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ICHTHYOFAUNAL DIVERSITY OF THE FRESHWATER SWAMP FOREST RATARGUL, SYLHET, BANGLADESH

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ABSTRACT: An ichthyofaunal study in the Ratargul swamp forest, north Sylhet was carried out from July 2014 to June 2015 resulted in the collection of 37 species of fishes belonging to nine orders and 21 families. Order Cypriniformes dominated contributing 27.03% of the total fish. Shannon-Wiener diversity index (*H'*), the Margalef species richness (*d*), the Pielou's evenness index (*J'*) and the Simpson dominance index (*c*) were calculated as 2.28±0.294, 5.18± 1.23, 0.96±0.013 and 0.96±0.012. SIMPER analysis divulged the highest dissimilarity (56.22%) in between the January-August group and lowest (10.07%) in the July-August group. Non metric-multidimensional scaling **(**nMDS) showed 50% similarity for all months, while 80% similarity showed four separate clusters among all months. Wise use of this wetland and establishment of fish sanctuary are suggested for long-term conservation of the native fish species and the ecosystem.

KEYWORDS: Ratargul swamp forest, Ichthyofaunal diversity, Cypriniformes, Diversity indices, SIMPER analysis, nMDS and Conservation

INTRODUCTION

In terms of aquatic biodiversity, Bangladesh possesses the third largest position (about 800 species in fresh, brackish and marine waters) in Asia[1]. The geographic location of Bangladesh is helpful and it gives huge opportunities to keep up prospects in fisheries sector[2]. Bangladesh has many flood plains in the form of saucer-shaped wetlands such as haors, baors and marshy or swampy water areas in the north-eastern region of the country, like in Sylhet division (Habiganj, Moulvibazar, Sunamganj and Sylhet districts). Ratargul swamp forest is the only forested fresh water wetland of Bangladesh and it is among twenty-two (22) freshwater swamp forests of the world. Nabahungu[3] mentioned freshwater swamp forest as 'biological supermarket' for its unique biodiversity. This ecosystem harbors rich species diversity with a number of timber and non- timber forest products which acts an important factor in maintaining biodiversity and same time sustaining livelihoods of local people[4]. Fish hold a large part of standing biomass of aquatic ecosystem (Fresh, Brackish and Marine water ecosystem)[5]. A large number of fresh water fish species already have entered into endangered list, for intense human intervention like, habitat degradation and loss[6,7] and freshwater ecosystem of Bangladesh is not out of these scenarios[8-11]. Research are being carried out worldwide to build conservation planning to preserve freshwater fishes[6,12-15]. Although,

Ichthyofaunal diversity of Ratargul has been made by Islam[16] but these studies are inadequate to discuss the crucial issues related to conserve fishes in the swamp forest. In this context, the present study was carried out (a) to find out the current pattern of ichthyofaunal diversity and abundance, and (b) to construct recommendations for ichthyofaunal conservation.

MATERIALS AND METHODS

Sampling

Ratargul swamp forest (latitude 25°00.025´N and longitude 91°58.180´E) is situated on the bank of the Goyain river and located at about 45 kilometers from Sylhet city **(Figure 1).** The Ratargul swamp forest covers an area of 30,325 acres area where 504 acres declared as the sanctuary in 1973. The word, "Rata" is one kind of tree, locally known the forest's name comes from used by the locals of Sylhet. This swamp forest is surrounded by nine villages of Fateh Pur union namely Ratarghul, Bagh Bari, Dewaner Gaon, Ram Nagar, Mashkher, Julurpar, Chailtha Bari, Kucharkandi and Erertuk under. Primary data on current pattern of ichthyofaunal diversity and abundance collected twice in a month for one year period. Ichthyofaunal diversity was studied and observed through the collection unsorted fish sample directly from the fishermen. The following formulas were used to calculate the relative fish abundance in this research.

