



Comprehensive Reconnoitre of Ichthyofauna in the Trans-Himalayan Region of Jammu and Kashmir and Ladakh: A Detailed Checklist, Threats and Conservation Measures

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Abstract

This study aims to collect a comprehensive list of fish species inhabiting the trans-Himalayan region of Jammu & Kashmir and Ladakh. A survey of published literature and field sampling on fish distribution in the trans-Himalayan region revealed 130 fish species belonging to 10 orders, 23 families, and 58 genera. Among these species, most fish species were classified as Least Concern. However, 2 endemic hill stream fish species were identified as Critically Endangered namely (*Triplophysa kashmirensis* and *Glyptothorax kashmirensis*). The study emphasizes the IUCN conservation status of these species and proposes management strategies for their conservation and sustainable management. The study highlights the importance of understanding fish diversity, distribution patterns, and habitat preferences in devising effective conservation measures. The region's unique biotic zones and abundant cold-water resources make it a significant habitat for freshwater fishes. Studies on fish species in the trans-Himalayan region, especially in Jammu & Kashmir and Ladakh, are still inadequate. This study aims to compile a detailed inventory of fish species in this region. The study also emphasizes the need for comprehensive research and conservation efforts to address the alarming decline of riverine fish resources in the trans-Himalayan region.

Keywords:

Fish diversity, IUCN conservation, trans-Himalayan region, Cold-water resources, Jammu & Kashmir, Ladakh

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Introduction

The biodiversity of freshwater ecosystems worldwide is drastically declining, and addressing the challenges raised by this crisis requires mobilizing significant resources and implementing ambitious goals (Cooke *et al.*, 2023; Piczak *et al.*, 2023). Freshwater biodiversity includes all freshwater ecosystems' genes, populations, species, communities, and habitats and offers crucial ecological services necessary for human livelihoods and well-being (Dudgeon *et al.*, 2006). This biodiversity is disappearing at never-before-seen rates (Darwall and Freyhof, 2016). As a result of dietary changes and population expansion, the FAO projects that food production will need to increase by 70% by 2050 to meet the growing demand (FAO, 2009). By effectively using the limited water resources, the fisheries industry may serve to address this issue and contribute significantly to nutrition and food security. The fishing and aquaculture industries are a significant source of nutrition, food, income, and livelihood for millions of people worldwide (FAO, 2016). Additionally, fish contribute to global food security by providing up to 17% of the protein consumed by the world's population (Bennett *et al.*, 2018), and fishing is one of the most widely practised livelihoods worldwide (FAO, 2014).

Fishes represent the most abundant class of vertebrates, comprising nearly half of all vertebrate species globally, with diverse characteristics in terms of size, biology, morphology, and habitat preferences (Kour *et al.*, 2015). Although fish are the most diversified group of vertebrates, they are the second most threatened species after amphibians (Collen *et al.*, 2014). Freshwater ecosystems, which account for 68.7% of the world's coldwater fisheries, are particularly significant, especially in regions like the Himalayas, where they support vital aquatic life and offer economic opportunities through aquaculture (Fricke *et al.*, 2023). Understanding the diversity, distribution, and habitat preferences of fish species is crucial for devising effective conservation strategies for fisheries resources. Fish distribution patterns are influenced by factors such as dispersal mechanisms, environmental tolerance, and historical factors, while aquatic organisms are directly impacted by variables like climate, land use, geological features, vegetation, topography, and water chemistry fluctuations (Wiley *et al.*, 1997). Cold-water fish species, predominantly belonging to the Cyprinodontiformes order, are particularly abundant and important in these ecosystems (Fricke *et al.*, 2023).

The biological diversity of the planet, including its freshwater ecosystems, has long been a subject of fascination and study (Joshi *et al.*, 2013). India is ranked ninth in the world for freshwater biodiversity, with over 2500 fish species, 930 of which are unique to freshwater environments. India has been recognized as one of the mega-diversity countries of the world (Mittemeier and Mittemeier, 1997; Jayaram, 2010). The Himalayan region alone contributes approximately 17% of India's fish population (Ghosh, 1997). Ichthyologists have made significant contributions to our understanding of fish fauna across India, documenting species diversity and distribution through various studies over the years (Hamilton, 1822; Day, 1878; Hora, 1940; Alikunti *et al.*, 1963; Jhingran, 1991; Jayaram, 1999; Sharma *et al.*, 2007; Rahim *et al.*, 2009). Although fish inhabit a wide range of aquatic environments, the majority, in terms of species count or abundance, are found in warm environments with moderate temperatures, while others have adapted to cold-water environments. These organisms serve as crucial food resources and indicators of ecological water health. Unfortunately, the deterioration of inland waters is causing a rapid decline in the rich diversity of freshwater fish in the Indian region (Dudgeon *et al.*, 2006; Sarkar *et al.*, 2010, 2012; Lakra *et al.*, 2011). Furthermore, the upland rivers, natural lakes, streams, reservoirs, high- and low-altitude lakes, and the Himalayan and peninsular areas of India are home to extensive and diverse cold-water/hill resources for fishing (Mahanta and Sarma, 2010). These water bodies exhibit characteristic features such as high-velocity waters, rapid cascades, deep pools, and diverse substrata, supporting rich ichthyofaunal diversity comprising indigenous and exotic fish species (Sehgal, 1999;

Mahanta and Sarma, 2010). In India, there are approximately 670 species of freshwater fish, with 227 of them classified as threatened (NBFGR, 1997). Coldwater fisheries harbour 258 species belonging to 21 families and 76 genera, with significant species diversity observed in various regions, including the North-East Himalaya, West and Central Himalaya, and the Deccan Plateau (Vass and Gopakumar, 2002).

Besides serving as indicators of water quality and ecosystem health, freshwater fishes are essential in determining the distribution and abundance of other creatures within their ecosystems. However, factors such as impoundment of rivers, discharge of sewage and industrial waste, and habitat degradation have led to freshwater fishes becoming one of the most threatened taxa globally (Darwall and Freyhof, 2016). Many factors endanger the number of fish in freshwater environments in India, including reduced water volume, illegal fishing, unsustainable fishing practices, increased sedimentation, the building of dams and barrages, and water abstraction (Nautiyal *et al.*, 1998; Menon *et al.*, 2000; Langer *et al.*, 2001). Habitat destruction, pollution, species introduction, and commercial exploitation are identified as major contributors to the decline in aquatic biodiversity (Moyle and Leidy, 1992; Kottelat and Whitten, 1996). However, freshwater fish resources in India have received less attention compared to marine species, highlighting the need for comprehensive studies and conservation efforts (Lakra *et al.*, 2010; Pathak *et al.*, 2021). To address the depletion of fisheries resources, there is a critical need for comprehensive studies on fish fauna inhabiting both lotic and lentic waters, along with effective management strategies to ensure sustainable exploitation and conservation (Sinha *et al.*, 1999; Medhi *et al.*, 2018; Chen *et al.*, 2023).

Jammu & Kashmir and Ladakh possess vast cold-water resources, establishing the region as one of northern India's primary habitats for freshwater fishes (Sarma *et al.*, 2018; Qadri, 2022; Jamwal *et al.*, 2024). These Union Territories (UTs) are endowed with numerous aquatic ecosystems, which are home to economically significant bioresources, including fisheries. The region comprises three distinct biotic zones: Temperate Kashmir, sub-tropical Jammu, and cold arid Ladakh, each characterized by differences in altitude, catchment area, and watershed. The three main rivers in the Indus basin—the Jhelum, the Chenab, the Indus, and the plentiful snow- and ice-melt waters—are vital to the approximately 300 million people who live upstream and downstream in the basin by providing food, energy, and water. The region has over 3650 wetlands and other bodies of water and is well-known for its freshwater lakes and wetlands (Romshoo *et al.*, 2020). The present status and distributional patterns of fish fauna in the Himalayan region remain poorly explored, highlighting the need for comprehensive research on fish species in the Union Territories of Jammu & Kashmir, and Ladakh. Therefore, the present study aims to provide a detailed checklist of fish

species, their threats, and conservation measures in the trans-Himalayan region.

