Journal Homepage: -www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR)

Article DOI: 10.21474/IJAR01/23242
DOI URL: http://dx.doi.org/10.21474/IJAR01/23242

RESEARCH ARTICLE

FRESHWATER FISH DIVERSITY IN AND AROUND VADODARA DISTRICT: A FOCUS ON SMALL INDIGENOUS SPECIES

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Manuscript Info

Manuscript History
Received: 10 February 2026
Final Accepted: 12 March 2026
Published: April 2026

Key words: -
Cyprinidae, Ichthyofaunal diversity, Small Indigenous Fish species (SIF)

Abstract

The present study aimed to document fish diversity in freshwater ecosystems located in and around the Vadodara district, from October 2020 to June 2023. The study specifically examines ichthyofaunal composition in freshwater lakes and reports.A total of 31 fish species were recorded, belonging to 10 orders, 16 families, and 29 genera. The assemblage was dominated by members of the Cyprinidae, contributing the highest number of species, followed by Ambassidae, while several other families such as Xenocyprididae, Bagridae, Siluridae, and Cichlid ae showed moderate representation, and the remaining families were represented by single species. Conservation assessment based on IUCN categories revealed that most species fall under the Least Concern category, with a smaller proportion classified as Near Threatened and Vulnerable, along with one Data Deficient species and a few species that have not yet been evaluated. This study provides an updated and site-specific assessment of freshwater fish diversity in the Vadodara district, building upon earlier studies conducted in Gujarat. These findi ngs contribute valuable baseline information for biodiversity conservati on, sustainable fisheries management, aquaculture development, and enhancement of nutritional security and livelihood opportunities for local communities.

Introduction: -

India is recognized as one of the world's important regions for freshwater fish diversity, with a high degree of endemism contributing significantly to global biodiversity. Understanding fish communities is essential for effective ecosystem management and the sustainable use of aquatic resources (Mogalekar *et al*., 2017; Sarma *et al*., 2017). Freshwater bodies, particularly lakes, support diverse fish assemblages that play a crucial role in inland fisheries and local economies. Their proper management depends on detailed knowledge of species composition, distribution, and availability (Goswami & Mankodi, 2010). In addition to their economic value, fishes serve as reliable indicators of environmental health and provide an important source of protein, micronutrients, and livelihood support for rural populations (Niraj, 2012; Bera *et al*., 2014; Delgado, 2003). As a megadiverse country (Nelson *et al*., 2016), India is home to more than 3,200 fish species, including around 800 freshwater species (Froese & Pauly, 2022; Gopi

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&Mishra, 2015; Bhattacharya *et al*., 2020). Numerous studies have documented Ichthyofaunal diversity across different aquatic systems in the country, highlighting regional variations in species composition (Jhingran et al., 1969; Rema Devi, 1996; Jayaram, 1999; Vijayalaxmi et al., 2010; Murugan & Prabaharan, 2012; Silambarasan & Senthilkumaar, 2014).

Gujarat, located along the western coast of India, is rich in fishery resources. However, research on freshwater fish diversity in the state remains relatively limited, as greater emphasis has traditionally been placed on marine fisheries (Sharma *et al*., 2016; Sarma *et al*., 2017). As a result, available information on freshwater fish diversity is fragmented and varies across studies (Hoagland, 1996). Previous investigations have reported differing levels of species diversity from various parts of the state (Sen & Banerjee, 2000; Devi & Indra, 2012; Dholakia, 2004; Goswami & Mankodi, 2010; Gohil & Mankodi, 2010; Banyal *et al*., 2019). Small Indigenous Fish (SIF) species, generally less than 25–30 cm in length, are widely distributed across freshwater habitats and are recognized for their high nutritional value. They play an important role in food and nutritional security, particularly for rural communities (Sarkar & Lakra, 2010; Mohanty *et al*., 2013). Overall, fish diversity is a key indicator of ecosystem health and serves as an important parameter for environmental assessment and conservation planning (Hamzah 2007).

