ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XII Issue VI June 2025

Fish Biodiversity Status in The Kobadak River of Bangladesh: Present Status, Threats and Conservation Perspectives.

Md. Jahangir Alam[1]*, Abdullah-Al-Hasan[2], Mst. Niloy Jaman[3], Md. Mahfuz Hassan[4], Abdullah Al Mamun Siddiqui[5], Seema Rani[5], Md. Atiqul Islam Mondal[6], Md. Habibur Rahman[7]

[1]Department of Fisheries Management, Patuakhali Science and Technology University, Patuakhali, Bangladesh.

[2]Department of Marine Fisheries and Oceanography, Patuakhali Science and Technology University, Patuakhali, Bangladesh.

[3]Department of Fisheries Technology, Patuakhali Science and Technology University, Patuakhali, Bangladesh.

[4]Faculty of Fisheries, Patuakhali Science and Technology University, Patuakhali, Bangladesh.

[5]Biological Oceanography Division, Bangladesh Oceanographic Research Institute, Cox's Bazar-4702, Bangladesh.

[6]Department of Oceanography, Faculty of Marine Sciences & Fisheries, University of Chittagong, Chattogram-4331, Bangladesh.

[7]Department of Oceanography, Khulna Agricultural University, Khulna, Bangladesh.

[*] Corresponding author

DOI: https://doi.org/10.51244/IJRSI.2025.12060016

Received: 06 June 2025; Accepted: 11 June 2025; Published: 27 June 2025

ABSTRACT

This study assessed the status of fish biodiversity in the Kobadak River basin of Tala Upazila, Satkhira, Bangladesh, from January to June 2024 at four locations. A total of 12,040 fishes (belonging 34 species, 19 families, and 9 orders) were identified, and data was collected through a structured questionnaire. The Shannon-Wiener Index and Simpson's Index showed moderate to high species diversity and richness in the river basin, with values of 3.20-3.45 and 0.80-0.96, respectively. The findings indicated a moderate to high diversity, with Cypriniformes dominating (40.39%), followed by Perciformes (30.66%) and Siluriformes (21.68%). The most abundant species were *Labeo rohita* and *Catla catla*, while the least abundant *Chitala chitala* and *Notopterus notopterus*. Conservation status indicated that 58.82% of species are least concern, 23.53% near threatened, and 17.65% vulnerable. This research emphasized the ecological importance of the Kobadak River's fish diversity and the necessity for sustainable management to protect its fish populations.

Keywords: Fish, Biodiversity, Kobadak River, Freshwater, Conservation.

INTRODUCTION

The Kobadak River, flowing through the Tala Upazila of the Satkhira District in southwestern Bangladesh, is a crucial water body supporting many local communities' livelihood. The river and its surrounding areas are rich in aquatic biodiversity, with numerous species of fish that form the backbone of the regional fisheries. Most people living in the Kobadak River basin are engaged in fishing and related activities, relying on the river for their sustenance and economic well-being. However, in recent years, there has been a noticeable decline in fish diversity in the region, raising concerns about the sustainability of local fisheries and the overall health of the river ecosystem.

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Fish biodiversity is essential not only for maintaining the ecological balance of aquatic ecosystems but also for ensuring food security and the economic stability of fishing communities. A diverse fish population contributes to the resilience of aquatic ecosystems, making them more capable of withstanding environmental changes and human-induced pressures. Moreover, different fish species play various roles in the ecosystem, such as controlling algae growth, recycling nutrients, and providing food for other wildlife, thus maintaining the health and productivity of aquatic habitats (Allan et al., 2005).

This study aims to assess the current status of fish biodiversity in the Kobadak river basin of Tala Upazila, Satkhira, and explore conservation strategies to protect and restore this invaluable resource. By understanding the factors driving changes in fish diversity and the impacts on local communities, this research will contribute to developing effective conservation policies and sustainable fisheries management practices.

