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Present status and diversity of small indigenous fish species (SIS) in the upper reaches of river Brahmaputra in Assam, north-eastern India

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ABSTRACT

An investigation was carried out to assess the status and diversity of small indigenous species (SIS) of fish in the upper reaches of the river Brahmaputra, Assam. The study was carried out for two years from January, 2013 to December, 2014 in five prominent landing stations. A total of 52 SIS of fish belonging to 15 families and 33 genera were recorded during the study period. Cyprinidae was observed to be the most dominant family with 22 species (42.31%). According to IUCN status (2015), species like *Amblyceps arunchalensis* and *Puntius fraseri* were listed as endangered species. It has been observed that the SIS were most abundant during pre-monsoon period and least abundant during winter season in the area of the river under study. The study also revealed that the upper reaches of river Brahmaputra is fairly rich in SIS fish diversity. However, better management strategies such as controlled harvest and scientific fishing policies will ensure sustainable exploitation and conservation of SIS fish in the region.

Keywords: Assam, Brahmaputra, Diversity, River, Small indigenous species (SIS)

Introduction

The Brahmaputra drainage system in North-east India is one of the largest hydrographic basins in South-east Asia. This mighty river has a very rich and diverse aquatic gene pool, particularly of fishes and featured among the global hotspots of freshwater fish diversity (Kottelat and Whitten, 1996). Out of the 765 native freshwater fish species available in India, 450 have been classified as SIS freshwater fish (NBFGR, 2011). Maximum diversity of SIS's has been recorded from the north-east region followed by Western Ghat and Central India (NBFGR, 2011). By standard definition, SIS fish should not exceed in length of about 25 cm/9 inch at maturity (Felts *et al*., 1996; Hossain *et al*., 1999; Khanam *et al*. (2003). But, as per the study conducted by Kostori *et al*. (2011), the above definition contradicts since for few species like *Puntius sarana*, *Clarias batrachus*, *Channa barca*, *Xenentodon cancila* and *Heteropneustes fossilis*, size exceeds 25 cm, yet they are considered as SIS fish.

SIS fish is a vital source of vitamin A, along with calcium for rural poor households (Roos *et al*., 2003). It has been reported that some species such as *Amblyphayngodon mola*, *Osteobrama cotio* and *Esomus danrica* contain high amount of vitamin A and other micronutrients and minerals (Thilsted *et al*., 1997). Some SIS fish like *Puntius* spp. contain double the amount of iron as compared to many cultivable carps like *Hypopthalmichthys molitrix* and *Labeo rohita*. On the other hand *Amblypharyngodon mola* contains three times more calcium and 50 times more vitamin A than that of *H. molitrix* and *L. rohita* (Villif and Jorgensen, 1993). SIS fish offer more minerals in their edible form than that of large sized fishes (Higashi, 1962).

From the upper stretches of the river Brahmaputra, very few reports are available regarding the diversity of SIS fish. Some of the works carried out in this regard are that of Sen (1985); Choudhury *et al.* (1990); Jhingran (1991); Sinha (1994); Yadava and Chandra (1994); Biswas *et al.* (1995) and Biswas and Sugunan (2008). Many SIS fishes have come under threatened and endangered category owing to overexploitation, habitat destruction, water pollution, channel fragmentation and siltation. In the present study, an attempt has been made to investigate the present status and diversity of SIS fish in the upper stretches of the river Brahmaputra.

Materials and methods

The present study area comprised 550 km stretch of the river Brahmaputra in its upper reaches from Dibru - Saikhowa (95°18'58.2" E; 27°34'52.6" N; elevation - 95 m) to Guwahati (91°45'03.6" E; 26°11'10.2" N; elevation - 53 m). Five study sites were selected from the entire upper stretches of the river Brahmaputra *viz*., Dibru Saikhowa, Tinsukia (S_1) (95°18'58.2" E; 27°34'52.6" N; elevation 95 m MSL); Dibrugarh Ghat, Dibrugarh (S_2) (94°54'45.4" E;

27°29'22.5" N; elevation 83 m MSL); Nematighat, Jorhat (S_3) (94°15'01.7" E; 26°51'28.7" N; elevation 96 m MSL); Bhairabi Ghat, Tezpur (S_4) (95°22'27.0" E; 27°42'24.8" N; elevation 51 m MSL) and Kachari Ghat, Guwahati (S_1) (91°45'03.6" E; 26°11'10.2" N; elevation 53 m MSL).

