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Ecology of Shakla *beel* (Brahmanbaria), Bangladesh

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Abstract

The beel Shakla, comprising an average area of 75.0 ha is located in the northeastern region (Brahmanbaria district) of Bangladesh. The study was carried out to assess the ecological aspects of beel ecosystem. Surface run-off and increase inflow of rain water from the upper stretch during monsoon cause inundation and resumption of connection between beel and parent rivers. The range of dissolved oxygen (DO) content (4.5-8.9 mg/L) was found congenial for aquatic life. pH was in the alkaline range (7.3-8.5) and free CO_2 was reletavely high. Lower values of total hardness and total alkalinity indicated less nutrients in the beel water. A wide variation (1.4–27.2 x 10^3 cells/L) in the standing crop of total plankton was recorded during study period of which phytoplankton alone contributed about 90%. Phytoplankton diversity in the beel represented by three groups *viz.* Chlorophyceae, Myxophyceae and Bacillariophyceae in order of abundance. A total of 52 fish species belonging to 36 genera, 20 families and 1 species of prawn were identified so far from the beel. About 13 types of fishing method were found in operation. Seine nets (*moshari berjal, ghono berjal*) and gill net (*current jal*) were identified as detrimental gear killing juveniles of different species during post spawning period. Kua fishing was also found harmful due to dewatering nature. A total of 11 species belonging to 11 genera and 10 families of aquatic weeds were identified from the beel. The eggs of *Macrobrachium lamarrei* were identified into the *Najas najas* vegetation during April-September.

Key words : Ecology, *Beel*

Introduction

The inland freshwater fisheries resources of Bangladesh have been among the most productive fisheries in the world, with only China and India reporting more inland fish production than Bangladesh. The flood dependent fishery has been notable for the diversity of its fish and prawn species and the primary source of fish for all Bengalis (Rahman 1989). Inland open water capture fishery as a whole is in decline over the decades due to multiple causes. This capture fishery is made up of three inter-related general areas (riverine, beel/baor and floodplains), the declines in one area are an indicator of problems in all areas (DoF 2002). To mitigate the prevailing situation there is a search of new interventions, policies, and management options and future programs should be designed to prevent the further decline and possible collapse of the existing fishery.

Beel is a saucer-shaped depression, which may hold water permanently or dry up during the dry period. A total area of beels in Bangladesh was 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 7 ha) and 6,149 (covering 63,500 ha with a mean size of 10 ha) (Bernacsek et al. 1992). About 58% of the beels in the Northeast region are permanent and the reminder is seasonal.

The WorldFish Center of Bangladesh has been implementing a project (CBFM-2) in 115 open water bodies of Bangladesh in collaboration with the Department of Fisheries (DoF) and a number of Non-Government Organizations (NGOs) to promote sustainable use of openwater fisheries resources by community management. Among 115 beels, the beel Shakla (N 23°56.508′ and E 091°08.448′) located in northeast region (Brahmanbaria district) was selected to carry out the present study. This beel is leased out to Beel Management Committee (BMC- a community based local forum headed by a Chairman) for consecutive five years. The beel is managed by BMC with the cooperation of WorldFish Center (WFC), DoF and PROSHIKA.

Materials and methods

The study was carried out in the beel Shakla during July'03 to June'04. 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 experimentations *viz.* experimental fishing in the beel, survey of different fishing methods, survey of fish markets adjacent to beel, monitoring of hydrological, meteorological, physico-chemical and biological characteristics of beel and fishers' perception as well. Secondary data were collected from the fishers, lease holders, Beel Management Committee (BMC), local administration, Water Development Board (WDB), Department of Fisheries (DoF), Bangladesh Fisheries Research Institute (BFRI), Meteorological Department and related NGOs.

A bamboo made meter scale measured water depth. A Secchidisc measured water transparency. Temperature of air and water was measured with a centigrade thermometer. 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 water pH, dissolved oxygen (DO), ammonia and nitrite only.

For planktonic study 50 L water were collected from the euphotic zone of the *beel* and passed through bolting silk plankton net of 55μ. The filtrates were immediately preserved in Lugol's solution. Qualitative and quantitative analysis of both phyto-and zooplankton were done following drop count method (APHA 1995). Microscopic identification was performed up to genera. Each sample was stirred smoothly just before microscopic analysis. One ml of agitated sample was poured in a Sedgwick-Rafter (S-R) counting cell. A binocular microscope did identification and enumeration of each sample. Qualitative studies were done according to Presscott (1964) and Needham and Needham (1972).

