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A study on ichthyofaunal diversity and water quality of Bakhira Lake, Uttar Pradesh, India

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Abstract
The ichthyofaunal study was conducted on the seasonal basis from October 2014 to November 2015 in relation to water quality of Bakhira Lake. The study exposed that physicochemical parameters of Bakhira Lake were agreeable for 45 commercially importance fish species, belonging to 7 orders, 17 families, and 32 genera. The Cypriniformes were dominant with 18 species, followed by Siluriformes (12), Perciformes (9), Clupeiformes (3), Osteoglossiformes, Mugiliformes and Synbranchiformes each with 1 species. About their conservation condition, 38 species were least concern, 1species was vulnerable, 3 species were near threatened and 3 species was data deficient. The water quality parameters such as temperature, pH, alkalinity, hardness, dissolved oxygen, ammonia, nitrate, nitrite and phosphate were recorded and found to be good for aqua life.

Keywords: Bakhira Lake, Ichthyofaunal diversity, conservation status, economic value

Introduction
Bakhira Lake is the largest natural lake of Uttar Pradesh, situated 44 km east of Gorakhpur city. It is a vast stretch of water body expanding over an area of 29 km^2. The landscape and terrain of the wetland is almost flat, representing a typical 'tarai' landscape. This is an important lake of eastern UP, which provides wintering and staging ground for a number of migratory waterfowls and is a breeding ground for resident birds. The villagers from the surrounding villages depend on the lake for their livelihood in the form of fishing, agricultural activities and fuel wood collection. The aquatic ecosystem is highly dependent on water quality and biological diversity. Physicochemical parameters of water play a significant role in the biology and physiology of fish [1]. Lakes and reservoirs contribute to the single largest inland fishery resources in terms of both size and production potential. Fishes are the important indicator of aquatic ecosystem and occupy a remarkable position from a socioeconomic point of view. Decline in aquatic diversity as a result of overfishing, insufficient management practices and habitat degradation, which reduces the chances of its sustainability [2]. Environmental changes are either due to natural causes or human activity. At present, most lakes and rivers in the world are used by people for multiple purposes such as waste disposal, industrial processes, fisheries, recreation, etc. identified habitat alteration and destruction as the major cause of most extinction of freshwater fishes. In the current study, our main objective was to estimate the suitability of water to nurture sustainable fishery, by examine water quality parameters. We explain the ichthyofaunal diversity in Bakhira Lake, in relation with the physicochemical parameters of water.

Materials and Methods
For the evaluation of ichthyofaunal diversity and water quality of Bkhira Lake we were selected five sampling sites statistically (Fig.1). For analysis of water quality parameters of Bkhira lake using standard methods [3] sampling were conducted between 9:00 AM and 11:00 AM. Water samples were directly taken in wide mouth pre cleaned plastic bottles for analysis of various physico-chemical properties. ELICO water quality analyzer PE 138 kit used for the determination of dissolved oxygen concentration or by winklers method on site. Samples were transported to the laboratory for analysis of other parameters, under standard ideal conditions. ELICO water quality analyzer model no.PE 138 was used for analysis of Temperature, pH and dissolved oxygen. ELICO SL27 spectrophotometer used measurement of Ammonia, nitrate, nitrite and phosphate. Through experimental fishing at all sampling sites of Bakhira lake alive fish samples were collected for identification at that place and also preserved in 10% formalin

for further analysis at laboratory. Fishes are identified based on the work of Jhingran (1991) [4] with minor amendment as followed by Day's Fauna [5-7]. For catching fish mainly tow type of fishing nets gill net and cost net of varying mesh size were operated by local expert fisherman. During netting maximum care should be taken to avoid defecation or disgorgement of fish's organs due to stress. Collected specimens were identified on the basis of morphometric and meristic characters.

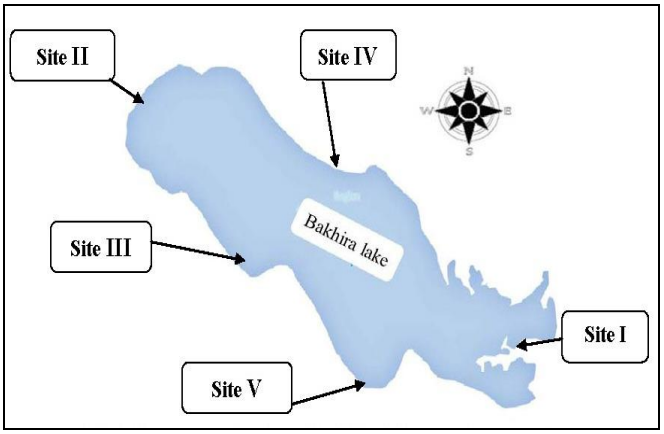

Fig 1: Sampling sites of Bakhira lake (Google map)

Table 1: Morphometric characters and metrological data of Bakhira lakes.