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

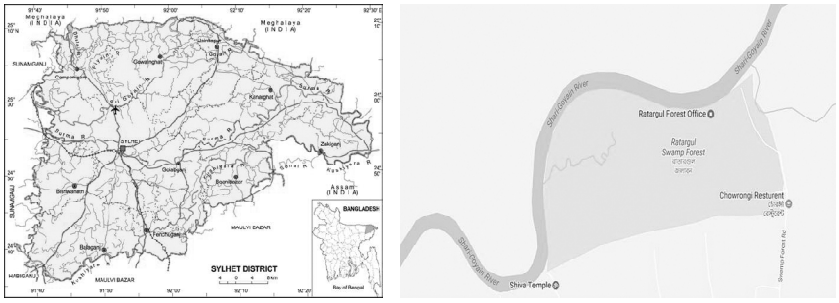

Figure 1: Map of the Ratargul swamp forest area showing the location of the study area

The collected fish samples were immediately preserved in ice box and transferred to the Laboratory of Fish Biology and Genetics Department, Sylhet Agricultural University, Sylhet. Collected sample were sorted, rinsed with tap water and identified based on morphological characteristics[17-21].

Analysis

Shannon-Wiener index (*H2*)[22] was used to analyze the fish diversity in the species assemblage, Margalef index (*d*)[23] was used to measure the species richness,

Pielou's index (*J2*)[24] was used to determine evenness and dominance by Simpson dominance index (*c*)[25].

Shannon-Wiener diversity index (*H'*):

H'= - Sum [pi x log (pi)]

Where,

H' = Shannon-Wiener index

pi = n_i/N

n_i = no. of individuals of a species

N = Total number of individuals

Pielou's evenness index (*J'*):

Where,

H (s) = the Shannon-Wiener information function.

H (max.) = the theoretical maximum value for H(s) if all species in the sample were equally abundant.

Simpson dominance index (*c*):

Where,

n_i = number of individuals in the 'each' species

N = total number of individuals

S = total number of species

All calculation were done using the PRIMER V6 (version 6.1) software.

The significance of temporal variation was found by One-way analysis of Similarity (ANOSIM) in the structure of fish assemblage[26, 27]. A Bray-Curtis similarity matrix test was used where log (X+1) transformed data were calculated. Similarity percentages analyses (SIMPER) Clarke[26] were used for finding the average non-similarity in the contribution of every taxon. Hierarchical agglomerative clustering with group-averaging linking and nMDS or non-metric multidimensional scaling was performed to investigate months similarities among fish abundance and analysis were done on the Bray-Curtis similarity[28]. For descriptive statistics and ANOVA, test SPSS (Statistical Package for Social Sciences) software V20[29] were used. The software PRIMER V6 version 6.1(Plymouth Routines in Multivariate Ecological Research) [26,27] was used for multivariate analyses.

RESULTS AND DISCUSSION

Fish species of Ratargul swamp forest

A sum of 37 fish species from nine orders and 21 families were reported from the study area **(Table 1).** Order Cypriniformes dominated contributing 27.03% of the fish assemblage, next were Siluriformes (24.32%), Perciformes (16.22%), Anabantiformes (10.81%), Clupeiformes (8.11%), Synbranchiformes (5.41%), Gobiiformes (2.70%), Mugiliformes (2.70%) and Tetraodontiformes (2.70%) **(Figure 2)**.

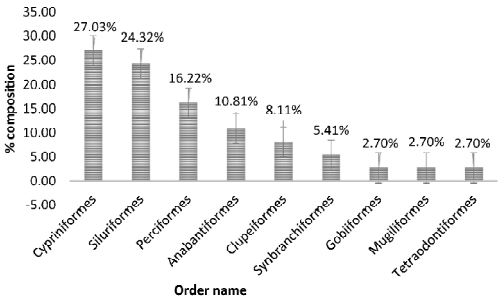

Figure 2: Order-wise composition of fishes in the study area

Table 1. List of different fish species with their order, family, scientific name, common name, local name, and IUCN status.

