**Freshwater faunal diversity conservation in India and their relationship with plants: Status, challenges, and future directions**

**Abstract**

Freshwater ecosystems in India harbor a rich diversity of faunal species, which play a crucial role in maintaining ecosystem balance and providing ecosystem services. However, these ecosystems face numerous threats, including habitat destruction, pollution, invasive species, and climate change. This study reviews the status of freshwater faunal diversity conservation in India, with a focus on their relationship with plants. Data from various sources, including published literature, government reports, and field observations, were analyzed. It was found that India's freshwater faunal diversity is declining rapidly, with many species being threatened with extinction. Several challenges to conservation efforts were identified, including inadequate policy frameworks, insufficient funding, and a lack of public awareness. The importance of plant-fauna interactions in freshwater ecosystems was also highlighted, and it was emphasized that conserving these interactions is essential for maintaining ecosystem health. Based on the findings, several future directions for conservation efforts are recommended, including the development of effective policy frameworks, an increase in funding for conservation initiatives, and the implementation of education and outreach programs to raise public awareness about the importance of conserving freshwater faunal diversity.

**Keywords**: Conservation challenges, ecosystem health, freshwater biodiversity, faunal conservation, plant-aquatic fauna interactions

**Introduction**

Freshwater ecosystems make up only around 0.8% of the Earth's surface. India, recognized as one of the 17 megadiverse nations globally, is home to roughly 7.5% of the world's total faunal diversity. Freshwater ecosystems such as rivers, lakes, wetlands, and groundwater occupy only a small portion of the Earth's surface, yet they support an exceptionally rich diversity of life. To adapt to their unique environments which are frequently defined by low oxygen, varying nutrient levels, fluctuating pH, and redox conditions the freshwater and wetland plants have developed a variety of specific features. These ecosystems deliver vital services, including water purification, flood regulation, and nutrient cycling, all of which are essential for human well-being and economic progress. The diverse range of freshwater fauna, including fish, amphibians, reptiles, birds, and mammals, plays a key role in sustaining the health and stability of these ecosystems. The loss of freshwater faunal diversity can have cascading effects on ecosystem function, leading to reduced water quality, decreased fisheries, and loss of ecosystem services (Chandra et al., 2017; Sharma 2018; Ghosh et al., 2021; Iversen et al., 2022). The conservation of freshwater faunal diversity in India has become an urgent and critical priority. India hosts a wide variety of freshwater ecosystems, such as the Ganges-Brahmaputra River system, the Western Ghats, and the lakes of the Himalayas. However, these ecosystems are under severe threat from habitat degradation, pollution, excessive water extraction, and the impacts of climate change. As a result, many freshwater species such as the iconic Ganges River dolphin and the endangered Indian rhinoceros are now facing a significant risk of extinction. The loss of freshwater faunal diversity can have significant economic, social, and cultural impacts on local communities, which depend on these ecosystems for their livelihoods (Sinha and Kannan, 2014; Devi et al., 2024). This review paper aims to provide a comprehensive overview of the status, challenges, and future directions for conserving freshwater faunal diversity in India, with a focus on plant-fauna interactions, by examining current knowledge on species distribution, abundance, and ecological roles. This review paper will also examine the major threats to freshwater faunal diversity in India such as habitat destruction, pollution, and climate change and explore future conservation directions, including the development of effective policy and legislative frameworks, community-based initiatives, and ecological restoration efforts. Focusing on the diverse freshwater ecosystems of India, including rivers, lakes, wetlands, and groundwater, the paper will highlight the faunal diversity of fish, amphibians, reptiles, birds, and mammals, as well as their ecological relationships with plants, drawing on a broad range of sources such as scientific literature, government reports, and publications from conservation organizations.