Materials and Methods

A fishing survey was conducted over twelve months, from March 2022 to February 2023, across the region's primary water bodies. Fish specimens were collected using cast nets, rods, and lines and from local fish markets. Sampling encompassed diverse habitats, including Dal Lake, Wular Lake, Mansabal Lake, and the Jhelum River in the Kashmir Valley; the Tawi River in Jammu; and the Suru River and Zaskar River in Ladakh. Primary data was collected through field sampling, including abundance and distribution of fish species, while secondary data was obtained through the published literature by various authors (Das and Nath, 1971; Malhotra et al., 1975; Malhotra and Dutta, 1976; Dutta and Malhotra, 1984; Kullander et al., 1999; Jyoti et al., 2006; Balkhi, 2007; Datta et al., 2015; Kumar et al., 2020; Bhat et al., 2020; Awas et al., 2023). During primary data collection, all samples were identified up to the species level with the help of standard taxonomical works (Day, 1878; Jayaram, 1981; 1999; 2002; 2009; Kullander et al., 1999; Talwar and Jhingaran, 1991 and Nelson, 2006) and other relevant scientific publications. Appropriate morphological and meristic characteristics were considered for the proper identification of the fishes. Figure 1 depicts the study area location.

Results and discussion

Kashmir Valley

Renowned for its abundant fishery resources, the Valley of Kashmir, nestled in the northern Himalayas of India, presents significant opportunities for fish production both for local consumption and export, accounting for 31% of the country's total cold-water fish production (Qayoom et al., 2019). The region's extensive water resources, including lakes, wetlands, ponds, streams, springs, and rivers, serve as prime habitats for cold-water fisheries, contributing significantly to the development of the fisheries sector (Qadri, 2022). The rivers of the Kashmir Valley host diverse indigenous fish species such as *Schizothrax* spp., *Glyptothorax* spp., and *Triplophysa* spp. Additionally, the region is globally acclaimed for its exotic brown trout (*Salmo trutta fario*) and rainbow trout (*Onchorhynchus mykiss*). Introduced to the Valley in the early 20th century, these trout species have become integral to the region's sport fishery, attracting visitors worldwide. Schizothoracids, or snow trouts or Himalayan trouts, are key food fishes in the Kashmir Himalaya, thriving in the network of snow-fed and spring-fed cool water rivers and streams throughout the region. Since Heckel's pioneering report on Kashmir's fish in 1838, several researchers have contributed to documenting the fish fauna of the valley (Day 1876; Silas 1960; Das and Subla 1964; Das

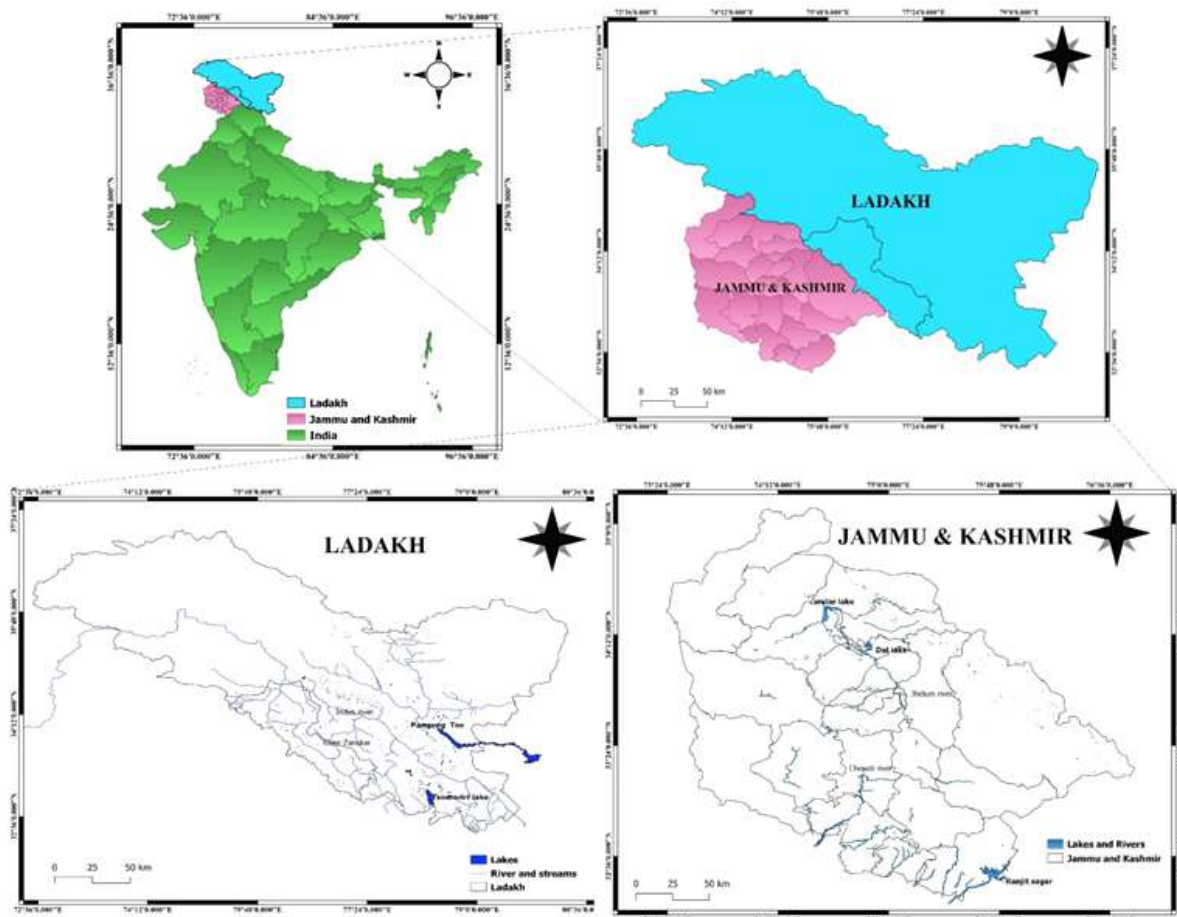


Fig. 1 Depicting the study area location.

1965; Yousuf 1996; Enderlin and Yousuf 1999; Kullander et al., 1999; Balkhi 2007; Sarkar et al., 2010; Lakra et al., 2010). Reported numbers of fish species by these researchers vary between 18 and 42, possibly due to synonymy or uncertainty in identification. Bhat et al. (2020) have identified 23 fish species within the Jhelum River system in the Kashmir Valley. The presence of mahseer in the Jhelum stretch of Kashmir has been noted (Bhat et al., 2020). In this study based on field works and a literature survey, we have observed that the mighty mahseer (*Tor putitora*) is completely absent in the stretch of the Jhelum River, in Kashmir Valley, due to the construction of Mangla Dam and Uri Hydroelectric Power Project down-stream of the river in the Pakistan and Kashmir (India) respectively. The absence of a fish ladder in these dams effectively restricts the anadromous fish's migration path. The fish had previously found its spawning grounds in the Kashmir valley, India (Nyman, 1995). The lower Jhelum Hydroelectric Project, constructed on the River Jhelum, has had significant detrimental environmental effects, particularly impacting the aquatic biodiversity of the river. This stretch of the river was once home to 18 fish species belonging to 12 genera, but since the project's initiation, various adverse effects have been observed, notably impacting the population of the formidable mighty mahseer, (*T. putitora*), now classified as an endangered species. Additionally, species like *Schizothorax plagiostomus*, *S. curvifrons*, *S. esocius*, and *S. labiatus* have also suffered adverse effects and become scarce in catches (Qureshi et al., 2008). Present survey revealed the occurrence of 22 fish species belonging to 4 orders, 6 families and 16 genera. Four orders namely, Cypriniformes, Siluriformes, Salmoniformes, and Cyprinodontiformes. In Cypriniformes, the survey identified species from three families: Cyprinidae (13

species), Nemacheilidae (3 species), and Botiidae (1 species). Siluriformes had two species from the Sisoridae family, while Salmoniformes had two species from Salmonidae. Moreover, Cyprinodontiformes contained one species from the Poeciliidae family in the Kashmir Valley (Table 1 and Fig. 2).

