

ICHTHYOFAUNAL DIVERSITY OF THE BETWA RIVER IN BUNDELKHAND

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ABSTRACT

The Betwa River is one of the major river systems of the Bundelkhand region of central India and an important tributary of the Yamuna. It supports a diverse freshwater fish community that contributes substantially to local fisheries, food security and aquatic ecosystem functioning. The present paper reviews and synthesizes available information on the ichthyofaunal diversity, ecological characteristics, threats and conservation requirements of the Betwa River, with particular emphasis on the Bundelkhand region. Earlier investigations have documented substantial variation in the number of fish species, depending on the period, sampling locations and methodology employed. A long-term study conducted during 2020–2025 recorded **80 fish species belonging to 54 genera, 23 families and 10 orders** from the Betwa River. Of these, 79 species were native and two-*Cyprinus carpio* and *Oreochromis niloticus*-were exotic. **Cyprinidae was the dominant family**, represented by 35 species. *Osteobrama cotio* was the most abundant species in the study. The Shannon–Wiener diversity index for Betwa was reported as 3.66, with an evenness value of 0.835. Other studies have recorded lower richness at particular stretches, demonstrating considerable spatial and temporal variation in fish assemblages. Deep pools constitute important refugia during the dry season and support native and threatened fish populations. Major pressures include flow regulation, dams and barrages, overfishing, bank disturbance, agricultural activities, declining water availability and deterioration of water quality. Conservation should therefore focus on maintaining environmental flows, protecting deep pools and breeding habitats, controlling destructive fishing practices, monitoring water quality and conserving native fish genetic resources. The Betwa River should be regarded as a significant aquatic biodiversity resource of Bundelkhand requiring integrated river-basin management.

KEYWORDS: Betwa River, Bundelkhand, ichthyofauna, freshwater fish diversity, Cyprinidae, fish conservation, river ecology, aquatic biodiversity.

1. INTRODUCTION

Freshwater ecosystems are among the most biologically productive yet vulnerable ecosystems in the world. Rivers provide habitat for a wide variety of organisms and perform important ecological functions, including nutrient cycling, sediment transport, food-web maintenance and support of fisheries. Fish communities are particularly useful indicators of the ecological condition of river systems because their distribution and abundance respond to changes in water quality, habitat structure, hydrological regimes and human disturbance.

India possesses exceptionally high freshwater fish diversity. Riverine fish resources are also economically

important because they provide food, employment and income to millions of people. However, increasing water abstraction, construction of dams and barrages, pollution, habitat modification, excessive fishing and introduction of non-native species have affected freshwater fish populations in many Indian rivers.

The **Betwa River** is one of the important north-flowing rivers of central India. It originates near Barkhera in Raisen district of Madhya Pradesh and ultimately joins the Yamuna in Uttar Pradesh. The river has a total length of approximately 590 km, with about 232 km in Madhya Pradesh and 358 km in Uttar Pradesh. It is essentially a rain-fed river, characterized by relatively high discharge

during the monsoon and substantially reduced flow during summer. Major tributaries include the Dhasan, Barwa, Parwaha and Jamini, among others. The river is particularly important to Bundelkhand, a historically and environmentally significant region shared by Madhya Pradesh and Uttar Pradesh. Bundelkhand experiences recurrent water scarcity, and the Betwa serves multiple purposes, including irrigation, fisheries, domestic water supply and industrial and energy-related uses. Consequently, the ecological condition of the river has direct implications for both biodiversity and human livelihoods.

Fish-diversity investigations in the Betwa have produced different estimates. Earlier investigations reported approximately 55–63 species, whereas a longer-term study undertaken by Joshi and colleagues documented **81 species belonging to 24 families, 55 genera and 10 orders**. The higher richness in the latter study was attributed partly to its longer duration and broader sampling effort.

A separate investigation specifically focused on the Bundelkhand stretch around Jhansi and reported 20 species belonging to seven orders and 12 families from four sampling locations. These differences demonstrate the importance of sampling design, geographical coverage, seasonality and habitat heterogeneity when interpreting fish-diversity data.

