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Invasive Intruders: A Strategic Approach to Protecting Native Freshwater Fish Species of South Punjab, Pakistan

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SUMMARY

Pakistan has a wide variety of native and exotic freshwater fish species. However, the introduction of exotic species might result in resource competition, which can have a severe influence on the native fish population. Therefore this study was designed to verify the status of exotic fish species and its impacts on the native fish species in south Punjab. Data were collected from January 2020 to December 2022. During the study period total of 65 species native and 6 exotic fish species were documented. During the study, 1918 native ichthyofauna samples were reported from the head of Taunsa, 4649 samples from the head of Punjnad, 1481 samples from the head of Islam, and 641 samples from the Chashma Barrage, whereas 42 exotic ichthyofauna samples were recorded from the head of Punjnad, 52 samples from the head of Islam, and 271 samples from the Chashma Barrage. Finally, different variables can influence native fish species diversity, and invading alien species can play a substantial role in lowering native populations due to increased competition. Further research into the food web and roosting sites of both invasive and local species in Pakistan is required to address this issue.

Keywords: Competition, Aliens fishes, Native, PCA, Diversity

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INTRODUCTION

When plants or animals relocate to a new site where they do not belong, the new owner may face serious problems. This might happen by design or by coincidence. The variety of life in water is changing significantly throughout the planet (McIntyre, 2010). It occurs because of pollution, the loss of these creatures' habitats, the introduction of species from other areas, their misuse, and other human-caused alterations to nature (Altaf, 2016; Bassem, 2020; Khan et al., 2011; Sala et al., 2000). Ichthyofauna has an essential function as key participants in aquatic environments. They aid in determining where other living creatures may be located depending on the standard of the water's content and the general health of the ecosystem (Sharma et al., 2019), which serves as an indicator in informing us about the surroundings (Manzoor et al., 2021). When new species of fish from various parts of the world are introduced, the entire planet is

worried (Pyek et al., 2020). This is due to the possibility that these new fish may compete with our local species, causing them to go extinct (Bueno et al., 2021). It affects not just the amount of fish and where they live, but also how humans make a living, particularly those that rely on a certain aquatic environment to survive (Kumar, 2000; Moyle and Leidy, 1992; Puth and Post, 2005).

Whilst the majority of exotic species of fish imports are for a variety of reasons (Le Hen et al., 2023), these species have introduced new rivals to the local ichthyofauna that are unable to thrive (Erarto and Getahun, 2020). Exotic fish species' effects on ichthyofauna and other living things are defined as social and ecological implications (EK et al., 2022). In turn, alien species-caused social and economic changes foster greater ecological changes (Haubrock et al., 2022; Pyek et al., 2020). As a result, a loss in native ichthyofauna may be caused by alien fauna, or it may be caused by increased fishing pressure or changes in landscape utilization as a result of the presence of newly established ichthyofauna (Imran et al., 2021).

Pakistan has the world's largest canal network, with over 225 wetlands that extend an incredible 0.78 million hectares (Altaf et al., 2014; Chaudhry, 2010). This huge system includes 19 Ramsar sites and features 26% coastal wetlands and 74% freshwater areas. Punjab noted for its five rivers, has an advanced irrigation system that includes barrages, dams, canals, and waterways (Altaf et al., 2014). Notable barrages illustrate Punjab's importance in aquatic biodiversity. These structures not only show engineering brilliance but also showcase Punjab as a rich and powerful aquatic life hotspot. The intricate network of rivers not only preserves the region's natural richness but also plays a crucial role in the survival of numerous species, making Punjab a key contributor to the world's animal variety (Iqbal et al., 2017; Muhammad et al., 2019a; Muhammad et al., 2017; Muhammad et al., 2019b).

Many ichthyologists, or fish scientists, have collected a large amount of data about fish from various locations (Altaf et al., 2011a, b, 2015a; Ashraf et al., 2022). Several foreign fish species have been introduced into Pakistan for several purposes, including recreational fishing, the eradication of aquatic plants and insects, and the enhancement of fish production. Warm-water species include *Oreochromis niloticus, O. mozambicus, O. aureus, Hypopthalmicthys nobilis, H. molitrix, Carassius auratus, Cyprinus carpio,* and *Ctenophryngdon idella*, while cold-water species include *Onchorynchus mykiss* and *Salmo trutta* (Khan et al., 2011). The current study aims to determine how introduced (or exotic) fish species affect the variety of native fish species in the rivers of South Punjab, Pakistan. This study is critical to understanding the ecological dynamics and possible effects of introducing foreign fish into native habitats.

MATERIALS AND METHODS

The data were collected from January 2020 to December 2022 in early the morning from different study areas of south Punjab, Pakistan.