The locations of the sampling sites were documented using global positioning system (GPS) receiver (Fig. 1) and were chosen on the basis of accessibility and similarity in physical habitat. The study was carried out during January, 2013 to December, 2014. Distance from one sampling site to another was approximately 100 km. Fishes were sampled from landing centre (twice a month) as well as by directly visiting the area where maximum fishing practices were being carried out. Experimental fishing were also carried out with the help of local fishermen employing cast net (90', 1"; 9', 1/2") and gillnet (75x1.3 m, 2"). The collected fishes were then preserved in 5-10% formaldehyde and were identified following Talwar and Jhingran (1991); Jayaram (1999) and (Vishwanath *et al.,* 2014).

Statistical analysis of the data collected for SIS fish diversity, abundance and their distribution in the river system was carried out using MS excel and MEGA software. Rarefaction curves, species distribution plot and abundance plot (rank) distribution for the collected SIS fish has been prepared using Bio Diversity Pro software (ver. 2015). The relative abundance (RA) (percentage of catch) of collected SIS fish across different stations was calculated using the following formula:

Number of samples of particular species x 100/Total number of samples

Similarity of the species in all sampling stations was calculated using Jacquard's index: $S_j = j/(x+y-j)$, where S_j is the similarity between any two zones x and y, j is the number of species common to both the zones x and Y, x is the total number of species in zone X and y is total number of species in zone Y. The fish diversity indices were calculated as per Shannon and Wiener (1963): $H' = -\Sigma\, pi \log (pi)$, where H' = Shannon-Weiner Diversity Index and *pi* = relative abundance of each group of organisms.

Results and discussion

Diversity, abundance and distribution of SIS fish

During the investigation period, a total of 52 SIS fish belonging to 15 families and 33 genera were recorded from the entire upper stretches of river Brahmaputra. Cyprinidae was found to be most abundant family with 22 species (42.31%), followed by Bagridae with 9 species (17.31%) and Cobitidae family with 4 species (7.69%) (Table 1). *Botia lohachata* which was not recorded earlier from this part of the river is reported during the present investigation.

