Journal of Institute of Science and Technology, 30(1), 31-44 (2025)
ISSN: 2467-9062 (print), e-ISSN: 2467-9240
https://doi.org/10.3126/jist.v30i1.73690

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Research Article

CURRENT STATUS OF SMALL INDIGENOUS FISH SPECIES OF WESTERN NEPAL

Santoshi Shrestha[1], Kumar Khatri[2], Nripesh Shrestha[3], Ram Chandra Poudel[4], Kumar Sapkota[1]
[1]*Central Department of Zoology, Institute of Science and Technology, Tribhuvan University, Kirtipur, Nepal*
[2]*Central Department of Environmental Science, Institute of Science and Technology, Tribhuvan University, Kirtipur, Nepal*
[3]*Bhaktapur Multiple Campus, Tribhuvan University, Bhaktapur, Nepal*
[4]*Nepal Academy of Science and Technology, Khumaltar, Lalitpur, Nepal*
Correspondence: santoshi.shrestha@cdz.tu.edu.np

(Received: *December 31, 2024;* **Final Revision:** *January 25, 2025;* **Accepted:** *January 26, 2025***)**

ABSTRACT

This study describes the diversity and current status of Small Indigenous Fish Species (SIS) in rivers and lakes of Western Nepal. Fish sampling was conducted between 2018 and 2022 across five major water bodies using cast nets and traditional fishing gear, with assistance from local fishermen. A total of 10,976 individual fish were recorded, representing 61 species from 9 orders, 21 families, and 43 genera, including six species apart from the SIS category. The identified species were grouped into nine categories: Barbs and Minnows, Catfishes, Eels, Featherbacks, Loaches, Minor carps, Perches, Snake heads, and Sucker heads. Among these, Barbs and Minnows were the most diverse, comprising 32.79% (20 species) of the total. Cypriniformes emerged as the dominant order, with Cyprinidae and Danionidae being the most represented families, highlighting their significant role in the region's fish diversity. The study classified species into three availability-based categories: commonly available (27 species), moderately available (25 species), and rare (9 species). The presence of rare species underscores the region's ecological richness and the urgent need for targeted conservation efforts. The study's findings emphasize the importance of abundance-based assessments in developing targeted conservation strategies. These strategies should include habitat restoration, sustainable fishing practices, policy reforms, and further research to fill existing knowledge gaps.

Keywords: Current status, rare category, SIS, western Nepal

INTRODUCTION

Global biodiversity refers to the variety of life forms found on earth, encompassing different species of plants, animals, fungi, genetic variations, and microorganisms, as well as the ecosystems they form (Hancock, 2024). Biodiversity is crucial for ecosystem services such as provisioning services, regulating services, supporting services and cultural services and forms the basis for pollination, soil fertility, water purification, climate regulation, pest control and cultural services and forms the basis for food production, water purification, climate regulation, and disease control (Ali & Kamraju, 2023; Zhang *et al*., 2019). The world is home to an estimated 8.7 million species, with millions still undiscovered (Saouter & Gibon, 2024). Fish are a vital component of global biodiversity, representing the most diverse group of vertebrates with more than 36,775 species identified so far (Fricke *et al*., 2024). However, despite this richness, biodiversity is under severe threat from habitat destruction, overexploitation, pollution, invasive species, agriculture practices, and climate change (Ogidi & Akpan, 2022; Rawat & Agarwal, 2015; Bănăduc *et al*., 2022; Brain & Prosser, 2022). Fish inhabit a wide range of aquatic environments, from freshwater rivers and lakes to salinity fluctuating estuaries to vast and varied marine ecosystems (Lévêque *et al*., 2008). This diversity is not only in terms of species richness but also in their morphological, ecological, and behavioral adaptations (Helfman *et al*., 2009; Keenleyside, 2012). Despite this diversity, many fish species face extinction risks. The IUCN Red List reports that approximately 25% of freshwater fish species are at risk of extinction, with at least 17% of these threatened species affected by climate change attributes such as decreasing water levels, ocean acidification, rising sea levels, increased water temperature, changes in water quality, altered hydrological cycles, and loss of ice cover (IUCN-US, 2023).

Nepal is home to a significant portion of the world's biodiversity, including many endemic species, across its 118 ecosystems, and home to over 200 fish species, with some estimates recording up to 258 species, indicating a rich ichthyofaunal diversity (Khatri *et al*., 2020; Shrestha & Thapa, 2020). In Nepal, several fish species are considered flagship species due to their ecological, economic, and cultural importance such as Golden mahseer (*Tor putitora*), Snow trout (*Schizothorax* spp.), Copper mahseer (*Neolissochilus hexagonolepis*), Sahar (*Tor tor*) (USAID-PAANI, 2020). These species, along with various SIS are those fishes that can grow up to a maximum size of 25 cm or 9 inches in their mature or adult stage of the life cycle (Felts *et al*.,1996, Hossain and Afroze, 1991). These fishes contribute significantly to the biodiversity of freshwater ecosystems. In India alone, there are about 450 species of small indigenous fish. Their presence helps maintain the ecological balance by supporting various trophic levels in the food web. These fish are a rich source of animal protein, vitamins, and minerals, making them an essential part of the diet for many communities (Roos *et al*., 2003, Mohanty *et al*., 2013). They contribute to cultural heritage, serve ornamental purposes, provide essential nutrients, and play crucial roles in ecosystem functioning (Lynch *et al*., 2016). These factors have led to critical population decline, increasing the risk of local or global extinction for several fish species including those of SIS (Arthington *et al*., 2016; Sayer *et al*., 2025; Aziz *et al*., 2021).