Jammu region

The ecological and geographical diversity of Jammu province underwent extensive exploration, initially documented by Das and Nath (1965, 1966), who recorded 20 fish species from the Chenab drainage system. Subsequent researchers further investigated the region's fish diversity across various areas (Das and Nath 1971; Malhotra et al., 1975; Malhotra and Dutta 1976; Dutta and Malhotra 1984; Jyoti et al., 2006; Balkhi 2007). Rathore and Datta (2015) expanded this knowledge by documenting 42 fish species in the River Ujh, a tributary of the River Ravi. Additionally, Datta et al. (2015) conducted a comprehensive survey of ichthyofauna in Udhampur district, identifying 76 fish species spanning 6 orders, 14 families, and 45 genera. Notably, they identified *Glyptothorax punjabensis* (Mirza and Kashmiri,1971) as a new record for the country and recognized *Barilius radiolatus* (Gunther,1868), *Botia lohachata* (Chaudhari,1912) and *Botia dario* (Hamilton, 1822) as new records for the region. Their survey also included stocked species introduced by the Jammu & Kashmir fisheries department. Further contributing to the repository, Datta et al., (2016) conducted a survey of fish diversity within Wajoo Nullah in Kathua district, uncovering 64 fish species distributed across 7 orders, 17 families, and 42 genera. Notably, they identified *Gudusia chapra* and *Parambassis bacails* as new additions to Jammu & Kashmir State fish records. Building upon these previous studies, Bhat et al. (2020) reported a total of

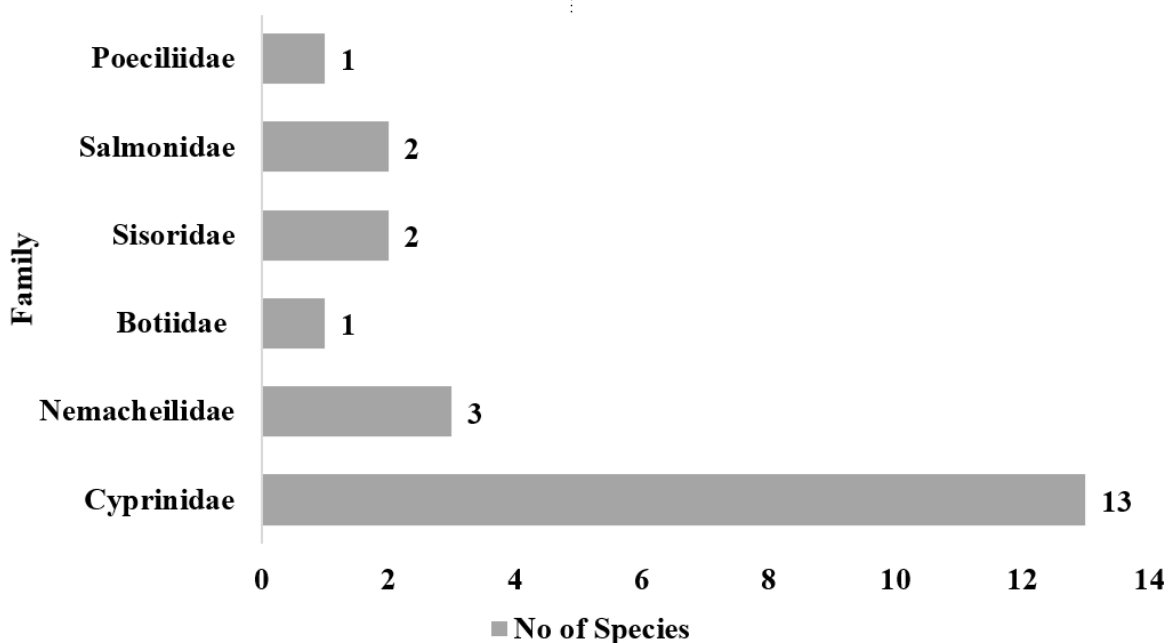


Fig. 2 Number of fish species in each family (Kashmir Valley)

Table 1: List of Ichthyofaunal diversity in Kashmir Valley

Sr No	Order	Family	Scientific Name	Common/ Local Name	IUCN Status
1	Cypriniformes	Cyprinidae	<i>Schizothorax niger</i> (Heckel, 1838)	Alegad/snow trout	Least Concern
2			<i>Schizothorax labiatus</i> (McClelland, 1842)	Kunar/Chush	Not Evaluated
3			<i>Schizothorax esocinus</i> (Heckel, 1838)	Chirruh	Vulnerable
4			<i>Schizothorax plagiostomus</i> (Heckel, 1838)	Snow carp/Khont	Vulnerable
5			<i>Schizothorax curvifrons</i> (Heckel, 1838)	Sattar gad /sattar snow trout	Least Concern
6			<i>Cyprinus carpio</i> Var. <i>communis</i> (Linnaeus, 1758)	Punjab gad	Vulnerable
			<i>Cyprinus carpio</i> Var. <i>specularis</i> (Lacepede, 1758)	Punjab gad	Vulnerable
7			<i>Carassius carassius</i> (Linnaeus, 1758)	Gang gad/ Crucian carp	Least Concern
8			<i>Pethia conchoniis</i> (Hamilton, 1822)	Safaid bach/Rosy barb	Least Concern
9			<i>Bangana diplostoma</i> (Heckel, 1838)	Ropput	Least Concern
10			<i>Crossocheilus diplocheilus</i> (Heckel, 1838)	Tethur	Not Evaluated
11			<i>Ditychus maculatus</i> (Steindachner, 1866)	Scaly osman	Not Evaluated
12			<i>Hypophthalmichthys molitrix</i> (Valenciennes, 1844)	Silver carp	Near Threatened
13			<i>Ctenopharyngodon idella</i> (Valenciennes, 1844)	Grass carp	Least Concern
14		Botiidae	<i>Botia birdi</i> (Chaudhuri, 1909)	Birdi loach	Not Evaluated
15			<i>Paraschistura punjabensis</i> (Hora, 1923)		Vulnerable
16		Nemacheilidae	<i>Triplophysa marmorata</i> (Heckel, 1838)	Ara gurun	Least Concern
17			<i>Triplophysa kashmirensis</i> (Hora, 1922)	Ara gurun	Critically Endangered
18			<i>Glyptosternon reticulatum</i> (McClelland, 1842)	Nayid	Least Concern
19	Siluriformes	Sisoridae	<i>Glyptothorax kashmirensis</i> (Hora, 1923)	Nayid	Critically Endangered
20			<i>Salmo trutta fario</i> (Linnaeus, 1758)	Brown Trout	Least Concern
21	Salmoniformes	Salmonidae	<i>Oncorhynchus mykiss</i> (Walbaum, 1792)	Rainbow Trout/Trooth	Not Evaluated
22	Cyprinodontiformes	Poeciliidae	<i>Gambusia holbrooki</i> Girard, 1859	Eastern mosquitofish	Least Concern

105 fish species in the Jammu region as part of a state-wide fishery survey initiated by the Indian Council of Agricultural Research (ICAR). Their study primarily focused on assessing fish diversity in the Jammu region. In the present study, the Jammu region has revealed the occurrence of 113 fish species, belonging to 8 orders, 22 families, and 58 genera. These species include representatives from Cypriniformes, Siluriformes, Osteoglossiformes, Clupeiformes, Perciformes, Beloniformes, Synbranchiformes, and Salmoniformes. Out of these, 66 species belonging to the order Cypriniformes (comprising 56 from the family Cyprinidae, 6 from Nemacheilidae, 3 from Botiidae and 1 from Cobitidae), two species to Salmoniformes (family Salmonidae), and 25 species to Siluriformes (12 from Sisoridae, 5 from Bagridae, 3 from Siluridae, 3 from Schilibeidae, 1 from Heteropneustidae and 1 from Amblycptidae), 2 species belong from Osteoglossiformes (family Notopteridae), 12 species from order perciformes (6 from family Channidae, 2 from family Ambassidae, 1 each from family Osphronemidae, Nandidae, Badidae, and Gobiidae). 1 species from the order Clupeiformes (Family Clupeidae), 1 species from the order Beloniformes (Belonidae), 4 species from the order Synbranchiformes (3 from the family Mastacembelidae and 1 from the family Synbranchidae). Notably, Cypriniformes displayed the highest diversity with 56 species, followed by Osteoglossiformes with 12 species. This comprehensive survey underscores the remarkable richness of fish biodiversity in the Jammu region (Table 2 and Fig. 3).

