



## Natural Food Abundance and SIS Biodiversity of Matshaya Rani Fish Sanctuary

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### Abstract

An investigation was carried out in the Matshaya Rani (fish queen) Fish sanctuary to evaluate the hydrographic status, natural food and SIS (small indigenous species) abundance in the old Brahmaputra River near the BAU campus. There were three treatment sites- inside sanctuary, upstream and downstream of the sanctuary named as treatments T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub>, respectively. A number of water quality parameters such as temperature (<sup>0</sup>C), transparency (cm), depth (cm), water velocity (m sec<sup>-1</sup>), pH, dissolved oxygen (mg l<sup>-1</sup>), conductivity (μs cm<sup>-1</sup>), TDS (mg l<sup>-1</sup>), alkalinity (mg l<sup>-1</sup>), phosphate-phosphorus (mg l<sup>-1</sup>), nitrate-nitrogen (mg l<sup>-1</sup>), ammonia-nitrogen (mg l<sup>-1</sup>) and chlorophyll-*a* (μg l<sup>-1</sup>) were recorded and were found within the suitable range for natural food and SIS in different treatments. Among all the water quality parameters, only water transparency and depth showed significant difference ( $P < 0.05$ ) among the treatments. Forty three genera of phytoplankton belonging to Bacillariophyceae (10), Chlorophyceae (22), Cyanophyceae (8), and Euglenophyceae (3) and nine genera of zooplankton were identified belonging to Rotifera (4) and Crustacea (5) in all the treatments. None of plankton group except Cyanophyceae and Rotifera showed significant difference ( $p < 0.05$ ) among the treatments. Thirty two species of SIS under ten groups were found in different treatments. The highest number of species was found in treatment T<sub>1</sub> (30) followed by T<sub>2</sub> (25) and T<sub>3</sub> (24). The catfishes, loaches and minnows dominated among thirty two species caught from the sampling sites. The highest numbers of species were found in April and May and the least species were found the month of January. Significant inter month and inter site variation ( $P < 0.05$ ) in numerical abundance of fish observed in the study area. Notable endangered fishes, Kanchan puti- (*Puntius conchonius*), Balichata (*Acanthocobitis botia*), Indian torrent catfish-*Amblyceps mangois* and Chaka- (*Chaca chaca*) species were only found in Matshaya Rani Fish sanctuary. The natural food abundance and SIS diversity were significantly more in the inside of Matshaya Rani Fish sanctuary than both the upstream and downstream of the sanctuary.

**Key words:** Conservation, Endangered fish, Fish biodiversity, Pollution

### Introduction

The small indigenous species (SIS) of fish in Bangladesh are generally considered to be those which grow to a length of about 25 cm or 9 inches at maturity (Hossain *et al.*, 1991 and 1999). They are also known as “miscellaneous species of fish and prawn”. Small indigenous fish species (SIS) have high nutritional value in terms of protein, micro-nutrients, vitamins and minerals, and these micro-nutrients and minerals are not commonly available in other foods. Prior to 1960, many different small indigenous fish species were abundant in the rivers, borropits, roadsides, canals, streams, *beels*, *jheels* and ponds of Bangladesh. Since 1960's, the biodiversity of small indigenous fish species has been in decline despite their ability to reproduce quickly in poor environmental condition. As 80% of the rural people mostly depend on SIS, the research will directly benefit the targeted marginal farmers, retailers and indirectly to numerous.

