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RESEARCH ARTICLE

Investigation of Fish Species Diversity in the Shuhada River in Badakhshan Province, Afghanistan

Abdul Hallim Majidi[1], Mohammad Shoaib Shariati[2], Habibullah Hadafmand[3], Abdul Baser Qasimi[4]

[1]Department of Biology, Education Faculty, Badakhshan University, Badakhshan, Afghanistan

[2]Department of Biology, Education Faculty, Parwan University, Parwan, Afghanistan

[3]Department of Biology Teacher Training of Shuhada District, Badakhshan, Afghanistan

[4]Geography Department, Education Faculty, Samangan University, Samangan, Afghanistan

ORCID: A.H.M. 0000-0001-6387-0220;
M.S.S. 0009-0007-3214-4315;
H.H. 0009-0008-1470-0629;
A.B.Q. 0000-0001-9180-831X

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Correspondence: Abdul Hallim Majidi
hallimm1@gmail.com

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Abstract

Objective: The present research was conducted on the existence and species diversity of fish in the Shuhada River, one of the Kokcha River tributaries situated in Badakhshan Province, Afghanistan. There has not been a previous study on fish species diversity; this is the first attempt to fill out this gap and identify the fish species of the river.

Materials and Methods: Fish specimens were collected from three selected sites in the Shuhada River. The study was performed twice in each season of the year 2022, by using a variety of fishing nets, like gill nets with a length of 5 m and a height of 2 m, although with meshes ranging from 3 to 3 cm knot to knot and hooks. Two samples were taken from each site in each season.

Results: Generally, 463 fish specimens were collected from the three selected zones. The Futtah was one of the selected zones that had the highest number of fish species (38.8%), followed by Yasich (34.04%), and the least number of fish species (28.07%) were collected from the Maidan zone. It found that *Salmo trutta* is the most abundant species at 52.9%, followed by *Schizothorax curvifrons* at 34.5% and *Paracobitis longicauda* at 12.5% was the least abundant species. During the cold seasons of autumn and winter, fish migrate down in the Kokcha River, and in spring and summer migrate to the upper zone in cold water.

Conclusion: During the current study, three fish species, *Salmo trutta, Schizothorax curvifrons,* and *Paracobitis longicauda*, were documented in the study area. Fish hunting and flooding are the main harmful forces causing the reduction of fish diversity in the Shuhada River.

Keywords: Shuhada River, fish species, *Salmo trutta, Schizothorax curvifrons, Paracobitis longitude*

Introduction

Fish constitute the most significant number of species and the greatest abundant group of vertebrates globally and live in vast aquatic ecosystems with varied ecological types found in various environments (Kelzang *et al*., 2021; Shendge, 2007; Yang *et al*., 2021). Fish show vast diversity in habitats, morphology, and biology (Mirza *et al*., 2018). Fish are a significant part of the biological diversity and the most essential bioindicator of the ecosystem. These aquatic living organisms have had a significant effect on human civilization (Majidi *et al*., 2023). Fish have impact on food web structure, nutrient cycle, energy dynamics, and different ecological functions in aquatic ecosystems (Wang *et al*., 2021). Knowledge of fish diversity has scientific, ecological, and economic significance, as it provides elementary guides on the diversity of different aquatic ecosystems (Mirza *et al*., 2011; Taiwo, 2023).