Sl. No.	Order	Family	Scientific Name	English Name	Local Name	IUCN Status*
1	Clupeiformes	Clupeidae	*Gudusia chapra* (Hamilton, 1822)	Indian river shad	Chapila	NT
2			*Tenualosa ilisha* (Hamilton, 1822)	Indian river shad	Ilish	NT
3			*Corica soborna* (Hamilton, 1822)	Ganges river sprat	Kachki	NT
4		Cobitidae	*Lepidocephalus guntea* (Hamilton, 1822)	Guntea loach	Gutum	NT
5	Cypriniformes	Cyprinidae	*Salmostomata acinaces* (Valenciennes,1844)	Silver razor belly minnow	Chella	NT
6			*Labeo calbasu* (Hamilton, 1822)	Black rohu	Kalibaush	EN
7			*Labeo gonius* (Hamilton, 1822)	Kuria labeo	Ghonia	EN
8			*Labeo bata* (Hamilton, 1822)	Bata	Bata	NT
9			*Osteobrama cotio* (Hamilton, 1822)	Cotio	Dhela	EN
10			*Amblypharyngodon mola* (Hamilton, 1822)	Mola carplet	Mola	NT
11			*Puntius ticto* (Hamilton, 1822)	Firefin barb/ticto barb	Tit punti	VU
12			*Puntius sophore* (Hamilton, 1822)	Spot fin swamp barb	Jat punti	NT
13			*Esomus danrica* (Hamilton, 1822)	Gangetic scissortail rasbora	Darkina	DD
14	Gobiiformes	Oxudercidae	*Awaous grammepomus* (Bleeker,1849)	Scribbled Goby	Goby	VU
15	Anabantiformes	Anabantidae	*Anabas testudineus* (Bloch, 1792)	Climbing perch	Koi	NT
16		Channidae	*Channa striatus* (Bloch, 1793)	Snakehead murrel	Shol	NT
17			*Channa punctatus* (Bloch, 1793)	Spotted snakehead	Taki	NT
18			*Channa orientalis* (Bloch & Schneider, 1801)	Asiatic snakehead	Cheng	VU
19	Perciformes	Centropomidae	*Chanda nama* (Hamilton, 1822)	High finglassy perchlet	Lomba chanda	VU
20			*Parambassis ranga* (Hamilton, 1822)	High finglassy perchlet	Lal chanda	VU
21		Sciaenidae	*Otolithoides pama* (Hamilton, 1822)	Pama croaker	Pama	NT
22		Nandidae	*Nandus nandus* (Hamilton, 1822)	Gangetic leaf fish	Meni/veda	VU
23		Osphronemidae	*Ctenops nobilis* (McClelland, 1845)	Frail Gourami	Neftani	EN
24		Sciaenidae	*Johnius coitor*(Hamilton, 1822)	Coitor croaker	Poa	NT
25	Mugiliformes	Mugilidae	*Rhinomugil corsula*(Hamilton, 1822)	Corsula mullet	Halla	NT
26	Siluriformes	Plotosidae	*Plotosus canius*(Hamilton, 1822)	Gray eel catfish	Gang magur	VU
27		Bagridae	*Mystus bleekeri* (Day,1877)	Gantatic mystus	Gulsha	NT
28			*Mystus tengra*(Hamilton, 1822)	Stripped dwarf catfish	Bujuri tengra	NT
29			*Mystus vittatus* (Bloch,1794)	Striped dwarf catfish	Tengra	NT

30		Sisoridae	*Bagarius bagarius*(Hamilton, 1822)	Gangetic goonch	Baghair	CR
31		Heteropneustidae	*Heteropneustes fossilis* (Bloch,1794)	Stinging catfish	Shing	NT
32		Schilbeidae	*Eutropiichthys vacha*(Hamilton, 1822)	Batchwa bacha	Bacha	CR
33		Ailiidae	*Ailia coila* (Hamilton, 1822)	Gangetic ailia	Kajuli	NT
34		Erethistidae	*Conta conta*(Hamilton, 1822)	Conta catfish		DD
35	Synbranchiformes	Mastacembelidae	*Macrognathus aculeatus*(Bloch,1786)	One striped spiny eel	Tara baim	VU
36			*Mastacembelus armatus* (Lacepede,1800)	Tire-track spiny eel	Shal baim	EN
37	Tetraodontiformes	Tetraodontidae	*Dichotomyctere fluviatalis* (Hamilton, 1822)	Green pufferfish	Potka	NT

*****Status DD,CR, EN, NT and VU are based on IUCN Bangladesh (2015); DD, Data deficient; CR,Critically Endangered; EN, Endangered; NT, Not Threatened and VU, Vulnerable.

