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ECOLOGICAL ASPECTS AND AFFECTIVITY OF BIODIVERSITY RESTORATION OF BAIKKA BEEL, MOULOVIBAZAR

Shanur Jahedul Hasan[1]*, Flura[1], Ashraful Alam[1], A.K.M Shafiqul Alam[1], Istiaque Haider[1] and Ehsanul Karim[2]

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Abstract

The study was carried out to assess the ecological aspects of Baikka beel ecosystem in Moulavibazar district and the affectivity of the ongoing biodiversity restoration program. Seventy-four fish species belonging to 21 families and two species of prawn were identified during the study period. At the same time, 10 types of fishing gear were identified in six major groups. Catch per unit effort (CPUE) of different gears varied between 1.5 and 14.0 kg/day. About 25 aquatic weeds were found in the Baikka beel of Hail haor, among them both emergent and spreading were 28% followed by floating 20%; 12% were rooted plants with floating leaves and 8% were submerged. The dissolved oxygen content 1.77-9.24 mg/l inside and 2.28-6.21mg/l outside the Baikka beel sanctuary were found to be congenial for aquatic life. pH of the beel water both inside and outside of the sanctuary were slightly acidic to moderately alkaline (6-7.5 inside and 6-7.25 outside the sanctuary). Lower values of alkalinity and hardness indicating beel water to be less nutrient enriched. The contribution of phytoplankton was (96%) than zooplankton. The diversity of phytoplankton both inside and outside of the sanctuary were dominated by three groups chlorophyceae >Myxophyceae > Bacillariophyceae.

Key words: Ecological aspects, Biodiversity restoration, Baikka beel.

Introduction

Bangladesh is blessed with enormous open water fisheries resources with an area of 4.90 million hectors. The inland open water fisheries resources of Bangladesh are the third richest in the world after China and India. These vast Inland open water fisheries resources composed of river and estuaries, beels (natural depression) and baors (Dead River) flood lands (seasonal floodplain) and a man-made Kaptai lake. The wetlands of Bangladesh are interplay of social, environmental, resources management and development concerns. Wetland of Bangladesh is blessed with huge resourceful aquatic biodiversity. A wide range of fish species, prawns and aquatic flora inhabiting in its extensive inland open water. Over the last four decades the production from inland open water have been facing gradual declension due to many natural calamity and anthropogenic reasons like use of chemicals in agricultural fields; unplanned construction of roads embankments and dams; over fishing; use of harmful fishing gears and systems; siltation of water bodies. Decrease in fish catch increasingly threatens the livelihoods of more than 12 million fishers in Bangladesh (Tsai and Ali,1997). According to a study by International Union for Conservation of Nature (IUCN) some 42 fish species are endangered and 12 specie are critically endangered (IUCN 2000). To mitigate the prevailing situation it is necessary to design effective interventions, policies, and management options.

Beel is a saucer shaped depression, which may hold water permanently or seasonal and dry up during the dry period. A total area of beels in Bangladesh were estimated to be 114,161 ha, occupying 27.0% of the inland freshwater area. The number of beels in the Northeast region has been reported to be between 3,440(covering 58,500 ha with a mean size of 7ha) and 6,149 (covering 63,500 ha with a mean size of 10ha) (Bernacsek *et al.*,1992) About 58% of the beels in the northeast region are permanent and the rest is seasonal.

*Corresponding Author: sunny_hasan80@yahoo.com
1Bangladesh Fisheries Research Institute, Riverine Station, Chandpur
2Bangladesh Fisheries Research Institute, Marine Fisheries and Technology Station, Cox's Bazar.

