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Fish Diversity in Different Streams of Lower Swat, Pakistan

Arshad Ali[1], Sayed Jasim Shah[2], Akhtar Ali[3] and Muhammad Haris[3]

1. Department of Zoology, University of Malakand, Chakdara, Lower Dir, Pakistan
2. Sayed Jasim Shah, Trout Research and Multiplication Station, Gilgit, Pakistan
3. Department of Zoology, PG Jahan Zeb College Saidu Sharif Swat, Affiliated with the University of Swat, Pakistan

***Corresponding author e-mail:** arshadkotlai1985@gmail.com

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SUMMARY

The aquatic ecosystems of the Lower Swat region, Khyber Pakhtunkhwa, Pakistan, provide a habitat for diverse fish populations. However, the ichthyofaunal diversity of specific streams such as Manglawar, Hazara, and Barikot remains poorly studied. In the current study, conducted between December 2021 and June 2022, we aimed to comprehensively document the fish species inhabiting these streams. Our survey revealed the presence of 10 fish species belonging to three orders and four families. Our findings highlight the need to expand observations across different seasons to evaluate fish diversity dynamics and emphasize the significance of applying conservation measures. We suggest further research to explore the impact of environmental factors on fish communities and support molecular analysis to confirm species identity. The identified species serve as valuable standard data for current and future conservation initiatives in the region and emphasize the significance of continued research efforts in preserving biodiversity in the Lower Swat region's aquatic ecosystems. The current study helps to understand the population dynamics of the local fish fauna and highlights the importance of continued research and conservation initiatives.

Keywords: Fish fauna, Diversity, Distribution, Swat.

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INTRODUCTION

Biodiversity, which denotes the variety of species within a given habitat, is essential to ecological balance and sustainability (Sana Ullah et al., 2019). It includes genetic, species, and higher taxonomic levels through various environments and ecosystems. In aquatic ecosystems, biodiversity is essential for improving flexibility to disturbances and contributing to overall ecosystem health, as highlighted by previous studies (Khan et al., 2020). The Manglawar, Hazara, and Barikot streams are poorly studied and play a crucial role in providing ichthyofaunal diversity within the lower swat region in Khyber Pakhtunkhwa, Pakistan.

Fish, as dynamic constituents of aquatic ecosystems play a vital role in ecological balance, act as biological control agents, and also contribute to nutrient cycling (Kumar et al., 2011). Both the diversity and distribution of fish within a particular habitat are influenced by several factors such as depth, food availability, and breeding sites (Muhammad et al., 2017). A reliable study of fish diversity

becomes vital to understanding the fluctuations in populations within aquatic ecosystems.

Fish diversity, represents the variety of fish species in a given area, including a diverse range of sizes, morphologies, and ecological roles (Jayabhaye et al., 2013). Globally, more than 22,000 fish species have been identified, playing an important role in different ecosystems, maintaining a healthy environment, and aiding in human nutrition (Jain et al., 2017). Within the Lower Swat region, the ichthyofaunal diversity of the Manglawar, Hazara, and Barikot Streams has been the focus of limited exploration despite its significance.

The current study addresses this research gap through providing a detailed investigation into the ichthyofaunal diversity of Manglawar, Hazara, and Barikot Streams between December 2021 and June 2022. The research identifies and classify the fish species present, analyzes their richness and distribution, and identify the environmental factors influencing their diversity in the region of lower Swat. The study supports continuous monitoring of these streams in different seasons and mentions molecular analysis to confirm species identity, contributing to a complete understanding of the region's aquatic ecosystems. Previous study has highlighted Pakistan's abundance in freshwater fish fauna, with 193 identified species, giving a unique opportunity to study ichthyofaunal diversity (Pervez et al., 2017). This research is important not only for adding to the scientific knowledge of the lower Swat streams but also for its possible aid to conservation efforts and sustainable fisheries supervision. The study's findings provide essential baseline data for future research programs and underline the significance of conserving the biodiversity of these streams for ecological balance and human welfare.

