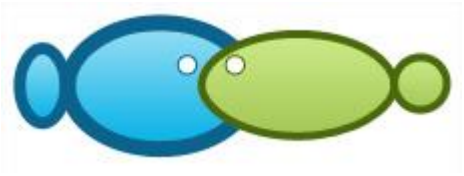

Physico-chemical properties, plankton composition and commercially important fish status of Vailadhora Beel, Bancharampur, Brahmanbaria, Bangladesh

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Abstract. Vailladhora Beel is one of the largest Beel of the Brahmanbaria district of Bangladesh. This Beel has an essential characteristic of holding water all-round the year, comprising an area of 156 ha in the dry season and is inundated up to approx. 1214 ha in the wet season. Thus, this Beel play has a vital role in freshwater fish diversity in Bangladesh. We conducted this study in three beels, namely Boro Beel, Hospital Ghat Beel, and Ruposhdi Beel of Vailadhora Beel, from December 2020 to June 2021. Several water quality parameters were determined monthly. The transparency ranged from 40-49 cm in these beels. The water temperature ranged from 20 to 34°C. Total dissolved solids (TDS) ranged from 50 to 340 mg L^{-1}, while the electric conductivity of water ranged from 150 to 380 µS cm^{-1}. The pH value ranged from 7 to 8.1 in the study areas. The concentration of DO ranged from 2.6 to 5.2 mg L^{-1}. In all the stations, the free CO_2 concentration was between 9-20 mg L^{-1}. Alkalinity and hardness values were moderate in all three beels (between 71-241 and 73-312 mg L^{-1}, respectively). Almost all water quality parameters were in a suitable range of fish growth. 36 genera of phytoplankton and 8 genera of zooplankton were identified, of which Cyanophyceae (8 genera) in the phytoplankton population and Branchiopoda (3 genera) together with Rotifera (3 genera) in the zooplankton population were dominant. Commercially important fish species were also identified during the study period. 23 commercially important fish species under 7 orders were recorded from the three beels of Vailadhora Beel, with 4 of them threatened. Longer-term research is required to improve Vailadhora Beel management and to better understand the commercially important fish population.
Key Words: beel management, conservation, water quality.

Introduction. Beels are an integral part of the waterbody of Bangladesh. Beels are low-lying areas of a zone partially connected with a small river and its tributaries. Most of the Beels are the source of different fish for rural people living around the Beel. There are more than thousands of beel in Bangladesh. Total fish catch from beel fisheries is essential to Bangladesh's total annual fish production. Vailadhora Beel is one of the largest beel of Bangladesh, also known as Bamandhar, Bariadaha Chakbasta, Vailadhora, or Bailladhara Beel. This beel is a source of crucial fisheries resources of Bangladesh. Nevertheless, climate and other anthropogenic changes directly damage the total annual catch of Vailadhora Beel, Bancharampur, Brahmanbaria. Climate has a significant influence on water quality and, consequently, on the biodiversity within the water bodies (Boyd & Tucker 1998). This beel is connected with Titasin River mainly through Jhonar char, Hoglakandi, Fardabad, Khagkanda, Gokolnagar, and Katakana Khal (Ahmed et al 2007). This beel has a kidney shape, with the lower section larger than the upper region in the northwest. The total area of the beel is approx. 156 ha, being inundated up to approx. 1214 ha in the wet season. Good water quality of an area is a prerequisite for good fish health. The water quality of this beel is important to study because of several environmental changes and the use of agrochemicals. On the other hand, the water

quality of a given area defines its primary products, such as plankton production, which in turn determines natural fish production. Phytoplankton is the primary producer for the entire aquatic body and comprises a significant portion of the ecological pyramid (Odum 1971). Therefore, knowledge of plankton community structure or simply ecology of microalgae is an essential tool for managing the water of the beel for higher yields.

In Bangladesh, 265 freshwater fish species are available (Rahman 2005). However, very few are reported to be present in naturally poor conditions. As a result, many of the fish become vulnerable, endangered, or critically endangered. However, for sustainable exploitation and proper management of resources, the fish diversity in the water must be known. Little or no studies have been conducted on the physico-chemical properties, plankton composition, and fish composition of Vailadhora Beel. By considering these aspects, this study was conducted to determine the physico-chemical properties, plankton composition, and commercially available fish status in Vailadhora Beel, Bangladesh.