Methodology: -

The study area comprised freshwater resources within Vadodara and its surrounding regions in Gujarat. Vadodara district (Fig. 1) is located in the central part of Gujarat, between 21°30′ to 22°30′ N latitude and 72°45′ to 74°30′ E longitude, covering an area of approximately 7,548.50 km² (Vadodara District Report, 2001).

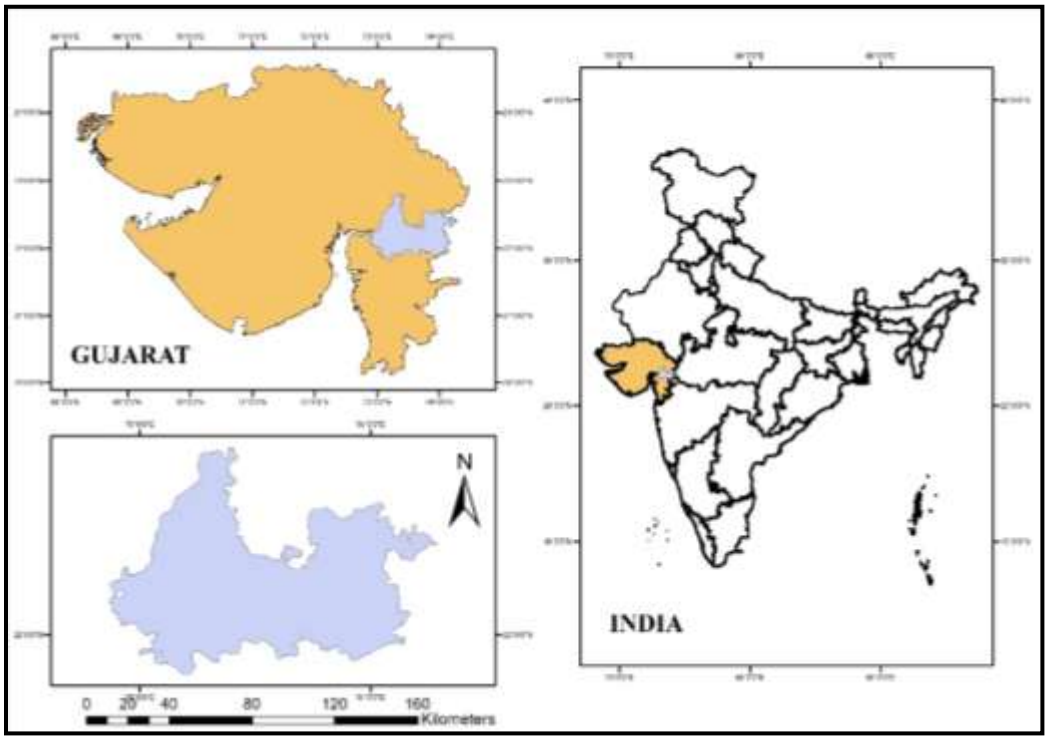

Fig. 1. Map of the study area

Fish sampling was carried out from multiple freshwater ponds distributed across Vadodara district and nearby peri-urban areas. These ponds were selected to represent a range of ecological conditions, including differences in size, depth, water quality, vegetation cover, and levels of anthropogenic influence. Both permanent and seasonal water bodies were included to ensure broader ecological representation.

Fig. 2. Illustrates the netting activity

Sampling was conducted at regular intervals over a one-year period to account for seasonal variation in fish diversity. Standardized fishing methods such as cast nets, gill nets, and hand nets were used across all sites, with comparable effort maintained at each location (approximately 2–3 hours of active sampling per site per visit). Efforts were made to minimize sampling bias by applying uniform sampling effort and standardized fishing techniques across all sites. This helped ensure consistency and comparability of data across sites and sampling periods. Fish samples were collected through systematic fishing activities to assess species diversity and relative abundance. For each species encountered, three individuals were collected to ensure accurate identification. Preliminary identification was performed in the field using standard taxonomic keys and identification guides, followed by detailed examination in the laboratory. Among the collected specimens, one individual per species was preserved in 10% formalin for morphological studies, while the remaining two individuals were stored at −20 °C for further molecular analysis. Detailed taxonomic identification was carried out using standard reference works, including those by Francis Day (1958), K. C. Jayaram (1999), and Rainer Froese & Daniel Pauly (2022).

