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Status of fish diversity in Surha Taal, a natural lake in the floodplains of river Ganga, in Ballia District, Uttar Pradesh, India

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ABSTRACT

The study presents the status of fish diversity, abundance and habitat structure of Surha Lake, which is a perennial and natural lake fed by the river Ganga. The study was conducted between 2011 to 2013 covering pre and post-monsoon seasons. In total, 4,852 individual fish specimens were collected representing 66 fish species belonging to 23 families. The species diversity comprised 65 species in pre-monsoon and 60 species in post-monsoon seasons ($p < 0.05$). The highest species diversity was recorded for the family Cyprinidae (22), followed by Bagridae (7). An assessment of conservation status of 66 fish species as per IUCN Red List 2019 criteria listed 6 species under near threatened (NT), 54 under least concern (LC) and 2 species under vulnerable (VU) category. The study reports several commercially important species under near threatened (*Chitala chitala*, *Labeo pangusia*, *Ompok bimaculatus*, *Ompok pabda*, *Ailia coila* and *Bagarius bagarius*) which makes Surha Taal an important natural lake from fishery management point of view. The study also prioritised different habitat types important for different species. The slow water in the mid-channel areas of the lake were categorised as important habitats for near threatened and vulnerable fish species like *C. chitala*, *B. bagarius* and *Wallago attu*, which can be prioritised for population level management.

Keywords: Conservation status, Fish diversity, Ganga River basin, Surha Taal

Surha Tal, a tropical oxbow lake which was declared as bird sanctuary in 1991, forms an important source of fisheries in Ballia District, Uttar Pradesh, India. The lake provides diverse habitat for a large number of aquatic birds, mostly winter migrants from the Central Himalayas as well as for numerous fish and insect species (Jha and Chaudhary, 2011). At present, the lake is under pressure due to indiscriminate fishing, exotic species invasion, water abstraction and infestation of submerged aquatic weeds. The lake has high assimilative capacity due to which it is free from pollutants and has good potential for pisciculture and as drinking water source (Sharma and Soni, 2013).

The Surha Lake is an important habitat for different groups of fishes like the Indian major carps, minor carps, catfishes, featherbacks and forage fishes. Very few studies on fish diversity from this lake are available. Previous study reported 41 fish species belonging to 16 families and 25 genera (Singh *et al.*, 2009) where Cypriniformes reportedly dominated which comprised 23 species including 4 exotics. Earlier to that, Swarup and Singh (1975) listed 51 fish species from this lake. The amalgamation of physical and biological processes that

results from different biotic pressures is now declining the ecological quality thus impacting the fish biodiversity. Therefore, it was felt essential to monitor the fish diversity of this lake which is a potential source of livelihood of fishermen and local communities.

The present study was carried out to assess the fish biodiversity structure employing different diversity indices, along with water quality parameters. The study also provides the conservation status of collected fish fauna as per IUCN red list criteria 2019.

Surha Tal, an oxbow lake in the floodplains of the river Ganga (Fig.1) extends between the parallels 25°48' and 25°52'N and 84°8' and 84°13'E. The lake is situated about 7 km north of Ballia town covering Beruarbari, Hanumanganj and Dubhar revenue blocks. The economically important resources related to the lake are fisheries, agriculture and integrated farming as it offers multiple avenues and dominant water use for irrigation and other domestic purposes. The lake is well connected with the river Ganga through Katehar Nullah (approximately of 8 km stretch) which acts both as inlet and outlet depending upon the water level of the river Ganga. A concrete barrier with wire mesh screen is provided in the nullah to prevent

entry of aquatic weeds mainly *Eichhornia crassipes*. The lake encompasses an area of 3,422 ha at full storage level (FSL) and 1,260 ha at dead storage level (DSL) with an average area of approximately 2,000-2,200 ha. The lake expands consequent to the incursion of water from the inlet and annual precipitation, and inundates vast low lying areas. During the late winter and summer, the lake becomes a chain of discontinuous water patches with intermittent islands. A sizeable quantity of water is drawn for irrigating the rabi crops in the district. The water fowls that feed on the small forage fishes contribute to the nutrient enrichment of the lake through the droppings.