Hail Haor is a large wetland in Sreemongol Upazilla under Moulavibazar District, in northeastern Bangladesh. This haor covers an area of 1400 hectares in the wet season, but in the dry season it season shrinks to become about 130 beels and narrow canals covering a total area of less than 400 hectares. More than 172,000 people in 30,000 households are involved in fishing in the haor, many as regular professionals (chakraborty *et al.*2005). Baikka beel is a part of Hail Haor. It currently supports about 90 species of fish and is also important as a bird sanctuary. Every year in winter season hundreds of bird species come here and tourists from home and abroad visit the place for its natural beauty and biological diversity (Mahbub, 2012)

Baikka Beel sanctuary was designed to conserve and restore fish. About 100 hectares was set aside by the government as a sanctuary in 2003. This site was managed through a project funded by United States Agency for International development (USAID) called Management of Aquatic Ecosystem through Community Husbandry (MACH), which was implemented by a consortium of NGOs including Winrock International, the Center for Natural resources Studies (CNRS), caritas, and the Bangladesh center for Advanced Studies(BCAS). After the MACH project ended in 2008, the sanctuary continued to operate and now has links with a successor USAID- funded initiative called the Integrated Protected area Co-Management (IPAC) provides support to a wide range of protected areas in Bangladesh, including the hail haor wetland of which Baikka beel is a part.

The present study was carried out to asses the ecological aspects of the Baikka beel, which covered limno-biological characteristics of the beel, comparison on the fish species diversity of the sanctuary and non sanctuary areas of the beel, information on aquatic vegetation and finally the impact of sanctuaries on biodiversity of the beel. The study is an endeavor of giving an understanding of the present status of fishery of the beel, which will help to take measures in terms of regulating the fishery to achieve optimal fishing and adopt measures of biological management to maintain the productivity of the beel.

Materials and Methods

The study was carried out in the Baikka beel from July 2011 to June 2012.The research was based on both primary and secondary data, comprehensive literature review and extracts of local knowledge and information. Data collection was limited with the visiting schedule. Collection of primary data was made by field observation and different experimentation *viz.* experimental fishing within the beel ecosystem out side the sanctuary, survey of fish market adjacent to beel, survey of katha *and* kua fishing, monitoring of water quality, recording of water level and fishers perception as well. Secondary data was collected from fishers, lease holders**,** Beel Management Committee (BMC), Local administrations, Water development Board (WDB), Department of Fisheries, Meteorological Department and related NGOs.

Hydrological, meteorological, physico-chemical and biological characteristics of beel ecosystem have been monitored monthly basis. In each sampling day water quality data was collected from both inside and outside of the beel sanctuary separately. A bamboo made meter scale measured water depth. A seechi-disc measured transparency. A centigrade thermometer measured temperature of air and water. Free CO_2 content was determined by phenolphthalein indicator method (Welch, 1948).Total alkalinity was estimated by using phenolphthalein and methyl orange indicator method (Welch, 1948). Total hardness was determined by EDTA titrimetric method (APHA, 1995). HACH test kit (Model-FF-2, USA) was used to measure pH, dissolved oxygen (DO), ammonia and nitric acid only.

For plankotonic study, water (50L) collected from euphotic zone of beel and passed through bolting silk plankton net of 55µ. The filtrates were immediately preserved in Luglo's solution. Qualitative and quantitative analysis of both phytoplankton and zooplankton were done following drop count method (APHA,1995). Microscopic identification was performed up to genera. Each sample was tired smoothly just before microscopic analysis. One ml of agitated sample was poured in a Sedgwick-Rafter (S-R) cell counter. A binocular microscope was used (10×0.25 magnification) for identification and enumeration of samples. Qualitative studies were done according to Presscott (1962), Needham and Needham (1962).

Identification of resident as well as migratory fishes were done through collection of different species directly from fisher's catch, experimental fishing, fishing through enclosure bana, Kua fishing and surveying local fish markets. Monitoring of different types of fishing gears were done through *in situ* observation. Resident fish species was recorded through experimental fishing in the deep pool areas in the beel and men-made kuas where water remains during dry season (early January- mid April).Local knowledge as well as fisher's perception has been considered for conceptual knowledge regarding the identification of resident fishes. Different types of of aquatic weeds (floating, spreading, emergent, rooted plants with floating leaves) were collected from the beels and identification was made in the laboratory.