**Freshwater Ecosystems in India**

India is home to a diverse range of freshwater ecosystems, including rivers, lakes, wetlands, and groundwater. The country's vast network of rivers, which includes the Ganges, Brahmaputra, Godavari, Krishna, Narmada, Mahanadi and Indus, supports a wide range of aquatic life. India's lakes, such as the Dal Lake in Kashmir and the Chilka Lake in Odisha, Loktak lake of Manipur are also important habitats for freshwater faunal species. Wetlands, including marshes, swamps, and floodplains, cover around 4.7% of India's geographical area and provide critical habitat for many freshwater faunal species. Freshwater ecosystems in India support a rich array of faunal diversity, including crustaceans, mollusks, fish, amphibians, reptiles, birds, and mammals (Chandra et al., 2017; Mogalekar and Canciyal, 2018; Devi et al., 2024). The country's wetlands support a wide range of mammalian species, including the smooth-coated otter, and the Asian small-clawed otter. Many of these species are found only in specific regions of the country, highlighting the importance of conserving freshwater ecosystems at the local and regional levels. India’s freshwater faunal diversity is especially rich in regions like the Western Ghats, the Himalayas, and the Indo-Gangetic Plain. The Western Ghats, extending along the country's western coastline, are home to numerous endemic species of freshwater fish, amphibians, and reptiles. In the north, the Himalayan region hosts a variety of high-altitude freshwater habitats such as rivers, lakes, and wetlands that support diverse aquatic life. The Indo-Gangetic Plain, which covers much of northern and eastern India, supports a wide range of freshwater faunal species, including fish, birds, and mammals (Chandra et al., 2017; Pinder et al., 2015; Sarkar et al., 2008; Raghavan et al., 2016).

**Current Status of Freshwater Faunal Diversity in India** (Chandra et al., 2017)

**Kingdom Protista**

In India, a total of 3,510 species across six phyla have been documented, with approximately 52% being free-living and the remaining comprising parasitic forms. Current estimates indicate that around 1,600 species of free-living protozoans have been identified in the country. Specifically, freshwater ecosystems in India are home to 106 species of ciliates, classified under 58 genera and 36 families.

**Phylum Porifera**

Poriferans, commonly referred to as sponges, include more than 219 freshwater species worldwide, distributed across 45 genera in six families. In India, 31 freshwater sponge species have been recorded, all belonging to a single family and spread across 11 genera.

**Phylum Cnidaria**

Cnidarians, a diverse group of animals that includes medusae, anemones, corals, and polyps, are highly successful in marine environments, though a few species also inhabit freshwater systems. In India, freshwater habitats are home to 9 species of cnidarians, classified under 6 genera and 4 families.

**Phylum Platyhelminthes**

In India, 116 species of cestode parasites have been recorded infecting freshwater fishes, affecting a total of 46 fish species across 22 genera, 10 families, and 5 orders.

**Phylum Rotifera**

Rotifers are essential components of many freshwater ecosystems and are widespread, inhabiting nearly all types of freshwater environments. To date, 419 valid species of rotifers have been documented in India’s freshwater habitats, representing 67 genera and 25 families.

**Phylum Nematomorpha**

Horsehair worms, a fascinating group of nematode-like organisms, have free-living adult stages that inhabit freshwater, while their larvae are parasitic, primarily on arthropods. Globally, around 356 freshwater species have been identified, whereas in India, only 20 species across 5 genera have been reported.

**Phylum Gastrotricha**

Gastrotrichs are one of the most abundant yet least studied groups of freshwater invertebrates. Worldwide, 324 species have been identified from freshwater environments, while in India, 24 species across six genera have been documented.

**Phylum Nematoda**

Nematodes are unsegmented, thread-like pseudocoelomates and rank among the most diverse metazoan groups found in aquatic sediments. In India, 412 species of freshwater nematodes have been recorded, spanning 119 genera and 57 families.

**Phylum Acanthocephala**

Acanthocephalans, commonly known as thorny-headed worms, are a significant group of internal parasites. Around 1,150 species are classified into four orders: Neoechinorhynchidea, Aporhynchidea, Echinorhynchidea, and Gigantorhynchidea. In India, 140 species of these parasites have been reported in fishes, showing a notable level of regional endemism.

**Phylum Annelida**

Polychaeta: Polychaetes, commonly known as ‘brittle worms’, are a non-monophyletic group within the annelids, primarily found in sandy and muddy substrates along seashores and in marine environments. Some marine species have transitioned into and adapted to freshwater habitats. Worldwide, 168 species of freshwater polychaetes have been identified. In India, current studies report 41 species across 25 genera and 15 families in freshwater ecosystems.