Fish sampling in the lake was conducted at monthly intervals during pre-monsoon (January to April) and post-monsoon (September to December) seasons. Collections were made with the help of cast net, gillnet and other indigenous nets in the shoreline and middle areas of the lake. Voucher specimens of the collected samples were preserved and identified following Jayaram (2010) and Talwar and Jhingran (1991) and the species names were further validated with reference to Catalogue of Fishes (Fricke *et al.*, 2020). The threat assessment of the identified fishes was done as per IUCN Red List criteria 2019. For water quality assessments, a total of four sampling surveys were done, two each in pre and post-monsoon seasons. The water quality measurements

were carried out in the field with the help of multi-parameter kit (YSI EX03). The data on 19 physico-chemical parameters including pH, water temperature (°C), water depth (cm), dissolved oxygen (mg l⁻¹), free carbon dioxide (mg l⁻¹), carbonate (mg l⁻¹), bicarbonate (mg l⁻¹), hardness (mg l⁻¹), calcium (mg l⁻¹), magnesium (mg l⁻¹), chloride (mg l⁻¹), iron (mg l⁻¹), silicate (mg l⁻¹), phosphate (mg l⁻¹), nitrate (mg l⁻¹), dissolved organic matter (mg l⁻¹), TDS (mg l⁻¹) and specific conductance (µmhos cm⁻¹) were recorded.

Species diversity was assessed using four different indices *viz.*, species richness, Shannon-Wiener diversity, Evenness and Dominance indices. Shannon-Wiener diversity index (Shannon and Weaver, 1949; Ramos *et al.*, 2006) considers both the number of species and the distribution of individuals among species. The Shannon-Wiener diversity was calculated using the formula:

$$H = - \sum_{i=1}^S P_i * \log P_i$$

where, S is the total number of species and P_i is the relative cover of *i*th species.

Margalef index (d) (Margalef, 1968) was used to measure species richness using the formula:

$$d = (S/1) = \log (N);$$

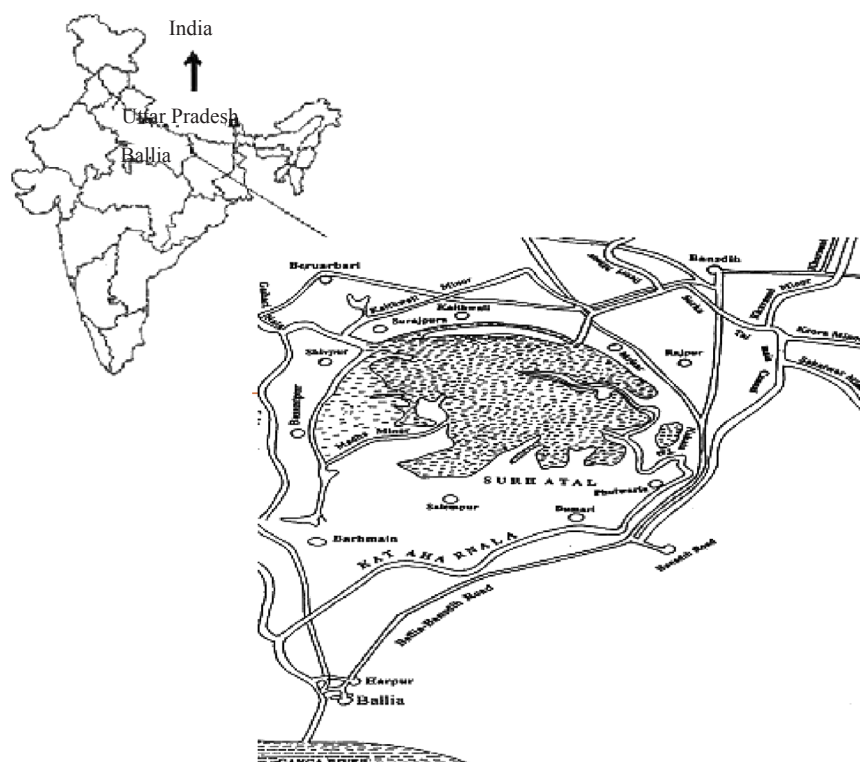


Fig.1. Location map of Surha Taal, Uttar Pradesh, India (Source: Pandey *et al.*, 2010)

where, S is the total no. of species and N is the total no. of individuals.

