

Fish Biodiversity of Zebi Dam: Insights from Karak District, Khyber Pakhtunkhwa

Umar Saddique

Department of Zoology

Email: saddiqueumar68@gmail.com

Sawera Inam

Khushal Khan Khattak University Karak, Pakistan

Email: sawerainam1234@gmail.com

Wajid Ullah

Department of Zoology

Email: wajidullahkhan485@gmail.com

Muhammad Hamid

Khushal Khan Khattak University Karak, Pakistan

Email: muhammadhamidk1@gmail.com

Tamsila Nawaz

Department of Zoology, Khushal Khan Khattak University Karak, Pakistan

Email: afnankhan9660574@gmail.com

Zuhra Saif Ullah

Department of Zoology, Khushal Khan Khattak University Karak, Pakistan

Email: zuhraqtiq@gmail.com

ABSTRACT

Biodiversity encompasses the variety of life forms on Earth, with ichthyodiversity (or ichthyofauna) referring specifically to the diversity of fish species within a given ecosystem. Fish play a vital role in maintaining aquatic ecosystem balance and contribute significantly to human livelihoods through fisheries, aquaculture, and recreational activities. The present study investigated the ichthyofauna of Zebi Dam, located in Karak District, Khyber Pakhtunkhwa, Pakistan. Sampling was conducted from November 2024 to July 2025. A total of 179 specimens were collected randomly with the assistance of local fishermen using standard fishing techniques, including hand nets, cast nets, and hooks. Specimens were photographed prior to preservation in 10% formalin to minimize loss of external coloration. Unethical practices such as poisoning or the use of electric current were strictly avoided. Overall, five species of fishes were recorded, representing three orders, two families, and four genera. The family Cyprinidae was the most dominant, with four species: *Cyprinus carpio*, *Oreochromis*

niloticus, Ctenopharyngodon idella, and Hypophthalmichthys molitrix. The family Heteropneustidae was represented by a single species, Heteropneustes fossilis. Notably, Ctenopharyngodon idella (Grass Carp) was documented for the first time in this region during the present study. The dominance of cyprinid species suggests that the environmental conditions of Zebi Dam are particularly favorable for their growth and survival. These findings provide a baseline inventory of fish diversity in the area and highlight the ecological and economic potential of the dam. Sustainable management and promotion of carp aquaculture in this region could enhance local fisheries, conserve biodiversity, and strengthen the livelihoods of fishing communities.

Keywords: Zebi Dam; Cyprinidae; Cyprinus carpio; Oreochromis niloticus; Hypophthalmichthys molitrix; Ctenopharyngodon idella; Heteropneustes fossilis

Introduction

Biodiversity represents the variety of life on Earth and is considered one of the most essential components for sustaining ecosystems. It encompasses diversity within species, between species, and of ecosystems, and is formally defined as the variation among living organisms from terrestrial, aquatic, and other ecological complexes (UNDP, 1992). The concept of biodiversity gained prominence in 1985 and has since been used to describe both the richness of species and their relative abundance within ecosystems. It plays a critical role in understanding ecological functions, maintaining environmental quality, and ensuring the intrinsic balance of life systems across the globe (Ehrlich and Wilson, 1919).

Among the different components of biodiversity, ichthyodiversity, or fish diversity, is of particular ecological and economic significance. Ichthyodiversity refers to the variety of fish species across populations, habitats, and regions, encompassing genetic variability, species richness, and community structure (Burton et al., 1992). It can be assessed through multiple parameters, such as the total number of species (species richness), their relative abundance within a community (species evenness), and genetic variation within and between populations. Fish biodiversity is influenced by both natural and anthropogenic factors, including climatic variability, temperature fluctuations, hydrological conditions, and destructive human activities such as pollution, overfishing, and habitat alteration (Burton et al., 1992). Because fish form an integral part of aquatic ecosystems, studying their diversity provides valuable insights into the health and sustainability of freshwater environments.

