

## **A Comparative Analysis of Fish Fauna in Arunachal Pradesh and Jammu & Kashmir: Ecological Traits and Conservation Challenges.**

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### **Abstract**

The fish fauna, ecological traits, and environmental circumstances of two different Indian regions—Arunachal Pradesh and Jammu and Kashmir—are thoroughly compared in this research paper. Both regions, which are found in the Eastern and Northwestern Himalayas, respectively, are notable hotspots for biodiversity with distinctive aquatic environments. They vary, nevertheless, in terms of the variety of species, altitude, climate, river systems, and environmental stresses. The present study examines the fish diversity, ecological adaptations of various fish species, the environmental factors that impact aquatic ecosystems, and the conservation challenges that arise from human activities and climate change in these regions. The results show that the fish fauna of Arunachal Pradesh is more varied and tropical, whereas the aquatic systems of Jammu & Kashmir are typified by cold-water species with a reduced range of diversity. In order to protect the aquatic biodiversity and uphold the ecological integrity of both regions, the study emphasizes the significance of region-specific conservation strategies including the strategies for sustainable management and the role of local communities in conservation efforts.

**Keywords:** Fish fauna, Endemism, Arunachal Pradesh, Jammu & Kashmir, Biodiversity, Conservation.

### **1. Introduction**

The fish fauna of India is rich and diverse, with notable differences between various geographical regions due to the unique environmental factors affecting aquatic ecosystems (Sarkar et al., 2020). Fishes are important indicators of aquatic ecosystem health and biodiversity (Pinna et al., 2023). The regions of Arunachal Pradesh and Jammu & Kashmir, both situated in the Himalayan range, represent distinct ecological zones with unique hydrological and climatic conditions that influence their aquatic ecosystems. Arunachal Pradesh, located in the Eastern Himalayas, is characterized by its subtropical to tropical climate and vast river systems flowing through dense forests that provide habitats of diverse environmental conditions fish species (Gurumayum et al., 2016). On the other hand, Jammu & Kashmir, in the Northwestern Himalayas, features cold-water streams and rivers, fed primarily by

glacial melt and snowmelt. It shares a similar ecological setting to that of Arunachal Pradesh but with notable differences in the species composition of its aquatic systems (Scott et al., 2019).

Despite the geographic proximity of these two regions within the greater Himalayas, their fish faunas differ considerably due to variations in altitude, climate, and environmental conditions. This comparative analysis aims to examine these differences, explore the environmental pressures impacting fish diversity, and evaluate conservation challenges.

The paper begins with a geographical and climatic overview of both regions, followed by an analysis of the fish fauna diversity and species composition. Subsequently, the ecological adaptations of fish in response to environmental conditions are discussed, leading into an examination of environmental threats and conservation challenges.

## **2. Geographical and Climatic Overview**

### **2.1 Arunachal Pradesh**

Arunachal Pradesh is located in the northeastern corner of India, sharing borders with China, Bhutan, and Myanmar. It spans altitudes ranging from the lowland floodplains at 100 meters above sea level to the high peaks of the Eastern Himalayas exceeding 7,000 meters (Sharma & Shukla, 1992). This elevational gradient results in a variety of habitats, from tropical rainforests in the foothills to alpine ecosystems at higher altitudes (Nath & Dey, 2000).

Arunachal Pradesh is part of the Indo-Burma hotspot, recognised as one of the most significant biodiversity hotspots among the twenty-five global mega biodiversity hotspots (Myers et al., 2000). The state's major river systems—such as the Brahmaputra River and its tributaries, the Siang, Subansiri, and Lohit rivers—originate in the Eastern Himalayas (Rawat & Laskar, 2010). Fish species can find a wide variety of aquatic habitats in these swift-moving rivers as they meander through dense forests. The Southwest Indian monsoon, which brings intense rains from June to September, is the main factor influencing the climate in Arunachal Pradesh (Dikshit & Dikshit, 2014). This rainfall helps create large seasonal variations in river discharge and high-water flow, both of which have an impact on fish migration and breeding patterns.

### **2.2 Jammu & Kashmir**

Situated in the Northwestern Himalayas, Jammu and Kashmir is a cold-water region distinguished by glacial meltwaters, alpine lakes, and swift-moving rivers like the Jhelum, Chenab, and Indus. The climate of the area is temperate to alpine, with mild summers and frigid winters (Sehgal, 1999).

The main sectors in the state that directly depend on these water resources are agriculture, irrigation, horticulture, hydroelectricity, and tourism (Shukla & Ali, 2018). While snowmelt is the primary cause of seasonal flow variations, especially in the spring and early summer, glaciers are essential in preserving river water levels during the summer (Raina & Petr, 1999).