Table 2. SIMPER analysis showing % dissimilarity between different months with their contributing fish species

January & February Average dissimilarity = 17.76%		**Groups January & March Average dissimilarity = 26.76**		**Groups February & March Average dissimilarity = 20.89**	
Species	Cont.(%)	Species	Cont.(%)	Species	Cont.(%)
M. aculeatus	18.90	M. tengra	14.66	M. tengra	16.04
H. fossilis	12.79	C. nama	10.44	C. nama	11.43
N. nandus	12.79	H. fossilis	10.44	N. nandus	9.06
A. testudinious	12.79	C. soborna	8.28	C. srtiatus	9.06
G. chapra	8.07	C. srtiatus	8.28	A. testudinious	9.06
A. mola	8.07	M. aculeatus	7.12	C. soborna	8.49
M.vittatus	6.51	M. vittatus	6.90	M. armatus	6.99
M. bleekeri	5.47	A. mola	6.90	G .chapra	5.72
C. nama	3.92	M. bleekeri	5.94	C. orientalis	5.72
C. punctatus	3.35	M. armatus	5.22	M. aculeatus	5.6
January & April Average dissimilarity = 35.65		February & April Average dissimilarity =33.95		Groups March & April Average dissimilarity = 20.11	
Groups Jan & May Average dissimilarity = 40.23		Groups January & November Average dissimilarity = 37.30		Groups February & November Average dissimilarity = 38.85	
Groups Mar & May Average dissimilarity= 29.30		Groups April& May Average dissimilarity=14.37		Groups January& June Average dissimilarity=43.15	
Groups February & June Average dissimilarity=38.54		Groups March &June Average dissimilarity=30.59		Groups April & June Average dissimilarity=20.20	
Groups May &June Average dissimilarity=11.91		Groups January & July Average dissimilarity=50.77		Groups February & July Average dissimilarity=44.97	
Groups March & July Average dissimilarity=39.87		Group April & July Average dissimilarity=30.88		Groups May & July Average dissimilarity = 23.20	

Groups June & July Average dissimilarity = 19.10	Groups January & August Average dissimilarity = 56.22	Groups February & August Average dissimilarity = 46.72
Groups March & August Average dissimilarity = 42.96	Groups April & August Average dissimilarity = 36.20	Groups May & August Average dissimilarity = 28.06
Groups June & August Average dissimilarity = 24.33	Groups July & August Average dissimilarity = 10.07	Groups January & September Average dissimilarity = 47.02
Groups February & September Average dissimilarity = 40.66	Groups March & September Average dissimilarity = 36.32	Groups April & September Average dissimilarity = 34.14
Groups May & September Average dissimilarity = 25.71	Groups June & September Average dissimilarity = 20.59	Groups July & September Average dissimilarity = 15.29
Groups August & September Average dissimilarity = 18.83	Groups January & October Average dissimilarity = 42.25	Groups March & October Average dissimilarity = 33.77
Groups April & October Average dissimilarity = 34.68	Groups May & October Average dissimilarity = 27.19	Groups June & October Average dissimilarity = 21.65
Groups July & October Average dissimilarity = 23.1	Groups August & October Average dissimilarity = 26.39	Groups September & October Average dissimilarity = 12.56
Groups March & November Average dissimilarity = 36.58	Groups April & November Average dissimilarity = 40.82	Groups May & November Average dissimilarity = 31.66
Groups June & November Average dissimilarity = 31.97	Groups July & November Average dissimilarity = 33.04	Groups August & November Average dissimilarity = 38.03
Groups September & November Average dissimilarity = 25.09	Groups October & November Average dissimilarity = 19.68	Groups January & December Average dissimilarity = 46.35
Groups February & December Average dissimilarity = 43.27	Groups March & December Average dissimilarity = 43.93	Groups April & December Average dissimilarity = 50.12
Groups May & December Average dissimilarity = 42.30	Groups June & December Average dissimilarity = 44.83	Groups July & December Average dissimilarity = 45.62
Groups August & December Average dissimilarity = 49.46	Groups September & December Average dissimilarity = 40.75	Groups October & December Average dissimilarity = 38.97
Groups November & December Average dissimilarity = 22.59		