2. OBJECTIVES

The major objectives of this research paper are:

1. To review the ichthyofaunal diversity reported from the Betwa River in the Bundelkhand region.
2. To examine the taxonomic composition and relative representation of major fish groups.
3. To summarize available information concerning fish abundance and diversity indices.
4. To identify important ecological habitats supporting fish populations.
5. To assess major anthropogenic and environmental pressures affecting Betwa ichthyofauna.
6. To highlight fish species and habitats requiring conservation attention.
7. To propose measures for sustainable management of fish diversity and fisheries in the Betwa River.

3. Study Area

The Betwa River is a major tributary of the Yamuna and forms an important component of the aquatic landscape of central India. Its upper reaches occur in Madhya Pradesh, while a substantial portion of its course passes through Uttar Pradesh.

The river originates in the Vindhyan region at an elevation of approximately 576 m above mean sea level. It flows northward through Madhya Pradesh and Uttar Pradesh before joining the Yamuna. The river is strongly influenced by seasonal rainfall, resulting in substantial fluctuations in discharge between monsoon and

summer. Within Bundelkhand, the river provides a range of aquatic habitats, including: Deep pools, Shallow riffle-like areas, Sandy river beds, Rocky stretches, Backwater habitats, Reservoir-influenced stretches, Tributary confluences, Vegetated river margins.

Such habitat heterogeneity is important because different fish species have different requirements for feeding, reproduction, shelter and seasonal migration.

Recent research mapping deep-pool habitats in Bundelkhand identified **more than 5,000 deep pools in the Betwa River**, substantially more than were mapped in the Ken and Dhasan rivers. Field observations indicated that these pools support rich fish diversity and may act as refugia during periods of water scarcity.

4. METHODOLOGY

4.1 Research approach

The present paper is a **review and synthesis of published information**, rather than a report of newly collected field data. Published studies concerning fish diversity, river ecology, conservation and habitat conditions of the Betwa and Bundelkhand aquatic systems were examined.

For a future primary field investigation, the following methodology would be appropriate.

4.2 Sampling design

Sampling stations should be selected to represent different ecological conditions along the Betwa, including: Relatively undisturbed upstream stretches, Agricultural areas, Urban-influenced stretches, Dam and barrage-influenced areas, Tributary confluences, Deep pools, Downstream stretches.

Sampling should ideally cover **pre-monsoon, monsoon and post-monsoon/winter periods** to capture seasonal changes in fish assemblages.

A previous long-term study of the Ken and Betwa rivers sampled during summer, monsoon and winter over five years, with sites selected to represent riverine habitats influenced by dams, barrages and tributaries.

4.3 Fish collection

A combination of conventional fishing gears may be used, including: Cast nets, Gill nets, Drag nets, Hand nets, Locally operated fishing gear.

The earlier Bundelkhand investigation around Jhansi used gill nets and cast nets of different mesh sizes in collaboration with local fishermen. Nets were set in the evening and catches collected the following morning, while some fishermen also used boats during daytime fishing. Where possible, non-destructive photographic identification and voucher specimens should be prioritized.

4.4 Fish identification

Collected specimens should be identified using standard taxonomic keys and current nomenclature. Identification should be verified against authoritative databases and recent taxonomic literature because scientific names and family-level classifications can change.

4.5 Diversity analysis

The following ecological indices can be calculated:

Shannon–Wiener diversity index

$$H' = -\sum_{i=1}^S p_i \ln p_i$$

where p_i represents the proportion of individuals belonging to species i and S represents total species richness.

Simpson's diversity index

$$D = 1 - \sum p_i^2$$

Margalef richness index

$$d = S - 1 \ln \frac{S}{N}$$

Where S is the number of species and N is the total number of individuals.

Pielou's evenness index

$$J = H' / \ln S$$

These measures permit comparison of fish communities between sites and seasons.

