Diversity of freshwater fish and water quality parameters associated threats of commercially important freshwater species caught by bottom trawl and mid-water trawl from the various habitat

Naveed Ahmed Abro

Department of Freshwater Biology and Fisheries,
University of Sindh, Pakistan
Email: naveed.chishtis@gmail.com

Zameer Ali Palh*

Department of Freshwater Biology and Fisheries,
University of Sindh, Pakistan
Email: alizameer735@gmail.com
*Corresponding author

Shaharyar Brohi

Department of City and Regional Planning,
Mehran UET Jamshoro, Pakistan
Email: 19smcrp10@students.muet.edu.pk

Khalid Lashari

Department of Freshwater Biology and Fisheries,
University of Sindh, Pakistan
Email: kh_lashari@yahoo.com

Mehjabeen Noor

Institute of Plant Sciences,
University of Sindh, Pakistan
Email: Mjabeen_noor@yahoo.com

Sujo Meghwar

Department of Geography,
University of Sindh,
Jamshoro, Pakistan
Email: sujo@usindh.edu.pk

Muneer Hussain

Fisheries Development Board,
Ministry of National Food Security and Research, Pakistan
Email: Munirm29@yahoo.com

Sarfaraz Ahmed Channa

Department of City and Regional Planning,
Mehran UET Jamshoro, Pakistan
Email: channasarfaraz@gmail.com

Abstract: The River Indus is one of the most extended water bodies in Pakistan. It is a source of drinking water, hydroelectric power generation, irrigation, agriculture and aquaculture. The present examination wanted to survey the river's physicochemical parameters and biodiversity from June 2016 to May 2017. Total eight stations have been selected along the Indus River, and 08 water quality parameters, i.e., temperature, salinity, dissolved oxygen, power of hydrogen, transparency, alkalinity, hardness, and total dissolved solids, have been checked from all stations on the spot and bring water samples in a plastic bottle. Fish samples were also collected from all stations, preserved all the samples in 10% formalin, and further investigated in the Fresh Water Biology Laboratory at the University of Sindh Jamshoro. A total of 45 fish species have been identified throughout the study period.

Keywords: biodiversity; water quality parameters; Indus River.

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Biographical notes: Naveed Ahmed Abro is a PhD scholar at the Department of Freshwater Biology and Fisheries, University of Sindh Jamshoro. He completed his MSc from the University of Sindh, Jamshoro in the field of Fisheries and Aquaculture. His research interests are investigation of zoo plankton and phytoplankton.

Zameer Ali Palh is a PhD scholar at the Department of Freshwater Biology and Fisheries, University of Sindh Jamshoro. He completed his MSc from the University of Sindh, Jamshoro in the field of Fisheries and Aquaculture. His research interests are investigation of zoo plankton and phytoplankton.

Shaharyar Brohi is a research scholar at the Department of City and Regional Planning, Mehran Unviersity of Engineering and Technology Jamshoro. He completed his Bachelor's in the field of City and Regional Planning, and also he completed his Master's in the field of Urban Planning with specialisation in Transportation and Planning. His research interests are urban morphology, transportation planning and management.

Khalid Lashari is a Professor at the Department of Freshwater Biology and Fisheries, University of Sindh Jamshoro. He holds strong skills in the field of fisheries and aquaculture. He is well experienced and dynamic research. He

holds a Doctor of Philosophy in the field of Freshwater Biology and Fisheries. His research interests are aquatic and fisheries sciences, ecosystem modelling, ecosystem-based fisheries management, and marine and fisheries policy.

Mehjabeen Noor is an Associate Professor at the Institute of Plant Sciences, University of Sindh, Jamshoro. She is an experienced botanist with a demonstrated history of working in the research and field industries. She has a strong educational and professional background in the field of plant sciences. She holds an MSc from the University of Sindh Jamshoro in the field of Plant Sciences and also holds her Doctor of Philosophy in the field of Plant Sciences from Sindh Agriculture University Tando Jam, in 2017. Currently, she is supervising the Doctor of Philosophy and Master of Philosophy student in the field of Plant Sciences.

Sujo Meghwar is a Professor at the Department of Geography, University of Sindh. He completed his MSc in the field of Geography from the University of Sindh. He also holds a Doctor of Philosophy in the field of Geography from the University of Sindh, Jamshoro. He is experienced in research with a demonstrated history of working in the research and field industries. He has a strong educational and professional background in the field of geography. His research interests are physical geography, geomorphology, human geography, cartography zoogeography, plant geography, geography of Pakistan, geography of South Asia, hydro-geography, weather maps and equipment, instrumental surveying, advanced cartographic technique, map interpretation and topographic maps.