Fish diversity indices

The mean Shannon-Wiener diversity index (*H'*)[22] value was 2.28±0.294 which ranged from 2.22 (January) to 3.29 (August) **(Figure 3)**. The Margalef species richness (*d*)[23] ranged from 3.01 (January) to 7.63 (August) with a mean value of 5.18± 1.23 **(Figure 3**). The highest Pielou's[24] evenness index (*J'*) 0.98 was recorded in May and June; lowest 0.94 was in August and December with a mean value of 0.96±0.013 (**Figure 3)**. The peak Simpson Dominance index (*c*)[25] value 0.93 was observed in January and 0.97 in May to September with a mean value of 0.96±0.012 (**Figure 3**).

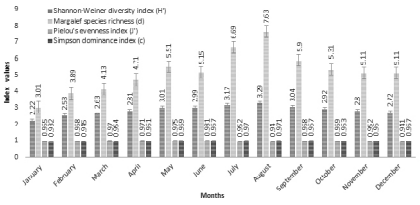

Figure 3: Different diversity index values in different months

Fish species assemblage

- **Similarity Percentage (SIMPER) between months**

SIMPER analysis divulged the average percent dissimilarity of species between different months. In the present study, highest dissimilarity (56.22%) was observed in between January-August group and lowest (10.07%) in the July-August group **(Table 2).** The highest contributing species in the January –August group were *Mystus tengra* (7.35%), *Chanda nama* (6.73%), *Mystus tengara* (6.52%), *Pethia ticto* (5.30%), *Osteobrama cotio* (4.96%), *Macrognathus aculeatus* (4.54%), *Eutropiichthys vacha* (4.54%), *Labeo calbasu* (4.30%), *Ailia coila* (4.30%), *Mystus bleekeri* (4.08%), *Mastacembelus armatus* (4.07%), *Puntius sophore* (3.73%), *Dichotomyctere fluviatilis* (3.70%), *Heteropneustes fossilis* (3.33%), *Salmostoma acinaces* (3.33%), *Amblypharyngodon mola* (3.11%), *Channa gachua* (2.86%), *Gudusia chapra* (2.27%), *Corica soborna* (1.87%), *Tenualosa ilisha* (1.43%) and *Esomus danricus* (1.43%). On the other hand the contributing species in the July-August group were *Heteropneustes fossilis* (13.03%), *Mystus tengara* (10.41%), *Mastacembelus armatus* (7.05%), *Nandus nandus* (5.61%), *Otolithoides pama* (5.61%), *Plotosus canius* (5.61%), *Conta conta* (5.61%), *Ailia coila* (5.61%), *Salmostoma acinaces* (4.14%), *Puntius sophore* (3.82%), *Rohtee cotio* (3.66%), *Awaous grammepomus* (3.28%), *Labeo bata* (3.28%), *Dichotomyctere fluviatilis* (3.28%), *Gudusia chapra* (2.33%), *Channa gachua* (2.33%), *Pethia ticto* (2.12%), *Amblypharyngodon mola* (2.03%) and *Eutropiichthys vacha* (2.03%).

- **Cluster analysis and Non-metric Multidimensional Scaling (nMDS)**

Four marked separation was observed in the abundance of fish in different months (figure 4). At the similarity of 72.9% fish species, four groups were attained in which January, February, March represents one cluster; April, May, June a second cluster and July, August, September, October a separate cluster. In November and December represents a single cluster during the research period.

(nMDS) Non-metric_Multidimensional scaling was employed to hit off abundance similarities among fish. Non-metric_Multidimensional scaling shows 50% similarity for all months. On the other hand, three separate clustering showed in 70% similarity. However, at 80% similarity four separate clusters were observed in the fish abundance in the Ratargul swamp forest area (**figure 5)**.

