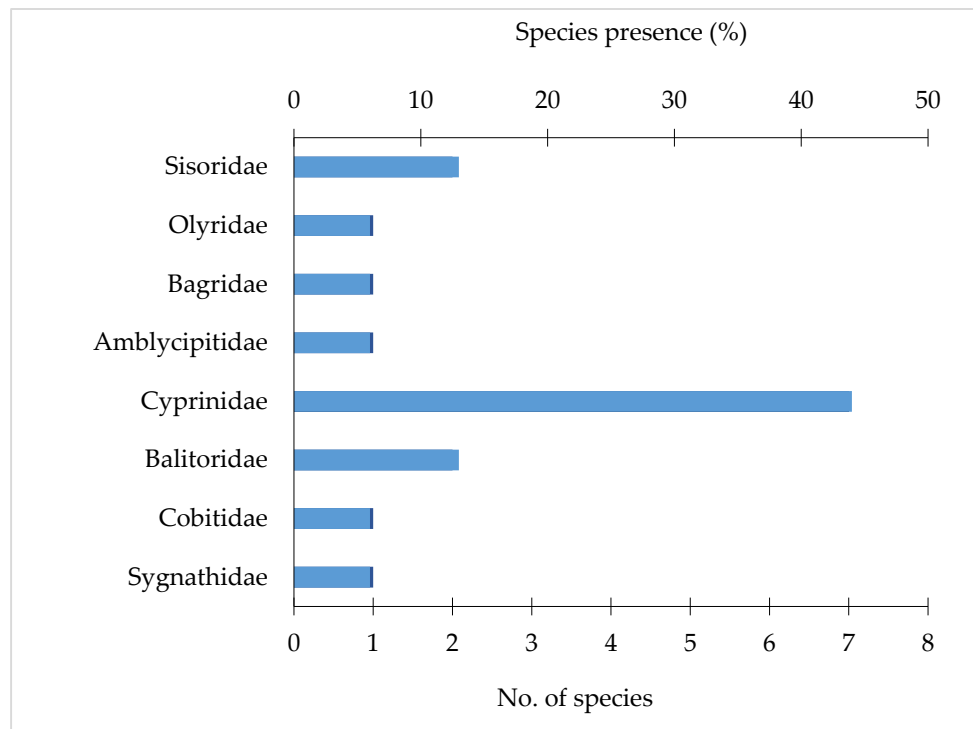
Figure 5. Diagrammatic representation of families rich in endemic freshwater species in Sylhet division.
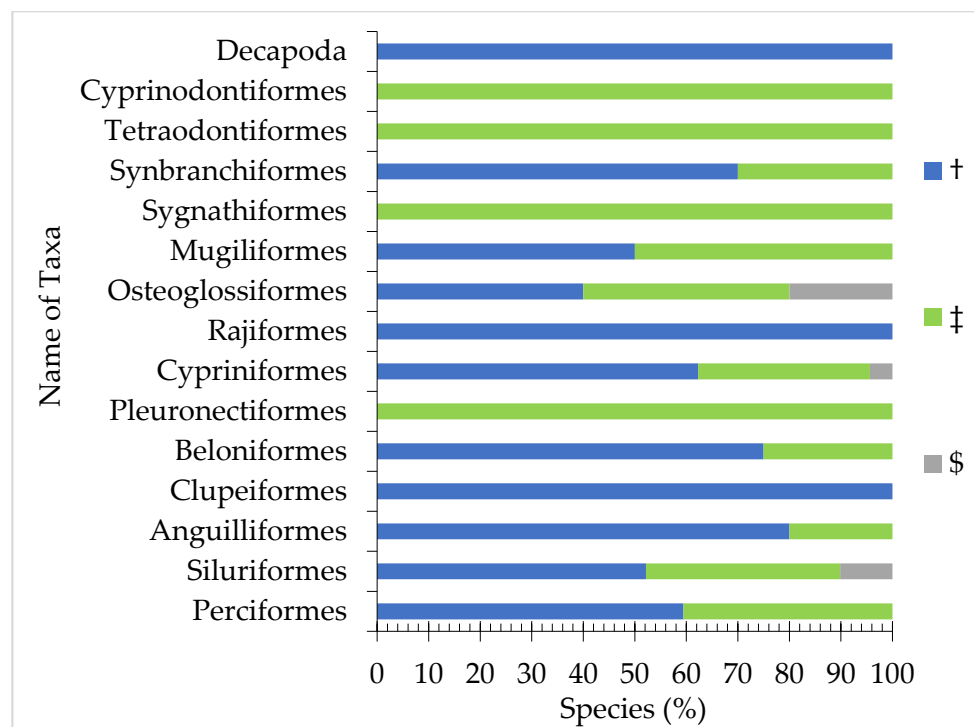

