

## Fish Diversity of Hill Streams and Sirsa River in Solan District of Himachal Pradesh, India

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### ARTICLE INFO

#### Article History:

Received: Feb. 2<sup>nd</sup>, 2025

Accepted: March 9, 2025

Online: April 2, 2025

#### Keywords:

Lotic riverine bed,  
Baddi industry,  
Pollutants,  
Fish fauna,  
Decline,  
Restoration

### ABSTRACT

The significant status of fish in one's life and in animal kingdom needs no debate all around the globe due to their niche ecology and stress of environment. Such a vast and un-exposed habitat structure has varied impact on biotic regime to support abiotic resources in this ecotonic belt of foot Himalaya including crisscross rivers valley, streams and khads. The pristine streams of rivers in Solan District harbor fishes of commercial importance on and near Sirsa riverine system in Baddi area. The fish diversity in this foot hill ecotone range includes 35 species (4 Orders, 6 Families and 25 genera) out of which Cypriniformes act as dominant order (29 sp.) with 2 species of each of the following orders Siluriformes, Perciformes and Synbranchiformes, as per earlier study. The upper reaches of Sirsa and its riverine tributaries were rich in some species of genus: *Danio*, *Chagunius*, *Barilius*, *Garra*, *Glyptothorax*, *Puntius*, *Tor*, *Mastacembalus*, *Crossocheilus*, *Devario*, *Acanthocobitis*, *Schistura*, *Macrogathus*, *Badis* and *Schizothorax* or *Oreinus*. The important fishes in order of their abundance include *Channa gachua*, *Cyprinus carpio* var. *specularis*, *Labeo rohita*, *Labeo calbasu*, *Cirrhinus mrigala* and *Aorichthys seenghala* (Fig. 1). As per IUCN Red List, the above reported 21 fish species in present studies, 16 species are categorized under the Least Concern (LC), 2 species are designated as Vulnerable (VU), 1 species falls into the Data Deficient Category (DD), 1 species has not been evaluated (NE) and 1 species is classified as Endangered (EN). The facts, such as scientific outcome and perceptions, reduced fish numbers, new trends and environmental stress ecology, research input gap at grass root level to narrow issues and combat steps for further conservation and water management, have been kept in light.

### INTRODUCTION

Fish enjoy the prime position in vertebrates and are of considerable importance in providing proteins, vitamins, minerals, fats and various other nutrients required for nourishment. In one socio-economic domain of Indian demography including unskilled workers and skilled anglers, fisheries is only a source of income as well as balanced diet in their daily life. Income is not only through the sale of the fish but also by attracting the

tourists in different laps of Himalaya's due to the presence of hill stream fishes. The species were unique due to sub temperate climate and zoogeographic affiliations to lotic and lentic region. It is imperative for Fish Diversity of Hill Streams and Sirsa River in Solan District of Himachal Pradesh, India to compile a comprehensive data on fish diversity in relation to water quality of riverine system for perspective planning of fisheries and conservation of endemic fish germplasm. However, it is not possible for the researchers to discuss the whole fish diversity in this communication; therefore, the further focus is mainly on commercially important fish species of Sirsa River basin around industrial area to ascertain health of aquatic body. The reasons to ascertain the diversity status of fishes relied upon the fish biologists to study more diverse group of taxonomic phyla (35800 species of fishes FishBase 10/2024) and has more species than vertebrates (**Matthews, 1998**), there by constituting more than fifty percent of vertebrate animals (**Nelson *et al.*, 2016; Thakur *et al.*, 2021**) on the biosphere. Fish contribution to global fish diversity by Indian subcontinent (2904 fish species out of which 1081 fish species as freshwater fishes) is 11.7% (**Stephen *et al.*, 2015**) and 7.7% (**Froese & Pauly 2020**). The impact of pollutants reported (residual of pharmaceutical antibiotics on algae, daphnia and fishes) is a major threat to the sustainability of Sirsa riverine, thereby declining population of aquatic animals rapidly (**Dixit *et al.*, 2024**). The status of standing state and crop of an aquatic niche is denoted by fishes (as bio-indicators) to ascertain the health of river resources. This study investigated the ichthyofaunal diversity and characteristics of hill streams and the Sirsa River, aiming to provide baseline data to freshwater biodiversity in the Himalayan region, which remains unexplored and limited.

## MATERIALS AND METHODS

This study is based on an extensive survey conducted at selected sampling sites along the streams of the Sirsa riverine system: (S1) upstream near Baddi, (S2) mixed-water (estuary-like) lentic zone near seasonal khads and the CETP, and (S3) downstream at the Ghanauli bridge on the Sirsa River, just before its confluence with the Sutlej River in Punjab. The fishes collected by fishermen by using various methods were purchased, studied for color patterns, photographed. For the present study, fish identification and procedures such as collection, preservation in 10% formaldehyde, morphometric analysis, systematic arrangement, and the use of taxonomic keys were carried out following standard references and monographs (**Talwar & Jhingran, 1991; Jayaram, 1999, 2013; Johal, 1998; Brraich *et al.*, 2003; Negi & Johal, 2005**).



