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Study of diversity and distribution of fishes in selected stretches of the Mahanadi River, Odisha

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Abstract
The Mahanadi River is one of the major rivers in the country. This study was split into seven regions of the Mahanadi river for sampling to evaluate fish diversity. The sampling areas were situated in riverine areas, from upstream in Sambalpur district to downstream in Jagatsinghpur district of Odisha. The choice of sites was determined by areas where fishing communities live. and take part in fishing activities. Standard protocols and techniques were adhered to throughout the sampling, data gathering, and analysis processes. A total of 42 fish species were recorded, representing 37 genera, 18 families, and 7 orders across seven sites along the Mahanadi River. The assessment disclosed that the family Cyprinidae was the most dominant, come up with 34% of the total species recorded. The distribution pattern indicated greater diversity of species at water dams, barrages, or storage facilities. Several species, including *Catla catla, Labeo rohita, Cirrhinus mrigala, Labeo bata, Clarias batracus, and Chanda nama.* found to be in good abundance in the study regions. The conservation assessment indicated that at least 24% of the fish fauna is under threat, being classified as either vulnerable or near Threatened. These findings highlight the urgent need to embrace effective biodiversity conservation measures to safeguard the fish diversity of the Mahanadi River and preserve this vital natural heritage.

Keywords: Mahanadi River, fish diversity, conservation. Natural heritage

Introduction

Biodiversity, the extensive "genetic library" preserved by natural ecosystems, forms the foundation of all human life-support systems (Dudgeon *et al*., 2006; Balian *et al*., 2008) [1, 4]. While its significance has long been recognised by ecologists and environmental scientists, it globally emphasises the conservation of biodiversity. Conserving biodiversity is now recognised as central not only to agriculture, fisheries, and forestry, but also to maintaining evolutionary processes, stabilising ecosystems, and preserving overall environmental quality. Additionally, the value of all species is acknowledged as a fundamental ethical imperative (Ehrlich & Wilson, 1991) [5].

Aquatic ecosystems, mainly freshwater, covering less than 1% of the earth's surface, are among the most biodiverse and ecologically important habitats on the planet. They include rivers, lakes, streams, floodplains, and wetlands, providing habitats for a wide distribution of fish species that are critical for ecosystem functioning, food security, and livelihoods. Globally, freshwater fish account for approximately 15,000–16,000 species, representing nearly 40% of all known fish species, despite freshwater habitats being a tiny fraction of the total aquatic environment. Freshwater fish exhibit remarkable diversity in terms of morphology, behaviour, and ecological niches.

In India, thirty-four global biodiversity hotspots support approximately 9.6% of the global fish species (Banerjee *et al.*, 2022) [2]. The country's freshwater ecosystems, including rivers, streams, and springs, are indispensable not only for human wellbeing but also as habitats supporting aquatic flora and fauna. According to ICAR-NBFGR (Annual Report, 2022) [7], of the 3,398 fish species reported from India, comprising 2,936 native and 462 exotic species and about 936 freshwater species. It has the baseline information on species occurrence, abundance, and distribution, which has become essential for the effective protection and conservation of existing fish diversity.

In India Mahanadi River begins near Pharsiya village in the Dhamtari district of Chhattisgarh and flows eastwards into the Bay of Bengal. Covering a course of approximately 851 km and draining a basin of about 141,600 km² across Chhattisgarh, Odisha and smaller portions of Jharkhand, Maharashtra and Madhya Pradesh, the river is a key contributor to water resources and flood potential in peninsular India. Many researchers have conducted their studies on fish diversity in the river Mahanadi, Tyagi *et al.* (2021) [11] and Singh *et al.* (2020). Most of the work was limited to certain stretches of the river. The study was carried out in the month of April 2023 and completed in May 2025. In which seven selected places along the upper and upper-middle stretch of the Mahanadi River