Ladakh region

In Ladakh, the aquatic realm has been extensively studied, by some researchers. Tilak (1990) provided a detailed account of 22 fish species, including representatives from Cyprinidae, Cobitidae, and Sisoridae. Notably, two new species within the *Noemacheilus* genus, *N. drassensis* and *N. shehensis*, were discovered. Sivakumar (2008) expanded the list to 32 species, focusing on the Indus Shyok and Zaskar rivers and incorporating five exotic fish species found within the Indus catchment. However, a subsequent analysis revealed that the list by Sivakumar (2008) may have been inflated due to the inclusion of synonyms and exotic species bred in enclosed fish farms. Bhat *et al.* (2020) conducted a study documenting 15 fish species in Ladakh, classifying them into Cypriniformes (Cyprinidae and Balitoridae families), Siluriformes (Sisoridae family), and Salmoniformes (Salmonidae family). Another study by Kumar *et al.* (2020) recorded 26 fish species, including indigenous and exotic varieties from four families. The Indus River exhibited the highest diversity, with 23 species, followed by the Shyok River with 12 species and the Zaskar River with 10 species. It is worth noting that commercial fishing is not practised in Ladakh's waters. While religious considerations discourage fish consumption among the majority of the population in Leh whereas in Kargil districts, there is a noticeable demand for fish from the local populace and security forces. This has led to the establishment of several fish farms in the region to meet the demand for fish products. The reported fish diversity in the

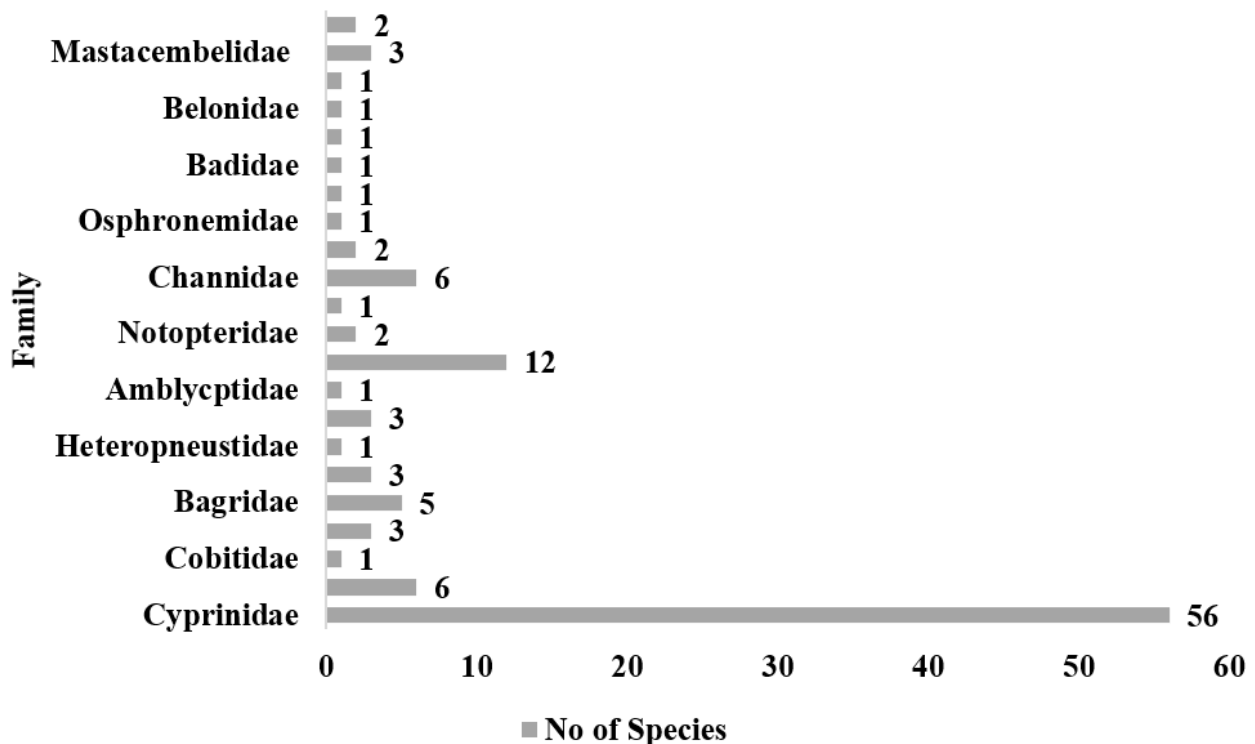


Fig. 3 Number of fish species in each family (Jammu region)

Table 2: List of Ichthyofaunal diversity of Jammu region

Sr. No	Order	Family	Scientific Name	Common/Local Name	IUCN Status
1	Cypriniformes	Cyprinidae	<i>Aspidoparia morar</i> (Hamilton, 1822)		Least Concern
2			<i>Amblypharyngodon gadigarhi</i> (Malhotra & Singh Dutta, 1975)		Least Concern
3			<i>Amblypharyngodon mola</i> (Hamilton, 1822)	Mola carplet	Least Concern
4			<i>Barilius bendelisis bendelisis</i> (Hamilton, 1807)		Least Concern
5			<i>Barilius vagra</i> (Hamilton, 1822)		Least Concern
6			<i>Barilius barila</i> (Hamilton, 1822)		Least Concern
7			<i>Bangana diplostoma</i> (Heckel, 1838)		Least Concern
8			<i>Cirrhinus mrigala</i> (Hamilton, 1822)		Least Concern
9			<i>Cirrhinus reba</i> (Hamilton, 1822)	Reba carp	Least Concern
10			<i>Chela cachius</i> (Hamilton, 1822)		Least Concern
11			<i>Chela atpar</i> (Hamilton, 1822)		Not Evaluated
12			<i>Laubuka laubuca</i> (Hamilton, 1822)		Endangered
13			<i>Garra gotyla</i> (Gray, 1830)	Sucker head	Least Concern
14			<i>Ctenopharyngodon idella</i> (Valenciennes, 1844)	Grass carp	Least Concern
15			<i>Cyprinus carpio</i> Var. <i>communis</i> (Linnaeus, 1758)	Scale carp	Vulnerable
16			<i>Cyprinus carpio</i> Var. <i>specularis</i> (Lacepede, 1758)	Mirror carp	Vulnerable
17			<i>Devario devario</i> (Hamilton, 1822)		Least Concern
18			<i>Danio rerio</i> (Hamilton, 1822)	Zebra danio	Least Concern
19			<i>Esomus danricus</i> (Hamilton, 1822)	Flying barb	Least Concern
20			<i>Garra variabilis</i> (Heckel, 1843)	Variable garra	Least Concern
21			<i>Hypophthalmichthys molitrix</i> (Valenciennes, 1844)	Silver carp	Near Threatened
22			<i>Crossochilus latius diplochilus</i> Hamilton		Least Concern
23			<i>Labeo catla</i> (Hamilton, 1822)	Catla	Least Concern
24			<i>Labeo rohita</i> (Hamilton, 1822)	Roho labeo	Least Concern
25			<i>Labeo dyocheilus</i> (McClelland, 1839)		Least Concern
26			<i>Labeo boggut</i> (Sykes, 1839)		Least Concern
27			<i>Labeo bata</i> (Hamilton, 1822)	Bata	Least Concern
28			<i>Labeo calbasu</i> (Hamilton, 1822)	Orangefin labeo	Least Concern

29	<i>Labeo gonius</i> (Hamilton, 1822)	Kuria Labeo	Not Evaluated
30	<i>Labeo dero</i> (Hamilton, 1822)		Least Concern
31	<i>Labeo pangusia</i> (Hamilton, 1822)		Near Threatened
32	<i>Osteobrama cotio</i> (Hamilton, 1822)		Least Concern
33	<i>Oxygaster bacaila</i> (Hamilton, 1822)		Least Concern
34	<i>Pethia conchoniis</i> (Hamilton, 1822)	Rosy barb	Least Concern
35	<i>Pethia ticto</i> (Hamilton, 1822)	Ticto barb	Least Concern
36	<i>Systemus sarana</i> (Hamilton, 1822)	Olive barb	Least Concern
37	<i>Cabdio morar</i> (Hamilton, 1822)		Least Concern
38	<i>Rasbora rasbora</i> (Hamilton, 1822)		Least Concern
39	<i>Salmostoma bacaila</i> (Hamilton, 1822)	Large razorbelly minnow	Least Concern
40	<i>Salmophasia punjabensis</i> (Day, 1872)		Not Evaluated
41	<i>Schizothorax plagiosomus</i> (Heckel, 1838)	Snow carp/Khont	Vulnerable
42	<i>Schizothorax labiatus</i> (McClelland, 1842)	Kunar/Chush	Not Evaluated
43	<i>Schizothorax esocinus</i> (Heckel, 1838)	Chirruh	Vulnerable
44	<i>Schizothorax curvifrons</i> (Heckel, 1838)	Sattar snowtrout	Least Concern
45	<i>Schizothorax progastus</i> (McClelland, 1839)	Dinnawah snowtrout	Least Concern
46	<i>Schizothorax richardsonii</i> (Gray, 1832)	Snow trout	Vulnerable
47	<i>Tor putitora</i> (Hamilton, 1822)	Putitor mahseer/Golden mahseer	Endangered
48	<i>Tor tor</i> (Hamilton, 1822)		Endangered
49	<i>Tor khudree</i> (Sykes, 1839)	Deccan mahseer	Least Concern
50	<i>Securicula gora</i> (Hamilton, 1822)		Least Concern
51	<i>Bariilus modestus</i> Day, 1872		Not Evaluated
52	<i>Puntius sophore</i> (Hamilton, 1822)		Least Concern
53	<i>Puntius chola</i> (Hamilton, 1822)		Least Concern
54	<i>Puntius chola</i> (Hamilton, 1822)	Swamp barb	Least Concern
55	<i>Puntius terio</i> (Hamilton, 1822)	Onespot barb	Least Concern
56	<i>Bariilus radiolatus</i> (Günther, 1868)		Data Deficient