Figure 6. Relative frequency (%) of commercial utilization of fish. † Food fish, ‡ Ornamental fish, $ Sport fish.
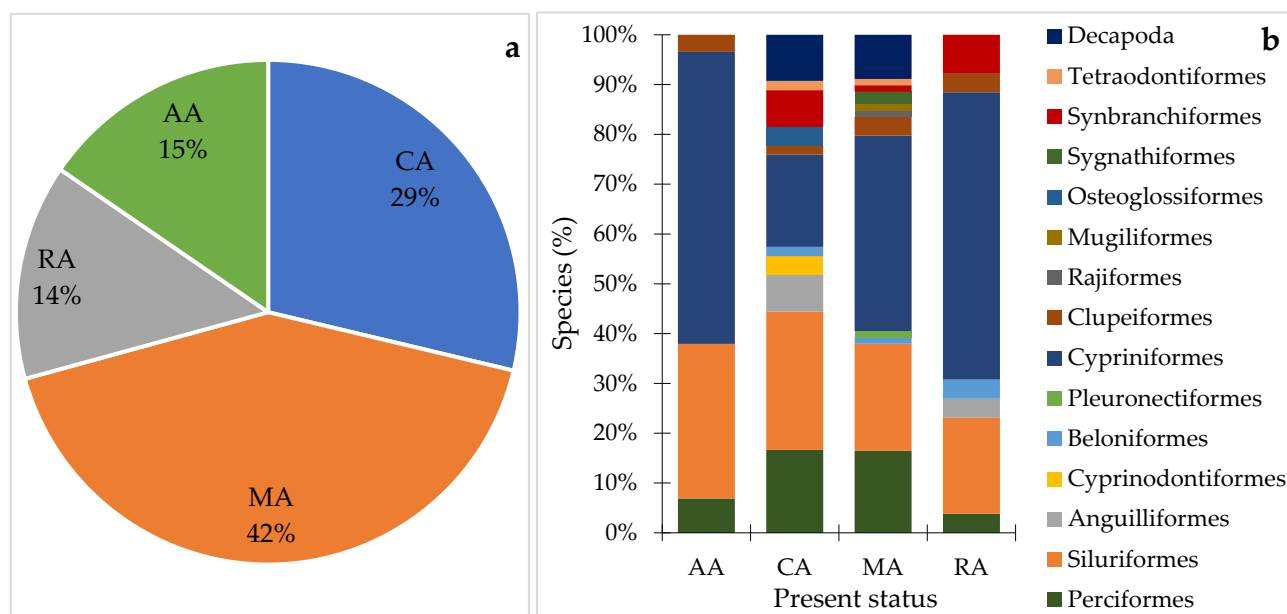
Figure 7. Present status of identified fish (**a**) and frequency of occurrence (%) based on order (**b**). AA = Abundantly available; CA = Commonly available; MA = Moderately available; RA = Rarely available.

3.6. Conservation Status

A total of 161 species (86.1%) and 157 species (83.95%) were evaluated in the national list [10] and global list, respectively. Of these recorded species, 50 species (26.74%) were considered threatened at a national level (CR—7 sp.; EN—23 sp. and VU—20 sp.) and eight species (4.27%) at a global level (CR—1 sp.; EN—3 sp.; VU—4 sp.). The majority of recorded species were listed as LC both in the present study (42.55%) and globally (70.21%). Out of 188 species, 19 species were listed as NT, and 11 as DD, differing from their global category. We obtained a substantially large number of species (26 species in national status and 31 species in global) that have not been assessed in IUCN evaluation (Table 4).