There are many different types of ecosystems found in Jammu and Kashmir's water bodies, including wetlands, lakes, and rivers. Two of the most well-known lakes are Wular and Dal. These aquatic habitats in Jammu & Kashmir are distinguished by low water temperatures which restrict the diversity of fish species in contrast to the subtropical conditions in Arunachal Pradesh.

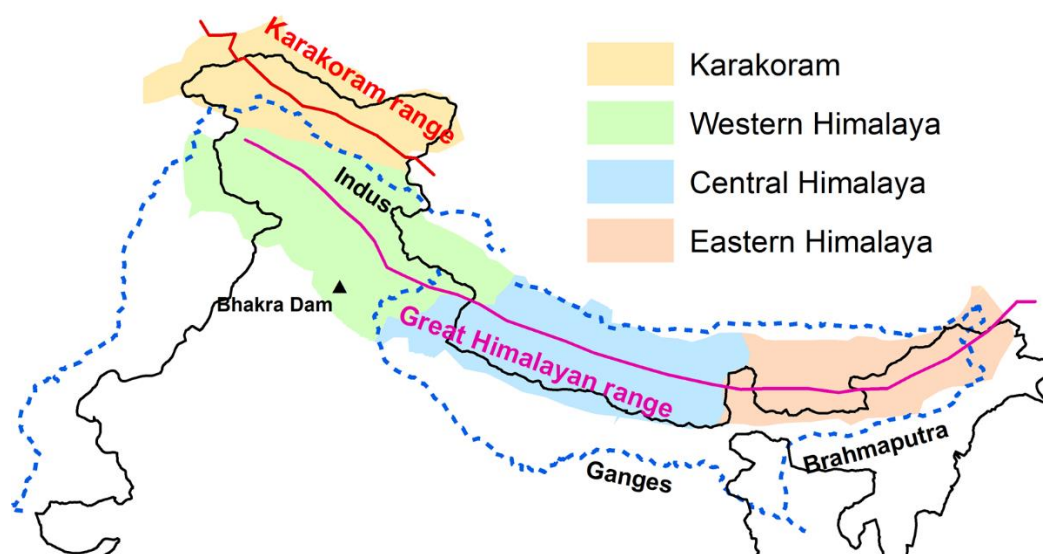


Fig. 1: Showing Divisions of Himalayas (Kulkarni et al., 2018)

### 3. Fish Fauna Diversity and Composition

#### 3.1 Fish Fauna of Arunachal Pradesh

Arunachal Pradesh boasts one of the richest fresh water fish faunas in all of India, with 259 species of fish identified from its diverse river systems (Gurumayum et al., 2016). The region's diverse topography, a broad range of habitats, and subtropical to tropical climate, which support a variety of ecological niches, are primarily responsible for the diversity of fish found in Arunachal Pradesh. Among the most common fish families are:

- **Cyprinidae:** This is the largest family of freshwater fish in Arunachal Pradesh, with genera such as *Tor*, *Neolissochilus*, *Garra*, and *Barilius* being well-represented (Bagra et al., 2009). Species such as *Tor putitora* (golden mahseer) and *Neolissochilus hexagonolepis* are iconic migratory species.

- **Sisoridae:** This family of catfishes is common in the fast-flowing hill streams of Arunachal Pradesh. *Bagarius bagarius*, a large sisorid catfish, is an apex predator in many rivers.
- **Balitoridae:** Hill stream loaches such as *Balitora* spp. and *Schistura* spp. are adapted to the fast currents and rocky substrates of the hill streams.

The abundant system of wetlands and floodplains in Arunachal Pradesh contributes significantly to the region's high fish biodiversity by offering young fish and other aquatic species vital habitats. (Goswami et al., 2012). The geographical location and altitudes ranging from lower to higher elevations creates suitable conditions for cold water fish species in Arunachal Pradesh. The abundance of rivers, streams, and lakes at different altitudes provides various aquatic environments suited to cold water fishing, with 108 species classified as prospective cold-water fish species (Gurumayum & Tamang, 2017).



Fig. 2: Siang River near Pasighat

### 3.2 Fish Fauna of Jammu & Kashmir

With only 120 species reported, the fish fauna of Jammu and Kashmir is relatively less diverse (Bhat et al., 2020). This is mostly because of the cold-water conditions that restrict the number of species that can thrive in these environments (Sehgal, 1999). The Cyprinidae family holds the greatest dominance, especially with regard to species belonging to the genus *Schizothorax*, which is widely recognized as snow trout.