STUDY AREA

The south Punjab is a unique region within the greater province of Punjab, distinguished by its diverse landscape and climate (Figure 1). The people who live in this area confront numerous obstacles, as many are uneducated and live in terrible

poverty (Iqbal et al., 2023; Yousaf et al., 2009). Their main sources of income include handcrafted wooden products, agriculture, cattle, and traditional crafting. South Punjab stretches from 71°27′ to 73°15′ east and 29°12′ to 31°15′ north, covering a large area of 105,504 km^2. The natural abundance of the region is attributed to its unique geographical features. It has borders with the native regions of Dera Ghazi Khan, Sahiwal, Multan, Dera Ghazi Khan, and Rajanpur to the north. Sadiqabad and Rahim Yar Khan are also in the extreme northwestern part of this area Vehari and Bahawalnagar are in the southwest, and Bahawalpur is in the west. (Farooq et al., 2018; Hasan et al., 2017; Sajjad et al., 2019; Younas and Yaqoob, 2005). Saraiki is the most frequently spoken language in South Punjab (Iqbal and Altaf, 2019). Furthermore, Punjabi speakers are also present in this region. Geographically, South Punjab is distinguished by its distant and difficult terrain, which is characterized by rugged and desolate areas. The location is remote from urban areas, and residents endure financial issues, as well as restricted access to healthcare. Roads and other infrastructure are frequently in disrepair. Many inhabitants in this area rely on agriculture, cattle, and small local enterprises for a living (Atta et al., 2020; Kausar et al., 2015; Mughal, 2020).

METHODOLOGY

Data were collected and samples were identified from the appropriate identification keybook (Mirza, 2004). While photograph of each species was added to the Questionnaire and formal questions were asked about the diversity of fish species and population and decline from fishermen, local villagers, hunters etc.

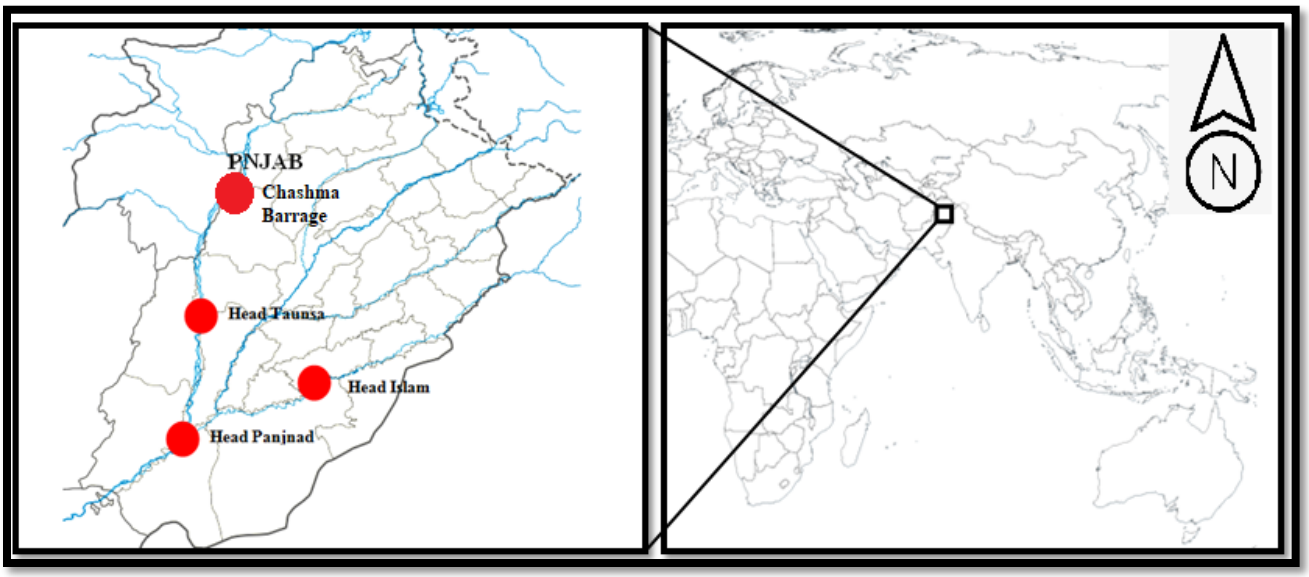

Figure 1: Map of study area i.e. head Taunsa (HT), head Punjnad (HP), head Islam (HI), and Chashma Barrage (CB).

STATISTICAL ANALYSIS

Past (Version 4.03) statistical tool was used to know the diversity indices, and PCA value (Hammert et al., 2001).

RESULTS AND DISCUSSION

During the research duration, 65 native (Table 1) and 6 foreign (Table 2) fish species were identified. During the research project, a total of 1918 samples of native ichthyofauna were reported from head Taunsa, 4649 from head Punjnad, 1481 from head Islam, and 641 populations of native from Chashma Barrage (Table 3), while 42 samples of exotic ichthyofauna were reported from head Taunsa, 40 from head Punjnad, 52 from head Islam, and 271 from Chashma Barrage (Table 4). There's a fascinating story regarding several fish species in the rivers of South Punjab. In contrast to other places, Chashma Barrage is the major site, with the most exotic fish samples (P=271). Unexpectedly unlike in other areas, native fish (P=641) struggle the most in Chashma Barrage. When examined closely, the population numbers (D=0.3446 and E=0.5674) indicate that exotic fish are present in South Punjab, notably in Punjnand, which has less exotic fish (P=40) and more native fish (P=4649) than other regions such as Taunsa, Head Islam, and Chashma.