Conservation assessments are essential for evaluating biodiversity health, identifying key species and habitats, and guiding effective conservation strategies (Dudgeon *et al*., 2006; Noss, 1990). However, there is a notable lack of published documentation regarding SIS and the local conservation status of fish in Nepal (Rajbanshi, 2012; Shrestha, 1981, 1995; Shrestha, 2019). This gap hampers our understanding of fish biogeography, population densities, and the threats they face. Detailed scientific studies are needed to document the distributions and ecology of freshwater species and to assess their conservation status. The outcomes of such studies can serve as blueprints for guiding research efforts, management, and conservation planning, thereby improving knowledge of species and areas that urgently require further research and conservation status assessment. Small fish species, often overlooked in conservation efforts, play a vital role in maintaining the health and productivity of aquatic ecosystems. However, a comprehensive baseline of fish diversity, including the local conservation status, is currently lacking, yet it is essential for developing effective conservation measures. This study aims to establish baseline data on the local status of SIS across five water bodies in Western Nepal. Such information is crucial for impact monitoring and forms the foundation for future management strategies. Additionally, it can contribute to updating the current IUCN Red List of fishes at a local scale.

MATERIALS AND METHODS

The study was conducted in various aquatic habitats of Western Nepal (Fig. 1; Table 1). Five water bodies - two lentic and three lotic. The study addresses the limited data on fish diversity and conservation status in the region by selecting a range of diverse water bodies. By including lesser-studied aquatic systems, it provides valuable insights that enhance the understanding of regional biodiversity. Fish samples were collected during the post-monsoon, winter, and pre-monsoon seasons between 2018 and 2022, using cast nets with assistance from local fishermen. In rivers, a 300-meter stretch was covered at each site, while five cast-net deployments were made at selected lake sites. Data on fish morphology, size (length and weight), distinctive markings (e.g., body patches and spots), and other relevant characteristics (coloration patterns, mouth structure, lateral line system, barbels, etc.) were recorded in the field. Specimens were preserved in formaldehyde (4% for smaller fish and 10% for larger specimens) and absolute ethanol and transported to the Central Department of Zoology (CDZ) laboratory for detailed analysis. Preserved samples were deposited in the Central Department of Zoology Museum at Tribhuvan University (CDZMTU).

Table 1. Coordinates of study area

S.N.	Water body type	Water bodies	Sites	Altitude (m.a.s.l)	Latitude	Longitude
1	Lotic	Dano River	Butwal	204	27.7101°N	83.4624 °E
			Semlar	140	27.6681°N	83.3687°E
			Gundi	121	27.5074°N	83.3377°E
2		Banganga	Bodgaun	167	27.6972°N	83.1675°E
			Laxmanghat	143	27.6674°N	83.1116°E
			Ramghat	122	27.5683°N	83.0179°E
3		Arung Khola	Damar	341	27.693°N	83.9517°E
			Arungkhola-bazar	195	27.6164°N	83.9575°E
			Vyuran	174	27.5778°N	83.9645°E
4	Lentic	Jagadishpur	Site I	131	27.6163°N	83.0991°E
			Site II	130	27.6174°N	83.0955°E
			Site III	129	27.6208°N	83.095°E
			Site IV	131	27.624°N	83.0951°E
			Site V	134	27.6252°N	83.1056°E
5		Gajedi	Site I	142	27.6621°N	83.2745°E
			SiteII	143	27.6621°N	83.2753°E
			SiteIII	142	27.6629°N	83.2754°E
			SiteIV	140	27.6642°N	83.2755°E
			Site V	149	27.6625°N	83.2763°E

Fish identification was conducted following standard literature (Jayaram, 1999; Shrestha, 1981, 1994, 2012; Shrestha, 2019; Talwar & Jhingran, 1991; Vishwanath, 2021) and online databases (Fricke *et al*., 2024; Froese & Pauly, 2024). The identified species were classified into nine groups: Barbs and Minnows, Catfishes, Eels, Featherbacks, Loaches, Minor Carps, Perches, Snakeheads, and Sucker heads following with modification (Pandit *et al*., 2015).

The local status of SIS in the study area was assessed through key informant interviews with local fishermen, focus group discussions, and an analysis of catch during the survey (Baishya *et al*., 2016; Crisfield *et al*., 2024; Ferdous *et al*., 2023; Pandit *et al*., 2015). Based on different literatures, availability of species and informants' perceptions, the status was revised and categorized in three categories bases on availability to access the local status of SIS, viz., commonly available (CA), moderately available (MA), and rare (R). Species classified as 'commonly available' were present throughout the year and caught in most sampling sites. In contrast, 'rare' species were only caught during a single season and in very small numbers, or their occurrence was infrequent based on catch. Similarly, 'moderately available' species were caught in fewer than three instances per unit effort, typically in specific seasons or years. The global conservation status of the fish species was determined based on the IUCN Red List (IUCN, 2024), while (Shrestha, 1995; 2012) was referenced for their national conservation status.

