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Study of aquatic biodiversity of Gharia beel of Bangladesh

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ABSTRACT

A total number of 70 species of fishes, four species of prawn, one species of crabs and five species of reptiles were identified so far from the Gharia beel. About 11 types of fishing methods were found in operation. Increasing the rate of fishing pressure within five years by seine net (moshari jal) from 16.6 to 24.1% and gill net (current jal) from 23.5% to 36.1% were identified as detrimental gear killing including different species during spawning and post spawning periods. The increasing rate in exploitation of the water bodies a thread to aquatic biodiversity of the Gharia beel. The fisheries production of the Gharia beel declined dramatically over the last five (2001-2005) years. The total production of the beel was decreased from 104.65±5.50 to 48.03±2.97 mt within five years and the percentage of total production was sharply decreased from 21.88 to 59.25% over the same period. As a result, a number of commercial important fish species like as major carps, mohasher (*Tot tor*, Cyprinidae), nandina (*Labeo nandina*, Cyprinidae), sharpunti (*Puntius sarana*, Cyprinidae), Gajar (*Channa marulius*, Channidae) and reptiles (*Kachuga kachuga*, Chelonia and *Morenia petersi*, Chelonia) were extinct from the Gharia beel.

Key words **:** Biodiversity, extinct, endangered, vulnerable, lower risk, threatened

Gharia bell receives surface runoff water by rivers and *khals*, and consequently, a beel becomes very extensive water body in the monsoon and dries up mostly in the post-monsoon period. Gharia bell is of tectonic origin and connected with the Ghagotia River. The beel basin comprised the flood plains of the Ghagotia tributaries with abundant aquatic vegetation. But through gradual sedimentation, the basin becomes shallower leading to the formation of reeds and sedges. This resulted in providing enough food and shelter for fish and other aquatic fauna and added to the fertility of the water bodies by their excreta promoting rich growth of phytoplankton and macrophytes thus partly contributing to the process of eutrophication.

The basin of the beel supports a large variety of wetland bio-diversity and works as natural reservoir as it plays a key role in basin water resources by regulating water flows of the Ghagotia river system. The beels are also important fishing grounds of the country. In the past century or so, when the population pressure was less, most of the rim-lands of the bills remained as cultivable wasteland and was used for extensive grazing in the dry season. As population increased, boro cultivation expanded on these marginal lands leading to a large area being drained. Thus, the existences of these wetlands are now threatened.

Once this beel had abundance of native wild fish species, crabs and reptiles. Due to over-exploitation and various ecological changes in the Gharia beel, some important fish species, and reptiles have disappeared. This beel is under great stress and its existence is under danger because of changing aquatic ecosystems and habitat degradation. Like other floodplains the feeding and breeding grounds of fishes in and around the Gharia beel have been reducing drastically from various human created problems. Indiscriminate destructive fishing practices, soil erosion, siltation, construction of flood control and drainage structures and agro-chemicals have caused havoc to the aquatic biodiversity in Bangladesh.

A planned and systematic study is needed to determine the present status of biodiversity in the Gharia beel with a view to undertake appropriate measures to conserve and manage the aquatic resource. The present study conducted to determine the abundance, species combination, catch statistics and related aspects of Gharia beel. Aquatic biodiversity of an area should be studied in relation to ecology of beel, flood plain and the entire catchments area of a water body.

MATERIALS AND METHODS

Experimental procedure

The Beel Gharia Comprising an average are of 62.0 ha with an average depth 1.82±0.82 m. The beel is surrounded by Tarikandi, Haripur and Shanandakhila villages. The study was conducted during January 2001 December 2005. The research was based on both primary and secondary data, comprehensive literature review and extracts of local knowledge and information. 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, physical-chjemical and biological characteristics of beel and fishers'

perception as well. Secondary data were collected from the fishers, lease holders, local administration and department of Fisheries (DoF).

Study of Meteorological and Physico-chemical parameters and plankton

A bamboo made meter scale measured water depth. Water temperature was recorded using a Celsius thermometer and transparency was measured by using a Secchi disc of 20 cm diameter. Dissolved oxygen and pH were measured directly using a digital electronic oxygen meter (YSI Model 58) and an electronic pH meter (Jenway Model 3020). Alkalinity was determined by titrimetric method (Clesceri *et al.,* 1989).

The plankton sample was collected fortnightly from the euphotic zone using 0.55 blotting silk plankton net and later analyzed numerically with the help of Sedgewick-Rafter counting cell (SR-cell) under a compound microscope (Clesceri *et al.*1989). Calculation of the abundance of plankton was done by Stirling, 1985.

Sampling of Fish

The beel was sampled simultaneously during winter (mid November to February), premonsoon (February to April), monsoon (May to August) and post monsoon (September to mid November) for assessment of fish abundance and availability

Data collection

An organized sampling program spread over a reasonably long time is needed to get a true picture of the catch and composition. The present study, being a survey, gives only a broad picture of a stock of fishes, crabs and reptiles that could be obtained through collection of different species directly from fishers" catch, fishing through enclosure with bana (locally known pati, made by bamboo), khata fishing, kua fishing and market survey (Dhubaura market, Ghoshgaon bazaar, Guathola and Munsirhat market). Catch-effort survey was done through fishers' nets. Resident fish species was recorded through fishing in the deep pool areas and man-made kuas where water remains during dry season (January to mid April). Local knowledge as well as interaction with fishers' in the beel side and even in the beel considered also. Aquatic weeds were collected and identification was made into the laboratory.

Analysis of experimental data

The data were analyzed through one way ANOVA using MSTAT followed by Duncan's Multiple Range Test to find out whether any significant difference existed among treatment means (Zar, 1984).

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 related 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 rain fall and flooded water from the Meghaloya's hilly range, India. The Ghagotia River passes through the southern side of the beel. This beel is connected with the Ghagotia River by two cannels locally called khal. In the dry season, almost 75% areas of the beel become dried up except the canals, and khata and kua fishing area where water remains during January to mid-April. Flooding originates from the Ghagotia river, the south of the beel. 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 river. The more water gain or exchange of water takes place during southwest monsoon when floodplains are flooded. The early flood phase (April to early June) occurs in the early monsoon season when the water level in basin is relatively low. The water level in the floodplain rises and falls in accordance with the water level in adjacent with Gharia bill. The deep flood phase (June to September) begins when the water level in the Ghagotia and Kangshow River, causing deep flooding in the two unions of Dhubaura Upazilla, Mymensingh. Floodwater in flood plains starts receding in the post-monsoon season (October to December). After recession of flood, water level in the beel decreases snapping the beel connection with the river. The beel gets dried up through evapo-transpiration and seepage. Except deeper portion of the 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.

Physical characteristics

Soil texture of Gharia beel varied from clay to loam. The soil structure of the deeper bed appeared to have predominantly clay and in the surrounding structure of the wet land was recorded loam to clay (Table 1).

The water physico-chemical parameters of the Gharia beel, which included temperature, transparency, pH, dissolve oxygen and alkalinity of water, were are furnished in Table 2. It is evident from the Table 2 that the mean water temperatures

were not statistically significant (P>0.05) in the entire beel. Mean Secchi disk transparency differed significantly (*P*<0.05) during the year 2001-2005. Higher values occurred during the year 2002 and summer months due to reduced flow and relatively stable conditions. pH did not differ significantly (*P*>0.05). A significant rise in pH during pre-monsoon followed by a drop in winter was noted. The mean dissolved Oxygen (DO) was not differ significantly (*P*>0.05) during study period. Total alkalinity was differed significantly (*P*<0.05). Lowest value alkalinity (98.26 mg L^{-1}) was recorded in the in the winter during 2005.