But here's the good news: despite the exotic fish causing destruction our native fish seem to be doing just fine. The Simpson index shows that Taunsa, Punjnad, Head Islam, and Chashma have a varied variety of fish, with Taunsa (S=0.9691), Punjnad (S=0.9773), Head Islam (S=0.9), and Chashma (S=0.8271). The Shannon diversity index, such as Taunsa (H'=3.759), Punjnad (H'=3.928), Head Islam (H'=2.486), and Chashma (H'=0. When we examine how many different varieties of fish we have in Taunsa (R=8.467), Punjnad (R=7.579), Head Islam (R=3.287), and Chashma (R=9.902), it becomes clear that our local fish do extraordinarily well in all of these categories.

Different types of foreign ichthyofauna, including *Oreochromis mossambicus*, were transported to Pakistan for various purposes over the years. *O. mozambicus*, for example, came from Thailand, Indonesia, and Egypt in 1951 and 1954. This ichthyofauna feeds on detritus and phytoplankton, and it competes with other species by eating on ichthyofauna and their young. It constructs its nests and lays its eggs in shallow water. Another ichthyofauna, *O. niloticus*, was brought from Egypt to Pakistan in 1985. This ichthyofauna eats a variety of meals and damages adjacent ichthyofauna. *O. niloticus* builds shallow-water nests and keeps the eggs in her mouth while eating other fish and their progeny (De Silva, 2004; Naik, 1973).

The two axes accounted for 75% of the variance in ichthyofauna species, according to the PCA analysis (Component 1: 41%; Component 1: 34%). Head Taunsa (r = 0.17219), Head Punjnad (r = 0.48971), Head Islam (r = 0.82802), and Chashma Barrage (r = 0.21194) were variables placed into Component 1. Component 2 also corresponded to research areas (r = -0.0327, r = 0.86689, r = -0.45369, and r = -0.20395). Both components were discovered to be unrelated, and the fish diversity patterns explained by Component 2 were not related to those explained by Component 1. Almost all variables in landscapes did not closely correlate with other PCA components, indicating that the impact of alien species was the most important factor impacting the ichthyofauna. Component 2 was separated into two portions, with HT and HI being negatively connected with alien species and HP and CB being favourably correlated (Figures 2 and 3). These results are supported by Altaf (2016) and Imran et al. (2021).

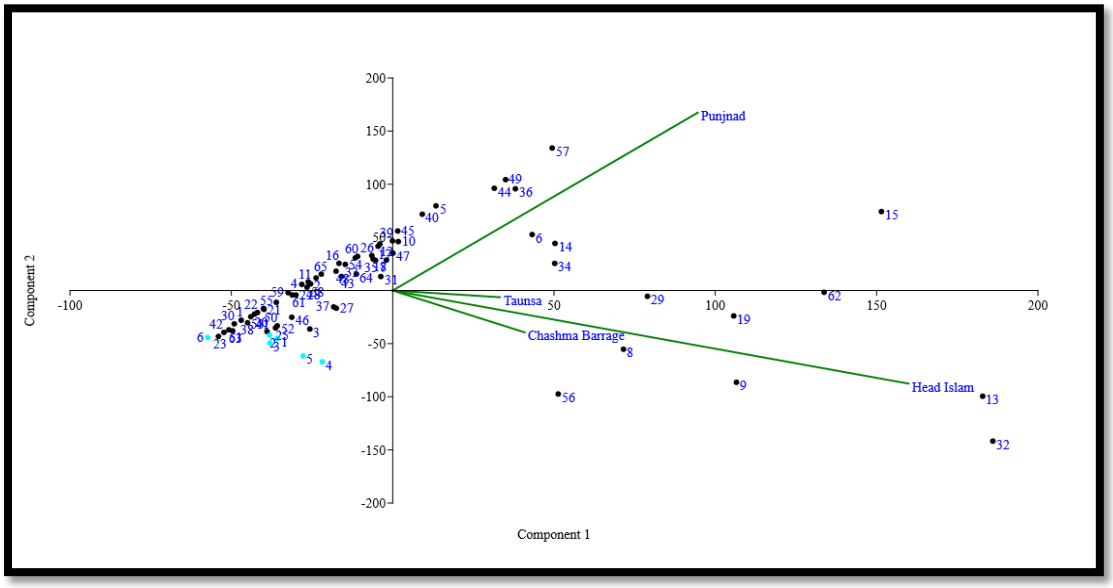

Figure 2: Analysis of aliens' fish species impact on the diversity of native fish species through PCA.

