# Assessment of Ichthyofaunal Diversity and Habitat Variables in Himalayan Brahmaputra River of Assam, North-Eastern India

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**Abstract** In the present communication, we report ichthyofaunal diversity and habitat variables from eight major landing centers spread across three stretches (upper, middle and central) of River Brahmaputra in Assam from 2019 to 2021. The environmental variables such as temperature (21.2–28.6 °C), dissolved oxygen (6.52–8.27 mg/l), pH (7.1–8.2), alkalinity (62–87 mg/l), nitrate (0.018–0.038 mg/l) and phosphate (0.003–0.016 mg/l) were observed to be in a suitable range for aquatic fauna and flora. From the studied region, 110 fish species belonging to 33 families and 69 genera were reported. Among the families, Cyprinidae was the most prevalent family representing 42.73% then Bagridae (6.38%), Channidae (6.36%), Ambassidae and Osphronemidae (3.63%), Badidae, Mastacembelidae, Schilbeidae Siluridae, and Sisoridae (2.73%), and other families contributing about 1%. According to the International Union for Conservation of Nature and Natural Resources (IUCN) status, two species were included under Endangered category, two species under Vulnerable category, 6 species under Near threatened, 4 species have Data deficient and 96 species under Least concern category. Most of the fish species observed were indigenous, with a few endemic and rare species in the region. Small indigenous fishes (such as *Cabdio morar* and *Ailia coila*) are the most abundant fish species. Fish species richness and diversity indices showed seasonal fluctuation. Highest species richness (105) was observed during pre-monsoon, then post-monsoon (88), and monsoon (82) seasons. The Shannon (H′) indices varied from 3.45 (monsoon) to 3.86 (pre-monsoon), with an evenness index between 0.38 (monsoon) to 0.45 (pre-monsoon) indicating a slightly impacted pattern of the studied river stretch i.e., (H′) > 3.0. Various natural and man-made threats are presumed to affect biodiversity in River Brahmaputra. Therefore, strategies such as fish harvest regulation, desiltation, controlling of water pollution and anthropogenic activities are suggested for conservation of the aquatic biodiversity in the River.

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**Keywords** Brahmaputra river · Fish diversity · Environmental variables · Threats · Conservation

## 1 Introduction

One of the largest river systems in South Asia, the River Brahmaputra flows approximately 3000 km transboundary through China, India, and Bangladesh, covering 1625 km, 918 km, and 337 km, respectively, before it merges with the Ganges and flows into the Bay of Bengal. More than half of its basin area is spread across China (50.5%), followed by India (33.6%), Bangladesh (8.1%) and Bhutan (7.8%) [22, 34, 36]. The River descends to India through a network of tributaries beginning in the northern Himalayas as Tsangpo. Through the Siang hills of Arunachal Pradesh, Brahmaputra reaches India; however, when it arrives at the plains, it is called Dihang. Dibang and Lohit, two tributaries in Assam, join the Brahmaputra to form a very wide river. It descends in Assam from east to west over approximately 650 km having 42 important tributaries in Northeast India, including 15 on the south bank and 27 on the north bank. As the River passes through the valley of Assam many Himalayan streams comprising Kameng, Subansiri, Bharali, Dhansiri, Manas, Saralbhanga, Champamati and Sankosh rivers join the Brahmaputra. Numerous floodplain wetlands, or beels, are created by these rivers as they travel through the valley. The Brahmaputra and its tributaries are the lifeline of millions of people in the region, who are dependent on agricultural activities. It contributes to almost 17% of the gross domestic product of India [30, 31]. River provides numerous benefits in the form of and not limited to, irrigation, ecosystem services, domestic use, navigation, tourism, wildlife areas and hydropower, thereby supporting livelihoods and food security.

Brahmaputra basin comes under one of the mega biodiversity hotspots of the Indo-Burma biodiversity hotspot region as recognized by the IUCN. The region is blessed with enormous floral and faunal diversity. The unique physiographic and climatic characteristics make the region rich in biodiversity. The Brahmaputra basin has the highest forest cover of 59% in the country. Different types of endemic vegetation including about 600 plant species, more than 800 orchid species and nearly 67 species of animals are endemic and endangered to the region supported by nearly 75 protected areas in the basin. Brahmaputra River system is home to many indigenous and endemic freshwater fishes as well [21, 27, 40]. Reportedly, there are 422 fish species found in different water-bodies of northeast India, and 141 finfishes in River Brahmaputra of Assam [7, 20]. However, the available scientific information on aquatic biology and fisheries is fragmented and not up-to-date. Impact of rivers on fisheries and habitat variables are poorly studied. Therefore, the present chapter focused on assessing habitat variables and ichthyofaunal diversity in selected stretches of River Brahmaputra including seasonal variations in fish species richness and diversity indices.