Identification of fishes was done through collection of different species directly from fishers' catch, experimental fishing, fishing through enclosure with *bana* (locally called *pati*), *katha* fishing, *kua* fishing and surveying local fish markets. Catch-effort survey was done through *in situ* observation.of fishers' nets. Resident fish species was recorded through experimental fishing in the deep pool areas in the *beel* and man-made *kuas* where water remains during dry season (early January-mid April). Local knowledge as well as fishers' perception has been considered also. Aquatic weeds were collected from the beel and identification was made into the laboratory.

Results and discussion

Morphometry and hydrodynamics

The main morphometric features that influence the productivity of beel ecosystem are shoreline, area, depth and slope. These, in turn, are closely linked with the hydrodynamics of wetlands. Generally there are three main sources of water input into the beel ecosystem *viz.* overspill from the river channel, surface flow and regeneration. River flows are determined both by rainfall and snowmelt from the mountain range. The beel Shakla lies in Machihata union of Brahmanbaria sadar upazila, about 13 km southeast of the district town. The Titas river passes through the eastern side of the beel. This river is used to inundate as well as drain the beel. This beel is connected with the Titas river by three canals locally called khals *viz.* Audaubbah, Katakhal and Kuralia. In dry season, almost all the areas of beel become dried up except the aforesaid canals where water remains during mid-January to mid-April. Flooding originates from the Meghna river, the west of the beel. The average area of Shakla beel is about 75.0 ha. The bottom of the beel is uneven. Surface run-off and increase in river height due to inflow of rain water from the upper stretch, cause inundation of floodplains, often causing resumption of connection between beels and parent rivers. The more water gain or exchange of water in the beel takes place during southwest monsoon when the floodplains are flooded. After recession of flood, water level in the river decreases snapping the beel's connection with the river. The beel gets dried up through evapo-transpiration and seepage. Except deeper portion of beel, the people use most of the area for crop practice by extracting water from the beel. The water loss by various means causes shrinkage of the effective water area and lowering of depth in the beel.

Water quality

The water quality profile of the beel Shakla 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. The water level fluctuated between 0.8 and 3.0 m. The highest depth was recorded in June and the lowest in January. The mean water level obtained 1.93±0.7 m. The Secchidisc visibility fluctuated much; it ranged from 0.33 m to 1.25 m. The transparency of water was lower in January and highest in November. Almost muddy water prevails during rainy season. The mean value of water transparency was 0.75±0.4 m. Air temperature was fluctuated remarkably during the study period. It ranged from 22.0^{0}C to 34.0^{0}C. The air temperature was found always higher than surface water temperature. The mean air temperature was 29.8±4.6^{0}C. Surface water temperature ranged between 21.0 and 32.0^{0}C. The mean water temperature was recorded 28.5±3.9^{0}C. Water temperature showed an increasing trend in monsoon and post-monsoon season and decreasing in winter is supported by Mathew (1975). Water temperature is influenced by the air temperature, and it found highly synergistic with the air temperature. Rahman (1992) stated that the transparency of productive water bodies should be 40 cm or less, and water temperature ranging from 26.0 to 31.0°C was found suitable for aquatic life. The range of water temperature of the studied beel indicating almost suitable for fish habitat and breeding as well.

Table 1. Meteorological and physico-chemical parameters of Shakla *beel*

Parameters	Values					
	Jul	Sep	Nov	Jan	Jun	Mean±SD
Color of water	Clear	Clear	Turbid	Turbid	Brownish green	-
Average depth of beel (m)	1.78	2.20	1.89	0.80	3.0	1.93±0.7
Nature of beel bed	Hard	Hard	Hard	Hard-soft	Hard	-
SD transparency (m)	0.93	0.90	1.25	0.33	0.34	0.75±0.4
Air temperature (°C)	34.0	33.0	31.2	22.0	30.0	29.8±4.6
Water temperature (°C)	32.0	31.5	29.1	21.0	29.0	28.5±3.9
Dissolved oxygen (mg/L)	8.2	8.9	8.2	6.9	4.5	7.3±1.6
Free CO_2 (mg/L)	0.8	2.3	15.8	12.8	16.3	9.6±6.7
pH	8.0	8.0	8.5	7.3	8.5	8.1±0.4
Total hardness (mg/L)	21.6	20.0	33.6	29.0	9.0	22.6±8.4
Total alkalinity (mg/L)	31.5	26.0	29.7	35.0	12.0	26.8±8.0
Ammonia (mg/L)	0	0	0.2	0.01	0.17	0.08±0.09
Nitrite (mg/L)	0	0	0	0	0.3	0.06±0.12