Material and Method

Site selection and study period. The study was conducted for 7 months, from December 2020 to June 2021, at Hospital Ghat Beel, Boro Beel, and Ruposhdi Beel of Vailadhora Beel, Brahmanbaria, Bangladesh (Figure 1).

Figure 1. Location of Vailadhora Beel, Bancharampur, Brahmanbaria, Bangladesh.

Water quality monitoring. Throughout the study period, the water quality parameters such as temperature (°C), transparency (cm), dissolved oxygen (mg L^{-1}), carbon dioxide (mg L^{-1}), pH, alkalinity, hardness, TDS, and conductivity were recorded monthly. The water temperature was recorded with a Celsius thermometer during the study period. Transparency was measured with a Secchi disc of 20 cm diameter. The pH of the water samples was measured by a direct reading of a digital pH meter (Jenway, model 3020 CORNING 445 pH meter), and dissolved oxygen was also measured using a digital DO meter (YSI, model 58) on the spot. The HACH kit (HACH FF2) with sodium hydroxide determined the concentration of carbon dioxide. Alkalinity was also determined by the HACH kit with phenelopheline indicator, bromocresol methyl red, and sulfuric acid. The same HACH kit and buffer solution, Manvar 2 and EDTA, was used to determine the hardness. Finally, TDS and conductivity were measured directly using a digital TDS meter (HACH, USA).

Plankton content. Plankton samples were collected monthly from Dec 2020 to June 2021. Collection of plankton was carried out by filtering 50 L of habitat water from approximately 10-12 cm below the surface. For this purpose, the surface level passed through a 25 µm mesh net and was finally concentrated to 25 mL. The plankton population accumulated in the container was then transferred to another container and immediately preserved in 4% formalin, labeled, and then transferred to the Limnology laboratory of Bangladesh Fisheries Research Institute, Riverine Station, Chandpur, for further experimentation. Plankton identification was made after Ward & Whipple (1959) and Prescott (1962). Each sample was stirred smoothly just before microscopic examination. 1 mL from the agitated sample was transferred to an S-R cell with a wide-mouth graduated pipette. Plankton samples were categorized according to their class for both phytoplankton and zooplankton.

Fish composition observation. Samples of different fish species were collected from the fishermen catches landed at the selected sampling areas. A digital camera was used to capture the photos of different fish species. The collected fish samples were identified by analyzing their morphometric and meristic characteristics following Rahman (1989, 2005) and Talwar & Jhingran (1991). The valid scientific names of the identified fish species were ensured by checking Eschmeyer's Catalog of Fishes (2022). The global conservation status was determined following the IUCN (2016) database, whereas the local conservation status was based on IUCN (2015). Fish of Vailadhora Beel were categorized according to different fish orders throughout the study period. By analyzing their morphology, fish species were grouped according to their feeding habits, namely carnivorous, herbivorous, and omnivorous. Collected data were analyzed by computer software Microsoft Excel 2010.

Results and Discussion

Water quality of Vailadhora Beel. The water quality parameters are presented in Figures 2, 3 and 4.

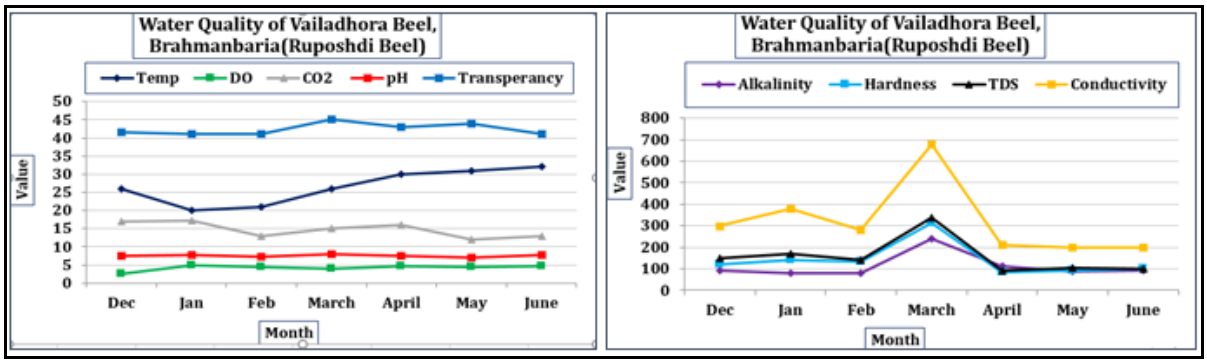

Figure 2. Water quality parameters of Ruposhdi Beel, Vailadhora Beel, Brahmanbaria.