Results and Discussion

Baikka beel situated in N-24^{0}22.517; E-91^{0}42.55 is about 100 ha of wetlnads in the eastern part of Hail Haor near Sreemongal, a tea growing town in Moulavibazar district about 200 km northeast of Dhaka. Baikka beel includes three sub-beels Chapra, Maguara and Jaduria and retains water year round. These beels along with surrounding marshy areas known as Baikka beel Sanctuary covering 100 hectares. Baikka Beel Wetland Sanctuary is the first of its kind in Bangladesh. The Bangladesh Government declared Baikka beel a permanent sanctuary on July 1, 2003.Objective of the declaration of Baikka beel as a sanctuary is to improve wetland habitat for existing flora and fauna and to protect wetland biodiversity. The present study was conducted with a view to reveal ecological status of the beel.

Water Quality:

The water quality profile of the Baikka beel is given in Table 1. The color of beel water was found to be changed periodically. The nature of the beel bed was observed almost hard-muddy in both inside and outside of the sanctuary. The water level was fluctuated inside the sanctuary from 3 to 0.62m and outside the sanctuary from 3 to 0.56 m. The Highest depth was found in July and lowest in February. The Secchi disk reading showed much variation with the change of season; it ranged from 0.30 to 1.52 m and 0.33 to 1.63 m inside and outside of the sanctuary respectively. The transparency was found lower in March and highest in September. Almost muddy water prevails during rainy season.. Air temperature fluctuated significantly during the study period; it ranged from 23.8 to 34.5(^{0}C) inside and 23.8 to 36.8 outside of the sanctuary. The air temperature mostly found to be higher than that of water temperature during experimental period.. Water temperature showed an increasing trend in monsoon and post monsoon and decreasing in winter that is supported by Mathew (1975). Rahman (1992) stated that the transparency of productive water body should be 40 cm or less; and water temperature ranging from 26.0 to 31.0 ^{0}C was found suitable for aquatic life. The ranges of water temperature of the study area indicate suitable for fish habitat and breeding as well.

The concentration of Dissolved Oxygen (DO) varied between 1.77 to 9.24 mg/lt inside and 2.28 to 6.21 outside of the sanctuary and highest concentration was found in post monsoon period. Banerja (1967) reported that the water bodies having a range of dissolved oxygen 5 to 7 mg/ l is productive while below this range arte unproductive. The values of free CO_2 were observed high at the advent of beel inundation; it showed wide fluctuation inside the sanctuary that was 1.32 to 20.3 mg/l while CO_2 concentration range outside of the beel sanctuary was 5.28 to 35.9 mg/l. The average CO_2 concentration was found 11.75±5.21 and 13.69±8.29 respectively inside and outside of the sanctuary. The high values of (5-65 mg/l) of free CO_2 were also reported from the Surma-Kushiyara project area (FAP-16, 1992). Free CO_2 content more than 20 mg/l in water may be harmful for fishes and even lower concentration may be equally harmful when dissolved oxygen contents are less than 3 mg/l (Lagler 1972). Ruttner (1953) reported that very low value even 0 mg/l of free CO_2 , the photosynthetic activities of phytoplankton occurs normally.

Table-1 Physico-chemical parameters of Baikka beel (inside and outside the sanctuary)

Parameters	Inside	Outside
Water depth (m)	1.705±0.89	1.56±0.88
Air temp (^{0}C)	30.25±3.85	31.35±4.21
Water temp (^{0}C)	29.69±4.48	29.28±3.87
Water colour	Brown	Brown
Bottom Type	Soft and muddy	Comparatively hard and muddy
Transparency (m)	0.79±0.38	0.74±0.39
Dissolve O_2 (mg/l)	4.99±1.77	4.93±1.25
Free CO_2 (mg/l)	11.75±5.21	13.69±8.29
pH	6.73±0.35	6.65±0.26
NH_3 (mg/l)	0.03±0.06	0.02±0.06
Total alkalinity	26.54±7.70	26.40±9.98
Total hardness	24.30±6.19	24.29±5.46