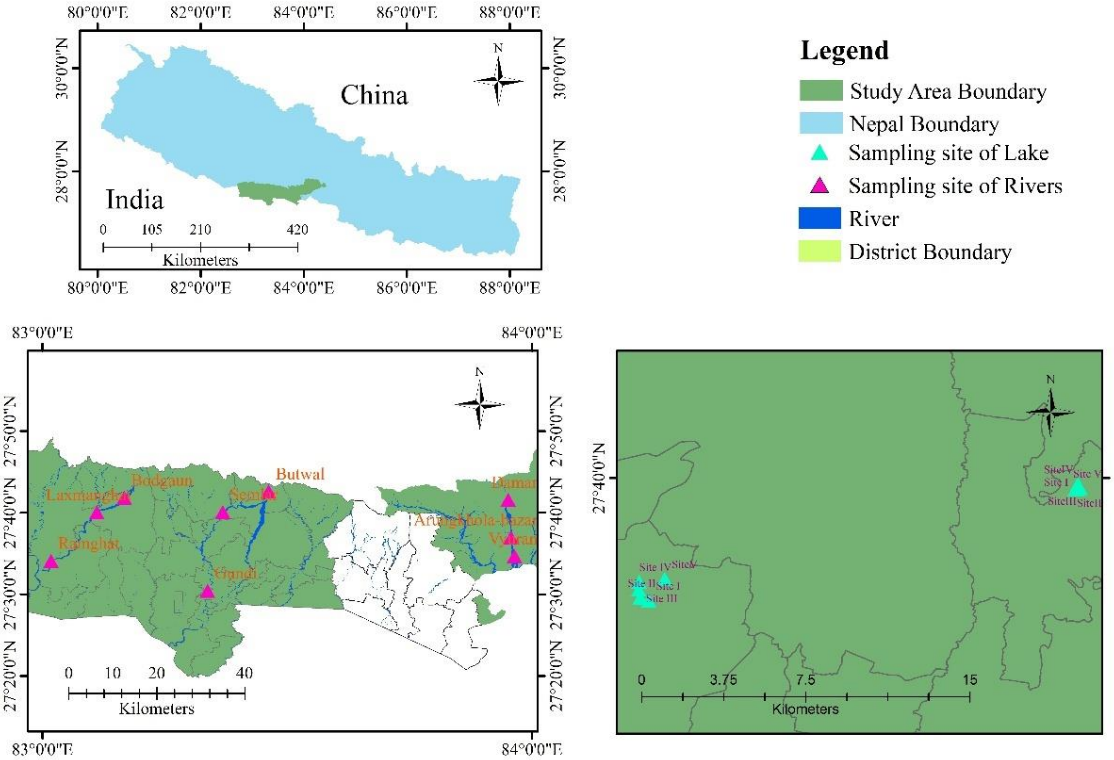

Figure 1. Map of the study area.

RESULTS AND DISCUSSION

Diversity of Fish Species

A total of 10, 976 SIS fish individuals representing 61 species belonging to 9 Orders, 21 Families, and 43 Genera were recorded from three rivers (Dano River, Banganga River, and Arung Khola) and two lakes (Jagadishpur Reservoir and Gajedi Lake), including six species apart from SIS of Western Nepal. The Order Cypriniformes was the most dominant, comprising a total of 33 species across all water bodies. The families Cyprinidae and Danionidae were the most dominant, each represented by 13 species. In contrast, several families, including Badidae, Nandidae, Osphronemidae, Belonidae, Botiidae, Cobitidae, Gobiidae, Mugilidae, Notopteridae, Amblycipitidae, Clariidae, Heteropneustidae, and Schilbeidae were the least recorded, with each family represented by only a single species during the study period (Fig. 2).

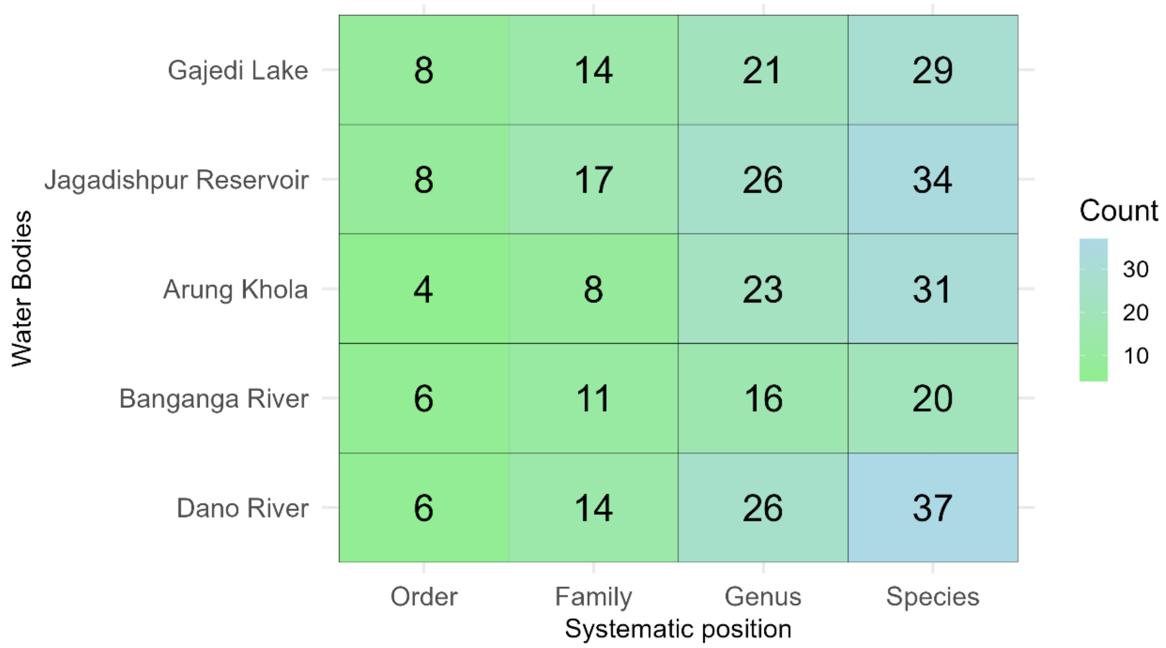

Figure 2. Taxonomic Hierarchy of fish species in different water bodies.

A total of 1,503 individuals were recorded in the Dano River among these, *Garra gotyla* was the most abundant species (271 individuals), while *Nemacheilus corica*, *Mystus bleekeri*, and *Macrognathus lineatomaculatus* were the least abundant, with only 2 individuals each. The Arung Khola had a total of 1,825 individuals, where *Puntius sophore* was the most abundant species (333 individuals), while *Schismatorhynchos nukta* and *Glyptothorax* sp. were the rarest, with only 1 individual each. Similarly, Gajedi Lake had a total of 2,110 individuals where *Amblypharyngodon mola* was the most abundant species (566 individuals), and *Macrognathus lineatomaculatus* was the least common, with only 1 individual recorded. In the Banganga River, a total of 2,360 individuals were documented, where the most abundant species was *Puntius sophore* (683 individuals), whereas *Botia lohachata* had the lowest count (6 individuals). Finally, the Jagadishpur Reservoir recorded the highest 3,178 individuals, and among them the most abundant species was *Rasbora daniconius* (758 individuals), while *Badis badis* was the least represented by just 1 individual.