Materials and Methods

1. Study Area

The study was carried out along the longitudinal gradient of the Mahanadi River, Odisha, India, extending from the upper stretch at Sambalpur to the lower estuarine segment at Jagatsinghpur. Seven representative sampling stations were selected, these are Hirakud at Sambalpur district, Thengo Dam at Sonepur district, Marjakud Island at Boudh district, Satakosia Gorge at Angul district, Dhableswar, Naraj at Cuttack district and Jagatsinghpur district (Table-1), and (Fig.1). These sites represent reservoir inflow areas, stretches, midstream sections, and estuarine transitional zones, ensuring comprehensive ecological coverage. To examine important physicochemical parameters, water samples were collected from the different sites with the help of the local fishermen and staff of the Fisheries Department, Government of Odisha. Water temperature, pH, DO, Free CO2, Conductivity and total alkalinity were measured using standard methods by following APHA (2017).

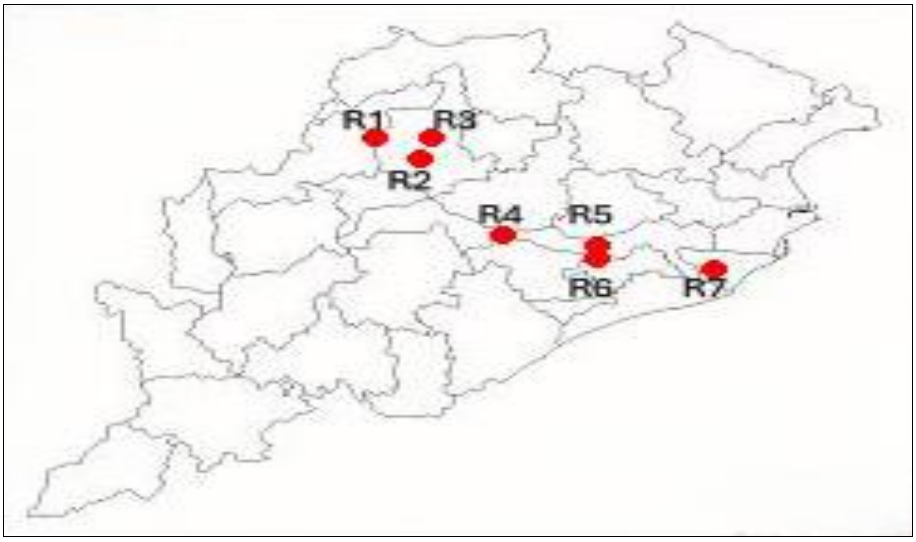

Fig 1: Seven sampling sites of Odisha

Table 1: Study area and geographic details of sampling sites along the Mahanadi River

Site Code	Location	District	Coordinates
R1	Hirakud	Sambalpur	21°27′N,83°58′E
R2	Thengo Dam	Sonepur	20°75′N,83˚75′ E
R3	Marjakud Island	Boudh	20°87′ N,84°20′ E
R4	Satakosia Gorge	Angul	20°34′ N; 84°48′ E
R5	Dhableswar	Cuttack	20°21′ N; 85°25′ E
R6	Naraj	Cuttack	20°29′ N; 85°25′ E
R7	Jagatsinghpur	Jagatsinghpur	20°16′ N; 86°10′ E

2. Study Period

Sampling was conducted from April 2023 to May 2025, covering four seasons

1. Pre-monsoon
2. Monsoon
3. Post-monsoon

3. Fish Collection and Preservation

Fish specimens were obtained from

1. Riverine fishing grounds, Local landing centres, Fishermen's catch and nearby markets

4. Diversity Indices

Fish diversity was calculated using standard ecological indices.

4.1. Species Richness (S)

Total number of species recorded per station.

4.2. Diversity Index (H′)

$H' = -\sum pi \ln(pi)$

Where pi is the proportion of individuals belonging to species *i*.

4.3. Shannon equitability index (E)

$E=H'/\ln(S)$

Where H` is the Shannon-Wiener Index, and S represents the total number of species Determined uniformity of individual distribution across species.