- ***Schizothorax* spp.:** Native species such as *Schizothorax curvifrons* (Satter gad), *Schizothorax niger* (Ael gaad), *Schizothorax plagiostomus* (Khont), *Schizothorax esocinus* (Chirru), and *Schizothorax labiatus* (chhush) are well adapted to the cold, oxygen-rich waters of the region's

rivers and lakes. These species have specialized feeding mechanisms and body structures that enable them to graze algae from rocks in fast-moving waters (Bharti et al., 2023).

- *Oncorhynchus mykiss* (rainbow trout) and *Salmo trutta* (brown trout): Introduced during the colonial period, these non-native trout species have become established in the region and are now an important part of the fishery industry (Ganie et al., 2024). However, their introduction has also raised concerns about competition with native species.

Compared to the rich fish diversity in Arunachal Pradesh, the cold-water ecosystems in Jammu & Kashmir support fewer species but are ecologically significant due to the unique adaptations of the native fish.

## 4. Endemism

### 4.1 Endemic species of Arunachal Pradesh

The state is home to 32 endemic fish species, including *Amblyceps arunachalensis*, *Bhavana arunachalensis*, *Glyptothorax dikrongensis*, *Devario horai*, *Creteuchiloglanis kamengensis* etc (Gurumayum et al., 2016). Among the 63 fish species found in the type locality, which belong to 04 orders, 13 families, and 26 genera, 56 are found to be endemic to this region (Gurumayum et al., 2020). This indicates that the state's fish fauna is highly endemic.

### 4.2 Endemic species of Jammu & Kashmir

Although Jammu and Kashmir is well-known for having endemic fish species, especially in the Cyprinidae family, it has less fish diversity than Arunachal Pradesh, which results in fewer endemic fish species. *Schizothorax niger*, *Schizothorax esocinus*, and *Schizothorax curvifrons* are among the species that find a special home in the region's cold-water rivers (Sehgal, 1999). These species have adapted well to the region's chilly rivers. Because endemic species in this area are particularly sensitive to changes in the environment and habitat degradation, conservation efforts are essential to the survival of these species.

## 5. Ecological Adaptations and Environmental Conditions

### 5.1 Arunachal Pradesh

Arunachal Pradesh's fish species have evolved to survive in a variety of habitats, including lowland rivers and swift-moving hill streams. During the monsoon season, migratory species like the golden mahseer (*Tor putitora*) travel great distances in order to breed in the

upper reaches of rivers (Bhatt & Pandit, 2016). Changes in the temperature and flow of the water, as well as the presence of appropriate spawning grounds, cause these migrations.

The rivers in Arunachal Pradesh have different flow patterns and steep gradients, which have caused fish in the area to adapt as well. For instance, species like *Garra* spp. and *Schistura* species, possess streamlined bodies and unique mouthparts that enable them to cling to rocky substrates and consume algae and detritus, making them suited to life in swift currents (Husain, 2015).

## 5.2 Jammu & Kashmir

Jammu and Kashmir's fish fauna has adapted to live in cold-water environments with high oxygen content, chilly temperatures, and swift-moving streams. Native species like *Schizothorax* spp. are well adapted to the nutrient-poor conditions of glacial meltwater rivers. These species demonstrate key adaptations like allometric growth patterns, which suggest they can thrive even in environments with limited nutrient availability (Qadri et al., 2016).

The natural dynamics of Jammu and Kashmir's aquatic ecosystems have also changed as a result of the introduction of non-native trout species. Predatory species like *Salmo trutta* (brown trout) and *Oncorhynchus mykiss* (rainbow trout) have created new trophic interactions in the area and may have an impact on native species by competing with them for food and habitat (Zutshi and Gopal, 2000; Farooq, 2024).



Fig.3: Trout fish farming project, Kokernag (Ganie, et al., 2024)

## 6. Environmental Threats and Conservation Challenges

### 6.1 Arunachal Pradesh

Arunachal Pradesh's rich fish fauna is increasingly threatened by a range of human activities, including:

- **Hydropower Development:** One of the biggest threats to aquatic biodiversity in Arunachal Pradesh is the building of dams for the purpose of producing hydroelectric power. Dams damage fish migration paths, split river systems, and change the natural flow patterns that are necessary for feeding and spawning. Species that migrate, like the golden mahseer, are especially susceptible to these modifications (Patir et al., 2023).
- **Deforestation and Habitat Degradation:** The region's fast deforestation and shifting land uses have caused soil erosion and sedimentation in rivers, lowering water quality and harming fish habitats (Tewari, 2004). Because it stabilizes riverbanks, adds to nutrient cycling, and provides shade, riparian vegetation is critical to the health of river ecosystems.
- **Overfishing and Illegal Fishing Practices:** There have been decreases in fish populations in various rivers in Arunachal Pradesh due to unsustainable fishing methods like using poison and dynamite fishing. Both non-target species and young fish are especially harmed by these practices. (Darshan et al., 2019).