Plankton content. 36 genera of phytoplankton (Table 1) and 8 genera of zooplankton (Table 2) were identified, out of which Cyanophyceae (8 genera) in the phytoplankton population and Branchiopoda (3 genera) together with Rotifera (3 genera) in the zooplankton population were dominant. Eight groups of phytoplankton: Cyanophyceae (8 genera), Bacillariophyceae (5 genera), Chlorophyceae (7 genera), Coscinodiscophyceae (2 genera), Dinophyceae (2 genera), Mediophyceae (1 genus), Euglenophyceae (3 genera), Trebouxiophyceae (1 genus), and Zygnematophyceae (1 genus) were found (Figure 5). Three groups of zooplankton, Rotifera (3 genera), Branchiopoda (3 genera), and Copepoda (2 genera) were also identified (Figure 6).

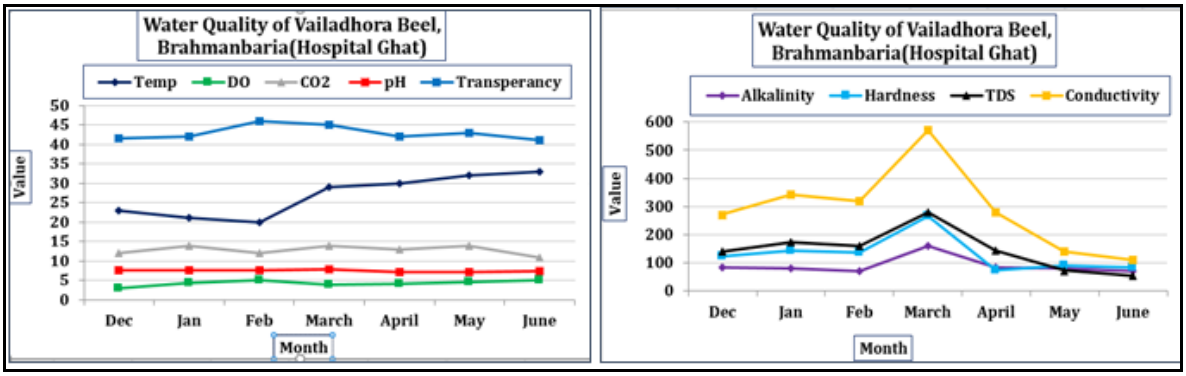

Figure 3. Water quality parameters of Hospital Ghat, Vailadhora Beel, Brahmanbaria.

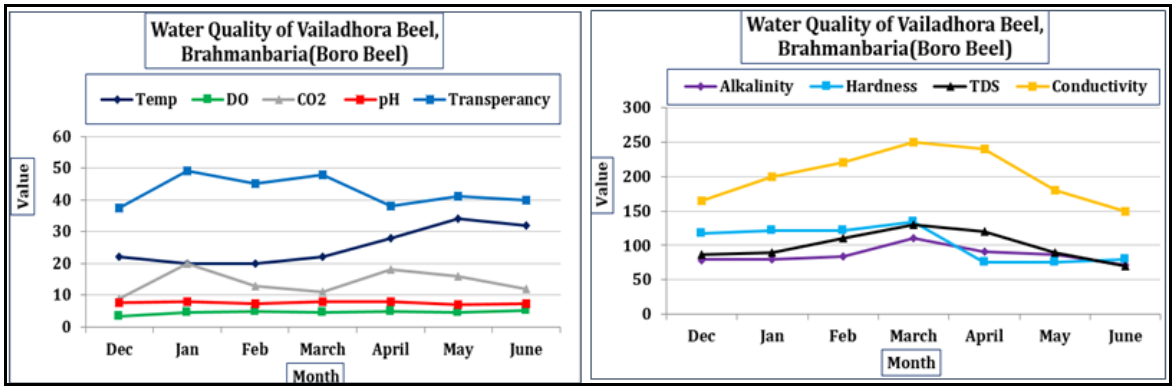

Figure 4. Water quality parameters of Boro Beel, Vailadhora Beel, Brahmanbaria.

