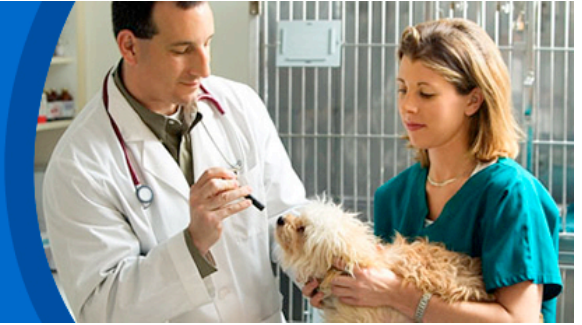




International Journal of Veterinary Sciences and Animal Husbandry



ISSN Print:

ISSN Online: 2456-2912

NAAS Rating (2026): NAAS

Rating (2026): 4.61

IJSAH 2026; 11(9): 31-35

www.veterinarypaper.com

Received: 10-07-2026

Accepted: 12-08-2026

Published: 19-09-2026

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Seasonal variation in fish diversity and feeding guild structure in Indrabati Dam, Odisha

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DOI: <https://www.doi.org/10.22271/veterinary.2026.v11.i9a.3771>

ABSTRACT

We conducted a one-year study (2025) to assess seasonal variation in fish diversity, water quality, and feeding guild structure in Indrabati Dam, Nabarangpur district, *Odisha*. Four sampling stations were selected across three seasons (winter, summer, monsoon). A total of 17 fish species belonging to 4 orders and 8 families were recorded. Cypriniformes dominated with 9 species (53%), followed by Siluriformes (4 species, 23%), Perciformes (3 species, 18%), and Decapoda (1 species, 6%). Water quality parameters showed seasonal variation: temperature (21-32 °C), pH (7.1-8.5), DO (5.6-8.0 mg/L), and TDS (178-290 ppm). Fish diversity was highest during winter at Station 2 (Shannon $H = 2.079$) and lowest during summer at Station 4 (Shannon $H = 0.581$). Four trophic guilds were identified: carnivores (8 species), omnivores (5 species), detritivores (3 species), and planktivores (2 species). Carnivores formed the largest group (47%), including *Channa marulius*, *Sperata seenghala*, and *Ompok bimaculatus*. We conclude that Indrabati Dam supports moderate fish diversity with clear seasonal patterns, and winter season at Station 2 showed the highest species richness and diversity.

Keywords: Fish diversity, Seasonal variation, Indrabati Dam, Trophic guilds, Water quality, Odisha

Introduction

Inland freshwater reservoir ecosystems are among the most diverse and productive ecosystems on Earth. They play a vital role in maintaining biodiversity, ecological balance, and supporting human livelihoods. Reservoirs are man-made artificial ecosystems that provide many ecological functions such as nutrient cycling, habitat support, and societal benefits including fish production, hydroelectric power, irrigation, and drinking water supply (Wetzel, 2001) [1]. In India, large freshwater reservoirs associated with the monsoon period represent some of the most important inland fisheries, contributing significantly to fish production and providing livelihoods for many rural communities (Sugunan, 1995) [2].

The Indrabati Dam is located within the Indravati River basin in Nabarangpur district, *Odisha*. It is a multi-purpose reservoir that supports fisheries, agriculture, and water storage. Despite its ecological and socio-economic significance, there is a significant lack of scientific data documenting the fish assemblages, seasonal fluctuations, and trophic structure in this reservoir. Understanding such systems is important because reservoirs are constantly subjected to physical, chemical, and biological alterations due to seasonal cycles, hydrological variability, and anthropogenic pressures.

Tropical freshwater ecosystems possess marked seasonality. In India, distinct pre-monsoon, monsoon, and post-monsoon periods regulate water levels, nutrient inflow, habitat structure, and productivity (Jhingran, 1991) [3]. Hydrological changes affect key physicochemical parameters such as temperature, dissolved oxygen, turbidity, pH, conductivity, and nutrient concentrations, thereby determining the composition, distribution, and abundance of fish communities (Welcomme, 2001) [4]. Monsoon inflows enhance habitat complexity and plankton abundance, offering suitable conditions for planktivorous fish and allowing spawning of many indigenous species. The pre-monsoon period is often characterized by low water levels, high temperature, reduced dissolved oxygen, and heightened competition for resources.