To assess relative abundance, a semi-quantitative approach based on frequency of occurrence across sampling events was used. Species were categorized as:
Rare (+): recorded in less than 25% of sampling events
Common (++): recorded in 25–75% of sampling events
Abundant (+++): recorded in more than 75% of sampling events
This approach provided a consistent and more objective basis for abundance classification across all sites. All identified species were preserved and catalogued for future reference.

Result: -

The present study is based on a primary survey of commercially important freshwater lake fisheries in the Vadodara district. Although several studies have reported fish diversity from different parts of Gujarat, comprehensive and site-specific documentation for this region remains limited. All recorded species were identified using standard taxonomic keys, and their scientific names, common names, taxonomic classification, and IUCN conservation status are presented in Table 1.

Table 1. List of freshwater fishes with their order, family, scientific name, common name, IUCN status and level of abundance(+ = Present, ++ = Common, +++ = Abundant, - = Rare; VU- Vulnerable; LC- Least concern; DD-Data Deficit; NE- Not evaluated, NT-Near threaten)

SN	Family	Scientific Name	Common Name	IUCN Status	Level of Abundance
Order: Cypriniformes					
1.	Cyprinidae	*Catla catla* (Hamilton, 1822)	Catla	LC	+++
2.		*Labeo rohita* (Hamilton, 1822)	Rohu	LC	+++

3.		*Cirrhinus mrigala* (Hamilton, 1822)	Mrigal carp	LC	+++
4.		*Hypophthalmichthys molitrix* (Valenciennes, 1844)	Silver carp	NE	++
5.		*Barbonymus gonionotus* (Bleeker, 1849)	Silver barb	LC	++
6.		*Puntius sophore* (Hamilton, 1822)	Pool barb	LC	+++
7.		*Osteobrama cotio* (Hamilton, 1822)	-	LC	+++
8.		*Vimba vimba* (Linnaeus, 1758)	Vimba bream	LC	+++
9.		*Tor tor* (Hamilton, 1822)	Tor barb	DD	-
10.		*Pethia ticto* (Hamilton, 1822)	Ticto barb	LC	-
11.	Danionidae	*Rasbora daniconius* (Hamilton, 1822)	Slender rasbora	LC	+
12.	Leuciscidae	*Alburnus alburnus* (Linnaeus, 1758)	Bleak	LC	++
13.	Xenocyprididae	*Ctenopharyngodon idella* (Valenciennes, 1844)	Grass carp	NE	+
14.		*Culter alburnus* (Basilewsky, 185)	-	NE	++
Order: Siluriformes					
15.	Bagridae	*Mystus cavasius* (Hamilton, 1822)	Gangetic mystus	LC	-
16.		*Sperata seenghala* (Sykes, 1839)	Giant river-catfish	LC	+
17.	Siluridae	*Wallago attu* (Bloch and Schneider, 1801)	Wallago	VU	+
18.		*Ompok bimaculatus* (Bloch, 1794)	Butter catfish	NT	+++
19.	Pangasiidae	*Pangasius pangasius* (Hamilton, 1822)	Pangus catfish	LC	++
Order: Cichliformes					
20.	Cichlidae	*Oreochromis mossambicus* (Peters, 1852)	Mozambique tilapia	VU	+++
21.		*Oreochromis niloticus* (Linnaeus, 1758)	Nile tilapia	LC	-
Order: Ovalentaria					
22.	Ambassidae	*Chanda nama* (Hamilton, 1822)	Elongate glass-perchlet	LC	+++
23.		*Parambassis ranga* (Hamilton, 1822)	Indian glassy fish	LC	+++
24.		*Parambassis lala* (Hamilton, 1822)	Highfin glassy perchlet	NT	-
Order: Anabantiformes					
25.	Channidae	*Channa striata* (Bloch, 1793)	Striped snakehead	LC	+++
26.	Osphronemidae	*Trichogaster lalius* (Hamilton, 1822)	Dwarf gourami	LC	-
Order: Gobiiformes					
27.	Gobiidae	*Glossogobius giuris* (Hamilton, 1822)	Tank goby	LC	+

