Original Research Article

ICHTHYOFAUNAL DIVERSITY OF GHAGHARA RIVER, SIWAN (BIHAR), INDIA

Abstract

The Ghaghara River, a key tributary of the Ganges, flows through northern India, providing essential water resources for agriculture, communities and biodiversity. The river's fish diversity is vital for maintaining local ecological balance and supporting livelihoods. Fish biodiversity and diversity indices were studied in the study area from August 2021 to July 2022. Data was collected from four locations namelyDarauli (S-1), Rakauli (S-2), Phulwariya (S-3) and Semariya (S-4) of the GhagharaRiver and we found 61 species belonging to 47 genera, 21 families and 07orders.Cypriformeswasthemostpredominantorder,contributing to 42 % of fish species, followed by Siluriformes with (31%),Perciformes (18%).Cyprinidae is the most abundant family; contributing39.3% (24 species) fish fauna followed by the family Bagridae (06 species)andSisoridae. Total number of individuals, relative abundance(percentage catch), minimum and maximum size ofeach species were calculated.However, the river's aquatic ecosystems, particularly its fish populations are increasingly under threat due to human activities, including habitat degradation, pollution, overfishing and the construction of hydropower projects. This study aims to assess the fish diversity of the Ghaghara River and explore the current conservation challenges and opportunities.

Keywords: ***Ghaghara River, Fish Diversity, Species composition, Bihar.***

Introduction

Life on Earth is diverse on many levels, starting with genes and proceeding to the richness and complexity of species, life forms and functional functions, all organized in spatial patterns that range from biological communities to ecosystems, regions and beyond (Colwell, 2009). In other terms, it refers to the diversity and variability of living species their genetic differences and the habitats in which they live. The various climatic and physical factors lead to the great

biodiversity.Biodiversity has been seen in a number of ways, based on the opinions of experts in various professions. It has also been called "life" or "wilderness" in a number of instances. Detecting uncommon species and the underlying complexity of the environmental template make it difficult to quantify patterns of variety at the species level, even when the creatures are well known to science. Biodiversity is described as the genetic and biological diversity of populations, species, communities, and ecosystems (Winter and Hughes, 1997). Biodiversity affects biological systems' ability to adjust to environmental changes and is required for ecosystems to deliver goods and services including nutrient cycling and clean water (Rahbek and Colwell, 2011). Bihar has a high potential for aquatic bioresources and provides substantial opportunities for inland fishing and aquaculture development. The state accounts for approximately 14.68% of the total national fish diversity (Lakra, 2010). Aquatic resources comprise 28,500 kilometers of rivers and canals, 1.38 lakh hectares of reservoirs, 1.61 lakh hectares of ponds and tanks, 1.33 lakh hectares of floodplain lakes, and unused water. The total fish production from all resources in the state is 3.93 million tons (2009-2010) (www.fisheries.bihar.nic.in).The state's fish biodiversity has been rapidly declining in recent decades as a result of the introduction of exotic fish species (Dwivedi and Nautiyal, 2010; Pathak et al, 2011) and anthropogenic environmental degradation, such as urbanization, damming, water abstraction for irrigation and power generation, and pollution. These effects have severely strained rivers and other natural water bodies, wreaking havoc on the variety of freshwater fish (Lakra, 2010). The purpose of this study was to provide the first comprehensive description of fish in the Ghaghara River in Bihar's Siwan district, as well as to investigate the current ichthyofaunal variety.

Materialsand Methods

The Ghaghara River, a major tributary of the Ganga River system in northern India, has been selected for the current study. The river rises in the Mapchachungo glaciers on Tibet's southern Himalayan slope at an elevation of around 3,962 metres. This river spans 1,080 kilometers until it joins the Ganges near Revelganj in Bihar.Fish biodiversity and diversity indices were studied in this article from August 2021 to July 2022. Data was collected from four locations: Darauli (S-1), Rakauli (S-2), Phulwariya (S-3), and Semariya (S-4) of the river. GPS was used to accurately record the positions of sampling stations.

Study Area

The Ghaghara River**,** also known as the Karnali River in Nepal, flows through northern India and Nepal. The river is an important tributary of the Ganges River, covering an area of about 507 km in India. It serves as a vital ecological resource, supporting a rich diversity of fish species and providing livelihood opportunities to local communities.