Plankton population

Abundance of total plankton in Gharia beel is presented in Table 3. The quantity of phytoplankton and zooplankton was particularly dominant in the month of June and July and lowest count was obtained in December and January. The phytoplankton consisted of 27 in the Gharia beel in four broad groups' viz., Chlorophyceae, Bacillariophyceae, Cyanophyceae and Euglenophyceae. Chlorophyceae contributed the genera were *Protococcus*, *Mougeotia*, *Microspora*, *Mesotenium*, *Clasterium*, *Eremesphaera*, *Chlorococcum*, *Ophiocytium*, *Penium*, *Spyrogyra*, *Zygnema*, *Kirchneriella*, *Gonotozygon*, *Pediastrum*, *Oocystis*, *Tetraedron*, *Volvox*. Bacillariophyceae included various species belonging to genera *Melosira*, *Diatoma*, *Fragilaria* and *Navicula*. Cyanophyceae included the genera of *Anabaena*, *Chroococcus*, *Merismopedia*, *Mycrocystis* and *Oscillatoria*. Euglenophyceae included only the genera of *Euglena*. Chlorophyceae was the dominant group which was significantly higher (*P*<0.05) during five years study period. The abundance of Bacillariophyceae did not differ significantly (*P*<0.05). The mean abundance of total phytoplankton was not differ significantly (*P*<0.05) during investigation period. Among zooplankton the represented genera were *Bosmina*, *Brachionus*, *Cyclops*, *Filinia*, *Keratella*, *Trichocerca*, *Lecane*, *Diaptomus*, *Daphnia*, *Moina*, *Nauplius* and *Oicomonas* belonging to two groups. The zooplankton population consisted of 12 genera including nauplii in two groups viz., Rotifera, Crustacea and other groups. Rotifera and Crustacea were not significantly differed (*P*<0.05) in the Gharia beel during investigation periods. The mean abundance of total zooplankton did not differ significantly (*P*<0.05).

Macrophytes

A total number of 12 species belonging 12 genera and 10 families of aquatic weeds were identified from Gharia beel (Table 4). The weeds usually grow along the beel margins and only Hizal area of the beel, which gives shelter and additional nutrients of aquatic wild animal. Hizal (*Barringotonia acutangula*, Myrtaesae) grows in the deeper regions. The weeds are usually used as human consumption and cattle food. Najas (*Najas najas*, Najadaceae) species was accounted dominant among the identified weeds. The eggs of prawn and different fish species were identified into the *N. najas* and water hyacinth (*Eichhornia crassipes*, Pontederiaceae) during summer to winter. Water hyacinth usually covered a layer on the surface of Khua in the deep.

Craft and gears used

Fishermen generally used boat for transport of nets and related materials during fishing, for fish catch they used seine net or ber jal, komor jal, thela jal, dharma jal, bua jal, lift net, cast net, current jal and various type fish trap, hook and line and Fishing by dewatering FAD (Fish aggregating device) according to season and availability of different species of fishes. There are so many fish trap (vair, dugair, ghuni and phlo etc.) and hook and line (barshi, fulkuichi, Jhupi aikra etc.) was used to capture groups of major carp, minor carp, cat fish, small cat fish, clupidae, eels, large and small prawn, crabs and reptiles. In the figure 1, it was remarkable that every year increased fishing effort by using illegal fishing gear like gill net (current jal) and ber jal (moshari jal). The percentage of catch statistics by using current jal and ber jal (moshari jal) were 23.50%, 27.10%, 30.50%, 33.10% and 36.10%; and 16.60%, 18.70%, 20.20%, 22.20% and 24.10% within the year 2001, 2002, 2003, 2004 and 2005, respectively and using of current jal and ber jal (moshari jal) differed significantly (P<0.05). Catch statistics by using of komor jal were17.80%, 16.40%, 15.50%, 15.20% and 14.60% in the year 2001, 2002, 2003, 2004 and 2005, respectively but using of komor jal was also differed significantly (P>0.05). The catch statistics by using thela jal, dharma jal, bua jal, lift Net, cast net, fish trap and hook and line was decreasing and also differed significantly (P<0.05) in the year 2001, 2002, 2003, 2004 and 2005. As a result, a significant reduction by decreasing fish abundance in the Gharia beel every year.

Fish catch and composition

An organized sampling program was run for a long time to get a true picture of the catch and composition of Gharia beel. The present investigation gave a broad picture of a stock of aquatic wild animal that obtained through market survey and interaction with fishers' in the beel.

Fishing activity in the Gharia beel was

consisted 80 aquatic wild animals (70 species of wild fishes, four species of prawn, one species of crabs and five species of turtles) belonging to 48 genera, 21 families. Fishing was done throughout the year. During monsoon and post monsoon, fishermen used lift net, current jal, cast net, traps, and lines to catch fishes. Fishermen also operated kata fishing by sein net (Ber jal and Komor jal) in the season of winter and spring. The annual catch assessment of the river was around 104.65±5.50, 82.75±4.68, 71.27±4.23, 59.17±3.52 and 48.03±2.97 mt in the year 2001, 2002, 20003, 2004 and 2005, respectively consisting of 11 groups viz., Major carp, Minor carp, Small fish, Knife fish and Feather back, Snake head fish, Cat fish, Small Cat fish, Spiny eel, Prawn, Crabs and Reptiles (Table 5). Small cat fish was the dominant group (highest production) of the Gharia beel in the year 2001-2005 and second highest production was recorded in group of small fish. The catches of all the groups of fishes, crabs and reptiles were higher in 2001 but gradually lower catches was recorded in the year 2002, 2003, 2004 and 2005 (Figure 4). The production or total catch of the beel was decreased in 2002 followed by 2003, 2004 and 2005, respectively. However, the total catches in different years were significantly different ($P<0.05$). Commercial important major carps mohasseer (*Tot tor*, Cyprinidae), nandina, (*Labeo nandina*, Cyprinidae) were rarely found in the year of 2001. But these species were extinct within 2002 to 2005. Local sarpunti (*Puntius sarana*, Cyprinidae), Gajar (*Channa marulius*, Channidae) and Reptiles (*Kachuga kachuga*, Chelonia and *Morenia petersi*, Channidae) were rarely found in the year of 2001 to 2004, but these species were extinct in the year 2005. Bhagna (*Cirrhinus reba*, Cyprinidae), Along (*Bengala elanga*, Cyprinidae), Bata (*Labeo bata*, Cyprinidae), dhela, (*Rohtee cotio*, Cyprinidae), Chitol (*Notopterus chitala*, Notopteridae), Ayre (*Aorichthys aor*, Bagridae), Guzia (*Aorichthys seenghala*, Bagridae), Baghair (*Bagarius yarrellii*, Bagridae), Rita (*Rita rita*, Bagridae), Kani papda (*Ompok bimaculatus*, Siluridae), Modhu pabda (*Ompok pabda*, Siluridae), Magur (*Clarius batrachus*, Claridae), Baim (*Mastacembalus armatus*, Mastacembelidae), Galda isa (*Machrobrachium* rosenbergii, Palaemonidae), *Kakra* (*Stylla serrata*, Palaemonidae), Reptile (*Kachuga tecta*, Chelonia) like a major commercial importance aquatic wild life species of the beel was facing as extremely high risk of extinction day by day.