Order: Beloniformes					
28.	Belonidae	*Xenentodon cancila* (Hamilton, 1822)	Freshwater garfish	LC	+++
Order: Synbranchiformes					
29.	Mastacembeleidae	*Macrognathus aculeatus* (Bloch, 1786)	Lesser spiny eel	NE	++
Order: Osteoglossiformes					
30.	Notopteridae	*Notopterus notopterus* (Pallas, 1769)	Bronze featherback	LC	++
Order: Characiformes					
31.	Serrasalmidae	*Piaractus brachypomus* (Cuvier, 1818)	Pirapitinga (Paca)	NE	+

A total of 31 fish species belonging to 10 orders, 16 families, and 29 genera were recorded. The family Cyprinidae was the most dominant, contributing the highest number of species, a pattern widely reported from Indian freshwater ecosystems (Jhingran, 1991; Talwar & Jhingran, 1991; Battul *et al.,* 2007). This was followed by the family Ambassidae, while families such as Xenocyprididae, Bagridae, Siluridae, and Cichlidae showed moderate representation. The remaining families were represented by single species, indicating a relatively diverse but uneven distribution across taxonomic groups. All species identifications were carefully re-verified using updated taxonomic references and Fish Base (Froese & Pauly, 2022), and doubtful records were critically re-examined to ensure accuracy. The study recorded only bony fishes (Class: Osteichthyes), highlighting their dominance in these freshwater ecosystems.