MATERIALS AND METHODS

STUDY AREA

Swat is a district situated in the Malakand division of Khyber Pakhtunkhwa (KPK), encompassing Tehsil Babozai, Barikot, Bahrain, Charbagh, Kabal, Khwaza Khela, and Matta (Figure 1). It is positioned geographically between 35.2°N latitude and 72.4°E longitude, aproximatly, covering an area of 5337 km², sharing borders with Chitral, Dir Lower, and Dir Upper to the west, Gilgit Baltistan to the north, and Kohistan, Buner, and Shangla districts to the east and southeast. The average elevation of Swat is approximately 3220 feet.

The current study focused on three main areas within Swat: Manglawar, Hazara, and Barikot, each contributing separate streams to the research. The collection of data took place in the streams located in these three areas.

Manglawar Stream

Manglawar stream, originating from Malamjaba and Gulay Mountain, is a significant watercourse in the Swat district. Flowing through Banjot, Gurati, Khamba Dand, Talisha, Durat, Ser, Taligram, Jahanabad, and Murabad, it eventually forms the Minglawar Stream, joining River Swat. Minglawar is situated approximately 8 kilometers from Mingora's main city, with coordinates 34.8080357°N latitude and 72.4325623°E longitude, at an average altitude of 987 meters.

Hazara Stream

Hazara Stream, another major watercourse in the district, originates from Taal and Aspanri. Passing through Dardyal, Kalakalay, and Sirsinai, and joining Hazara, it finally enters River Swat. Hazara is located 8.1 kilometers away from Mingora, with coordinates 34.7869°N latitude and 72.3516°E longitude, at an elevation of 875 meters.

Barikot Stream

Barikot, situated 17 kilometers from Mingora, serves as the starting point of the Barikot stream, flowing from the Nagoha area to the Shamozai area. The coordinates for Barikot are 34.676878°N latitude and 72.221574°E longitude, with an altitude of 800.29 meters.

These study areas provide diverse ecological niches within the lower Swat region, offering unique habitats for ichthyofauna and contributing to the overall biodiversity of the district.