The catch statistics of Gharia beel showed that the percentage of fishing pressure is increasing year by year. As a result, the total production of the beel was decreased 21.88%, 34.93%, 47.59% and 59.25% in the year 2001-02, 2002-03, 2003-04 and 2004-05, respectively. Not only that the total catch statistics of the Gharia beel showed that the abundance of different important species of the beel was facing as extremely high risk of extinction between 2004 and 2005. The status of the 80 aquatic wild animal of the Gharia beel was identified as E-04, CR-05, EN-35, VU-29, LR-06 and NO-01, respectively.

In the figure 3, it is found that the percentage of capture fishes, crabs and reptiles in the river was recorded highest status in 2001-02, where the capture was decreased in 2002-04 and sharply decreased in 2004-05. Cyprinids and catfishes are dominant groups of the river. However, the production percentage (%) differed significantly ($P<0.05$) among the different years (Figures 4 and 5). Table 5, shows the existing structure of wild fishes. A total of five species of fresh water turtles, viz. narrow headed soft shell (*Chiitra indica*, Chelonia), spotted flapshell (*Lissemys punctata*, Chelonia), common roof turtle (*Kachuga tecta*, Chelonia), painted roof turtle (*Kachuga kachug*, Chelonia) *and* Bengal eyed turtle (*Morenia petersi*, Chelonia) with family were found in the Gharia beel. But two important species of turtles was extinct within five years. During investigation period, it was found that fishing effort with mesh size was increased in every year as a result, average size and number of individual fish declined every year.

During investigation periods, wildlife includes, amphibians (*Buffo melanostictus*, *Rana tigerina*, *Rana limnocharis*, *Rana cyanophyctis* and *Salamandra salamondra*), aves (whistling duck, great crested grebe, great cormorant, red crested pochard, water cock, swamphen, great black headed gull, gray-headed fish eagle, curlew, spotted redshank) and mammals (musk shrew, fishing cat, small Indian mongoose, jackle, flying fox) were identified.

The loss biodiversity of Gharia beel is studied during five year investigation period, which is accepted as a major problem (Moyle and Williams 1990). The physico-chemical factors and plankton were found to be optimum level. Water temperature of the Gharia beel an increasing trend in monsoon and post monsoon season and decreasing in winter is supported by Mathew (1975). Transparency was consistently higher in deeper portion of the beel, possibly due to stagnant of water. Rahman (1992) stated that the transparency of productive water bodies should be 40 cm or less. Fluctuation of dissolve oxygen concentration might be attributed to photosynthetic activity. Banerjee (1967) reported that a range 5 to 7 mg L^{-1} is productive. The higher concentration of oxygen values was found in post

monsoon period. The uniformly average value of oxygen was noted in the experimental period. Similar Phenomena were noted by Saha *et al.* (1988). pH values agree well with the findings of Rahman and Rahman (2003). Alkalinity levels of the beel were medium to high (Bhuiyan, 1970).

The phytoplankton consisted of 27 genera into four broad groups viz., Chlorophyceae, Bacillariophyceae, Cyanophyceae and Euglenophyceae, which is more or less similar investigation of Ehsha et al., 1997; Hossain et al., 1998; Sugunan and Bhattacharya, 2000. The zooplankton population consisted of 12 genera into two groups viz., Rotifera, Crustacea and other groups. Almost similar observation was studied by Ahmed et al. (1997) and Sugunan and Bhattacherjya (2000). In the present study the quantity of both phytoplankton and zooplankton was higher in lower region due to running water flows.

A total number of 13 species of marginal and submerged vegetation was observed in the floodplain wetlands of Gharia beel, which was very similar to Sugunan and Bhattacharya (2000) who found marginal and submerged vegetation in the floodplain of Bhramaputtra basin. The swamp forests, which were once dominant with the flood tolerant tree species like hijal (*Barringtonia acutangula*, Myrtaesae), have been reduced to a few small patches.

It was found that fishing effort with various types of fishing gear seine net (especially kaperi jal), gill net (current jal) and fish trap uses was increased in every year but average size and number of individual fish declined in the Gharia beel. Haroon *et al.* (2002) reported eighteen types of fishing gears from the sylhet sub-basin and thirteen types from Mymensingh sub-basin which is very similar to this study. Sugunan and Bhattacharya (2000) found a wide variety of fishing methods employed in the beels of Assam, India which are very similar to the present study. Cast net **(**Kepla Jal/ Jaki jal) is used whole year in the river. This net is also used in other area of Bangladesh (Ahmed, 1962).

The catch statistics indicate that fishing pressure of the river was increased. As a result, decreasing percentage of production was increased from 21.88 to 59.25% within five years, respectively which was very similar to the study of Moyle and Leidy, 1992. He found that worldwide 20% of all freshwater species are extinct, endangered or vulnerable. The total catch statistics of fishes in the river is indicated that percentage of different group of fishes was sharply decreased in every year. As a result, commercial important major carps mohasseer (*Tot tor*, Cyprinidae), nandina (*Labeo nandina*, Cyprinidae), local sarpunti (*Puntius sarana*, Cyprinidae), Gajar (*Channa marulius*, Channidae) and reptiles (*Kachuga kachuga*, Chelonia and *Morenia petersi*, Chelonia) were extinct between 2004 and 2005 which is more or less similar to IUCN, Bangladesh 1998. According to IUCN, Bangladesh about 56 freshwater fish species as critically or somewhat endangered. Due to over-exploitation and various ecological changes in natural aquatic ecosystem of Gharia beel, these commercial important major carps are in the verge of extinction, which was similar investigation of Sarkar (1993). Among major and minor carps Common carp (*C. carpio*, Cyprinidae) and Ghonia (*P. gonionotus*, Cyprinidae) among catfishes Ayre (*M. aor*, Schilbeidae), Bujuri (*M. tengra*, Schilbeidae) and Schilbeidae (*W. attu*, Siluridae), Magur (*C. batrachus*, Claridae), Singi (*H. fossilis*, Heteropneustidae) occurred significantly in the study area. Catla (*C. catla*, Cyprinidae), Bhangna Bata (*C. reba*, Cyprinidae), Along (*B. elanga*, Cyprinidae), Bata (*L. bata*, Cyprinidae), Dhela (*R. cotio*, Cyprinidae), Chitol (*N. chitala*, Notopteridae), Baghair (*Bagarius yarrellii*, Bagridae), Kani Pabda (*O. bimaculatus*, Siluridae), Madhu Pabda (*O. pabda*, Siluridae), Baim (*M. armatus*, Mastacembelidae), Golda Isa (*M. rosenbergii*, Palaemonidae), Kakra (*S. serrata*, Palaemonidae), Common Roof Turtile (*K. tecta*, Chelonia) like a major commercial importance species of the beel is facing as extremely high risk of extinction between 2004 and 2005.

During winter season turtles (*Morenia petersi*, Chelonia and *Kachuga tecta*, Chelonia) were caught in the Gharia beel. The species of turtles (*Kachuga tecta*, Chelonia) has been reported to be distributed between the Ganges River and the Brahmaputra River and the species is endemic to Bangladesh (Khan, 1982). Das (1991) mentioned that the Bengal eyed turtle (*Morenia petersi*, Chelonia) is restricted to the eastern part of the Ganges River and the western part of the Brahmaputra River. Turtles in the Gharia beel have been declining because of dewaterization of its habitat for irrigation in the winter season. Another region is destruction in its breeding ground and nesting sites. Over exploitation for local consumption and trade indiscriminately posses a threat to all species of turtles as well. According to IUCN, 2000, the status of the 80 aquatic wild animals is clearly proved the present condition is facing as extremely high risk of extinction day by day.

With the recession of floodwater, a large variety of small fishes, water snails and bivalves, and pasture spread over the surface attracting a large number of migratory birds. These birds use the beel

as temporary resting and roosting ground before moving elsewhere.