Table 1

List of phytoplankton groups identified in Vailadhora Beel

Phytoplankton group	*Genera*
Bacillariophyceae	*Navicula* sp. *Asterionella* sp. *Fragilaria* sp. *Nitzsehia* sp. *Synedra* sp.
Chlorophyceae	*Ankistrodesmus* sp. *Eudorina* sp. *Padiastrum sp.* *Pandorina* sp. *Scenedesmus* sp. *Tetraedron* sp. *Volvox* sp.
Coscinodiscophyceae	*Coscinodiscus* sp. *Melosira* sp.
Cyanophyceae	*Anabaena* sp. *Aphanocapsa* sp. *Coelosphaerium* sp. *Gloeocapsa* sp. *Microcystis* sp. *Oscillatoria* sp. *Polycystis* sp. *Spirulina* sp.

Table 1

List of phytoplankton groups identified in Vailadhora Beel (continuation)

Phytoplankton group	*Genera*
Dinophyceae	*Ceratium* sp. *Peridinium* sp.
Euglenophyceae	*Phacus* sp. *Euglena* sp. *Trachelomonas* sp.
Mediophyceae	*Cyclotella* sp.
Trebouxiophyceae	*Chlorella* sp.
Zygnematophyceae	*Euastrum* sp. *Arthrodesmus* sp. *Closterium* sp. *Cosmarium* sp. *Desmidium* sp. *Spirogyra* sp. *Staurastrum* sp.

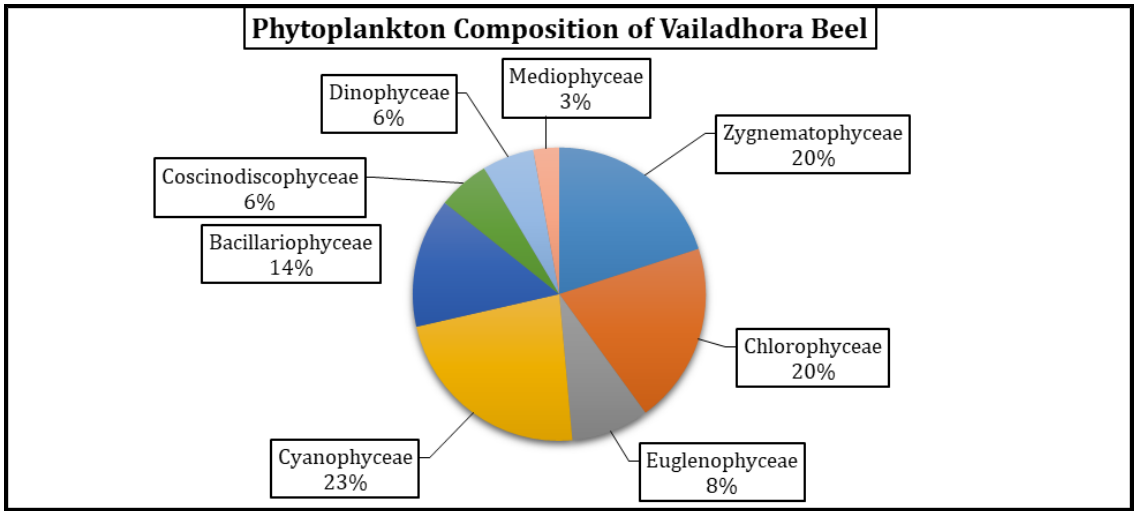

Figure 5. Phytoplankton composition (percentage) of Vailadhora Beel.