4.4. Bay Curtis Similarity Index

Bray–Curtis Similarity $=1 - [\Sigma |A_i - B_i| / \Sigma (A_i + B_i)]$

Where:

A_i =Total no. of species i in site A

B_i =Total no. of species i in site B

Σ =denotes the summation over all species being compared

4.5. Abundance Index (AI)

$AI = (n \times 100) / N$

Where n is the number of individuals of a specific species in the sample area.

N is the total number of individuals of all species in the sample area.

Measured the relative contribution of each species to the total catch.

Result and Discussion

1. Fish fauna of the Mahanadi River

All the collected specimens were identified and arranged according to their taxonomic order. The survey recorded 42 fish species belonging to 36 genera, 19 families and 7 orders from the seven regions along the stretch of the Mahanadi River in Odisha selected for this study (Table 2). The local markets survey confirmed the presence of the same species as recorded from fish catch. The fish species collected at the different study regions under the present study are listed in Table 1. However, the sample from the local markets was documented. The Indian Major Carps were also available in the daily market. The fish species found at the different study regions under the present study are listed in (Table 1). The Samples analysis in the study further revealed that Cyprinidae was the most abundant family, contributing 29% of the total species belonging to different families recorded from this region. 12 species from 9 genera are represented from the family Cyprinidae. Siluridae has four species. Among the orders, Perciformes constituteby 6 families and Siluriformes by 5 families, priniformes and Synbrachiformes both represented by two families and others have one family.

Table 2: Diversity of Fish Species in the Different Study Regions

Sl. No.	Order	Family	Species
1	Perciformes	Ambassidae	*Chanda nama*
2		Ambassidae	*Parambassis lala*
3		Ambassidae	*Parambassis rang*
4		Anabantidae	*Anabas testudineus*
5		Anabantidae	*Trichogaster fasciatus*
6		Channidae	*Channa gachua*
7		Channidae	*Channa marulius*
8		Channidae	*Channa punctatus*
9		Cichlidae	*Oreochromis niloticus*
10		Gobiidae	*Glossogo biusgiuris*
11		Nandidae	*Nandus nandus*
12	Beloniformes	Belonidae	*Xenentodon cancila*
13	Clupeiformes	Clupeidae	*Gudusia chapra*
14	Cypriniformes	Cobitidae	*Lepidocephalichthys guntea*
15		Cyprinidae	*Amblypharyngodon mola*
16		Cyprinidae	*Catla catla*
17		Cyprinidae	*Cirrhinus mrigala*
18		Cyprinidae	*Danio devario*
19		Cyprinidae	*Danio rerio*
20		Cyprinidae	*Labeo bata*
21		Cyprinidae	*Labeo fimbriatus*
22		Cyprinidae	*Labeo gonius*
23		Cyprinidae	*Labeo rohita*
24		Cyprinidae	*Osteobramavi gorsii*
25		Cyprinidae	*Rasbora daniconius*
26		Cyprinidae	*Salmostoma bacaila*
27		Cyprinidae	*Systomuss arana*
28	Siluriformes	Bagridae	*Mystusten gara*
29		Bagridae	*Sperataseen ghala*
30		Siluridae	*Ompok bimaculatus*
31		Siluridae	*Ompok pabda*
32		Siluridae	*Ompok pabo*
33		Siluridae	*Wallago attu*
34		Saccobranchidae	*Heteropneustes fossilis*
35		Claridae	*Clarias batrachus*
36		Schilbeidae	*Ailia coila*
37		Schilbeidae	*Clupiso magarua*
38	Osteoglossiformes	Notopteridae	*Chitala chitala*
39		Notopteridae	*Notopterus notopterus*
40	Synbranchiformes	Mastacembelidae	*Macrogn athusaral*
41		Mastacembelidae	*Mastacembelu spuncalus*
42		Synbranchidae	*Monopterus cuchia*

2. Diversity and Community Structure of Fish Assemblages in the Mahanadi River

Across seven selected sites along the Mahanadi River, the Shannon–Wiener diversity index ranged significantly, with values ranging from 1.48 at Satakosia to 3.62 at Hirakud (Fig. 2).