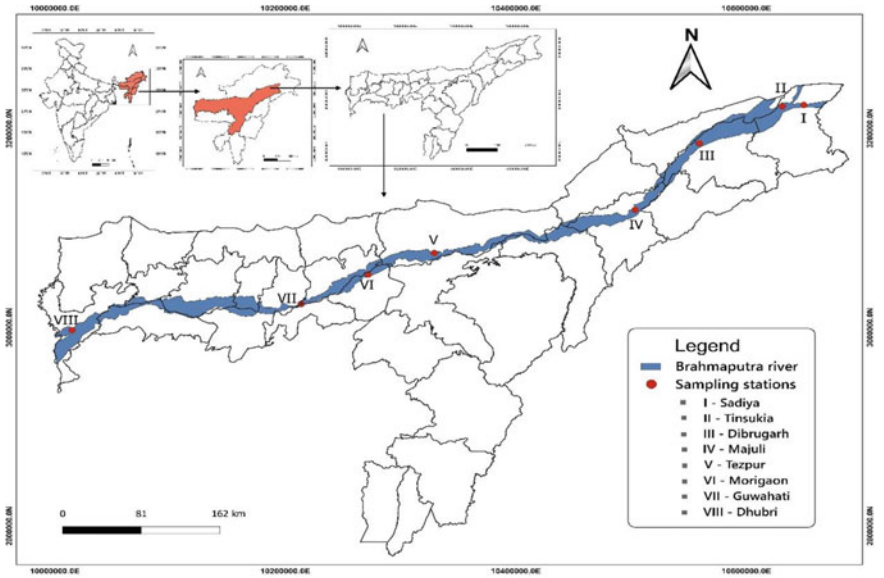


**Fig. 1** Brahmaputra River, Assam along with sampling sites

## 2 Study Area

The present investigation was carried out in River Brahmaputra, Assam from November 2019 to December 2021 from Sadiya to Dhubri, Assam. Sampling was carried out on seasonal basis from eight major landing centers (Fig. 1), marked as site I (Sadiya; 95°40′52″ E & 27°49′14″ N), II (Tinsukia; 95°32′49″ E & 27°57′79″ N), III (Dibrugarh; 94°54′13″ E & 27°29′9″ N), IV (Majuli; 94°29′85″ E & 26°91′67″ N), V (Tezpur; 92°47′27″ E & 26°36′58″ N), VI (Morigaon; 92°06′40.8″E & 26°17′20.7″N), VII (Guwahati; 91°45′20″E & 26°11′43″N) and VIII (Dhubri; 89°59′41″ E & 26°1′20″ N).

## 3 Methodology

### *3.1 Water and Sediment Quality*

Water samples were collected from each sampling station using clean 1000 ml polypropylene bottles for the determination of various physico-chemical parameters. At each point of water sample collection, pH, water temperature, specific conductivity and total dissolved solids were measured using a portable water testing kit. Winkler's method was used to measure dissolved oxygen. Total water alkalinity and free carbon

dioxide were assessed using standard methods [1, 2]. Phosphate–phosphorus content of water was estimated with the help of a spectrophotometer. Phenol disulphonic acid reduction method was used to assess Nitrate–nitrogen [25]. An Ekman dredger was used to collect sediment samples in the study area. Three samples were collected from each sampling site. In order to produce uniform composite samples, debris, as well as other parts from plants and animals, were removed and thoroughly mixed. Samples were brought to the laboratory in plastic pouch bags for further analysis. The sediment samples that were collected were air-dried and ground into a fine powder, strained through a 2 mm mesh sized sieve and air-dried again. Determination of sediment quality was done by standard procedures given by [25]. Mechanical analysis with a Bouyocos hydrometer (graduated in g/l) was used to determine the texture of the sediment, which was expressed as percentages of sand, clay, and silt particles. A pH meter was used to estimate the pH of the sediment. Total organic carbon and organic matter were analyzed using Walkley–Black's method (1934) and loss-on-ignition method, respectively and the results were expressed in percentages. Available phosphorous and nitrogen in the sediments were estimated by Trougss (Bray's) method (1945) and the alkali permanganate method, respectively.