57	Nemacheilidae	<i>Acanthocobitis botia</i> (Hamilton, 1822)	Mottled loach	Least Concern
58		<i>Triplophysa kashmirensis</i> (Hora, 1922)		Critically Endangered
59		<i>Triplophysa yasinensis</i> (Alcock, 1898)		Not Evaluated
60		<i>Paraschistura punjabensis</i> (Hora, 1923)		Vulnerable
61		<i>Nemacheilus corica</i> (Hamilton, 1822)		Least Concern
62		<i>Paraschistura parshadi</i> (Hora, 1933)		Vulnerable
63	Botiidae	<i>Botia almorhae</i> Gray, 1831	Almorha loach	Least Concern
64		<i>Botia lohachata</i> Chaudhuri, 1912	Reticulate loach	Least Concern
65		<i>Botia dayi</i> (Hora, 1932)		Not Evaluated
66	Cobitidae	<i>Lepidocephalichthys guntea</i> (Hamilton, 1822)	Guntea loach	Least Concern
67	Bagridae	<i>Mystus bleekeri</i> (Day, 1877)	Day's mystus	Least Concern
68		<i>Mystus cavasius</i> (Hamilton, 1822)	Gangetic mystus	Least Concern
69		<i>Mystus vittatus</i> (Bloch, 1794)	Striped dwarf catfish	Least Concern
70		<i>Rita rita</i> (Hamilton, 1822)	Ritha	Least Concern
71		<i>Sperata seenghala</i> (Sykes, 1839)		Least Concern
72	Siluridae	<i>Ompok bimaculatus</i> (Bloch, 1794)		Near Threatened
73		<i>Wallago attu</i> (Bloch & Schneider, 1801)		Near Threatened
74		<i>Ompok pabda</i> (Hamilton, 1822)	Pabda catfish	Near Threatened
75	Heteropneustidae	<i>Heteropneustes fossilis</i> (Bloch, 1794)	Singhi	Least Concern
76	Schilbeidae	<i>Clupisoma garua</i> (Hamilton, 1822)	Garua bachcha	Least Concern
77		<i>Eutropiichthys vacha</i> (Hamilton, 1822)	Batchwa vacha	Least Concern
78		<i>Pachypterus atherinoides</i> (Bloch, 1794)	Indian potasi	Least Concern
79	Amblycypidae	<i>Amblyceps mangois</i> (Hamilton, 1822)	Indian torrent catfish	Least Concern
80	Sisoridae	<i>Bagarius bagarius</i> (Hamilton, 1822)	Goonch	Vulnerable
81		<i>Gagata cenia</i> (Hamilton, 1822)	Indian gagata	Least Concern
82		<i>Glyptothorax pectinopterus</i> (McClelland, 1842)	River cat	Least Concern
83		<i>Glyptothorax kashmirensis</i> (Hora, 1923)	Nayid	Critically Endangered
84		<i>Glyptothorax stoliczkae</i> (Steindachner, 1867)		Least Concern
85		<i>Glyptosternon reticulatum</i> (McClelland, 1842)	Nayid	Least Concern
86		<i>Glyptothorax botius</i> (Hamilton, 1822)		Least Concern

87		<i>Glyptothorax punjabensis</i> Mirza & Kashmiri, 1971	Endangered
88		<i>Glyptothorax cavia</i> (Hamilton, 1822)	Least Concern
89		<i>Glyptothorax garhwali</i> Tilak, 1969	Least Concern
90		<i>Glyptothorax telchitta</i> (Hamilton, 1822)	Least Concern
91		<i>Glyptothorax indicus</i> Talwar, 1991	Least Concern
92	Notopteridae	<i>Notopterus notopterus</i> (Pallas, 1769)	Least Concern
93	Osteoglossiformes	<i>Chitala chitala</i> (Hamilton, 1822)	Near Threatened
94	Clupeiformes	<i>Gudusia chapra</i> (Hamilton, 1822)	Least Concern
95	Clupeidae	<i>Channa punctata</i> (Bloch, 1793)	Least Concern
96	Channidae	<i>Chanda nama</i> Hamilton, 1822	Least Concern
97		<i>Channa marulius</i> (Hamilton, 1822)	Least Concern
98		<i>Channa gachua</i> (Hamilton, 1822)	Least Concern
99		<i>Channa orientalis</i> Bloch & Schneider, 1801	Vulnerable
100		<i>Channa striata</i> (Bloch, 1793)	Least Concern
101	Perciformes	<i>Parambassis ranga</i> (Hamilton, 1822)	Least Concern
102		<i>Parambassis baculis</i> (Hamilton, 1822)	Least Concern
103	Osphronemidae	<i>Trichogaster fasciata</i> Bloch & Schneider, 1801	Least Concern
104	Nandidae	<i>Nandus nandus</i> (Hamilton, 1822)	Least Concern
105	Badidae	<i>Badis badis</i> (Hamilton, 1822)	Least Concern
106	Gobiidae	<i>Glossogobius giuris</i> (Hamilton, 1822)	Least Concern
107	Beloniformes	<i>Xenentodon cancila</i> (Hamilton, 1822)	Least Concern
108	Synbranchidae	<i>Monopterusuchia</i> (Hamilton, 1822)	Least Concern
109	Mastacembelidae	<i>Mastacembelus armatus</i> (Lacepède, 1800)	Least Concern
110	Synbranchiformes	<i>Macragnathus aral</i> (Bloch & Schneider, 1801)	Least Concern
111		<i>Macragnathus pancalus</i> Hamilton, 1822	Least Concern
112	Salmonidae	<i>Salmo trutta fario</i> (Linnaeus, 1758)	Least Concern
113	Salmoniformes	<i>Oncorhynchus mykiss</i> (Walbaum, 1792)	Not Evaluated

region of Ladakh has led to some ambiguity. Various authors have provided varying numbers of fish species found in this area. In the present study, 25 fish species were recorded to be present in the cold arid Ladakh region. However, Kumar *et al.* (2020) documented a total of 26 fish species, including two strains of the common carp, namely *C. carpio* Var *specularis* and *C. carpio* Var *communis*. It is important to note that these are two different varieties of the same species. Therefore, the total number of species documented in that study appears to be higher compared to the present study. The present survey revealed the occurrence of 25 fish species belonging to 3 orders, 5 families and 13 genera in the Ladakh region. These species belong to three orders namely: Cypriniformes, Siluriformes, and Salmoniformes. Among these orders, Cypriniformes is the most diverse, with representatives from three families: Cyprinidae (12 species), Botiidae (1 species), and Nemacheilidae (9 species). Siluriformes are represented by one family, Sisoridae (1 species), while Salmoniformes are represented by Salmonidae (2 species) (Table 3 and Fig. 4).

Fish diversity of Jammu & Kashmir and Ladakh

A survey of published literature and field sampling on an inventory of fish distribution in the trans-Himalayan region of Jammu & Kashmir and Ladakh conducted in the present study resulted in the documentation of 130 fish species across 10 orders, 23 families, and 58 genera. Among these species, the majority, comprising 92 species, were classified as Least Concern, indicating a relatively low risk of extinction. However, 2 species were identified as Critically Endangered namely (*Triplophysa kashmirensis* and *Glyptothorax kashmirensis*), 4 as Endangered, 11 as

Vulnerable, and 5 as Near Threatened, indicating significant conservation concerns. Moreover, 14 species were categorized as Not Evaluated, and 2 as Data Deficient, highlighting gaps in knowledge and the need for further research to assess their conservation status (Fig. 5). Figure 6 depicts the most common fish species in the trans-Himalayan region.