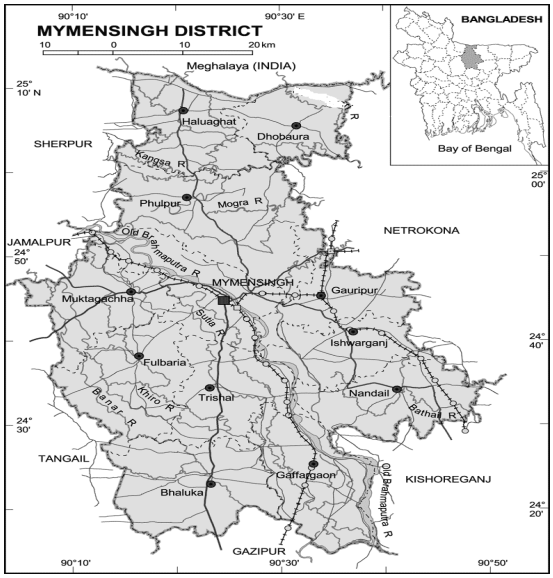

Fig. 1 : Map of Bangladesh and Mymensingh district showing the location of Gharia beel.

The studies of the Gharia beel have brought out clearly that the fish stocks have been over fished and changing aquatic ecosystems due to construction of flood control barrage, soil erosion, siltation and drainage structures and agro-chemicals. This beel is siltated during over flooding, which reduces the water level and causes habitat degradation. Domestic organic wastes (sewage) directly or indirectly through canals or drains to the beel are polluting the aquatic ecosystem. The genetic stock structure of fish populations is reduced due to pollution and destructive fishing practices. Indiscriminate killing of fish occurs due to the use of pesticides in improper doses, use of forbidden chemicals, aerial spray of chemicals used for paddy field etc. which was very much similar to the study of Mazid 2002. In addition, indiscriminate destructive fishing practices have caused havoc to the aquatic biodiversity of Gharia beel. As a result, the ecosystem and biological diversity of the Gharia beel have been depleting at an unprecedented rate. Similar investigation was found by Hussain and Hossain 1999. Intervention to control floods, adoption of new agricultural technologies and construction of road networks has altered the ecology of Gharia beel significantly which was similar investigation to Khan 1993 and Ali 1991.

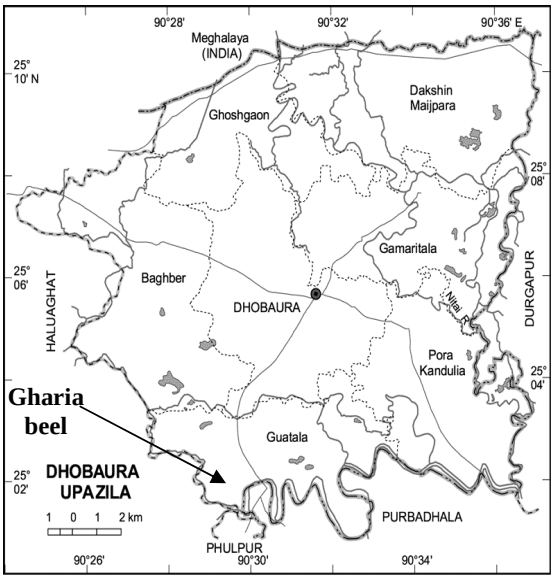

Fig. 2 : Map of Dhubaura Upazilla in Bangladesh showing the study area of Gharia beel.

Stock of the wildlife broad fishes and other species in the breeding ground have suffered significant damages, resulting in a reduction of biodiversity as well as a decline in the socioeconomic importance of the beel as a source of food and materials of livihood which was very similar investigation of Nishat 1993 and Zaman 1993.

The action plan efforts for saving the stock of fish species and others will be as stricter enforcement of fishing rules to prevent fishing with gill net (current jal) and ber jal (moshary jal); prevention of killing brood fish and juveniles from the breeding ground; the river need to be declared as sanctuaries because sanctuary protects the fish in all season and may be stocked every year with fingerlings; and develop community based management of open water system for the interest of stakeholder.

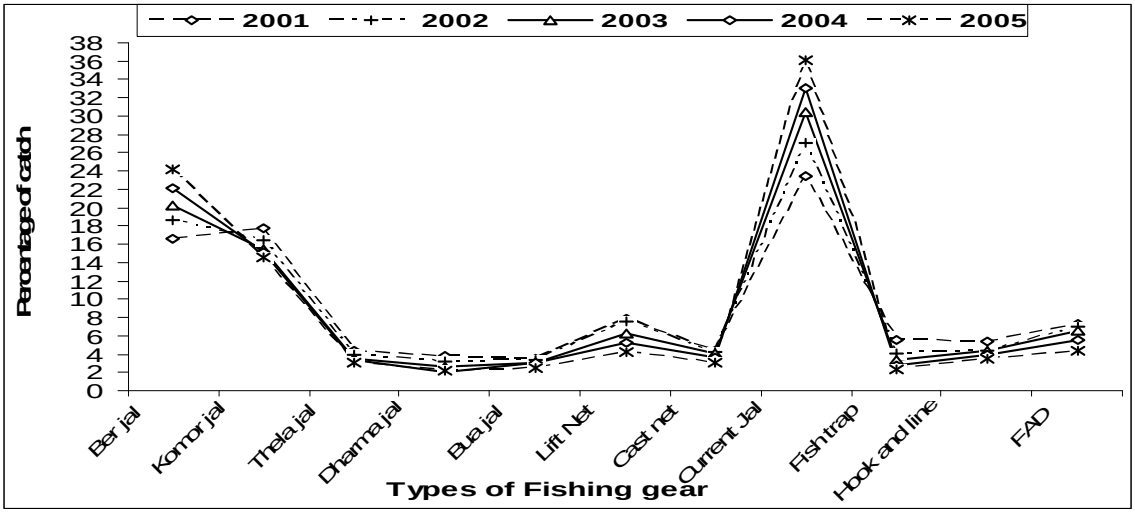

Fig. 3 : Percent composition of catches by different types of fishing methods, 2001- 2005.

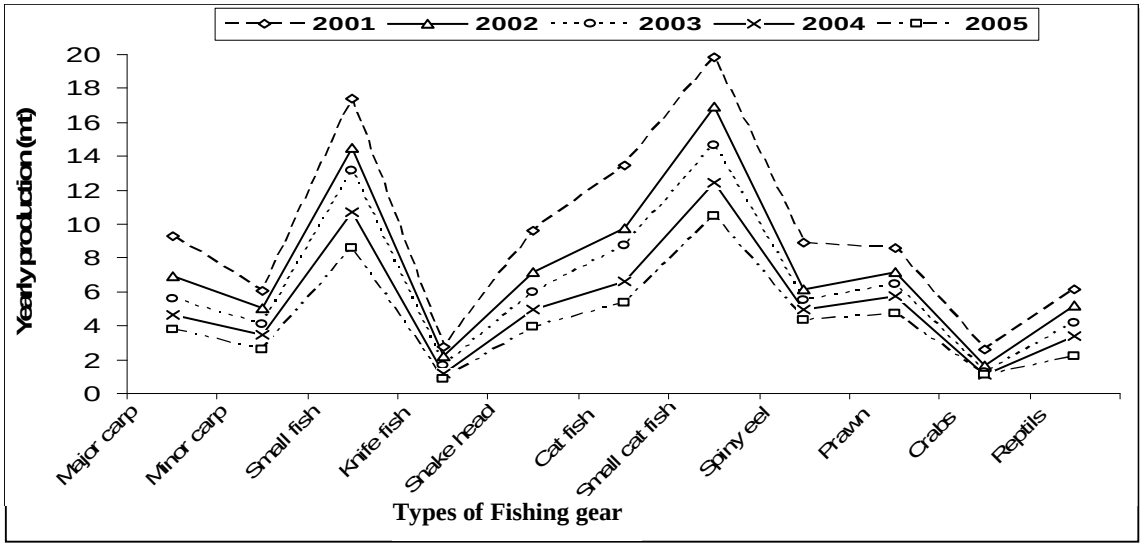

Fig. 4 : The production of different groups of aquatic wild animal in the Gharia beeldecreasing in the year 2001 to 2005.