Fish diversity provides important insights into ecological integrity and environmental health of aquatic ecosystems. High species richness indicates stable habitat, functioning trophic networks, and high resilience, while declines in diversity or presence of only tolerant species may indicate ecological stress or habitat degradation (Karr, 1981; Dudgeon *et al.*, 2006) [6, 5]. The eastern Indian river basins, including *Odisha*, are areas of high biodiversity due to many endemic and native fish species (Sarkar *et al.*, 2010) [7]. Similar patterns of seasonal environmental variation affecting aquatic communities have been documented in other river ecosystems (Dar *et al.*, 2022; Ratnakar *et al.*, 2024) [8, 9].

In addition to species richness, feeding guild structure provides a functional ecological perspective. Feeding guilds categorize fish into groups based on feeding habits (herbivores, omnivores, carnivores, planktivores,

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detritivores, insectivores), which helps understand energy flow, trophic interactions, and ecosystem stability (Winemiller *et al.*, 1998) [10]. Seasonal changes in food availability (plankton blooms, detritus buildup, insect emergence) can lead to significant shifts in guild dominance. Given this background, we designed this study with the following objectives: To investigate fish species' seasonal diversity and composition in Indrabati Dam

Materials and Methods

Study area

The research took place in Indrabati Dam, located in the Indravati River basin, Nabarangpur district, Odisha. Four sampling stations were selected representing different areas of the dam: inflow into the reservoir, middle of the reservoir, near the dam, and a peripheral environment. Samples were collected over one full annual cycle (2025) covering three primary seasons: winter, summer, and monsoon.

Sampling design and frequency

We used a seasonal sampling design at each station during three seasons (winter, summer, monsoon). Three replicate samples for fish and three replicate water samples were collected per station per visit to provide within-station replication. Sampling effort was standardized for each gear type.

Fish sampling methods

A combination of gear types was used to sample different habitats and size classes:

- **Gill nets** with mesh sizes 10 mm, 20 mm, 30 mm, 40 mm, and 60 mm set for 2 hours
- **Seine nets** (10-20 m length) with cod-end mesh sizes 1-5 mm for littoral areas
- **Cast nets** in shallow nearshore areas (3-5 throws per replicate)
- **Local catch surveys** to complement field sampling

Field processing of fish

Fish were identified to species level using regional keys (Jhingran, 1991; Mogalekar, 2018) [3]. Representative specimens were photographed.

Feeding guild analysis

Stomach contents were examined under a stereomicroscope. Prey items were identified to the lowest feasible taxonomic level. The Index of Relative Importance (IRI) was calculated for each prey category:

$$IRI = (N\% + V\%) \times F\%$$

Where $N\%$ = numerical percentage, $V\%$ = volumetric percentage, $F\%$ = frequency of occurrence. Trophic guilds (planktivore, detritivore, herbivore, omnivore, carnivore/insectivore) were assigned based on dominant food items.

Water quality analysis

Surface water samples (0.5 m below surface) were collected in clean, pre-rinsed polyethylene bottles. Temperature, DO, and pH were measured in situ using portable probes. Nutrients were analyzed in the laboratory. Three replicates were collected per station per visit.

Diversity indices

We calculated:

- Shannon-Weaver diversity index (H) = $-\sum (p_i \times \ln p_i)$
- Pielou's Evenness index (E) = $\frac{H}{\ln S}$
- Simpson index ($1-\lambda$) = $1 - \sum (\pi_i)^2$

$$\text{Margalef richness index} = \frac{S - 1}{\ln N}$$

Where π = relative abundance of i th taxon, S = total number of species, N = total number of individuals.