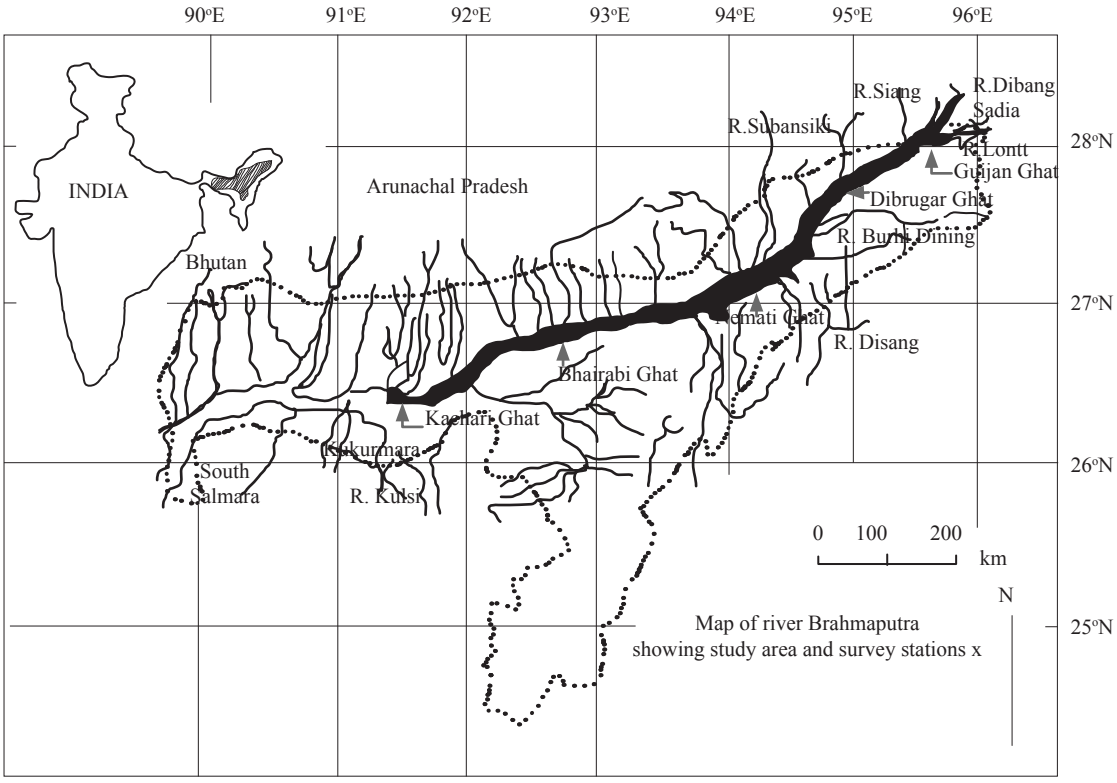

Fig. 1. Map showing study area with sampling sites

Table 1. SIS fish with their IUCN (2015) status, relative abundance (RA) and distribution status in the upper reaches of the river Brahmaputra