MATERIALS AND METHODS

Study Area

The Kobadak river basin is located in Tala Upazila, Satkhira District, Bangladesh. The basin is part of the larger Ganges-Brahmaputra-Meghna delta and features a complex network of rivers, canals, and wetlands that create diverse aquatic habitats. These habitats support a rich biodiversity of fish species (Rahman et al., 2012). The geographical coordinates of the study area range from 22.45° to 22.75° N latitude and 89.00° to 89.25° E longitude. The data were collected from those locations: Patkelghata (S1), Tala (S2), Islamkati (S3), and Binerpota (S4) (Fig 1).

Fig 1: Sampling Areas in the Kobadak River Basin in Tala Upazila

Duration of Research

The research was conducted for six months, from January 2024 to June 2024. This duration allowed for data collection, ensuring a comprehensive understanding of the fish biodiversity in the Kobadak River basin.

Preparation of Interview Schedule

To gather additional data on fish biodiversity and conservation practices, semi-structured interviews were conducted with local fishermen, fish traders, and community leaders. An interview schedule was prepared, consisting of both open-ended and closed-ended questions. The schedule covered identifying fish species, perceived changes in fish populations, fishing practices, and conservation efforts. The interview schedule was pretested with a small group of respondents and revised accordingly to ensure clarity and relevance.

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Collected Sample Identification

Fish species collected from the sampling areas were identified by examining their morphometric and meristic characteristics according to Eschmeyer's Catalog of Fishes, California Academy of Sciences; Hossain et al, 2019; Van Der Laan et al., 2014. After identification, the fish species were systematically categorized according to above mentioned references.

Fish Abundance and Biodiversity Status Analysis

To analyze the abundance and diversity of fish species in the Kobadak river basin, several indices were used, including the Shannon-Wiener diversity index (H), Simpson's dominance index (D), Simpson's index of diversity (1-D), Margalef's index (d), and the evenness index (E)

Relevant tables and graphs were created during the analysis phase to present the results clearly and visually. These tables and graphs were designed with the study's specific objectives in mind, facilitating easy interpretation and understanding of the findings.

Biodiversity Parameters

The biodiversity of the Kobadak river basin was assessed using the following parameters:

Shannon-Weiner diversity index, $H = -\Sigma P \times \ln Pi$

Where,

Pi = n/N; n = number of individuals of each species in the sample;

N = total number of individuals of all species in the sample.

Simpson's dominance index, $D = \Sigma ni\ (ni-1)/N\ (N-1)$

Where,

ni = number of individuals of each species in the sample;

N = total number of individuals of all species in the sample.

Simpson's index of diversity, $1\text{-}D = 1- \Sigma ni\ (n-1)/N\ (N-1)$

Evenness, $E= H/\ln S$

Where,

H = diversity index;

S = total number of species.

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

Where,

S = total number of species,

N = total number of individuals.

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RESULTS

Many freshwater species from different families and orders naturally congregate in the research region. A total of 12,040 fish individuals were observed in the Kobadak river, encompassing 34 species from 9 orders and 19 families. Table 3.1 contains the family, scientific name, sub-total, percentage of composition, and conservation status of the species found in the study area.

Species Composition Analysis

Table 3.1 presents the biodiversity and conservation status of fish assemblages at four stations (S1, S2, S3, S4) in the Kobadak River, Tala Upazila, Satkhira, Bangladesh. It details the species composition across various families, including Cyprinidae, Siluridae, Percidae, and others, listing scientific names. The table records the total number of individuals observed for each species and their conservation status, which ranges from Least Concern to Vulnerable and Near Threatened. Notable species include *Labeo rohita* (Rohu), *Catla catla* (Catla), and *Channa striata* (Striped Snakehead). This data highlights the diversity and varying conservation needs of fish species in the region

Table 3.1: Biodiversity and conservation status records of fish assemblages at four stations of the Kobadak River, Tala Upazila, Satkhira, Bangladesh.