Table 4. Number and frequency of occurrence of threat categories of fish recorded in Sylhet division, Bangladesh.

Conservation Status	National		Global	
	N	%	N	%
CR—Critically endangered	7	3.72	1	0.53
EN—Endangered	23	12.23	3	1.60
VU—Vulnerable	20	10.64	4	2.13
NT—Near threatened	19	10.11	13	6.91
LC—Least concern	80	42.55	132	70.21
DD—Data Deficient	12	6.38	8	4.26
NE—Not Evaluated	27	14.36	27	14.36

Most species belonging to Cypriniformes (CR 57.14%, EN 56.52%, VU 45%) and Siluriformes (CR 42.86%, EN 30.43%, VU 20%) were listed as threatened in the present study (Figure 8a). Based on endemism, species belonging to Sygnathidae, Cobitidae and Olyridae were listed as VU and EN, respectively. Approximately 50% and 57.14% species from Balitoridae and Cyprinidae, respectively, were in the EN category (Figure 8b).
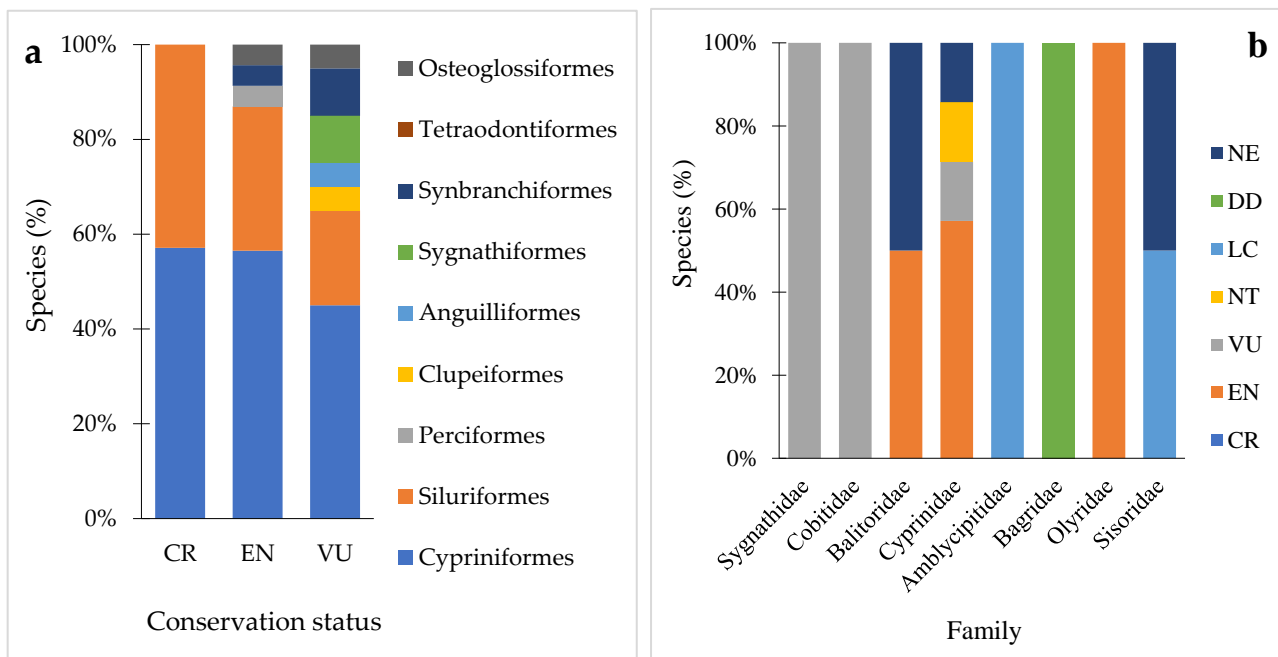
Figure 8. Conservation status of fish: (**a**) all combined fish; (**b**) endemic species. CR—Critically endangered; EN—Endangered; VU—Vulnerable; NT—Near threatened; LC—Least concern; DD—Data Deficient; NE—Not Evaluated.