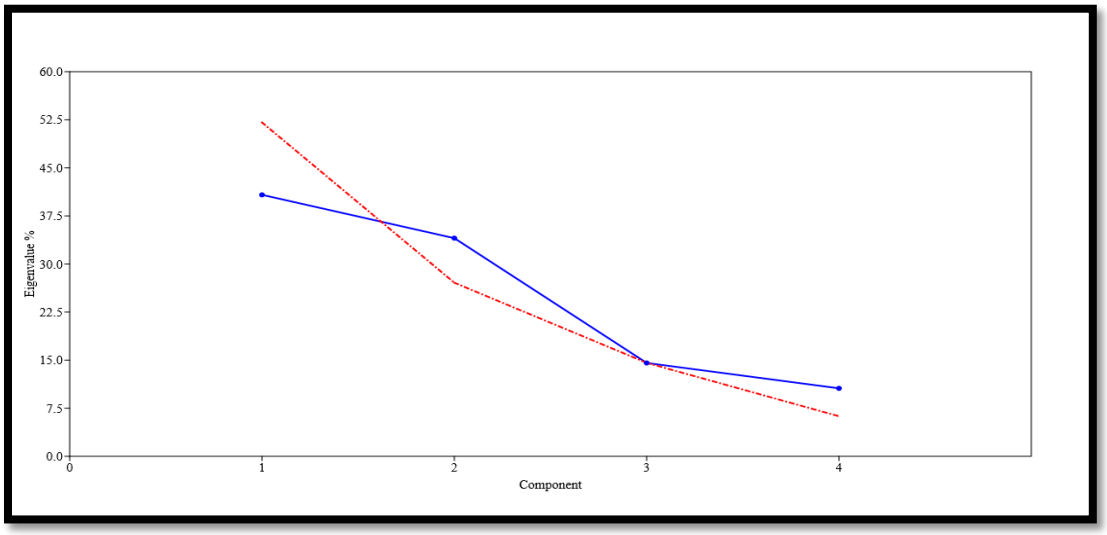

Figure 3: Loading of PCA showed that correlation among the four sites.

Many different fish species have been introduced into India for aquaculture, decoration, and other purposes. Fish species escaped into the wild and became invasive to the system throughout time. Some foreign fish species have wreaked havoc on the environment and the economy (Sandilyan et al., 1998; Sandilyan et al., 2018). *Catla catla*, *Labeo rohita*, *Cirrhinus mrigala*, and *Labeo calbasu* are economically significant carnivorous, detritivorous, and vegetarian local fishes. Alien fish are omnivorous, grazing mostly on plants and plankton. *O. aureus* (foreign fish) favours tiny fish, fish larvae, and detritus (Welcomme et al., 2003). The work of McNeely (2001) showed that the introduction of foreign species such as *Ctenophryngdon idella*, *Oreochromis mozambicus*, *Cyprinus carpio*, and *Hypophthalmichthys nobilis* into

Philippine lakes resulted in the extinction of local ichthyofauna. The introduction of non-native fish species, according to Khan et al. (2011), poses a significant danger to the conservation of fish diversity. *Oreochromis aureus* has become completely invasive due to direct competition for food with local fish species. In contrast, grass carp and mosquito fish were introduced to control water weeds and mosquito larvae, respectively. These invasions may jeopardise native fish habitats.

Competition between invasive and indigenous freshwater fish species has been observed to occur at several levels, including fish distribution, population dynamics, and food chain structure (Garber and Sullivan, 2006; Yan et al., 2001). The IUCN (2004) studied the impact of invasive fish on native fish populations ranging from threatened to endangered species and advocated habitat restoration and conservation activities in Pakistan. Exotic fish species, as stated by Taylor et al. (1984), can also alter the food web by generating trophic level alterations such as competition, predation, changes in food web structure, parasite introduction, and disease transmission. *Cyprinus carpio* was classified as a pest by Wahab et al. (1995) because of its proclivity to uproot plants in bodies of water, resulting in increased turbidity and lower water clarity. According to Cambray (2003), the impact of alien fishes varies in space and time, and the introduction of a few species may result in the extinction of many indigenous fish species worldwide.

The species *O. niloticus* has grown established in the region after being introduced to boost aquaculture. This import, according to De Silva (2004), began in Egypt in about 1985. Similarly, *O. mozambicus* species have been successfully created to enhance aquaculture. In 1951 and 1954, the import sources were Thailand and Egypt, respectively (Naik, 1973). The introduction *of C. auratus* species in the area, according to Mirza (2003), serves the goal of establishing ornamental aquaculture. There is no evidence *of H. molitrix* or *C. idella* species being established. Both were introduced to boost aquaculture and were imported from China in 1964, according to FAO (1970). *C. carpio* was successfully introduced to boost fish output. In 1964, Thailand was the source of the import for this purpose by FishBase (2003).

CONCLUSION

According to scientific studies, various factors influence the variety of local fish populations. However, the presence of invasive alien species has a considerable impact on native species extinction, owing to competition for resources such as food, roosting sites, and shelter. To solve this issue, a full examination of the food chain and roosting places for both alien and local species in Pakistan is required. Such research is needed to acquire a better understanding of the impact of invasive species on native fish communities and develop appropriate management methods in the future.