Fishing gears and crafts of Jammu & Kashmir and Ladakh

The understanding of fishing gear, crafts, and methods is pivotal for the scientific and judicious management of fishery resources. In the trans-Himalayan region, traditional fishing techniques are predominantly used by inland fishermen, yet detailed documentation of indigenous methods is lacking, hindering effective management efforts. Fishing techniques are influenced by the behavioural characteristics and microhabitats of fish species (Raju *et al.*, 2016), with various types of nets and gears employed for capturing fish of different sizes (Azam *et al.*, 2014). However, many fishing crafts in India remain primitive and non-mechanized (Khanna and Singh, 2003). Understanding traditional methods is crucial for modern improvements (Mundy and Campton, 1991), especially in the face of overfishing and declining fish populations (Amos *et al.*, 2018). Sustainable fishing practices are imperative for maintaining fish populations and aquatic ecosystem health (Amos and Peter 2018). Fishing gear selectivity plays a crucial role in fisheries management, impacting catch composition and target species sizes. The present survey has recorded a variety of traditional, commercial, and destructive fishing techniques, prevalent in the trans-Himalayan region.

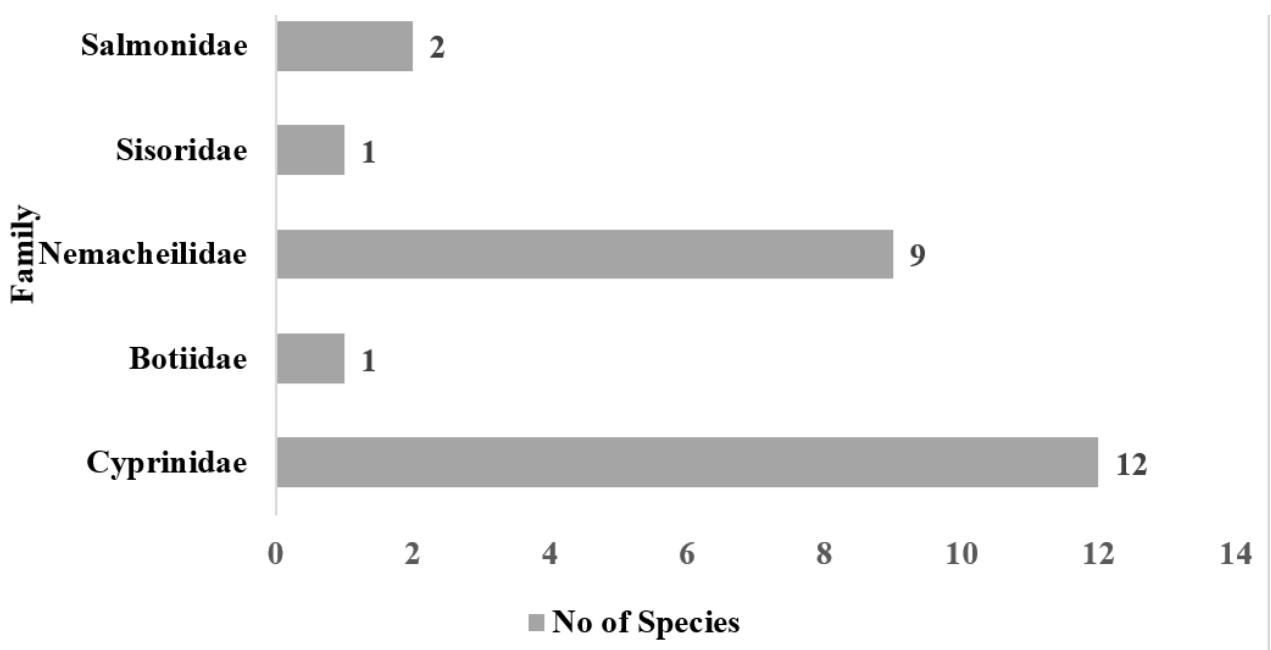


Fig. 4 Number of fish species in each family (Ladakh region)

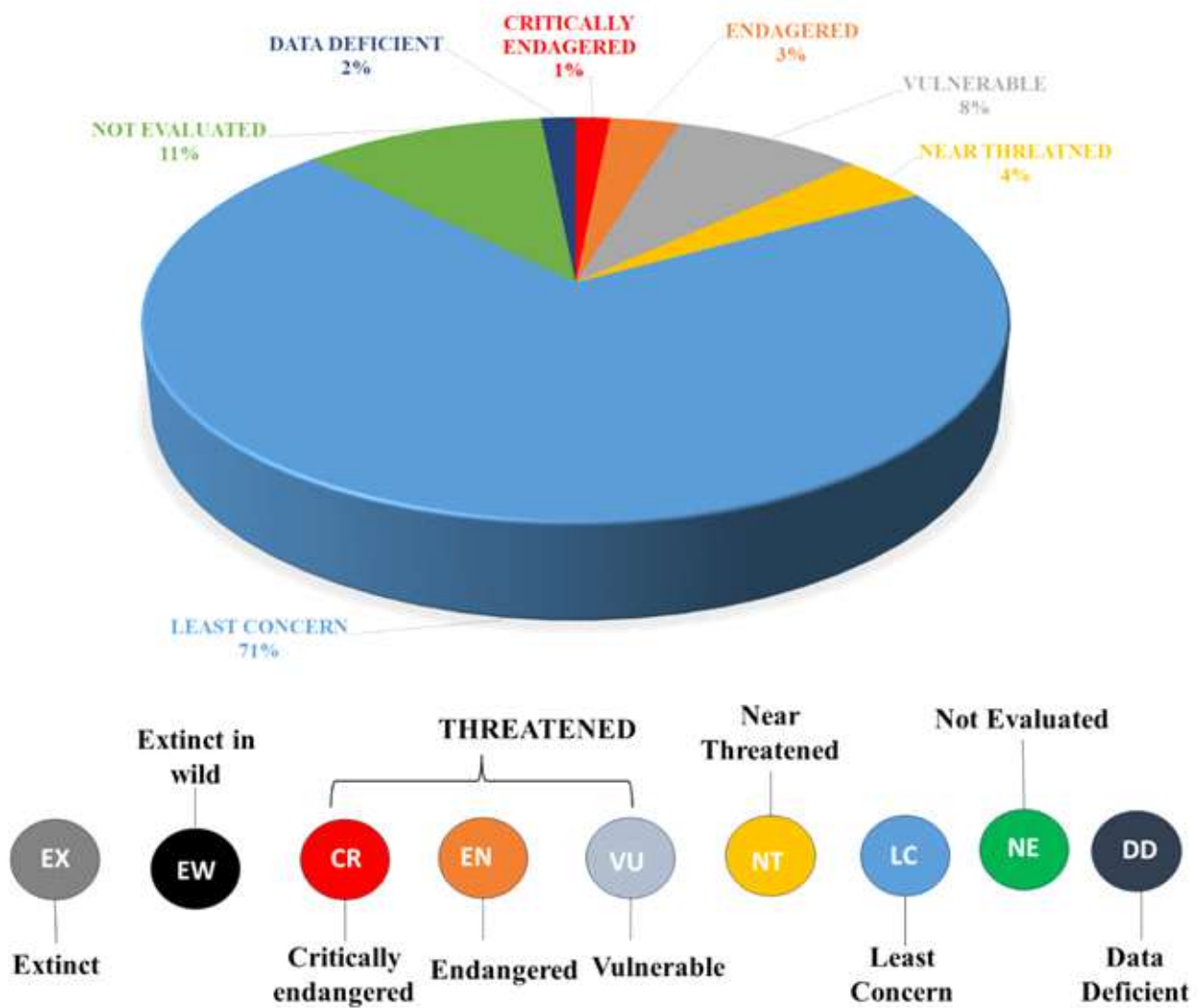


Fig. 5 IUCN status of fish species

Traditional Fishing Methods

Local communities employ various traditional fishing methods, primarily for domestic consumption. While some are eco-friendly, others are destructive. These methods depend on factors like fish behaviour, seasonal abundance, and habitat. They are often practised in small to medium-sized streams. These are:

Goda: During monsoon, *Tor* spp. migrate to small tributaries for spawning, where locals use "goda" traps made of shrubs to catch them. The design of goda, combined with strong water flow, prevents fish escape. It's deployed at night and collected in the morning. **Hammering:** Fishermen use hammers to strike boulders in upland streams, injuring hidden fish for collection. **Hand-picking:** Skilled fishermen catch fish hidden under stones in shallow streams with bare hands, targeting specific species. **Water Diversion:** Water from secondary streams is diverted using mud and boulders to collect fish. Common in fast-flowing water habitats. **Gaad Hodd (Fishing Tunnels):** Fish are attracted to bait placed in tunnels on mud banks, and then trapped when the opening is closed. **Scare Fishing:** Fish are scared downstream using noise, then

intercepted with a large net positioned at the channel mouth.