S/N	Family	Species	S1	S2	S3	S4	Total	Sub-total	Composition (%)	Conservation status
1	Cyprinidae	*Labeo rohita*	302	251	203	252	1,008	5937	49.31	Least Concern
		Catla catla	247	267	210	230	954			Least Concern
		Cirrhinus mrigala	213	180	150	174	717			Vulnerable
		Puntius sophore	181	174	143	161	659			Vulnerable
		Puntius ticto	151	142	123	147	563			Least Concern
		Amblypharyngodon mola	136	118	108	127	489			Least Concern
		Barbonymus gonionotus	134	115	87	118	454			Near Threatened
		Osteobrama cotio	114	105	82	107	408			Least Concern
		Labeo calbasu	104	87	73	98	362			Vulnerable
		Esomus danricus	93	81	62	87	323			Least Concern
2	Bagridae	*Mystus tengara*	102	86	74	84	346	890	7.39	Least Concern
		Mystus vittatus	81	75	63	78	297			Least Concern
		Rita rita	72	57	49	69	247			Least Concern

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S/N	Family	Species	S1	S2	S3	S4	Total	Sub-total	Composition (%)	Conservation status
3	Siluridae	*Wallago attu*	102	92	76	99	369	369	2.99	Least Concern
4	Clariidae	*Clarias batrachus*	89	81	73	87	330	330	2.74	Least Concern
5	Pangasiidae	*Pangasius pangasius*	91	83	68	98	340	340	2.82	Near Threatened
6.	Heteropneustidae	*Heteropneustes fossilis*	83	74	56	78	291	291	2.42	Least Concern
7	Schilbeidae	*Ailia coila*	68	59	53	71	251	251	2.08	Least Concern
8	Channidae	*Channa striata*	121	109	90	113	433	780	6.33	Least Concern
		Channa punctata	71	55	51	65	242			Near Threatened
		Channa marulius	40	10	5	50	105			Near Threatened
9	Anabantidae	*Anabas testudineus*	106	98	83	101	388	388	3.22	Near Threatened
10	Nandidae	*Nandus nandus*	97	95	65	91	348	348	2.89	Least Concern
11	Cichlidae	*Oreochromis niloticus*	88	79	81	89	337	337	2.79	Vulnerable
12	Gobiidae	*Glossogobius giuris*	71	82	75	87	315	315	2.62	Least Concern
13	Ambassidae	*Parambassis ranga*	78	75	68	83	304	304	2.54	Least Concern
14	Osphronemidae	*Trichopodus trichopterus*	65	59	45	61	230	230	1.91	Least Concern
15	Clupeidae	*Gudusia chapra*	4	7	20	15	46	169	0.20	Vulnerable
		Corica soborna	20	42	22	39	123			Vulnerable
16	Notopteridae	*Notopterus notopterus*	4	2	5	10	21	50	0.42	Near Threatened
		Chitala chitala	5	7	15	2	29			Near Threatened
17	Synbranchidae	*Monopterus cuchia*	11	2	4	8	25	25	0.20	Vulnerable
18	Belonidae	*Xenentodon cancila*	22	25	31	57	135	135	1.12	Least Concern

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S/N	Family	Species	S1	S2	S3	S4	Total	Sub-total	Composition (%)	Conservation status
19	Mugilidae	*Mugil cephalus*	75	62	51	78	266	266	2.16	Least Concern

Catch composition

The Cyprinidae family is the most dominant in the Kobadak river, contributing 49.31% of the total fish populations (Fig. 2), with species like *Labeo rohita* and *Catla catla* being the most abundant within this family. Other significant families include Bagridae (7.39%), Channidae (6.33%), and Siluridae 2.99%). These families collectively account for most of the fish diversity in the river (Fig. 3). Families like Clupeidae, Notopteridae, Synbranchidae, Belonidae, and Mugilidae have smaller representations, contributing between 0.20% and 2.16% to the total fish population (Fig. 3). Despite their lower numbers, these families add to the overall biodiversity of the river, with some species having specialized roles or being of conservation concern.