Afghanistan is rich in natural resources, and its stunning landscapes of deserts, mountains, open woods, forests, and rivers are home to a vast range of biological diversity. Unfortunately, recent decades of conflict, climate change, and population growth have destroyed ecosystems (UNEP, 2008). Afghanistan is mountainous and landlocked; the average altitude is 1300 m. The weather differs between the lowlands and highlands. Rivers are a vital landscape of the globe and are considered the principal factor in urban, agricultural, rural, and industrial development, as well as vital from the viewpoint of biological diversity (Majidi *et al*., 2023). 101 fish species can be found in Afghanistan, and an additional 38 species are assumed to exist in the country. Many fish species are described as being endemic in Afghanistan, especially in the genera *Schizothorax* and *Nemacheilus*. However, the classification of these genera is consequently ambiguous, so they may be mistaken for more extensively spread species (Coad & Bogutskaya, 2012; UNEP, 2017). Fish diversity in Afghanistan is poorly studied by Canadian ichthyologists relative to other fauna. Because of the civil war for a few decades, the fish diversity of Afghanistan has not been studied, and there has been no attempt to record fish species in this country (Coad, 2009; Majidi *et al*., 2023).

The Badakhshan territory is known as a biological diversity hotspot in Afghanistan because of its vast range of biodiversity and unique fish resources. Because of its geographical situation and topographical conditions, there are few studies on the diversity and distribution patterns of fish species in the study area. According to the National Environmental Protection Agency (NEPA)," the local office says that excessive and improper fishing has endangered several fish species in this aquatic ecosystem. Based on NEPA's evidence, so far nobody has been prosecuted over the crime of fish hunting which has further encouraged and contributed to the poaching of animals" (Majidi *et al*., 2023).

The Shuhada River originates from the high mountains located in the eastern part of the Shahada district, where the waters of Khoshdare, Yaghurde, Gharspan, and Korkhodare have all found the Shahada River, which flows into the Kokche River in the Bahark district of Badakhshan province, Afghanistan. The Shuhada River supports some aquatic organisms, and fish are one of the most important components of this aquatic ecosystem. Moreover, there are severe threats to the fish diversity in the Shuhada River from illegal fishing and water pollution. It is the first effort to study the Shuhada River ichthyofauna in the Badakhshan province of Afghanistan. This survey aims to identify and document fish species that inhabit the Shuhada River in Badakhshan Province, Afghanistan.

Material and Methods

Study area

This survey was performed in the Shuhada River, situated in the Shuhada District of the Badakhshan Province, Afghanistan, and lies between latitudes 36°59'59" and 36°4'16" and longitudes 70°51'15" and 71°16'7" (Fig. 1). The river originates from the high mountains located in the eastern part of the Shahada district, where the waters of Khoshdare, Yaghurde, Gharspan, and Korkhodare have all found the Shahada River, which flows into the Kokche River in the Bahark district. This river originates from springs and natural caves in the area. Its fish is famous throughout the country. Those who come for tourism in this area will benefit from this fish meat. We selected three sites (Yasich, Maidan, and Futtah) for the assistance of fish species in the Shuhada River. The Shahada River is 35 km long and 1 to 2 m deep. Its temperature fluctuates from -13 to 25°C. There are numerous fish species in this river. Its fish have short migration, in the cold seasons of autumn and winter, fish migrate down the Kokcha River. In the spring and summer, the fish migrate to the upper zone in cold water. Fish hunting and flooding are the main harmful forces causing the reduction of fish diversity in the study area. Thus, we saw more than fifty people hunting in the river during the survey (Khattak *et al*., 2015; Majidi *et al*., 2023; Muhammad *et al*., 2017).