Table 2

List of zooplankton groups identified from Vailadhora Beel

Zooplankton group	*Genera*
Branchiopoda	*Bosmina* sp. *Daphnia* sp. *Moina* sp.
Copepoda	*Cyclops* sp. *Naplius* sp.
Rotifera	*Keratella* sp. *Lecanae* sp. *Brachionus* sp.

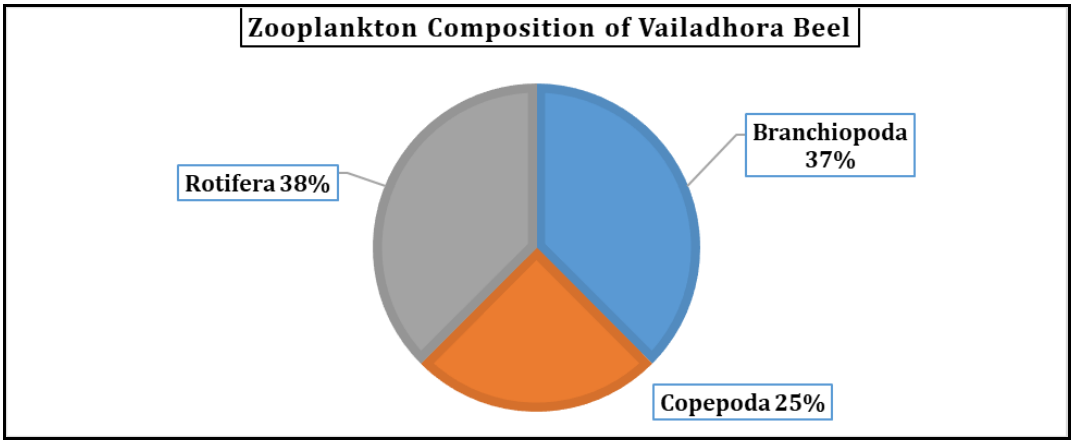

Figure 6. Zooplankton composition (percentage) of Vailadhora Beel.

23 commercially important fish species under 7 orders were recorded from Vailadhora Beel throughout the study period. A list of existing fish species with their taxonomic position (order), scientific name, local name, group name, and their conservation status in Bangladesh and global aspects are presented in Table 3 and their images are presented in Figure 7.

Table 3

List of commercial and available fish species collected from Vailadhora Beel

Order	*Scientific name*	*Local name*	*Group name*	*IUCN conservation status (BD)*	*IUCN conservation status (GB)*
Cypriniformes	*Puntius sophore*	Bhadi punti	Barb	LC	LC
	Puntius ticto	Tit punti	Barb	VU	LC
	Amblypharyngodon mola	Mola	Minnow	LC	LC
	Labeo calbasu	Kalibaus	Carp	LC	LC
	Labeo rohita	Rui	Carp	LC	LC
	Lepidocephalus guntea	Gutum	Loach	LC	LC
Perciformes	*Glossogobius giuris*	Baila	Mudskipper	LC	LC
	Nandus nandus	Meni	Perches	NT	LC
	Parambassis ranga	Chanda	Perches	LC	LC
	Trichogaster lalius	Boicha	Perch	LC	LC
	Trichogaster fasciata	Kholisha	Perch	LC	LC
	Anabas testudineus	Koi	Perch	LC	DD
Siluriformes	*Mystus vittatus*	Tengra	Catfish	LC	LC
	Mystus tengra	Bajuri	Catfish	LC	LC
	Wallago attu	Boal	Catfish	VU	NT
	Ompak pabda	Pabda	Catfish	CR	NT
	Heteropneustes fossilis	Shing	Catfish	LC	LC
	Clarias batrachus	Magur	Catfish	LC	LC
Channiformes	*Channa punctata*	Taki	Snake head	LC	NE
	Channa striata	Shol	Snake head	NT	LC
Osteoglossiformes	*Notopterus notopterus*	Foli	Feather back	VU	LC
Beloniformies	*Xenentodon cancila*	Kankila	Gar	LC	LC
Synbranchiformes	*Mastacebelus pancalus*	Baim	Eel	NT	LC

Note: least concern (LC), near threatened (NT), vulnerable (VU), endangered (EN), data deficient (DD), critically endangered (CR), not evaluated (NE), NEBD - Bangladesh, GB - global.