Production from open water is gradually declining because of over-fishing, siltation, pollution and myopic management practices and so on. A good number of natural fishes which are highly regarded for their taste and nutritive value are now endangered. To protect the native species different development

projects attempted to establish fish sanctuaries in the open water bodies in different areas of the country. Although establishing sanctuary in open waters is a well-known method for conservation of biodiversity in the open waters, the information on size, seasonality, *katha* materials, fish preference, local knowledge on sanctuaries are very scarce under Bangladesh context. Study is essential to know the number and weight of fish species, yearly production, relative abundance of fish and impacts of fish sanctuary on production and biodiversity of fish in rivers and *beels*. The distribution of the fish and other fisheries fauna are accelerated by different types of limnological as well as hydrographic status viz. temperature, transparency, depth, velocity, sunshine, pH, dissolved oxygen, etc. The production of natural food organisms especially different types of plankton depend on hydrographic status. Since planktons furnish direct food of fishes, precise information on the species composition of planktons and their seasonal variations are of special importance to proper fisheries management. It is, therefore, imperative to undertake a detailed study of the composition of the planktonic flora and fauna in relation to various physical, chemical and biological conditions. Very little work has been done in Bangladesh on the dynamic aspects of plankton and other qualitative values of water, establishment of

fish sanctuaries, and conservation of SIS and keeps the biodiversity sustainable from generation to generation. During 2005-2006, the Matshaya Rani Fish Sanctuary were developed through people's participation for enhancing production, maintaining biodiversity of fish and other aquatic flora and fauna and improving the livelihood of the poor fishers.

The distribution of fish depends on the natural food availability, environmental variables and other factors (Whitefield *et al.*, 1981). Despite many studies, little information is available on fish specially SIS abundance inside and outside sanctuary in open water bodies of Bangladesh. However, the proposed study was carried out to evaluate the hydrographic status, natural food and SIS abundance in the Matshaya Rani Fish sanctuary and compared with the same parameters upstream and downstream of the sanctuary.

## Materials and Methods

### *Site selection*

The study was conducted for a period of five months, from January to May in Matshaya Rani Fish sanctuary which was established on 1 January 2008 in a section of the river old Brahmaputra beside the BAU campus under Mymensingh district. The sanctuary area is about 200 m × 25 m, and the water depth increases up to 9.14 m to 15.24 m during the monsoon months and goes down to 3.04 m in the dry months.

### *Experimental design*

For the present study, three treatments were used namely, Matshaya Rani fish sanctuary for treatment (T<sub>1</sub>), upstream of the river (1 km distance from the sanctuary) as treatment (T<sub>2</sub>) and downstream of the river (1 km distance from the sanctuary) as treatment (T<sub>3</sub>) having three replicates of each treatments.

### *Analysis of water quality parameters*

A number of water quality parameters such as temperature (°C), transparency (cm), depth(cm), water velocity(m/s), pH, dissolved oxygen (mg/l), conductivity (µs/cm), TDS (mg/l), alkalinity (mg/l), phosphate-phosphorus (mg/l), nitrate-nitrogen (mg/l), ammonia-nitrogen (mg/l) and chlorophyll-*a* (µg/l) were recorded monthly. Temperature (°C), transparency (cm), pH and dissolved oxygen (mg/l) were measured on the spot and rests of the above parameters were measured at the Water Quality and Pond Dynamics Laboratory in the Department of Fisheries Management, Bangladesh Agricultural University, Mymensingh.

### *Sampling of plankton*

Plankton samples were collected monthly from each treatment. Twenty liters of water sample was taken from different places and depths of the river and passed through fine (25 µ) mesh plankton net. Filtered samples was taken into a measuring cylinder and carefully made up to a standard volume of 50 ml. Then the collected plankton samples were preserved in 5% buffered formalin in small plastic bottles each for subsequent studies.

From each 50 ml preserved sample, 1 ml sub-sample was examined by using a Sedge Wick-Rafter cell (S-R cell) and a binocular microscope (Olympus CH-40) with phase contrast facilities. One ml of sub sample was transferred to the S-R cell and then all planktonic organisms present in 10 squares of the cell chosen randomly were identified and counted. Plankton identification was performed following APHA (1992). The quantitative estimation of plankton was done using the following formula:

$$N = \frac{A \times 1000 \times C}{V \times F \times L}$$

Where, N is the number of plankton cells or units per liter of original water, A is the total number of plankton counted, C is the volume of final concentrate sample in ml, V is the volume of field in cubic mm, F is the number of field counted and L is the volume of original water in liter. For each treatment, mean number of plankton was recorded and expressed numerically in per liter of water.