Geographical location of Ghaghara River

Darauli (S1 – Site 1)	Rakauli(S2 – Site 2)	Phulwariya (S – Site 3)	Semaria (S4 – Site 4)
26°04'41.3" N 84°07'18.8" E	26.03'38.4" N 84.22'01.3" E	25°89'56.9" N 84°49'24.7" E	25.79'59.0" N 84.62'25.9" E

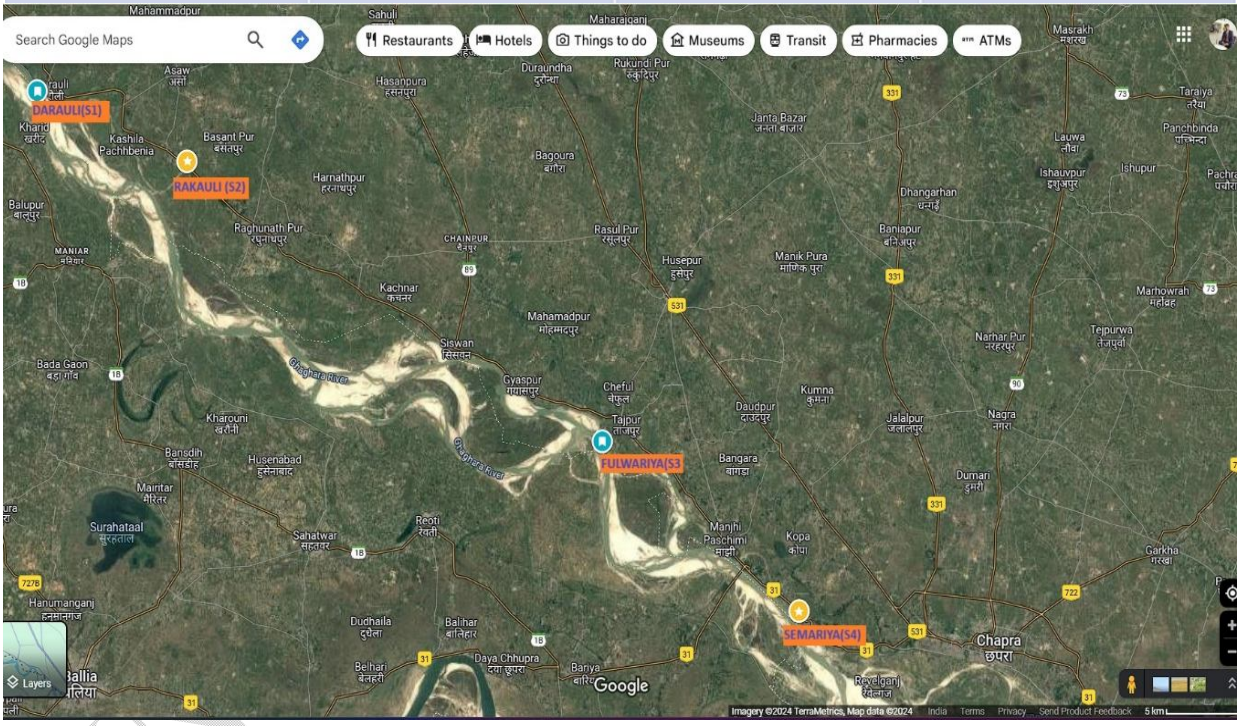


Fig. 1. Map showing Ghaghara River Sampling Sites

Fish sampling and Data Collection

Experimental fishing was conducted using local and skilled fishermen's expertise. Fishes were collected using various nets and photographs were taken before formalin preservation. Specimens were fixed in separate jars. Smaller fishes were directlyplaced in the formalinsolution while the larger ones weregiven an incision on the abdomen before fixing for better

penetration of the preservative.The bottles/jars that were collected Fish specimens were labelled with proper serial numbers, locality, date of collectionand local name of fish used in that region.

Data Analysis

One aspect of biodiversity is species' Relative Abundance (RA), which describes how frequent or uncommon a species is in relation to other species in a given area or population.The percentage composition of an organism of a specific sort in relation to the overall number of organisms in the region is known as relative abundance.

$$Relative\ Abudance = \frac{\text{Number of Individuals of a Species}}{\text{Total Number of Individuals of all Species}} \times 100$$

The Shannon-Wiener Diversity Index is a commonly used index to quantify species diversity, which includes both species richness and the relative abundance of species.

$$H' = -\sum_{i=1}^{s} (pi \times \ln(pi))$$

Where:

- H' = Shannon-Wiener Diversity Index (species diversity)
- S = Total number of species in the sample
- pi = Proportion of individuals of species iii in the total sample (calculated as the number of individuals of species iii divided by the total number of individuals)

The Shannon index provides a measure of diversity that accounts for both the number of species (richness) and their relative abundances. A higher value of H' indicates greater diversity.