Muneer Hussain is a Research Fellow in the Fisheries Development Board, Ministry of National Food Security and Research, Pakistan. He is working as a Field Research Officer in the Fisheries Development Board, MNFS&R Islamabad since 2013 to date. He is graduated in Fisheries and Aquaculture from the University of Veterinary and Animal Science Lahore. Also, an MPhil in Freshwater Biology and Fisheries in the University of Sindh Jamshoro having nine year experience in tilapia cage fish farming, carp fish farming, and breeding, marine shrimp/fish farming management, and marine finish breeding techniques (grouper).

Sarfaraz Ahmed Channa is a research scholar at the Department of City and Regional Planning, Mehran UET Jamshoro. He completed his Bachelor's in the field of Urban and Regional Planning from the Mehran Unviersity of Engineering and Technology Jamshoro.

1 Introduction

Indus River traverses about 3,100 km (1,900 miles) through India and Pakistan to the Arabian Sea. River Indus also receives water at Panjnsad created throughout the Chenab and Sutlej Rivers' intersection and moved to the Arabian Sea through three barrages Guddu, Sukkur and Kotri Barrage (Mahessar et al., 2013; Qureshi et al., 2014). Indus River is passing from Sindh, and its total length is 537 miles, having 108 miles attain from Gudu to Sukkur Barrages. Gudu Barrage is located at altitude 28.3164 north and longitude 69.2101 east and Sukkur Barrage at altitude 27.4447 north and longitude 68.5658 east.

Water is one of the significant sources to protract life (Brohi et al., 2021a, 2021b). Surface water and groundwater are going to increase contaminated day by day due to agricultural and industrial activity (Kalwar et al., 2018; Sahito et al., 2020b). Water is well-known to contain many chemical elements, the interaction of both physical and chemical properties (Palh et al., 2017). The physico-chemical study could help understand the structure and function of the particular water body concerning its habitats.

Water is the essential component of life (Lashari et al., 2017). The affluence of human beings is related to the availability of water sources (Ghaffar et al., 2021). The presence of water has ensured the food security of the existing world (Han et al., 2019; Sahito et al., 2020a). Water pollution is one of the world's cruel problems and faces so many problems at present (Memon et al., 2021). There are so many water bodies that are found contaminated on a large-scale. The pollution of freshwater will spread speedily in freshwater sources in less developed countries compared to developed countries. Most agriculture countries are worst hit due to lacking drainage capacities. Presently, so many countries face salinity problems like Egypt, Argentina, Australia, Pakistan, India, Bangladesh, China, Iran, Iraq, Thailand, Russia, etc. (Qureshi et al., 2008). Pakistan uses nearly 70% of its canal irrigation water for agriculture purposes (FAO, 2000; World Bank, 1997; Jurriens and Mollinga, 1996).

Indus River hovers around more than 16 million hectares, a length of 57,000 km by canal networking system. The 88,600 outlets for the irrigation of service areas, 17 barrages and canal diversion works, 78,000 watercourses, 42 major canals, 6,000 km of minor canals, 600 km of link canals, and the length of the farm channels and watercourses is about 1.6 million km (Collins and Hasnain, 1995; Ferguson, 1984; Milliman et al., 1984; Monenco, 1984; Searle, 1991). There are five rivers in Asia serving 870 million people that are most threatened in the world, according to the Worldwide Fund for Nature (WWF). The Indus River is the top five most threatened river basins globally, and various studies were carried out to investigate the quality of Indus River water (Sadia et al., 2013; Ali et al., 2004; Tassaduqe et al., 2003; Khuhawar et al., 2000). Millions of Sindh people have taken massive benefit from Indus water, i.e., drinking purpose, agriculture, aquaculture, etc.

The major threats to biodiversity conservation as a whole of estuaries are overexploitation, and introduction of invasive alien species, and aquatic pollution (Khoshoo, 1994). The best approach to reduce species depletion is by technological improvements and modifications of gears and time and area restrictions on fishing activities (Butchart et al., 2010). Kennish (2002) suggested that decreased freshwater flow can significantly change the salinity, sediment regimes, and nutrient loadings of an estuary, directly affecting the habitat, abundance, distribution of estuarine organisms trophodynamics of the system. This study helps to know the current water quality parameters and ichthyofauna of the Indus River and the selected stations.