**Oligochaeta:** Oligochaetes are elongated, segmented annelids without appendages, typically found either burrowing in soil or inhabiting aquatic environments. Globally, around 1,700 oligochaete species have been recorded in freshwater habitats. In India, 72 freshwater species have been identified, classified under 20 genera within a single family.

**Hirudinea:** Freshwater leeches (Hirudinea) are primarily predatory or parasitic annelids, equipped with terminal suckers used for attachment, movement, and feeding. Globally, around 700 leech species have been identified, with 482 occurring in freshwater habitats. In India, 70 species have been documented, of which 55 species belonging to 25 genera and 5 families are found in freshwater ecosystems, and 36 of these are endemic.

**Phylum Arthropoda**

**Subphylum Crustacea**

Crustaceans, an important group within Arthropoda, comprise organisms such as lobsters, barnacles, krill, crabs, crayfish, shrimp, ostracods, and copepods. Globally, more than 73,141 species have been identified. In India's freshwater habitats, four classes are found: Branchiopoda, Ostracoda, Maxillopoda, and Malacostraca. Out of 11,990 freshwater crustacean species worldwide, approximately 822 are recorded from India.

**Class Arachinida**: The class Arachnida, which includes spiders and mites, primarily occupies terrestrial habitats, though some species are found in freshwater environments. Globally, 26 spider species from 12 genera and 9 families have been reported in freshwater, while in India, 6 species belonging to 6 genera and 3 families have been documented.

**Class Insecta**: Insects are the most successful and diverse group of animals, particularly within freshwater ecosystems. An estimated 4,842 insect species are found in India’s inland wetlands.

**Phylum Mollusca**

Freshwater molluscs serve as key components in the trophic dynamics of freshwater ecosystems. Globally, their diversity is estimated at around 5,000 species. In India, freshwater habitats are home to 217 documented species, including 150 species of gastropods and 67 species of bivalves.

**Phylum Bryozoa**

Bryozoa, also referred to as polyzoa, ectoprocta, or moss animals, are colonial organisms that predominantly occupy marine habitats. While around 5,000 species are found in marine environments, freshwater ecosystems worldwide are known to host 94 species across 24 genera and 10 families. In India, the freshwater bryozoan fauna includes 22 species belonging to 13 genera and 6 families.

**Phylum Chordata**

**Class Pisces:** India's freshwater fish diversity is substantial, comprising 1,027 species that include primary, secondary, and alien types. Among them, 858 primary freshwater species span 167 genera, 40 families, and 12 orders. Furthermore, 137 secondary species, known to frequently inhabit river systems, are also present. In addition, 32 alien species have become established in Indian freshwater bodies, with 16 identified as potentially invasive.

**Class Amphibia:** Amphibians belong to three living orders: Gymnophiona (eg. caecilians), Caudata (eg. salamanders), and Anura (eg. frogs), with 7,604 species globally. India hosts 386 species which is about 5% of the world total across 59 genera and 15 families. Around 275 of these occur in freshwater habitats.

**Class Reptilia:** Reptiles, the earliest terrestrial poikilothermic amniote vertebrates, inhabit all environments except extreme cold regions. India records over 570 reptile species, including 3 crocodiles, 33 testudines, 234 lizards, and 296 snakes. Among these, 46 species are linked to freshwater habitats, consisting of one species each from Crocodylia and Gavialidae, 21 testudines, two monitor lizards, one skink, and 21 snakes.

**Class Aves:** Birds (Aves) inhabit all continents and environments, from deserts to oceans. Of the 10,000 described species, about 5% (560 species) rely on freshwater habitats for at least one life-history trait. In India, 243 bird species, including wetland-dependent ones, have been recorded from wetlands.

**Class Mammalia:** There are approximately 5,500 mammal species worldwide, classified into 29 orders and 154 families. Among them, 124 species from 11 orders are freshwater mammals found across all continents except Antarctica. In India, only six of these species are present: European otter, Oriental small-clawed otter, Smooth-coated otter, South Asian River dolphin, elegant water-shrew, and Himalayan water-shrew.