### *3.2 Fish Diversity*

Fish species were collected through fishing by local fishermen with different fishing gears such as cast net, gill net, hook and lines, and various types of traps and also recorded from study area, landing centers and local markets of the sampling area. Most of the fish species were identified on the spot and unidentified specimens were brought to the laboratory in well-preserved 5–10% formalin and further identification was done using standard manuals of [24, 38] and Viswanath (2002). Conservation status evaluation was done according to the IUCN Red List of threatened species (IUCN 3.1). Data on threats to fish fauna were collected from both primary (direct observations and interactions with local fishermen and stakeholders) and secondary sources. Abundance, diversity and species richness were determined by following [29, 37] and diversity indices (Evenness Index and Shannon-Weinner Index,).

### *3.3 Data Analysis*

Relative abundance (RA) of fish species was calculated as

$$\text{RA}\ (\%) = \text{Isi}/\sum \text{Nsi} \times 100 \tag{1}$$

where, Isi is the no. of samples of particular species, $\sum$ and Nsi is the total no. of samples.

The Shannon and Weiner diversity index (H′) was estimated for fishes employing the following formula.

$$H\prime = \sum\{pi \times \ln(pi)\} \quad (2)$$

where, s is the no. of fish species, p is the proportion (n/N) of individuals of one particular fish species observed (n) divided by the total no. of individuals observed (N), ln is the natural log and Σ is the sum of the calculations.

The Evenness index (E) was assessed using the following formula

$$E = H/\text{In}S \quad (3)$$

where, H = diversity index; S = total no. of fish species

## 4 Results and Discussion

### *4.1 Water and Sediment Quality*

The water and sediment quality variables were found to be in a suitable range for aquatic fauna and flora (Table 1). It was characterized by alkaline pH (7.1–8.2), rich dissolve oxygen (6.52–8.27 mg/l) and poor nutrients (nitrate: 0.018–0.038 mg/l and phosphate: 0.003–0.016 mg/l). Water temperature, pH, DO and alkalinity were satisfactory for the survival and growth of aquatic organisms. The sediments were dominated by sandy soil and loamy-sandy soil from upper to lower stretches, having mostly alkaline pH (6.82–8.64), low organic carbon (0.347–0.495%), organic matter (0.596–0.851%) and low available nutrients. Similar observations were reported by [7] in River Brahmaputra except for some tributaries. Kotoky and Sarma [26] studied the water quality of the river in Kamrup district of Assam. They suggested that the water was not fit for drinking, and might be used for agricultural purposes. Many researchers studied the physico-chemical parameters of Brahmaputra river and its tributaries and the water was found to be suitable for aquatic organisms [3, 12–14].

### *4.2 Ichthyofaunal Diversity of Brahmaputra River*

In the present investigation, a total of 110 fish species belonging to 33 families and 69 genera were reported from the studied region. Among the families, Cyprinidae was the most dominant one representing 42.73% of the species followed by Bagridae (6.38%), Channidae (6.36%), Ambassidae and Osphronemidae (3.63%), Badidae, Mastacembelidae, Schilbeidae Siluridae, and Sisoridae (2.73%), and other families

**Table 1** Water and sediment quality of River Brahmaputra, Assam

| Water parameters | Range | Soil parameters | Range |
|---|---|---|---|
| Temperature | 21.2–28.6 °C | Soil texture | Sandy (dominant) to Loamy Sandy (lower stretches)<br>Sand: (80.64–93.64) %<br>Silt: (4.64–14.64) %<br>Clay: (1.72–4.72) % |
| pH | 7.1–8.2 | | |
| Dissolve Oxygen | 6.52–8.27 mg/l | | |
| Free $CO_2$ | 0–2.21 mg/l | | |
| Total alkalinity | 62–87 mg/l | pH | 6.82–8.64 |
| Total Dissolve Solids | 46–78 mg/l | Organic Carbon | 0.347–0.495% |
| Salinity | 0.01–0.12 ppt | Available P | 0.28–1.9 mg/100 g sediment |
| Phosphate ($PO_4$) | 0.003–0.016 mg/l | Available N | 9.84–22.84 mg/100 g sediment |
| Nitrate ($NO_3$) | 0.018–0.038 mg/l | Organic matter content | 0.596–0.851% |

contributing about 1% (Fig. 2). Fishes having both ornamental and/ or food values were found abundantly in the river and its tributaries.