Species	Family	Local name	IUCN status (2015)	R.A. (%)	Abundance status
Ailia coila (Hamilton,1822)	Schilbeidae	Kajuli	NT	3.59	Very common
Amblyceps arunchalensis (Nath & Dey, 1989)	Amblycipitidae	-----	EN	0.55	Very rare
Amblypharyngodon mola (Hamilton,1807)	Cyprinidae	Moa	LC	2.48	Very common
Badis badis (Hamilton,1822)	Badidae	Randhoni	LC	2.90	Rare
Badis dibruensis (Geetakumari & Vishwanath, 2010)	Badidae	-----	DD	0.78	Rare
Barilius bendelisis (Hamilton,1807)	Cyprinidae	Korang	LC	1.06	Very common
Barilius shacra (Hamilton,1822)	Cyprinidae	Korang	LC	0.69	Very rare
Barilius vagra (Hamilton,1822)	Cyprinidae	Korang	LC	0.83	Common
Batasio batasio (Hamilton,1822)	Bagridae	-----	LC	0.18	Common
Batasio tengana (Hamilton,1822)	Bagridae	Batasimas	LC	2.25	Very common
Botia dario (Hamilton,1822)	Cobitidae	Gethu	LC	1.20	Very common
Botia lohachata Chaudhuri 1912	Cobitidae	Ranibotia	NE	0.09	Very rare
Botia rostrata Gunther, 1868	Cobitidae	Gethu	VU	0.37	Very rare
Cabdio morar (Hamilton,1822)	Cyprinidae	Boriola	LC	5.06	Very common
Chanda nama Hamilton1822	Ambassidae	Chanda	LC	3.86	Very common
Devario assamensis (Barman, 1984)	Cyprinidae	-----	VU	0.69	Very rare
Devario devario (Hamilton,1822)	Cyprinidae	Laupati/Dahrie	LC	2.67	Very common
Esomus danrica (Hamilton, 1822)	Cyprinidae	Dorikona	LC	1.89	Rare
Eutropiichthys murius (Hamilton,1822)	Schilbeidae	Bosa	LC	0.18	Common
Eutropiichthys vacha (Gunther, 1868)	Schilbeidae	Bosa	LC	1.01	Common
Gagata cenia (Hamilton,1822)	Sisoridae	Keyakatta	LC	2.34	Very common
Gonorhynchus latius (Hamilton,1822)	Cyprinidae	Bhol	LC	2.02	Very common
Gudusia chapra (Hamilton,1822)	Clupeidae	Karoti	LC	2.16	Very common
Labeo boga (Hamilton,1822)	Cyprinidae	Bhangone	LC	0.78	Common
Laubuca laubuca (Hamilton,1822)	Cyprinidae	Laopota	LC	1.38	Very common
Leiodon cutcutia (Hamilton,1822)	Tetraodontidae	Gangatope	LC	0.69	Common
Lepidocephalichthys guntea (Hamilton,1822)	Cobitidae	Botia	LC	2.67	Very common
Mystus bleekeri (Day, 1877)	Bagridae	Singorah	LC	0.92	Rare
Mystus carcio (Hamilton,1822)	Bagridae	-----	LC	0.92	Rare
Mystus cavasius (Hamilton,1822)	Bagridae	Xingarah	LC	3.63	Very common
Mystus dibrugarensis (Chaudhuri 1913)	Bagridae	Shingi	LC	4.51	Very rare
Mystus tengara (Hamilton,1822)	Bagridae	Tingara	LC	4.83	Very common
Mystus vittatus (Bloch, 1794)	Bagridae	Xingarah	LC	2.53	Common
Nandus nandus (Hamilton,1822)	Nandidae	Gadgedi	LC	1.10	Common
Olyra kempi Chaudhuri, 1912	Bagridae	-----	LC	0.46	Very rare
Opsarius barna (Hamilton,1822)	Cyprinidae	Korang	LC	0.78	Very common
Osteobrama cotio (Hamilton,1822)	Cyprinidae	Hafo/Hamto	LC	2.53	Very common
Paracanthocobitis botia (Hamilton,1822)	Balitoridae	Balibotia	LC	2.53	Rare
Parambassis lala (Hamilton,1822)	Ambassidae	Chanda	NT	0.18	Very rare
Parambassis ranga (Hamilton,1822)	Ambassidae	Chanda	LC	4.87	Very common
Pethia conchonius (Hamilton,1822)	Cyprinidae	Puthi	LC	1.52	Very rare
Pethia ticto (Hamilton,1822)	Cyprinidae	Puthi	LC	0.60	Common
Puntius chola (Hamilton,1822)	Cyprinidae	Puthi	LC	4.64	Common
Puntius fraseri (Hora & Misra, 1938)	Cyprinidae	-----	EN	0.55	Very rare
Puntius sophore (Hamilton,1822)	Cyprinidae	Puthi	LC	5.52	Very common
Puntius terio (Hamilton,1822)	Cyprinidae	Puthi	LC	1.24	Very common
Raiamas bola (Hamilton,1822)	Cyprinidae	Rajamas	LC	0.41	Rare
Rasbora ornatus (Vishwanath & Laisram, 2005)	Cyprinidae	-----	VU	0.60	Common
Rasbora rasbora (Hamilton,1822)	Cyprinidae	-----	LC	1.06	Common
Rhinomugil corsula (Hamilton,1822)	Mugilidae	Kharkhari	LC	0.87	Very rare
Trichogaster fasciata Bloch and Schneider, 1801	Belontiidae	Kholihona	LC	6.71	Very common
Xenentodon cancila (Hamilton,1822)	Belonidae	Kakila	LC	2.11	Very common

Note: Very rare: 1-10 individuals recorded during one season of the year; Rare: Seldom found species but not very rare, recorded during two seasons of the year; Few: not rare and available during three seasons of the year; Very common: Frequently available species all along the four seasons of the year. RA: Relative abundance

Family-wise abundance of SIS fishes is shown in Fig. 2. In the present investigation, it was observed that among all the collected SIS fishes, the relative abundance (RA) of *Trichogaster fasciata* (Belontiidae family) was relatively higher (6.71%), followed by *Puntius sophore* and *Cabdio morar* (both Cyprinidae family) with RA of 5.52 and 5.06% respectively. It was also observed that the SIS fishes were most abundant during the monsoon and retreating monsoon seasons (26% in each season) and less abundant in the winter season forming only 23% (Fig. 3).