**Plant-Fauna Interactions in Freshwater Ecosystems**

Plant-fauna interactions play a crucial role in maintaining the health and resilience of freshwater ecosystems. Plants provide habitat, food, and shelter for faunal species, while faunal species help to regulate plant growth, disperse seeds, and maintain nutrient cycles (Rout and Kumar 2023). These interactions play a crucial role in shaping the structure and functioning of freshwater ecosystems, impacting factors such as water quality, sediment dynamics, and primary productivity. For instance, aquatic plants contribute by stabilizing sediments, minimizing water turbulence, and offering shelter and habitat for fish and invertebrates. (Hubendick 1962; Shanthakumar and Padmakumar 2023). There are several types of plant-fauna interactions in freshwater ecosystems, including herbivory, predation, symbiosis, and commensalism. Herbivory takes place when animal species consume plant matter, for example, fish feeding on aquatic macrophytes. Predation, on the other hand, involves animals preying on other animal species linked to plants, such as fish-eating insects that inhabit aquatic vegetation (Khyriem et al., 2024). Symbiosis occurs when plants and faunal species live together in a mutually beneficial relationship, such as Coral-algal symbiosis in freshwater ecosystems (Reddy 2014). Commensalism refers to an interaction where one species benefit while the other remains unaffected, such as fish using aquatic plants for shelter. Freshwater ecosystems in India display a diverse array of interactions between plants and animal species. For example, the lotus plant (*Nelumbo nucifera*) provides habitat and food for several faunal species, including fish, frogs, and insects. The water hyacinth (*Eichhornia crassipes*) provides shelter and breeding grounds for several fish species, including the Hump-backed mahseer (*Tor remadevii*) (Pinder et al., 2015; Jadhav and Patil 2024; Devi et al., 2025). Indian freshwater ecosystems also harbor various symbiotic relationships, such as those between freshwater sponges and their associated fauna, including fish, crustaceans, and insects. These interactions are essential for sustaining the health and stability of these ecosystems (Sarkar et al., 2008). Freshwater ecosystems offer essential services to humans, including supplying drinking water, controlling floods, regulating climate, and supporting food production. Today, aquatic ecosystems significantly contribute to the wellness industry through tourism and recreation, as natural water bodies such as lakes and backwaters especially those in coastal plains and mountainous regions are recognized as key tourist attractions for their scenic beauty (Chandra et al., 2017).

**Status of Freshwater Faunal Diversity Conservation in India**

In recent years, efforts to conserve freshwater faunal diversity in India have intensified, with both government and non-governmental organizations (NGOs) implementing various initiatives to safeguard freshwater ecosystems. The Indian government has also designated numerous protected areas, such as national parks and wildlife sanctuaries, to support the conservation of freshwater species. For example, the Ganges River Dolphin Sanctuary in Uttar Pradesh and the Chilka Lake Wildlife Sanctuary in Odisha are two protected areas that provide habitat for several endangered freshwater faunal species. Additionally, several NGOs, such as the World Wildlife Fund (WWF) and the Wildlife Conservation Society (WCS), are working in collaboration with the government to conserve freshwater faunal diversity in India (Chandra et al., 2017; Chandra et al., 2018). There are several success stories in freshwater faunal diversity conservation in India. For example, the conservation of the Ganges River dolphin (*Platanista gangeticus*) is a success story, with the population of this endangered species increasing in recent years due to conservation efforts. Another success story is the conservation of the Hump-backed mahseer (*Tor remadevii*), a large freshwater fish species that is found in the Himalayan rivers. The government and NGOs have launched several conservation initiatives, including habitat restoration and fish sanctuaries, to protect this species (NPCA 2019). Several community-based conservation programs have also been initiated in India, actively engaging local communities in efforts to protect freshwater faunal diversity. Despite some successful efforts, freshwater faunal diversity conservation in India faces several challenges and gaps. A key issue is the limited awareness and understanding among local communities regarding the importance of conserving freshwater biodiversity. Moreover, there is an absence of strong policy and legal frameworks to effectively protect freshwater ecosystems and their fauna. Habitat destruction and degradation, pollution, and over-fishing are also major threats to freshwater faunal diversity in India. Additionally, increased research and monitoring of freshwater faunal diversity in India are essential, along with the formulation of effective conservation strategies and action plans to safeguard freshwater ecosystems and their biodiversity (Chandra et al., 2017).