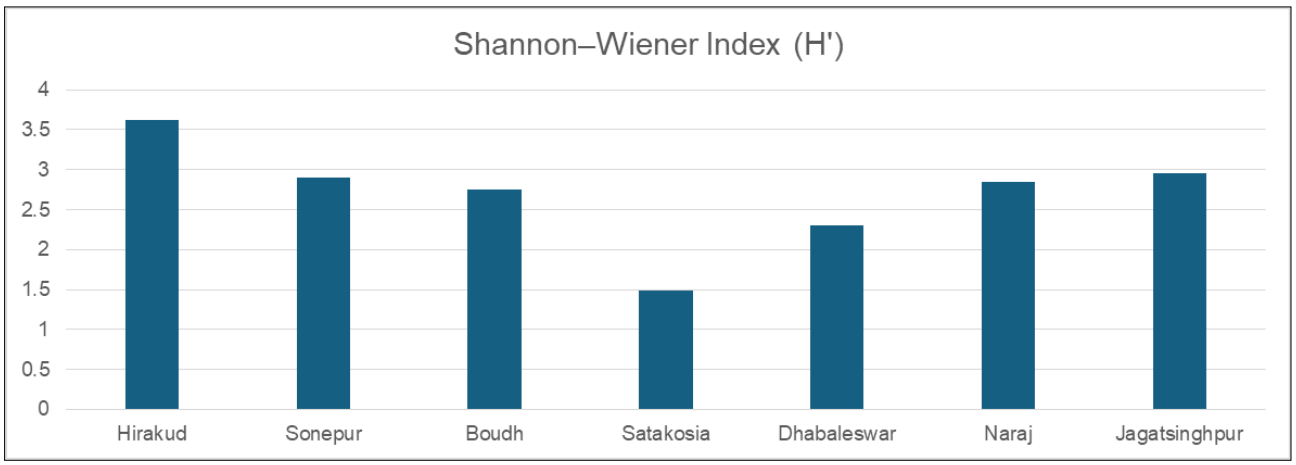

Fig 2: Shannon–Wiener Diversity Index (H') of Fish Species at Different Sites along the Mahanadi River

This range highlights substantial spatial variation in species richness, with Hirakud recording the highest species richness. Satakosia had the lowest, which is similar to Singh *et al.,* and slightly differs from Chandran, R. *et al*. (2019) [3] and Trivesh, R. *et al*. (2022) [10] in their study sites. The evenness index showed range between 0.63 at Satakosia, indicating an uneven species distribution, and 0.95 at Cuttack, which suggests a more balanced assemblage there than Chandran.R. *et al*. (2019) [3] in their study area (Fig.3).