Results and Discussion

The distribution pattern of fishes in river Ghaghara showed variationsamongdifferentsites.Outof61species,15specieswheredistributedthroughout the river from, (S1 to S4) five, sevenand twospecies is confinedtoonly inupper, middle and lower regions respectively. The species viz*Salmostomabacaila,Channapanctatus,Puntiusticto,MastacembelusarmatusMystuscavasius,Cirrhinusmrigala,Clupisomagarua*wereranked. Conversely, the *Clarias batrachus, Anabas testudineus, Glyptothoraxtelchitta,Amblypharyngodonmola,Labeodero,andAspidopariamorar*were the scarcestspecies (occurrence frequency<10%).The commoncarp (*Cyprinus carpio*) is the only common non-native species (occurrencefrequency>50%).Therelativeabundanceofthroughoutdistributedfishspecies was also varied across the stretch. The species *Salmostomabacaila*and*Puntiusticto*showedhigherabundanceineachsite.Interestingly, some of the species of high conservation importance showedrelatively high relative abundance in different

sampling sites (*Ompokpabda*and*Channamarulius*fromsite2;*Ompokbimaculatus*,*Notopterusnotopterus*from site 3; *Sperataaor*, *N. notopterus*, *Labeocalbasu*,*Sperataaor*, *N. notopterus*and *Rita rita*,*S. seenghala*and*Mystus vittatus*from site 4indicatingrelatively stable population inspiteofheavyfishingpressureandhabitatdegradation.Thesitewisedistributionoffamilies,generaand speciesinriverarepresentedin the table given below.

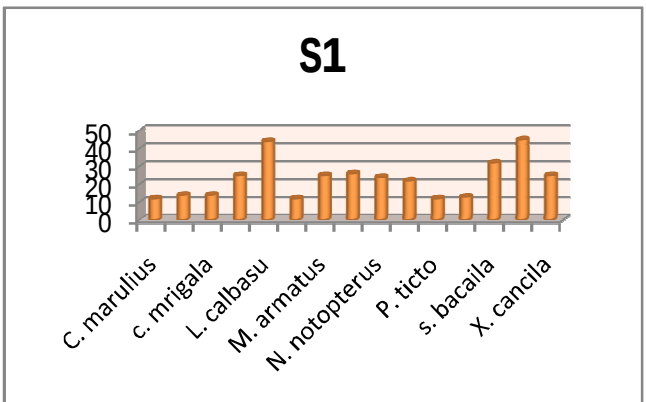
Table-1.

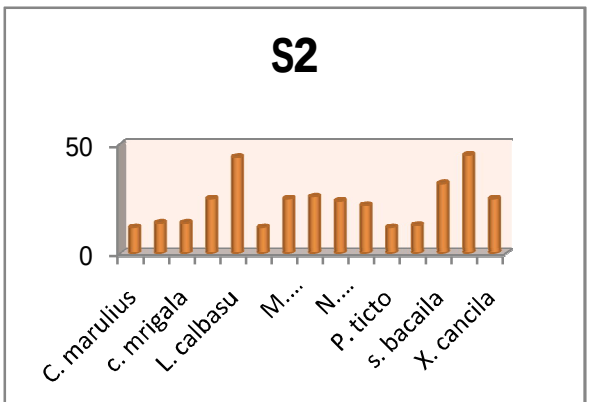
Site-wiseoccurrenceoffishspeciesinRiverGhaghara