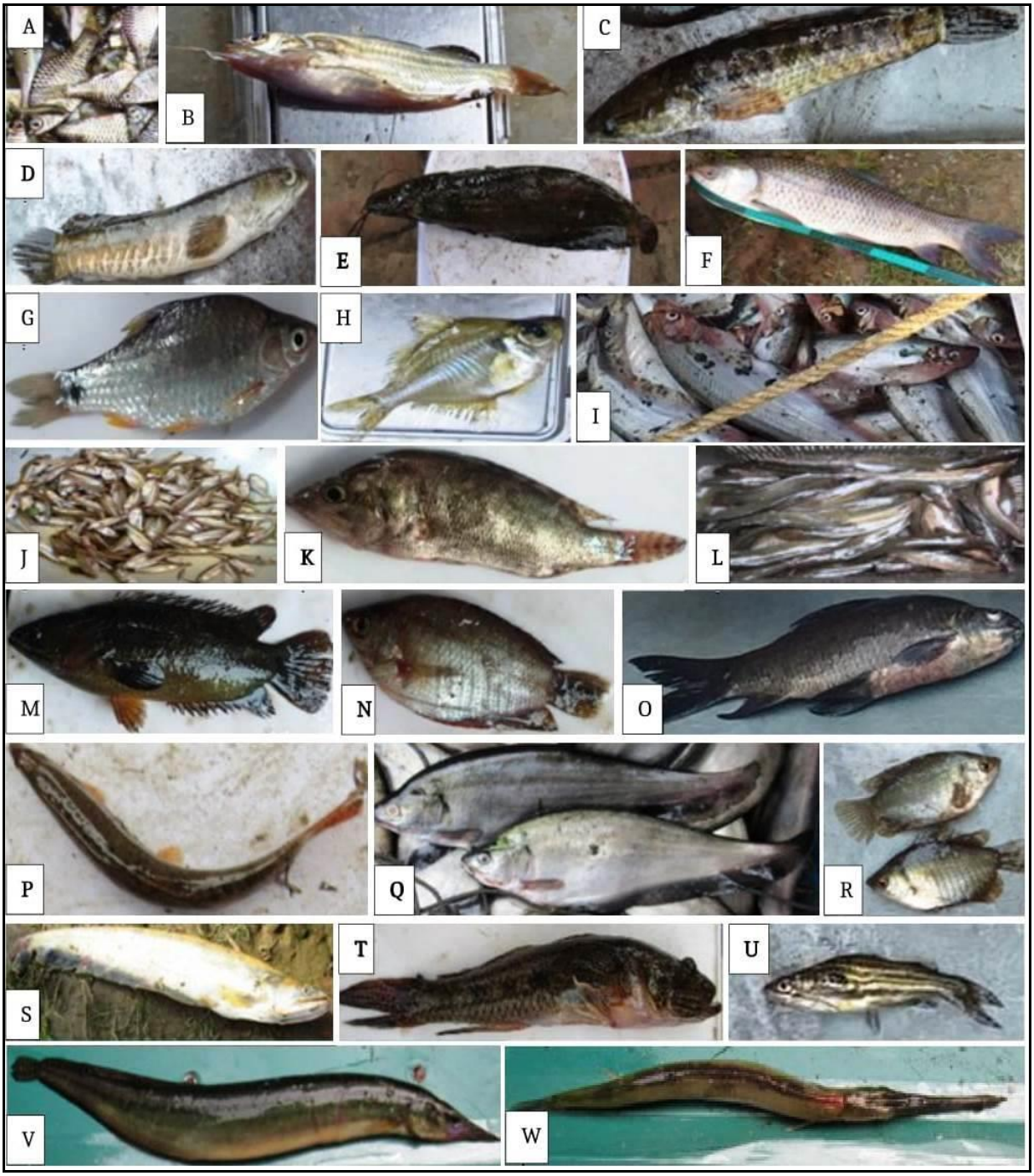

Figure 7. Fish species of Vailadhora Beel. A - tit punti (*Puntius ticto)*; B - tengra (*Mystus vittatus*); C - taki (*Channa punctata*)*;* D - shol (*Channa striata*); E - shing (*Heteropneustes fossilis*); F - rui (*Labeo rohita*); G - punti (*Puntius sophore*); H - chanda (*Parambassis ranga*); I - pabda (*Ompok pabda*); J - mola (*Amblypharyngodon mola*); K - meni (*Nandus nandus*); L - magor (*Clarias batrachus*); M - koi (*Anabas testudineus*); N - kholisha (*Trichogaster fasciata*); O - kalibaus (*Labeo calbasu*); P - gutum (*Lepidocephalichthys guntea)*; Q - foli (*Notopterus notopterus*); R - boicha (*Trichogaster lalius*); S - boal (*Wallago attu*); T - baila (*Glossogobius giuris*); U - bajuri (*Mystus tengra*); V - baim (*Mastacembelus pancalus*); W - kankila (*Xenentodon cancila*).

Conservation status. According to the IUCN (2015), 64 native freshwater fish species of Bangladesh have been declared as threatened species. Among them, 4 fish species that are commercially available were recorded in the Vailadhora Beel. 3 species of them (75%) were found as vulnerable (VU) and 1 species (25%) as critically endangered (CR)