2 Materials and methods

2.1 Study areas and selection of sampling stations

Determination of water quality parameters of Indus River, the water samples were collected from eight stations as:

1 Gudu Barrage

2 Shikarpur

3 Sukkur Barrage

4 Manchar Lake

5 Manjhand Tributary

6 Kotri Barrage

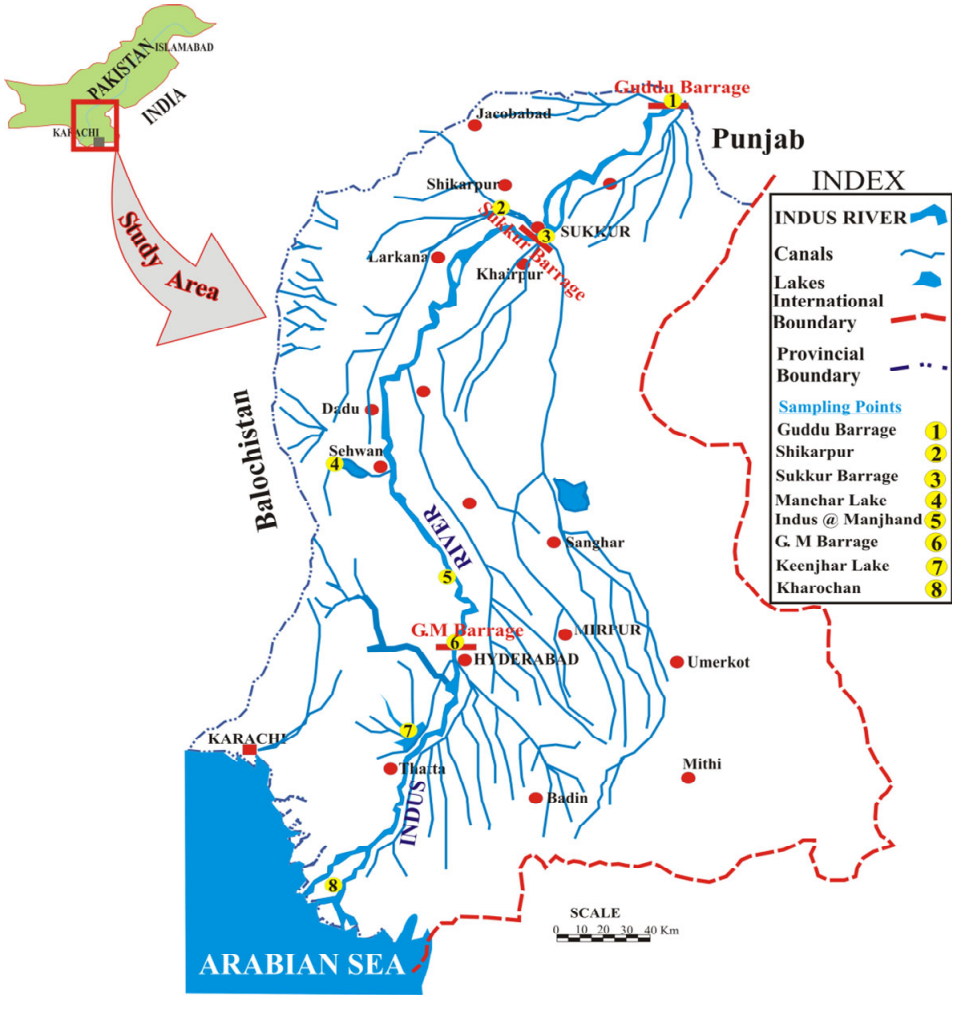
7 Keenjhar Lake

8 Kharochan monthly.

Water samples were collected through a standard water sampler poured in plastic bottles and placed in an icebox immediately to preserve the parameters. The Hanna thermometer determined the temperature at different water levels on a fortnightly basis from June 2016 to May 2017 from all the stations. The thermometer dropped down at a depth of 8 to 10 cm for a few minutes and was taken out for reading temperature levels. Each time the temperature was noted at different levels/centres of the water in all stations. Power of hydrogen pH estimation was checked using the scientific instrument's pH metre make of Orion 5 star. The calibration of the pH was applied according to the instructional manual. The pH metre's electrode is dipped in the water, and reading was noted when the metre showed a stable value. Dissolved oxygen was determined by the Hanna metre at different periods because the temperature is changed to varying hours of the day, even changes in the nighttime. The salinometer determined salinity. The calibration of the salinometer was applied according to the instructional manual. Transparency of water was measured with sachhi disc of 20 cm diameter with four quadrates of alternate black and white. Transparency is measured; it was slowly lowered into the water, free from currents or disturbances.