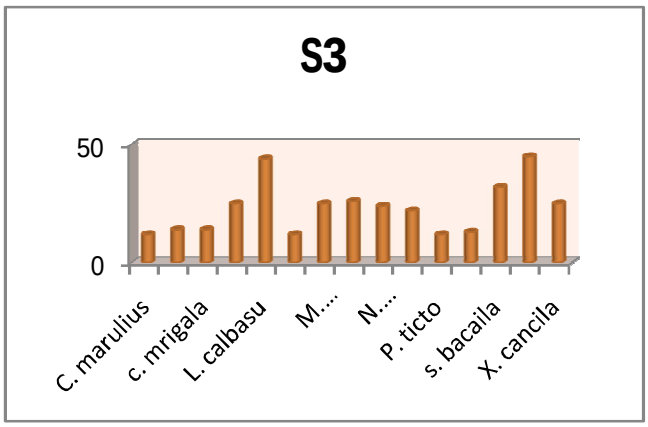
Sl. No	Species	Darauli (S1)	Rakauli (S2)	Fulwariya (S3)	Semariya (S4)
1.	*Ailiacoila*				√
2.	*Amblypharyngodon Mola*		√		
3.	*Anabastestudineus*			√	
4.	*Aspidopariamorar*		√		
5.	*Bagariusbagarius*				√
6.	*Botialohachata*			√	
7.	*Catlacatla*		√		√
8.	*Chaguniuschagunio*				
9.	*Chandanama*	√	√		
10.	*Channamarulius*	√	√		√
11.	*Channapunctatus*	√	√		√
12.	*Channastriatus*		√		√
13.	*Chelalaubuca*				
14.	*Chitalachitala*				√
15.	*Cirrhinusmrigala*	√	√		√
16.	*Cirrhinusreba*		√		√
17.	*Clariasbatrachus*			√	
18.	*Clariasgariepinus*			√	
19.	*Clupisomagarua*	√	√		√
20.	*Colisafasciatus*	√	√		
21.	*Ctenopharyngodaon idellus*				√
22.	*Cyprinuscarpio*		√		√
23.	*Devariodevario*	√	√		
24.	*Esomusdanricus*	√			
25.	*Eutropiichthysvacha*		√		√
26.	*Gagatacenia*		√		
27.	*Glossogobiusguiris*		√		
28.	*Glyptothorax Telchitta*		√		
29.	*Gudusiachapra*			√	
30.	*Heteropnestesfossilis*			√	

31.	*Hypophthalmichthys molitrix*				√
32.	*Labeobata*		√		√
33.	*Labeoboggut*			√	
34.	*Labeocalbasu*	√	√		√
35.	*Labeodero*		√		
36.	*Labeogonius*		√		√
37.	*Labeorohita*	√	√		√
38.	*Lepidocephalus Guntea*		√		
39.	*Macrognathus Pancalus*		√		√
40.	*Mastacembalus Armatus*	√	√		√
41.	*Mystuscavasius*	√	√		
42.	*Mystustengara*		√		√
43.	*Mystusvittatus*	√	√		√
44.	*Nandus nandus*		√	√	
45.	*Nangranangra*			√	
46.	*Notopterus Notopterus*	√	√		√
47.	*Ompokbimaculatus*		√		√
48.	*Ompokpabda*		√		√
49.	*Osteobramacotio*		√		√
50.	*Puntiussarana*	√	√		
51.	*Puntius sophore*	√	√		√
52.	*Puntius ticto*	√	√		√
53.	*Rasbora daniconius*	√	√		√
54.	*Rhinomugilcorsula*			√	
55.	*Rita rita*				√
56.	*Salmostomabacaila*	√	√		√
57.	*Sperataaor*				√
58.	*Sperataseenghala*		√		√
59.	*Tetradoncutcutia*			√	
60.	*Wallago attu*	√	√		√
61.	*Xenentodon cancila*	√	√		√

Note: √ sign Indicates presence of a particular fish species.







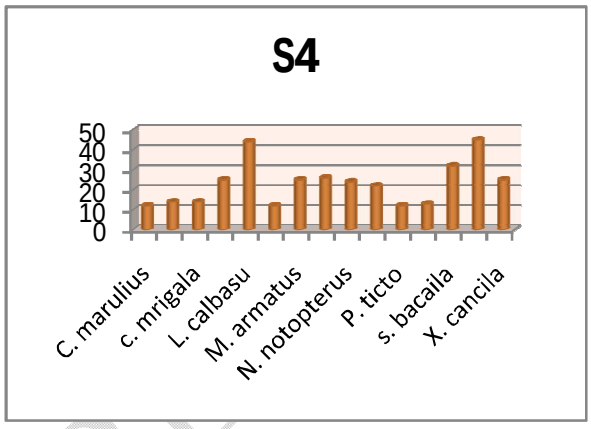


Fig.2Site-wiserelativeabundanceoffishspecies.

Catchperunit effort(CPUE)

Gill nets and drag nets of various sizes were the most common fishing gear in the Ghaghara River. The capture per unit effort was computed using a gill net. The mean values of c.p.u.e. at several sample locations ranged from 0.52 to 2.14 kg/man/hour. Higher values of c.p.u.e. at site 4 indicate greater fishing intensity, which might be attributed to the presence of large-sized fish and their favored habitat characteristics such as deep pools, rural and semi-urban land use patterns, low to moderate river velocity, etc.