Local conservation status of Vailadhora Beel fish species showed that the highest percentage was recorded as least concern (70%), followed by near threatened (13%), vulnerable (13%), and critically endangered (4%).

According to IUCN (2016), the highest percentage of fish species was occupied by the least concern category (83%), followed by near threatened (9%) and not evaluated (4%). Only 4% of the total fish species were found in the data deficient category.

Orderwise percentage composition. Fishes of Vailadhora Beel were categorized according to different fish orders throughout the study period. The dominant fish order was Cypriniformes (47%), followed by Perciformes (24%) (Figure 8).

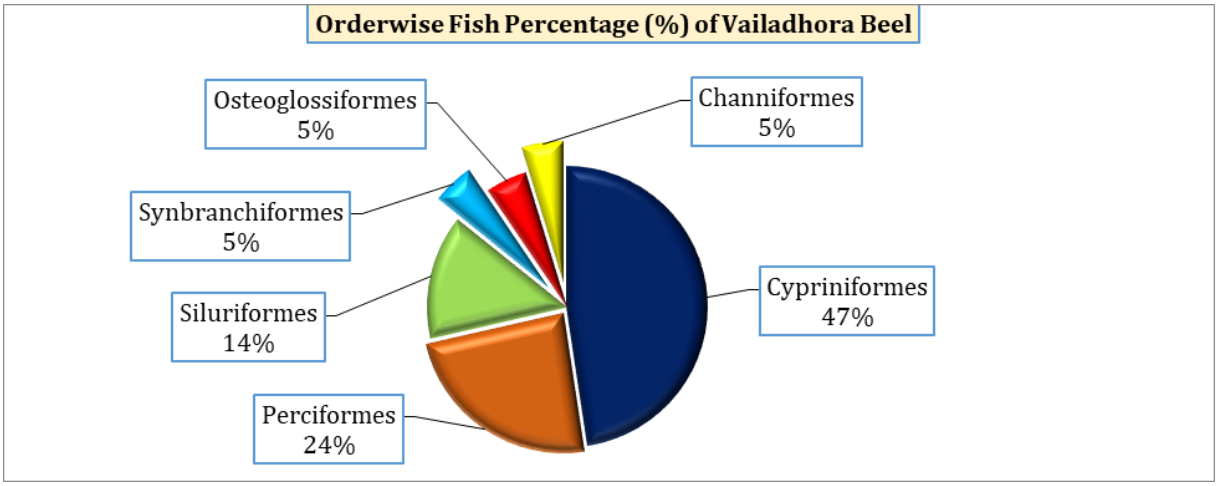

Figure 8. Orderwise percentage of Vailadhora Beel fish species.

Feeding behavior. 50% of the commercially important fish species were classified as carnivores, 45% as omnivores, and 5% as herbivores. The greater biomass of predatory fishes is apparent since the percentage of carnivore fish species is higher than the others found in the current study.