**Challenges to Freshwater Faunal Diversity Conservation in India**

Habitat destruction and degradation pose significant threats to the conservation of freshwater faunal diversity in India. Infrastructure developments such as dams, barrages, and other water projects have disrupted natural river flows and damaged habitats. Moreover, activities like sand and gravel extraction from rivers and streams have further degraded habitats and reduced biodiversity. The transformation of wetlands and floodplains into agricultural fields, urban settlements, and other human-dominated areas has also resulted in habitat loss and fragmentation. Pollution is another significant challenge to freshwater faunal diversity conservation in India (NPCA 2019). Agricultural pollution, particularly from pesticides and fertilizers, has contaminated freshwater ecosystems, contributing to a decline in faunal populations (Hong et al., 2020). Industrial pollution, caused by the release of effluents from factories and power plants, has severely harmed freshwater ecosystems. Engineered nanomaterials present a serious risk to aquatic organisms and are expected to make managing health threats to freshwater biodiversity even more difficult in the coming years. A significant and growing worldwide concern is the high levels of micro- and nanoplastic pollution and its detrimental impacts on ecosystems, particularly freshwater biodiversity. The epidermis, gills, and even the lymphatic system of freshwater creatures can all be penetrated by minute microplastic particles because of their extraordinary small size.



(Photo source from internet)

**Plate 1:** Challenges to Freshwater Faunal Diversity Conservation in India

This issue is worsened by domestic pollution, such as sewage and waste disposal. The resulting contamination has led to declining faunal populations, reduced biodiversity, and the deterioration of ecosystem services. Additionally, invasive species pose a significant threat to freshwater faunal diversity in India (Hong et al., 2020; Ghosh et al., 2021; Ahmed et al., 2022; Devi et al., 2024). Introduced non-native species like the Nile tilapia and African catfish have disrupted Indian freshwater ecosystems by displacing native species and reducing biodiversity. These invasive species often outcompete native fauna for food and habitat, resulting in population declines of native species. They can also introduce new diseases and parasites, further threatening native species (Ghosh et al., 2021). Climate change poses a major threat to the conservation of freshwater faunal diversity in India. Variations in temperature and rainfall patterns are affecting the distribution and population dynamics of many freshwater species. In response to these environmental changes, numerous species are moving toward higher altitudes or different latitudinal zones. Additionally, climate change is impacting the timing of key seasonal activities like migration and breeding, thereby disturbing the natural life cycles of freshwater fauna. Alongside this, the excessive exploitation of natural resources remains a critical issue hindering efforts to preserve freshwater biodiversity in the country. Overfishing and harmful fishing techniques have resulted in significant reductions in fish populations and the deterioration of freshwater habitats. Additionally, the illegal hunting and poaching of freshwater species like turtles and crocodiles have further contributed to their declining numbers (Arya 2021). The over-extraction of water from rivers and groundwater has further exacerbated the problem, leading to reduced water flows and altered ecosystem processes (Plate 1).

**Future Directions for Freshwater Faunal Diversity Conservation in India**

Effective conservation of freshwater faunal diversity in India requires a multi-pronged approach. Strengthening environmental laws and introducing freshwater-specific policies, along with inclusive and enforceable frameworks, is essential. Integrated River Basin Management (IRBM) ensures sustainable river resource use while preserving ecological balance. Community-based conservation empowers local communities through training and support, encouraging co-managed initiatives like fish sanctuaries. Ecological restoration focuses on rehabilitating degraded habitats by involving communities in planning, reconstruction, and monitoring efforts. Education and awareness programs for schools, communities, and stakeholders help build widespread support, while collaboration with media and grassroots initiatives promotes long-term engagement. Lastly, continuous research and monitoring are crucial for tracking biodiversity changes, guiding conservation strategies, and fostering cooperation among researchers and policymakers (Gadgil et al., 1993; Tharme 2003; Jha et al., 2008; Strayer and Dudgeon, 2010; Jena and Gopalakrishnan, 2012; Verbrugge et al., 2014; Bhatt et al., 2016; Geist and Hawkins, 2016; Chandra et al., 2017; Linke et al., 2022; Carangan 2023; De and Dwivedi, 2024; Marinović and Đuretanović, 2024).