5. RESULTS

5.1 Overall ichthyofaunal diversity

Published research indicates considerable ichthyofaunal richness in the Betwa River. Joshi et al. documented **81 fish species representing 55 genera, 24 families and 10 orders** during their long-term investigation. Of these, **79 species were native and two were exotic**—*Cyprinus carpio* and *Oreochromis niloticus*. Earlier investigations had reported approximately 55–63 species. The increase to 81 species in the long-term study likely reflects greater sampling duration and geographic coverage rather than a sudden increase in actual fish richness.

Table 1: Summary of reported ichthyofaunal diversity of the Betwa River.

Study/source	Sampling context	Fish diversity reported
Adholia (1977), as cited in later studies	Earlier Betwa investigation	58 species
Lakra et al. (2010), as cited in later literature	River Betwa	63 species
Joshi et al. (2017)	Long-term Ken–Betwa investigation	81 species
Mishra et al. (2020)	Four Bundelkhand sites near Jhansi	20 species
WII/CIFRI-related assessment	Betwa stretch near Babina	21–26 species

The differences among these estimates illustrate strong spatial variation and differences in sampling effort.

5.2 Taxonomic composition

Cyprinidae was the most species-rich family, with **35 species**, followed by Bagridae with seven species and Schilbeidae with five species in the 81-species dataset.

bata (6.525%), *Gudusia chapra* (6.437%), *Chanda nama* (5.773%) and *Cirrhinus reba* (5.675%). *Acanthocobitis botia* showed the lowest reported relative abundance, approximately 0.019%.

Table 2: Major taxonomic groups represented in the Betwa ichthyofauna.

Taxonomic level	Reported diversity
Orders	10
Families	24
Genera	55
Total species	81
Native species	79
Exotic species	2
Dominant family	Cyprinidae
Cyprinid species	35

Cyprinids are ecologically important in the Betwa because they include several commercially valuable and widely distributed carps and minnows.

5.3 Relative abundance

The long-term study reported *Osteobrama cotio* as the most abundant species in the Betwa River, contributing approximately **8.454%** of recorded individuals. Other relatively abundant species included *Labeo*

Table 3: Selected abundant fish species reported from the Betwa.

Species	Relative abundance (%)
<i>Osteobrama cotio</i>	8.454
<i>Labeo bata</i>	6.525
<i>Gudusia chapra</i>	6.437
<i>Chanda nama</i>	5.773
<i>Cirrhinus reba</i>	5.675
<i>Acanthocobitis botia</i>	0.019

These figures are from the published long-term study and should not be interpreted as current 2026 abundance estimates.

5.4 Diversity indices

The Shannon–Wiener diversity index for the Betwa was reported as **3.66**, while evenness was **0.835**. The corresponding values for the Ken were slightly higher at 3.76 and 0.842, respectively.

The relatively high evenness indicates that although some species were more abundant than others, the

community was not overwhelmingly dominated by a single taxon.

5.5 Important fish species

The Betwa supports numerous economically and ecologically significant species. Reported fish include: *Labeo rohita* – Rohu, *Catla catla* - Catla, *Labeo calbasu* – Kalbasu, *Labeo gonius*, *Labeo bata*, *Cirrhinus reba*, *Cirrhinus mrigala*, *Osteobrama cotio*, *Gudusia chapra*, *Wallago attu*, *Bagarius bagarius*, *Chitala chitala*, *Notopterus notopterus*, *Ompok bimaculatus*, *Ompok pabda*, *Tor tor*, *Anguilla bengalensis*.

Several large-bodied fishes occur particularly in deeper habitats. Deep pools have been reported to support large individuals of *Labeo rohita*, *Catla catla*, *Labeo calbasu*, *Sperata aor*, *Sperata seenghala*, *Bagarius bagarius*, *Wallago attu*, *Chitala chitala* and *Tor tor*.

6. DISCUSSION

6.1 High fish diversity and habitat heterogeneity

The recorded richness of 81 species demonstrates that the Betwa is an important freshwater fish habitat within Bundelkhand. The presence of multiple taxonomic groups indicates considerable ecological heterogeneity.