The depth of water was taken by finding a point between appearance and disappearance. Hardness was determined from all stations. The 25 ml water was put in a flask measured with a pipette, then mixed with 0.5 mg of buffer tablet (Erichrome black-T) and 1 ml of concentrate ammonium hydroxide (NH_4OH) as an indicator. The sample was titrated with a 0.1 N (EDTA) solution; at the last point, the colour changed from red to blue, i.e., the endpoints recorded as the water's hardness. The TDS value of water in the Indus River from respective stations was recorded with the WTW 320 conductivity metre. The electrode was washed with distilled water and left for drying. The electrode was dipped into the water sample. The electrode kept stirring gently for a few seconds to allow the display value to stabilise; when the display value appeared, it was then recorded. Alkalinity was determined by an already established method, i.e., a 50 ml sample of water collected by pipette in the conical flask in which 2–4 drops of phenolphthalein as an indicator were added. The conical flask was shacked until the colour changed pink. The sample was then titrated with hydrochloric acid (0.01 N) till the colour disappeared. After titration, the consumed volume was noted and labelled as p-alkalinity. Then, the same sample was added with 2–3 drops of methyl orange as an indicator. The titration continued until the change of colour from yellow to pink, representing the last point regarded as total alkalinity (TA). The volume consumed was noted, and the amount mg/l was calculated as m-alkalinity.

Figure 1 Map showing study areas of Indus River Sindh, Pakistan (see online version for colours)



2.2 Fish samples collection

A total of eight stations have been selected to collect fish samples from June 2016 to May 2017 during the pre-monsoon and post-moon soon season; all samples were collected with bottom trawl and midwater trawl with the fishermen. After collecting samples from the stations, samples were preserved in 10% formalin. Some samples were also stored in ice boxes with ice and brought out all the samples in the Fresh Water Biology and the Fisheries, Laboratory University of Sindh Jamshoro.

3 Results and discussion

The water samples were collected from June 2016 to May 2017, respectively. Total eight stations were selected, i.e.:

1 Gudu Barrage

2 Shikarpur

3 Sukkur Barrage

4 Manchar Lake

5 Manjhand Tributary

6 Kotri Barrage

7 Keenjhar Lake

8 Kharochan along the Indus River and eight water quality parameters, i.e., temperature, salinity, dissolved oxygen, power of hydrogen, transparency, alkalinity, hardness, and total dissolved solids have been checked from all station.

Water temperature was recorded a maximum of 32°C in the month of may at Sukkur barrage and the minimum was 17°C in February in Keenjhar lake and Ph were recorded maximum of 8.9 in November at Manchar Lake and minimum were 6.5 in January at Shikarpur station and in November at Keenjhar Lake. Dissolved oxygen has recorded a minimum of 5.2 in August at Keenjhar Lake, and the maximum was 13.6 in March at Shikarpur station. Salinity has recorded a minimum of 0.045 in November at Gudu Barrage, and the maximum was 27 in August at Kharochan. Transparency has recorded a minimum of 25 in August at Gudu Barrage and Manchar Lake and in October at Kharochan station. Alkalinity has recorded a minimum of 130 in March at Kharochan, and a maximum was 244 in February at Shikarpur station. Hardness was recorded at 140 in August at Manchar Lake, and the maximum was 323 in May at Kharochan station. Total dissolved solids have recorded a minimum of 898 in August at Manjhand, and a maximum was 10296 in September at Kharochan station, respectively, all figures shown in Table 1.

Table 1 Descriptive statistics of physicochemical parameters were collected from the Indus River from 2016 to 2017

Parameters	*Minimum*	*Maximum*	*Mean ± SD*	*WHO limits*
Temperature	17°C	32°C	24.5 ± 7.5	
Dissolved oxygen	5.2	13.6	9.4 ± 4.2	> 4.0 mg/l
pH	6.5	8.9	7.7 ± 1.2	7–8.5
Salinity	0.045	27	13.52 ± 13.48	Fresh water, < 0.5 ppt Brackish water, 0.5–30 ppt
Transparency	25	55	40 ± 15	5 NTU
Alkalinity	130	244	192 ± 52	100
Hardness	140	323	231.5 ± 91.5	300 mg/l $CaCo_3$
TDS	898	10296	5,597 ± 4,699	500 mg/l

The fish samples were collected from all the stations throughout the study period. A total of 45 fish species have been identified from all the stations. Fish samples have been collected monthly from respective stations, all figures shown in Table 2.