### *Sampling of fish*

Fish samples were collected monthly from the three treatments of the Matshaya Rani. For the collection of fish samples a bamboo made fishing trap, locally called 'Ucha' with 9 feet length and 7 feet wide and a mesh size of 2- 4 mm was used. Three Ucha were set inside the sanctuary and three Ucha were set in the river at the upstream and downstream of the sanctuary each. Every month, the individual length and weight of the collected fishes was measured by using a measurement scale and a digital electronic balance (KERN, Model No. EMB 2000-0), respectively. The morphometric characteristics of each sample were also observed to identify the fish species. Total numbers of each collected species were counted and then released carefully into the sanctuary. Fish samples were also collected from 1 km distance in both sides of the sanctuary (up and down) to understand the monthly fluctuation in fish catch.

**Results**

**Water quality parameters**

Water quality parameters were analyzed to observe any appreciable changes that might have occurred in

response to different treatments. The results of the water quality analysis indicated the suitable ranges of quality parameters for natural food and SIS in treatment T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub> (Table 1).

**Table 1.** Water quality parameters as obtained under three treatments during the study period, in mean ± standard error.

Parameter	Treatments			Level of significance
	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>	
Surface Temperature (°C)	25.50±1.54 (15-32)	25.04±1.38 (15-31)	24.49± 1.35 (15-30)	NS
Bottom Temperature (°C)	24.32±1.26 (16 -30.00)	24.61±1.32 (16-30.20)	24.19±1.35 (15-30)	NS
Transparency (cm)	175.20 <sup>a</sup> ±5.89 (141-208)	84.4000 <sup>b</sup> ±2.27993 (77-99)	82.6000 <sup>b</sup> ±2.06051 (70-95)	*
Velocity (m/s)	0.12±0.003 (0.10-0.14)	0.12±0.001 (0.10-0.12)	0.11±0.001 (0.10-0.12)	NS
Depth (cm)	256.20 <sup>a</sup> ±3.86 (220-276)	93.53 <sup>b</sup> ±2.80 (79-110)	91.80 <sup>b</sup> ±2.69 (75-106)	*
Conductivity (µs/cm)	251.80±6.12 (202.77-286)	248.00±6.46 (202-278)	243.20±6.67 (202-278)	NS
TDS (mg/l)	159.89±1.84 (145-170)	160.50±1.39 (149-171)	159.92±1.55 (149-171)	NS
pH	8.113±0.093 (7.30-8.70)	8.126±0.091 (7.40-8.60)	7.973±0.076 (7.40-8.40)	NS
Surface DO (mg/l)	6.740±0.351 (5.28-8.45)	6.794±0.357 (5.30-8.39)	6.676±0.328 (5.30-8.39)	NS
Bottom DO (mg/l)	6.663±0.321 (5.34-8.40)	6.678±0.322 (5.29-8.43)	6.678±.032 (5.29-8.43)	NS
NO <sub>3</sub> -N (mg/l)	0.0407±0.00345 (0.02-0.06)	0.0507±0.00371 (0.03-0.07)	0.0407±0.00248 (0.03-0.06)	NS
PO <sub>4</sub> -P (mg/l)	0.226±0.018 (0.12-0.35)	0.275±0.042 (0.17-0.83)	0.229±0.009 (0.15-0.29)	NS
NH <sub>3</sub> -N (mg/l)	0.200±0.018 (0.11-0.37)	0.222±0.026 (0.10-0.44)	0.206±0.017 (0.12-0.35)	NS
Alkalinity (mg/l)	133.800±2.338 (118-148)	132.466±2.074 (117-144)	135.933±1.837 (125-146)	NS
Chlorophyll-a (µg/l)	63.372±5.943 (30-113.5)	87.398±32.916 (28.80-234.88)	63.573±6.984 (30.50-120.30)	NS

\*P<0.05 and NS=Not significant

**Plankton populations**

Forty three genera of phytoplankton belonging to four major groups: Bacillariophyceae, Chlorophyceae, Cyanophyceae, and Euglenophyceae were identified during the study period. Nine genera of zooplankton

belonging to Rotifera and Crustacea group were also identified. The mean abundance of plankton populations with their different groups are shown in Table 2.