ACKNOWLEDGEMENT

The authors are thankful to hunters, fishermen, and villagers of south Punjab for guidance and help during the field surveys.

Table 1: Native species of south Punjab.

Sr.	Scientific name	Species authority	Common name	Family	Taunsa	Punjnad	Islam	Chashma	IUCN Status
1	*Ambylpharyngodon mola*	Hamilton, 1822	Chilwa, Mola	Cyprinidae	7	19	0	1	Least concern
2	*Aspidoparia morar*	Hamilton, 1822	Common chilwa	Cyprinidae	11	65	0	1	Least concern
3	*Bagarius bagarius*	Hamilton, 1822	Fauji Khaga	Sisoridae	9	22	23	3	Near Threatened
4	*Botia birdi*	Chaudhuri, 1909	Birdi loach	Botiidae	4	58	0	2	Not Evaluated
5	*Botia lohachita*	Chaudhuri, 1912	Bagha, Lohachat	Botiidae	5	143	0	1	Not Evaluated
6	*Catla catla*	Hamilton, 1822	Thaila	Cyprinidae	41	132	34	5	Least concern
7	*Chanda nama*	Hamilton, 1822	Sheesha Machali	Chandidae	74	87	0	2	Least concern
8	*Channa marulius*	Hamilton, 1822	Saul	Channidae	28	53	112	27	Least concern
9	*Channa punctuata*	Bloch, 1793	Daula,Guddu snakehead	Channidae	123	37	145	23	Least concern
10	*Channa striata*	Bloch, 1793	Murrel	Channidae	25	107	2	5	Least concern
11	*Chela cachius*	Hamilton, 1822	cachuis Budha, Bidda	Cyprinidae	6	61	0	3	Least concern
12	*Chitala chitala*	Hamilton, 1822	Battu	Notopteridae	7	103	2	2	Near Threatened
13	*Cirrhinus mrigala*	Hamilton, 1822	Mori, Mrigal	Cyprinidae	22	67	243	13	Least concern
14	*Cirrhinus reba*	Hamilton, 1822	Sunni Machali	Cyprinidae	36	128	47	1	Least concern
15	*Clupisoma garua*	Swainson, 1838	Bachwa	Schilbeidae	25	204	126	3	Least concern
16	*Colisa fasciata*	Bloch and Schneider, 1801	bari kanghi, Fider, Chidu	Osphronemidae	2	81	1	1	Least concern
17	*Colisa lalia*	Hamilton, 1822	Choti Kanghi	Osphronemidae	7	101	2	4	Least concern
18	*Crossocheilus diplochilus*	Heckel, 1838	Dogra	Cyprinidae	41	88	0	7	Not Evaluated
19	*Eutropiicthys vacha*	Hamilton, 1822	Jhalli Machali	Schilbeidae	11	96	138	1	Least concern
20	*Glossogobius giuris*	Hamilton, 1822	Tank goby	Gobiidae	10	26	0	2	Least concern
21	*Glyptothorax cavia*	Hamilton, 1822	Heart Throat Catfish	Sisoridae	11	39	0	3	Least concern

22	*Glyptothorax punjabensis*	Mirza anf kashmiri, 1971	Glyptothorax punjabi	Sisoridae	7	28	0	4	Endangered
23	*Glyptothorax stocki*	Mirza and Nijssen	Glyptothorax stocki	Sisoridae	12	2	0	3	Endangered
24	*Gonialosa manminus*	Hamilton, 1822	Ganges river gizzard shad	Clupeidae	11	48	2	3	Least concern
25	*Gudusia chapra*	Hamilton, 1822	Palli	Clupeidae	77	14	1	2	Least concern
26	*Heteropneustes fossilis*	Bloch, 1794	Sanghi Machali	Heteropneustidae	5	93	3	11	Least concern
27	*Labeo bogga*	Hamilton, 1822	Bhangan	Cyprinidae	9	43	21	1	Least concern
28	*Labeo boggut*	Sykes, 1839	minor carp	Cyprinidae	13	56	1	3	Least concern
29	*Labeo calbasu*	Hamilton, 1822	Kalbans, Kalu, Di, Galbans	Cyprinidae	13	117	34	231	Least concern
30	*Labeo dyocheilus pakistanicus*	McClelland, 1839	Pakistani tokri	Cyprinidae	6	15	0	1	Least concern
31	*Labeo gonius*	Hamilton, 1822	Seereha	Cyprinidae	93	72	1	9	Least concern
32	*Labeo rohita*	Hamilton, 1822	Dambra, Rohu	Cyprinidae	111	34	223	110	Least concern
33	*Macrognathus pancalus*	Hamilton, 1822	Gorj	Mastacembelidae	6	81	2	3	Least concern
34	*Mastacembelus armatus*	Lacepede, 1800	Baam	Mastacembelidae	17	114	54	21	Least concern
35	*Mystus bleekeri*	Day, 1877	Kanghar,Tingara bleekri	Bagridae	57	86	0	2	Least concern
36	*Mystus cavasius*	Hamilton, 1822	Kanghar,Tingara	Bagridae	83	165	0	3	Least concern
37	*Mystus horai*	Jayram, 1954	Indus catfish	Bagridae	117	38	0	3	Vulnerable
38	*Mystus tengara*	Hamilton, 1822	Tinggarah	Bagridae	23	17	0	2	Least concern
39	*Mystus vittatus*	Bloch, 1794	Kuggur	Bagridae	32	106	0	1	Least concern
40	*Nangra robusta*	Mirza & Awan, 1973	Nangra	Sisoridae	6	134	0	1	Least concern
41	*Notopterus notopterus*	Pallas, 1769	But, Pari	Notopteridae	42	12	5	7	Not Evaluated