Buzas and Gibson's evenness (Harper, 1999) was measured using the formula:

$$E = e^H/S$$

where, E is the measure of evenness or equitability, H is the diversity measure and S is species richness.

The dominance index (Harper, 1999) was measured to determine whether or not a particular fish species dominate in a particular aquatic ecosystem, and can be a useful index of resource monopolisation by a superior competitor, particularly in communities that have been invaded by exotic species. This index was determined using the formula:

$$D = \sum_i \left(\frac{n_i}{n} \right)^2$$

where n is the number of individuals of i^{th} species

Fish habitats were categorised as open river, slow water, fast water, mid channel, deep pool and lateral scour pool as per the description by Bain and Stevenson (1999). After sampling, the fish diversity was categorised based on segregation of data under different habitat categories.

The average values of water quality parameters are given in Table 1.

A total of 4,852 individual fishes were collected, that represented 66 fish species belonging to 21 families (Table 2). A total of 2,937 individuals representing 65 species were collected in pre-monsoon and 1,915 individuals representing 60 species were collected in post-monsoon. Maximum number of individuals was recorded for *Amblypharyngodon mola* (355 individuals) and minimum for *Tariqilabeo latius* (1 individual) and *Ophichthys cuchia* (1 individual).

Results of the data analyses showed higher species diversity (65 species) in pre-monsoon compared to post-monsoon season (60 species) (Table 3). The Shannon-Wiener diversity index, Margalef richness, dominance index and evenness index for pre and post-monsoon seasons are presented in Table 3.

An assessment of conservation status of the 66 species as per IUCN Red List 2019 indicated 6 species under near threatened (NT), 2 under vulnerable (VU), 54 under least concern (LC), 3 under not evaluated (NE) and one under data deficient (DD) category (Table 2).

Habitat of the Surha Lake was classified into seven micro habitat categories viz., open river, slow water, fast water, mid channel, deep pool and lateral scour pool. The

Table 1. Mean values of physico-chemical parameters recorded from the lake during pre and post-monsoon seasons

Parameters	Values (Mean±SD)
Water temperature (°C)	22.85 ± 0.64
Depth (cm)	222.5 ± 3.53
Transparency (cm)	81.5 ± 2.12
pH	8.3 ± 0.14
Dissolved oxygen (mg l ⁻¹)	10 ± 0.28
Carbonate (mg l ⁻¹)	19.1 ± 0.85
Bicarbonate (mg l ⁻¹)	80.75 ± 0.64
Hardness (mg l ⁻¹)	80.95 ± 0.49
Calcium (mg l ⁻¹)	39.5 ± 0.14
Magnesium (mg l ⁻¹)	41.55 ± 0.35
Chloride (mg l ⁻¹)	20.8 ± 0.85
Iron (mg l ⁻¹)	0.6 ± 0.14
Silicate (mg l ⁻¹)	2.6 ± 0.28
Phosphate (mg l ⁻¹)	0.13 ± 0.01
Nitrate (mg l ⁻¹)	0.31 ± 0.02
Dissolved organic matter (mg l ⁻¹)	2.39 ± 0.16
TDS (mg l ⁻¹)	76.5 ± 1.77
Conductivity (µmhos cm ⁻¹)	153.8 ± 0.85

slow water habitats of the lake showed maximum species richness (28) whereas, deep pools were assessed to have minimum species richness (5) (Fig. 2).

The present study highlights that physical habitat variables play an important role in the distribution of freshwater fishes in the lake. A total of 66 species belonging to 21 families were recorded from the lake which is higher than the previous reports (Srivastava and Srivastava, 2009). Among all the families, Cyprinids dominated, with varied species structure including threatened as well as economically important species. Some of the important species which were not reported during the

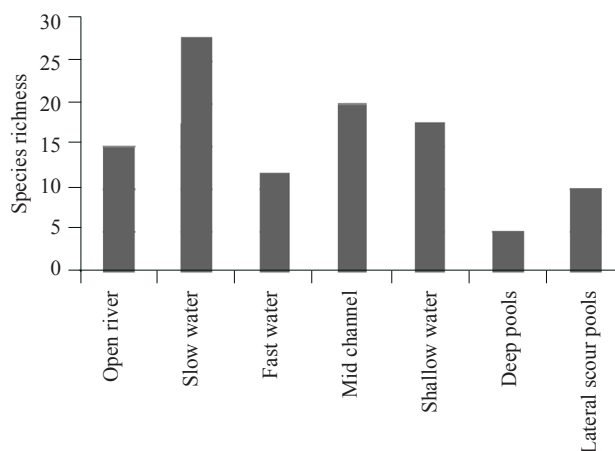


Fig. 2. Diversity of fish species (species richness) recorded in different habitats of the lake