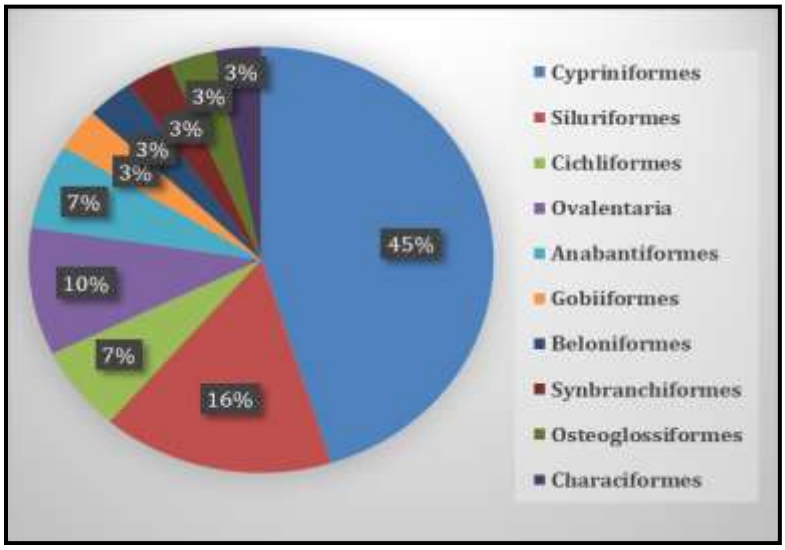

Fig. 3. Order wise percentage distribution of the species

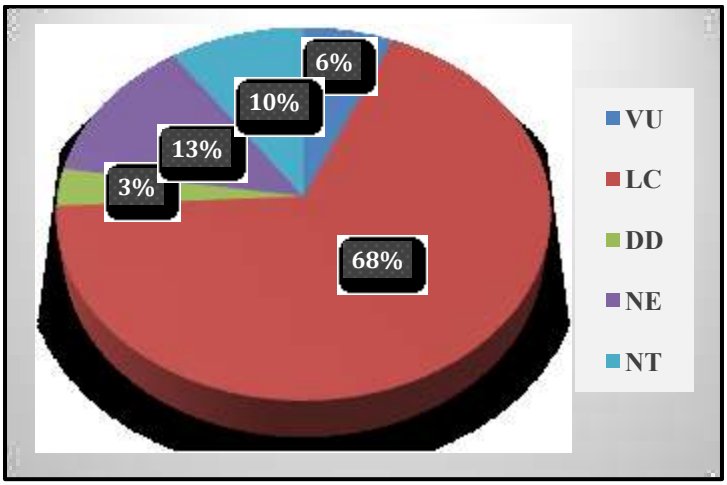

Fig. 4. Categorization of available fish species depending on IUCN-threatened status (Updated 2021)

Analysis of species distribution revealed that 68% of the recorded species fall under the Least Concern category, followed by 13% Not Evaluated, 10% Near Threatened, 6% Vulnerable, and 3% Data Deficient (IUCN, 2022). The dominance of Cypriniformes, particularly Cyprinidae, reflects both ecological suitability and their economic importance in aquaculture systems. However, conservation status was interpreted cautiously for introduced and cultured species, as global assessments may not accurately reflect their local ecological roles. The presence of species such as *Hypophthalmichthys molitrix* and *Ctenopharyngodon idella* further indicates the influence of aquaculture practices in shaping species composition in the study area (FAO, 2020).

Table 2. List of Small Indigenous Fish species (SIF) with their order, family, scientific name

S. N.	Order	Family	Species
1.	Cypriniformes	Cyprinidae	*Puntius sophore* (Hamilton, 1822)
2.			*Osteobrama cotio* (Hamilton, 1822)
3.			*Pethia ticto* (Hamilton, 1822)
4.		Danionidae	*Rasbora daniconius* (Hamilton, 1822)
5.		Leuciscidae	*Alburnus alburnus* (Linnaeus, 1758)
6.		Xenocyprididae	*Culter alburnus* (Basilewsky, 185)
7.	Siluriformes	Bagridae	*Mystus cavasius* (Hamilton, 1822)
8.		Siluridae	*Ompok bimaculatus* (Bloch, 1794)
9.	Ovalentaria	Ambassidae	*Chanda nama* (Hamilton, 1822)
10.			*Parambassis ranga* (Hamilton, 1822)
11.			*Parambassis lala* (Hamilton, 1822)
12.	Anabantiformes	Osphronemidae	*Trichogaster lalius* (Hamilton, 1822)
13.	Gobiiformes	Gobiidae	*Glossogobius giuris* (Hamilton, 1822)
14.	Osteoglossiformes	Notopteridae	*Notopterus notopterus* (Pallas, 1769)

Wild fish species belonging to families such as Bagridae, Siluridae, Cichlidae, Channidae, Belonidae, Mastacembelidae, and Serrasalmidae were also recorded, reflecting the ecological diversity of these water bodies. The Small Indigenous Fish (SIF) species documented in this study (Table 2) were largely dominated by members of

Cypriniformes, followed by other orders such as Siluriformes, Ovalentaria, Anabantiformes, Gobiiformes, and Osteoglossiformes. Although often overlooked, SIF species are nutritionally rich and play an important role in local food security. Their high protein content, essential fatty acids, and micronutrients, along with the advantage of whole consumption, make them valuable for human nutrition (Sarkar & Lakra, 2010; Mohanty *et al.,* 2013; Thilsted, 2012). In addition, these species contribute significantly to the livelihoods of local communities (FAO, 2014).