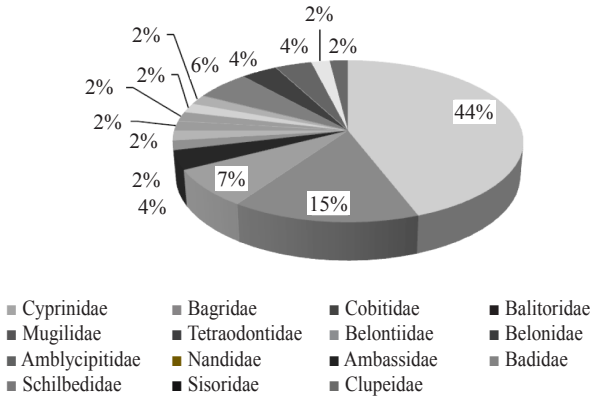

Fig. 2. Family-wise abundance of SIS fish in the upper stretches of river Brahmaputra

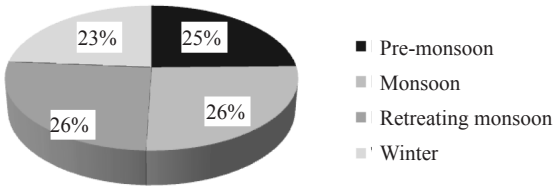

Fig. 3. Seasonal availability of SIS fish in the upper stretches of river Brahmaputra

The Shannon-Weiner diversity index of the collected SIS fishes (seasonal) indicated a diverse distribution with overall index of 3.63. The species richness variation across different study sites ranged from 3.47 to 3.58. Simpson's diversity and Margaleff diversity indices were also estimated for the five study sites (Table 2). The highest SIS fish diversity was recorded during monsoon season in all sampling sites, whereas lowest diversity was recorded during winter season. Maximum fish diversity was recorded in upper stretch of the river *i.e.*, in S_1, followed by S_4, S_5, S_2 and S_3 respectively. This observation is in agreement with the earlier reports that fish communities in riverine systems typically follow a pattern of increasing species richness, diversity and abundance from upstream to downstream (Welcomme, 1985; Bayley and Li, 1994; Granado, 2000).

Similarities in species composition among the study sites were analysed using the Jaccard index (JI) for calculating the extent of similarity between pairs of data sets (Table 3). The JI value between sites S_1 and S_3 was found to be highest while it was lowest between sites S_1 and S_5 (Specht and Paller, 2004). Similarity in species composition across the study sites is shown as a dendrogram in Fig. 4, obtained from the JI coefficients of similarity using the average linkage method.

Table 3. Jaccard similarity coefficient of SIS fish among five sampling stations

Sampling stations	S_1	S_2	S_3	S_4	S_5
S_1	1.00				
S_2	3.42	1.00			
S_3	4.93	3.53	1.00		
S_4	2.06	3.35	4.73	1.00	
S_5	1.30	3.25	2.51	1.54	1.00

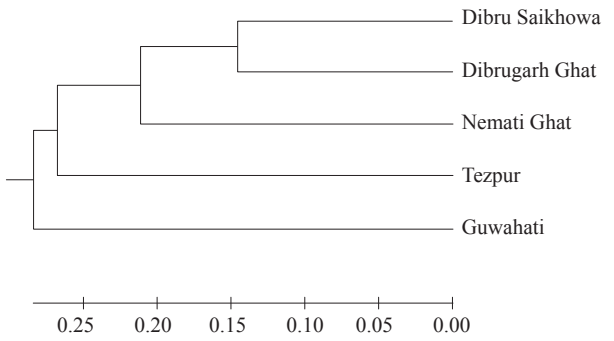

Fig. 4. Dendogram showing similarity in composition of SIS fish across five sampling stations of upper Brahmaputra River based on Jaccard index