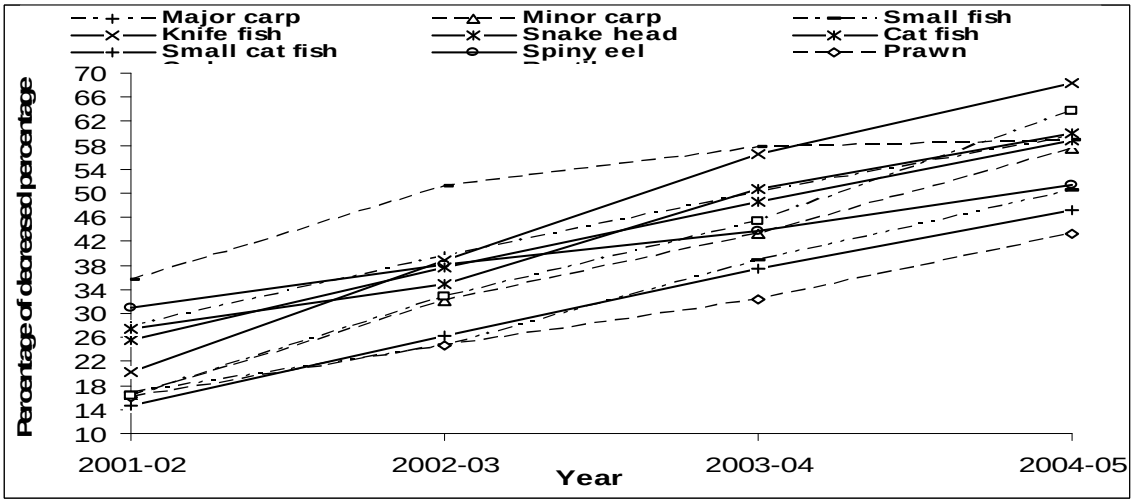

Fig. 5 : The production percentage of different groups of aquatic wild animal in the Gharia beel decreasing in the year 2001 to 2005.

Table 1: Physical features of sediment of the Gharia beel

Location	Soil texture of the bed of beel (%)		
	Clay	Loam sand	Sandy
Deeper bed	94.4±4.15[a]	4.1±2.52[b]	1.5±1.02[c]
Wet land bed	18.4±2.11[b]	78.7±5.88[a]	2.9±1.12[c]

Figures with different superscripts in the same row varied significantly (P>0.05).
Figures in the parenthesis indicate the range.

Table 2: Physico-chemical parameters of Gharia beel

Parameters	Years				
	2001	2002	2003	2004	2005
Temperature (^oC)	26.22±6.88 (16.28-33.44)	27.58±7.85 (17.11-32.80)	26.02±8.47 (16.2-33.20)	25.88±7.72 (16.08-32.85)	25.09±8.82 (15.95-33.08)
Transparency (cm)	34.68±8.44[d] (28.52-50.22)	45.82±6.02[a] (32.02-52.62)	30.55±6.48[e] (24.38-47.41)	39.87±7.74[c] (28.30-48.44)	42.22±6.74[b] (27.18-50.72)
pH	7.48± 3.07 (6.70-8.80)	7.56±2.6 6 (6.55-8.70)	7.55± 1.58 (6.55-8.68)	7.48±1.86 (6.65-8.60)	7.60±2.06 (6.50-8.40)
Dissolved oxygen (mg L^{-1})	5.14±1.54 (4.18-8.02)	5.44±1.08 (4.04-7.74)	5.84±1.42 (4.48-7.45)	4.85±1.28 (4.24-7.14)	5.05±1.66 (4.24-7.88)
Alkalinity (mg L^{-1})	122.28±10.24[c] (100.24-135.45)	127.02±10.02[b] (99.88-138.02)	110.28±9.21[e] (101.25-137.35)	116.02±9.32[d] (102.80-135.12)	133.76±12.22[a] (98.26-137.85)

Figures with different superscripts in the same row varied significantly (P>0.05).
Figures in the parenthesis indicate the range.

Table 3 : Mean variation of phytoplankton (individual ml-1) and zooplankton (organism ml-1) population in the Gharia beel.

Plankton group ($\times10^3$ cells L-1)	Years				
	2001	2002	2003	2004	2005
Chlorophyceae	26.05±5.18[a] (17.88-29.43)	22.77±7.22[d] (16.04-30.62)	20.05±6.28[e] (16.69-29.48)	25.17±5.22[b] (17.54-30.72)	24.05±6.85[c] (17.80-31.45)
Bacillariophyceae	12.42±3.04[d] (8.48-18.47)	14.28±4.46[a] (10.28-20.30)	13.48±3.44[b] (8.38-20.92)	13.88±2.46[b] (9.18-20.14)	12.44±3.44[d] (9.88-19.40)
Cyanophyceae	7.22±2.08 (6.15-11.08)	8.07±2.55 (7.11-13.12)	7.82±1.88 (6.05-12.48)	8.11±2.05 (7.01-12.12)	7.77±3.02 (6.15-12.21)
Euglenophyceae	0.00±0.00	1.0±0.02 (0.80-1.22)	0.88±0.00 (0.24-1.40)	1.01±0.82 (0.40-1.32)	0.00±0.00
Total Phytoplankton ($\times10^3$ cells L-1)	45.69±11.00[c]	46.12±9.25[b]	42.23±8.16[e]	48.17±10.21[a]	44.26±10.06[d]
Rotifera	5.28±1.22[a] (3.10-5.76)	4.66±1.12[c] (3.21-6.58)	5.08±1.05[b] (4.00-7.16)	4.22±1.22[c] (3.22-6.98)	5.38±1.15[a] (3.88-7.16)
Crustaceae	3.78±1.06[d] (2.62-4.28)	4.04±1.12[c] (3.36-6.72)	3.68±1.26[e] (2.62-5.18)	4.14±1.22[b] (3.06-6.62)	4.28±1.46[a] (2.90-5.18)
Others	1.10±0.20 (1.80-2.03)	1.17±0.82 (1.01-2.88)	1.15±0.48 (10.88-2.13)	1.07±1.32 (0.88-2.18)	1.05±0.28 (0.99-2.30)
Total Zooplankton ($\times10^3$ Organisms L-1)	10.16±2.12[b]	9.87±1.86[c]	9.91±1.99[c]	9.43±1.80[d]	10.71±2.25[a]

Figure in the same row having the same superscript are not significantly different (P>0.05).
Figures in the parenthesis indicate the range.

Table 4 : Aquatic weeds of Gharia beel.