Fishes are the most diverse group of vertebrates, adapted to almost all aquatic habitats ranging from Antarctic waters to hot springs, and showing remarkable tolerance to variations in salinity and temperature (Ali, 1993). They are cold-blooded, gill-breathing animals belonging to paraphyletic groups, typically reproducing sexually with external fertilization, and most species are oviparous (Asmat et al., 2014). Ecologically, fishes dominate the biotic component of aquatic systems in terms of biomass and abundance, playing crucial roles in energy flow and nutrient cycling. Nutritionally, they provide high-quality protein, essential fatty acids, vitamins, and minerals that are indispensable for human health (Hamzah et al., 2007). Economically, fishes and fisheries contribute substantially to national incomes, food security, and rural livelihoods. In many regions, stocking reservoirs with native and economically valuable fish species has proven to be

a productive measure for enhancing aquaculture and fisheries development (Sinha et al., 1986; Shinde et al., 2009). Furthermore, consumption of fish, especially oily fishes rich in omega-3 fatty acids, has been linked with reduced risks of cardiovascular diseases and improved nutrition worldwide (Shaikh et al., 2011). Thus, ichthyofauna holds ecological, nutritional, and economic importance, making its study a central aspect of biodiversity research.

Globally, fish represent the largest group of vertebrates, with an estimated 35,500 species, of which nearly 14,000 are freshwater species (Froese and Pauly, 2019). Taxonomically, they are classified into three major groups: Agnatha (jawless fishes), Chondrichthyes (cartilaginous fishes), and Osteichthyes (bony fishes), which are further divided into numerous orders and families (Day et al., 2012). South and Southeast Asia are particularly rich in ichthyodiversity. For instance, India is home to around 2,500 fish species, including 930 freshwater species and 1,570 marine species (Kar et al., 2003). Similarly, ichthyofaunal surveys in Nepal and Bangladesh have documented numerous freshwater species across rivers, lakes, and biosphere reserves, highlighting the richness of aquatic biodiversity in the region (Shrestha et al., 2009; Bhuiyan et al., 1992; Negi and Mangain, 2013; Rankhamb, 2011; Baliarsingh et al., 2013). However, despite this richness, global ichthyodiversity is increasingly under threat. The introduction of exotic fish species has led to the decline and even extinction of native species in several regions, as reported in Iberian freshwater systems (Leunda et al., 2010). Endemism also plays an important role in freshwater fish communities, with unique species recorded from isolated lakes such as Lake Rara in Nepal and Lake Sentani in Indonesia (Terashima et al., 1984; Allen et al., 1991). These examples emphasize the need for continuous monitoring and assessment of freshwater ecosystems to safeguard their biodiversity.

Pakistan, with its diverse freshwater and marine environments, harbors a rich fish fauna. Early studies recorded approximately 193 freshwater fish species belonging to 13 orders, 30 families, and 86 genera (Ahmad et al., 1963; Peter et al., 1999; Helfrich et al., 2009). Of these, about 30 species are considered economically important, including *Labeo rohita*, *Hypophthalmichthys molitrix*, *Catla catla*, *Cirrhinus mrigala*, *Cirrhinus reba*, *Channa striata*, *Channa marulius*, *Sperata sarwari*, *Wallago attu*, and *Bagarius bagarius*. Since independence in 1947, the fisheries sector of Pakistan has grown from small-scale operations to a developing industry, though challenges such as overfishing, pollution, and habitat degradation persist (Nazir et al., 2015). Subsequent ichthyofaunal surveys have expanded knowledge across different provinces, including records from the Swat River, Tanda Dam, Baran Dam, River Kurram, and various other freshwater bodies in Khyber Pakhtunkhwa (Khan and Hassan, 2011; Ishaq et al., 2014).

In Karak District, several ichthyodiversity studies have been conducted in lakes, dams, and rivers, consistently showing Cyprinidae as the dominant family. For example, seven species were documented in Dandi Idhar Khel Lake, four in Khaisari Dam, and six in Khurum Dam (Zubia et al., 2015; Tahir et al., 2016; Saqib et al., 2016). Changhoz Dam yielded seven species, including both native and exotic taxa (Ilyas and Ahmad, 2014). Previous surveys of Zebi Dam itself reported 12 species belonging to the families Cyprinidae and Channidae, while other adjacent regions such as Braganatu Dam in FR Bannu recorded nine species (Wazir et al., 2009; Khan and Hassan, 2011). More recent studies suggest that floods and other disturbances have reduced fish

diversity in certain areas, with some species washed downstream (Hameed et al., 2015). These findings highlight the dynamic nature of fish communities and the importance of updating species inventories to reflect current conditions.