The observed variation in species richness across the surveyed water bodies highlights the ecological diversity of the aquatic ecosystems under study. In general, the highest species richness in the rivers typically hosts diverse fish communities due to a combination of habitat heterogeneity, water flow, and nutrient availability (Stefani *et al.*, 2024; Stoffers *et al.*, 2022; van der Sleen & Albert, 2021). The presence of rich species in the Jagadishpur Reservoir suggests that reservoirs can support diverse fish communities, especially when managed to maintain ecological balance (NLCDC, 2021; Sandhya *et al.*, 2019). Ecological balance in the Jagadishpur Reservoir is maintained through a combination of natural and human interventions aimed at preserving biodiversity and supporting a stable aquatic ecosystem. This reservoir is home to diverse fish species due to its favorable water quality, abundance of aquatic vegetation, and the presence of a variety of habitats such as open water, submerged vegetation, and shallow areas that cater to the needs of different species. Additionally, local and governmental efforts focus on controlling pollution, regulating water levels, and preventing invasive species that could disrupt the ecosystem (Bhuju *et al.*, 2007). These measures collectively ensure that the reservoir provides a balanced environment where diverse fish communities can thrive, highlighting the importance of active management in maintaining ecological equilibrium.

The dominance of the order Cypriniformes is consistent with its well-documented occurrence in freshwater ecosystems, particularly in South Asia, where this order has diversified extensively (Berra, 2007; Nelson *et al.*, 2016). A number of studies from Nepalese water bodies have also reported the dominance of Cyprinids (Shrestha, 1981; Shrestha, 2019; Sharma & Shrestha, 2001, Jha 2006). The families Cyprinidae and Danionidae further highlight this trend, as they are known for their adaptability to varying environmental conditions and their dominance in lentic and lotic ecosystems (Alam *et al.*, 2024; Sudasinghe, 2024). In contrast, the lower species richness in the aquatic ecosystems could reflect limited habitat complexity, anthropogenic pressures, or environmental stressors such as pollution, water abstraction, or habitat fragmentation, emphasizing the role of environmental degradation in reducing aquatic biodiversity (ADB, 2018; Dudgeon *et al*., 2006).

During the study period, 5 species were found common to all water bodies. 28 species were found common in two lakes and 10 species were common in three rivers. *Badis badis, Nandus nandus, Notopterus notopterus, Chanda nama, Heteropneusteus fossilis, Mastacembelus armatus* were only found in Jagadishpur reservoir whereas *Osteobarma cotio* and *Eutropiichthys vacha* from Banganga River, *Minimugil cascasia* from Gajedi Lake and *Cyprinion semiplotum*, *Schismatorhynchus nukta, Glyptothorax trilineatus, Myerglanis blythii* from Arung khola whereas *Garra* sp and *Glyptothorax* sp from the Dano River and Arungkhola respectively. *Pethia ticto, Puntius sophore, Acanthocobitis botia, Esomus danrica,* and *Lepidocephalichthy guntea* were recorded in all seasons throughout the study areas. *Badis badis* in the Jagadishpur reservoir, *Minimugil cascasia* in Gajedi Lake, and *Glyptotorax* sp and *Schismatorhynchos nukta* in Arung Khola, were rarely documented with only a single individual being captured during the present study except for *Minimugil cascasia* (n=3).

The presence of families such as Badidae, Nandidae, and Osphronemidae, each represented by only one species in the Jagadishpur Reservoir, reflects their rarity or highly specialized niche requirements within the ecosystem. These families are not necessarily rare globally, but their occurrence in specific habitats may depend on ecological conditions such as water quality, habitat complexity, and food availability. Many species within these families are known to be sensitive to environmental changes, including pollution, habitat degradation, and alterations in water flow or temperature. For example, Badidae species are often associated with clear, slow-moving waters with abundant vegetation, while members of Nandidae are ambush predators that rely on well-structured habitats for hunting and survival. Osphronemidae, are known for their dependence on oxygen-rich waters and are often found in environments where they can utilize their labyrinth organ for aerial respiration. The fact that these families are represented by only one species each in the reservoir may indicate their specialized habitat needs or a marginal suitability of the reservoir for their broader ecological requirements (Boulangeat *et al*., 2012; Callaghan *et al*., 2023).

The study highlights the distribution and occurrence patterns of fish species across different water bodies, reflecting the ecological variability and uniqueness of each habitat. The species common to all surveyed sites indicates their broad ecological tolerance and adaptability to varying environmental conditions (Fausch *et al*., 1990; Pinna *et al*., 2023). The species shared between the two lakes suggests overlapping habitat preferences and ecological requirements, likely influenced by similar limnological conditions in lake systems (Boll *et al*., 2023; Irz *et al*., 2006).

Species restricted to specific waterbodies, such as *Badis badis* in the Jagadishpur Reservoir and *Osteobrama cotio* in the Banganga River, indicate localized environmental factors and niche specialization (Mason *et al*., 2008). *Badis badis* is found in freshwater ecosystems in India, Bangladesh, Nepal, and Bhutan, particularly in slow-moving streams, ponds, and reservoirs with abundant vegetation (Talwar & Jhingran 1991). Its presence in the Jagadishpur Reservoir indicates that the ecological conditions there are favorable for its survival, such as the availability of microhabitats and a balanced predator-prey dynamic. Moreover, the occurrence of *Osteobrama cotio* in the Banganga River may reflect suitable ecological conditions such as slow-moving waters and abundant organic matter, which serve as food and breeding grounds (Bhakta, 2020).

Notably, the documentation of unidentified fish species highlights the need for more detailed surveys and taxonomic studies to thoroughly document and understand the aquatic biodiversity in Nepal's rivers. Such discoveries highlight the rich and unique ecosystems present in the region, emphasizing the need for continued research and conservation efforts (Lakra *et al*., 2010).

Seasonal Diversity of Fish Species

The seasonal fish richness in the river showed the Dano River exhibited the highest species richness, with 30 species recorded during both the post-monsoon, while the Banganga River reported the lowest richness, with only 16 species observed during the post-monsoon and winter seasons. In the lakes, the Jagadishpur Reservoir recorded the highest richness, with 30 species during the pre-monsoon season, whereas Gajedi Lake had the lowest richness, with only 21 species documented in the post-monsoon season (Fig. 3).

The Kruskal-Wallis test indicated no significant variation in species composition across different seasons in all water bodies. However, despite the overall no-significance, Dunn's test revealed significant variations in certain species through pairwise comparisons across all sampling sites during seasons (Table 2).