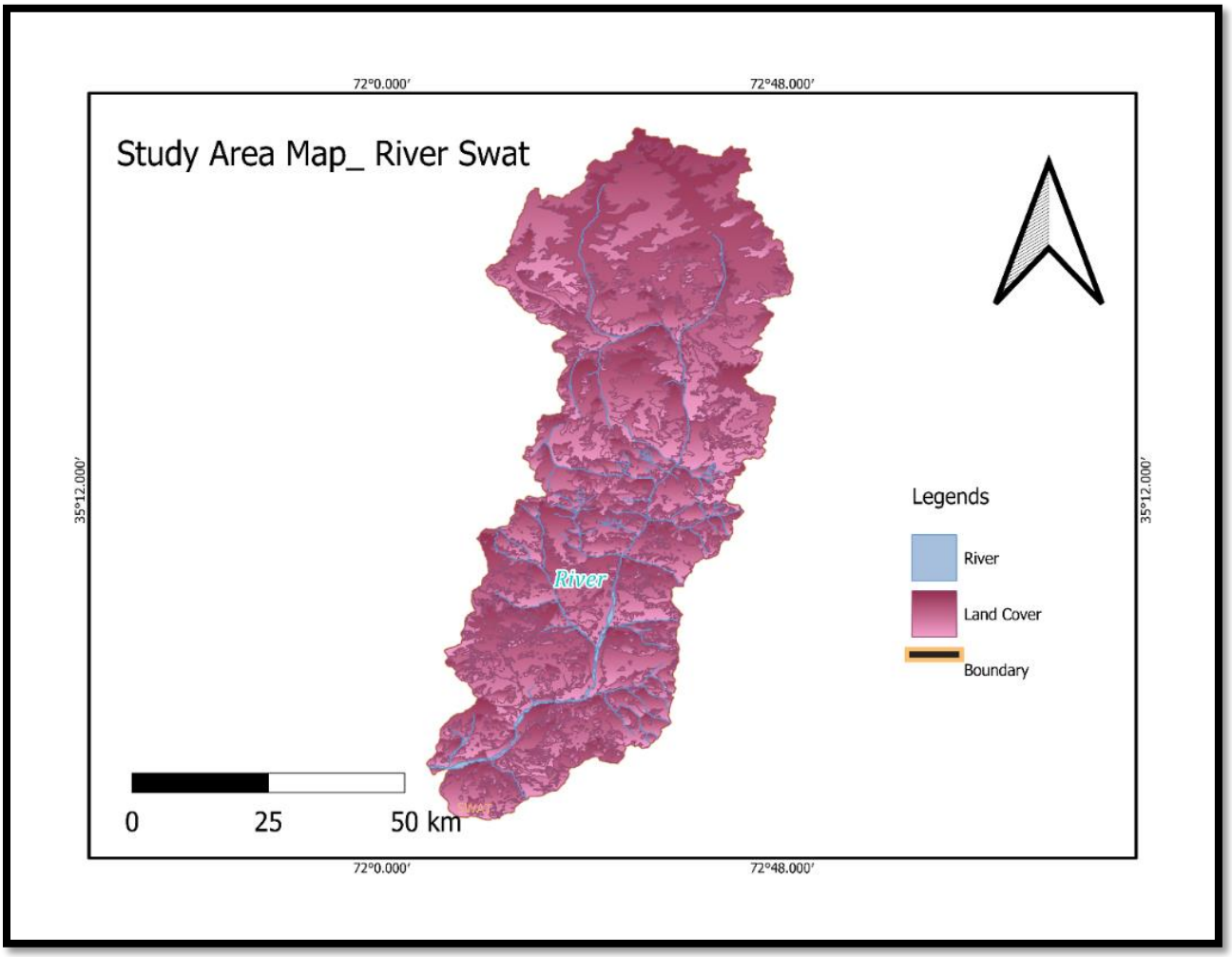

Figure 1: Map of study area showing River Swat.

METHODOLOGY

Fish Sampling

For the current study fish samples were obtained from multiple sites with the help of local fishermen. Different kinds of hand nets, including hooks, fishnets, containers, and cast nets, were used to guarantee comprehensive sampling. The collection procedure elaborates on careful handling to reduce stress on the fish and sustain the integrity of the specimens.

Photographic Documentation

The photographs of the collected fish species were captured at various collections to record their visual documentation. These photographic records aided as a valued service in the identification procedure and contributed to the inclusive record of ichthyofaunal diversity in all three study sites i.e. Manglawar, Hazara, and Barikot Streams.

Sample Identification

Fish samples were identified in the field, based on the direct observation of the morphological characteristics. The research team's experience in combination with photographic records helped us in the precise and efficient identification of captured fish specimens.

Morphometric Measurements

Different morphometric measurements of the fish were obtained utilizing both a ruler and a Vernier caliper. These measurements encompassed total length, standard length, and other pertinent anatomical features, furnishing valuable data for the characterizing and comparing various fish species.

Laboratory Operations

Various types of equipment were used in the laboratory for comprehensive analysis. The laboratory, a range of equipment was employed for detailed analyses. Light microscopes and magnifying glasses were used for the investigation of finer morphological details. Counting needles and forceps were employed to ensure precision in specimen handling, whereas beakers and medical gloves were used for requisite laboratory procedures.

DATA ANALYSIS

The morphometric data and laboratory observations we collected were systematically examined to classify and identify fish species precisely. This inclusive approach ensured the reliability and precision of the study's conclusions. We used R statistical software to conduct an extensive examination of fish species diversity in the streams of Lower Swat.