Parameters	Bakhira lakes
Longitude	83°12'18" E
Latitude	26°56'38" N
Altitude (masl)	167
Area (ha)	2894
Maximum depth (m)	5.8
Surface area (km^2)	9.69
Catchment area (km^2)	8.79
Annual rainfall (mm)	2089

Results and Discussion

The mean values ± standard error of water quality parameters were shown in Table 2, and the fish diversity and seasonal availability are presented in Table3, 4 and 5. The seasonal survey of the ichthyofauna showed the occurrence of 45 commercially importance indigenous fish species, belonging to 7 orders, 17 families, and 32 genera. The Cypriniformes were dominant with 18 species, followed by Siluriformes (12), Perciformes (9), Clupeiformes (3), Osteoglossiformes, Mugiliformes and Synbranchiformes each with 1 species. Similar results, a total of 29 fish species belonging to 10 families, 7 orders, and 15 genera were reported for the Halali Reservoir, Vidisha, Madhya Pradesh [8]. For fish growth and sustainable development of ichthyofaunal diversity aquatic habitat and water quality parameters play key role in aquatic ecosystem.

Table 2: Seasonal variation of physico-chemical parameters of water during the study period

Parameters	Summer	Winter	Monsoon
Temperature (^{0}C)	30.00	20	27.00
pH	7.89±0.08	7.78±0.09	7.95±0.19
Alkalinity (mg l^{-1})	93.60±1.10	105.46±2.16	98.66±2.43
Hardness (mg l^{-1})	123.20±3.31	117.33±2.60	121.60±2.83
Dissolved oxygen (mg l^{-1})	5.49±0.13	6.01±0.08	5.94±0.09
Ammonia (mg l^{-1})	0.58±0.00	0.60±0.01	0.59±0.01
Nitrate (mg l^{-1})	0.70±0.14	1.39±0.22	1.43±0.18
Nitrite (mg l^{-1})	0.30±0.03	0.33±0.02	0.33±0.02
Phosphate (mg l^{-1})	0.25±0.01	0.21±0.01	0.21±0.01

Temperature is one of the important factors for the aquatic flora and fauna. Increase or decrease of temperature directly or indirectly impacts species distribution and the seasonality of production in fishes [9]. Bakhira lake temperature were recorded 20 to 30 (^{0}C) which is suitable for aqua life except winter season temperature goes down. pH is calculated mathematically by, the negative logarithm of hydrogen ions concentration. Carbon dioxide which is an acidic gas those concentration greatly influenced pH of natural water body. Bakhira lake has pH value ranges between 7.78±0.09 to 7.95±0.19. Between 6.7 and 9.5 suitable pH range for fish fauna [10]. Alkalinities ranged were recorded between 93.60±1.10 mg $l^{-1}$to 105.46±2.16mg l^{-1}. During winter season maximum alkalinity values were recorded and during summer season minimum value of alkalinity were recorded. Bakhira Lake hardness value ranged between 117.33±2.60 mg l^{-1} to 123.20±3.31 mg l^{-1} were recorded similar result also observed [11]. During winter minimum concentration of total hardness were recorded and in the summer season maximum in concentration. Availability of dissolved oxygen was recorded in the Bakhira lake water ranges between 5.49±0.13 mg $l^{-1}$to 6.01±0.08 mg l^{-1}.During summer season dissolved oxygen concentration were recorded minimum, whereas maximum dissolved oxygen were concentration were recorded during winter season. DO level >5 mg $l^{-1}$is essential for support good fish production [12]. Increased microbial activity and raise temperature depletion of dissolve oxygen in water. Decomposition of organic matter and protein metabolism after feed digestion ammonia excreted by bacteria and fish such as dead planktons and wasted food *etc*., concentration of ammonia were recorded 0.58±0.00 mg l^{-1} to 0.60±0.01mg l^{-1} during the investigation. Other parameters like nitrate, nitrite and phosphate were recorded under desired condition.