Most of the fish species observed were indigenous by habitat, with a few endemic to the region and a few rare species. During our field visits, majority of the fishes were available in the form of live, fresh, frozen, smoked and dried forms in local markets. *Cabdio morar* and *Ailia coila* were the most abundant fish species from the River. The Indian major carps (*Labeo catla*, *Labeo rohita, Cirrhinus mrigala)*, minor carps (*Bangana dero, C. reba, L. gonius*, *L. bata*, *L. calbasu)*, air breathing fishes

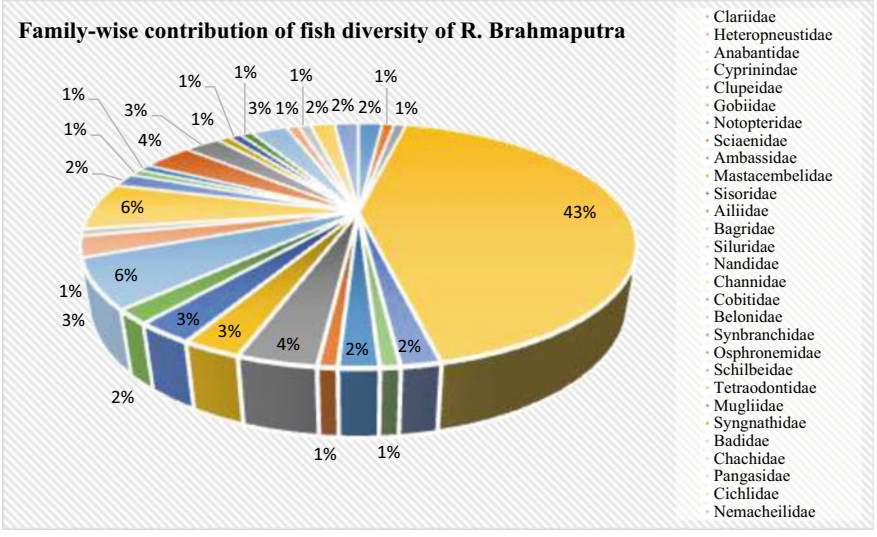


**Fig. 2** Family-wise contribution of fish diversity of selected stretches of River Brahmaputra, Assam

(*Channa* spp., *Clarias magur, Heteropneustes fossilis, Anabas testudineus)*, catfishes (*Wallago attu, Sperata aor, S. Seenghala, Mystus tengara, M. cavasius, M. bleekeri, Ompok pabda, Eutrophiichthys vacha, Clupisoma garua, Rita rita)* and several prawn species were reported from all the stretches. Migratory fishes such as anadromous Hilsa (*Tenualosa ilisha*) were observed in the lower stretches, amphidromous fishes (*Otolithoides pama*) and catadromous migrant (*Anguilla bengalensis bengalensis*) were also observed in lower stretches of the River. *Tor tor, T. putitora*, *Neolissocheilus hexagonolepis*, *Bangana dero, L. dyocheilus*, *Raimas bola*, *Cyprinion semiplotus*, *Barilius* spp. and *Silonia silondia* were some of the fishes that migrate between the main river and tributaries.

Among exotic fishes recorded from the main river were common carp (*Cyprinus carpio*), grass carp (*Ctenopharyngodon idella*), silver carp (*Hypophthalmichthys molitrix*), bighead carp (*Hypophthalmichthys nobilis*), African catfish (*Clarias gariepinus)*, pangas (*Pangasius* spp.,) tilapia (*Oreochromis* spp.) and pacu (*Piaractus brachypomus*) were recorded in associated wetlands and Brahmaputra valley. According to IUCN (2021), the conservation status of the recorded fishes was classified into five categories such as Endangered, Near Threatened, Least Concern, Vulnerable and Data Deficient. Accordingly, two species were included under Endangered category, two species under Vulnerable category, 6 species under Near threatened, 4 species have Data deficient and 96 species under Least concern category. Due to large-scale diversity in environments in river Brahmaputra, fishes thriving in it comprises of plainwater forms, estuarine forms, torrential forms, coldwater forms and it is also home to river dolphin *Platanista gangetica* [7, 8, 11, 33, 39]. [20] recorded 422 fish species from Northeast states of India belonging to 133 genera and 38 families having commercial importance as food and/ or ornamental values. Bhattacharjya et al. [6] recorded 216 fish species from Brahmaputra and Barak river systems in Assam and 141 finfish species including 29 families and 84 genera were reported from the Brahmaputra alone [7]. Ninety seven fish species were recorded from lower reaches of river Brahmaputra [32], 57 fish species from Kulsi river [23] and 50 fish species from Dihing river, a tributary of river Brahmaputra [17]. Although there are differences in ichthyofaunal diversity recorded in the present and earlier studies, the message which comes out profoundly is that there is rich diversity in fish species thriving in river Brahmaputra and its tributaries. Our experience also suggests that fishes undertake migration within the river(s) to adjust to changes in climatic variables. Studies related to generating updated information on ichthyofaunal diversity and distribution range of species in river Brahmaputra are encouraged.