Commercial Fishing

Local fishermen commonly utilize these methods for commercial fishing, often focusing their activities near fish markets. However, fishermen may also practice these methods in remote areas, transporting the caught fish to markets. While some fish farmers may attempt to overexploit fishing resources, these methods do not inherently threaten fish populations if practised within limits. Proper regulation and management can help ensure the sustainability of these fishing practices while allowing for the continued livelihoods of fishermen. These are:

Lift Net

The lift net, locally known as Khurizal, Kochibi, or Sagean, is a traditional fishing gear operated in Wular Lake. It comprises two wooden semicircular poles joined together, with a long central pole bisecting them to ensure the ends are widely separated. The net is immersed in water for a duration typically ranging from 20 minutes to 1 hour, although immersion times

Table 3: List of Ichthyofaunal diversity of Ladakh region

Sr. No	Order	Family	Scientific Name	Common/Local Name	IUCN Status
1	Cypriniformes	Cyprinidae	<i>Schizothorax richardsonii</i> (Gray, 1832)	Snow trout	Vulnerable
2			<i>Schizothorax progastus</i> (McClelland, 1839)	Dinnawah snowtrout	Least Concern
3			<i>Schizothorax labiatus</i> (McClelland, 1842)		Not evaluated
4			<i>Schizothorax esocinus</i> (Heckel, 1838)		Vulnerable
5			<i>Schizothorax plagiostomus</i> (Heckel, 1838)	Nya	Vulnerable
6			<i>Schizothorax curvifrons</i> (Heckel, 1838)		Least Concern
7			<i>Schizopygopsis stoliczkae</i> (Steindachner, 1886)	False osman	Not Evaluated
8			<i>Diptychus maculatus</i> (Steindachner, 1866)	Scaly osman	Least Concern
9			<i>Ptychobarbus conirostris</i> (Steindachner, 1866)	Indus snowtrout	Least Concern
10			<i>Ptychobarbus kaznakovi</i> Nikolskii, 1903		Not Evaluated
11			<i>Crossocheilus diplocheilus</i> (Heckel, 1838)		Not Evaluated
12			<i>Cyprinus carpio</i> Var. <i>communis</i> (Linnaeus, 1758)	Scale carp	Vulnerable
			<i>Cyprinus carpio</i> Var. <i>specularis</i> (Lacepede, 1758)	Mirror carp	Vulnerable
13			<i>Acanthocobitis botia</i> (Hamilton, 1822)	Mottled loach	Least Concern
14			<i>Paraschis turamontana</i> (McClelland, 1838)		Not Evaluated
15			<i>Paraschis turaprashari</i> (Hora, 1933)		Not Evaluated
16			<i>Schistura fascimaculata</i> (Mirza & Nalbant, 1981)		Vulnerable
17		Nemacheilidae	<i>Schistura arifi</i> (Mirza Banarescu, 1981)		Least Concern
18			<i>Triplophys ayasinensis</i> (Alock, 1898)		Not Evaluated
19			<i>Triplophys gracilis</i> (Day, 1877)		Not Evaluated
20			<i>Triplophys tenuicauda</i> (Steindachner, 1866)		Data Deficient
21			<i>Triplophys amicrops</i> (Steindachner, 1866)		Least Concern
22		Botiidae	<i>Botia dayi</i> (Hora, 1932)	Hora loach	Not Evaluated
23	Siluriformes	Sisoridae	<i>Glyptosternon reticulatum</i> (McClelland, 1842)	Nayid	Least Concern
24			<i>Oncorhynchus mykiss</i> (Walbaum, 1792)	Rainbow Trout	Not Evaluated
25	Salmoniformes	Salmonidae	<i>Salmo trutta fario</i> (Linnaeus, 1758) (Ex)	Brown Trout	Least Concern



Schizothorachthys esocinus (Heckel, 1838)



Schizothorax niger (Heckel, 1838)



Schizothorax curvifrons (Heckel, 1838)



Schizothorax plagiostomus (Heckel, 1838)



Triphophysa kashmirensis (Hora, 1922)



Triphophysa marmorata (Heckel, 1838)



Cyprinus carpio var. *communis* (Linnaeus, 1758)



Ctenopharyngodon idella (Valenciennes, 1844)



Cyprinus carpio Var. *specularis* (Lacepede, 1758)



Pethia conchonius (Hamilton, 1822)



Schizothorax labiatus (McClelland, 1842)



Crossocheilus diplocheilus (Heckel, 1838)

Fig. 6 Most common coldwater fish species in the trans-Himalayan region

can sometimes extend up to 2 hours. Fishing involves luring fish over a bag-like netting area using effective baits such as rice husk, flour mixed with turmeric, or small insects. Once the fish gather, the net is swiftly lifted out of the water upward to capture them. The net is made of PA multifilament material with a mesh size of 30–35 mm and is primarily used to catch species like *Schizothorax* spp. and *Cyprinus* spp. (Dar et al., 2014; Syed et al., 2020).

Rod and line

Locally known as Bislai in Kashmir. This fishing gear is a hook-and-line fishing variant featuring a bamboo stick attached to the fishing line. A float-like structure is positioned above the hook on the line, aiding in detecting when a fish takes the bait and is about to be hooked. The bait typically consists of wheat flour, baked rice, and ground trash fish. This method is primarily practised as a leisure activity by many locals in the lake area to catch common carp and *Schizothorax* spp. (Dar et al., 2014).

Long line fishing

This method represents a primitive form of fishing, employing techniques based on the feeding and hunting behaviours of the target species. Known as long-line fishing or "walraaz," in Kashmir. It involves the use of a nylon line approximately 1000 m in length, typically utilized in lakes. Hooks, made of either stainless steel or iron, are spaced approximately 1 meter apart along the line. To submerge the line in the water, stones weighing 50-60 gm each are attached at 1-meter intervals. Standard-sized hooks with earthworms or a bait mixture of maize flour and candy (Gur) are used to attract the fish. The Jammu and Kashmir State Fisheries Act stipulates that the length of the line should not exceed 500 meters. Fishing with long lines typically lasts between 3 to 5 hr. This method is commonly employed to catch species such as *Schizothorax* spp. and *Cyprinus carpio* in the lake. Long line fishing is primarily conducted during the winter months when the water level is low (Malik et al., 2018).

Cast net

The cast net, locally referred to as "Zaal," is a widely used fishing net typically made of nylon or cotton thread, with nylon being the more common material choice among fishermen. Cast net is most predominantly used for commercial fishing and trans-Himalayan region. It has a circular shape resembling an umbrella, with diameters ranging from 1.0 to 2.0 meters. The size of the mesh openings varies between 1.2 to 3.0 cm from bar to bar. Iron or lead sinkers, weighing approximately 5.0 gm, are attached around the peripheral cord of the net. When thrown, the cast net is aimed to land flat on the water's surface, covering the area where fish are present. The weighted edges of the net facilitate its closure around the fish. Casting this gear requires significant skill. In the Kashmir Lake region, fishermen utilize the cast net throughout the year, except for the months from December to February. Different specifications of the

local cast nets may vary slightly depending on the preferences and practices of the fishermen (Yousuf et al., 2023).

Shadow fishing (Tchaai Gaad)

In many parts of the world, traditional fishing is a way of life passed down from generation to generation. It is often an important part of a community's cultural and social fabric giving livelihood to a large section of poor fisher folk. They depend for their success on local and indigenous pieces of knowledge and people have fished sustainably for thousands of years. One such local fishing technique in Kashmir known as "Tchaai Gaad" (Shadow Fishing) is a local technique of Kashmiri fishermen to catch fish in the waters of Kashmir, especially in Lakes. These indigenous fishing methods are eco-friendly and sustainable in the long term. In this technique where fishermen hide under a thick blanket on the nook of a wooden boat, which helps them create a shadow on the part of the water and attracts fishes towards that shadow and later on, catch them with the help of a harpoon, narchoo and panzer (Double pronged spear and Multiple head spear). Today's sustainable fishing practices reflect some lessons learned from these cultures.