Table 3: Fish species diversity in Bakhira lake.

SL. number	Order	Family	Scientific name	Common name	Local name	IUCN Status	Seasonal Abundance	Economic value
1			*Gibelion catla*	Catla	Bhakur	LC	TY	Food fish
2			*Labeo bata*	Bata labeo	Bata	LC	TY	Food fish
3			*Labeo calbasu*	Black rohu	Karonchi	LC	TY	Food fish
4			*Labeo dero*	Kalabans	Khaira	LC	SM	Food fish
5			*Labeo rohita*	Rohu	Rui	LC	TY	Food fish
6			*Cirrihina reba*	Reba carp	Raia	LC	SM	Food fish
7			*Cirrhinus mrigala*	Mrigal	Nain/ Mrigal	LC	RS	Food fish
8			*Aspidoparia morar*	Morar	Kenwachi	LC	WN	Food fish
9	Cypriniformes	Cyprinidae	*Hypophthalmichthys nobilis*	Bighead carp	Briged	DD	TY	Food fish
10			*Ctenopharyngodon idella*	Grass carp	Grass	DD	TY	Food fish
11			*Cyprinus carpio*	Common carp	China	VU	TY	Food fish
12			*Esomus danricus*	Flying barb	Dendua	LC	TY	Ornamental
13			*Hypophthalmichthys molitrix*	Silver carp	Silver	NT	TY	Food fish
14			*Amblypharyngodon mola*	Mola carplet	Dhawai	LC	SM	Food fish
15			*Securicula gora*	Dariyari	Chal	LC	WN	Food fish
16			*Puntius sarana*	Barb/ Olive barb	Puthiya	LC	TY	Food fish
17			*Puntius sophore*	Pool barb	Jatpunti	LC	SM	Ornamental
18			*Puntius ticto*	Ticto barb	Tit punti	LC	SM	Food fish/Ornamental
19		Siluridae	*Wallago attu*	Fresh water shark	Padhani/Barari	NT	WN	Food fish/Ornamental
20		Bagridae	*Mystus bleekeri*	Tengar catfish	Tengra	LC	WN	Food fish/Ornamental
21			*Mystus cavasius*	Gangetic mystus	Sutahawa tengra	LC	SM	Food fish
22			*Mystus tengara*	Tengra catfish	Tengana	LC	SM	Food fish
23			*Sperata aor*	Long whiskered catfish	Dariai tengara	LC	TY	Food fish
24			*Sperata seenghala*	Giant river catfis	Dariai tengara	LC	TY	Food fish
25	Siluriformes	Schilbeidae	*Ailia coila*	Gangetic ailia	Patasi/Minti	NT	RS	Food fish/Ornamental
26			*Clupisoma garua*	Garua	Baikari/Karahi	LC	TY	Food fish
27			*Eutropiichthys vacha*	Batchwa vacha	Banjhoo	LC	TY	Food fish
28		Pangasiidae	*Pangasius pangasius*	Pangas catfish	Payasi	LC	TY	Food fish/Ornamental
29		Heteropneustidae	*Heteropneustes fossilis*	Stinging catfish	Singhi	LC	SM	Food fish/Ornamental
30		Clariidae	*Clarias batrachus*	Air breathing catfish	Mangur	LC	SM	Food fish/Ornamental
31		Clupeidae	*Gudusia chapra*	Indian River Shad	Suhia	LC	TY	Food fish
32	Clupeiformes		*Gonialosa manmina*	Ganga river gizzard shad	Majhali suhia	LC	TY	Food fish
33		Engraulidae	*Setipinna phasa*	Gangetic-hairfin anchovy	Phansi	LC	TY	Food fish
34	Osteoglossiformes	Notopteridae	*Notopterus notopterus*	Bronze featherback	Patra	LC	WN	Food fish/Ornamental
35	Mugiliformes	Mugilidae	*Sicamugil cascasia*	Yellowtail mullet	Yellowtail mullet	LC	RS	Food fish
36		Channidae	*Channa gachua*	Dwarf Snakehead	Chanaga	LC	TY	Food fish
37			*Channa marulius*	Great snakehead	Saur	LC	TY	Food fish
38			*Channa punctata*	Spotted snakehead	Girai	LC	TY	Food fish
39			*Channa striatus*	Asian snakehead	Sauri	LC	TY	Food fish
40	Perciformes	Ambassidae	*Chanda nama*	Elongate glass perchlet	Chanri	LC	TY	Food fish/Ornamental
41			*Parambassis ranga*	Indian Glassy Fish	Chanri	LC	WN	Food fish
42		Badidae	*Nandus nandus*	Gangetic leaffish	Dhebri	LC	RS	Food fish/Ornamental
43		Anabantidae	*Anabas testudineus*	Climbing perch	Kawai	DD	TY	Food fish
44		Osphronemidae	*Trichogaster fasciata*	Banded gourami	Khosti	LC	WS	Food fish/Ornamental
45	Synbranchiformes	Mastacembelidae	*Mastacembelus armatus*	Zig-zag eel	Bam	LC	TY	Food fish/Ornamental