Family	Local name	Scientific name	Type
Lemnaceae	Edurkanipana	*Wolffia arrhiza*	Floating
Pontederiaceae	Kachuripana	*Eichhornia crasssipes*	Floating
Gramineae	Dal	*Hudroryza aristota*	Emergent
Najadaceae	Najas	*Najas najas*	Submerged
Compositaceae	Helencha	*Enhydra flucktuans*	Spreading
Marsiliaceae	Shusnishak	*Marsileaquadrifolia*	Emergent
Gramineae	Arail	*Leersia hexandra*	Spreading
Commelinaceae	Kanaibashi	*Commelina bengalensis*	Spreading
Convolvulaceae	Kalmilata	*Ipomoea aquatica*	Spreading
Nymphaceae	Shapla	*Numphaea nouchali*	Rooted plants with floating leaves
Nymphaceae	Padma	*Nelumbo nucifera*	Rooted plants with floating leaves
Myrtaesae	Hizal	*Barringotonia acutangula*	Rooted plants with floating

Table 5 : Status and distribution of Gharia beel of northern Bangladesh. Status code : E: Extinct, CR: Critically Endangered, EN- Endangered, VU-Vulnerable, LR- Lower risk, NO- Not threatened (As per IUCN, 2000)

SL No	Group / Family	Local name	Scientific name	Production (mt)					Status
				Someswari River					
				2001	2002	2003	2004	2005	
A.	**Major carps:**								
1	Cyprinidae	Catla	*Catla catla*	1.01 ±0.44	0.83 ±0.33	0.48 ±0.32	0.27 ±0.32	0.14 ±0.30	EN
2	Cyprinidae	Rui	*Labeo rohita*	1.25 ±0.43	0.98 ±0.51	0.64 ±0.62	0.47 ±0.42	0.37 ±0.48	EN
3	Cyprinidae	Mrigal	*Cirrhinus mrigala*	1.18 ±0.25	0.88 ±0.03	0.72 ±0.33	0.55 ±0.40	0.42 ±0.52	EN
4	Cyprinidae	Mahashol	*Tot tor*	0.01 ±0.02	0.00 ±0.01	0.00 ±0.01	0.00 ±0.00	0.00 ±0.00	E
5	Cyprinidae	Nandil	*Labeo nandina*	0.01 ±0.01	0.00 ±0.00	0.00 ±0.00	0.00 ±0.00	0.00 ±0.00	E
6	Cyprinidae	Kalbaus	*Labeo calbasu*	1.01 ±0.44	0.87 ±0.34	0.74 ±0.33	0.62 ±0.14	0.41 ±0.74	VU
7	Cyprinidae	Ghonia	*Labeo gonius*	0.90 ±0.46	0.59 ±0.41	0.38 ±0.32	0.26 ±0.40	0.18 ±0.21	EN
8	Cyprinidae	Common carp	*Cyprinus carpio*	3.10 ±0.18	2.21 ±0.26	2.16 ±0.47	2.01 ±0.15	2.98 ±0.42	LR
9	Cyprinidae	Silver carp	*Hypophthalmicichthys molitrix*	0.44 ±0.22	0.32 ±0.27	0.25 ±0.18	0.25 ±0.38	0.11 ±0.48	LR
10	Cyprinidae	Grass carp	*Ctenopharyngodon idellus*	0.35 ±0.15	0.27 ±0.55	0.22 ±0.18	0.18 ±0.22	0.14 ±0.45	LR
B.	**Minor carp:**								
11	Cyprinidae	Along	*Bengala elanga*	~ □□ ±0.28	~ □□ ±0.17	~ □1 ±0.16	~ □□ ±0.12	~ □□ ±0.08	EN
12	Cyprinidae	Bata	*Cirrhinus reba*	0.92 ±0.37	0.78 ±0.28	0.65 ±0.29	0.47 ±0.26	0.35 ±0.12	EN
13	Cyprinidae	Bhangna bata / Bata	*Labeo bata*	1.11 ±0.88	0.98 ±0.54	0.72 ±0.52	0.68 ±0.44	0.37 ±0.35	CR
14	Cyprinidae	Puda / Sharpunti	*Puntius sarana*	0.48 ±0.06	0.36 ±0.05	0.18 ±0.01	0.01 ±0.0	0.0 ±0.0	E
15	Cyprinidae	Thi sarpunti	*Puntius gonionotus*	1.88 ±2.58	1.61 ±2.46	1.42 ±1.40	1.4 ±1.22	1.15 ±1.02	LR
C.	**Small fish:**								
16	Cyprinidae	Mola/ Moya	*Amblypharyngodon mola*	0.82 ±0.44	0.61 ±40	0.57 ±33	0.46 ±30	0.38 ±28	VU
17	Cyprinidae	Laubuca / kashkhaira	*Chela laubuca*	0.22 ±0.08	0.17 ±0.05	0.14 ±0.04	0.11 ±0.02	0.08 ±0.01	CR
18	Cyprinidae	Dhela / Dhiphali	Rohtee *cotio*	0.41 ±0.05	0.34 ±0.02	0.28 ±0.01	0.11 ±0.01	0.02 ±0.01	EN
19	Cyprinidae	Chola punti	*Puntius chola*	0.38 ±0.08	0.31 ±0.05	0.28 ±0.04	0.17 ±0.02	0.08 ±0.01	EN
20	Cyprinidae	Taka punti	*Puntius conchonius*	0.58 ±0.04	0.41 ±0.04	0.36 ±0.04	0.30 ±0.02	0.29 ±0.01	VU
21	Cyprinidae	Phutani punti	*Puntius phutunio*	0.68 ±0.08	0.55 ±0.05	0.42 ±0.04	0.36 ±0.02	0.31 ±001	EN
22	Cyprinidae	Jatpunti / Vali Punti	*Puntius Sophore*	0.35 ±0.05	0.31 ±0.03	0.27 ±0.03	0.21 ±0.01	0.18 ±0.01	EN
23	Cyprinidae	Teri punti	*Puntius terio*	0.44 ±0.06	0.38 ±0.05	0.33 ±0.04	0.3 ±0.02	0.28 ±0.01	VU
24	Cyprinidae	Tit Punti	*Puntius ticto*	0.59 ±0.02	0.52 ±0.02	0.46 ±0.02	0.41 ±0.01	0.40 ±0.01	VU
25	Cyprinidae	Fulchela	*Salmostoma phulo*	0.28 ±0.01	0.24 ±0.01	0.20 ±0.01	0.17 ±0.01	0.12 ±0.01	VU
26	Anabantidae	Khailsha	*Colisa fasciata*	0.90 ±0.05	0.88 ±0.04	0.75 ±0.05	0.66 ±0.05	0.52 ±0.02	VU
27	Anabantidae	Lal khailsha	*Colisa lalia*	0.68 ±0.22	0.58 ±0.11	0.43 ±0.01	0.38 ±0.01	0.40 ±0.01	VU