Destructive Fishing Methods:

These methods indiscriminately kill fish and impact aquatic ecosystems, these methods are primarily used for large-scale commercial purposes these are. Poisonous Plant Extracts: Plant extracts mixed with mud cause abnormal behaviour in fish, making them easy to collect. Impactful and practised in pool habitats. Dynamite: Explosives thrown into deep pools or riffles stun or kill fish, leading to significant fish abundance and diversity declines. Highly destructive includes Bleaching Powder: Used to kill fish in stagnant water, bleaching powder causes rapid mortality. However, it adversely affects other aquatic life and ecosystem balance.

Traditional fishing methods vary in their impact on fish populations and ecosystems. While some techniques are sustainable and deeply rooted in local culture, others pose significant threats due to their destructive nature. Sustainable fishing practices, supported by proper regulation, education, and awareness, are essential for preserving fish populations and maintaining the health of aquatic ecosystems. By respecting traditional knowledge and promoting eco-friendly approaches, we can ensure the long-term sustainability of fishing activities while safeguarding the environment for future generations.

Threats and conservation measures

The fish populations in the Union Territories of Jammu and Kashmir and Ladakh face several significant threats.

One of the primary challenges is the lack of adequate conservation measures. Insufficient enforcement of fishing regulations, limited protected areas, and a lack of comprehensive conservation initiatives contribute

to the decline of fish populations. Without proper safeguards and management, the fish are vulnerable to exploitation. Population pressures resulting from population growth and industrialization pose significant threats to freshwater fish (Arthington *et al.*, 2016). As demands increase, alterations in flow patterns, pollution, changes in drainage basins, and overexploitation of fish resources become more prevalent. These activities disrupt the natural balance of ecosystems and have detrimental effects on fish populations. Environmental policies also play a role in the conservation of fish species. However, the exclusion of freshwater fish from conservation laws often prioritizes hydropower benefits over the preservation of native biodiversity. This neglects the adverse effects on freshwater fish, especially those that rely on natural movements and spawning migrations that may be hindered by hydropower projects. The creation of large lacustrine habitats, commonly associated with dam construction, poses ecological consequences. These habitats experience high evaporation rates, which threaten the life stages of fish species and impact human water usage (Balkhi and Bhat, 2022). Additionally, the introduction of invasive species and the release of non-indigenous (exotic) fish species from captive-rearing facilities further disrupt the integrity of the ecosystem, leading to imbalances and potential harm to native fish populations (Joshi *et al.*, 2021; Magloo *et al.*, 2024). Unsustainable fishing practices, including the use of illegal nets, dynamite fishing, and electrofishing, contribute to overfishing and pose severe threats to fish fauna. These practices result in rapid declines in fish populations, particularly in areas where there is high market demand for fish (Arthington *et al.*, 2016). Climate change exacerbates the challenges faced by fish populations. Altered precipitation patterns, increased temperatures, and changes in river flow regimes directly affect fish populations. These changes disrupt spawning cues, alter food availability, and increase the susceptibility of fish to diseases and parasites, further compromising their survival activities, factors such as population growth, industrialization, and intensive farming, contribute to anthropogenic stressors on fish populations (Winfield *et al.*, 2016). These activities, combined with the impacts of climate change, affect crucial spawning areas and increase river flow variability, posing additional challenges to the survival of fish species. Habitat destruction is another significant threat to fish populations. Factors such as deforestation, urbanization, and infrastructure development result in the degradation or destruction of natural habitats. This loss of breeding grounds and shelter further diminishes the viability of fish populations. The *Schizothorax* group is highly vulnerable to climate change, typically found at elevations below 1000 meters and mainly inhabiting major rivers (Mandal and Jha, 2013). Predictions indicate that climate change will impact downstream areas of the Ganga and Indus rivers in the Indian Himalayan Region (IHR), altering natural water

flows and spatial dynamics (Immerzeel *et al.*, 2010). Consequently, this may isolate fish populations by displacing their natural habitats. Research indicates that climate change often leads to the restricted distribution and localized extinction of many cold-water-adapted fish species (Comte and Grenouillet, 2013). Pollution is a pervasive threat to fish populations in the region. Industrial discharge, agricultural runoff, and urban waste contaminate water bodies, negatively impacting water quality and posing risks to the health of fish populations (Pande and Posti, 2023). To address these threats, comprehensive conservation measures are necessary. These may include stricter enforcement of fishing regulations, the establishment of protected areas, the integration of fish conservation into environmental policies, the promotion of sustainable fishing practices, mitigation of climate change impacts, preservation of essential habitats, and efforts to reduce pollution. By implementing these measures, we can work towards safeguarding the diversity and abundance of fish populations in the Union Territories of Jammu & Kashmir and Ladakh.

Conservation measures

Conservation strategies are essential for protecting and preserving endangered species and ecosystems. One important aspect of fish diversity conservation is the restoration of their habitat. This involves implementing measures such as artificial propagation, distribution of resulting fry and fingerlings, and improved aquaculture practices (Closs *et al.*, 2016). Ranching, a form of aquaculture enhancement, has been proposed as a means to rehabilitate fish populations in their natural environments, such as rivers and streams. Innovative methods like habitat fingerprinting and artificial imprinting, when combined with ranching, can further enhance conservation efforts. Ex-situ conservation measures are also being employed for the conservation of fish fauna in this region (Sharma and Mehta, 2010). This involves preserving their genetic diversity through gene banking, which includes cryopreservation of milt and spermatozoa. In-situ conservation focuses on preserving fish diversity in their natural habitats. This includes the establishment of fish sanctuaries along suitable river segments, which provide protected areas to thrive. Active community participation and awareness are crucial components for the conservation of fish diversity. A complete prohibition on the destructive fishing practices that harm fish populations is imperative. Fishing regulations and restrictions are implemented to control the exploitation of fisheries resources. These regulations often include restrictions on fishing methods, catch limits and fishing seasons. By implementing these measures, overfishing is prevented, and sustainable management of fish populations is ensured (Chandra and Ganie, 2023). Despite advancements in risk assessments, conservation planning, fisheries management, and restoration techniques, enhancing

fish conservation poses significant challenges and involves trade-offs, especially amidst new threats and climate change scenarios. It is crucial to minimize human impacts on marine and freshwater fish and fisheries as much as possible, while also addressing food security concerns. This approach aims to restore resilience and facilitate human-assisted adaptations in carefully managed environments. Effective implementation, monitoring, and review of fish conservation and management strategies require continuous exchange of information among researchers, managers, and the public. This collaborative effort is essential to determine feasible actions and consensus on navigating the uncertainties of the future.

Conclusion

The study on the fish fauna of the Union Territories of Jammu & Kashmir and Ladakh, provides valuable insights into the diversity, distribution, and conservation status of fish species in this region. The comprehensive checklist compiled in this study serves as a valuable resource for researchers, conservationists, and policymakers involved in the management and conservation of fisheries resources. The study highlights the importance of understanding the ecological dynamics and habitat preferences of fish species for effective conservation strategies. By considering the IUCN conservation status of the fish species, this study emphasizes the urgency and need for conservation efforts to protect threatened species and their habitats. The unique geographical features and diverse biotic zones of Jammu and Kashmir and Ladakh contribute to the rich fish biodiversity in the region. The presence of numerous wetlands, lakes, and rivers, further enhance the significance of these areas for freshwater fish populations. However, the study also reveals the challenges and threats faced by fish populations in the region. Factors such as habitat destruction, pollution, unsustainable fishing practices, and the construction of dams pose significant risks to the conservation of fish species. It is imperative to address these challenges through the implementation of effective management strategies, including habitat restoration, regulation of fishing practices, and the establishment of protected areas. The intricate relationship between fish, environment, and human involvement is essential. Sustainable fishing practices must be enhanced to protect biodiversity and environmental health. Fishermen's resourcefulness in using diverse fishing gears and crafts is evident, especially in regions like the trans-Himalayas. Upgrading methods with modern technology is crucial for ecological alignment. While traditional techniques should be conserved, some may be harmful, requiring awareness-raising for sustainable practices. The findings of this study underscore the need for continued research and monitoring of fish populations in the Union Territories of Jammu and Kashmir, and Ladakh. Long-term studies and collaborative efforts

among researchers, local communities, and governmental organizations are essential for the sustainable management and conservation of fish biodiversity in the region. Overall, this study contributes to the existing knowledge of fish diversity in Jammu and Kashmir and Ladakh and provides a foundation for future research, conservation initiatives, and policy development aimed at preserving the aquatic wealth of the region for present and future generations.

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Conflict of Interest

The authors of this manuscript declare that they have no financial and personal relationships with other people or organizations that could inappropriately influence their work

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