WN= winter, SM = summer, TY = throughout the year, and RS = rainy season LC = least concern, VU= vulnerable, NT = near threatened and DD= data deficient.

Highest percentage shared by family Cyprinidae 40.00% comprising fish species are *Gibelion catla, Labeo bata, Labeo calbasu, Labeo dero, Labeo rohita, Cirrhinus mrigala, Cirrihina reba, Aspidoparia morar, Hypophthalmichthys nobilis, Ctenopharyngodon idella, Puntius sarana, Puntius sophore* etc. Second largest share by family is Bagridae (11.11%) comprising fish species are *Mystus bleekeri, Mystus cavasius, Mystus tengara, Sperata aor, Sperata seenghala* followed by Channidae comprising four fish species *Channa gachua, Channa marulius, Channa punctata, Channa striatus.*

Table 4: Composition of the fish community by order.

Sl. Number	Taxa	Number of species	Percentage (%)
1	Order: Cypriniformes	18	40.00
2	Order: Siluriformes	12	26.67
3	Order: Perciformes	9	20.00
4	Order: Clupeiformes	3	6.67
5	Order: Osteoglossiformes	1	2.22
6	Order: Mugiliformes	1	2.22
7	Order: Synbranchiformes	1	2.22
Total		45	

Family Schilbeidae comprises only three fish species *Ailia coila, Clupisoma garua,* and *Eutropiichthys vacha* family Ambassidae and Clupeidae shared only two species each. Other family Notopteridae, Mugilidae, Badidae, Osphronemidae, Mastacembelidae, Siluridae, Pangasiidae, Heteropneustidae, Clariidae, Engraulidae and Anabantidae contributed only one species each. The fisheries of lake and reservoire are based on relatively large number of species and a wide range of fishing gears and craft. Habitat degradation, invasion of exotic fishes and fishing pressure are the main causes for loss of fish biodiversity in aquatic ecosystem [13, 14]. Environmental stress and fishing pressure are reflected in the fish community composition and biodiversity of fishes [15]. However, more understanding and motivation is required on the value of indigenous fish diversity and conservation of aquatic resources to ensure the sharing of benefits of its utilization in an reasonable manner so that the aquatic ecosystem gets sufficient time to restore its natural community structure [14, 16].

Table 5: Composition of the fish community by family.

Sl. Number	Taxa	Number of species	Percentage (%)
1	Family : Cyprinidae	18	40.00
2	Family : Bagridae	5	11.11
3	Family : Channidae	4	8.89
4	Family : Schilbeidae	3	6.67
5	Family : Ambassidae	2	4.44
6	Family : Clupeidae	2	4.44
7	Family : Notopteridae	1	2.22
8	Family : Mugilidae	1	2.22
9	Family : Badidae	1	2.22
10	Family : Osphronemidae	1	2.22
11	Family : Mastacembelidae	1	2.22
12	Family : Siluridae	1	2.22
13	Family : Pangasiidae	1	2.22
14	Family : Heteropneustidae	1	2.22
15	Family : Clariidae	1	2.22
16	Family : Engraulidae	1	2.22
17	Family : Anabantidae	1	2.22
Total		45	

Conclusion

After whole year examine of Bakhira lake we were recorded the ichthyofaunal diversity and it was found that this lake is wealthy in ichthyofaunal diversity but conservation measure is also required. A fluctuation of physico- chemical parameters of this lake is directly or indirectly correlated with and biological productivity potential. Habitat degradation, anthropogenic activity, sewage disposal, etc are some of the reasons for adversely affecting the occurrence of ichthyofauna in this lake. Proper management of this lake may help to boost the fish production and habitat conservation.

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