Some important steps are discussed below.

**Development of Effective Policy and Legislative Frameworks**:

The development of effective policy and legislative frameworks is crucial for freshwater faunal diversity conservation in India. This can be achieved through several key measures. First, by strengthening existing laws such as the Wildlife Protection Act (1972) and the Environment Protection Act (1986) to better address freshwater biodiversity. Second, by introducing new policies specifically focused on freshwater faunal conservation. Third, by ensuring proper implementation and enforcement of these laws. Finally, by promoting public participation and stakeholder involvement in the policy-making process to support inclusive and effective conservation (De and Dwivedi, 2024; Shristi 2024; Strayer and Dudgeon 2010).

**Integrated River Basin Management (IRBM):**

Adopting a holistic approach to river management is crucial, as it considers the needs and interests of all stakeholders. IRBM supports the sustainable use of river resources while preserving ecological flow and maintaining the natural connectivity of river systems. Key actions include maintaining minimum environmental flow levels, avoiding unnecessary dam construction while ensuring fish passages, and incorporating ecological indicators in river health assessments (Tharme, 2003; Jha et al., 2008; Bhatt et al., 2016).

**Community-Based Conservation Approaches:**

Community-based conservation plays a vital role in preserving freshwater faunal diversity in India. This involves empowering local communities with training, financial aid, and technical guidance, while fostering joint management of conservation areas and supporting locally-driven initiatives. Establishing and promoting community-managed fish sanctuaries is also crucial (Gadgil et al., 1993).

**Ecological Restoration of Degraded Habitats:**

Restoring degraded habitats is vital for protecting freshwater faunal diversity in India. Key steps include selecting priority areas, involving local communities in planning, carrying out habitat rebuilding and species reintroduction, and assessing the success of restoration efforts (Geist and Hawkins, 2016).

**Education and Awareness-Raising Among Stakeholders:**

Enhancing education and awareness is essential for effective freshwater faunal diversity conservation in India. This can be achieved by designing and implementing targeted programs for local communities, schools, and key stakeholders to increase understanding of freshwater ecosystems and their importance. Collaborating with media outlets and social media platforms can help amplify conservation messages and reach wider audiences. Additionally, organizing workshops, training sessions, and conferences can build capacity, encourage knowledge-sharing, and strengthen stakeholder engagement. Supporting community-led awareness initiatives further ensures long-term commitment and grassroots involvement in conservation efforts (Carangan, 2023; Verbrugge et al., 2014).

**Research and Monitoring of Freshwater Faunal Diversity:**

Monitoring and research play a crucial role in the conservation of freshwater faunal diversity in India. Key actions include carrying out routine surveys to observe species trends, backing studies on freshwater ecology and conservation, creating robust monitoring frameworks, and fostering cooperation among scientists, conservationists, and policy-makers (Chandra et al., 2017; Linke et al., 2022).

The absence of strong policy and legislative backing poses a major obstacle to conserving freshwater faunal diversity in India. While various environmental laws and policies exist, they are often insufficient or poorly implemented. This weak regulatory framework has limited the effectiveness of conservation initiatives and permitted harmful activities to persist (Devi et al., 2024). Stronger laws and policies are urgently needed to safeguard freshwater ecosystems and faunal diversity in India. A major barrier to effective conservation is the lack of adequate funding and resources. Successful conservation requires substantial investment in manpower, equipment, and infrastructure, yet financial support is often limited and resources insufficient. This shortfall has weakened conservation outcomes and enabled harmful activities to persist. Enhancing financial and resource allocation is essential to strengthen freshwater faunal conservation efforts across the country.