Table 2 The 45 species were collected at eight sampling sites of Indus River Sindh during the study period

S. no.	*Scientific name*	*Common name*	*Sampling station*							
			S1	*S2*	*S3*	*S4*	*S5*	*S6*	*S7*	*S8*
1	*Chitala chitala*	Batee	+	+	+	–	–	–	+	–
2	*Notopterus notopterus*	Gandan	–	–	–	–	–	–	+	–
3	*Gudusia chapra*	Palri	–	–	–	–	+	+	–	+
4	*Tenualosa ilisha*	Palla	–	–	–	+	+	+	–	+
5	*Tenualosa toil*	Dothar	–	–	–	–	+	+	–	+
6	*Channa marulius*	Chito shakur	+	+	+	+	+	+	+	–
7	*Channa straitus*	Katter shakur	–	+	+	–	–	–	+	–
8	*Channa punctata*	Mukur	+	+	–	–	+	+	+	–
9	*Cirrhinus mrigala*	Morakhi	+	+	+	+	+	–	+	–
10	*Cyprinus carpio*	Gulfam	–	–	–	+	–	–	–	–
11	*Labeo pungusia*	Pangas	–	–	+	+	–	–	+	–
12	*Labeo bata*	Bata	–	–	–	–	+	–	+	–
13	*Labeo calbasu*	Dahi	+	+	+	+	–	+	+	–
14	*Labeo catla*	Thaila	+	+	+	+		+	+	–
15	*Labeo gonius*	Cirreho	–	–	–	–	+	–	–	–
16	*Labeo rohita*	Rahu	+	+	+	+	–	+	–	–
17	*Osteobrama cotio*	Cotio	–	–	–	–	+	+	–	–
18	*Pethia ticto*	Daro	–	–	–	–	+	–	–	–
19	*Puntius chola*	Popri	–	–	–	–	–	+	–	–
20	*Puntius sophore*	Popri	–	–	–	+	+	+	–	–
21	*Systomus sarana*	Popri	–	–	–	+	–	–	–	–
22	*Ctenopharyngodon idella*	Grass	–	–	–	+	–	–	+	–
23	*Hypophthalmichthys molitrix*	Silver	–	–	–	+	–	–	+	–
24	*Salmostoma bacaila*	Salma	–	–	–	–	+	–	–	–
25	*Crihinus reba*	Suhni	+	+	–	–	+	–	–	
26	*Mystus cavasius*	Dhongno	+	+	+	+	–	+	+	–
27	*Rita rita*	Khago	+	+	+	+	–	–	+	–
28	*Sperat aaor*	Aor	–	–	–	–	+	–	–	–
29	*Sperata seenghala*	Singhari	+	+	+	+	–	+	+	–
30	*Ompok bimaculatus*	Phaboono	–	–	+	–	–	–	+	–
31	*Wallagoattu*	Jarko	+	+	+	–	–	–	+	–
32	*Bagarius bagarius*	Foji Khaga	–	–	–	+	–	+	–	–
33	*Heteropneustes fossilis*	Singhee	–	–	–	–	–	–	+	–
34	*Clupisoma garua*	Shalee	–	–	–	–	+	+	–	–

Table 2 The 45 species were collected at eight sampling sites of Indus River Sindh during the study period (continued)

S. no.	Scientific name	Common name	Sampling station							
			S1	S2	S3	S4	S5	S6	S7	S8
35	*Eutropiichthys vacha*	Vacha	–	–	–	–	+	–	–	–
36	*Xenentodon cancila*	Kung	–	–	–	+	–	–	+	–
37	*Mastacembelus armatus*	Goj	–	–	+	–	–	+	–	–
38	*Macrognathus pancalus*	Bam	–	–	–	–	–	+	–	–
39	*Chanda nama*	Nama	–	–	–	–	+	–	–	+
40	*Latescal carifer*	Dangri	–	–	–	–	–	–	–	+
41	*Coptodon zillii*	Sao Dayo	–	–	–	–	–	–	+	–
42	*Oreochromis niloticus*	Neero Dayo	–	–	–	+	–	–	+	–
43	*Oreochromis mosambicus*	Karo Dayo	–	+	+	+	–	–	–	+
44	*Sarotherodon galilaeus*	Irani Dayo	–	–	–	+	–	–	+	–
45	*Valmugil speighleri*	Mullet	–	–	–	–	–	–	–	+
46	*Glossogobius giuris*	Gupgolo	–	–	–	–	+	–	–	–

4 Conclusions

The present study shows that the Indus River of Sindh has a rich diversity of finfish species. The fluctuations in vertebrate fauna's diversity are due to increased habitat loss, illegal hunting, industrial effluents, illegal hunting and increased anthropogenic activities. It is recommended that conservation measures should be adopted on top priority to protect biodiversity from further decline and extinction. The Indus River's water quality is suitable for fish diversity; there are no water hazards found during the study period, so it's recommended that the Indus River's water is ideal for fish.

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