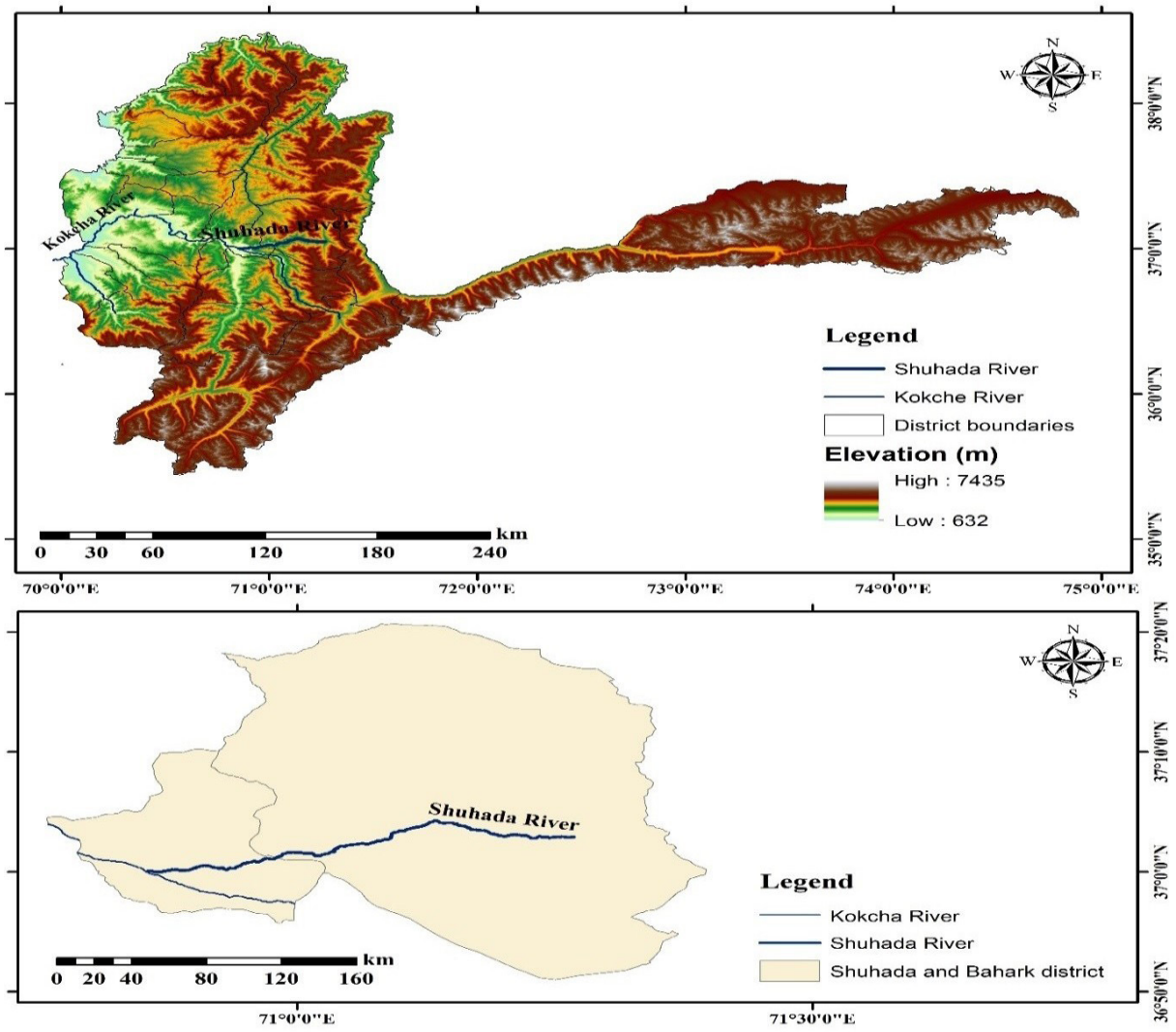

Figure 1. The location of the Shuhada River in Badakhshan Province.

Methods and analyses

The species diversity of fish in the Shuhada River was collected from three selected sites (Yasich, Maidan, and Futtah) in 2022. We obtained permission from the Wildlife Protection Department of Badakhshan province to capture fish in the study area. The study was conducted twice in each season of the year by using a variety of fishing nets, such as gill nets with a length (5 m) and height (2 m), although with meshes ranging from 3 to 3 cm knot to knot and hooks. Two samples were taken from each site in each season.