Seasonal changes have a significant impact on fish diversity and abundance (Shimadzu *et al*., 2013) as the seasons affect a range of environmental variables in ecoystems. During the pre-monsoon and post-monsoon seasons, rivers exhibit high fish species richness due to stable water levels, favorable temperatures, and enhanced primary productivity, which provide abundant food resources (Akhi *et al*., 2020; Leela *et al*., 2021). These seasons align with fish breeding cycles too, offering ideal conditions for the survival of eggs, larvae, and juveniles (Sharma *et al*., 2014; Takemura *et al*., 2010). Furthermore, diverse microhabitats during the pre-monsoon period and expanded river channels with floodplains in the post-monsoon season create a variety of habitats that support different species (Qasim & Qayyum, 1962; Vollenweider *et al*., 2011). Reduced human disturbances, such as fishing and pollution in some regions, further contribute to thriving fish populations during these periods (De Santis *et al*., 2023; Larentis *et al*., 2022).

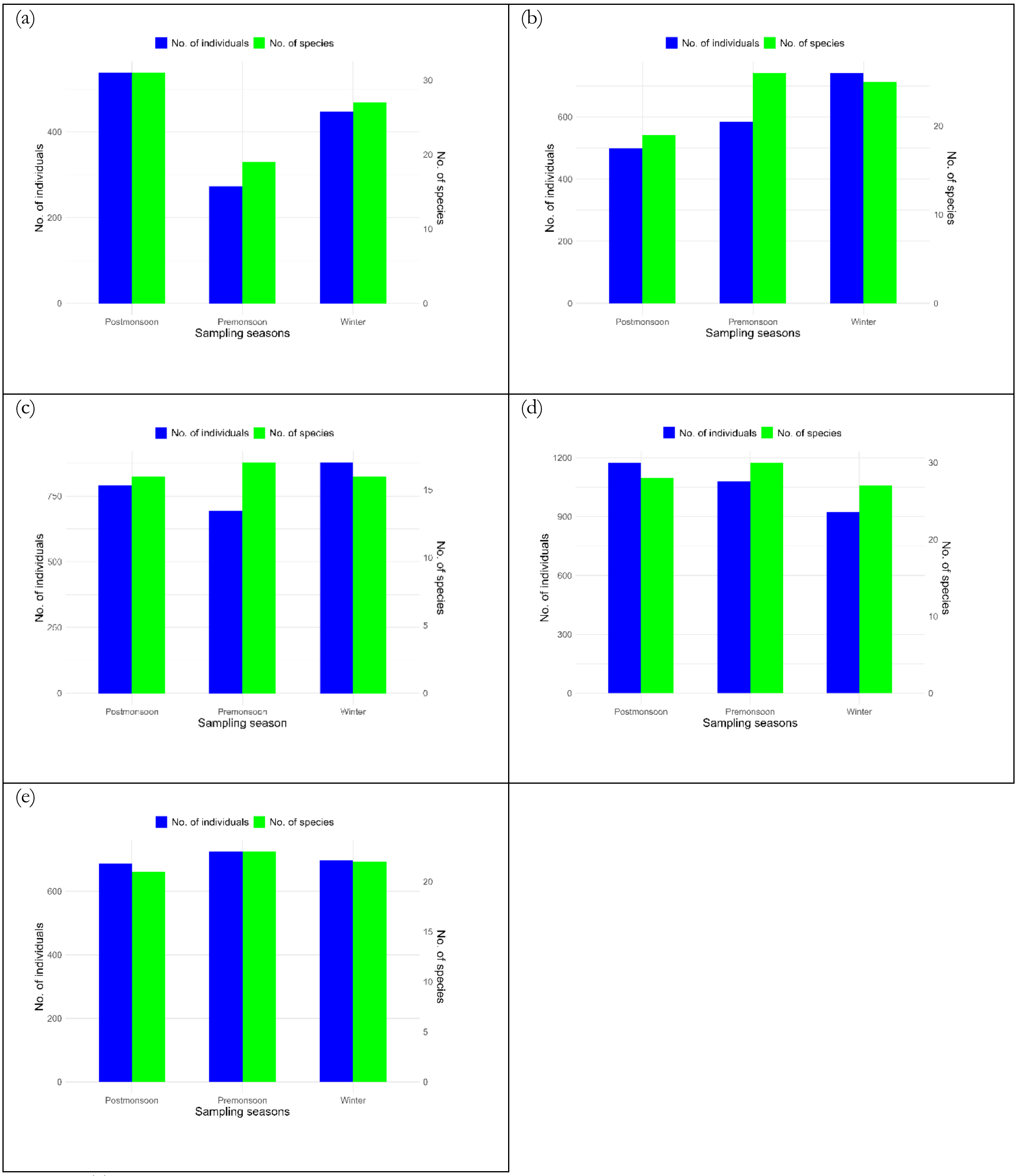

Figure 3. The total catches with number of fish species at different seasons from the Dano River(a), Banganga River (b), Arung Khola(c), Jagadishpur Reservoir (d) and Gajedi Lake (e).

Table 2. Fish species show significant difference during season in sampling sites.

Water bodies	Chi-Square	df	P value	Species Significant
Dano River	0.501	2	0.778	*Barilius barila, Schistura beavani* and *Mastacembelus armatus*
Banganga River	2.55	2	0.279	*Channa punctata, Xenontodon cancila* and *Garra annandalei*
Arung Khola	3.318	2	0.19	*Lepidocephalichthys guntea* and *Barilius barila*
Jagadishpur Reservoir	1.191	2	0.382	*Pethia phutunio, Pethia ticto, Danio rerio Glossogobius* and *Macrognathus pancalus*
Gajedi Lake	1.566	2	0.456	*Trichogaster fasciata*, *Laubuka laubuca* and *Esomus danrica.*

In contrast, the Banganga River, with low species richness during the post-monsoon season, may be due to altered water levels and flow rates from the Banganga Irrigation Project which can disrupt habitat structure and water quality, leading to reduced species richness (Khanal *et al*., 2022). In winter, lower temperatures slow fish metabolism and activity, further decreasing their abundance (Soyano & Mushirobira, 2018; Volkoff & Rønnestad, 2020). Seasonal variations in food resources, such as reduced nutrient influx and diminished biological activity in winter, also contribute to declining fish populations (Pease *et al*., 2020). Since many species breed during the monsoon, the post-monsoon and winter periods often fall outside optimal breeding times, resulting in lower observed richness (Baki *et al*., 2017). Moreover, increased human activities like fishing, pollution, and habitat modification during the winter season exacerbate the decline in fish diversity (Larentis *et al*., 2022; Ogidi & Akpan, 2022).