The values of pH were found in the slightly acidic to alkaline range; that was 6 to 7.5 inside the sanctuary and 6 to 7.25 outside of the sanctuary. Throughout the study period pH of the studied beel exhibited narrow range of fluctuation. According to Swingle (1967), pH value of 6.5 to 9 is suitable for fish culture and more than nine is unsuitable because free CO_2 is not available in this situation. Total hardness varied between 15.01 to 33.83 and 16.12 to 31.25 mg/l inside and outside of the beel sanctuary respectively. Again, alkalinity of the *beel* varied between 18.7 to 48.3and 15.3 to 48.8 mg/l inside and outside of the beel sanctuary respectively.. The lower concentration of alkalinity and hardness of the beel water is an indication of less nutrient

enrichment. Almost similar values of total hardness and alkalinity were reported by FAP-16 (1992) from northeastern areas of Bangladesh. Banerjea(1967) reported that 60 to 70% of average to highly productive ponds have total alkalinity ranging from 20-200 mg/l. Lake water registering hardness as calcium carbonate below 24 mg is generally regarded as soft (Clegg, 1974). From the above discussion, it may be concluded that the beel water was found as soft medium hard type and moderately productive.

Planktonic Biomass

Abundance of plankton in sanctuary and non-sanctuary areas showed a wide range of variation. Average total plankton density (Nos./l) outside the sanctuary areas of Baikka beel was higher (28,552±7,486) than the sanctuary areas (25,117 ±8,114) (Table2). Phytoplankton largely dominated over zooplankton throughout the study period. The mean contribution of phytoplankton was more than 96% in the study area and zooplankton contributed the rest (Table 2).

Table-2 Plankton biomass inside and outside the sanctuary of Baikka Beel

Phyto-plankton (nos/L)		Zoo-plankton (nos/L)	Total plankton	Phyto-plankton (%)	Zoo-plankton(%)
Inside	24,510 ±7,922	607±109	25,117 ±8,114	97.60±0.22	2.40±0.24
Outside	27,683±7,273	869±173	28,552±7,486	96.90 ±0.17	3.10±0.18

Among the planktonic algae, 47 genera of phytoplankton under 6 families and 15 genera of zooplankton under 11 families were recorded inside the sanctuary areas of Baikka *beel*. In case of outside the sanctuary Baikka *beel*, about 41 genera of phytoplankton under 6 families and 12 genera of zooplankton under 10 families were found (Table 3). The presence of higher content of fish biomass inside the sanctuary might exert a significant role on the presence lower amount of planktonic algae over there, because higher the amount of fish higher the predation over the planktonic mass.

Table-3 List of different group of plankton found in Baikka beel

Plankton Group	Family	Genera	
		Inside Sanctuary	Outside Sanctuary
Phyto-	Chlorophyceae	Ankistrodesmus, Chlamydomonas,Chlorella, Closteridium, Closterium, Crucigenia, Mougeotia, Pediastrum, Scenedesmus, Selenestrum, Staurastrum, Spirogyra, Spirotaenia, Trochiseia, Volvox	Ankistrodesmus, Chlamydomonas, Chlorella, Closterium, Cosmarium, Crucigenia, Mesotaenium, Mougeotia, Palmellococcus, Pediastrum, Scenedesmus, Selenestrum, Sphaerostoma, Spirogyra, Staurastrum, Tetraedon,Volvox, Westella, Zygnema,
	Myxophyceae	Anabaena, Anacystis, Aphanocapsa, Coelospharium, Chlorococcus, Gomphosphaeria, Merismopedia, Microcystis, Nostoc, Oscillatoria, Spirulina, Tetrapedia	Anabaena, Anacystis, Aphanocapsa, Chlorococcus, Merismopedia, Microcystis, Oscillatoria, Tetrapedia,
	Bacillariophyceae	Amphora, Asterionella, , Cyclotella, Coscinodiscus, Diatoma, Gyrosigma, Melosira, Navicula, Nitzschia, Synedra, Stephanodiscus	Amphora, Cyclotella, Diatoma, Melosira, Navicula, Nitzschia, Synedra, , Tabellaria,
	Euglenophyceae	Euglena, Phacus,	Euglena, Phacus,
	Xanthophyceae	Chloranllanthus, Tribonema	Tribonema
	Dinophyceae	Mesotaenium, Netrium, Protococcus, Tetraspora, Ulothrix	Netrium, Tetraspora, Ulothrix
Zoo-	Brachionidae	Keratella,, Brachionus, Trichocerca	Keratella, Brachionus,
	Bosminidae	Bosmina	Bosmina
	Cyclopidae	Cyclops	Cyclops
	Diaptomidae	Diaptomus	Diaptomus
	Daphnidae	Nauplius, Daphnia	Nauplius, Daphnia
	Holopedidae	Diaphanosoma	Diaphanosoma
	Polycystidae	Polycystis	-
	Sididae	Sida	Sida
	Synchaetidae	Cypris, Polyarthra	Polyarthra
	Testudinellidae	Filinia	Filinia
	Trichocercidae	Tricocerca	Tricocerca