Figure 1 Drainage Map showing Catchment Area of River Sirsa basin at Baddi-Nalagarh Area, Solan Area of Himachal Pradesh (Source: IPI Department, HP)

## RESULTS AND DISCUSSION

The diversity of commercially important fish species is declining, possibly due to the expansion of industrial activities in the Baddi area of Solan. This observation aligns with previous studies and supports the findings of **Oberdorff *et al.* (1995)** and **Johal *et al.* (2001)**, who reported a decline in fish species diversity with increased latitude and altitude in natural ecosystems. Riverine streams crossing through valley and hill eco-zones support diverse fish populations, including many rare, threatened, and endangered species, which serve as bio-indicators for water quality, habitat alterations, and changes in lotic water flow. Significant scientific contributions to Indian fisheries (marine and freshwater) include the work of **Hamilton (1822)** on tributaries of the Ganga River, **Day *et al.* (1875)**, who documented 1,418 marine and freshwater fish species, and **Jhingran (1982)**, who listed 1,475 species from India's marine and freshwater ecosystems. **Jayaram (1999)** further recorded 852 fish species belonging to 16 orders, 71 families, and 272 genera.

The works of many fish biologists on aquatic biodiversity of Himachal Pradesh's rivers and hill streams in relation to fishes (Hora, 1927, 1937; McClelland, 1942; Menon, 1951, 1962; Bhatnagar, 1973; Sehgal, 1974; Tilak & Hussain, 1977; Tilak & Juneja, 1978; Sharma & Tandon, 1990; Sharma, 1991; Uniyal, 1995; Johal, 1998; Mehta, 2000) is worth mentioning here to draw a focus on fish and fisheries of hill streams of Sirsa riverine ecosystem, as there is no such research work on fishes of this ecotone. The common decline trends in fish diversity of Indian riverine system were industrial effluents, water pollution (landfill dumping sites), encroachments, poaching, close season violations, management conflicts and awareness educational gap.

Table (1) enlists 21 fishes (4 orders, 7 families, 20 genera) from the western Himalayan foothill range of Himachal Pradesh. The dominance of Cypriniformes in the catch spectrum (15 species, 71.4% of total fish species) was reported with two species of each order, Siluriformes, Perciformes and Synbranchiformes (9.5% of total population). The family wise Cyprinidae was found to be more with 13 species (61.9%) followed by Nemacheilidae and Mastacembelidae with 2 species each (9.5%), Sisoridae with 1 species (4.7%), Channidae with 1 species (4.7%), Bagridae with 1 species (4.7%) and Nandidae with 1 species (4.7%). The present status of conservation (IUCN red list) of the reported 21 fishes was that 16 species come under Least Concern (LC) category, 2 species come under Vulnerable (VU) category, 1 species come under Data Deficient category (DD), 1 species come under Not Evaluated (NE) category, 1 species come under Endangered (EN) category. Johal *et al.* (2001, 2002, 2003) and Dhanze and Dhanze (2004) have worked on fish diversity of hill stream fishes of Himachal Pradesh, with special reference to ecology, adaptations, economic status, habitat conservation and restoration for the purpose of fish and fisheries in the state for sustainable growth and development of riverine resources. Moreover, Mehta and Uniyal (2005) reported 104 species of fishes (48 genera 14 families and 8 orders) in the state of Himachal Pradesh, out of which 50 fish species inhabiting riverine water system of Solan District with *Macrogathus pancalus* as a new record. Singh and Johal (2009) studied fish species diversity of Ganga River near Allahabad. Kumar (2010) reported six fish species from the River Beas near Kullu and suggested that *Schizothorax richardsonii* populations may decline due to the introduction of the rainbow trout. Sharma and Sidhu (2016) recorded 81 fish species comprising 49 genera, 18 families, and 6 orders, observing a decline in species numbers from 50 to 35 in hill streams and rivers of Solan, and highlighted the declining status of the mirror carp. Bhatnagar *et al.* (2016) documented 59 fish species in the freshwater ecosystems of Haryana, noting a decrease from 82 species in 2004, and recorded the new species *Parapsilorhynchus discophorus*, originally native to the Kaveri River basin. Sharma and Dhanze (2018) reported 58 ornamental fish species in the western Himalayan region, classified under 5 orders, 13 families, and 36 genera, with Cyprinidae (46.55%) remaining the dominant family.