**Table 2.** Mean abundance  $\pm$ SE of plankton ( $\times 10^3$  cells  $l^{-1}$ ) as recorded from the fish sanctuary under different treatments

Plankton group	Treatments			Level of significance
	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>	
Bacillariophyceae	24.433 $\pm$ 8.34 (11-139.5)	31.500 $\pm$ 9.32 (6.5-119.5)	30.033 $\pm$ 9.22 (5.5-119)	NS
Chlorophyceae	42.966 $\pm$ 3.76 (15.5-63)	38.666 $\pm$ 4.41 (13.5-73)	37.800 $\pm$ 4.27 (12.5-70)	NS
Cyanophyceae	11.466 <sup>a</sup> $\pm$ 1.23 (4-21)	8.4666 <sup>b</sup> $\pm$ .93 (4-18.5)	7.666 <sup>b</sup> $\pm$ 0.91 (3.5-17.5)	*
Euglenophyceae	9.600 $\pm$ 1.61 (3-28.5)	8.100 $\pm$ 1.56 (2-19.5)	7.466 $\pm$ 1.44 (2-18)	NS
Total Phytoplankton	88.467 $\pm$ 10.12 (48.5-219)	86.733 $\pm$ 14.00 (34-217)	82.967 $\pm$ 13.61 (31.5-212)	NS
Rotifera	1.0000 <sup>b</sup> $\pm$ 0.23 (0-3.5)	1.7333 <sup>b</sup> $\pm$ 0.33 (0.5-4)	8.666 <sup>a</sup> $\pm$ 0.15 (0-2)	*
Crustacea	2.366 $\pm$ 0.40 (0-5.5)	2.500 $\pm$ 0.18 (1.5-4)	2.133 $\pm$ 0.16 (1-3)	NS
Total Zooplankton	3.366 <sup>b</sup> $\pm$ 0.49 (0-5.5)	4.233 <sup>b</sup> $\pm$ 0.46 (2-7.5)	10.779 <sup>a</sup> $\pm$ 0.24 (1-4.5)	*
Total Plankton	91.833 $\pm$ 10.28 (49.5-224)	90.961 $\pm$ 14.32 (37-223.5)	85.966 $\pm$ 13.56 (35-214)	NS

Means with the different superscripts are significantly different ( $P < 0.05$ )

**SIS biodiversity**

A total of 32 species were recorded from different treatments viz. 30 from *Matshyarani* fish sanctuary and 25 and 24 species from 1 km upstream and downstream of the sanctuary, respectively. The national biodiversity status of fish species that were found in the study sites is shown in Table 3. The

number of SIS fluctuated in the sampling months in all the sites. Analysis of Variance (ANOVA) indicates inter-month, inter site and their interaction is significant ( $P < 0.05$ ) in SIS numerical abundance (Table 4). Most abundant SIS in weight (top five in each treatment) in different treatments is presented in (Table 5).

**Table 3.** The SIS and prawn species found in different treatments of the studied sites over 5 months of the sampling period in 2008 and their national biodiversity status (Red Book, IUCN, 2000). CR: Critically endangered; EN: Endangered; VU: Vulnerable; NO: Not threatened and DD: Data deficient

Local name	Scientific name	IUCN BD status	Treatments	Jan	Feb	Mar	Apr	May
Biam	<i>Mastacembelus armatus</i>	EN	T <sub>1</sub>	√	√	√	√	√
			T <sub>2</sub>	√	√	√	√	√
			T <sub>3</sub>	√	√	√	√	√
Baila	<i>Glossogobius giuris</i>	NO	T <sub>1</sub>	√	√	√	√	√
			T <sub>2</sub>	√	√	√	√	√
			T <sub>3</sub>	√	√	√	√	√
Gulsha	<i>Mystus bleekeri</i>	NO	T <sub>1</sub>	√	√	√	√	√
			T <sub>2</sub>	√	√	√	√	√
			T <sub>3</sub>	√	√	√	√	√