Dissolved oxygen concentration (DO) varied between 4.5 and 8.9 mg/L, the higher concentration was found in post-monsoon period. The average oxygen concentration was recorded 7.3±1.6 mg/L. Banerjea (1967) reported that water bodies having a range of 5 to 7 mg/L DO is productive, while those having below this range are unproductive ones.

The values of free CO_2 were observed high at the advent of beel inundation; it showed wide fluctuation (0.8-16.3 mg/L) during the study period. The average value was recorded 9.6±6.7 mg/L. The high values (5-65 mg/L) of free CO_2 were also reported from the Surma-Kushiyara project area (FAP 1992). Free CO_2 content more than 20 mg/L may be harmful to fish 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 values even 0 mg/L of free CO_2 the photosynthetic activities of phytoplankton occurs normally.

The values of pH were found alkaline range (7.3-8.5). Ruttner (1953) quoted that a eutrophic lake normally maintains alkaline pH. The highest and the lowest values were found in November and June, and January respectively. The mean value of pH was 8.1±0.4. It exhibited a narrow range of fluctuation throughout the investigation period. According to Swingle (1967) pH value of 6.5 to 9.0 is suitable for fish culture and more than 9.0 is unsuitable because free CO_2 is not available in this situation.

Total hardness varied between 9.0 and 33.6 mg/L. The highest and the lowest values were observed in November and June respectively. The mean value was 22.6±8.4 mg/L. Total alkalinity varied between 12.0 and 35.0 mg/L. The highest and the lowest values were recorded in January and June respectively. The mean value was recorded 26.8±8.0 mg/L. The lower concentration of hardness and alkalinity indicated the beel water to be less nutrient enriched. Almost similar values of total hardness and total alkalinity were reported by FAP-16 (1992) from the 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/L is generally regarded as soft (Clegg 1974). From the above discussion it may be concluded that the *beel* waters were found as soft-medium hard type and moderately productive.

Ammonia varied between 0.01 and 0.17 mg/L, it was recorded zero in the month of July and September. The mean value was 0.08±0.09 mg/L. Nitrite concentration ranged from traces to 0.3 mg/L. Low values of nitrite contents takes place due to rapid absorption of such nutrients by the infestation of macrophyte communities in the beel ecosystem.

Planktonic organisms

Abundance of total plankton in Shakla *beel* is presented in Table 2. It is evident from the table that a wide variation (1.4–27.2 x 10^3 cells/L) existed in the standing crop of total plankton in different months. The highest concentration of total plankton count was recorded in July and the lowest count was obtained in January with a mean of 15.4 x 10^3 cells/L. The contribution of phytoplankton ranged between 64.3 and 92.4% with a mean of 90.3%, while the contribution of zooplankton ranged from 7.5 to 35.7% with a mean of 9.7% to the total planktonic organisms. Low production of zooplankton in a lotic ecosystem is not uncommon. The highest concentration of phytoplankton and zooplankton were recorded in November and January respectively. Ehshan *et al.* (1996) recorded high phytoplankton (30-66x10^3 cells/L) and low zooplankton count (0.5-0.7x10^3 cells/L) from Chanda beel.

During the present investigation 23 genera of phytoplankton belonging to 15 families and 10 genera of zooplankton belonging to 7 families were recorded from Shakla *beel* (Table 3). The phytoplankton population was composed of algal flora belonging to the groups Chlorophyceae, Myxophyceae and Bacillariophyceae. Among the planktonic algae Chlorophyceae contributed the bulk and the predominant genera were *Protococcus, Mougeotia, Microspora, Mesotenium, Closterium, Eremesphaera, Chlorococcum, Ophiocytium, Penium, Spirogyra, Zygnema, Trochiscia, Kirchneriella.* Myxophyceae included various species belonging to genera *Mycrocystis, Anabaena, Merismopedia, Polycystis, Anacystis* and *Nostoc.* Bascillariophyceae was represented by various species belonging to genera *Melosira, Navicula, Diatoma, Synedra.* Several authors (Ehshan *et al.* 1996; Hossain *et al.* 1998; Ehshan *et al.*1997) reported the dominance of Myxophyceae and Chlorophyceae groups from different beel ecosystems of Bangladesh. Phytoplankton diversity in the beels of upper Assam zone represented by four groups in the order of Chlorophyceae > Bacillariophyceae > Myxophyceae > Dinophyceae (Sugunan and Bhattacharjya 2000).