According to the Bangladesh standards, almost all water quality parameters were in the acceptable range for fish growth and survival (EQS 1997; DoE 2001). Some exceptions were observed in the case of TDS and conductivity among the sampling spots. Air temperature of all the sites was recorded slightly higher in the months of May-June, according to DoE (2001). Islam & Chowdhury (2013) recorded air and water temperature ranging from 19-33.5°C and 20-32.5°C, respectively, in Trimohoni Beel, Rajshahi. Dewan et al (2002) recorded water temperatures between 20.1-28.7°C in Raktodaha Beel, Bogura, Bangladesh. Water temperature between 16 and 33°C was noticed by Alam et al (2007) in Posna Beel, Tangail. DO value was found lower than the standard value of 6.5 mg L^{-1} (DoE 2001). Dewan et al (2002) recorded DO values varying from 3.7-5.2 ppm in Raktodaha Beel, Bogura, Bangladesh. Alam et al (2007) found a DO level ranging from 6.6-9.6 mg L^{-1} in Posna Beel, Tangail. Islam & Chowdhury (2013) found DO values between 5.3-5.7 mg L^{-1} (yearly mean value 5.57±0.16 mg L^{-1}) in Trimohoni Beel, Rajshahi. Fluctuation of DO concentration may be attributed to photosynthetic activity and variation in the rate of oxygen needed by fish and other aquatic organisms (Boyd 1982). Islam & Chowdhury (2013) found free CO_2 ranging from 13 to 23 mg L^{-1} (yearly mean value of 17.50±3.23 mg L^{-1}) in Trimohoni Beel, Rajshahi. Alam et al (2007) found seasonal variation in free CO_2 content in water (5-13 mg L^{-1}) for Posna Beel, Tangail. The pH value recorded in all sampling sites was acceptable (EQS 1997). Dewan et al (2002) recorded pH values from 5.5 to 6.4 in Raktodaha Beel, Bogura, Bangladesh. Islam & Chowdhury (2013) found that pH varied from 7.2 to 7.5 in Trimohoni Beel, Rajshahi. Alam et al (2007) found a pH level of water between 6.8 and 8 in Posna Beel, Tangail. Transparency was between 20-110 cm in the waters of Trimohoni Beel, Rajshahi (Islam & Chowdhury 2013). Alkalinity levels indicate a medium with a higher level of productivity.

Dewan et al (2002) recorded a total alkalinity between 55.7 and 97 ppm in Raktodaha Beel, Bogura, Bangladesh. Alkalinity was recorded inside the accepted range (Boyd & Tucker 1998). Total alkalinity of water varied from 34 to 51 mg L^{-1} in Posna Beel, Tangail (Alam et al 2007). Islam & Chowdhury (2013) recorded total hardness values ranging from 120 to 137 mg L^{-1} in Trimohoni Beel, Rajshahi. Hardness was also recorded inside the accepted level (DoE 2001), although it fluctuated throughout the study period. TDS and conductivity were also recorded within a suitable range. Electric conductivity ranged from 84.6-110.5 µmho cm^{-1} in Trimohoni Beel, Rajshahi (Islam & Chowdhury 2013).

Islam & Chowdhury (2013) enlisted 38 genera of zooplankton in Trimohoni Beel, Rajshahi, Bangladesh, of which Copepoda had 12 genera, Cladocera 12 genera, and Rotifera 14 genera. Alam et al (2007) recorded 48 genera of phytoplankton and 41 genera of zooplankton in Posna Beel, Tangail.

Conclusions. Vailadhora Beel has a great potential for fisheries resources. The lake is handy as a refuge when many other wetlands in the vicinity dry up entirely during droughts. However, with daily increasing fishing pressure, this beel presents adverse conditions for fisheries resources. Therefore, this is a proper time to take some necessary actions to save/preserve its biodiversity. The current research focused on documenting the composition of commercially important fish species in the Vailadhora Beel and their current conservation status in Bangladesh and around the world. The physico-chemical parameters of water were mainly in line with Bangladesh standards. High nutrient concentrations are indicated by the presence of more phytoplankton groups than zooplankton groups in Vailadhora Beel. A higher percentage of carnivorous fish indicates higher predatory fish biomass. Longer-term research is required to improve Vailadhora Beel management and better understand the commercially important fish population.

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Conflict of Interest. The authors declare that there is no conflict of interest.

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