## 6.2 Jammu & Kashmir

The cold-water ecosystems of Jammu & Kashmir face different challenges, including:

- **Climate Change and Glacial Retreat:** The region's aquatic ecosystems are seriously threatened by climate change. Since fish populations depend on cold, oxygen-rich water, the retreat of glaciers due to global warming has reduced the amount of water available in rivers and lakes (Qureshi et al. 2015). Variations in the amount and timing of snowmelt also cause disturbances to the seasonal flow patterns that are essential for fish migration and reproduction.
- **Introduction of Non-native Species:** The aquatic biodiversity of the area has been impacted by the introduction of trout in different ways. Although sport fishing and aquaculture have benefited the local economy from trout farming, native fish populations have been negatively impacted by the presence of predatory trout species, especially the slow-growing *Schizothorax* species (Naik et al., 2015).
- **Habitat Degradation and Pollution:** Many water bodies are experiencing increased pollution and habitat degradation as a result of urbanization, agriculture, and tourism. Fish populations in the lakes of the Kashmir Valley, such as Dal Lake and Wular Lake, have been



impacted by eutrophication, invasive species, and deteriorating water quality (Zargar et al., 2012).



*Fig.4: Dead fish floating on the surface of Dal Lake, Kashmir, on 25 May 2023, (Javeed, 2023) (Image: Umer Asif)*

## 7. Conservation Strategies and Recommendations

### 7.1 Arunachal Pradesh

Given the significant threats to the aquatic ecosystems of Arunachal Pradesh, conservation efforts should focus on:

- **Sustainable Hydropower Development:** Planning and management of hydropower projects are necessary to reduce their effects on fish migration and river ecology. Building fish passages, preserving minimum flow levels, and prior to approving new projects, environmental impact assessments (EIA) should be carried out.
- **Community-based Conservation:** Overfishing and illicit fishing can be decreased by involving the local community in conservation initiatives. Fish biodiversity in the area can be sustained over the long term with the help of community-led programs to monitor fish populations, control fishing methods, and restore riparian habitats.
- **Protected Areas and Habitat Restoration:** Protecting important fish habitats from habitat destruction can be achieved by establishing protected areas that include spawning grounds and



migratory corridors. Restoring riparian vegetation, reducing erosion, and enhancing water quality in impaired river systems should be the main goals of habitat restoration initiatives.

## 7.2 Jammu & Kashmir

In Jammu & Kashmir, conservation strategies should focus on:

- **Glacier and Water Resource Management:** Understanding how climate change affects cold-water fish species requires tracking its effects on glaciers and water resources. The ecological integrity of glacial meltwater rivers should be preserved, and sustainable water management techniques that take into consideration potential future climate changes should be the main goals of conservation efforts.
- **Regulating Trout Introductions:** Maintaining the biodiversity of native fish requires controlling the introduction of non-native trout species. Researching the ecological relationships between native and introduced species, encouraging native fish farming, and limiting the spawning of trout in sensitive areas are a few possible ways to achieve this.
- **Pollution Control and Habitat Restoration:** In the lakes and rivers of the Kashmir Valley, efforts to reduce pollution and rebuild damaged habitats are essential to maintaining fish populations. This include limiting the amount of nutrients that urban and agricultural areas add to the water, managing invasive species, and enhancing waste management techniques to improve the quality of the water.

## 8. Conclusion

The distinct geographical, ecological, and environmental conditions of Arunachal Pradesh and Jammu and Kashmir have shaped their respective fish faunas. In contrast to the high diversity of fish species found in Arunachal Pradesh's tropical to subtropical rivers, which include numerous endemic and migratory species, Jammu & Kashmir's cold-water ecosystems are home to a smaller number of species, primarily cold-adapted fish like *Schizothorax* spp. and introduced trout.

Numerous environmental challenges, such as habitat fragmentation, climate change, and pollution caused by humans, are present in both areas. Every region has unique ecological needs and threats, so conservation strategies must be customized to meet those needs. Safeguarding riverine environments, controlling the building of dams, and encouraging environmentally friendly fishing methods are Arunachal Pradesh's top priorities. Lessening the effects of climate change, controlling the introduction

of trout, and cleaning up degraded and contaminated water bodies should be the main priorities in Jammu and Kashmir.

The adoption of successful conservation strategies that strike a balance between ecological preservation and sustainable development will determine the future of aquatic biodiversity in both regions.

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