Table 2. List of species with number of individuals caught in pre and post-monsoon seasons

Sl. No.	Fish species	Total	Pre-monsoon	Post-monsoon	Conservation status* (IUCN)
	Family/Species				
	Notopteridae				
1	<i>Chitala chitala</i>	5	4	1	NT
2	<i>Notopterus notopterus</i>	6	4	2	LC
	Clupeidae				
3	<i>Gudusia chapra</i>	238	138	100	LC
	Engraulidae				
4	<i>Setipinna phasa</i>	249	109	140	LC
	Cyprinidae				
5	<i>Amblypharyngodon mola</i>	355	225	130	LC
6	<i>Cabdio morar</i>	60	40	20	LC
7	<i>Labeo catla</i>	42	30	12	LC
8	<i>Salmostoma bacaila</i>	35	27	8	LC
9	<i>Laubuka laubuca</i>	30	20	10	LC
10	<i>Chagunius chagunio</i>	22	14	8	LC
11	<i>Cirrhinus cirrhosus</i>	40	21	19	VU
12	<i>Cirrhinus reba</i>	136	86	50	LC
13	<i>Tariqilabeo latius</i>	1	1	0	LC
14	<i>Labeo bata</i>	143	83	60	LC
15	<i>Labeo calbasu</i>	77	55	22	LC
16	<i>Labeo dyocheilus</i>	2	2	0	LC
17	<i>Labeo pangusia</i>	5	5	0	NT
18	<i>Labeo rohita</i>	71	42	29	LC
19	<i>Osteobrama cotio</i>	50	36	14	LC
20	<i>Systomus sarana</i>	124	84	40	LC
21	<i>Puntius sophore</i>	300	200	100	LC
22	<i>Pethia ticto</i>	225	164	61	LC
23	<i>Puntius puntio</i>	19	11	8	NE
24	<i>Rasbora daniconius</i>	100	66	34	LC
25	<i>Securicula gora</i>	136	90	46	LC
26	<i>Raiamas bola</i>	4	4	0	LC
	Botiidae				
27	<i>Botia lohachata</i>	10	8	2	NE
28	<i>Botia dario</i>	3	0	3	LC
	Bagridae				
29	<i>Mystus cavasius</i>	200	114	86	LC
30	<i>Mystus tengara</i>	140	85	55	LC
31	<i>Mystus vittatus</i>	190	105	85	LC
32	<i>Mystus bleekeri</i>	10	7	3	LC
33	<i>Rita rita</i>	10	3	7	LC
34	<i>Sperata aor</i>	30	20	10	LC
35	<i>Sperata seenghala</i>	90	60	30	LC
	Siluridae				
36	<i>Ompok bimaculatus</i>	8	6	2	NT
37	<i>Ompok pabda</i>	7	5	2	NT
38	<i>Wallago attu</i>	46	25	21	VU

Contd.....