The collected specimens were stored in 10% formalin for further study in the biology laboratory of Badakhshan University (Pazira *et al*., 2016). The specimens were identified by species, genus, family, and order using taxonomic keys (FishBase, 2023; Coad, 2015). The calculation of data for Shannon (h), Dominance (D), Simpson (S), Margalef (R), Evenness (E), Brillouin index (B), Menhinick index (M) and Fisher's alpha of fish species was documented using PAST 4.03 and Ms Excel 2016 (Altaf *et al*., 2015; Dube & Kamusoko, 2013; Mirza *et al.*, 2011).

Percentage frequency of occurrence was calculated using the following formula;

$$\text{Percentage frequency} = \frac{\text{number of individual species}}{\text{total number of species}} \times 100$$

Results

The current survey is of the Shuhada River, one of the tributaries of the Kokcha River, situated in the Shuhada District of Badakhshan Province, Afghanistan. A total of 463 fish specimens were collected from the three sampling zones. The recorded three fish species were belonging to three families and three orders. The list of collected fish species is presented in Table 1 and Figures 2 – 4. These

Table 1. Fish species in the Shuhada River of Badakhshan Province.

Station No	Order	Family	Species	Local name
1	Salmoniformes	Salmonidae	*Salmo trutta*	Alahbuqa
2	Cypriniformes	Cyprinidae	*Schizothorax curvifrons*	Shirmahi
3	Cypriniformes	Nemacheilidae	*Paracobitis longicauda*	Mohidehantang

Figure 2. *Salmo trutta* (Order Salmoniformes, Family Salmonidae).

Figure 3. *Schizothorax curvifrons* (Order Actinopterygii, Family Cyprinidae).

Figure 4. *Paracobitis longicauda* (Order Cypriniformes, Family Nemacheilidae).

species were *Salmo trout* 52.9%, *Schizothorax curvifrons* 33.5%, and *Paracobitis longicauda* 12.5% (Table 2). We found that *S. trutta* was a highly abundant species, and *P. longicauda* was the least abundant species in the study region (Khattak *et al*., 2015; Majidi *et al*., 2023; Mirza *et al*., 2012).

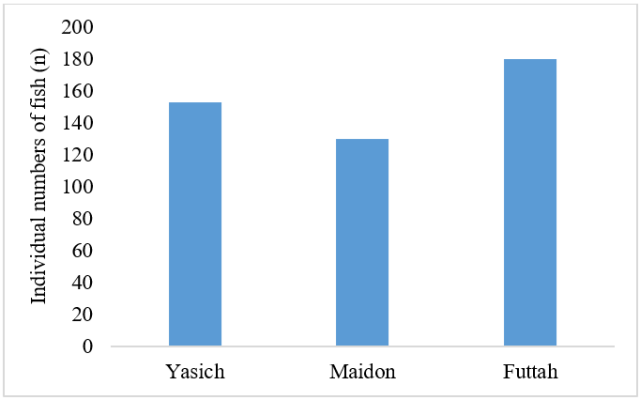

Figure 5. The abundance values (n) of fish in the sampling sites.

In the sampling areas, Futtah had the highest number of collected fish (38.8%), followed by Yasich (33.04%), and the least amount of fish (28.07%) was collected from the Maidan site (Fig. 5). All fish collected from the study site are of Asian origin (Bari *et al*., 2014), and it is known that natural flow systems are the main factors controlling riverine fish groups in aquatic ecosystems (Mirza *et al*., 2011).

Table 2. Fish numbers documented in three sites of the Shuhada River

Fish name	Yasich	Maidon	Futtah	Total collected specimens
Salmo trutta	98	79	68	245
Schizothorax curvifrons	43	36	81	160
Paracobitis longicauda	12	15	31	58
Total number of fish observed	**153**	**130**	**180**	**463**

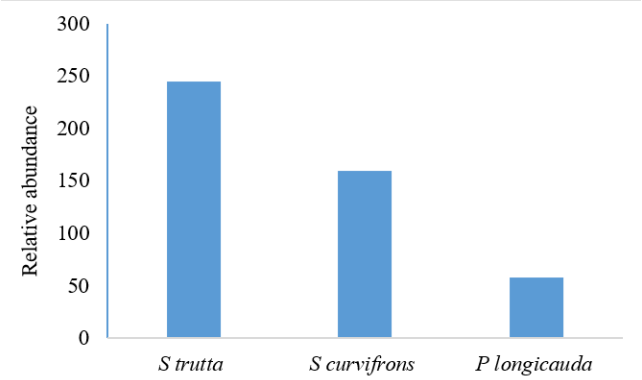

Figure 6. The relative abundance of each fish species in the study area.