Results

3.1 Water quality parameters

Water quality parameters showed seasonal variation across all stations.

Air temperature ranged from 23-38 °C (lowest in winter, highest in summer). Water temperature ranged from 21-32 °C, following similar seasonal patterns. pH ranged from 7.1-8.5, indicating slightly alkaline conditions throughout the year. DO ranged from 5.6-8.0 mg/L, with lowest values in summer due to higher temperatures. TDS and conductivity peaked during monsoon due to runoff. Nitrate and phosphate levels were highest during summer at Station 4, indicating nutrient input from surrounding areas.

Fish species composition

A total of 17 fish species belonging to 4 orders and 8 families were recorded. Cypriniformes was the most dominant order with 9 species (53% of total), which is typical for Indian freshwater ecosystems. Siluriformes ranked second with 4 species (23%), followed by Perciformes with 3 species (18%). Decapoda (prawn) contributed 1 species (6%). The dominance of Cypriniformes reflects their adaptability to a wide range of freshwater habitats.

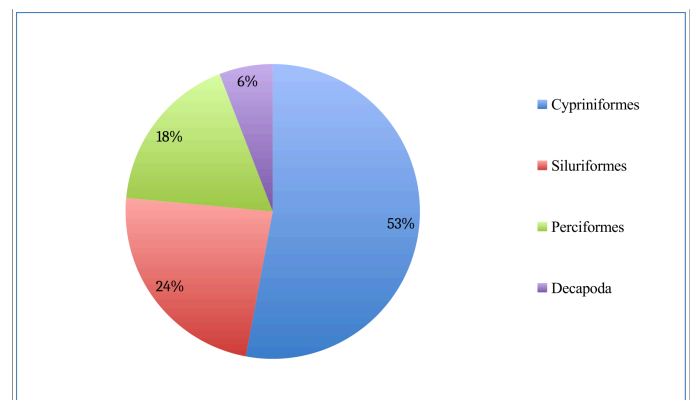


Figure 1.1. Order wise (%) fish species composition

Species density distribution

Station 3 had the highest number of species (11) during winter, followed by Station 2 (10). Station 4 consistently showed the lowest species richness across all seasons, with only 2 species during summer. This indicates that the peripheral area (Station 4) is less suitable for fish diversity, possibly due to anthropogenic disturbance or habitat degradation.

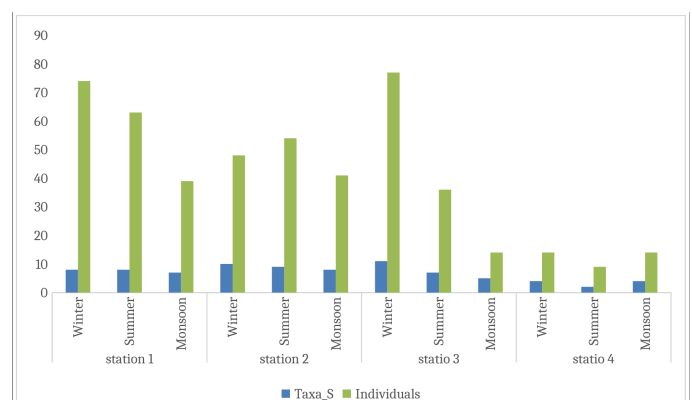


Figure 4.17. Order showing density of fishes

Diversity indices

Shannon diversity index (H') was highest at Station 2 during winter (2.079) and monsoon (2.379), indicating rich and balanced fish diversity. The lowest Shannon value was at Station 4 during summer (0.581), indicating poor diversity and possible environmental stress. Simpson index (1-D) values close to 1 indicate high diversity and low

dominance. Station 2 during monsoon showed the highest Simpson value (0.9057), meaning no single species dominated the community. Evenness values were high (> 0.8) at most stations, indicating fairly uniform distribution of individuals among species. Margalef richness index was highest at Station 2 across all seasons (2.198-2.325), confirming this station as the most species-rich area.