4. Discussion

4.1. Fauna Composition

Freshwater fish species are represented in all areas at the national level, which is one of the richest diversity of fish fauna with a rich variety of morpho-species. Approximately 253 fish species have been identified from freshwater in Bangladesh [10]. Rahman [11] recorded 265 species comprising 154 genera and 55 families and Hossain et al. [31] obtained 293 species of freshwater fish including 13 orders and 61 families in Bangladesh, both of which were higher than the present study. The most species-rich orders that covered all types of water bodies and ecosystems in the Sylhet division are similar to those found in national and global surveys, and there were six orders for which the proportion of freshwater species in the Sylhet division was 67.87% of national prevalence and 2.16% of global prevalence (Table 2). This indicates that freshwater fish in the Sylhet Belt play a significant role in the national and global freshwater fish species bank. The fish belonging to the Cyprinidae family in the present study were the most dominant, a common feature of the fish community similar to Asian rivers [32–34]. Nonetheless, little research has been conducted on the fish biodiversity and conservation status in the greater Sylhet region. For instance, lower freshwater fish diversity has been reported in *haor* and wetland ecosystems at the district level within the Sylhet division [31–35], which may be attributed to extremely insufficient sampling areas. Ray and Grassle [36] noted that hydrographic conditions, climatic patterns, and habitat are influential factors that drive the number of species. Moreover, the observed image of species diversity during the study period may also be influenced by the sampling strategies and efforts used [37].

The number of small indigenous fish (140 species) listed in the entire Sylhet division was similar to the number found in Bangladesh [38]. The leading SIS orders in the study area were Cypriniformes, Perciformes, and Siluriformes, similar to observations from the Gorai River [39] and the southern coastal waters of Bangladesh [40]. Geographically, the connection of freshwater habitats such as rivers, floodplains, and diverse landscape areas maintains continuity to facilitate the movement of SIS [33].

Exotic species are extensively cultured in Bangladesh but are also found in open aquatic habitats, most likely due to escape from adjacent ponds and periodic water bodies

during flash floods [40]. Our synthesis found 176 freshwater fish, of which 166 were indigenous and the remaining 10 exotic. Mukul et al. [40] found 16 exotic freshwater fish species in Bangladesh. Galib and Mohsin [41] listed 92 varieties of exotic fish in Bangladesh, of which 16 were cultured fish species and the rest were ornamental fish species. Islam and Hossain [42] estimated a total of 57 fish species in Dekar *haor*, of which 52 were native and 5 were exotic. Suravi et al. [43] highlighted 51 species in Dekar *haor*, of which 47 were indigenous and 4 were exotic. Sayeed et al. [44] and Mahalder and Mustafa [45] reported seven and nine exotic freshwater fish species in the Hakaluki *haor* in Moulovibazar and Sunamganj regions, respectively, within CBRMP's working area. Exotic species may harm the food web and breeding ground for native species, leading to the depletion of natural reserves of endemic species and the extinction of some native species [46]. Therefore, greater emphasis should be placed on preventing the potential negative effects of exotic species on native stocks.

4.2. Habitat and Trophic Ecology of Fish

Floodplain-dwelling fish take shelter in nearby perennial water bodies, such as rivers and deep *beels*, when the floodplain's water level decreases during the dry season, which complicates their classification. According to IUCN Bangladesh [10], floodplain species dominate. Similarly to the present study, Pandit et al. [47] found that 54.9% of the species of the Dhanu river and surrounding wetlands in Kishoreganj were *beel* residents and 45.1% were riverine residents. Based on their habitat preference, freshwater fish spend the majority of their lives in rivers and/or floodplains, where they tend to live for much longer than in other types of freshwater environments. Feeding is the leading activity throughout the entire life cycle of fish [46]. The current trophic structure study revealed the dominance of carnivores and omnivore fishes, which corresponded to previous findings [14,17,20,48]. Sarker et al. [49] observed similar composition of feeding types in the Western Ghats and Ganges river in India. Nevertheless, several fish species had multiple trophic levels depending on their ecological resources or prey availability [50], which was similar to the current findings.