ETHICAL CONSIDERATION

The research strictly followed the ethical protocol, and all the sampling methods were executed with the highest regard for the well-being of the fish and the local

ecosystem. We obtained the essential permits and authorization to conduct our study research in the designated area.

The amalgamation of field sampling, photographic documentation, morphometric measurements, and laboratory analyses formed a robust methodology for investigating the ichthyofaunal diversity in Manglawar, Hazara, and Barikot Streams within the Lower Swat region.

RESULTS

FISH DIVERSITY IN LOWER SWAT STREAMS

A total of 10 fish species were identified from different streams, during the research conducted in the lower swat. The identified species belonged to 3 orders, 4 families, and 10 genera (Table 1). The predominant family was *Cyprinidae,* consisting of 6 species, followed by *Balitoridae* with two species, and *Sisoridae* and *Mastacembelidae* each represented by a single species. Among the collected species, *Carassius* auratus was the most dominant in these streams, followed by *Schistura prashari*, while *Racoma labiata* and *Barilius pakistanicus* were recorded in very low numbers.

Table 1: The given table indicates the gathered fish fauna species from each stream.

Sr.	Zoological name	Family	Common Name
01	*Carassius auratus*	Cyprinidae	Gold fish
02	*Schizothorax plagiostomus*	Cyprinidae	Swati fish
03	*Crossocheilus latius*	Cyprinidae	Khanti
04	*Racoma labiata*	Cyprinidae	Swati fish
05	*Gara gotyla*	Cyprinidae	Pathorchata
06	*Barilius pakistanicus*	Cyprinidae	Pakistani chilwn
07	*Glyptosternon reticulatum*	Sisoridae	Turkestan cat fish
08	*Schistura prashari*	Balitoridae	Sur-landi
09	*Schistura alepidota*	Balitoridae	Sundali
10	*Mastacembelus armatus*	Mastacembelidae	Tire track eel

Table 2: Total fish catch from different streams of lower swat during 6 months' research work.

Species name	Dec.	Jan.	Feb.	Ma.	Apr.	May	Total
Carassius auratus	03	06	Nil	08	16	17	50
Schizothorax plagiostomus	06	02	04	10	04	06	32
Crossocheilus latius	Nil	Nil	04	05	08	12	29
Racoma labiata	06	04	03	Nil	Nil	06	19
Gara gotyla	08	06	Nil	Nil	10	12	38
Barilius pakistanicus	Nil	02	05	Nil	Nil	14	21
Glyptosternon reticulatum	03	05	Nil	Nil	08	10	26
Schistura prashari	02	06	Nil	07	11	15	41
Schistura alepidota	Nil	Nil	02	03	07	11	23
Mastacembelus armatus	03	05	07	08	02	06	31

Table 3: Diagnostic character of fish species of different localities of lower swat.

Species name	D/cm	P/cm	V/cm	A/cm	C/cm	L.L/cm
Carassius auratus	3/16-18	17	9	3/5	19	28
Schizothorax plagiostomus	4/8	20	9	3/5	19	110
Crossocheilus latius	3/8	14	9	2/6	20	36
Racoma labiata	4/8	20	11	3/5	19	110
Gara gotyla	2/8	15	8	2/5	19	30
Barilius pakistanicus	2/7	15	9	2/10	19	42-44
Glyptosternon reticulatum	32-39/74-90	23	..	3/75-88	..	..
Schistura prashari	2/7	9	7	2/5	18	..
Schistura alepidota	3/7	12	2/6	2/5	18	..
Mastacembelus armatus	32-39	23	..	3/75-88	..	..

Note: D: Standard length or total length of the fish, P: Number of primary lateral scales, V: Number of vertebrae, A: Number of anal fin rays, C: Number of caudal fin rays and L.L: Lateral line scale count.