**Conclusion**

This review underscores the importance of conserving freshwater faunal diversity in India, with an emphasis on plant-fauna interactions within these ecosystems. It summarizes the current status, major threats, and challenges to conservation efforts. The paper also highlights successful initiatives, including community-based conservation and habitat restoration. The findings stress the need for a holistic conservation approach that considers the interdependence of fauna, flora, and their habitats. It also emphasizes community involvement and the necessity for strong policy and legislative support to ensure effective conservation and management of freshwater ecosystems. Furthermore, the paper highlights the importance of ecological restoration of degraded habitats and the need for research and monitoring of freshwater faunal diversity to inform conservation efforts. The present study recommends several areas for future research and conservation efforts. Firstly, there is a need for further research on the ecology and conservation of freshwater faunal species in India, including their habitat requirements, population dynamics, and responses to environmental change. Secondly, there is a need for more effective conservation initiatives that take into account the complex relationships between faunal species, plants, and their habitats. Finally, there is a need for greater community engagement and participation in conservation efforts, as well as more effective policy and legislative frameworks to support conservation initiatives. By addressing these research and conservation gaps, we can work towards a more effective and sustainable conservation of freshwater faunal diversity in India.

**References**

Ahmed SF, Kumar PS, Kabir M, Zuhara FT, Mehjabin A, Tasannum N, Hoang AT, Kabir Z, Mofijur M. (2022). Threats, challenges and sustainable conservation strategies for freshwater biodiversity. Environmental Research. 214: 113808. Doi: 10.1016/j.envres.2022.113808

Arya S. (2021). Freshwater biodiversity and conservation challenges: A review. International Journal of Biological Innovations. 3 (1): 74-78.

Bhatt JP, Manish K, Mehta R, Pandit MK. (2016). Assessing potential conservation and restoration areas of freshwater fish fauna in the Indian river basins. Environmental Management 57: 1098-1111. Doi: 10.1007/s00267-016-0670-x

Carangan MAC. (2023). Assessing the stakeholders’ level of awareness in environmental education in coastal schools: Basis for an action plan. International Journal of Open-Access, Interdisciplinary & New Educational Discoveries of ETCOR Educational Research Center. 2(3): 355-372.

Chandra K, Gopi KC, Rao DV, Subramanian KA and Valarmathi K. (2018). Current status on freshwater faunal diversity of India - An overview. Current Status of Freshwater Biodiversity in India. Zoological Survey of India. 1-25.

Chandra K, Gopi KC, Rao DV, Valarmathi K and Alfred JRB. (2017). Current status of freshwater faunal diversity in India. Zoological Survey of India. Pp. 1-624

De K, and Dwivedi AK. (2024). Bridging gaps in the Indian freshwater biodiversity conservation through science-based and policy-backed recommendations. Ecohydrology & Hydrobiology. 24(1): 169-177. Doi: 10.1016/j.ecohyd.2023.06.013

Devi RS, Maggirwar R, Jadhao A and Kumar S. (2025). Floral Diversity of Loktak Lake, Manipur, India. Indian Forester,151(5): 430‐435.

Devi RS, Satapathy KB and Kumar S. (2024). Loktak Lake of the state Manipur: A review to educate the intellectuals and awareness on its biowealth. Educational Administration: Theory and Practice.30(5): 6936 – 6947.

Gadgil M, Berkes F, Folke C. (1993). Indigenous knowledge for biodiversity conservation. Ambio, 22(2-3), 151–156.

Geist J, and Hawkins SJ. (2016). Habitat recovery and restoration in aquatic ecosystems: current progress and future challenges. Aquatic Conservation: Marine And Freshwater Ecosystems. 26: 942-962. doi: 10.1002/aqc.2702

Ghosh R, Ozaslan C and Ray P. (2021). Invasive alien freshwater hydrophytes: Co-facilitating factors with emphasis on Indian scenario. Indian Journal of Weed Science. 53(3): 216-229.

Hong NT, Chiang KY, Bhattarai SK, Thu NTH, Tho HT and Tuyet NTA. (2020). Determination of the acute toxicity of nickel (Ni) in water environment to zebrafish at different pH levels. Journal of Science Technology and Food. 20 (2):80-92.

Hubendick B. (1962). Aspects on the diversity of the fresh-water fauna. Oikos, 13(2), 249–261. Doi: 10.2307/3565088

Iversen LL, Girón JG, Pan Y. (2022). Towards linking freshwater plants and ecosystems via functional biogeography. Aquatic Botany. 176: 103454. Doi: 10.1016/j.aquabot.2021.103454

Jadhav HS and Patil MB. (2024). Freshwater ecosystems in India: A limnological review. International Journal of Scientific Research in Engineering and Management. 37467: 1-26.