4.3. Endemic Status of Fish

An endemic fish is defined as a fish species localized in a particular area or country where it originated. As no previous research has been conducted on the endemic fish species of *haor* in Sylhet division, the present findings can be compared to those of neighboring countries. However, Dey et al. [20] at the Ganges river in India and De Silva et al. [51] in South-East Asia reported similar patterns. Higher endemicity was reported by [52,53] in Assam and the neighboring North-Eastern states of India (48 and 33 species respectively). The presence of a high number of endemic species in the aforementioned Indian states could be attributed to hilly terrain and perennial wetlands. Therefore, a comprehensive study of the aforementioned fish endemicity variations in the Sylhet region is required.

4.4. Commercial Utilization Status of Fish

Nature provides a wide variety of fish species used as food, which differ in shape and taxonomic group [54]. According to [19,20], in West Bengal, India, food fish were dominant over ornamental fish, resulting in a reverse pattern. We identified 94 native fish out of 188 fish species as ornamental fish. Some of them are already used as ornamental fish, while others could be used based on their diverse ornamental criteria *viz.* beautiful color, shape and size, banding pattern, hardiness, transparent body, calm behavior, and adhesive suckers [24]. For instance, a lower number of potential indigenous freshwater fish and non-fish species (31 spp.) were identified as having ornamental value in Bangladesh [55]. It is difficult to list the commercial utilization of fish due to the lack of preceding evidence on fish diversity, but the current study could be considered baseline information for upcoming commercial utilization status investigation.

4.5. Present Status of Identified Fish Species

The current status of freshwater fish is consistent with that of the fish communities in various wetland ecosystems in the *haor*-based, floodplain-rich Sylhet division [35,44,46,56,57]. Observing the current status of fish, it is possible that a large proportion of the fish fauna under Cypriniformes and Siluriformes classified as rarely available in that region will disappear in the near future.

4.6. Conservation Status

IUCN classification is widely used for evaluating the conservation status of fish around the world. However, due to the lack of data on the regional list, it was impossible to assess the species' regional, national and global conservation status to validate a similar pattern. According to IUCN Bangladesh [10], 25.3% of species are listed under a threatened category. We highlighted that 26.74% of our species found were considered to be threatened at the national level. This result reflects the findings reported by [44,58,59] at different *haors* and other water bodies in the Sylhet division. The threatened species composition recorded in the present study was lower than in earlier reports from Sylhet Sadar and Dekhar *haor* in Sunamganj District [60,61]. According to Hossain and Wahab [30] and IUCN Bangladesh [10], most of the fish belonging to Cypriniformes and Siluriformes faced significant threat, and the majority of them were categorized as either endangered or critically endangered over the last 10 years, which was similar to the present findings. Species listed as critically endangered experienced at least an 80% population decline over the past 10 years or three generations, indicating a significant threat to extinction in near future in the Sylhet region.

Pangasianodon hypophthalmus, a Critically Endangered species at the global level, infiltrated Bangladesh in the early 1990s and is now an intensively cultured species that frequently occupies freshwater bodies on a large scale [62]. Chowdhury et al. [63] reported that *Tor tor, Pangasius pangasius* and *Anguilla bengalensis* were extinct at the regional level. Islam et al. [34] and Chakraborty and Mirza [64] demonstrated that two species, *viz. Tor tor and Labeo nandina*, were extinct from the Juri River in Sylhet and the Someswari River in Netrokona respectively, compared to 10–20 years previously. *Channa barca* was found to be regionally extinct from the survey area during the study period. Furthermore, species identified as Critically Endangered at the national level, such as *Ompok pabo, Bagarius bagarius, Sisor rabdophorus, Schistura corica, Labeo boga, Labeo nandina,* and *Tor tor* were captured in limited numbers but should be prioritized for conservation owing to their population decline. According to IUCN Bangladesh [10], *Wallago attu* was listed as Vulnerable and *Notopterus notopterus*, *Canna marulius*, *Mystus armatus* as Endangered; however, these species have recently moved into the Least Concern and Endangered categories, respectively, due to signs of population growth and are now abundant in the *haor* [43].