42	*Ompok bimaculatus*	Bloch, 1794	Butter catfish Pafta	Siluridae	13	6	0	1	Near Threatened
43	*Ompok pabda*	Hamilton, 1822	Machali,Pallu	Siluridae	48	68	0	1	Near Threatened
44	*Oreochromis niloticus*	Linnaeus, 1758	Chirra Machali	Cichlidae	49	164	0	2	Least concern
45	*Osteobrama cotio*	Hamilton, 1822	Pali-ro Machali	Cyprinidae	13	116	0	1	Least concern
46	*Parambasiss baculis*	Hamilton, 1822	Baculius Sheesha	Chandidae	81	25	0	1	Least concern
47	*Parambassis ranga*	Hamilton, 1822	Ranga Shisha	Chandidae	67	94	0	1	Least concern
48	*Pseudeutropius atherinoides*	Bloch, 1794	Indian potasi	Schilbeidae	23	73	0	2	Not Evaluated
49	*Puntius chola*	Hamilton, 1822	Swamp barb, katchi paral	Cyprinidae	45	173	0	1	Least concern
50	*Puntius conchonius*	Hamilton, 1822	Red barb, Rosy barb	Cyprinidae	14	31	0	1	Least concern
51	*Puntius punjabensis*	Day, 1871	Punjabi popra	Cyprinidae	12	9	0	2	Least concern
52	*Puntius sophore*	Hamilton, 1822	Sophore Popra, pool barb	Cyprinidae	78	16	0	3	Least concern
53	*Puntius terio*	Hamilton, 1822	Teri barb	Cyprinidae	13	23	0	1	Least concern
54	*Puntius ticto*	Hamilton, 1822	Popra, Ritatus	Cyprinidae	19	87	0	1	Least concern
55	*Rita macracanthus*	Ng, 2004	Macracanthus	Bagridae	9	32	0	2	Not Evaluated
56	*Rita rita*	Hamilton, 1822	Desi khaga, Tarkanda	Bagridae	14	5	125	3	Least concern
57	*Salmophasia bacaila*	Hamilton, 1822	Small chal	Cyprinidae	31	207	0	2	Least concern
58	*Salmophasia punjabensis*	Day, 1872	Punjabi Chal	Cyprinidae	17	59	0	2	Least concern
59	*Securicula gora*	Hamilton, 1822	Bari Chal	Cyprinidae	5	49	0	2	Least concern
60	*Sicamugil cascasia*	Hamilton, 1822	Yellowtail mullet	Mugilidae	15	89	0	3	Least concern
61	*Sisor rabdophorus*	Hamilton, 1822	Kirla Machali	Sisoridae	18	47	0	2	Least concern

62	*Sperata seenghala*	Sykes, 1839	Singhara, seenghala, Auri	Bagridae	29	132	134	51	Least concern
63	*Systomus sarana*	Hamilton, 1822	Jundoori	Cyprinidae	23	8	0	1	Least concern
64	*Wallago attu*	Bloch and Schneider, 1801	Malli	Siluridae	28	75	0	23	Vulnerable
65	*Xenetodon cacila*	Hamilton, 1822	Kaan Machali, Cowa tokia	Belonidae	9	69	0	1	Least concern

Table 2: Exotic species of south Punjab.

Sr.	Scientific name	Species authority	Common name	Family	Taunsa	Punjnad	Islam	Chashma	IUCN Status
1	*Oreochromis aureus*	Steindachner, 1864	Chirra, Golden tilapia	Cichlidae	12	10	15	12	Not Evaluated
2	*Oreochromis mossambicus*	Peters, 1852	Tilapia	Cichlidae	9	11	14	5	Vulnerable
3	*Ctenopharyngodon idella*	Valenciennes, 1844	Grass carp	Cyprinidae	4	7	10	34	Not Evaluated
4	*Cyprinus carpio*	Linnaeus, 1758	Gulfam	Cyprinidae	7	5	11	109	Vulnerable
5	*Hypophthalmicthys molitrix*	Valenciennes, 1844	Silver Carp	Cyprinidae	9	7	2	110	Near Threatened
6	*Carassius auratus*	Linnaeus, 1758	Gold fish	Cyprinidae	1	0	0	1	Least concern

Table 3: Indices of native fishes of South Punjab.