### Fish Diversity of Sirsa Riverine System in HP, India

It has been recommended that scientific guidelines and regulatory mechanisms be revised before introducing exotic fish species into the Indian rivers. Additionally, improving culture fisheries in the state using standardized breeding technologies could significantly enhance the socio-economic status of local fishermen. **Sharma (2019)** documented 63 fish species in a study on ichthyo-diversity in the River Beas of the northwest Himalayan region in Himachal Pradesh. **Singh *et al.* (2021)** investigated fisheries and cooperatives in the Gobindsagar reservoir, reporting 51 fish species, including the exotic carp, with the mirror carp constituting over 85% of the catches at the Bhakra landing station, alongside various hill-stream species. **Uniyal and Uniyal (2021)** recorded 132 fish species (67 genera, 27 families, and 8 orders), identifying Schizothoracine species as dominant in hilly areas and Barilius species in plain areas. **Dutta (2021)** reported 97 fish species from Punjab and Jammu & Kashmir, noting new records of *Clupisoma naziri* and *Ailia punctata* from the Ravi River and its tributaries between Shahpur and Gogga Mahal and around Chamba.

**Table: 1 Fishes of Sirsa Riverine system up and down stream of Baddi industrial hub**

Order	Family		Zoological Name	Vernacular Name	IUCN Status
Cypriniformes	Cyprinidae	1	<i>Barilius barila</i> (Hamilton)	Barila	LC
		2	<i>Danio rerio</i> (Hamilton)	Zebra fish	LC
		3	<i>Tor putitora</i> (Hamilton)	Mahseer	EN
		4	<i>Chagunius chagunio</i> (Hamilton)	Chaguni	LC
		5	<i>Puntius sophore</i> (Hamilton)	Barb	LC
		6	<i>Oreinus richardsonii</i> (Gray)	Gugali	VC
		7	<i>Crossocheilus latius latius</i> (Hamilton)	Latia	LC
		8	<i>Labeo rohita</i> (Hamilton)	Rohu	LC
		9	<i>Devario devario</i> (Hamilton)	----	DD
		10	<i>Cyprinus carpio specularis</i> (Laccedede)	Mirror carp	VC
		11	<i>Cirrhinus mrigala</i> (Hamilton)	Mrigal	LC
		12	<i>Labeo calbasu</i> (Hamilton)	Kalabasu	LC
		13	<i>Garra lamta</i> (Hamilton)	Gotyla	LC
	Nemacheilidae	14	<i>Acanthocobitis botia</i> (Hamilton)	Botia loach	LC
		15	<i>Schistura rupecula</i> (McClelland)	Hill loach	LC
Siluriformes	Bagridae	16	<i>Aorichthys seenghala</i> (sykes)	Seenghari	LC
	Sisoridae	17	<i>Glyptothorax pectinopterus</i> (McClelland)	---	NE
Perciformes	Channidae	18	<i>Channa gachua</i> (Schneider)	Snake headed fish	LC
	Nandidae	19	<i>Badis badis</i> (Hamilton)	----	LC
Synbranchiformes	Mastacembelidae	20	<i>Mastacembelus armatus</i> (Laccedede)	Eel	LC
		21	<i>Macrognathus pancalus</i> (Hamilton)	Kante eel	LC
04 orders	07families		20 genera, 21 fish species		



***Labeo rohita******Puntius sophore******Tor putitora******Glyptothorax pectinopterus******Chagunius chagunio******Cyprinus carpio specularis******Labeo sp.******Barilius barila******Badis badis******Oreinus or Schizothorax sp.******Sperata or Aorichthys seenghala******Cirrhinus mrigala*****Fig.2 Commercial Fish Fauna of Sirsa riverine system Solan H.P.**

The observed declining trend in fish diversity is consistent with similar findings reported from other states in India. **Banyal and Bains (2023)** studied fish diversity in the Dhauladhar mountain range of Himachal Pradesh, recording 85 fish species belonging to 8 orders, 15 families, and 37 genera. Similarly, streams and foothill khads, including Palli Mahadev khad, Kanahan nadi, Chikni khad, Khera khad, Bagbania khad, Manpura khad, Chotta Ratta khad, Ratta nadi, Sandholi khad, Balad nadi, Satiwal nadi, Kuranwala khad, and Kotian khad—which drain through the western Himalayan ranges including the subtropical zone of the Kasauli Hills—also support the findings of **Carla et al. (2009)**.