The species recorded in all seasons, such as *Pethia ticto* and *Puntius sophore*, demonstrate strong ecological resilience and adaptability to seasonal environmental changes (Mia *et al*., 2019). In contrast, the rare occurrences of species like *Badis badis* and *Schismatorhynchos nukta*, with minimal individuals captured, indicate potential vulnerability or specialized habitat requirements (Froese & Pauly, 2024). Such findings emphasize the need for targeted conservation efforts to protect these rare and potentially endangered species from threats like habitat loss and overfishing (Cooke *et al*., 2012; Gillette *et al*., 2023).

Different Groups of SIS

Among the 61 identified fish species, barbs and minnows were the most diverse group (n = 20), making up 32.79% of the total followed by Catfishes (n = 12), accounting for 19.67%. Loaches and perches each represented 11.48% (n = 7), while eels comprised 8.20% (n = 5). Minor carps, snakeheads, and sucker heads each contributed 4.92%. Featherbacks were the least represented, making up just 1.64% of the species (Fig. 4).

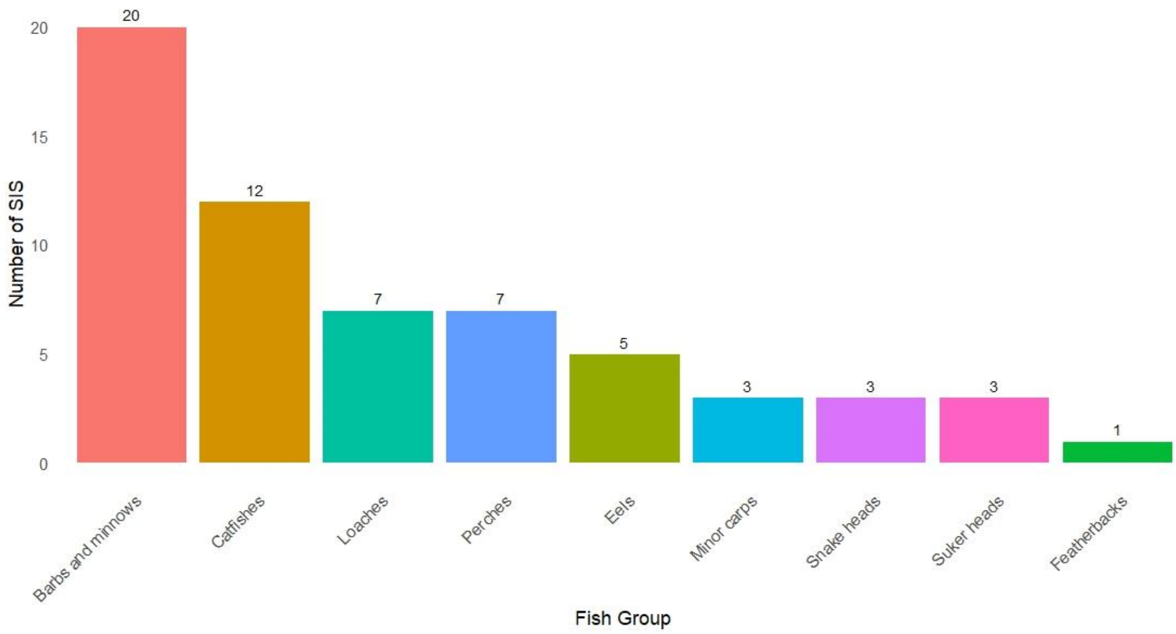

Figure 4. Different groups of SIS with their numbers.

The predominance of barbs and minnows can be attributed to their remarkable adaptability to a wide range of environmental conditions, extensive distribution, and ecological versatility. These traits enable them to thrive in various niches within freshwater ecosystems (Matthews, 1998). Additionally, their high reproductive potential and resilience to fluctuations in water quality contribute to their common presence across diverse habitats (Sarkar *et al*., 2019). Catfishes, representing 19.67% of the species, are another significant group, reflecting their ability to thrive in different aquatic environments, including slow-moving rivers, lakes, and reservoirs (Segaran *et al*., 2023). Their benthic lifestyle and tolerance to low oxygen levels make them well-suited for various habitats, particularly those with muddy substrates and organic matter (Chakrabarty, 2005). Other groups, such as perches and loaches each comprising 11.48%, highlight the diversity of small-sized fish adapted to specific niches. Loaches, for instance, are bottom-dwellers and thrive in streams with strong currents, whereas perches are often associated with structured habitats like submerged vegetation or rocky substrates (Berra, 2007; Nelson *et al*., 2016). Minor carps, snakeheads, and sucker heads, each contributing 4.92% to the total species, further reflect the ecological diversity of the surveyed water bodies. Snakeheads are airbreathing predators, often found in lentic or slow-moving waters, while sucker heads and minor carps typically inhabit flowing waters with specific substrate preferences (Courtenay Jr & Williams, 2004). Conversely, featherbacks, accounting for just 1.64%, demonstrate low diversity in the ecosystems surveyed. Their specialized habitat preferences, such as slow-moving or stagnant waters with dense vegetation, may limit their distribution and abundance (Rainboth, 1996). Featherbacks are also more susceptible to habitat degradation and overfishing, contributing to their lower representation. The varying proportions of these groups emphasize the influence of habitat diversity, environmental conditions, and anthropogenic factors on fish community composition (Bartley *et al.*, 2015).