Table 1.1. Temporal variation in water quality of Indrabati Dam during 2025

Season/ Sites		AT	WT	pH	TDS	EC	TA	Cl ⁻	CO ₂	DO	TH	Ca	Mg	NO ₂ ⁻	NO ₃ ⁻	PO ₄ ⁻
Winter	S1	24	22	8	190	305	38	17	0	8	140	75	15.7	0.65	0.97	0.45
	S2	25	23	8.2	210	320	47	16.5	0	7.8	155	77.5	18.8	0.67	0.86	0.34
	S3	23	22	7.6	209	340	85	48	9	7.5	220	116	25.2	0.54	1.44	0.64
	S4	25	23	7.7	240	350	92	54	0	7.7	218	121	23.5	0.75	1.5	0.53
Summer	S1	35	31	7.2	180	290	40	26	0	7.1	150	78.5	17.3	0.7	0.98	0.44
	S2	34	29	7.8	178	285	81	31	0	7	139	68	17.2	0.45	0.92	0.32
	S3	37	30	7.1	220	330	82	69	11	5.7	260	140	29.1	0.62	1.47	0.54
	S4	38	28	7.2	230	340	95	65.9	13	6.5	265	139.5	30.4	0.86	1.76	0.61
Monsoon	S1	29	24	8.2	235	365	33	40.5	11	7.4	150	78	17.4	0.6	0.79	0.47
	S2	31	25	8.3	250	390	37	28.9	0	6.7	145	76.5	16.6	0.65	0.78	0.57
	S3	30	24	7.5	245	385	71	49.5	11	6.3	215	117.5	23.6	0.79	0.61	0.68
	S4	28	24	7.4	280	410	94	70.9	0	6.2	245	130	27.9	0.55	0.68	0.67
Average		29.9	25.4	7.6	222.2	342.5	66.2	43.1	4.5	6.9	191.8	101.4	21.8	0.65	1.06	0.52
Standard Deviation		4.9	3.06	0.40	29.2	37.9	24	18.6	5.4	0.68	47.78	26.9	5.1	0.10	0.36	0.11

Table 1.2. Fish species encountered from Indrabati Dam

S.No.	Order	Family	Scientific Name	Common Name
1	Cypriniformes	Cyprinidae	<i>Labeo bata</i>	Bata
			<i>Labeo Rohita</i>	Rohu
			<i>Catla-Catla</i>	Catla
			<i>Cirrhinus Cirrhosus</i>	Mirgal Carp
			<i>Cyprinus Carpio</i>	Common Carp
			<i>Cirrhinus reba</i>	Naren
			<i>Rasbora doniconius</i>	Zhan zara
			<i>Osteobroma cotio</i>	Gudgudi
			<i>Hypophthalmichthys Molitrix</i>	Silver Carp
			<i>Fenneropenaeus Indicus</i>	prawn
2	Decapoda	Penaeidae		
3	Perciformes	Channidae	<i>Channa punctata</i>	Dhadkya
			<i>Channa marulius</i>	Marai
			<i>Parambassis range</i>	Indian glass fish
4	Siluriformes	Ambassidae		
		Bagridae	<i>Sperata Seenghala</i>	Singhara
		Aniliidae	<i>Clupisoma garua</i>	Cat fish
		Clariidae	<i>Heteropneustes fossili</i>	Shikker
		Siluridae	<i>Ompokbimaculatus</i>	Patava

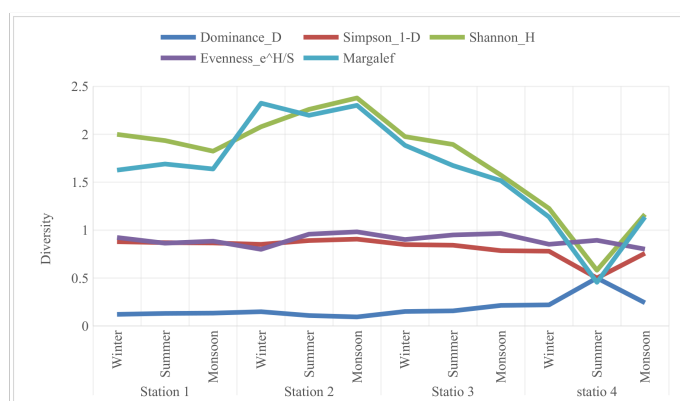


Figure 1.3. Showing diversity of fishes.