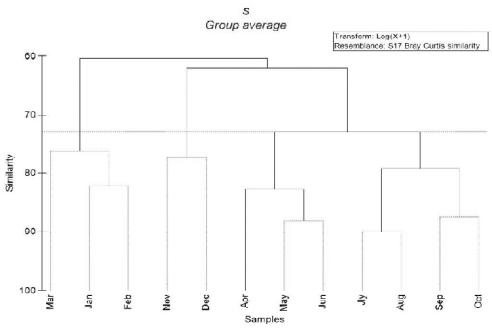

Figure 4: Cluster analysis based on Bray-Curtis similarity matrix of different months.

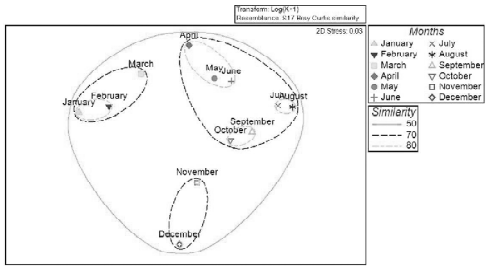

Figure 5: 2-dimensional ordination in nMDS showing similarity of different months

Swamp forest has a great ecological significance due to their unique characteristics in maintaining wetland biodiversity. Nishat[30] mentioned Ratargul swamp forest as 'Bio-ecological zones of Bangladesh'. Ratargul swamp forest, Sylhet, was reported with 73 species plants, 20 species amphibians, 175 species of birds and 26 species of mammals by Choudhury[31]. After 12 years, Islam[16] studied ichthyofaunal pattern in Ratargul swamp forest, they found only 12 numbers of fishes and the study period was only for one week. In our study, a total of 37 species of fishes were found from one-year time duration.

In the study time, order Cypriniformes dominated contributing 27.03% of the total fish assemblages **(Figure 2)** similar to the results from Hakaluki Haor, Sylhet[9], in Upper Halda River, Chittagong[32] and in River choto Jamuna of Naogaon[7]. In the present study, 14 threatened species (37.84%) including endangered species five, Vulnerable seven species and Critically Endangered two fish species were found. Freshwater fish diversity in Bangladesh rich with 253 species, among these 64 are categorized as threatened (IUCN, 2015)[33]. The two Critically Endangered species of the swamp were *Bagarius bagarius* and *Eutropiichthys vacha* from the order Siluriformes.

Iqbal[9] recorded mean values of different indices: Shannon-Wiener diversity (*H'*)[22], richness (*d*), Evenness (e) and Dominance indices were as 2.53, 5.94, 0.66 and 0.081, respectively in Hakaluki Haor, Sylhet – while mean values were found 2.28, 5.18, 0.96 and 0.96, respectively in Ratargul swamp forest. Shannon-Wiener diversity (*H'*)[22], richness (*d*) values of Ratargul swamp were lower than Hakaluki Haor, the reasons might be few numbers of fish species and less water spread area of swamp. Biligrami[34] recommended that Shannon-Wiener diversity index[22] ranged from 3.0-4.50, which represents good condition for fish diversity of particular waterbody. In present study, Shannon-Wiener diversity[22] mean value was 2.28, indicates the muddy condition of water body.

Magurran[35] stated that a biodiversity index is a single number which used to

identifying the diversity of a specimen or species. Again, the two components, those are: the number of species or richness and the distribution of specimen among species mainly involve in the concept of species diversity[36,37].

Shannon Wiener diversity index represents the proportion and richness of each species. Evenness and Dominance indices consider the contribution of common species and the relative number of individuals in the sample respectively.

Shannon-Wiener diversity index (*H'*)[22] showed that fish assemblage was moderately diverse in Ratargul Swamp Forest. Shannon-Wiener diversity index (*H'*)[22] and Margalef species richness (*d*)[23] index were observed high in August (3.29 and 7.63 respectively) while low in January month (2.22 and 3.01 respectively). In August, the Ratargul swamp area was inundated by floodwater and fish species were migrated to the swamp forest from Guine river. Again, in this month the native fishermen found more fish in their catch, so diversity showed peak this month. According to Pielou's evenness index[24], fish species were more evenly distributed in May and June (0.98) compared to other months. Simpson dominance index was estimating the highest in June (0.97) which indicates species dominancy was peak in that month compared to other months.