SL No	Group / Family	Local name	Scientific name	Production (mt)					Status
				Someswari River					
				2001	2002	2003	2004	2005	
28	Anabantidae	Chuna Khalisha	*Colisa sota*	0.39 ±0.02	0.35 ±0.01	0.37 ±0.01	0.22 ±0.01	0.18 ±0.01	VU
29	Nandidae	Mini / Bheda	*Nundas nandus*	1.08 ±1.01	0.78 ±1.00	0.64 ±0.05	0.44 ±0.02	0.35 ±0.01	EN
30	Cyprinidae	Darkina	*Esomus danricus*	0.33 ±0.02	0.22 ±0.01	0.20 ±0.01	0.18 ±0.01	0.08 ±0.01	VU
31	Cyprinidae	Kanpona	*Oryzias melastigma*	0.12 ±0.11	0.1 ±0.02	0.08 ±0.01	0.06 ±0.01	0.04 ±0.01	VU
32	Mastacembelidae	Gutum	*Lepidocephalus gontea*	2.09 ±0.18	1.88 ±0.80	1.37 ±0.60	1.22 ±0.05	1.08 ±0.04	VU
33	Clupeidae	Chapila	*Gadusia chapra*	0.99 ±1.82	0.85 ±1.05	0.77 ±1.00	0.66 ±0.06	0.55 ±0.08	VU
34	Centropomidae	Chanda	*Chanda nama*	1.27 ±1.11	0.97 ±0.82	0.82 ±0.80	0.80 ±0.44	0.65 ±0.35	VU
35	Centropomidae	Chanda	*Pseudambasis bacuculis*	0.66 ±0.80	0.50 ±0.66	0.51 ±0.42	0.45 ±0.17	0.38 ±0.14	VU
36	Centropomidae	Ranga chanda	*Pseudambasis ranga*	0.67 ±1.01	0.62 ±0.72	0.58 ±0.32	0.50 ±0.10	0.32 ±0.05	VU
37	Cobitidae	Rani/Botya	*Botia dario*	0.60 ±0.05	0.51 ±0.04	0.38 ±0.10	0.32 ±0.08	0.30 ±0.04	EN
38	Cobitidae	Rani	*Botia dayi*	0.50 ±0.11	0.45 ±0.08	0.40 ±0.07	0.37 ±0.06	0.35 ±0.02	EN
39	Tetradontidae	Potka	*Tetrodon cutcutia*	1.34 ±2.20	1.15 ±1.86	1.49 ±1.72	1.06 ±0.68	0.80 ±0.55	EN
40	Gobiidae	Baila / bele	*Glossogobus giuris*	1.06 ±1.20	0.83 ±0.88	1.04 ±0.65	0.76 ±0.52	0.46 ±0.30	VU
D.	**Knife fish & Feather back**								
41	Notopteridae	Chitol	*Notopterus chitala*	1.01 ±0.08	0.80 ±0.06	0.55 ±0.04	0.27 ±0.02	0.15 ±0.02	EN
42	Notopteridae	Foli	*Notopterus notopterus*	0.35 ±0.02	0.30 ±0.02	0.22 ±0.01	0.13 ±0.01	0.11 ±0.01	LR
43	Belonidae	Kakila	*Xenentodon cancila*	1.4 ±0.07	1.1 ±0.05	0.92 ±0.02	0.8 ±0.02	0.61 ±0.01	VU
E.	**Snake heads**								
44	Channidae	Gajar	*Channa marulius*	0.68 ±0.42	0.47 ±0.33	0.33 ±0.21	0.02 ±0.01	0.00 ±0.00	CR
45	Channidae	Shol	*Channa striatus*	2.20 ±2.44	1.58 ±1.12	1.08 ±1.05	0.88 ±0.08	0.54 ±0.04	EN
46	Channidae	Cheng / Gachua raga	*Channa gachua*	1.58 ±0.85	1.35 ±0.50	1.22 ±0.22	1.0 ±0.07	0.98 ±0.06	VU
47	Channidae	Taki / Lata / Okol	*Channa punctatus*	2.60 ±1.48	2.00 ±1.25	1.80 ±1.08	1.65 ±1.0	1.10 ±0.44	VU
48	Anabantidae	Koi	*Anabas testudineus*	1.88 ±0.58	1.22 ±0.50	1.11 ±0.46	1.01 ±0.21	0.90 ±0.13	EN
49	Anabantidae	Neftani	*Ctenops nobiilis*	0.68 ±0.08	0.54 ±0.07	0.45 ±0.07	0.38 ±0.07	0.44 ±0.06	EN
F.	**Cat fish:**								
50	Schilbeidae	Ayre/Aor	*Mystus aor*	1.48 ±0.88	1.32 ±0.75	1.18 ±0.70	1.00 ±0.17	0.90 ±0.80	VU
51	Schilbeidae	Guizza / Guizza	*Mystus seenghala*	1.02 ±0.08	0.98 ±0.06	0.86 ±0.04	0.65 ±0.02	0.48 ±0.02	EN
52	Bagridae	Baghair	*Bagarius yarrellii*	0.99 ±0.05	0.77 ±0.04	0.69 ±0.04	0.46 ±0.02	0.33 ±0.01	EN
53	Bagridae	Rita	*Rita rita*	2.35 ±1.14	1.13 ±.0.80	1.07 ±0.06	0.92 ±0.05	0.61 ±0.02	EN
54	Siluridae	Boal	*Wallago attu*	7.59 ±1.25	5.53 ±1.11	4.96 ±1.00	3.58 ±0.70	3.06 ±0.40	VU

SL No	Group / Family	Local name	Scientific name	Production (mt) Someswari River 2001	2002	2003	2004	2005	Status
G.	**Small cat fish:**								
55	Schilbeidae	Bujuri	*Mystus tengra*	2.88 ±0.74	2.54 ±0.52	2.0 ±0.44	1.68 ±0.22	1.27 ±0.11	LR
56	Schilbeidae	Tengra	*Mystus vitttus*	2.22 ±1.05	1.81 ±0.05	1.45 ±0.04	1.22 ±0.02	1.08 ±0.02	VU
57	Schilbeidae	Gulsa	*Mystus cavasius*	1.59 ±1.08	1.37 ±1.02	1.22 ±0.10	1.14 ±0.06	1.00 ±0.04	EN
58	Siluridae	Kani Pabda	*Ompok bimaculatus*	1.65 ±0.04	1.38 ±0.04	1.25 ±0.03	1.12 ±0.03	0.92 ±0.02	EN
59	Siluridae	Madhu Pabda	*Ompok pabda*	2.14 ±0.80	1.6 ±0.50	1.37 ±0.02	1.12 ±0.02	0.99 ±0.01	EN
60	Siluridae	Pabda	*Ompok pabo*	1.25 ±0.40	1.12 ±0.20	1.01 ±0.20	0.94 ±0.20	0.88 ±0.08	EN
61	Schilbeidae	Kajuli	*Ailia coila*	0.98 ±0.03	0.78 ±0.02	0.62 ±0.02	0.38 ±0.01	0.29 ±0.01	EN
62	Schilbeidae	Gharua	*Clupisoma garua*	0.96 ±0.04	0.86 ±0.02	0.77 ±0.02	0.66 ±0.01	0.52 ±0.01	EN
63	Schilbeidae	Bacha	*Eutropiichthys vacha*	0.75 ±0.02	0.62 ±0.01	0.53 ±0.02	0.42 ±0.01	0.35 ±0.01	EN
64	Schilbeidae	Batashi	*Pseudontropius atheronoides*	1.50 ±0.06	1.28 ±0.04	1.16 ±0.02	1.08 ±0.02	0.90 ±0.01	VU
65	Claridae	Magur	*Clarius batrachus*	2.06 ±1.35	1.88 ±1.20	1.60 ±1.10	1.46 ±0.10	1.21 ±0.05	EN
66	Heteropneustidae	Singi	*Heteropneustes fossilis*	1.89 ±0.07	1.72 ±0.05	1.66 ±0.05	1.22 ±0.02	1.08 ±0.02	VU
H.	**Spinyeel**								
67	Mastacembelidae	Baim	*Mastacembalus armatus*	2.05 ±0.80	1.21 ±0.62	1.01 ±0.41	0.98 ±0.20	0.77 ±0.11	EN
68	Synbranchidae	Kuicha	*Monopterus cuchia*	2.90 ±0.52	1.62 ±0.45	1.46 ±0.35	1.25 ±0.24	1.01 ±0.12	EN
69	Mastacembelidae	Tara Baim	*Macrognathus aral*	2.08 ±0.41	1.69 ±0.20	1.52 ±0.11	1.44 ±0.08	1.32 ±0.04	VU
70	Mastacembelidae	Chikra/Guchi	*Macrognathus pancalus*	1.86 ±0.35	1.62 ±0.22	1.50 ±0.18	1.33 ±0.06	1.23 ±0.02	VU
I.	**Prawn**								
71	Palaemonidae	Golda Isa	*Machrobrachiu rosenbergii*	1.80 ±0.06	1.34 ±0.04	1.02 ±0.03	0.88 ±0.03	0.72 ±0.02	EN
72	Palaemonidae	GKatakia chingri	*Machrobrachium villosimanus*	2.40 ±0.06	2.17 ±0.0.5	2.08 ±0.05	1.78 ±0.04	1.51 ±0.03	NO
73	Palaemonidae	Gura chingri	*Machrobrachium birmanicum*	2.56 ±0.45	2.22 ±0.41	2.02 ±0.38	1.84 ±0.35	1.48 ±0.31	VU
74	Palaemonidae	Shotka chingri	*Machrobrachium malcolmsnii*	1.79 ±0.07	1.44 ±0.06	1.32 ±0.05	1.28 ±0.04	1.05 ±0.02	VU
J.	**Crabs**								
75	Palaemonidae	Kakra	*Stylla serrata*	2.62 ±0.44	1.69 ±0.32	1.28 ±0.30	1.11 ±0.23	1.08 ±0.16	VU
K.	**Reptiles:**								
76	Chelonia	Narrowheaded Shoft shell	*Chiitra indica*	1.60 ±0.11	1.42 ±0.08	1.22 ±0.05	1.12 ±0.04	0.79 ±0.02	EN
77	Chelonia	Spotted Flapshell	*Lissemys punctata*	1.80 ±0.14	1.50 ±0.10	1.27 ±0.06	1.18 ±0.08	0.80 ±0.04	EN
78	Chelonia	Common Roof Turtile	*Kachuga tecta*	1.51 ±0.08	1.29 ±0.08	1.08 ±0.06	0.95 ±0.03	0.61 ±0.02	EN
79	Chelonia	Painted Roof Turtile	*Kachuga kachuga*	0.84 ±0.06	0.68 ±0.02	0.44 ±0.01	0.08 ±0.01	0.00 ±0.00	E
80	Chelonia	Bengal Eyed Turtile	*Morenia petersi*	0.42 ±0.01	0.28 ±0.01	0.14 ±0.01	0.04 ±0.00	0.00 ±0.00	CR
	Total			104.65 ±5.50	82.75± 4.68	71.27± 4.23	59.17± 3.52	48.03± 2.97	