We synthesized 27 species considered Not Evaluated, of which 10 were exotic and the remaining 17 were indigenous. Due to a lack of indigenous entities, these invasive species were not included in IUCN Bangladesh [10]. Four species, *Tetraodon nigroviridis, Pseudorhombus arsius, Hypostomus Plecostomus,* and *Morigua raitaborua*, were used as ornamental fish at national and global levels, with *Hypostomus Plecostomus* having both food and ornamental value. Thirteen species listed as Not Evaluated at national levels with only food value, including *Mastacembelus oatesii, Himantura bleekeri, Puntius parrah, Lamnostoma orientalis, Panna microdon, Barilius dogarsinghi, Syncrossus hymenophysa, Oreonectes evezardi, Lepidocephalus thermalis, Parambassis thomassi, Mystus keletius,* and *Gagata sexualis*, were used as food for local inhabitants as well as recreational purposes; *Glyptothorax platypogonoides* was considered an ornamental fish among the non-evaluated fish [65]. Additionally, a significant number of species listed as Not Threatened and Data Deficient by IUCN Bangladesh [10] require further investigation at the regional and national levels in subsequent assessments. Assessment should be prioritized at the regional level for conservation and justifying the current status of endemic species.

Local environmental knowledge, participatory planning with fisheries stakeholders, and the adoption of sustainable fisheries management practices could be the first steps in eradicating the decline in threatened species diversity and availability [66]. Fishing during the breeding and spawning seasons, indiscriminate harvesting of fish larvae and fingerlings, and the use of harmful fishing gear and crafts must be prohibited immediately. Declaring some parts of or the whole of a *haor* as a "fish sanctuary", and the concept of a "*beel* nursery", could be effective steps toward conserving endangered and vulnerable species in Sylhet division. Breeding and nursery grounds, migration routes and hotspots of fish biodiversity in the *haor* region must be designated as nature reserves and delineated by a demarcation line, with fishing strictly prohibited and navigation temporarily stopped during the breeding season. Fishing limitations by completely drying out water bodies and regular dredging of silted water are required to facilitate fish habitat, breeding, nursing, maturation, and relocation. Eco-friendly fishing technologies for the monitoring, controlling and surveillance of protected areas and threatened species, selection of fishing gear and crafts, and development of a digital fishing calendar for effective banning periods and catch restrictions should be initiated to conserve the threatened fish species [67]. In addition, a live fish gene bank could be an effective way to conserve threatened species. However, the most important aspect of conserving the threatened fish of *haor* in Sylhet division is to raise awareness among the stakeholders through effective communication, collaboration, and education. Furthermore, financial support from the government and donor agencies is crucial for further research and monitoring, along with raising awareness among fishers regarding the importance of conserving fish diversity in the *haor* areas. In short, since fish and fisheries in this region support the livelihoods of thousands of marginalized poor, particularly fishers, the government should adopt a long-term conservation strategy to ensure sustainable production in the *haor* region in Sylhet division.

5. Conclusions

The number of species documented during the study is a good indication of rich biodiversity in the Sylhet division. Fish species belonging to Cypriniformes and Siluriformes face significant threat levels. In addition, species that are critically endangered, endangered and vulnerable at national and global levels are intensively being cultured and a live gene bank is being established to conserve threatened species. Furthermore, the findings of this study could serve as an important benchmark for assessing biodiversity and fish conservation in the *haor* region. Notably, a large number of fish might have been excluded from evaluation due to insufficient scientific research. The threatened fish recorded in the Sylhet division indicate an alarming threat to fish conservation. Community and ecosystem-based co-management programs that promote the conservation of biodiversity and social protection schemes can be very effective to conserve fish diversity. However, fish sample collection from fishers, rather than direct sampling, limited sample size, and taxonomic identification through barcoding due to lack of funding were the major drawbacks of the present study. In addition, current status and threat level were recorded based on fishers' perceptions via a survey and researcher observation. In order to conserve fish biodiversity in this area, a thorough study is needed on species composition and assemblages, along with species' taxonomic identification, life history, geographic range, ecology and reproductive biology.

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