Trophic guild structure

Carnivores formed the largest trophic guild (8 species, 47%), including top predators like *Channa marulius*, *Sperata seenghala*, and *Ompok bimaculatus*. Omnivores ranked second (5 species, 29%), including commercially important carps like *Labeo rohita* and *Cyprinus carpio*. Detritivores (2 species, 12%) included *Cirrhinus cirrhosus* and *Labeo bata*, which play important roles in nutrient recycling by consuming bottom detritus. Planktivores (2 species, 12%) included *Catla catla* and *Hypophthalmichthys molitrix*, which help control plankton populations. The balanced representation of different trophic levels indicates a functionally diverse and relatively stable ecosystem.

Table:1.3- Species-wise Trophic Guild Assignment

S.No.	Scientific Name	Common Name	Trophic / Ecological Guild	Justification
1	<i>Labeo bata</i>	Bata	Omnivore / Detritivore	Bottom feeder; feeds on detritus, algae, diatoms.
2	<i>Labeo rohita</i>	Rohu	Omnivore	Feeds on phytoplankton, zooplankton & detritus.
3	<i>Catla catla</i>	Catla	Planktivore / Omnivore	Surface feeder; feeds on zooplankton & phytoplankton.
4	<i>Cirrhinus cirrhosus</i>	Mrigal carp	Detritivore	Specialized bottom detritus feeder.
5	<i>Cyprinus carpio</i>	Common carp	Omnivore / Detritivore	Generalist feeder; mud & benthos feeder.
6	<i>Cirrhinus reba</i>	Naren	Detritivore / Omnivore	Feeds on detritus, algae & small organisms.
7	<i>Rasbora daniconius</i>	Zhan zara	Omnivore	Feeds on insects, crustaceans & plant matter.
8	<i>Osteobrama cotio</i>	Gudgudi	Omnivore	Consumes insects, crustaceans & algae.
9	<i>Hypophthalmichthys molitrix</i>	Silver carp	Planktivore	Filter-feeder specializing in phytoplankton.
10	<i>Fenneropenaeus indicus</i>	Indian prawn	Carnivore	Feeds on worms, crustaceans, small fish.
11	<i>Channa punctata</i>	Dhadkya	Carnivore	Piscivorous; feeds on fish, frogs, insects.
12	<i>Channa marulius</i>	Marai	Carnivore / Top predator	Strong piscivore; apex predator in reservoirs.
13	<i>Parambassis ranga</i>	Indian glass fish	Carnivore / Insectivore	Feeds on larval insects & small crustaceans.
14	<i>Sperata seenghala</i>	Singhara	Carnivore	Predatory catfish feeding on fish & crustaceans.
15	<i>Clupisoma garua</i>	Catfish	Carnivore	Feeds on aquatic insects, small fish & larvae.
16	<i>Heteropneustes fossilis</i>	Shikker	Omnivore / Carnivore	Eats insects, small fish, larvae & detritus.
17	<i>Ompok bimaculatus</i>	Patava	Carnivore	Predatory; consumes fish, insects & larvae.

Discussion

Our study recorded 17 fish species from 4 orders and 8 families in Indrabati Dam. The dominance of Cypriniformes (53%) is typical for Indian freshwater ecosystems. Cyprinids dominate because of their high adaptability, varied feeding strategies, and large reproductive capacity (Jayaram, 2010) [11]. Similar cyprinid dominance has been observed in other freshwater reservoirs across India (Sarkar *et al.*, 2013) [12]. The presence of commercially important species like *Labeo rohita*, *Catla catla*, and *Cirrhinus cirrhosus* indicates the reservoir's fisheries potential.