Fish species diversity

Seasonal transformation of the water flow and versatile habitat has made Hail haor as one of most productive areas. The fish species diversity of the haor was virtually enriched along with the presence of large number of indigenous species. Until, June 2012 about 73 fish species and 2 Macrobrachium specie of prawn were found from the Baikka beel of Hail haor. Among 73 fish species maximum 32 species belonged to the family Cyprinidae followed by Bagridae (6 species), Chanidae (4 species), Siluridae (4 species). Rest of the species belonged to another 17 families. Among the IUCN declared 54 species, some are still found in the Hail haor to a little extent *viz.* Chital, Rita, Baga, Air, Chepchela, Tatkini, Kaliboush, Gonia, Sharpunti, Rani, Modupabda, Napit Koi, Gozar etc. During the investigation, about 12 nonresident species, 61 resident species belonging to 21 families were found available in Baikka. Among the available species in Baikka beel barbs/ minnows are the most common (51%) followed by glass perch(15%), catfish (11%), goramy (5%), crustacean(4%). No published data were available about the intensity of different species, but this investigation reveals that intensity has been increased many folds after the establishment of the sanctuary in the beel. But the result has found to become more fruitful in case of Baikka *beel*, as it has declared as the permanent sanctuary

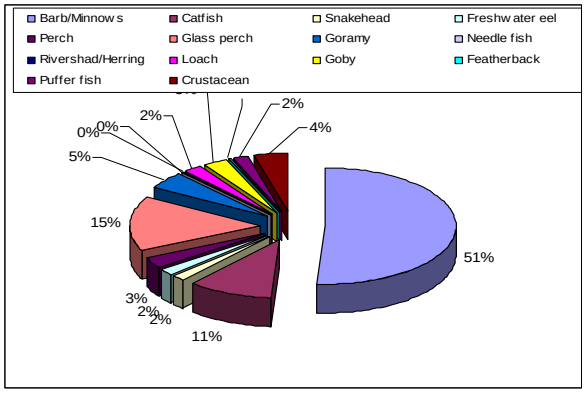

Fig. 2. Species composition of Baikka beel

Table 4. Fish species diversity of Baikka beel

Sl No.	Order	Family	Local name	Scientific Name	Sanctuary	Non-sanctuary
1.	Anguilliformes	Anguillidae	Banehara	*Anguilla bengalensis*	+	+
2.	Anguilliformes	Anguillidae	Kuchia	*Monopterus cuchia*	+	+
3.	Beloniformes	Belonidae	Kakila	*Xenentodon cancila*	++	+
4.	Clupeiformes	Clupeidae	Kachki	*Corica soborna*	+++	+++
5.	Clupeiformes	Clupeidae	Chapila	*Gudusia chapra*	++	+
6.	Cypriniformes	Cyprinidae	Mola	*Amblypharyngodon mola*	+++	++
7.	Cypriniformes	Cyprinidae	Rajputi	*Barbonymus gonionotus*	++	+
8.	Cypriniformes	Cobitidae	Bou mach	*Botia dario*	++	+
9.	Cypriniformes	Cyprinidae	Katol	*Catla catla*	+	+
10.	Cypriniformes	Cyprinidae	Chep chela	*Chela laubuca*	+++	++
11.	Cypriniformes	Cyprinidae	Mrigal	*Cirrhinus cirrhosus*	++	+
12.	Cypriniformes	Cyprinidae	Minor carp	*Crossocheilus latius*	++	+
13.	Cypriniformes	Cyprinidae	Grass carp	*Ctenopharyngodon idella*	++	+
14.	Cypriniformes	Cyprinidae	Common carp	*Cyprinus carpio var. communis*	++	+
15.	Cypriniformes	Cyprinidae	Mirror carp	*Cyprinus carpio var. specularis*	+	+
16.	Cypriniformes	Cyprinidae	Darkina	*Esomus danricus*	+++	+++
17.	Cypriniformes	Cyprinidae	Silver carp	*Hypophthalmichthys molitrix*	+	+
18.	Cypriniformes	Cyprinidae	Big head carp	*Aristichthys nobilis*	+	+
19.	Cypriniformes	Cyprinidae	Bata	*Labeo bata*	+	+
20.	Cypriniformes	Cyprinidae	Bhangan	*Labeo boga*	+	+
21.	Cypriniformes	Cyprinidae	Kalibaus	*Labeo calbasu*	+	+
22.	Cypriniformes	Cyprinidae	Shada ghonia	*Labeo gonius*	++	+
23.	Cypriniformes	Cyprinidae	Nandil	*Labeo nandina*	+	+
24.	Cypriniformes	Cyprinidae	Rui	*Labeo rohita*	+	+
25.	Cypriniformes	Cyprinidae	Rajpunti	*Puntius gonionotus*	+	+
26.	Cypriniformes	Cyprinidae	Punti	*Puntius chola*	+++	+++
27.	Cypriniformes	Cyprinidae	Kanchan punti	*Puntius conchonius*	+++	+++
28.	Cypriniformes	Cyprinidae	Gilipunti	*Puntius gelius*	++	++