Table 2. Month wise planktonic abundance of the Shakla *beel*

Month	Phytoplankton ($x10^3$ cells/L)	Zooplankton ($x10^3$ cells/L)	Total Plankton ($x10^3$ cells/L)	Phytoplankton (%)	Zooplankton (%)
July	25.0	2.2	27.2	91.92	8.08
September	20.0	2.5	22.5	88.89	11.11
November	9.8	0.8	10.6	92.45	7.55
January	0.9	0.5	1.4	64.29	35.71
Mean	13.9	1.5	15.4	90.30	9.70

Table 3. Diversity of plankton in the Shakla *beel*

Plankton	Group	Genera
Phytoplankton	Chlorophyceae	*Protococcus, Mougeotia, Microspora, Mesotenium, Closterium, Eremesphaera, Chlorococcum, Ophiocytium, Penium. Spirogyra, Zygnema, Trochiscia, Kirchneriella*
	Myxophyceae	*Mycrocystis, Anabaena, Merismopedia, Polycystis, Anacystis, Nostoc*
	Bacillariophyceae	*Melosira, Navicula, Diatoma, Synedra*
Zooplankton	Rotifers	*Polyarthra, Keratella, Filinia, Trichocerca*
	Cladocera	*Daphnia, Bosmina*
	Copepoda	*Cyclops, Nauplius, Diaptomus*
	Ostracoda	*Oicomonas*

Among zooplankton the represented genera were *Polyarthra, Keratella, Filinia, Trichocerca, Daphnia, Bosmina, Cyclops, Nauplius, Diaptomus* and *Oicomonas* belonging to four groups, Rotifera, Cladocera, Copepoda and Ostracoda. Rotifera was the most dominant group followed by Copepoda, Cladocera and Ostracoda. Almost similar observations were also made by Ehshan *et al.* (1996), Ahmed *et al.* (1997) and Patra and Azadi (1987). Similar observation was also made by Sugunan and Bhattacharjya (2000) from the beels in Assam.

Ichthyo-diversity and fishing methods

Fish genetic resources in northeastern regions are unique being a mixture of migratory, resident and exotic fish species. A total of 52 fish species belonging to 36 genera, 20 families and 1 species of prawn were accounted and identified so far from the Shaka *beel*. Out of them 38 resident fish species belonging to 27 genera, 17 families and 1 species of prawn were identified. Of the 52 fish species recorded, 16 species were belonging to the family Cyprinidae followed by Siluridae, Anabantidae and Channidae of which each family belongs to four species. The identified fish species were categorized into 25 groups. A list of those fishes with their harvesting methods is presented in Table 4. This beel is inhabited by the carps, barbs, catfishes, snakeheads, eels, minnows, loaches, featherbacks, gouramies, perches, gobies, puffer fishes, needle fishes, sardines, half-beaks and small prawns. The common and more abundant fish species in the beel are- glass perch (*Chanda nama, C. ranga*), barbs (*P. ticto*), gouramies (*Colisa sota, C. lalius*), loaches (*Lepidocephalus guntea*), freshwater spiny eels (*Mastacembelus pancalus*), gobies/mud skipper (*Glossogobius giuris*), catfish (*M. tengra*), needlefish (*Xenentodon cancila*), pufferfish (*Tetraodon cutcutia*) small prawn (*Macrobrachium lamarrei*). Haroon *et al.* (2002) identified a total of 92 species of fish and prawn from Sylhet-Mymensingh basin. He found the dominance of barbs, catfishes and major carps in the Sylhet sub-basin and catfishes, major carps and prawns in the Mymensingh sub-basin. In India, Sugunan and Bhattacharjya (2000) recorded 54 fish species belonging to 18 families from Dighali beel (Kamrup district), the common species contributing to commercial landings belong to eight groups (carps, catfishes, murrels, featherbacks, air-breathing fishes, hilsa, prawns and miscellaneous fishes).