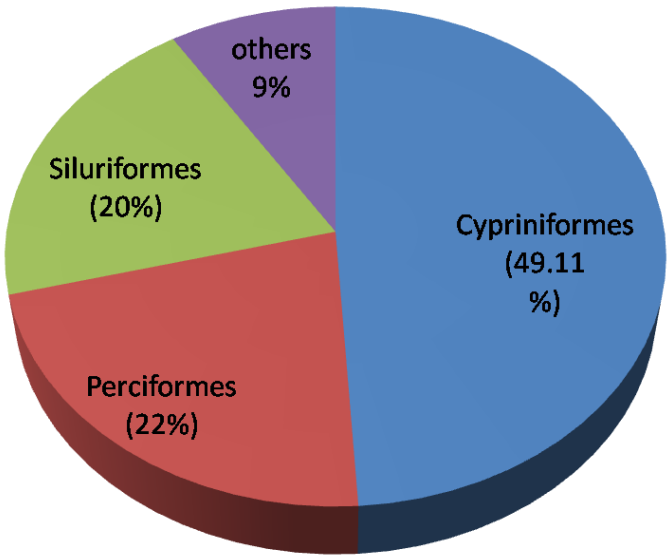

Figure 2: The percentage of catch composition of fish species under orders.

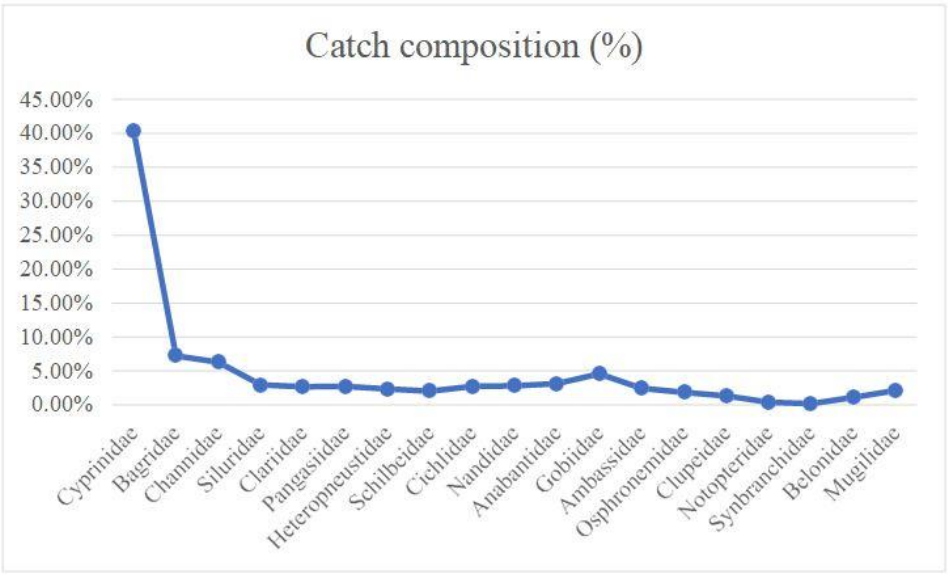

Fig. 3: The percentage of catch composition of fish species with various families.

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Temporal abundance of eight most available species

This chart depicts the temporal abundance of the eight most abundant fish species at four stations (S1, S2, S3, and S4) in the Kobadak River, Bangladesh. The most abundant species is *Labeo rohita*, which has 1,008 individuals recorded and is distributed fairly evenly across the four stations (Fig. 4). *Catla catla* closely follows 954 individuals, with a peak at Station 2 (267 individuals). *Cirrhinus mrigala* is abundant, particularly at Station 1 (213 individuals), contributing to the species' overall population of 717. *Puntius sophore* and *Puntius ticto* are also widely distributed, with total populations of 659 and 563, respectively, shown in (Table 3.1). *Amblypharyngodon mola* and *Barbonymus gonionotus* have lower total counts but still represent a significant proportion of the fish population, with 489 and 454 individuals, respectively.

