



# Ichthyofaunal Diversity of Irrigation Reservoirs in Bundelkhand Region

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## Abstract

The Bundelkhand region of central India contains numerous irrigation reservoirs, dams, tanks and associated freshwater habitats that support diverse fish communities and provide important ecological and socioeconomic services.

The present study reviews and proposes a systematic assessment of ichthyofaunal diversity in selected irrigation reservoirs of Bundelkhand, with emphasis on species composition, taxonomic diversity, seasonal variation, relative abundance and conservation significance. Published studies indicate considerable fish diversity in the region. A regional assessment reported 93 freshwater fish species belonging to six orders and 18 families, with Cypriniformes representing the largest proportion of recorded species. Studies of individual reservoirs have documented 27 species from Matatila Reservoir in Jhansi and 19 species from Saprar Dam in Mauranipur, Jhansi. Seasonal and habitat-related variation in fish assemblages is expected because reservoir water levels, aquatic vegetation, dissolved oxygen, temperature, nutrient availability and fishing pressure vary substantially during the year.

The present synthesis indicates that irrigation reservoirs of Bundelkhand constitute important refuges for native freshwater fishes and contribute to inland fisheries and local livelihoods. However, habitat alteration, overfishing, water-quality deterioration, invasive species and fluctuations in reservoir water levels may threaten fish diversity. Regular biodiversity monitoring, habitat conservation, scientific fish stocking, regulation of fishing pressure and community participation are recommended for sustainable management of reservoir fisheries in Bundelkhand.

**Keywords:** Ichthyofauna, fish diversity, irrigation reservoir, Bundelkhand, freshwater biodiversity, Cypriniformes, fisheries, conservation.

## 1. Introduction

Freshwater ecosystems are among the most biologically productive ecosystems and support a wide variety of fish species. Fish communities are important components of aquatic food webs and contribute directly to human welfare through fisheries, nutrition, employment and income generation. Reservoirs constructed primarily for irrigation and water storage frequently develop secondary fisheries resources and may provide important habitats for both native and introduced fishes.

Bundelkhand is a semi-arid to sub-humid region distributed across parts of Uttar Pradesh and Madhya Pradesh. The region is characterized by highly variable rainfall, seasonal rivers, rocky terrain, agricultural landscapes and numerous artificial water bodies. Irrigation reservoirs have become particularly important because water availability is strongly seasonal. These reservoirs support agriculture and livestock and, in many locations, also sustain capture fisheries and fish culture.

The fish fauna of Bundelkhand has been investigated by several researchers, but information is geographically fragmented and many smaller irrigation reservoirs remain poorly studied. A regional review published in 2023 compiled records of **93 freshwater fish species belonging to six orders and 18 families** from different parts of Bundelkhand. Cypriniformes was the dominant order, accounting for approximately 55% of the recorded fauna, followed by Siluriformes and Perciformes. Individual reservoir investigations further demonstrate the importance of these artificial water bodies. For example, a 12-month investigation of Matatila Reservoir in Jhansi recorded **27 fish species**, including major carps, minor carps, catfishes and weed fishes. The study also reported species such as *Chitala chitala* (then reported as *Notopterus chitala*), *Notopterus notopterus*, *Ompok bimaculatus* and *Eutropiichthys vacha* as conservation-significant components of the assemblage. Similarly, an investigation of Saprar Dam in Mauranipur, Jhansi, conducted from January to December 2017, recorded **19 species belonging to 17 genera, eight families and six orders**, with Cyprinidae being the dominant family. These observations demonstrate that irrigation reservoirs can contribute substantially to regional fish biodiversity. Nevertheless, changes in water level, habitat structure, water quality and fishing intensity can alter reservoir fish communities. Therefore, systematic documentation of ichthyofaunal diversity is essential for conservation and sustainable fisheries management.

## 2. Objectives

The major objectives of the proposed study are: To document the fish species occurring in selected irrigation reservoirs of Bundelkhand, To determine the taxonomic composition of the fish assemblages, To assess seasonal variation in fish diversity and abundance, To identify dominant, rare, economically important and conservation-significant fish species, To evaluate the influence of major environmental variables on fish diversity, To compare ichthyofaunal composition among selected reservoirs, To identify major threats to fish biodiversity and suggest appropriate conservation and management measures.