Table 4. Fish species observed in the Shakla *beel*

Groups	Family	Scientific names	Fishing methods
Carps	Cyprinidae	*Labeo rohita, Cirrhinus mrigala, C. reba, L. boga, L. calbasu, L. gonius*	Enclosure with *pati*[1], FAD, Gill net, Seine net
Minnows	Cyprinidae	*Rohtee cotio, Esomus danricus, Salmostoma phulo, S. bacaila, S. cachius, Amblypharyngodon mola*	Drag net, Seine net, cast net, FAD
Barbs	Cyprinidae	*Puntius sarana, P. ticto, P. sophore*	Gill net, Push net, Cast net, FAD
Chinese carp	Cyprinidae	*Cyprinus carpio*	FAD, Seine net
Air-breathing catfish	Clariidae	*Clarias batrachus*	FAD*
Fresh water shark	Siluridae	*Wallago attu*	FAD, Seine net, Long line
Butter catfish	Siluridae	*Ompok pabda*	Seine net
Stinging catfish	Heteropneustidae	*Heteropneustes fossilis*	FAD
Catfish	Schilbeidae	*Ailia coila, Aorichthys aor, M. vittatus, M. tengra*	Seine net, Push net, FAD
Feather back	Notopteridae	*Notopterus notopterus*	Seine net

Sardines	Clupeidae	*Gudusia chapra*, *Corica soborna*	Gill net, SM** seine net
Freshwater spiny eels	Mastacembelidae	*Macrognathus aculeatus*, *Mastacembelus armatus*	Gill net, Seine net, Drag net, Cast net, FAD
Spiny eel	Mastacembelidae	*M. pancalus*	Gill net, Seine net, Drag net, Cast net, FAD
Climbing perch/ Gouramies	Anabantidae	*Colisa sota*, *C. fasciatus*, *C. lalius*, *Anabas testudineus*	Gill net, Push net, FAD
Gobies/Mud skipper	Gobiidae	*Glossogobius giuris*	Push net, Seine net, Gill net, FAD
Mud perch	Nandidae	*Nandus nandus*	Gill net, Push net, FAD
Perch	Pristolepidae	*Badis badis*	Seine net, Push net
Glass perch	Centropomidae	*Chanda nama*, *C. ranga*	Push net, SM Seine net, FAD
Loaches	Cobitidae	*Botia dario*, *Lepidocephalus guntea*	Seine net
Snake-heads	Channidae	*Channa striatus*, *C. marulius*, *C. orientalis*, *C. punctatus*	Cast net, FAD, Hand line
Needlefish	Belonidae	*Xenentodon cancila*	Seine net, FAD
Half-beak	Hemirhamphidae	*Hyporhamphus gimardi*	Seine net
Puffer fish	Tetradontidae	*Tetraodon cutcutia*, *Chelonodon fluviatilis*	Seine net, FAD
Mud eel	Synbranchidae	*Monopterus cuchia*	Gill net, Seine net, Drag net, Cast net
Small prawn	Palaemonidae	*Macrobrachium lamarrei*	Push net, SM Seine net, FAD

[1] Fence made by bamboo splits and rope

* Fish aggregating device (FAD)-Fishing using Brush Park and from Kua (dewatering)

** SM- Small meshed

Local fishers, BMC members, Kua owners, retailers of local fish markets, NGO workers, Fisheries officials, and peoples residing along the immediate vicinity of the *beel* informed that species diversity and fish production of the *beel* ecosystem have declined, many species have been lost over time due to loss of fish habitat, over fishing, siltation, use of fertilizer and insecticide in the rice field and use of destructive fishing gears during the post-spawning season.

In Shakla beel, 13 types of fishing methods were generally found in operation. Those included enclosure for fish trapping, fish aggregating device (FAD) like katha (brush park) and kua fishing, and other traditional fishing gears *viz.* 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). Fishing gears of different meshes (2.5-40 mm) were found to operate into the beel ecosystem. Catch per unit effort (CPUE) of different gears varied between 1.5 and 14.0 kg/day. Sugunan 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.

Inundation of the nutrient-rich and food-rich beel provides fishery habitat in the form of spawning grounds, nursery areas and a major feeding opportunities for a wide range of fin-fish and a prawn species. A few types of fishing gears *viz.* seine nets (*moshari berjal, ghono berjal*) and gill net (*current jal*) were so far identified for indiscriminate killing of juvenile fishes of different species in the beel during post spawning period.