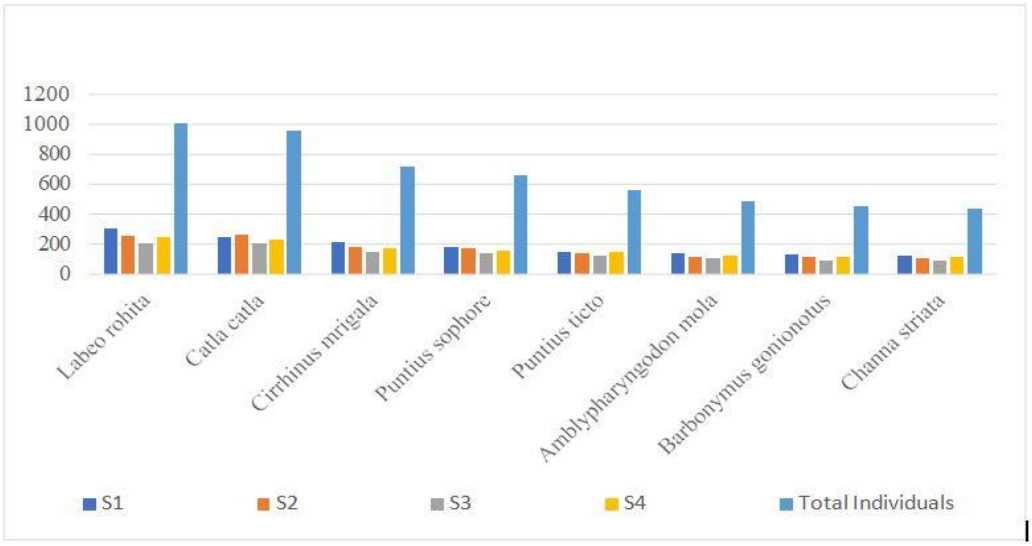

Fig. 4: Depicts the temporal abundance of the eight most available fish species in the study areas.

Conservation status analysis

The table highlights the diversity of conservation concerns among the fish species in the Kobadak River, Bangladesh. Most species (68%) are classified as Least Concern, indicating a stable population and low risk of extinction shortly. However, a significant portion of species falls under the Near Threatened (13%) and Vulnerable (19%) categories, signaling potential threats to their populations (Fig. 5). These findings underscore the need for targeted conservation efforts to ensure the protection of species that are at risk, particularly those categorized as Vulnerable.

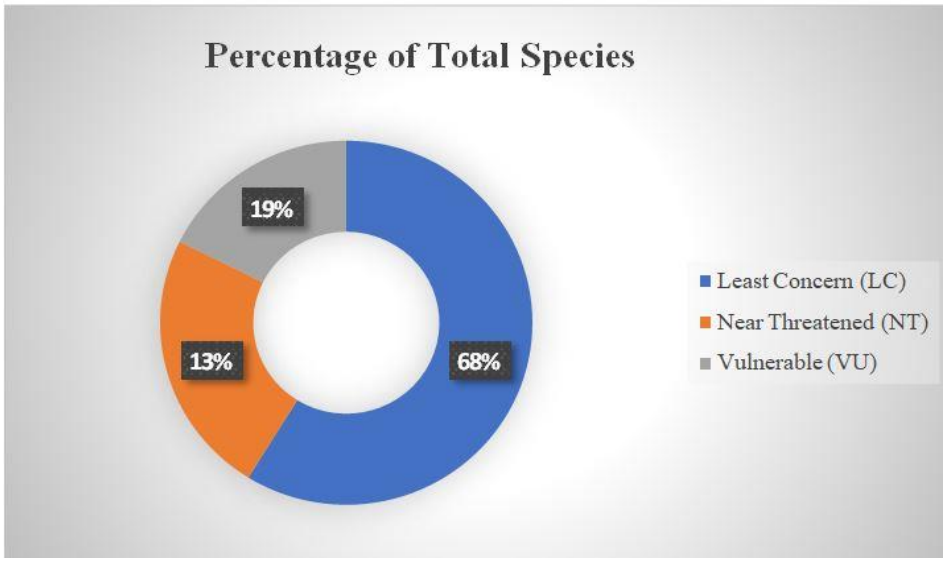

Fig. 5: The conservation status of available fish species in the study area.