Table 3. Present status of SIS in Western Nepal during the study period

Family	Genus	Sampling area/ season	IUCN	Shrestha 1995/2012	Present Status
		Diversity of Barbs and Minnows			
Cyprinidae	*Schismatorhynchos nukta*	A(WI)	EN	Uncommon*	R
	Osteobrama cotio	B (WI, PR)	LC	Common *	MA
	Pethia conchonius	All	LC	Common	CA
	Pethia phutunio	J (PO, PR), G(PO)	LC	Uncommon*	R
	Pethia ticto	B(All), A(All), J(All), G(All)	LC	Common	CA
	Puntius chola	J(All), G(All)	LC	Uncommon*	CA
	Puntius sophore	All	LC	Common	CA
Danionidae	*Barilius barila*	D(All), B(All), A (WI, PR)	LC	Common	CA
	Barilius vagra	D (WI, PR), A(All)	LC	Common	MA
	Cabdio morar	D (PO, PR)	LC	Common	MA
	Opsarius barna	D(All), B(All), A(All)	LC	Common	CA
	Opsarius bendelensis	D(All), B(PO), A(All)	NA	Common	CA
	Salmostoma bacaila	D(All), A (WI, PR), J (WI, PR), G (WI, PR)	LC	Common	CA
	Danio rerio	A(WI), J (PO, PR), G(All)	LC	Vulnerable	CA
	Devario aequipinnatus	J(All), G (WI, PR)	LC	Uncommon*	MA
	Devario devario	A (PO, WI), G (PR)	LC	Common	CA
	Laubuka laubuca	D(All), J (WI, PR), G(PR)	LC	Common	CA
	Esomus danrica	D (PO, WI), B(All), A(All), J(All), G (PO, WI)	LC	Common	CA
	Amblypharyngodon mola	A (PO, WI), J (All), G (All)	LC	Common	CA
	Rasbora daniconius	J(All), G(All)	LC	Fairly Common	CA
		Diversity of Catfishes			
Amblycipitidae	*Amblyceps mangois*	D (PO, PR), A(PR)	LC	Rare	R
Bargidae	*Mystus bleekeri*	D(PO), J(All), G(All)	LC	Common	CA
	Mystus cavasius	D(WI)	LC	Common	CA
	Mystus tengara	D(All), B(All), J(All), G(All)	LC	Common	CA
	Mystus vittatus	D (PO, WI), B (PO, PR)	LC	Common*	CA
Clariidae	*Clarias batrachus*	J (PO, WI), G(PR)	LC	Common	MA
Heteropneustidae	*Heteropneustes fossilis*	D(ALL), J(All)	LC	Common	MA
Schilbeidae	*Eutropiichthys vacha*	B (WI, PR)	LC	Occasional	MA
Sisoridae	*Myerglanis blythii*	A(WI)	NA	Rare	R
	Pseudchenesis sulcata	D (PO, WI), A(All)	NA	Occasional	MA
	Glyptothorax trilineatus	A (WI, PR)	NA	Rare	MA
	Glyptothorax sp.	A(PR)	NA	NA	R
		Diversity of Eels			
Belonidae	*Xenontodon cancila*	D (PO, WI), B (WI, PR), J (All), G (All)	NA	Common	MA

Mastacembelidae	*Mastacembelus armatus*	D (PO), A (PR), J (PO, WI)	LC	Common	CA
	Macrognathus aral	J (All), G (WI, PR)	LC	Common*	CA
	Macrognathus pancalus	D (WI), A (All), J (PR), G (PO, WI)	LC	Common	CA
	Macrognathus lineatomaculatus	D (PO, PR), J (PO), G (PO)	DD	NA	R
		Diversity of Featherback			
Notopteridae	*Notopterus notopterus*	J(All)	LC	Common	CA
		Diversity of Loaches			
Nemachelidae	*Acanthocobitis botia*	D (PO, PR), B (All), A(All), J (All), G (All)	LC	Common	MA
	Nemacheilus corica	D(PO)	LC	Uncommon*	R
	Schistura beavani	D (WI, PR), A (WI, PR)	LC	R*	MA
	Schistura sp. *1*	D (All), A (All)	NA	NA	MA
	Schistura sp. *2*	D (All), A (PR)	NA	NA	MA
Botiidae	*Botia lohachata*	D (PO, PR), B (PO, WI) J (PO, PR), G (PO, WI)	LC	Common	MA
Cobitidae	*Lepidocephalychthys guntea*	D (PO, PR), B(All), A(All), J(All), G(WI)	NA	Common*	MA
		Diversity of Minor carp			
Cyprinidae	*Cyprinion semiplotum*	A (All)	VU	Uncommon*	MA
	Tariqilabeo latius	D (All), A (PR)	LC	Common	MA
	Chagunius chagunio	D(All)	LC	Fairly Common*	MA
		Diversity of Perches			
Badidae	*Badis badis*	J (PR)	LC	Fairly Common	R
Nandidae	*Nandus nandus*	J (WI, PR)	LC	Common	MA
Osphonemidae	*Trichogaster fasciata*	D (PO, WI), J (All), G(All)	LC	Common	CA
Gobiidae	*Glossogobius guiris*	D (WI, PR), B(All), J(WI), G (All)	NA	Common	MA
Mugilidae	*Minimugil cascasia*	G(PR)	LC	R	R
Ambassidae	*Chanda nama*	B (All), J (All)	LC	Common	CA
	Parambassis baculis	J (All), G (All)	LC	Uncommon*	CA
		Diversity of Snakeheads			
Channidae	*Channa gachua*	J (All), D (PR), A (All), G (PO, PR)	LC	Fairly Common	MA
	Channa punctata	J (All), D (PO, WI), B (PO)	LC	Fairly Common	MA
	Channa stewartia	A (PO, PR), J (PO, PR), G (All)	LC	Uncommon*	MA
		Diversity of Sucker heads			
Cyprinidae	*Garra annandalei*	D (All), B (WI, PR), A (All)	LC	Uncommon*	CA
	Garra gotyla	D(All), B (PO, WI), A(All)	LC	Uncommon*	CA
	Garra sp	D(All)	NA	NA	MA