Table 2. Seasonal diversity, Shannon-Weiner index, Simpson's diversity and Margaleff diversity index of SIS fish

Seasons	Species diversity	Shannon-Weiner diversity index	Simpson's diversity (D)	Simpson's diversity (1/D)	Margaleff M Base 10.
Pre-monsoon	47	3.51	0.037	27.127	18.496
Monsoon	49	3.56	0.033	30.036	18.005
Retreating monsoon	49	3.58	0.033	30.427	18.896
Winter	45	3.47	0.036	27.883	19.419

The rarefaction curve (Fig. 5) indicates maximum species richness in monsoon and retreating monsoon periods followed by pre-monsoon and winter seasons. Species distribution for the whole SIS fish community sampled from the study sites revealed wide variation in distribution during all the seasons (Fig. 6). The number of unique species in each season for pooled data is shown in Fig. 7. Descriptions of SIS fish diversity in the upper Brahmaputra River are shown in Table 4. Maximum diversity variance (140.39±11.85 SD) was observed in the monsoon season for 49 species (680 individuals). Lowest variance (66.35±8.15 SD) was recorded in the winter season with 423 individuals (45 species).

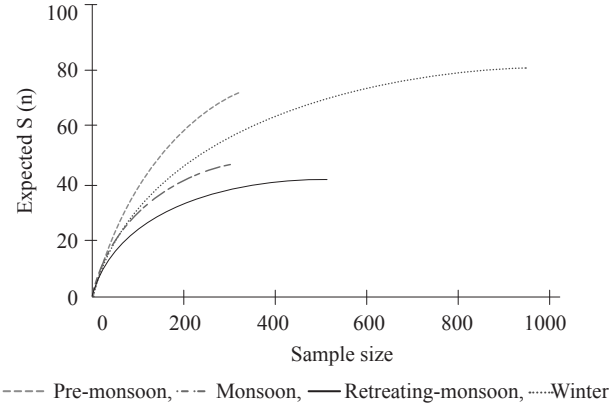

Fig. 5. Season-wise rarefaction curves, where X axis shows individuals actually sampled and Y axis shows estimation of the expected number of SIS fish

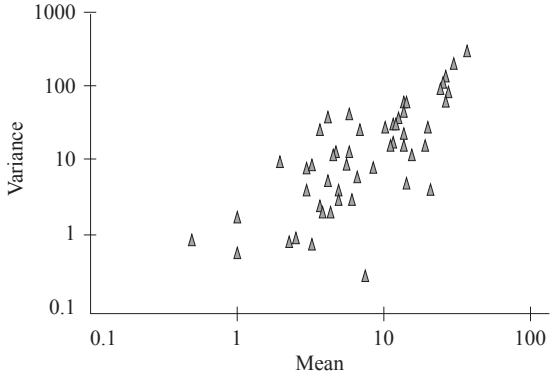

Fig. 6. Species distribution plot for SIS fish community sampled from upper Brahmaputra River

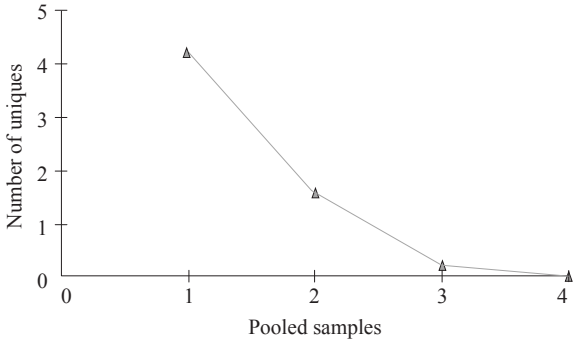

Fig. 7. Species richness of each season with number of unique SIS fish sampled from upper Brahmaputra River