In the present survey, we found that *S. trutta* is the most abundant species with 52.9% (n = 245) in all three sites, followed by *S. curvifrons* with 33.5% (n = 160), and *P. longicauda*'s abundance significantly differs in the three sampling sites with 12.5% (n = 58), which is the least abundant in the study region. In the following graph, *S. trutta* is 245 ± 4.5, *S. curvifrons* is 160 ± 3.7, and *P. longicauda* is 58 ±1.5 (Fig. 6) (Kelzang *et al*., 2021; Dube & Kamusoko, 2013).

As Altaf *et al.* (2015), in the fish species diversity indices (Table 3), the surveyed area exhibited the Shannon of the fish at Yasich 0.84, followed by Maidan 0.90, and Futtah 1.03. The dominance of the fish at the Yasich is 0.49, followed by Maidan, 0.45, and Futtah, 0.37. The Simpson index at the Yasich is 0.50, followed by Maidan, 0.54, and Futtah, 0.62. The Margalef index at Yasich is 0.39, followed by Maidan 0.41 and Futtah 0.38. Evenness index at 0.77, followed by Maidan at 0.82 and Futtah at 0.93. Brillouin index at Yasich: 0.81, followed by Maidan: 0.87, and Futtah: 1.00. Menhinick index at Yasich is 0.24, followed by Maidan 0.26 and Futtah 0.22. Fisher's alpha index at Yasich is 0.52, followed by Maidan 0.54 and Futtah 0.51. Biodiversity indices and statistically computed results indicate that the site of Futtah is marked by an abundance of fish species. According to local people, there is a lot of flooding during the spring season; it may be transferring fish, fingerlings, and eggs from the upper to the lower zone of this aquatic ecosystem (Altaf *et al*., 2015; Majidi *et al.,* 2023).

Table 3. Statistical analysis of the fish diversity in the Shuhada River

Diversity indices	Yasich	Maidan	Futtah
Numbers	3	3	3
Individuals	153	130	180
Shannon (H')	0.84	0.90	1.03
Dominance (D)	0.49	0.45	0.37
Simpson (S)	0.50	0.54	0.62
Margalef (R)	0.39	0.41	0.38
Evenness (E)	0.77	0.82	0.93
Brillouin index (B)	0.81	0.87	1.00
Menhinick index (M)	0.24	0.26	0.22
Fisher's alpha	0.52	0.54	0.51

Majidi *et al.* (2023) in a survey, on fish diversity in the Kokcha River used a range of fishing tackle, e.g., dragnets, hooks, and gill nets with the same length (5 m) and height (2 m) with meshes varying from 3 to 3 cm, knot to knot. Altaf *et al*. (2015) in a survey, on the diversity of fish in the Chenab River used gill nets with the same length (100 m to 20 m) and height (1.6 m), but with a mesh size of 1.5 inches.

During the current survey, we documented two main threats to Ichthyofauna in the Shuhada River: hunting and floods. According to the study area's locality, the fish population in this aquatic ecosystem is declining due to overfishing (Fig. 7). The Shuhada River has been heavily affected in recent decades by various types of human activities, such as agricultural fertilizers and dumping of household waste, which have severely affected its fauna.