Sl No.	Order	Family	Local name	Scientific Name	Sanctuary	Non-sanctuary
29.	Cypriniformes	Cyprinidae	Punti	*Puntius puntio*	+++	+++
30.	Cypriniformes	Cyprinidae	Shorpunti	*Puntius sarana*	++	+
31.	Cypriniformes	Cyprinidae	Bhadi punti	*Puntius sophore*	++	+
32.	Cypriniformes	Cyprinidae	Tit punti	*Puntius ticto*	+++	+++
33.	Cypriniformes	Cyprinidae	Bhol	*Raiamas bola*	+	+
34.	Cypriniformes	Cyprinidae	Darkina	*Rasbora daniconius*	+++	+++
35.	Cypriniformes	Cyprinidae	Chela	*Salmostoma phulo*	+++	+++
36.	Cypriniformes	Cyprinidae	Tatkini/Kalabata	*Crossocheilus latius*	+	+
37.	Cypriniformes	Cyprinidae	Dhela	*Osteobrama cotio*	+	+
38.	Osteoglossiformes	Notopteridae	Chital	*Chitala chitala*	++	+
39.	Osteoglossiformes	Notopteridae	Foli	*Notopterus notopterus*	++	+
40.	Perciformes	Anabantidae	Kawai'in	*Anabas testudineus*	+++	++
41.	Perciformes	Anabantidae	Koi	*Anabas cobojius*	++	+
42.	Perciformes	Badidae	Napte koi	*Badis badis*	++	+
43.	Perciformes	Ambassidae	Lomba chanda	*Chanda nama*	+++	++
44.	Perciformes	Ambassidae	Gol chanda	*Chanda beculis*	+++	++
45.	Perciformes	Ambassidae	Ranga chanda	*Chanda ranga*	+++	++
46.	Perciformes	Channidae	Gachua	*Channa orientalis*	+++	++
47.	Perciformes	Channidae	Taki	*Channa punctata*	+++	++
48.	Perciformes	Channidae	Shol	*Channa striata*	++	++
49.	Perciformes	Osphronemidae	Khailsha	*Colisa fasciata*	+++	++
50.	Perciformes	Osphronemidae	Lal kholisha	*Colisa lalia*	++	++
51.	Perciformes	Gobiidae	Bele	*Glossogobius giuris*	++	++
52.	Siluriformes	Schilbeidae	Kajuli	*Ailia coila*	+	+
53.	Siluriformes	Sisoridae	Baghair	*Bagarius bagarius*	+	+
54.	Siluriformes	Bagridae	Tengra	*Batasio batasio*	++	+
55.	Siluriformes	Clariidae	Magor	*Clarias batrachus*	++	+
56.	Siluriformes	Schilbeidae	Muribacha	*Clupisoma garua*	+	+
57.	Siluriformes	Schilbeidae	River catfish	*Eutropiichthys vacha*	+	+
58.	Siluriformes	Sisoridae	Catfish	*Gagata gagata*	+	+
59.	Siluriformes	Heteropneustidae	Shingi	*Heteropneustes fossilis*	+++	++
60.	Siluriformes	Bagridae	Tengra	*Mystus bleekeri*	++	+
61.	Siluriformes	Bagridae	Stripped dwarf catfish	*Mystus tengara*	++	++
62.	Siluriformes	Bagridae	Tengra	*Mystus vittatus*	++	++
63.	Siluriformes	Siluridae	Kani pabda	*Ompok bimaculatus*	+	+
64.	Siluriformes	Siluridae	Madhu pabda	*Ompok pabda*	+	+
65.	Siluriformes	Bagridae	Air	*Sperata aor*	+	+
66.	Siluriformes	Bagridae	Guizza	*Sperata seenghala*	+	+
67.	Siluriformes	Siluridae	Boal	*Wallago attu*	++	+
68.	Synbranchiformes	Mastacembelidae	Tara baim	*Macrognathus aculeatus*	+++	++
69.	Synbranchiformes	Mastacembelidae	Pankal baim	*Macrognathus pancalus*	+++	++
70.	Synbranchiformes	Mastacembelidae	Baim	*Mastacembelus armatus*	++	+
71.	Synbranchiformes	Synbranchidae	Kuchia	*Monopterus cuchia*	++	+
72.	Synbranchiformes	Synbranchidae	Bamosh	*Ophisternon bengalense*	++	+
73.	Tetraodontiformes	Tetraodontidae	Tepa	*Tetraodon cutcutia*	++	++
74.		Palemonidae	Icha/chingri	*Macrobrachium spp.*	+++	+++
75.		Palemonidae	Golda chingri	*Macrobrachium rosenbergii*	+	+