Present status and conservation issues

SIS fishes like *Ailia coila, Badis badis, Cabdio morar, Chanda nama, Mystus cavasius, Mystus dibrugarensis, Mystus tengara, Parambassis ranga, Puntius chola, Puntius sophore and Trichogaster fasciata* were found abundantly throughout the year whereas, species like *Amblyceps arunchalensis, Badis dibruensis, Barilius shacra, Batasio batasio, Botia lohachata, Botia rostrata, Devario assamensis, Eutropichthys murius, Olyra kempi, Parambassis lala, Pethia ticto, Puntius fraseri, Raiamas bola* and *Rasbora ornatus* were found least abundant during the investigation period. Further, 12 species (23.08%) were categorised as very rare, followed by six species (11.54%) in rare category, 10 species (19.23%) in common category and 24 species (46.15%) in very common category (Fig. 8).

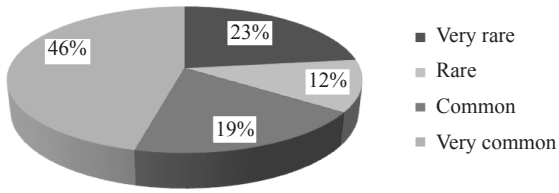

Fig. 8. Availability status of SIS fish in the upper stretches of river Brahmaputra

According to IUCN (2015) status, out of the total SIS fishes collected, 2 species (*A. arunchalensis* and *P. fraseri*) were categorised as endangered (EN), three species (*B. rostrata, D. assamensis* and *R. ornatus*) as

Table 4. Description of seasonal SIS fish diversity observed in the study sites

Seasons	Mean individuals	Variance	SD	SE	Total individuals	Total species	Mean CI
Pre-monsoon	11.00	123.92	± 11.13	1.54	572	47	33.68
Monsoon	13.08	140.39	± 11.85	1.64	680	49	38.16
Retreating monsoon	9.62	76.32	± 8.74	1.21	500	49	20.74
Winter	8.14	66.35	± 8.15	1.13	423	45	18.04

Note: SD - Standard deviation; SE - Standard error; Mean CI - Mean confidence interval

vulnerable (VU), two species (*A. coila* and *P. lala*) as near threatened (NT), 43 species as least concern (LC), one species as data deficient (DD) and one species as not evaluated (NE). Relative abundance (RA) of SIS fish under threatened category *viz*., *A. arunchalensis, P. fraseri, B. rostrata, D. assamensis, R. ornatus, A. coila* and *P. lala* were estimated to be 0.55, 0.55, 0.37, 0.69, 0.60, 3.59 and 0.18% respectively.

There are reports on small scale aquaculture of *A. mola, P. sophore, Osteobrama cotio, Cirrihinus reba, Labeo bata* and *Gudusia chapra* along with Indian major carps (Ayyappan and Jena, 2003, Roos *et al.,* 2003). Natural flow regimes and hydrological variability (quantity, timing and duration of flows and floods) are considered essential for maintaining biodiversity and fisheries of any seasonal river systems (Poff *et al*., 1997). Mitigation measures should include the restoration of hydrological and sediment dynamics, riparian vegetation, river habitat diversity and floodplain connectivity (Tockner and Stanford, 2002). Practice of overfishing in many parts of the river which brought some of the SIS fishes of the river system under threatened category, should be checked at the earliest.

Though the upper stretches of river Brahmaputra are subjected to varied pressures (both anthropogenic and natural), the findings of the present investigation indicate that the upper stretches are still very rich in terms of SIS fish diversity. For the conservation of these SIS fishes of the upper reaches of river Brahmaputra, strategies such as halting of siltation, promoting controlled harvest, check on illegal fishing and control of water pollution are the need of the hour. Fishing activities during the peak breeding seasons must be stopped. Active conservation organisations should come forward to formulate effective conservation strategies for sustaining diversity of SIS fish in the entire upper stretches of the river system. However, the conservation strategies need to be planned involving local communities for effective implementation.

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