Discussion: -

Fish diversity is fundamental to ecosystem stability and supports local livelihoods, making its conservation and sustainable management essential (Goswami & Mankodi, 2010; Gohil & Mankodi, 2010). The present study from Vadodara shows that Cypriniformes dominate the fish community, followed by Siluriformes and Ovalentaria. Similar dominance of cyprinids has been widely reported from freshwater systems across Gujarat and India, largely due to their ecological adaptability and feeding flexibility (Jhingran, 1991; Talwar & Jhingran, 1991; Goswami & Mankodi, 2010). However, the relatively lower representation of Siluriformes compared to riverine studies suggests the influence of lentic, pond-based habitats in shaping species composition. The species richness observed is broadly consistent with earlier regional assessments (Sen & Banerjee, 2000; Devi & Indra, 2012), though variations may reflect differences in habitat types, sampling effort, and seasonal coverage. Inclusion of both permanent and seasonal ponds in the present study likely enhanced species detection, particularly for taxa adapted to fluctuating environments.

The presence of Small Indigenous Fish (SIF) species such as *Puntius sophore, Osteobrama cotio*, and *Rasboradaniconius* supports earlier findings that SIFs are well adapted to small water bodies and contribute significantly to nutritional security (Sarkar & Lakra, 2010; Mohanty *et al*., 2013). Their comparatively lower abundance, however, may indicate competitive pressure from Indian major carps and introduced species, as well as habitat alterations driven by aquaculture practices. The occurrence of introduced species such as *Hypophthalmichthys molitrix* and *Oreochromis niloticus* further reflects the growing influence of stocking and culture activities. Similar patterns have been documented in other Indian freshwater systems, where exotic species can alter community structure and impact native biodiversity (FAO, 2020; Singh & Lakra, 2011). Although most recorded species fall under lower-risk conservation categories, the presence of Vulnerable and Near Threatened taxa highlights the need for localized conservation planning. It is also important to interpret conservation status cautiously for introduced species, as global assessments may not accurately represent local ecological impacts.Since the study is based primarily on morphological identification, future research incorporating molecular tools such as DNA barcoding is recommended to improve taxonomic resolution and reduce identification errors (Ward *et al*., 2005).

Conclusion: -

The present study provides an updated assessment of freshwater fish diversity in pond ecosystems of the Vadodara district, highlighting the dominance of Cypriniformes and the strong influence of aquaculture practices on species composition. While the widespread occurrence of Indian major carps and introduced species reflects the economic orientation of these water bodies, the presence of Small Indigenous Fish (SIF) species emphasizes their ecological resilience and nutritional importance. However, the comparatively lower abundance of SIFs suggests the need for targeted conservation and management strategies, including habitat protection, regulated stocking practices, and the promotion of SIF-based culture systems. Strengthening such approaches could enhance both biodiversity conservation and nutritional security at the local level.Future studies should focus on long-term monitoring, inclusion of diverse habitat types (both lentic and lotic systems), and integration of molecular identification techniques to improve taxonomic precision. Such efforts will provide a more robust foundation for sustainable fisheries management and biodiversity conservation in the region.

Declarations: -

Funding statement: -
The study was financially supported by the Government of Gujarat through the Scheme of Developing High Quality Research (SHODH) Scholarship.

Conflict of interest: -
The authors declare that there is no conflict of interest regarding the publication of this paper.

Authors' Contribution: -
GS: Data collection and Manuscript preparation; KS: editing; PM: Research guidance and supervision.

Data Availability: -
The above result is a part of doctoral research work. Hence the data is available with the corresponding author and will be presented as and when required.

AI usage Statement: -
Generative AI tools were used solely for language editing, including grammar correction, paraphrasing, and improving clarity. No AI was used for data analysis, interpretation, or generation of scientific content.

Acknowledgement: -

The authors express their sincere gratitude to the Head of the Department of Zoology, Faculty of Science, The Maharaja Sayajirao University of Baroda, for granting the necessary permissions and providing laboratory facilities throughout the study. The authors also extend their appreciation to the local fishermen for their valuable cooperation during the field surveys.

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