Indices of Native	Taunsa	Punjnad	Head Islam	Chashma
Species (S)N	65	65	25	65
Population (P)N	1918	4649	1481	641
Dominance (D)N	0.0309	0.02274	0.09999	0.1729
Simpson (X)N	0.9691	0.9773	0.9	0.8271
Shannon (H')N	3.759	3.928	2.486	2.61
Evenness (E)N	0.6604	0.7818	0.4805	0.2093
Margalef (R)N	8.467	7.579	3.287	9.902

Table 4: Indices of exotic fishes of South Punjab.

Indices	Taunsa	Punjnad	Head Islam	Chashma
Species (S)E	6	5	5	6
Population (P)E	42	40	52	271
Dominance (D)E	0.2109	0.215	0.2389	0.3446
Simpson (X)E	0.7891	0.785	0.7611	0.6554
Shannon (H')E	1.63	1.572	1.483	1.225
Evenness (E)E	0.8504	0.9628	0.8811	0.5674
Margalef (R)E	1.338	1.084	1.012	0.8925

REFERENCES

Altaf, M. 2016. Assessment of Avian and Mammalian Diversity at Selected Sites along river Chenab University of Veterinary and Animal Sciences, Lahore-Pakistan.

Altaf, M., A. Javid, A. M. Khan, A. Hussain, M. Umair, and Z. Ali. 2015. The Status Of Fish Diversity Of River Chenab, Pakistan. The Journal of Animal & Plant Sciences. 25: 564-569.

Altaf, M., A. Javid, and M. Umair. 2014. Biodiversity of Ramsar Sites in Pakistan: Wildlife and Ecology. LAP LAMBERT Academic Publishing.

Altaf, M., A. M. Khan, M. Umair, and S. A. Chattha. 2011a. Diversity of Carps in River Chenab, Pakistan. Punjab University Journal of Zoology. 26: 107-114.

Altaf, M., A. M. Khan, M. Umair, M. Irfan, M. A. Munir, And Z. Ahmed. 2011b. Ecology And Diversity of Freshwater Fishes of Head Qadirabad, Gujranwala. Punjab University Journal of Zoology. 26: 1-7.

Ashraf, S., M. Altaf, A. Khan, M. Haidar, N. Amjad, A. Naseem, and M. Khan. 2022. Fresh Water Fish Species Diversity at Chashma Barrage, Pakistan. Journal of Animal and Plant Sciences-Japs. 32: 855-860.

Atta, F., J. van de Weijer, and L. Zhu. 2020. Saraiki. Journal of the International Phonetic Association. 1-21.

Bassem, S. M. 2020. Water pollution and aquatic biodiversity. Biodiversity International Journal. 4.

Cambray, J. A. 2003. Impact on indigenous species biodiversity caused by the globalisation of alien recreational freshwater fisheries. Hydrobiologia. 500: 217-230.

De Silva, S. S. 2004. Tilapias as alien aquatics in Asia and the Pacific: a review. Food & Agriculture Org.

FAO. 1970. Report on the regional seminar on induced breeding of cultivated fishes, Barrackpore, Cuttack and Bombay, India, FAO.

FAO. 1998. FAO Fish stat PC. Fishery Information, Data and statistics Unit, Food and Agriculture Organization of the United Nations, Rome, Italy.

Farooq, Z., S. M. Akram, M. S. Khan, and M. Wajid. 2018. Ecological Assortment of snakes in southern Punjab, Pakistan. Pakistan Journal of Zoology. 50.

FishBase. 2003. http://www.fishbase.org/home.htm Accessed Date Accessed.| doi:DOI|

Garber, A. F., and C. V. Sullivan. 2006. Selective breeding for the hybrid striped bass (Morone chrysops, Rafinesque× M. saxatilis, Walbaum) industry: status and perspectives. Aquaculture Research. 37: 319-338.