In terms of the cluster analysis, two clusters were observed and in one cluster had majority in the Ratargul swamp forest. Two major clusters were also found in Meghna river estuary, Bangladesh by Hossain[38]. However, in Ratargul swamp, group A comprises the fish species of January, February and March month. Group B contains April, May, June, July, August, September, October, November and December and showed 72.9% similarity with the group A. In general, samples from first cluster (January, February and March) maintained a similarity which is also same for last two months (November and December). The Non-Metric Multi-dimensional Scaling (nMDS) analysis remarks four separate clusters at the 80% similarity in the Ratargul swamp forest; indicates the pattern of species abundance. The present study found maximum contributing species for months are similar but their number of percentages varies from one another.

According to Galib[7], the River Choto Jamuna of Naogaon district was found two exotic fishes. Again, the Hakaluki Haor of Sylhet was recorded fish species including three exotic species such as *Hypophthalmichthys molitrix (*Silver carp), *Oreochromis niloticus (*Nile tilapia) and *O. mossambicus* (Mozambic tilapia)[9]. Konoskhaihaor, Northeast Bangladesh, was also found to have two exotic fish species[10]. Parvez[39] found 10 exotic species, namely *Cyprinus carpio*, *Hypophthalmichthys nobilis*, *Barbonymus gonionotus*, *Ctenopharyngodon idella*, *Hypophthalmichthys molitrix*, *Mylopharyngodon piceus*, *Hypostomus plecostomus*, *Clarius gariepinus*, *Oreochromis mossambicus*, and

Pangasianodon hypopthalmus from three rivers Dhepa, Punarbhaba, and Atrai from northwestern part of Bangladesh. Exotic species are alarming if they are found in natural waterbodies; they compete with existing ichthyofaunal diversity and destroy the harmony of biodiversity. In this study, no exotic fish was found; it bears a mark of appreciation of the natural fish diversity of Ratargul. The reasons might be there were no hatcheries and aquaculture practices in surrounding areas.

CONSERVATION AND RECOMMENDATIONS

The "wise use", or "sustainable use" (Article 3 from the policies of National Wetland Policies' in the Ramsar Convention Secretariat, 2010)[40] of this swamp forest, should be followed for the conservation of Ratargul wetland in Bangladesh. The importance of improvement and protection of the environment and biodiversity is crucial for all nations, so the Government of Bangladesh (GoB) inserted the section in the constitution as "the state shall endeavor to protect and improve the environments preserve and safeguard the natural resources, biodiversity, wetlands, forests and wildlife for the present and future citizens"[41] (Bang. const. art. XVIII A, 2011). These lead us to recommend several conservation strategies to ensure the existing ichthyofauna of the Ratargul freshwater swamp forest. It has distinct flow regimes, so the average freshwater management plan will not be applicable here, the following points are needed to add in conservation strategies:

Freshwater swamp forest is recognized as valuable breeding ground and nursery regions for spawning and juvenile fishes by Thayer[42]. So, fishing should be banned in the breeding season (July-August). Moreover, fish diversity showed the highest in these months. Monofilament Synthetic Nylon Fibre Nets or Current jals should banned, because juveniles stocks of different fishes are destroyed by it.

Tourist flow to the Ratargul swamp forest should be regulated and managed. Poor families dependent on fishing should be provided with alternative livelihood programs in fish breeding seasons. Use of insecticides and pesticides in the cropping system of the surrounding forest should be a minimum in doses to protect the adverse effects on fish species. To conserve available fish species, wise use of this wetland and the establishment of fish sanctuary is recommended.

CONCLUSION

Ratargul swamp forest is important ecosystem in the aspect of fish resources, it will act as a fish harbor especially for breeding, feeding and nursing ground for fishes. A sum of 37 species including 14 threatened species and no exotic fish were found in the study. Again, the biodiversity indices (Shannon-Wiener diversity index[22] (*H'*), the Margalef species richness[23] (*d*), the Pielou's evenness index[24] (*J'*) and the Simpson dominance index[25] (*c*) were

2.28±0.294, 5.18± 1.23, 0.96±0.013 and 0.96±0.012) will provide key information for the conservation strategies of the ichthyofaunal diversity, Ratargul swamp forest.

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