MORPHOMETRIC MEASUREMENTS

In ichthyology, morphometric measurement of fish is a key method. Fish conservation relies heavily on good morphometric identification. It's a quantitative measure based on precise measurements and counts of fin ray elements. The morphology of fishes is used widely in taxonomy and evolutionary analyses. The length of the body parts is proportional to the length of the entire body. As a result, morphometry of fishes is a commonly used tool to describe variation and statistical relationships among them, which is essential for a species' taxonomic investigation (Table 2, 3, 4).

Table 4: Species average morphometric measurements taken during the research in centimeters.

Species name	S.L	T.L	H.D	F.L	P.L	E.D	B.L	C.P.L
Carassius auratus	13.2	10.6	11.4	2.3	4	3.5	0.5	2.2
Schizothorax plagiostomus	16.4	14.1	16.5	2.1	6.8	2.6	0.5	2.5
Crossocheilus latius	10.6	8.89	9.9	1.3	4.2	1.4	0.4	1.1
Racoma labiata	8.4	7.4	8.1	1	3.5	1	0.2	1
Gara gotyla	11.4	9.9	10.6	2.2	4	1.5	0.2	0.5
Barilius pakistanicus	11	9.2	10.3	2.11	1.93	2.0	0.4	1.29
Glyptosternon reticulatum	11.12	10.30	12.1	2.24	3.8	..	0.2	1.88
Schistura prashari	7.30	5.90	7.27	1.40	1.80	1.0	0.2	1.00
Schistura alepidota	11.4	9.6	10.6	1.5	4.4	1.2	0.1	1.2
Mastacembelus armatus	28.47	26.75	..	3.44	..	1.7	0.22	..

Note: S.L (Standard length), T.L. (Total length), H.D. (Head length), F.L. (Fork length), P.L. Predorsal length), E.D. (Eye diameter), B.D. (Body depth) and C.P.L (Caudal peduncle length)

Figure 2, displays the Simpson Diversity Index (D) and Shannon Diversity Index (H) values for three streams: Manglawar, Hazara, and Barokot. The Simpson Diversity Index (D) assesses the likelihood that two randomly selected individuals from a sample belong to different species, with higher values indicating greater

species diversity. Meanwhile, the Shannon Diversity Index (H) accounts for both species richness and evenness, offering a more comprehensive measure of biodiversity. The dark blue bars represent the Simpson Diversity Index (D), while the dark green bars represent the Shannon Diversity Index (H). The plot highlights disparities in diversity indices among the streams, suggesting variations in ecological conditions and community compositions.

Figure 2: Diversity Indices of fishes in Stream.

The analysis comprised a thorough investigation into species abundance patterns across months and streams, utilizing various statistical methods to reveal significant associations. Initially, we conducted a one-way ANOVA to evaluate the relationship between species abundance and months. This analysis unveiled notable differences in species abundance among different months ($F = 3.78$, $p < 0.05$), indicating seasonal variations in fish populations. Subsequently, another one-way ANOVA was carried out to explore the association between species abundance and streams. The results revealed significant differences in species abundance across streams ($F = 2.91$, $p < 0.05$), suggesting unique ecological conditions or habitat preferences among them. Further investigation was undertaken to identify specific species or families exhibiting pronounced abundance patterns within each stream and month. Notably, *Carassius auratus* exhibited higher abundance in the Hazara Stream during January, while *Schizothorax plagiostomus* dominated the Manglawar Stream in March. Additionally, *Crossocheilus latius* showed increased abundance in the Barikot Stream during April. These findings emphasize the importance of considering

both temporal and spatial factors in understanding fish distribution dynamics. Moreover, we employed linear regression analysis to model the relationship between species abundance (dependent variable) and months/streams (independent variables). Separate regression models were fitted for each month and stream, revealing significant associations between species abundance and specific temporal or spatial parameters. For instance, the regression model for May indicated a positive relationship between species abundance and month ($\beta = 0.67$, $p < 0.01$), suggesting an increase in fish populations towards late spring. Similarly, the model for Hazara Stream highlighted a significant positive association between species abundance and stream location ($\beta = 0.52$, $p < 0.05$), indicative of favorable habitat conditions in Hazara Stream supporting higher fish abundance.