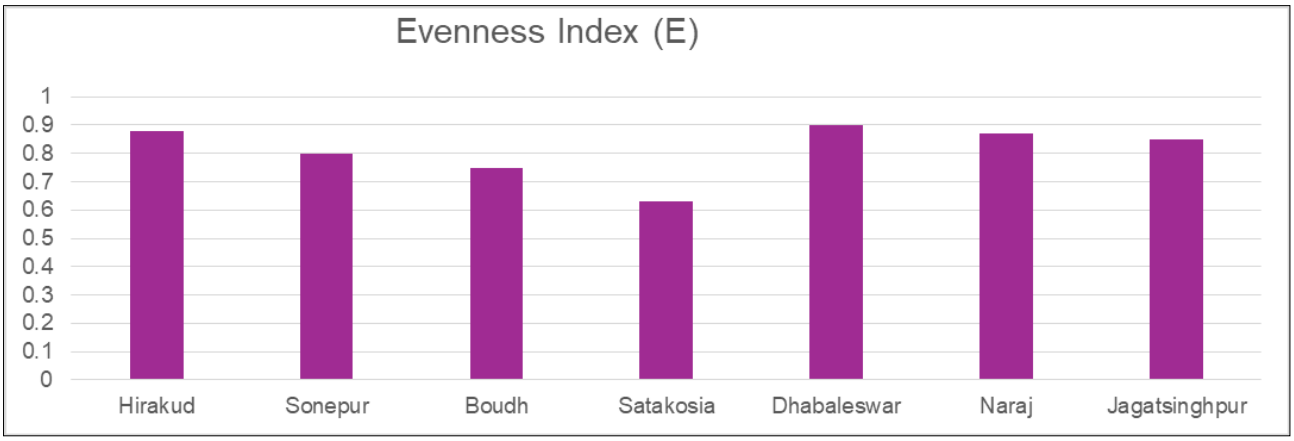

Fig 3: Species evenness along the Mahanadi River

Upon analysing the composition similarities, we found that the most similar fish communities were between Dhabaleswar and Jagatsinghpur, showing a similarity index of 0.762. In contrast, the fish populations of Hirakud and Satakosia showed the least similarity, with an index of 0.182. These findings highlight that Satakosia Tiger Reserve is home to the least diverse fish community, whereas Dhabaleswar exhibits a significantly richer variety of fish, which is similar to Singh *et al* (2020). (Fig. 4).

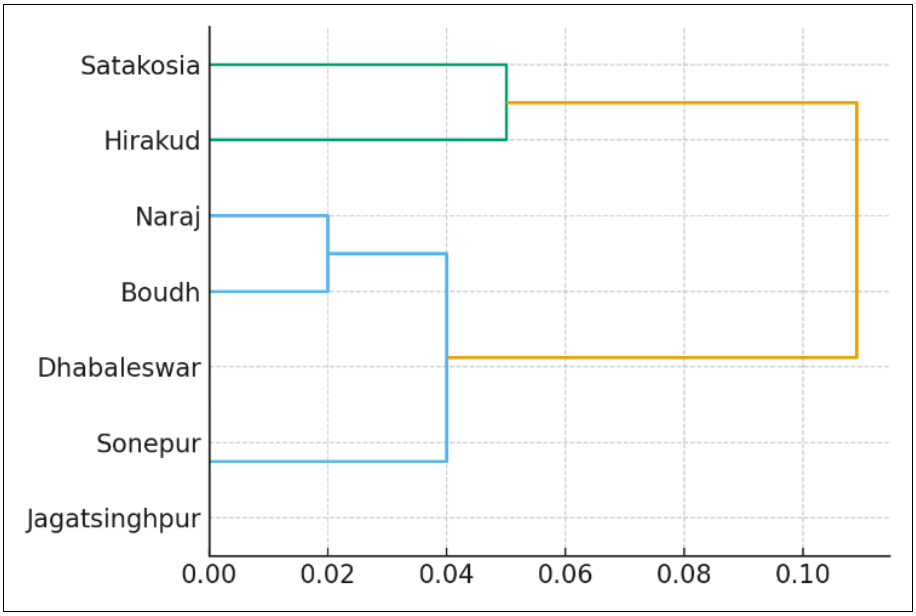

Fig 4: Bray–Curtis Cluster Dendrogram of Sampling Sites

The Aundance Index (AI) revealed distinct patterns of fish dominance across the surveyed stretches of the Mahanadi River. Among the most abundant species, *Catla catla* is the most abundant in contrast to *Labeo rohita by* Chandran, R. *et al*. (2019) [3], and *Parambassis lala* by Singh *et al. (2020)*. The AI values of *Catla catla* range from 4.92 to 7.64, followed by *Labeo rohita* (1.50–4.54) and *Cirrhinus mrigala* (1.09–3.23). *Labeo bata* exhibited higher abundance at certain sites, with values between 3.86 and 11.64, while *Gudusia chapra* ranged from 2.63 to 6.06.