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Fish abundance and diversity analysis

The diversity analysis of fish abundance in the Kobadak River Basin reveals moderate to high biodiversity, as indicated by the Shannon-Wiener Diversity Index (H=3.37). The Simpson's Dominance Index (D=0.043) suggests low dominance, meaning no single species overwhelmingly dominates the population. This is supported by Simpson's Index of Diversity (1-D=0.957), indicating a high probability that two randomly selected individuals belong to different species. The Evenness Index (E=0.940) shows a relatively even distribution of individuals across species, while Margalef's Richness Index (d=3.53) points to moderate species richness. These indices reflect a well-balanced and diverse community with a healthy and stable ecosystem, where numerous species contribute to the population without any species exerting overwhelming dominance.

Cluster analysis

Cluster analysis of the fish assemblages in the Kobadak River reveals distinct groupings based on species abundance, distribution across stations, and conservation status. Species *like Labeo rohita* and *Catla catla*, which are highly abundant and consistently present across all stations, form a dominant cluster, indicating their strong adaptation to the river's environment. In contrast, species with a Vulnerable or Near Threatened status, such as *Cirrhinus mrigala* and *Chitala chitala*, cluster together, highlighting shared conservation concerns due to their lower abundance and potential environmental pressures. Additionally, more abundant species at specific stations cluster together, reflecting localized environmental conditions or habitat preferences. This clustering underscores the need for targeted conservation efforts, particularly for the less abundant and at-risk species, while also informing station-specific management strategies to maintain the river's ecological balance (Fig. 5).