Hammert, Q., D. A. T. Harper, and P. D. Ryan. 2001. Past paleontological statistical software package for education and data analysis. Palaeontol. stat.: 4.
Hasan, M., Y. Shang, G. Akhter, and M. Khan. 2017. Geophysical investigation of fresh-saline water interface: A case study from South Punjab, Pakistan. Groundwater. 55: 841-856.
Imran, M. et al. 2021. Impact of alien fishes on the distribution pattern of indigenous freshwater fishes of Punjab, Pakistan. Brazilian Journal of Biology. 82: e238096.
Iqbal, K. J. et al. 2023. Cross-cultural diversity analysis: traditional knowledge and uses of freshwater fish species by indigenous peoples of southern Punjab, Pakistan. Journal of Ethnobiology and Ethnomedicine. 19: 1-17.
Iqbal, K. J., and M. Altaf. 2019. Socio economic status of fishermen community, south Punjab, Pakistan. Punjab University Journal of Zoology. 34: 115-118.
Iqbal, M. M. et al. 2017. Status of fish diversity of Islam Barrage, river Sutlej, Punjab, Pakistan. Journal of Wildlife and Ecology. 1.
IUCNP. 2004. Conservation Assessment and Management Plan Workshop for Freshwater Biodiversity of Pakistan, 13-17 December, 2004. Abstracts from ZOOTAXA. P. 4: 5.
Kausar, R., M. Sarwar, and M. Shabbir. 2015. The History of the Urdu Language Together with Its Origin and Geographic Distribution. International Journal of Innovation and Research in Educational Sciences. 2: 5-9.
Khan, A., Z. Ali, S. Shelly, Z. Ahmad, and M. Mirza. 2011. Aliens; a catastrophe for native freshwater fish diversity in Pakistan. J Anim Plant Sci. 21: 435-440.
Kumar, A. B. 2000. Exotic fishes and freshwater fish diversity. Zoos' Print Journal. 15: 363-367.
Manzoor, M. et al. 2021. Bio-indicator species and their role in monitoring water pollution Freshwater pollution and aquatic ecosystems. p 321-347. Apple Academic Press.
McIntyre, A. 2010. Life in the world's oceans: Diversity, distribution, and abundance. John Wiley & Sons.
McNeely, J. A. 2001. Global strategy on invasive alien species. IUCN.
Mirza, M. R. 2003. Checklist of freshwater fishes of Pakistan. Zoological Society of Pakistan.
Mirza, M. R. 2004. Freshwater fishes of Pakistan, (Urdu). Urdu Science Board.
Moyle, P. B., and R. A. Leidy. 1992. Loss of biodiversity in aquatic ecosystems: evidence from fish faunas Conservation Biology. p 127-169. Springer.
Mughal, M. A. 2020. Ethnicity, marginalization, and politics: Saraiki identity and the quest for a new Southern Punjab province in Pakistan. Asian Journal of Political Science. 28: 294-311.
Muhammad, N. et al. 2017. Assessment of the diversity and ethno-medicinal uses of the carps in Punjab, Pakistan. Journal of Wildlife and Ecology. 1: 52-60.
Muhammad, N. et al. 2019a. Statistical analysis of fish diversity of Rasul Barrage, Punjab, Pakistan. Journal of Wildlife and Ecology. 3: 6-12.
Muhammad, N. et al. 2019b. Statistical analysis of freshwater fishes of head Khanki, Punjab, Pakistan. Journal of Wildlife and Ecology. 3: 1-9.
Naik, I. 1973. Studies on Tilapia mossambica Peters in Pakistan. Agric. Pak. 24: 47-76.
Puth, L. M., and D. M. Post. 2005. Studying invasion: have we missed the boat? Ecology letters. 8: 715-721.
Sajjad, A., J. Lu, X. Chen, C. Chisenga, and S. Mahmood. 2019. The riverine flood catastrophe in August 2010 in South Punjab, Pakistan: Potential causes, extent and damage assessment. Appl. Ecol. Environ. Res. 17: 14121-14142.
Sala, O. E. et al. 2000. Global biodiversity scenarios for the year 2100. Science. 287: 1770-1774.
Sandilyan, S., B. Meenakumari, and A. Biju Kumar. 1998. Rupam Mandal. 2018. A review on Impacts of invasive alien species on Indian inland aquatic ecosystems. National Biodiversity Authority, Chennai No. 3. p 456-462. Corresponding Author: Sandilyan, S.< ssandilyan@ gmail. com> Copyright ….
Sandilyan, S., B. Meenakumari, Kumar, A. Biju, and R. Mandal. 2018. A review on Impacts of invasive alien species on Indian inland aquatic ecosystems, National Biodiversity Authority, Chennai.
Sharma, A. et al. 2019. Worldwide pesticide usage and its impacts on ecosystem. SN Applied Sciences. 1: 1-16.
Taylor, N., W. R. Courtenay Jr, and J. A. McCann. 1984. Known impacts of exotic fishes in the contintental United States.
Wahab, M., Z. Ahmed, M. A. Islam, M. Haq, and S. Rahmatullah. 1995. Effects of introduction of common carp, Cyprinus carpio (L.), on the pond ecology and growth of fish in polyculture. Aquaculture Research. 26: 619-628.
Welcomme, R. L., C. Vidthayanon, and M. R. Commission. 2003. The impacts of introductions and stocking of exotic species in the Mekong Basin and policies for their control.
Yan, X., L. Zhenyu, W. P. Gregg, and L. Dianmo. 2001. Invasive species in China—an overview. Biodiversity & Conservation. 10: 1317-1341.
Younas, M., and M. Yaqoob. 2005. Feed resources of livestock in the Punjab, Pakistan. Livestock research for rural development. 17: 2005.

Yousaf, M., A. Salam, and M. Naeem. 2009. Length–weight relationships of Wallago attu and *Sperata sarwari* from the Indus River, southern Punjab, Pakistan. Journal of Applied Ichthyology. 25: 614-615.

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