Given this context, the present study was undertaken to investigate the ichthyodiversity of Zebi Dam, located in Karak District of Khyber Pakhtunkhwa. The study provides an updated account of species richness, community composition, and the dominance of Cyprinidae, thereby contributing valuable baseline data for biodiversity conservation and fisheries management in the region. By documenting the current status of ichthyofauna, this research also offers insights for promoting sustainable aquaculture, preventing illegal fishing practices, and ensuring that aquatic resources continue to support local livelihoods and ecological balance.

Materials and Methods

Study Duration

The survey was conducted over a period of five months, from November 2024 to March 2025.

Study Area

The research was carried out at Zebi Dam, located in Karak District of Khyber Pakhtunkhwa (KPK), Pakistan. Karak is situated approximately 150 km south of Peshawar along the Indus Highway (N-55). Geographically, the district lies at 37° N latitude and 71°54' E longitude, with elevations ranging from 600–1,400 m above sea level. The area is characterized by hilly terrain, arid climate, and limited water resources.

Karak District is inhabited mainly by the Khattak tribe and is known for its deposits of gypsum, oil, and gas. Among its nine small dams, Zebi Dam is one of the most prominent. It was constructed by the Government of Khyber Pakhtunkhwa for rainwater storage and is utilized for drinking, irrigation, domestic activities, and aquaculture. The dam thus provides a suitable habitat for freshwater fish communities.

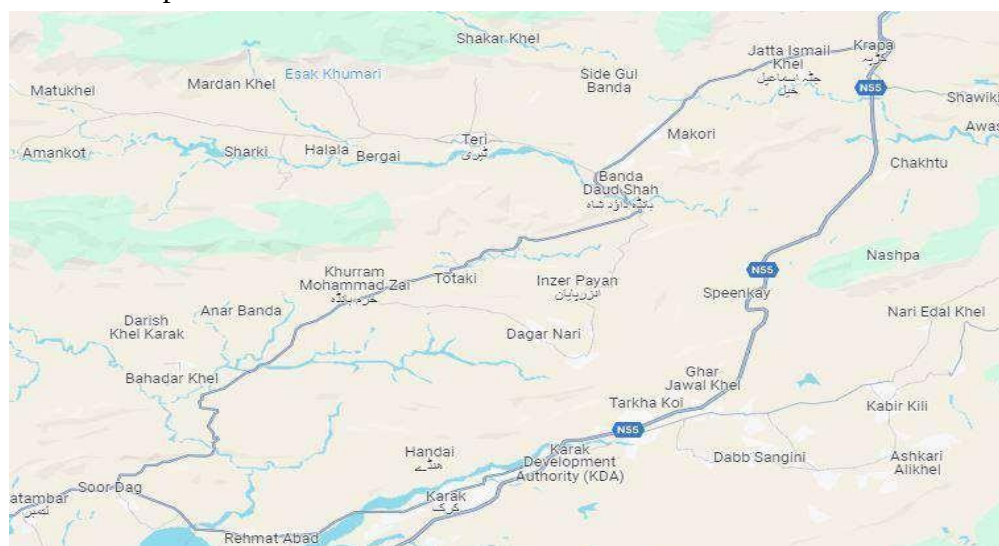


Figure-1: Map of district Karak

Fish Sampling

Fish specimens were collected randomly from different sites of Zebi Dam between October 2024 and July 2025 with the assistance of local fishermen. Multiple fishing gears were employed, including hand nets, cast nets, and hooks, to ensure broad species representation. Immediately after capture, each specimen was photographed to record external coloration prior to preservation. Ethical considerations were strictly followed, and destructive practices such as poisoning, toxins, or electric currents were not employed.

Preservation of Specimens

Fish samples were preserved in 10% neutralized formalin solution following standard ichthyological methods. Since formalin becomes acidic over time, calcium carbonate was added to maintain a neutral pH (Ali, 1999). Specimens were stored in tightly sealed glass or plastic jars to prevent leakage and deterioration.

Labelling and Handling of Samples

Each collected specimen was properly labeled at the time of collection. Labels contained detailed information, including collection date, time, and exact sampling site, to maintain traceability and reliability of data.

Identification of Fish Species

All collected fish were identified to the species level. Diagnostic features such as body shape, fin structure, and characteristic markings were examined. Identification was carried out using standard taxonomic keys, including *Fishes of the World* (Nelson, 2006) and *Freshwater Fishes of Pakistan* (Mirza, 1990).