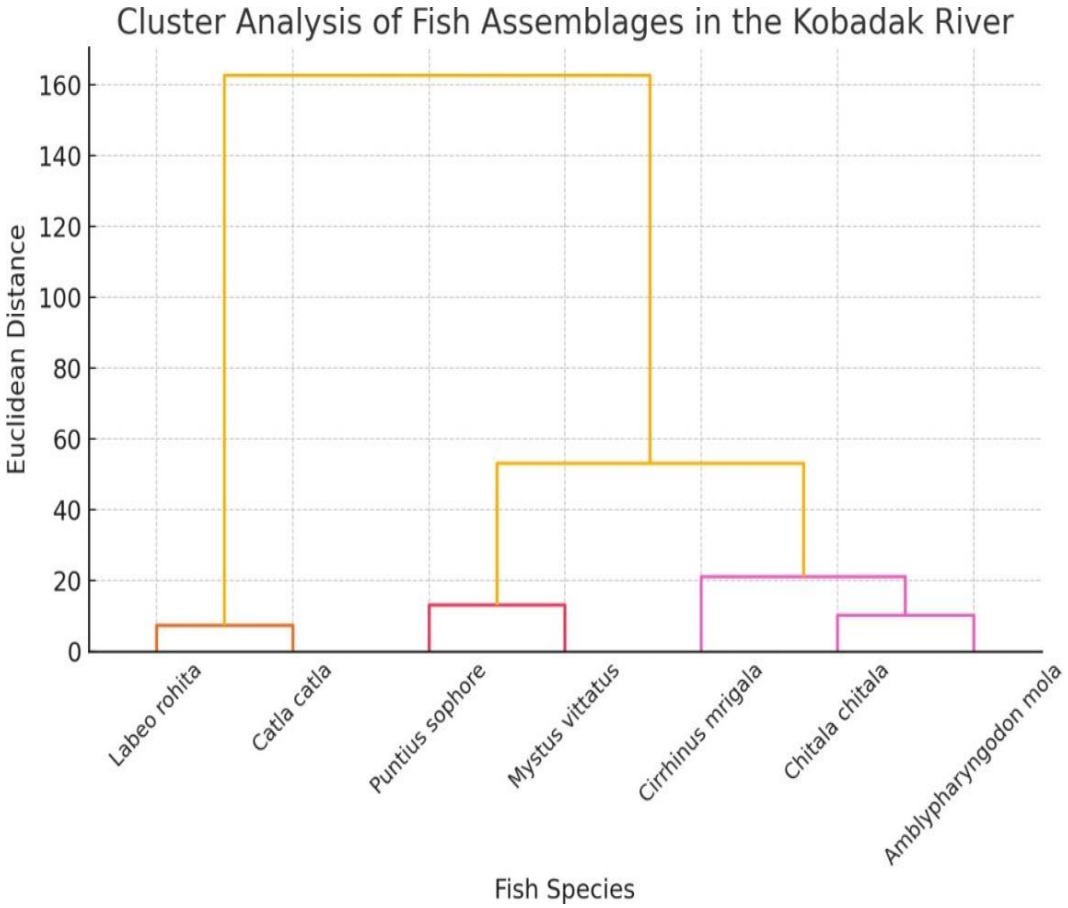

Fig. 5: Cluster analysis of the fish assemblages in the Kobadak River.

Threat assessment based on species composition analysis in the Kobadak River.

The biodiversity of fish species in the Kobadak River, Tala Upazila, Satkhira, Bangladesh, reflects varying levels of conservation concern, with some species thriving and others at risk. A majority (67.75.%) of the fish

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species, such as *Labeo rohita* and *Catla catla* , are classified as Least Concern (LC), indicating stable populations across all study stations (S1 to S4). However, 13.11% of the species, including *Barbonymus gonionotus* and *Channa punctata* fall under the Near Threatened (NT) category, showing early signs of stress from environmental pressures like habitat loss or overfishing. Additionally, 18.85% of species, such as *Cirrhinus mrigala* and *Puntius sophore*, are categorized as Vulnerable (VU) due to declining populations, which pose significant risks to their survival. Species like *Chitala chitala* and *Notopterus notopterus* are particularly rare, with very few individuals recorded, indicating their urgent need for targeted conservation efforts. Effective measures, including habitat restoration, regulated fishing, and population monitoring, are necessary to safeguard these species and maintain ecological balance in the river.

DISCUSSION

The findings of the present study in the Kobadak River reveal a moderate to high level of fish biodiversity, dominated by Cyprinidae, which is consistent with several other freshwater ecosystems in Bangladesh. For instance, Ahmed et al. (2015) reported that Cyprinidae accounted for over 50% of total fish diversity in the Atrai River, indicating a similar dominance pattern. Moreover, Hossain et al. (2019) observed comparable species richness in the Jamuna River, with a Shannon-Wiener index ranging from 3.10 to 3.50, aligning closely with the index values (3.20–3.45) observed in this study. In comparison, rivers such as the Ganga in India and the Indus in Pakistan, though significantly larger, exhibit analogous community structures where families like Siluridae and Bagridae also play critical ecological roles (Bhatnagar & Singh, 2020). However, unlike many of these rivers, the Kobadak River shows a relatively higher evenness index (E = 0.940), indicating a more balanced species distribution, which may reflect lower exploitation pressure or more stable microhabitats. This suggests that, although the Kobadak River shares ecological traits with other South Asian river systems, its particular conservation profile — especially with 18.85% of species categorized as Vulnerable — demands tailored management interventions.

A total of 34 species were identified across the four sampling stations (Patkelghata, Tala, Islamkati, and Binerpota), showing a rich diversity of fish fauna despite the variations in total individual counts among stations. The dominance of species like *Labeo rohita* (Rohu) and *Catla catla* (Catla) highlights the prevalence of the Cyprinidae family, which contributed the most to the overall fish biodiversity in the river. Specifically, Cyprinidae was the most abundant family, accounting for 49.31% of the total fish population, underscoring its ecological dominance in the Kobadak River (Table 3.1) .The next most prevalent family were Perciformidae and Siluriformidae, contributing 22.44% and 20.52% of the total fish population, respectively. These findings are consistent with other studies on freshwater fish diversity in Bangladesh, where Cyprinidae is frequently reported as the most diverse and abundant family (Rahman et al., 2020; Hossain et al., 2019).