**Table 3.** (cont'd)

Local name	Scientific name	IUCN BD status	Treatments	Jan	Feb	Mar	Apr	May
Jat puti	<i>Puntius sophore</i>	NO	T <sub>1</sub>	√	√	√	√	√
			T <sub>2</sub>	√	√	√	√	√
			T <sub>3</sub>	√	√	√	√	√
Tit puti	<i>Puntitus ticto</i>	VU	T <sub>1</sub>	√	√	√	√	√
			T <sub>2</sub>	√	√	√	√	√
			T <sub>3</sub>	√	√	√	√	√
Chirka	<i>Macrognaathus pancalus</i>	EN	T <sub>1</sub>	√	√	√	√	√
			T <sub>2</sub>	√	√	√	√	√
			T <sub>3</sub>	√	√	√	√	√
Chela	<i>Salmostoma phulo</i>	NO	T <sub>1</sub>	√	√	√	√	√
			T <sub>2</sub>		√	√	√	√
			T <sub>3</sub>		√	√	√	√
Chaka	<i>Chaca chaca</i>	EN	T <sub>1</sub>				√	√
			T <sub>2</sub>					
			T <sub>3</sub>					
Mola	<i>Amblypharyngodon mola</i>	NO	T <sub>1</sub>	√	√	√	√	√
			T <sub>2</sub>	√	√	√	√	√
			T <sub>3</sub>	√	√	√	√	√
Kutakanti	<i>Hara hara</i>	NO	T <sub>1</sub>	√	√	√	√	√
			T <sub>2</sub>			√	√	√
			T <sub>3</sub>			√	√	√
Napit koi	<i>Badis badis</i>	EN	T <sub>1</sub>		√	√	√	√
			T <sub>2</sub>			√	√	√
			T <sub>3</sub>			√	√	√
Kholisha	<i>Polyacanthus fasciatus</i>	NO	T <sub>1</sub>	√	√	√	√	√
			T <sub>2</sub>		√	√	√	√
			T <sub>3</sub>		√	√	√	√
Kakila	<i>Xenentodon cancila</i>	NO	T <sub>1</sub>	√	√	√	√	√
			T <sub>2</sub>	√	√	√	√	√
			T <sub>3</sub>	√	√	√	√	√
Tengra	<i>Mystus vittatus</i>	NO	T <sub>1</sub>	√	√	√	√	√
			T <sub>2</sub>	√	√	√	√	√
			T <sub>3</sub>	√	√	√	√	√
Dhela	<i>Osteobrama cotio cotio</i>	EN	T <sub>1</sub>		√	√	√	√
			T <sub>2</sub>			√	√	√
			T <sub>3</sub>			√	√	√