*D = Dano River, B = Banganga River, A= Arung Khola, G= Gajedi Lake, J = Jagdishpur Reservoir, PO= Post monsoon, WI= Winter, PR= Premonsoon, All = found in all seasons, EN = Endangered, VU= Vulnerable, NT= Nearly Threatened LC= Least Concern, DD= Data Deficient, NA = Not Available, * = updated in 2012 by author*

Conservation status

The threat status categorization of the observed fish species, was assessed following IUCN Red List 2024, is presented in Table 3. Of the 61 species recorded in this study, 48 are categorized as 'Least Concern', 10 as 'Not Assessed', and one as 'Data Deficient'. Additionally, *Schismatorhynchos nukta* is listed as 'Endangered', while *Cyprinion semiplotum* is designated as 'Vulnerable' (Table 3). Moreover, 33 species are categorized as 'Common', 10 as 'Uncommon', 1 as 'Vulnerable', 5 as 'Fairly Common', 2 as 'Occasional', 4 as 'Rare', and 5 as 'Not Available (NA)' according to the threat status provided by Shrestha (1995, 2012). The local status during this study was further categorized into three groups, with 27 species falling under the 'CA' category, 25 under 'MA', and 9 under 'R'. This difference in categorization highlights the varying conservation priorities and the current status of these fish species (Fig. 5). The assessment of the threat status of fish species in this study highlights important conservation implications. Fish species face a higher risk of extinction, likely due to habitat degradation, overfishing, and other anthropogenic pressures that threaten freshwater biodiversity in South Asia (Allen *et al.*, 2010; Dudgeon, 2022). For instance, the classification of species as 'Rare' reflects their limited distribution or reduced abundance, aligning with previous findings on the vulnerability of endemic freshwater fish species in the Himalayan region (Chandra *et al.*, 2018). These findings are consistent with the broader challenges of freshwater conservation in the region, where habitat fragmentation, pollution, and invasive species are key drivers of biodiversity loss (Darwall & Freyhof, 2016). Moreover, the categorization of five species as 'Not Available' suggests a lack of sufficient data, highlighting research gaps and the need for comprehensive biodiversity surveys.

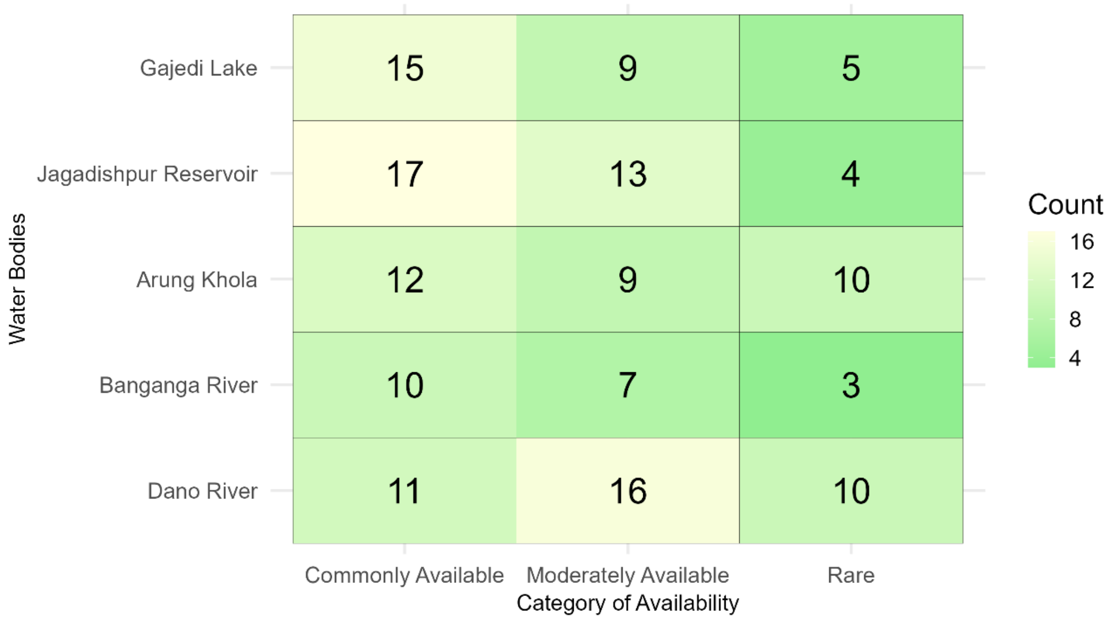

Figure 5. Current status of SIS in the study area.

CONCLUSIONS AND RECOMMENDATIONS

The findings of this research provide baseline information on the fish diversity along with the local status of SIS in Western Nepal. A rich diversity of SIS was documented, with the Cypriniformes order, particularly the barbs and minnows group, as the most dominant taxa, accounting for 32.79% of the total species. The presence of rare species with low abundance signals critical threats, including habitat degradation and overfishing. To address these challenges, the study emphasizes the necessity of habitat restoration, pollution control, the implementation of sustainable fishing practices and further suggest regular study of the water bodies.

Additionally, integrating global and regional conservation frameworks and policies is vital to mitigate these threats. These measures are essential for formulating effective conservation strategies and ensuring the long-term sustainability of freshwater fish populations. By prioritizing such actions, the ecological balance and biodiversity of aquatic systems can be preserved, benefiting both the environment and the communities that rely on these resources.

ACKNOWLEDGMENTS

The first author would like to acknowledge Nepal academy of Science and Technology (NAST) for providing PhD fellowship. We would like to acknowledge Department of Forests and Soil Conservation (GoN/MoFE), Gajedi Lake Management Committee, Jagadishpur Reservoir Management Multistake Holder's Forum, and local fishermen for their cooperation during field work.

AUTHOR CONTRIBUTIONS

SS: Field work, lab work, data preparation and analysis, conception, design and drafting manuscript; KK: Lab work, analysis, conception, design and drafting manuscript; NS: Field work, lab analysis, data preparation, logistics arrangement; RCP: Conceptualization, supervision, manuscript review and editing; KS: Conceptualization, supervision, manuscript review and final approval.

CONFLICT OF INTEREST

The authors declare no conflict of interests.

DATA AVAILABILITY STATEMENT

The data that supports the findings of this study are available from the corresponding author, upon reasonable request.

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