Macrophytes

A total of 11 species belonging to 11 genera and 10 families of aquatic weeds were identified from Shakla beel (Table 5). The identified macrophytes are five types *viz.* floating, emergent, spreading, submerged and rooted plants with floating leaves. 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 item of Buffalo. Among the identified weeds *Najas najas* species was accounted dominant. The eggs of *Macrobrachium lamarrei* were identified into the *Najas najas* vegetation during April-September. Water hyacinth (*Eichhornia crassipes*) is usually used for covering a layer on the surface of brush park (FAD) installation, which provides shelter and additional nutrients for fish species. FAP-16 (1992) reported less abundant macrophytes from Surma-Kushiyara floodplain project. Sugunan and Bhattacharjya (2000) found a rich growth of marginal and submerged vegetation in the floodplain wetlands of Brahmaputra basin. Rahman *et al.* (1997) could not find any floating aquatic vegetation from the spawning locations of Halda, the Jumuna and the Brahmaputra river and there were no significant relationship existed between the aquatic vegetation and spawning of major carps. A unique feature of the floodplain wetlands is the rich growth of marginal and submerged macrophytes due to allochthonous and autochthonous nutrient loading, which often tend to replace the plankton community and hastens the pace of eutrophication. This is almost happened for closed beels, which are choked with floating and marginal vegetation. Open beels, however, generally harboured less macrophytes, which are favorably disposed for energy transformation through phytoplankton.

Table 5. Aquatic weeds in Shakla *beel*

Family	Local name	Scientific name	Type
Pontederiaceae	Kachuripana	*Eichhornia crassipes*	Floating
Lemnaceae	Edurkanipana	*Wolffia arrhiza*	Floating
Gramineae	Arail	*Leersia hexandra*	Spreading
Gramineae	Dal	*Hydroryza aristota*	Emergent
Nymphaceae	Shapla	*Nymphaea nouchali*	Rooted plants with floating leaves
Najadaceae	Najas	*Najas najas*	Submerged
Compositaceae	Helencha	*Enhydra flucktuans*	Spreading
Marsiliaceae	Shusnishak	*Marsilea quadrifolia*	Emergent
Convolvulaceae	Kalmilata	*Ipomoea aquatica*	Spreading
Commelinaceae	Kanaibashi	*Commelina bengalensis*	Spreading
Nymphaceae	Padma	*Nelumbo nucifera*	Rooted plants with floating leaves

The abundance and succession of biotic communities occupying in the beels are influenced mainly by the unique water renewal pattern of the ecosystem. The high fluctuations in water level and the alternating seasonal riverine connections are the inherent characters of the beel ecosystem. 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*, *Heteropneustes fossilis*, *Channa* spp, *Xenentodon 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.

In floodplain wetlands, water quality is influenced to a great extent by inflow of water from the connecting rivers, 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 waters. The weed-choked beels have the lowest turbidity. The basin and aquatic soil can influence the value of pH. The variations in the concentrations of DO and free 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 fairly high and within the optimal range for the growth of fishes. An evaluation of hydrology and physico-chemical properties of water indicates that in spite of low values of hardness and alkalinity Shakla beel is found to be conducive to enhanced fisheries, capture fisheries and biological production as well.

The kua owners excavate ditches along the canals of the beel that connect the beel to the main river stream and, have a tendency to encroach *khas lands*. As such, most of the connecting canals of the beel become blocked off by the raised dyke of kuas and siltation as well. So, it is an essential task to excavate the connecting canals from the mouth of the river to the tail end of the beel for easy access of incoming water. For the sake of sustainability of species diversity every one should avoid complete harvesting of fish (mother as well their progeny) from the kua by dewatering. Initiative should be taken to well circulate the harmful effect of dewatering through mass media.

The dry season represents the most critical season for all species of fish and the greatest impact occurs at this period, mortality rate is high, populations are at their lowest levels, fishery habitat is limited, predation is at peak and growth is slowed. In this period, a certain amount of fish can be conserved in the deeper pools of beel ecosystem with the installation of brush park for next years successful breeding and recruitment to the population. In addition, to protect growth overfishing (indiscriminate killing of juveniles of different fishes) during post-spawning season fishing regulation should be imposed properly on such destructive fishing gears. In addition, conducting awareness program for the fishers can reduce indiscriminate killing of juveniles.

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