The dominance of Cyprinidae is consistent with patterns commonly observed in tropical South Asian river systems. Cyprinids occupy different ecological niches, ranging from shallow flowing water to pools and slower sections.

The river's seasonal hydrology is particularly important. During the monsoon, increased discharge expands available habitat and facilitates movement and reproduction. During the dry season, water contracts into deeper pools and connected refuges. Consequently, maintaining these perennial habitats is essential for sustaining fish populations through the dry period.

6.2 Deep pools as critical refugia

One of the most important recent findings concerning Bundelkhand rivers is the ecological significance of deep pools. A 2025 study mapped thousands of deep pools in the Betwa and reported that field observations indicated rich fish diversity within these habitats. The study also emphasized that unsuitable water-quality conditions in some Betwa deep pools require restoration and water-quality management. Deep pools can function as: Dry-season refuges, Feeding grounds, Breeding habitats, Nursery areas, Shelter for large-bodied fishes, Habitat for threatened or near-threatened species. Therefore, deep pools should be considered conservation units rather than simply portions of the river channel.

6.3. Effects of dams and flow modification

The Betwa has experienced substantial hydrological modification through dams, barrages and associated development. River regulation can alter: Seasonal flow patterns, Sediment transport, Floodplain connectivity,

Fish migration, Spawning habitats, Availability of deep pools, Downstream ecological flows.

Long-term studies of the Ken–Betwa system have specifically warned that existing developmental obstructions can negatively affect river ecology and fisheries. For migratory fishes, barriers are particularly significant. *Tor tor*, for example, is reported to migrate upstream for breeding, while *Anguilla bengalensis* and *Bagarius bagarius* also undertake movements associated with feeding and reproduction.

6.4 Fishing pressure and habitat degradation

The Wildlife Institute of India has identified cultivation along river banks, livestock grazing and overfishing among the pressures reducing the habitat potential of the Betwa and associated aquatic fauna. Unsustainable fishing can disproportionately affect large, slow-growing species because these fishes often mature later and contribute fewer individuals to the next generation. Removal of large breeding adults can therefore reduce population resilience.

6.5 Water quality

The ecological condition of the Betwa cannot be assessed solely through fish numbers. Fish assemblages respond to dissolved oxygen, temperature, pH, nutrients, turbidity, conductivity, organic pollution and toxic substances.

Earlier work characterized the Ken and Betwa as having oxygen-rich, alkaline water and moderate chemical conditions during the study period. Taylor & Francis Online However, this should not be generalized to all stretches or to present conditions.

Recent research on Bundelkhand river systems has emphasized water-quality concerns in Betwa deep pools. In addition, research reported by the Government of India in 2026 has identified trace-metal contamination concerns around the Betwa–Yamuna confluence, highlighting the need for continued monitoring of contaminants and sediments.

7. Conservation Status

The conservation significance of the Betwa ichthyofauna is particularly evident from the occurrence of species of conservation concern.

A long-term Ken - Betwa investigation identified **nine near-threatened fish species** in the two rivers, including: *Tor tor*, *Labeo pangusia*, *Chitala chitala*, *Bagarius bagarius*, *Wallago attu*, *Ompok bimaculatus*, *Ompok pabda*, *Ailia coila*, *Parambassis lala*, *Chitala chitala*, commonly known as the clown knifefish, is listed as **Near Threatened** in the IUCN assessment information available through India Biodiversity. India Biodiversity Portal The species has also received conservation attention from ICAR-NBFGR, which entered into an agreement with the Uttar Pradesh Fisheries Department concerning river ranching

of *Chitala chitala*. Indian Council of Agricultural Research. Historical assessments have also identified *Chitala chitala* and *Ompok bimaculatus* as threatened species occurring in the Betwa system. Wildlife Institute of India Because conservation categories and taxonomy can change, future research should use the **current IUCN Red List assessment for each species** rather than relying exclusively on older classifications.

8. Major Threats to Ichthyofaunal Diversity

The principal threats to fish diversity in the Betwa can be summarized as follows:

8.1 Water abstraction

High demand for irrigation and other human uses can reduce environmental flows, particularly during summer.