**Table 3.** (cont'd)

Local name	Scientific name	IUCN BD status	Treatments	Jan	Feb	Mar	Apr	May
Kanpona	<i>Aplocheilus panchax panchax</i>	NO	T <sub>1</sub>		√	√	√	√
			T <sub>2</sub>		√	√	√	√
			T <sub>3</sub>		√	√	√	√
Gutum	<i>Lepidocephalichthys guntea</i>	NO	T <sub>1</sub>		√	√	√	√
			T <sub>2</sub>		√	√	√	√
			T <sub>3</sub>		√	√	√	√
Gang gutum	<i>Lepidocephalichthys irrorata</i>	EN	T <sub>1</sub>			√	√	√
			T <sub>2</sub>				√	√
			T <sub>3</sub>				√	√
Bheda	<i>Nandus nandus</i>	VU	T <sub>1</sub>			√	√	√
			T <sub>2</sub>				√	√
			T <sub>3</sub>				√	√
Savon korika	<i>Schistura savona</i>	NO	T <sub>1</sub>			√	√	√
			T <sub>2</sub>				√	√
			T <sub>3</sub>				√	√
Panga	<i>Pangio pangia</i>	NO	T <sub>1</sub>				√	
			T <sub>2</sub>					
			T <sub>3</sub>					
Balichata	<i>Acanthocobitis botia</i>	NO	T <sub>1</sub>				√	√
			T <sub>2</sub>					
			T <sub>3</sub>					
Kanchan puti	<i>Puntius conchonius</i>	EN	T <sub>1</sub>					√
			T <sub>2</sub>					
			T <sub>3</sub>					
Chhep chela	<i>Chela cachius</i>	EN	T <sub>1</sub>				√	√
			T <sub>2</sub>					
			T <sub>3</sub>					
Chanda	<i>Chanda nama</i>	VU	T <sub>1</sub>				√	√
			T <sub>2</sub>				√	√
			T <sub>3</sub>				√	√
Ranga chanda	<i>Parambassis ranga</i>	VU	T <sub>1</sub>				√	√
			T <sub>2</sub>					
			T <sub>3</sub>					
Potka	<i>Tetraodon cutcutia</i>	NO	T <sub>1</sub>				√	√
			T <sub>2</sub>				√	√
			T <sub>3</sub>				√	√

**Table 3.** (cont'd)

Local name	Scientific name	IUCN BD status	Treatments	Jan	Feb	Mar	Apr	May
Indiant torrent catfish	<i>Amblyceps mangois</i>	DD	T <sub>1</sub>			√	√	√
			T <sub>2</sub>					
			T <sub>3</sub>					
Kucha chingri	<i>Machrobrachium rude</i>	NO	T <sub>1</sub>	√	√	√	√	√
			T <sub>2</sub>	√	√	√	√	√
			T <sub>3</sub>	√	√	√	√	√
Chhotka chingri	<i>Macrobrachium malcolmsonii</i>	NO	T <sub>1</sub>			√	√	√
			T <sub>2</sub>			√	√	√
			T <sub>3</sub>			√	√	√
Air	<i>Sperata aor</i>	VU	T <sub>1</sub>					
			T <sub>2</sub>				√	√
			T <sub>3</sub>					
Rani	<i>Botia daryo</i>	EN	T <sub>1</sub>					
			T <sub>2</sub>	√		√	√	√
			T <sub>3</sub>		√	√	√	√

**Table 4.** ANOVA of the effects of month, site and interaction on numerical abundance of SIS in the river Brahmaputra from January to May 2008 (DF, degree of freedom; SS, sum of square; MS, Mean square; SS/df; F, MS among/MS within).

Source	SS	DF	MS	F-value
Month	275.186	4	68.796	5.096 <sup>***</sup>
Sampling site	349.678	2	174.839	12.951 <sup>***</sup>
Month × Sampling site	375.147	8	46.893	3.474 <sup>***</sup>

**Table 5.** Weight (gm) of fish in different Sampling sites (mean weight ± standard error)

Most abundant species	Weight of fish in Sampling site		
	Sanctuary (T <sub>1</sub> )	Upstream (T <sub>2</sub> )	Downstream (T <sub>3</sub> )
Baim	263.55 ± 42.12 (1)	83.52 ± 14.78 (3)	86.4±13.55 (3)
Baila	142.53 ± 21.83 (3)	89.18 ± 14.33 (2)	97.17 ± 15.58 (2)
Gulsa	257.11 ± 52.98 (2)	123.1 ± 20.97 (1)	118.73 ± 17.95 (1)
Tengra	96.69 ± 14.74 (5)	-	-
Chotka chingri	112.22 ± 18.16 (4)	62.77 ± 16.03 (4)	59.4 ± 16.08 (4)
Jat punti	-	51.94 ± 10.68 (5)	59.1 ± 7.24 (5)