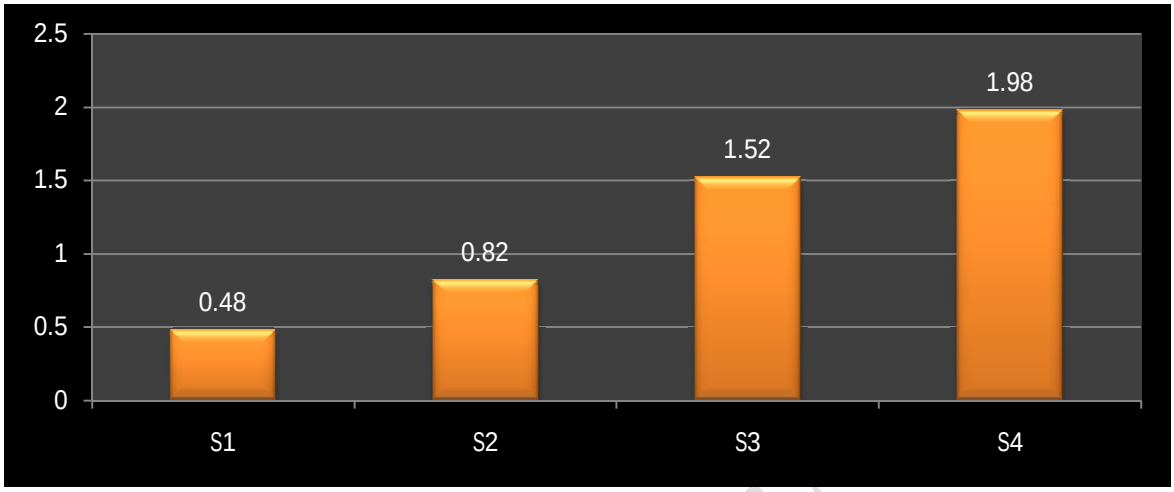


Fig.3,MeanCPUEoftotalfishpopulationindifferentsamplingsitesofGhagharaRiver.

Diversityindices

Thevariousdiversityindiceswerecalculatedineachselectedsampling sites of river Ghaghara which includes: Species richness, Shannon-Weinerindex,Simpsonindex,Speciesdominanceindex,Pileousevenness

Speciesrichness

The species richness at four sample sites varied significantly, with higher richness seen in the mid to downstream zones. Sites 3 (53 species), 2 (41 species), and 4 (37 species) had the highest species richness, whereas sites 1 and 4 had the lowest (22 and 36 species, respectively). The presence of migratory fish and channel confluence may have contributed to the high level of species diversity in the midstream area. The lower number of fish species in the upper section (site 1) might be attributed to water scarcity, low depth and flow, and the limited channel width of the river.

Table2
FishdiversityindicesofGhagharaRiver

Diversityindices	**Samplingsites**			
	S1	**S2**	**S3**	**S4**
Speciesrichness	24	41	53	36
Numberofindividuals	1339	5386	7877	2282
Shannon-Weinerindex (H)	2.69	2.11	3.08	2.55

Simpsonindex(D)	0.0887	0.0884	0.07264	0.07842
Speciesdominance index(d)	0.2018	0.1931	0.1753	0.1753
Evenness_eˆH/S	0.8486	0.7772	0.775	0.834