Results

A total of 179 fish specimens were collected from Zebi Dam during the study period (November 2024–March 2025). The ichthyofaunal survey revealed the presence of five species, belonging to three orders, three families, and five genera (Table 1). The identified species included *Hypophthalmichthys molitrix* (Silver Carp), *Cyprinus carpio* (Common Carp), *Ctenopharyngodon idella* (Grass Carp), *Oreochromis niloticus* (Nile Tilapia), and *Heteropneustes fossilis* (Stinging Catfish).

Among these, the family Cyprinidae was the most dominant, represented by three species (*H. molitrix*, *C. carpio*, and *C. idella*). *Ctenopharyngodon idella* was recorded for the first time in Zebi Dam, making it a new addition to the documented ichthyofauna of the area. The family Cichlidae was represented by a single species (*O. niloticus*), while the family Heteropneustidae was represented by *H. fossilis*.

Table 1: Fish species recorded from Zebi Dam, Karak District, Khyber Pakhtunkhwa, Pakistan.

S	Order	Family	Genus	Species	Common	Status
No				(Scientific Name)	Name	in Zebi Dam

1	Cypriniformes	Cyprinidae	Hypophthalmichthys	H. molitrix	Silver Carp	Previously reported
2	Cypriniformes	Cyprinidae	Cyprinus	C. carpio	Common Carp	Previously reported
3	Cypriniformes	Cyprinidae	Ctenopharyngodon	C. idella	Grass Carp	First record
4	Cichliformes	Cichlidae	Oreochromis	O. niloticus	Nile Tilapia	Previously reported
5	Siluriformes	Heteropneustidae	Heteropneustes	H. fossilis	Stinging Catfish	Previously reported

Species Accounts

Hypophthalmichthys molitrix (Valenciennes, 1844) – Silver Carp

This species is widely distributed across Asia and introduced in various regions of Pakistan. It inhabits rivers, lakes, reservoirs, and wetlands. The body is elongated and laterally compressed, with a keel along the belly, a large head, and an upturned mouth. It is a filter feeder, consuming phytoplankton, and typically breeds in spring when water temperature rises. Maximum length recorded during the study was approximately 100 cm TL.

Oreochromis niloticus (Linnaeus, 1758) – Nile Tilapia

Native to Africa and the Middle East, *O. niloticus* has been introduced to many countries, including Pakistan, for aquaculture. It is highly adaptable and occurs in rivers, reservoirs, and ponds. The body is laterally compressed with a pointed snout and large mouth, and fins include a continuous dorsal, anal, and caudal fin. It feeds mainly on plant material and breeds in warmer months at water temperatures of 26–30 °C.

Ctenopharyngodon idella (Valenciennes, 1844) – Grass Carp

This species is native to the Yangtze River Basin in China but is widely introduced across Asia, Europe, Africa, and North America for aquatic vegetation control. In Pakistan, it occurs in reservoirs and rivers. It has an elongated, torpedo-shaped body, a broad head, and a silvery-gray coloration. It feeds predominantly on aquatic vegetation and shows peak feeding activity at 18–22 °C. Breeding typically occurs between April and June. This study confirms its presence in Zebi Dam for the first time.

Cyprinus carpio (Linnaeus, 1758) – Common Carp

An exotic and globally cultured species, *C. carpio* is widely distributed in Pakistan. It exhibits high morphological variability, ranging from greenish-brown to reddish coloration. The species is omnivorous, feeding on benthic organisms, plants, and detritus. Spawning usually takes place between late April and June in shallow, vegetated waters. Individuals up to 100 cm TL were recorded during this survey.

Heteropneustes fossilis (Bloch, 1794) – Stinging Catfish

This air-breathing catfish is distributed widely across South and Southeast Asia, including all provinces of Pakistan. It inhabits ponds, swamps, marshes, and slow-flowing rivers. The body is elongated, brownish-black dorsally, and lighter ventrally. It is carnivorous, feeding mainly on crustaceans and insects. Breeding occurs during the monsoon, with peak spawning from July to August. Maximum size recorded was 30 cm TL.

Discussion

This study represents a recent attempt to assess the ichthyofaunal diversity of Zebi Dam, Karak District, during November 2024 to March 2025. A total of five fish species were documented, belonging to three orders and three families. Among these, *Cyprinus carpio*, *Oreochromis niloticus*, *Hypophthalmichthys molitrix*, and *Heteropneustes fossilis* were previously reported from Zebi Dam, while *Ctenopharyngodon idella* was recorded for the first time from this water body. The predominance of Cyprinid fishes in this survey is consistent with the findings of earlier studies conducted in Pakistan, where Cyprinidae are often reported as the dominant freshwater family due to their adaptability and ecological tolerance (Rehman et al., 2015).