Water quality parameters showed clear seasonal patterns. Water temperature ranged from 21-32 °C, within the optimal range for tropical freshwater fish. Dissolved oxygen was lowest during summer (5.7-6.5 mg/L) due to higher temperatures reducing oxygen solubility, but remained above critical levels for fish survival. pH remained slightly alkaline (7.1-8.5) throughout the year, suitable for most freshwater fish species. Higher TDS, conductivity, nitrate, and phosphate during monsoon indicate nutrient input from catchment runoff. Similar patterns of seasonal environmental variation affecting aquatic communities have been documented in other river ecosystems (Dar *et al.*, 2022; Ratnakar *et al.*, 2024) [8, 9].

Fish diversity was highest during winter at Station 2 (Shannon $H = 2.079$) and Station 2 during monsoon (Shannon $H = 2.379$). High diversity during winter can be attributed to stable water conditions, lower temperature stress, and adequate food availability. The high diversity during monsoon reflects increased water levels, habitat expansion, and nutrient input supporting primary productivity. Station 2 (middle of the reservoir) consistently showed the highest diversity, likely due to good riparian vegetation providing nutrient sources and well-balanced habitat substrate (Legendre, 1998; Medupin, 2020) [13, 14].

The lowest diversity was recorded at Station 4 during summer (Shannon $H = 0.581$). This station likely experiences higher anthropogenic pressure, lack of riparian vegetation, and poorer habitat qual-

ity (Patang *et al.*, 2018) [15]. Summer conditions (high temperature, low water level, reduced DO) further stress fish populations, leading to lower diversity.

The trophic guild analysis revealed a balanced ecosystem with carnivores (47%), omnivores (29%), detritivores (12%), and planktivores (12%). The presence of top predators like *Channa marulius* and *Sperata seenghala* indicates a healthy food web. Detritivores like *Cirrhinus cirrhosus* play important roles in nutrient recycling. Planktivores like *Catla catla* help control plankton populations. This functional diversity contributes to ecosystem stability and resilience (Winemiller *et al.*, 1998) [10].

Conclusion

This one-year study assessed seasonal variation in fish diversity, water quality, and feeding guild structure in Indrabati Dam, Odisha. A total of 17 fish species belonging to 4 orders and 8 families were recorded. Cypriniformes dominated with 9 species (53%), followed by Siluriformes (4 species, 23%), Perciformes (3 species, 18%), and Decapoda (1 species, 6%). Water quality parameters showed clear seasonal patterns: temperature (21-32 °C), pH (7.1-8.5), DO (5.6-8.0 mg/L), and TDS (178-290 ppm), with higher nutrient levels during monsoon due to catchment runoff. Fish diversity was highest during winter at Station 2 (Shannon $H = 2.079$) and during monsoon at Station 2 (Shannon $H = 2.379$), while the lowest diversity was recorded at Station 4 during summer (Shannon $H = 0.581$). Four trophic guilds were identified: carnivores (8 species, 47%), omnivores (5 species, 29%), detritivores (2 species, 12%), and planktivores (2 species, 12%). Carnivores formed the largest group, including top predators like *Channa marulius*, *Sperata seenghala*, and *Ompok bimaculatus*, indicating a healthy food web. The balanced representation of different trophic levels suggests a functionally diverse and relatively stable ecosystem. We conclude that Indrabati Dam supports moderate fish diversity with clear seasonal patterns, and Station 2 (middle of the reservoir) during winter and monsoon showed the

highest species richness and diversity, while Station 4 requires conservation attention due to consistently low diversity.

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How to cite this article: Panda A, Mishra R, Saxena S. Seasonal variation in fish diversity and feeding guild structure in Indrabati Dam, Odisha. *International Journal of Veterinary Sciences and Animal Husbandry*. 2026;11(9):31-35. doi: <https://www.doi.org/10.22271/veterinary.2026.v11.i9a.3771>