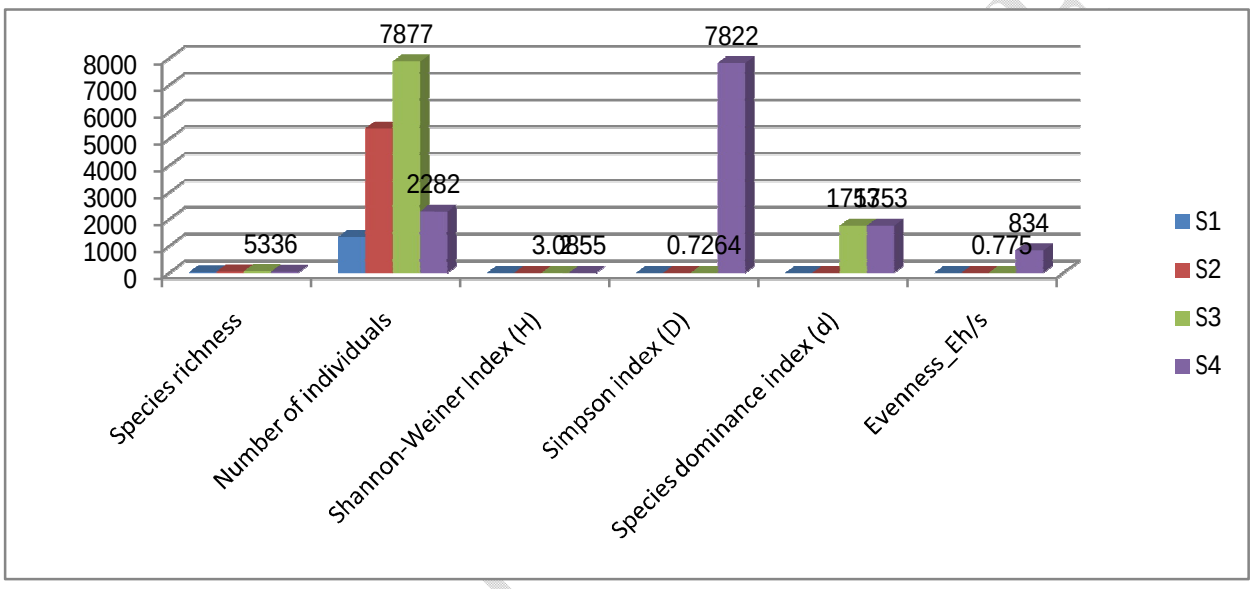


Fig .4 Diversityindexatdifferentsamplingsites.Bars withthe differentsuperscripts arestatisticallydifferent(p<0.05).

AssessmentofthethreatstatusofG1fishspeciesofriverGhagharaasper recent Lakra and Sarkar (2006), and Lakra *et al.*,(2010), showed six fishspecies as endangered (EN), 17species vulnerable, 27 lower risksand dataon12specieswerenotavailabletocategorizethemunderanythreatcategory Out of 61 species, about 28 % of species are underthreats (eitherendangered or vulnerable)and 44% underlowerrisks.Thesite wise analysis of conservation status of fishes of Ghaghara River showed thatsite4(Semariya)havingmorethreatenedspecieswhereasatsite1(Darauli), less number of threatened species were observed Themajor natural as wellasanthropogenicfactors responsible for declining offishhabitatanddiversityspeciesinriverGhagharawasrecordedwhichincludes: reducedwaterflow, riverpollution, urbanization,illegal

fishingandintroductionofinvasivespecies.Biodiversity and its conservation are regarded as one of the major issues of enabling sustainable use of natural resources. The present study is the first of its kind for the River Ghaghara and tries to quantify the species and their occurrences. The presence of 62 species indicates rich species diversity in this river. Payne *et al.,* (2004) described 30 and 56 fish species in Allahabad stretches of River Ganga,

Conclusion

River Ghaghara of the Ganges basin is found to support considerably rich fish diversity and also supported threatened fishes, with a well-defined pattern based on habitat status and land use pattern. A total 61 species belonging to 47 genera 21 families and seven orders were recorded. Cypriformes was the most predominant order, contributing to 42 % of fish species, followed by Siluriformes with 31 %, Perciformes (18 %). Cyprinidae is the most abundant family, contributing 39.3% (24 species) fish fauna of river Ghaghara followed by the family Bagridae (six species), Sisoridae. Since, no previous studies were available in this River of these locations so the results of present study is the first report and baseline data for further study to compare and calculate the rate of extinction of species.In this study we observed a significant structure of fish community in a complex, comprehensive dataset, and identified certain environmental factors such as depth, flow, dissolved oxygen and substrate as a major component. These components found to be the most important habitat variable in shaping fish distributions. The findings in this study provide specific guidance on channel habitats with inclusive ranges of depths, substrate and current velocities needed to support the threatened fish species of the River and therefore to include in conservation planning. Furthermore, our results suggest the importance of local environmental influences on the threatened fishes can be used to guide protection and management activities and support restoration efforts of the fish habitat. Management measures should be planned keeping in view the habitat requirements and associated relationship with the fish assemblage at local scale.The river ecosystem of the Ghaghara is vitally important in maintaining considerable freshwater diversity. It is recommended that further studies should be made to expand research on enhancement of indigenous fish species by adopting habitat restoration and species rehabilitation at local scale. The use of illegal methods to catch fishes should be banned in the area to prevent further

depletion of freshwater fish resources in this river. The data obtained on the fish biodiversity, habitat parameters with relations to fish species distribution and assemblage patterns may provide current relevant information for fisheries department as well as to the other stakeholders including fisher populations for proper conservation of aquatic biodiversity of this important tributary of Ganga basin.

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