Values in parenthesis indicate the abundance ranking of SIS in each treatment

**Discussion**

The growth of aquatic organisms strongly depends on the water quality. In the present study we investigated all physical and chemical factors of water quality

parameters of Matshyarani Fish sanctuary. The temperature of the Matshyarani fish sanctuary was found to vary from 15 to 32<sup>o</sup>C, which supposed to be suitable for growth of primary and secondary

producers and also for fish. Similar results were also found by the Nath and Srivastava (2001). In the present study the transparency ranges from 70 to 208 cm was recorded which is similar with the study of CIFRI (2000) who recorded water transparency ranging from 60 to 200 cm. The highest transparency observed in treatment T<sub>1</sub> might be due to the highest depth. The velocity of different treatments was also varied from 0.10 to 0.14 m/s during the study period. The maximum velocity of 0.14 m/s was found during March in treatment T<sub>1</sub> while the minimum velocity of 0.10 m/s was found during April in all the treatments. Nath and Srivastava (2001) reported that the water depth of Narmada River was moderate during post-monsoon period (3.0-15.0), which was reduced in winter (1.3-5) and was very low during summer. The present study was also observed a significant difference in depth with months among the treatments. Matshyarani sanctuary was built in the deeper place and the diversity of species depends primarily upon the nature of environment. The TDS of different treatments were varied from 145 to 171 mg/l during the study period. Hoq *et al.* (2006) revealed that 20-220 mg/l of TDS were observed in the Sundarbans water of Bangladesh. DoF (1996) reported that the range of pH of a suitable water body would be 6.5-8.5. In the present study, pH values varied from 7.3 to 8.7, which was similar to the findings of Nath and Srivastava (2001) and CIFRI (2000). The concentrations of dissolved oxygen in the experimental sites were generally fluctuated and having the range from 5.28 to 8.45 mg l<sup>-1</sup>, which were similar to the study of CIFRI (2000). In the present study, dissolved oxygen concentrations were suitable for fish culture throughout the experimental period. The range of NO<sub>3</sub>-N from 0.022 to 0.078 mg l<sup>-1</sup> was found in open water by Pathak *et al.* (2001) that is similar with the findings of this study. The major source of ammonia in pond water is the direct excretion of ammonia by fish (Tucker and Boyd, 1979). In the present study, the highest and the lowest concentration of total ammonia were 0.10 to 0.44 mg l<sup>-1</sup>, respectively. Rahman (2000) recorded NH<sub>3</sub>-N of 0.15 to 0.18 mg L<sup>-1</sup> in Padmai *beel* of Netrakona. Therefore, the concentrations of ammonia-nitrogen in all experimental sites of the present study were within acceptable limits, and there were no significant variations among the treatments. The values of chlorophyll *a* (µg l<sup>-1</sup>) indirectly expressed the abundance of phytoplankton of the water body. Ahmed (1993) found a negative relationship between chlorophyll *a* and water transparency. Khatrai (1984) also found a positive relationship between phytoplankton and chlorophyll *a*. In the present study, chlorophyll *a* values ranged from 28.80 to 234.88 µg l<sup>-1</sup> and the mean values in treatments 1, 2 and 3 were

63.3727±5.94331, 87.3987±32.91639 and 63.5733±6.98469 µg l<sup>-1</sup>, respectively. These values indicate that all the experimental sites were highly productive and suitable for fish production. The ranges of total alkalinity in present study found from 117 mg l<sup>-1</sup> to 148 mg l<sup>-1</sup>. These values are similar with the findings of Khan *et al.* (1990).

During the study period, a total of 43 genera of phytoplankton (Bacillariophyceae, Chlorophyceae, Cyanophyceae, Euglenophyceae) and 9 genera of zooplankton (Crustacea and Rotifera) were identified. Most dominant genera were *Fragillaria*, *Navicula*, *Nitzschia*, *Melosira*, *Ankistrodesmus*, *Chlorella*, *Pediastrum*, *Scenedesmus*, *Spirogyra*, *Tetraedron*, *Ulothrix*, *Microcystis*, *Gomphosphaeria*, *Oscillatoria*, *Euglena*, *Brachionus*, *Asplanchna*, *Notholca*, *Lecane*, *Keratella*, *Moina*, *Cyclops*, and *Nauplius*. Singh *et al.* (1999) identified 31 genera of phytoplankton and 14 of zooplankton. Total zooplankton was significantly higher in treatment T<sub>3</sub> might be due higher organic decomposition and lower current.