8.2 Dams and barrages

Physical barriers interrupt longitudinal connectivity and can restrict movements of migratory fishes.

8.3 Overfishing

Excessive fishing pressure may reduce recruitment and remove breeding-sized individuals.

8.4 Habitat destruction

Modification of river banks, sand extraction, vegetation removal and other physical alterations can reduce habitat complexity.

8.5 Agricultural pressure

Agricultural runoff may introduce nutrients, sediments and agrochemicals into the river.

8.6 Urban and industrial pollution

Untreated or inadequately treated wastewater can adversely affect dissolved oxygen and other water-quality parameters.

8.7 Invasive/exotic fish

The occurrence of *Cyprinus carpio* and *Oreochromis niloticus* demonstrates the presence of non-native fishes in the system.

8.8 Climate variability

Increasing temperature, irregular rainfall and prolonged dry periods can intensify seasonal water stress. Recent research on Bundelkhand documented increasing temperature trends and emphasized the importance of deep pools as refugia under water-stressed conditions.

9. Conservation and Management Recommendations

Effective conservation of Betwa ichthyofaunal diversity requires an integrated river-basin approach.

9.1 Maintain environmental flows

Minimum ecological flows should be established to maintain aquatic habitats during dry periods.

9.2 Protect deep pools

Deep pools should be mapped, monitored and protected from destructive fishing, excessive abstraction and physical modification.

9.3 Improve fish passage

Where technically and ecologically feasible, fish passages or other connectivity measures should be incorporated into barriers that obstruct important migration routes.

9.4 Establish fish conservation zones

Important breeding and nursery habitats should be designated as seasonal or permanent fish conservation areas.

9.5 Regulate fishing

Fishing regulations should include appropriate mesh sizes, seasonal restrictions during breeding periods and restrictions on destructive fishing methods.

9.6 Control pollution

Regular monitoring should include: Dissolved oxygen, Biochemical oxygen demand, Chemical oxygen demand, pH, Temperature, Electrical conductivity, Nutrients, Heavy metals, Pesticide residues where relevant.

9.7 Restore riparian vegetation

Vegetated river margins can reduce erosion, trap sediment and nutrients, provide shade and contribute organic matter to aquatic food webs.

9.8 Monitor exotic species

The distribution and abundance of non-native fish should be monitored to identify potential impacts on native communities.

9.9 Community participation

Local fishing communities should be incorporated into conservation programmes because their knowledge of seasonal fish movements, breeding areas and fishing grounds can complement scientific monitoring.

9.10 Long-term biodiversity monitoring

A standardized monitoring programme should be established across the Betwa using consistent sampling stations, gears, seasons and taxonomic protocols. This would make it possible to distinguish natural seasonal variation from genuine long-term population declines.

10. CONCLUSION

The Betwa River represents a **major freshwater biodiversity resource of Bundelkhand**. Available studies demonstrate substantial ichthyofaunal richness, with as many as **81 fish species belonging to 24 families, 55 genera and 10 orders** documented in a long-term investigation. Cyprinidae is the dominant family, while several commercially valuable, migratory and conservation-priority fishes occur in the river.

Differences among published species inventories—from approximately 20 species at localized Bundelkhand sampling sites to 81 species in broader long-term surveys—do not necessarily represent contradictory findings. Instead, they emphasize the importance of sampling location, habitat, season, fishing effort and study duration.

The continued ecological value of the Betwa depends on maintaining adequate river flow, preserving deep pools, protecting breeding and nursery habitats, reducing pollution and overfishing, and maintaining connectivity between riverine habitats. Recent research showing thousands of deep-pool habitats in the Betwa further emphasizes the importance of protecting these dry-season refugia.

Conservation planning should move beyond individual fish species and adopt a **river-ecosystem approach** in which hydrology, habitat, water quality, fisheries and local communities are considered together. Such an approach is particularly important in Bundelkhand, where increasing water stress makes the protection of perennial aquatic habitats essential for both biodiversity and human livelihoods.

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