## 3. Materials and Methods

### 3.1 Study Area

The proposed study covers selected irrigation reservoirs located within the Bundelkhand region of Uttar Pradesh and Madhya Pradesh. Representative reservoirs may be selected from districts such as Jhansi, Lalitpur, Chhatarpur, Panna, Sagar and Damoh, depending on accessibility and research objectives.

The reservoirs should preferably represent differences in size, age, catchment characteristics, degree of human disturbance, fisheries activity and water-use intensity.

### 3.2 Sampling Design

Fish sampling should be conducted for a minimum period of 12 months to cover three major seasons: Pre-monsoon, Monsoon, Post-monsoon/winter

Sampling should be carried out at representative ecological zones of each reservoir, such as: Inlet zone, Littoral zone, Open-water/pelagic zone, Vegetated zone, Dam/outlet zone, Seasonal sampling is particularly important because fish assemblages can change with water level, breeding activity, food availability and habitat complexity.

### 3.3 Fish Collection

Fish specimens may be collected with the assistance of licensed/local fishermen using commonly used fishing gears such as cast nets, gill nets, drag nets and other legally permitted gears. Different mesh sizes should be used where appropriate to sample fishes of different body sizes.

Sampling effort should be standardized among reservoirs and seasons. The date, sampling location, gear type, duration and approximate catch should be recorded for every sampling event. Representative specimens should be photographed and identified in the field wherever possible. Voucher specimens should be preserved according to accepted ichthyological procedures and deposited in an appropriate institutional collection.

### 3.4 Identification

Fish specimens should be identified using standard taxonomic literature and updated nomenclature databases. Morphometric and meristic characteristics should be recorded when necessary.

Taxonomic identification should be periodically cross-checked because fish nomenclature has undergone considerable revision in recent years.

### 3.5 Environmental Parameters

The following physicochemical parameters should be measured: Water temperature, pH, Dissolved oxygen, Electrical conductivity, Total dissolved solids, Turbidity, Total alkalinity, Hardness, Nitrate, Phosphate. Where facilities are available, chlorophyll-a, biochemical oxygen demand and additional nutrient parameters may also be examined.

### 3.6 Diversity Indices

Fish diversity can be quantified using the following indices.

#### Shannon–Wiener diversity index:

$$H' = -\sum p_i \ln p_i$$

where  $p_i$  is the proportion of individuals belonging to species  $i$ .

#### Simpson's diversity index:

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

#### Pielou's evenness index:

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

where  $S$  represents the total number of species.

Species richness should also be calculated using the total number of species recorded and, where appropriate, Margalef's richness index.

### 3.7 Relative Abundance

Relative abundance of each species can be calculated as:

$$\text{Relative abundance (\%)} = (\text{Number of individuals of a species} / \text{Total number of individuals collected}) \times 100.$$

This allows dominant and uncommon species to be identified.

### 3.8 Statistical Analysis

Differences in species richness and diversity among reservoirs and seasons may be tested using appropriate statistical procedures such as ANOVA or generalized linear models, depending on the structure and distribution of the data. Relationships between fish diversity and environmental parameters may be examined using correlation analysis, regression, principal component analysis or canonical correspondence analysis.

## 4. Results

### 4.1 Regional Ichthyofaunal Composition

Published literature demonstrates that Bundelkhand supports a substantial freshwater fish fauna. A regional synthesis reported **93 species representing 18 families and six orders**. Cypriniformes was the most diverse order, followed by Siluriformes and Perciformes. The same study reported substantial differences among districts, with Damoh showing the highest number of recorded species among the areas reviewed.

**Table 1. Published fish-diversity records from selected Bundelkhand locations**

| Location                   | Recorded species | Major observation                                            |
|----------------------------|------------------|--------------------------------------------------------------|
| Matatila Reservoir, Jhansi | 27               | Major carps, minor carps, catfishes and weed fishes recorded |
| Saprar Dam, Jhansi         | 19               | 17 genera, 8 families and 6 orders; Cyprinidae dominant      |
| Loni wetland, Bundelkhand  | 32               | 24 genera, 13 families and 7 orders                          |
| Bundelkhand region overall | 93               | 18 families and 6 orders reported in regional synthesis      |

Sources: Sen; Kumar & Giri; Thakur et al.; Niranjan et al.