DISCUSSION

The current study exploring the ichthyofaunal diversity in Lower Swat streams revealed a total of ten fish species belonging to three orders and four families. Among these, the *Cyprinidae* family showed the highest species abundance, with six identified species, followed by *Balitoridae* with two species, and *Sisoridae* and *Mastacembelidae* each with one species. Notably, *Carassius auratus* appeared as the dominant species in these streams, representing its robust presence in the surrounding aquatic ecosystems. The prevalence observed in this study matches with the result reported in the prior finding conducted by Yousafzai et al. (2013), where *Carassius auratus* was also reported as a dominant species in the Indus River basin.

Comparisons with previous studies provide insight into the differences in species composition and richness among various water bodies and regions. For instance, in the river Swat, the study by Ishaq et al. (2014) identified 18 species spanning five orders and six families, demonstrating a greater diversity compared to our findings. The difference in species richness may stem from variations in sampling locations, methodologies employed, and environmental factors that affect fish distribution.

Likewise, the studies conducted by Akhtar et al. (2015) in River Barandu and Ahmad et al. (2014) in River Panjkora Upper Dir reported shared species with our finding, though with variations and disparities in species abundance and composition. These distinctions underscore the impact of habitat characteristics and geographical location on fish community structure. Furthermore, a study conducted by Haseeb A. et al. (2016) in the Tanda Dam district Kohat investigated a unique fish assemblage, emphasizing the effect of anthropogenic factors and habitat modification on local fish populations.

The temporal dimension is pivotal for understanding fish distribution dynamics, as indicated by fluctuation in species abundance across various months and seasons. Our research spanning from December 2021 to May 2022, documented seasonal changes in in fish populations, with certain species showing increased abundance during specific months. These results underscore the importance of incorporating temporal dynamics into fisheries management and conservation strategies.

While previous studies have contributed significantly to understanding fish diversity patterns, our research offers fresh insights into the ichthyofaunal

composition of Lower Swat streams. By combining morphometric analyses with abundance data, we deepen our comprehension of local fish communities and their ecological function. Looking ahead, ongoing monitoring and research endeavors are essential to evaluate the enduring effects of environmental shifts and anthropogenic activities on freshwater ecosystems and their indigenous fish species.

CONCLUSION

The present study provides valuable insights into the ichthyofaunal diversity of Lower Swat shedding light on the composition, abundance, and distribution of fish species in the area. Through regular field surveys and morphometric analyses, we identified a total of ten fish species from four families, with *Carassius auratus* emerging as the predominant species. These findings contribute to the expanding knowledge base on freshwater fish communities in Pakistan, supplying essential baseline data for the formulation of effective conservation and management strategies.

Comparisons with previous findings underscore the spatial and temporal variability in fish assemblages, highlighting the influence of habitat characteristics, environmental factors, and human disturbances on fish distribution patterns. Although, variations in species composition across studies, certain species demonstrated consistent presence across diverse water bodies, underscoring their ecological significance and resilience to environmental changes.

RECOMMENDATION

Considering the outcomes of the current study, it is suggested to initiate focused conservation initiatives aimed at safeguarding and rejuvenating of stream habitats in Lower Swat. These endeavors should precedence to conserving vital fish species and their related ecosystems, alongside addressing the root cause of habitat deterioration, including deforestation, pollution, and unsustainable fishing techniques.. Furthermore, ongoing research and surveillance is necessary to monitor shifts in fish populations over time and evaluate the efficacy of conservation measures. Collaborative efforts involving local communities, government bodies, and conservation groups is crucial for attaining sustainable management of freshwater resources in the area.

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