Biodiversity is widely recognized as an important ecological parameter, reflecting ecosystem health, resilience, and the role of organisms in sustaining ecological processes (Rehman et al., 2015). Fish populations in freshwater ecosystems are known to fluctuate over time due to seasonal variation, recruitment, and anthropogenic pressures. Therefore, repeated surveys are essential to establish reliable baselines for long-term monitoring (William, 1998). Diversity in aquatic systems is generally assessed through species richness (the number of species) and evenness (their relative abundance), both of which may be influenced by ecological and environmental drivers (Magurran, 2005).

Previous research on Zebi Dam by Rehman et al. (2015) reported six Cyprinid species (*Cirrhinus mrigala*, *Hypophthalmichthys molitrix*, *Labeo rohita*, *Carassius auratus*, *Catla catla*, and *Cyprinus carpio*). Similarly, Ilyas (2004) documented ten Cyprinid species from the same site, including *Barilius vagra*, *Puntius ticto*, and *Puntius sophore*. In contrast, the present study recovered only five species, with three overlapping with earlier surveys (*H. molitrix*, *O. niloticus*, and *C. carpio*). Notably, *C. idella* was recorded for the first time, whereas species such as *C. auratus*, *C. catla*, and *L. rohita* were not encountered. These differences may be attributed to temporal variations in sampling, seasonal shifts, or possible local decline of some species due to ecological pressures.

Declines in fish diversity have been widely associated with anthropogenic activities, including overfishing, habitat alteration, damming, and pollution (Agostinho et al.,

2005). The restricted diversity recorded in this study may reflect the cumulative effects of such pressures in Zebi Dam. The finding of *C. idella* suggests either intentional introduction for aquaculture or natural dispersal from connected systems. Comparative studies in adjacent regions support these observations. For example, Wazir (2009) documented nine species in Braganatu Dam, Bannu, with three species (*H. molitrix*, *C. carpio*, and *O. niloticus*) overlapping with the present study. Similarly, Azeem et al. (2016) identified six species from Ghol Dam, Karak District, while Yousaf et al. (2016) reported three Cyprinid species from Chambai Dam. Together, these records suggest that while Cyprinidae dominate regional water bodies, the diversity varies depending on local ecological conditions and anthropogenic influences.

Overall, the relatively low species richness observed in Zebi Dam compared to earlier studies highlights the need for continuous monitoring and conservation interventions. The absence of several previously reported species, combined with the detection of a new one, indicates that the ichthyofaunal composition of the dam is dynamic and potentially vulnerable to environmental change.

Conclusions

The present study documented five fish species from Zebi Dam, representing three families and three orders. The most abundant species were *Hypophthalmichthys molitrix* and *Cyprinus carpio*, suggesting that the environmental conditions of the dam favor Cyprinid dominance. Importantly, *Ctenopharyngodon idella* was recorded for the first time, adding a new element to the ichthyofaunal profile of this habitat. These findings provide valuable baseline information for fisheries managers and aquaculturists and highlight the economic potential of carp culture in the district.

Recommendations

To ensure the sustainable management of fish biodiversity in Zebi Dam, several conservation and management measures are recommended. Regular ichthyofaunal surveys should be conducted to monitor temporal changes in species composition and assess the overall health of fish populations. Fishing bans must be enforced during breeding seasons in order to protect reproductive stocks and maintain natural recruitment. In addition, strict catch limits, both in size and number, should be implemented to minimize overexploitation. Destructive fishing practices such as the use of explosives, poisons, or electric currents must be completely prohibited, as they severely damage aquatic habitats and reduce fish diversity. Alongside these measures, regular monitoring of water quality parameters—including pH, temperature, and nutrient levels—is essential to maintain a suitable environment for fish survival. Community participation is equally important; therefore, awareness campaigns should be launched to educate local residents about the ecological and economic importance of preserving fish biodiversity. Finally, strict regulations should be imposed to control the discharge of domestic and agricultural wastewater into the dam, as such pollutants pose a serious threat to aquatic life and long-term ecosystem stability.

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