### 4.2 Dominance of Cypriniformes

Cypriniformes constitutes the dominant component of the Bundelkhand freshwater fish fauna. The regional synthesis reported approximately 55% of recorded species under this order. Cyprinidae was also the most prevalent family.

The dominance of cyprinids is consistent with their ecological adaptability and importance in Indian freshwater fisheries. Species of *Catla*, *Labeo*, *Cirrhinus* and other cyprinids commonly occur in reservoir environments and are also important components of culture and capture fisheries.

#### 4.3 Seasonal Variation

Seasonal variation is expected to be an important feature of fish assemblages in Bundelkhand reservoirs. During the monsoon, increased water inflow expands aquatic habitat, increases connectivity with tributary channels and introduces nutrients and food organisms. These conditions may enhance fish movement, recruitment and feeding opportunities. Evidence from a Bundelkhand wetland study supports this seasonal pattern. Thakur et al. recorded 32 species and found the highest Shannon diversity during the monsoon ( $H' = 3.001$ ), followed by pre-monsoon ( $H' = 2.918$ ) and post-monsoon ( $H' = 2.866$ ).

#### 4.4 Economically Important Fish

Irrigation reservoirs may support several economically important Indian major carps and other food fishes. Species such as *Catla catla*, *Labeo rohita* and *Cirrhinus mrigala* are particularly important to inland fisheries because of their market value, growth characteristics and suitability for aquaculture. At Matatila Reservoir, a range of major carps, minor carps and catfishes was reported, demonstrating the fishery potential of irrigation reservoirs in the region.

#### 4.5 Conservation-Significant Species

The occurrence of large-bodied native fishes and other species with conservation concerns is particularly important. The Matatila study reported *Chitala chitala*, *Notopterus notopterus*, *Ompok bimaculatus* and *Eutropiichthys vacha*. The Bundelkhand wetland study recorded 32 species and reported 29 species as Least Concern, two as Near Threatened and one as Vulnerable under the conservation framework used by the authors.

### 5. Discussion

#### 5.1 Fish Diversity of Bundelkhand Reservoirs

The available literature indicates that irrigation reservoirs make a significant contribution to freshwater fish biodiversity in Bundelkhand. The 93 species reported across the region should not, however, be interpreted as occurring simultaneously in every reservoir. Differences in reservoir size, hydrology, connectivity, water quality, habitat complexity and fishing intensity can result in substantial differences in local species richness.

The 27 species reported from Matatila Reservoir and 19 species from Saprar Dam illustrate this spatial heterogeneity.

#### 5.2 Importance of Habitat Heterogeneity

Fish diversity is strongly influenced by the availability of different habitats. Littoral vegetation provides shelter, feeding grounds and nursery habitats for small indigenous fishes and juveniles. Deeper open-water areas support pelagic and larger-bodied fishes, while inlet regions may retain some characteristics of riverine environments.

Consequently, maintaining a mosaic of littoral, pelagic and inlet habitats is important for conserving fish assemblages.

Studies from other Indian tropical reservoirs similarly demonstrate spatial differences in fish assemblages. Research on Panchet Reservoir, for example, found greater species richness and abundance in transitional areas than in the lacustrine zone.

#### 5.3 Influence of Water Quality

Water temperature, dissolved oxygen, turbidity, nutrients and conductivity can influence fish distribution and abundance. Excessive nutrient input from agricultural runoff may promote eutrophication, algal growth and changes in dissolved oxygen. During the hot pre-monsoon period, high temperature and declining dissolved oxygen may place stress on sensitive fish species. Conversely, monsoon inflow can improve habitat availability but may also produce high turbidity and rapid environmental changes.

Thus, water-quality monitoring should form an integral part of reservoir fish-diversity studies.

#### 5.4 Fisheries Pressure

Reservoir fisheries provide income and food to local communities. However, intensive fishing, small-mesh nets, destructive fishing practices and excessive removal of breeding adults can negatively affect fish populations.

Management should therefore distinguish between sustainable fishing and practices that disproportionately remove juveniles or reproductive individuals.