+++ Very common; ++ common; + rare

Baikka beel is a permanent sanctuary; all sorts of fishing, hunting are strictly prohibited without the prior permission of the authority. However, fishing was limited outside the sanctuary. During study period 10 types of fishing gear belonged to six major groups were identified. Those included seine nets (purse seine net, moshari berjal, ghono berjal), gill nets (chapila jal, current jal, koi jal), cast net (jhaki jal), push net (felun jal), drag net (moi jal) and long line (chara borshi). Catch per unit effort (CPUE) of different gears varied between 1.5 and 14.0 kg/day. Suganan and Bhattacharjya (2000) found a wide variety of fishing methods (passive gear, active gear, FAD, falling gear, dewatering) employed in the beels of Assam, which are very similar to the present findings. Haroon *et.al.* (2002) reported eighteen types of fishing gears from the Sylhet sub-basin and thirteen types from Mymensingh sub-basin. They also recorded many kinds and sizes of bamboo made traps.

Aquatic weeds

About 24 aquatic weeds were found in the Baikka beel of Hail haor, among them both emergent and spreading were 28% followed by floating 20%; 12% were rooted plants with floating leaves and 8% were submerged. The weeds usually grow along the beel margins and absent in the deeper regions. The weeds are used as human consumption, cattle food and main food of buffalo. These weeds also used as feed, shelter and breeding place for the resident species. FAP-16 (1992) reported less abundant macrophytes from Surma-Kushiyara floodplain project. Suganan and Bhattacharjya (2000) found a rich growth of marginal and submerged vegetation in the wetlands of Brahmaputra basin. Rahman (1992) could not find any find floating aquatic vegetation from the spawning location of Halda, the Jamuna, and the Brahmaputra river and no significant relationship existed between the aquatic and the spawning of major carps. A unique feature of floodplain wetlands is the rich growth of marginal and submerged macrophytes due to allochthonous and autochthonous nutrient loading, which often tends to replace plankton community and hastens the pace of eutrophication.