Jena J K, Gopalakrishnan A. (2012). Aquatic biodiversity management in India. Proceedings of the National Academy of Sciences, India-Section B: Biological Sciences 82(S2):363-379. Doi: 10.1007/s40011-012-0108-z

Jha R, Sharma KD, Singh VP. (2008). Critical appraisal of methods for the assessment of environmental flows and their application in two river systems of India. KSCE Journal of Civil Engineering. 12(3): 213-219 Doi: 10.1007/s12205-008-0213-y

Khyriem K, Yadav MK, Papang H, Saxena S and Kher D. (2024). Insect diversity of freshwater ecosystems in Meghalaya, Northeast of India. Uttar Pradesh Journal of Zoology. 45(19): 24-31.

Linke S, Desjonqueres C, Gifford T, Barclay L. (2022). Freshwater ecoacoustics-a new addition to the limnologists’ methods toolkit. In; Thomas Mehner, Klement Tockner (Eds). Encyclopedia of Inland Waters, Second Edition, Elsevier, pp. 657-666. Doi: 10.1016/B978-0-12-819166-8.00210-3

Marinović Z, Đuretanović S. (2024). Novel aspects in freshwater fauna conservation. Diversity. 16(11): 663. Doi: 10.3390/d16110663

Mogalekar HS and Canciyal J. (2018). Freshwater fishes of Orissa, India. Journal of Fisheries. 6(1): 587-598.

National Plan for Conservation of Aquatic Ecosystems (NPCA). (2019). Guidelines Ministry of Environment, Forest and Climate Change National River Conservation Directorate, Government of India.

Pinder AC, Raghavan R, Britton JR. (2015). The legendary hump-backed mahseer *Tor sp*. of India’s river Cauvery: an endemic fish swimming towards extinction? Endangered Species Research. 28: 11-17. Doi: 10.3354/esr00673

Raghavan R, Das S, Nameer PO, Bijukumar A and Dahanukar N. (2016). Protected areas and imperilled endemic freshwater biodiversity in the Western Ghats hotspot. Aquatic Conservation: Marine and Freshwater Ecosystems. 26 (1): 78-90.

Reddy PR. (2014). Freshwater ecosystems and biodiversity - a case study of Kolleru Lake, India: A review. The Journal of Indian Geophysical Union. 18(2): 277-288.

Rout S and Kumar S. (2023). Diversity of freshwater crabs, their importance, threats, and conservation aspects. Journal of Biodiversity and Conservation. 7(1): 1-4.

Sarkar UK, Pathak AK and Lakra WS. (2008). Conservation of freshwater fish resources of India: new approaches, assessment and challenges. Biodiversity and Conservation. 17: 2495-2511. Doi: 10.1007/s10531-008-9396-2

Shanthakumar M and Padmakumar V. (2023). Benthic macroinvertebrates in freshwater ecosystems of India: A review. International Journal of Fauna and Biological Studies. 10(6): 24-27.

Sharma V. (2018). Freshwater biodiversity in India's rivers and lakes. International Journal of Innovative Research in Engineering & Multidisciplinary Physical Sciences. 6(3): 1-6.

Shristi C (2024). The Wildlife (Protection) Act, 1972: A Comprehensive Study on Wildlife Conservation in India. Doi: 10.2139/ssrn.4848859

Sinha RK, and Kannan K. (2014). Ganges river dolphin: An overview of biology, ecology, and conservation status in India. AMBIO. 43, 1029-1046. Doi: 10.1007/s13280-014-0534-7

Strayer DL, and Dudgeon D. (2010). Freshwater biodiversity conservation: recent progress and future challenges. Journal of the North American Benthological Society. 29(1):344-358. Doi: 10.1899/08-171.1

Tharme RE. (2003). A global perspective on environmental flow assessment: Emerging trends in the development and application of environmental flow methodologies for rivers. River Research and Applications, 19: 397-441. Doi: 10.1002/rra.736

Verbrugge LNH, Leuven RSEW, Valkenburg JLCHV, and Born RJGVD. (2014). Evaluating stakeholder awareness and involvement in risk prevention of aquatic invasive plant species by a national code of conduct. Aquatic Invasions. 9(3): 369-381.