The present study area harbors several commercially important fish species such as *Channa gachua*, *Cyprinus carpio* var. *specularis*, *Labeo rohita*, *Labeo calbasu*, *Cirrhinus mrigala*, and *Aorichthys seenghala*. Among the total of 21 fish species documented, the minnows (*Barilius barila*, *Garra lamta*, *Danio rerio*, *Devario devario*, *Puntius* spp.), loaches (*Acanthocobitis botia*, *Schistura rupecula*), catfishes (*Aorichthys seenghala*, *Glyptothorax pectinopterus*), and carps (*Cyprinus carpio specularis*, *Cirrhinus mrigala*, *Labeo rohita*, *Labeo calbasu*) were prominent. These findings reflect the hypothesis proposed by **Hora (1922)** regarding the origin and evolution of hill-stream fish species such as *Garra*, *Glyptothorax*, *Schizothorax*, and *Crossocheilus*. The study area lies in a transition zone between lentic and lotic habitats of the Sirsa River basin, playing a crucial role in fish survival and resilience.

Further insights were provided by **Pal et al. (2024)**, who employed canonical correspondence analysis (CCA) to study the relationship between fish diversity and hydrological parameters in the Son tributary of the Beas riverine system, reporting for the first time 12 fish species belonging to 4 orders and 6 families. **Thakur et al. (2021)** reviewed the application of DNA barcoding as a modern taxonomical approach for fish species identification, while **Kumar et al. (2023)** studied bioindicators to assess the trophic status and productivity of certain lakes in the western Himalayas. Additionally, **Modeel et al. (2024)** sequenced DNA barcodes of 203 fish specimens from the River Beas, enhancing understanding of genetic diversity and conservation of endangered and vulnerable species. **Ngasainao et al. (2024)** focused specifically on the snow trout larvae in hilly areas.

In this study, fish species such as *Tor putitora*, *Garra*, *Glyptothorax*, and *Schizothorax* were observed at the upstream site (S1) but were absent at the downstream lentic zone (S2) due to severe pollution from industrial effluent discharge near House Board Nallah and Jagatkhana bridge. However, species like *Aorichthys seenghala*, *Cirrhinus mrigala*, *Channa gachua*, *Puntius sophore*, *Cyprinus carpio specularis*, *Labeo rohita*, and *Labeo calbasu* were recorded at the downstream site (S3), owing to the convergence of perennial streams such as Palli Mahadev khad, Kanahan nadi, and Chikni khad, and the resultant self-purification capacity of the water body.

To mitigate the impacts of industrialization on aquatic biodiversity, ecological restoration of river valley fisheries resources must be regulated using advanced

technologies such as Artificial Intelligence (AI), as recommended by **Mandal *et al.* (2025)**, to transform the fishing sector sustainably.

Additionally, air quality in the industrial region of Baddi-Barotiwala-Nalagarh (BBN)—ranked as the fourth most polluted city cluster in India—is alarmingly poor, with the air quality index (AQI) of 366, as reported by the Central Pollution Control Board, New Delhi, and The Tribune (January 5, 2025). This severe pollution poses serious health risks to residents due to ongoing industrial emissions, dust, ash, smoke, and ongoing road-construction activities (four-laning of the national highway).

## CONCLUSION

The impact of pollutants (organic or inorganic) on fish fauna of Sirsa riverine belt along industrial area of Baddi at selected sites were in-habited by hill stream fishes and catfishes. The permanent black color of Sirsa River water was observed during period of sample collection with dead fishes at the surface of water (site S<sub>3</sub>) in lentic zone before confluence with Sutlej River in Punjab. Some predatory birds and heaps of pharma raw chemicals (left over there due to washing or unloading of porter trucks), detected near CETP and site S<sub>2</sub>, can be co-related with the decline in aquatic life. The ultimate gutter is Sirsa River basin to receive effluents that deteriorate water quality, thereby endangering fish fauna from time to time as per the present study (2022-2023), irrespective of seasonal fluctuations and fishing. The hill stream fishes were migrating down course due to rapid water currents, over-flooding and terrain sliding by natural calamities thus unable to survive in toxic water body downstream. The Cyprinids include *Channa gachua*, *Cyprinus carpio*, *Labeo rohita*, *Labeo calbasu*, *Cirrhinus mrigala*, *Aorichthys seenghala* etc., common in catch of anglers and fish farmer in area lying adjacent to Punjab may be due to ecological adaptations and hydrology. The trends in fish diversity declined were directly proportional to pollutant load of Baddi industries and mismanagement of CETP near Sirsa riverine tributary. Hence, to save aquatic environments and present foot Himalayan western zone under study near Baddi pharma industrial hub of India, the area needs further investigation to attain comprehensive data about the impact of pollutants on fish and human health.

## Acknowledgements

Authors are thankful to Principal RKSD College Kaithal for his support and encouragement. The authors would like to acknowledge Department of Zoology NIILM University Kaithal India for Research Laboratory Facility and Department of Fisheries Himachal Pradesh for providing data and facts related to Hill streams by Fishermen community.



## Ethics

Fish samples obtained by authors of this study were collected and handled in accordance with the guidelines of Indian Government Principles for the Utilization and Care of Vertebrate Animals for Research Laboratory purpose.

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