Table 5: Aquatic weeds of the Baikka *beel*

Sl No	Family	Local Name	Scientific Name	Type	Sanctuary	Non-sanctuary
1.	ontederiaceae	Kachuripana	*Eichhornia crassipes*	Floating	+	++
2.	Araceae	Topapana	*Pistia stratiotes*	Floating	+	++
3.	Lemnaceae	Edurkanipana	*Wolffia arrhiza*	Floating	+	+
4.	Lemnaceae	Khudipana	*Lemna minor*	Floating	+	+
5.	Azollaceae	Kutipana	*Azolla pinnata*	Floating	+	+
6.	Gramineae	Dal	*Hydroryza aristota*	Emergent	+	++
7.	Oxalidaceae	Amrul shak	*Oxalis corniculata*	Emergent	-	+
8.	Marsiliaceae	Shusnishak	*Marsilea quadrifolia*	Emergent	-	+
9.	Polygonaceae	Bishkatali	*Polygonum hydropiper*	Emergent	-	+
10.	Araceae	Kachu	*Colocasia esculenta*	Emergent	-	+
11.	Najadaceae	Najas	*Najas najas*	Submerged	+	+
12.	Gramineae	Arail	*Leersia hexandra*	Spreading	-	++
13.	ompositaceae	Helencha	*Enhydra flucktuans*	Spreading	-	+
14.	onvolvulaceae	Kalmilata	*Ipomoea aquatica*	Spreading	-	+
15.	ommelinaceae	Kanaibashi	*Commelina bengalensis*	Spreading	-	+
16.	Compositaceae	Malancha	*Ehhydra sp*	Spreading	+	++
17.	Alismataceae	Arrowhead	*Sagitaria sagitifollia*	Emergent	+	+
18.	Oenotheraceae	Keshordam	*Jussiaea ripens*	Spreading	+	+
19.	Nymphaceae	Lalshapla	*Nymphaea rubna*	Rotted plants with floating leaves	+	+
20.	Nymphaceae	Shapla	*Nymphaea nouchali*	Rotted plants with floating leaves	+	+
21.	Nymphaceae	Padma	*Nelumbo nucifera*	Rotted plants with floating leaves	+	++
22.	Cyperaceae	Shakata chechra	*Scirpus actus*	Emergent	-	+
23.	-	Panikola	*Ludwigia adscendens*	Submerged	+	+
24.	Convolvulaceae	Dhol Kalmi	*Ipomoea fistulosa*	Spreading	-	+

+++ very common, ++ common, +rare, - absent

The abundance and succession of biotic communities occupying in the beels are influenced mainly by unique water renewal pattern of the ecosystem. The fluctuation in water level and the alternating seasonal riverine connections are the inherent characters of the beel ecosystem. Thus, the organisms inhabiting this ecosystem comprise a complex mix of lotic and lentic communities. This dynamic ecological character brought in by the cyclic changes in the *beel* morphometry, water chemistry and sediment characteristics leads to some unique faunal and floral associations. Thus, biotic communities adapt themselves to spatial and temporal fluctuation leading to a high degree of floral and faunal diversity. Fluctuation of water level in the *beel* ecosystem is an important parameter for fish spawning. The shallower areas of the beels were found suitable for the spawning of some resident fishes (*viz.*, *Glossogobius giuris*, *Heteropneustus fossilis*, *Channa* spp, *Xenontodon cancila*, *Puntius* spp, *Mystus* spp, *Matacembelus* spp, *Macrobrachium lamarrei*, etc.). Ali (1997) reported that most of the smaller sized fishes breed into the shallower water areas, mainly in beel floodplain.

Conclusion

In floodplain wetland, water quality is influenced largely by inflow of water from the connecting river, local catchment areas and by the metabolic processes of plants and animals living within the water body and the aquatic vegetation in particular. The turbidity in beel water was mainly due to silt and organic debris carried by the run-off water. The weed-choked beels have the lowest turbidity. The basin and aquatic soil can influence the value of pH. The variation in the

concentration of DO and CO_2 were mainly due to the rate of photosynthetic activity by aquatic vegetation and variation in the organic matter contents in the basin soil. The DO levels of beel water were not fairly high but within the acceptable limit for the growth of fishes. An evaluation of hydrology and physic-chemical properties of water indicates that in spite of low values of hardness and alkalinity Baikka beel is found to be conducive to enhanced fisheries, capture fisheries and biological production as well.

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