The dominance of Cyprinidae, represented by key species like *Labeo rohita* and *Catla catla*, can be attributed to their ecological adaptability and importance in local fisheries. These species are economically valuable and play a critical role in the river's ecosystem, acting as major consumers of plankton and contributing to nutrient cycling (Rahman, 2005). Their presence across all four stations, with relatively balanced distributions, suggests that these species thrive under the current environmental conditions of the river, which include varied flow regimes, substrate types, and availability of food resources. However, the significant presence of species with conservation concerns, such as *Cirrhinus mrigala* (Vulnerable) and *Barbonymus gonionotus* (Near Threatened), raises concerns about the long-term sustainability of fish populations in the Kobadak River. The vulnerable status of *Cirrhinus mrigala* is particularly concerning, as this species is vital for both biodiversity and local fisheries, highlighting the need for targeted conservation measures (IUCN, 2023).

Spatially, the four sampling stations sex habited notable differences in species abundance, with Patkelghata (S1) recording the highest total number of individuals (3,555) and Islamkati (S3) the lowest (2,742). Despite these differences, the consistent presence of 34 species across all stations suggests a relatively uniform biodiversity pattern throughout the study area. Several factors, including habitat heterogeneity, fishing pressure, and environmental variables such as water quality and flow rate, could influence individual counts. Conversely, species like *Chitala chitala* and *Notopterus notopterus* were among the least abundant, which may reflect specific habitat requirements or susceptibility to environmental stressors such as pollution and habitat fragmentation (Islam et al., 2018). These species' low abundance highlights the need for habitat protection and

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restoration efforts, particularly in river areas where human activities have degraded. The presence of families such as Bagridae, Channidae, and Siluridae also contributes significantly to the river's biodiversity, each playing unique ecological roles. For instance, Bagridae species such as *Mystus tengara* (Tengra) are important benthic feeders, contributing to controlling detritus and small invertebrate populations (Rahman, 2005). The Channidae family, represented by species like *Channa striata*, is crucial for maintaining the balance of predatory dynamics within the ecosystem. The ecological roles of these families highlight the importance of maintaining a diverse fish community to ensure the resilience and stability of the river's ecosystem. The conservation status analysis reveals that most of the fish species in the Kobadak River are classified as Least Concern, suggesting that their populations are currently stable. However, a significant proportion of species are classified as Near Threatened (13.11%) and vulnerable (18.85%), indicating that nearly half of the species face potential risks that could lead to population declines if current trends persist (IUCN, 2023). The Vulnerable status of species such as *Cirrhinus mrigala* and *Gudusia chapra* (Indian River Shad) underscores the impacts of overfishing, habitat degradation, and pollution, which are prevalent threats in many freshwater systems in Bangladesh (Rahman et al., 2021). The Near Threatened species, including *Barbonymus gonionotus* and *Anabas testudineus* (Climbing Perch), also require attention, as they may become more at risk without proactive conservation measures. The presence of species with different conservation statuses highlights the need for an integrated conservation strategy that addresses species-specific and ecosystem-wide challenges. Conservation efforts should include implementing sustainable fishing practices, habitat restoration, pollution control, and establishing protected areas to safeguard critical habitats. Additionally, community involvement and awareness-raising are essential to ensure the success of conservation initiatives, as local communities play a key role in resource management (Hossain et al., 2020).

Ethical Approval: The Animal Welfare and Ethical Committee, Patuakhali Science and Technology University approved the experimental procedures used in this study.

Conflict of Interests: The authors declare no competing interests.

Data Availability:

This dataset is not publicly available, but data-sharing will be considered upon request.

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