Similar research has been done in some rivers of Afghanistan and other countries. The current outcome corresponds with a survey that reported four fish species from the Kokcha River of Badakhshan province, Afghanistan (Majidi *et al*., 2023). Another study reported 1190 fish belonging to Cypriniformes, Salmoniformes, and Cichliformes from the Kabul River of Afghanistan. However,

Figure 7. The hunted fish in the study region.

Afghanistan's aquatic habitats are less suitable for and geographically remote from many of the more widespread Asian Siluriformes, resulting in a comparatively limited diversity of catfishes. Cyprinids can live in cold water and tolerate low oxygen levels. As a result, they are frequently found to be more prevalent in freshwater ecosystems in most of Asia when combined with historical events (Kelzang *et al*., 2021). Furthermore, Coad (1981) mentioned that coldwater fish stocks in the upper zone of the Kabul River basin are dominated by various cyprinid snow trutta (Schizothoracini) and Cobitidae. Afghanistan's rivers and streams contain Oriental and Palaearctic species, northern and southern species, and high and low-altitude-adapted fish species. The fauna is dominated by Cyprinidae (56.9%), Cobitidae (24.5%), and, to a lesser extent, Siluriformes (11.8%). In another research, Coad & Bogutskaya (2012) reported Cyprinidae from the northwestern region of Afghanistan and the northeastern region of Iran. Other corresponding reports are Khattak *et al.*, 2015, Mirza *et al.*, 2011, Muhammad *et al.*, 2017, and Hossain *et al.*, 2013.

Afghanistan has been endowed with natural riches and scenic beauty. The beautiful scenery of mountains, deserts, woodlands, forests, and water sustains a rich diversity of flora and fauna in a variety of environmental conditions (Majidi, 2023; UNEP, 2008). Biological diversity exhibits itself in a wide range of behaviors, species numbers, and differences in species groupings in various habitats and also in the different ecosystems that can be found in various zones of the country (Adil, 2000; Majidi *et al*., 2022). Decades of conflict and unrest, poor education, lawlessness, the wood mafia, high unemployment, general poverty, drought and other natural catastrophes, population increase, and the migration of displaced or returning peoples have all had significant impacts on the environment and wildlife in Afghanistan (Saidajan, 2012).

The current research is the first time to document fish species in the Shuhada River of Badakhshan province. Shuhada District has enough water and an ideal environment for fish aquaculture. Aquatic species are a smaller proportion of the Badakshan Province diet since fish producers are unable to produce enough fish to meet client demand. Fish hunting is currently outlawed across Badakhshan province, and as a result, the region's wildlife status has improved. There have been no previous reports on the Shuhada River's fish diversity. Therefore, these findings are of great importance for future studies on fish species diversity in Afghanistan.

Conclusion

The current investigation focused on assessing the fish species diversity in the Shuhada River one of the Kokcha River tributaries located in the Badakhshan Province of Afghanistan. The present research was conducted in 2022,

and three fish species belonging to three different orders and families were recorded. *Salmo trutta* was found to be the most abundant species, accounting for 52.9% of the total fish population across all three sampling sites followed by *Schizothorax curvifrons*, making up 33.5% of the population, while *Paracobitis longicauda* was the least abundant species, comprising only 12.5% of the fish population. The study also highlighted hunting and flooding as significant threats to the fish population in this aquatic habitat. Generally, this study provides valuable insights into the fish species composition and the potential challenges faced by the ichthyofauna in the Shuhada River.

Ethics Committee Approval: We obtained permission from the Wildlife Protection Department of Badakhshan province to capture fish in the study area.

Peer-review: Externally peer-reviewed.

Author Contributions: Conception/Design of Study – A.H.M.; Data Acquisition- A.B.Q.; Data Analysis/ Interpretation- H.H.; Drafting Manuscript- A.H.M., M.S.S.; Critical Revision of Manuscript- A.H.M.; Final Approval and Accountability- A.H.M.; Technical or Material Support – A.B.Q.

Conflict of Interest: The authors declare no conflicts of interest.

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