### 5.5 Reservoir Modification and Connectivity

The transformation of riverine habitats into reservoirs can benefit some lentic-adapted fishes while negatively affecting species dependent on flowing water, migration or specialized spawning substrates. More broadly, dam construction can modify fish migration routes and aquatic habitat conditions. Research from other Indian reservoirs has documented substantial effects of impoundment on fish assemblages, highlighting the importance of maintaining suitable habitat and connectivity wherever possible.

### 5.6 Introduced and Invasive Species

The introduction of non-native fish species requires careful monitoring. Although some introduced species may provide short-term fisheries benefits, they can compete with native fishes for food and habitat and potentially alter aquatic food webs. Reservoir fishery enhancement programmes should therefore prioritize locally appropriate native or established economically important species and conduct ecological risk assessments before introducing new species.

## 6. Major Threats to Ichthyofaunal Diversity

The major factors potentially affecting fish diversity in Bundelkhand irrigation reservoirs include:

- Fluctuation and excessive drawdown of reservoir water levels.
- Habitat degradation and removal of aquatic vegetation.
- Agricultural runoff and nutrient enrichment.
- Domestic sewage and solid-waste pollution.
- Excessive and unregulated fishing.
- Use of destructive or very small-mesh fishing gears.
- Introduction of non-native fish species.
- Siltation and loss of reservoir capacity.
- Reduction in aquatic connectivity.
- Climate variability and prolonged drought.
- Changes in rainfall patterns and monsoon intensity.
- Destruction of breeding and nursery habitats.

The semi-arid character of Bundelkhand makes water availability particularly important. Consequently, climate-related changes in rainfall and prolonged dry periods may have disproportionately strong effects on shallow reservoir habitats.

## 7. Conservation and Management Recommendations

The following measures are recommended for sustainable management of ichthyofaunal resources in Bundelkhand irrigation reservoirs:

**Long-term monitoring:** Establish annual fish-diversity monitoring programmes covering pre-monsoon, monsoon and post-monsoon periods.

**Habitat protection:** Protect littoral vegetation, shallow nursery habitats and inlet areas.

**Sustainable fishing:** Introduce scientifically determined fishing seasons, mesh-size regulations and protection of breeding stocks.

**Native fish conservation:** Prioritize conservation and enhancement of native fish populations rather than indiscriminate stocking.

**Water-quality management:** Regularly monitor dissolved oxygen, nutrients, turbidity, pH and other important parameters.

**Pollution control:** Reduce agricultural runoff, sewage discharge and solid-waste accumulation around reservoirs.

**Fish sanctuaries:** Establish no-fishing zones in selected breeding and nursery habitats.

**Community participation:** Involve local fishermen and village communities in fisheries monitoring and conservation programmes.

**Invasive-species surveillance:** Monitor the occurrence and spread of non-native fishes.

**Climate-resilient management:** Develop reservoir-specific fishery management plans that account for changing rainfall, drought and water-storage patterns.

## 8. Conclusion

Irrigation reservoirs constitute important components of the freshwater biodiversity network of Bundelkhand. Available studies demonstrate that the region supports a diverse fish fauna, with Cypriniformes and particularly cyprinid fishes forming a major component of the assemblage. Published investigations have documented 27 species from Matatila Reservoir and 19 species from Saprar Dam, while a broader regional synthesis has recorded 93 freshwater fish species. The diversity of fish communities varies according to reservoir characteristics, season, habitat availability, water quality and fishing pressure. Monsoon-associated changes in water volume, connectivity and food availability may increase fish diversity and abundance, while extreme summer conditions can reduce suitable habitat.

Bundelkhand's irrigation reservoirs therefore have dual importance: they support agricultural water requirements while simultaneously providing habitats and fisheries resources. Effective conservation requires integration of biodiversity protection with sustainable fisheries management. Regular taxonomic surveys, standardized seasonal sampling, water-quality monitoring, protection of breeding habitats and active participation of local fishing communities should form the basis of a long-term reservoir management strategy.

Future research should focus on standardized multi-reservoir sampling, molecular confirmation of difficult taxonomic groups, population-level assessments of threatened native fishes, assessment of invasive species and quantitative analysis of relationships between environmental variables and fish assemblage structure.

## 9. References

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7. Recent reservoir research also emphasizes the importance of integrating fish diversity assessment with water-quality monitoring and habitat management.