The air-breathing *Clarias batrachus* recorded substantial presence (4.00–15.27), and *Anabas testudineus* demonstrated remarkable site-specific peaks, reaching as high as 40.35. Among the snakeheads, *Channa marulius* varied from 4.96 to 35.08, *Channa punctatus* from 1.41 to 7.89, *Channa striatus* from 0.92 to 4.36, and *Channa gaucha* from 1.65 to 3.06. The small schooling fish, *Chanda nama*, remained comparatively less abundant, with AI values between 0.75 and 5.81.

Overall, these results indicate significant spatial variation in species abundance, reflecting both the dominance of key commercial and predator species and localised fluctuations of smaller or less abundant fish across the river stretches. (Fig.5)

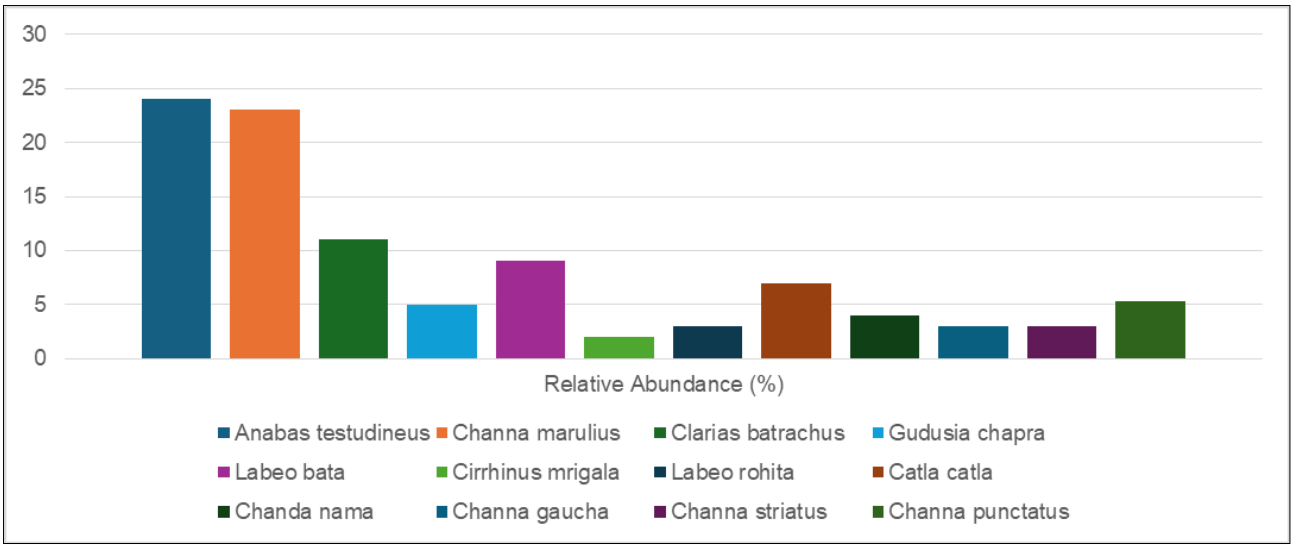

Fig 5: Abundance Index along the Mahanadi River

Conclusion

The present assessment demonstrates that the ichthyofaunal assemblage of the Mahanadi River exhibits considerable spatial heterogeneity in terms of species richness, evenness and community similarity. Reservoir- and barrage-influenced stretches such as Hirakud and Cuttack sustain comparatively higher richness, whereas Satkosia—despite being ecologically pristine—showed low detectability due to gear limitations and sampling constraints. Nearly one-fourth of the species pool is under threatened categories, indicating emerging conservation risk. Robust, multi-gear monitoring, habitat protection, and invasive-species control are therefore essential to maintain long-term fishery sustainability and ecological integrity in the basin.

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