## *4.3 Diversity Indices and Relative Abundance*

Indicators of fish species richness and diversity showed seasonal fluctuation (Table 2). Highest species richness (105) was observed during pre-monsoon, followed by post-monsoon (88) and monsoon (82) seasons. Shannon-Weiner indices (H′) varied from 3.45 (monsoon) to 3.86 (pre-monsoon) indicating slightly impacted pattern of

**Table 2** Diversity indices of fishes of River Brahmaputra, Assam

| | Pre-monsoon | Monsoon | Post-monsoon |
|---|---|---|---|
| No. of Species | 105 | 82 | 88 |
| Individual | 849 | 516 | 544 |
| Shannon (H) | 3.861 | 3.451 | 3.66 |
| Evenness (e^H/S) | 0.4523 | 0.3847 | 0.4416 |

the selected river stretch [10, 28]. Evenness index varied from 0.38 (monsoon) to 0.45 (pre-monsoon) indicating the frequency of dominating species present during pre-monsoon season. Margalef index was maximum for pre-monsoon season (15.42) indicating highest species richness during the season.

Relative Abundance of species measures how rare or common a species is in comparison to other species in a given area or population [28]. In the present study, SIFs dominated among the fishes in the River Brahmaputra of Assam (Fig. 3). *Cabdio morar* dominated in all the seasons; *Ailia coila* and *Clarias magur* dominated during pre-monsoon season. *Channa punctata*, *Parambassis baculis* and *P. ranga* dominated during monsoon season. High fish diversity in terms of species richness and evenness was observed in River and its associated tributaries by many researchers [4, 5, 15, 16, 18, 28, 35].

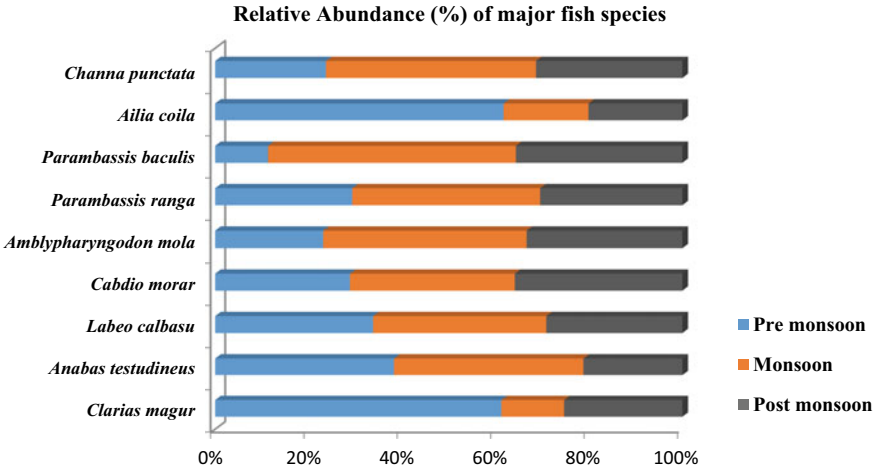


**Fig. 3** Relative abundance of major fish species in R. Brahmaputra, Assam

## 5 Conclusion

The present study on Brahmaputra river provided updated important information on hydrobiological conditions and ichthyofaunal diversity of selected stretches. Although the river is rich in fish diversity indicating good ecosystem health, however, it is facing many challenges. The major threats in the river is recognized as siltation of river bed and connected channels, habitat destruction/alteration, construction of flood-control embankments, construction of dams, over-exploitation of fish, illegal fishing, pollution and climate change. Majority of these threats are caused due to anthropogenic factors that are in the hands of mankind to control. Rational fishing practices and desiltation of selected stretches of the river might help in conserving aquatic biodiversity. It is strongly felt that mass awareness on sustainable utilization and management of the river among riparian fishers and other stakeholders would contribute significantly in this direction.

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