Sl. No.	Fish species	Total	Pre-monsoon	Post-monsoon	Conservation status* (IUCN)
	Schilbeidae				
39	<i>Ailia coila</i>	50	28	22	NT
40	<i>Clupisoma garua</i>	195	106	89	LC
41	<i>Eutropiichthys vacha</i>	144	86	58	LC
42	<i>Pachypterus atherinoides</i>	45	30	15	NE
	Sisoridae				
43	<i>Bagarius bagarius</i>	4	4	0	NT
44	<i>Gagata cenia</i>	109	72	37	LC
	Heteropneustidae				
45	<i>Heteropneustes fossilis</i>	10	6	4	LC
	Belonidae				
46	<i>Xenentodon cancila</i>	10	8	2	LC
47	<i>Trichogaster fasciata</i>	30	17	13	LC
	Osphronemidae				
48	<i>Trichogaster lalius</i>	29	19	10	LC
	Ambassidae				
49	<i>Chanda nama</i>	100	60	40	LC
50	<i>Parambassis ranga</i>	70	45	25	LC
	Sciaenidae				
51	<i>Johnius coitor</i>	110	65	45	LC
52	<i>Johnius gangeticus</i>	72	40	32	DD
	Nemacheilidae				
53	<i>Paracanthocobitis botia</i>	60	35	25	LC
	Mugilidae				
54	<i>Rhinomugil corsula</i>	80	20	60	LC
55	<i>Minimugil cascasia</i>	158	97	61	LC
	Gobiidae				
56	<i>Glossogobius giuris</i>	95	50	45	LC
	Channidae				
57	<i>Channa marulius</i>	20	12	8	LC
58	<i>Channa punctata</i>	46	22	24	LC
59	<i>Channa striata</i>	30	14	16	LC
	Mastacembelidae				
60	<i>Macrognathus aral</i>	12	8	4	LC
61	<i>Macrognathus pancalus</i>	30	25	5	LC
62	<i>Mastacembelus armatus</i>	49	15	34	LC
	Synbranchidae				
63	<i>Ophichthys cuchia</i>	1	1	0	LC
	Tetraodontidae				
64	<i>Leiodon cutcutia</i>	27	20	7	LC
	Clariidae				
65	<i>Clarias magur</i>	10	8	2	LC
	Pangasiidae				
66	<i>Pangasius pangasius</i>	27	15	12	LC

*NT-Near threatened, LC-Least concern, NE-Not evaluated, VU-Vulnerable, DD-Data deficient

earlier studies, but observed in good abundance include *C. chitala*, *N. notopterus*, *C. chagunio*, *L. dyocheilus*, *R. rita*, *S. seenghala*, *O. pabda*, *B. bagarius*, *M. cuchia* and *P. pangasius*. Sarkar *et al.* (2007) reported a total

of 46 species from a protected area *i.e.* Samaspur Bird Sanctuary and showed 28.26% of species under threatened category as per the IUCN. However, our study in Surha Lake provides different results as compared

Table 3. Species diversity, dominance, evenness and richness for pre and post-monsoon seasons

	Pre-monsoon	Post-monsoon
Taxa	65	60
No of individuals	2937	1915
Dominance index (D)	0.03281	0.03389
Shannon Diversity index (H)	3.688	3.634
Evenness index (E)	0.6146	0.6313
Margalef richness (M)	8.015	7.807

to a study conducted in Rihand Dam which reported 42 fish species (Khan 2000).

An assessment of conservation status of the species as per IUCN Red List criteria 2020 indicated 6 species under near threatened and 2 species under vulnerable category in the Surha Lake. Therefore, there is need for implementing better management strategies for protection of threatened fish species like *C. chitala*, *L. pangusia*, *O. bimaculatus*, *O. pabda*, *A. coila*, *B. bagarius*, *W. attu* and *C. cirrhosus*.

The result on fish diversity structure in different habitats of the lake provides a better understating for habitat management. The slow water in the mid-channel areas of the lake showed highest fish diversity of large species which can be considered important for sustenance of those fishes. Studies conducted on large tributaries of Ganga also showed importance of these areas for large river fishes like *C. chitala*, *W. attu* and *B. bagarius* (Dubey *et al.*, 2012). Since the lake was reported to be susceptible for exotic species invasion, managing the local fish diversity in the lake should be given priority.

The physico-chemical parameters recorded during the study appeared conducive for good biological productivity. A comparison on the diversity and species richness between pre and post-monsoon season was found to vary slightly, which might be due to impact of climatic and seasonal variations.

The present study reports a rich fish diversity of 66 species belonging to 23 families in the Surha Lake which include several threatened as well as economically important species. The lake provides a good habitat for fishes; however, there are several challenges such as invasion by exotic species and water abstraction activities. The water quality of the lake was found favourable for the living aquatic biota. The study provides a range of diversity indices which would be important in quantifying any changes amongst the common and rare species and also for better management of natural fish populations for biodiversity conservation.

Acknowledgements

Authors are grateful to the Director, ICAR-NBFGR, Lucknow for providing necessary facilities to carry out the work and Uttar Pradesh State Biodiversity Board, Lucknow for financial assistance.

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