A total of 32 species were recorded from different treatments *viz.* 30 from *Matshyarani* fish sanctuary and 25 and 24 species from 1 km upstream and downstream of the sanctuary, respectively. Khosru (2007) reported 25 species inside of the sanctuary and 30 species from outside of the sanctuary. So the number of species increased after establishment of sanctuary. The highest numbers of species were found in the last two months – April and May and the least species were found in the first month of the sampling – January might be due to fishes were took time to adapt in the new habitat. The most abundant SIS in number were *Macrobrachium rude* (Kucha chingri), *Puntius ticto* (Tit punti), *Mystus bleekeri* (Gulsha), *Mystus vittatus* (Tengra) and *Macrobrachium malcolmsonii* (Chotka chingri) in T<sub>1</sub>; *Macrobrachium rude* (Kucha chingri), *Puntius ticto* (Tit punti), *Glossogobius giuris* (Baila), *Puntius sophore* (Jat punti) and *Mystus bleekeri* (Gulsha) in T<sub>2</sub> and *Macrobrachium rude* (Kucha chingri), *Puntius ticto* (Tit punti), *Salmostoma phulo* (Chela), *Glossogobius giuris* (Baila) and *Puntius sophore* (Jat punti) in T<sub>3</sub>. Both number of species and individual fish gradually increased over the months in the *Matshyarani* sanctuary than the other sites of the present study, as more and more periphyton and other food materials grown on the tree branches and bamboos and the habitat became more suitable for the fish. Haque *et al.* (2007) observed 43 species with the highest availability of a loach - *Psilorhynchus sucatio* and a Bagrid catfish, Tengra - *Mystus vittatus* in the three sanctuaries established under CBFM-2 project in the three rivers namely - Updakhali, the Kalihar



and the Kangsha in Netrokona district using bamboo and tree branches as sanctuary materials.

The reported endangered fishes were reappeared in the sanctuary – the notable were kanchan puti- *Puntius conchonicus*, Balichata- *Acanthocobitis botia*, *Amblyceps mangois*, Chaka- *Chaca chaca*, chhep chela- *Chela cachius*, bheda- *Nandus nandus*, gang gutum- *Lepidocephalichthys irrorata*, etc species were found in different treatments throughout the study period whereas kanchan puti- *Puntius conchonicus*, Balichata- *Acanthocobitis botia*, *Amblyceps mangois*, Chaka- *Chaca chaca* species were only found in *Matshyarani* fish sanctuary. The availability of these species were highest in sanctuary, because of its potentiality, food availability, shelter for free breeding and hazardless environment. Kucha chingri was abundantly available in all the samplings and stood first regarding the number of individuals. The abundance of minnows and kucha chingri proved that the fish sanctuary was especially helpful and acted as friendly ecosystem for small fishes than the other sites.

### Conclusions

Setting up of a fish sanctuary can help to improve the status of fish habitat and biodiversity in perennial rivers like the old Brahmaputra which became a seasonal rivulet due to many manmade and natural factors. The setting up of a sanctuary in the deeper part of the Brahmaputra where fish and other aquatic animals can stay during the lean season and grow and attain maturity for spawning in the next monsoon– is obviously very significant. At the onset of next monsoon, these aquatic animals are expected to be dispersed on different part of the river and contributing the recruitments from the next year. The SIS abundance is related to natural habitat as well as the water quality and food abundance in the river.

The present study revealed that the qualitative and quantitative SIS diversity and natural food abundance inside the *Matshyarani* fish sanctuary were significantly more than both the upstream and downstream of the sanctuary. Sanctuary is an important fisheries management tool is used worldwide for the conservation, protection and restoration of fish species.

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