REFERENCES

Ahmed, K.K., Haque, G.C. Halder and S.B. saha. (1997). Ecological studies on the planktonic organisms of Kaptai lake. *Bangladesh J. Agrl*., **22**: 63-67.

Ahmed, N. (1962). Fishing gear of East Pakistan, Government of East Pakistan. Directorate of Fisheries, Dhaka.37 pp.

Ali, M. Y. (1991). Towards sustainable development: fisheries resources of Bangladesh International Union for Conservation of nature and Natural Resources. The World Conservation Union. National Conservation Strategy of Bangladesh and Bangladesh Agricultural Research Council.96 pp.

Banerjee, S.M. (1967). Water quality and soil condition of fish ponds in some states of India in relation to fish production. *Indian J. Fish*., 115-144.

Bhuiyan, R.R., (1970). Physico-Chemical qualities of some ancient tanks of Sibsagar, *Assam. Environ. Health* **12**, 129-134.

Clesceri, L. S., A. E. Greenberg and R. R. Trussell. (1989). *Standard Methods of the Examination of Water and Wastewater (17th ed.)*. American Public Health Association, American Water Works Association and Water Pollution Control Federation, 1015 Washington D. C., USA **20036**, 10-203.

Das, Indranil. (1991). Colour Guide to the turtles and Tortoises of the Indian sub continent. R & A publishing Ltd.

Dister Email. (1990). Floodplain protection in Central Europe. World Wildlife Found (WWF) Institute of Floodplains Ecology Visiting Card 31/90, Germany.

Ehshan, M. A., M.S. Hossain, A. Razzaque, M.F.A. Mollah and M.A Mazid, (1997). Limnology of a floodplain; Halti beel. *Univ. J. Zool. RajshahiUniv.* ,**19,** 95-98.

Haroon, A.K.Y., G.C. Halder, S. L. Rahman, M.A. Razzaque, M. Alam and S.M. Nurul Amin.(2002). Sylhet-Mymensingh Basin Fish Stock Assessment. Final Report. Bangladesh Fisheries Research Institute, Reverine Station, Chandpur, Bangladesh 81pp.

Hossain, M.S., M.A.Mazid, M.A. Ehshan, S. Rahman, A.K.M.S. Islam and M.M.M. Hossain, (1998). Limnological observation on Basukhali-Salimpur-Kola-Barnal (BSKB). *Bangladesh J. Zool.*, **26(1),** 79-84.

Hussain, M. G. and M. A. Hossain. (1999). Controlled breeding technology and step for conservation of gene pool of certain endangered fish species of Bangladesh. *Fish. News Letter*, **7**(1-3**),** 2-3.

IUCN, Bangladesh. (2000). *Red book of threatened animals of Bangladesh*. The world conservation Union xii+116 pp.

IUCN, Bangladesh. (1998). List of threatened animals of Bangladesh. Paper presented in the Special Workshop on Bangladesh Red Book of Threatened Animals, 22 February 1998, Dhaka, Bangldesh, 13 pp.

Khan, H. R.(1993). Water development activities and their impacts on wetlands. P 23-32 .In: A. Nisat, Z. Hossain, M. K. Roy, and Ansarul Karim (eds.). Freshwater wetlands in Bangladesh: Issues and Approaches for management. IUCN, Gland Switzerland. xii+283p.

Khan, M. A. R.(1982). Chelonians of Bangladesh and their conservation, *J. Bombay Nat. Hist. Soc.*, **79 (**i**)**, 110-116.

Khorshed Alam, A.K.M., Islam, M.B., (2004). Respose of the Someswari River (Bangladesh) to Neotectonics. *Bangladesh Geoscience J*., **10**, 27-37.

Mathew, P. W., (1975). Limnology and productivity of Govindgarh lake, Maddya Prodesh, India. *J. Inland Fish. Soc.India*, **11**, 16-24.

Mazid M. A. (2002). *Development of Fisheries in Bangladesh*: Plans and Strategic for Income Generation and Poverty Alleviation. Fisheries Research Institute, Mymensingh, Bangladesh. 78-79 pp.

Moyle, P. L. and R. A. Leidy. (1992). Loss of biodiversity in aquatic ecosystem: Evidence from Fish Fauna. In: P. L. Fielder and H. L. Jani (eds). Conservation of Biology: *the Theory and Practice of Nature Conservation, Preservation and Management*. Chapman and Hall, New York, USA. 562 pp.

Moyle, P. B. andJ. E. Williams. (1990). Biodiversity loss in the temperature zone; decline of the native fish fauna of California. *Conserv. Biol*. **4(**3**)**, 275-284.

Nishat, A. (1993). Freshwater wetlands in Bangladesh: status and issues. P. 9-22 In: A. Nishat Z. Hossain, M. K. Roy, and Ansarul Karim (eds.). *Freshwater wetlands in Bangladesh: Issues and Approaches for management. IUCN*, Gland Switzerland. xii+283p.

Rahman, M.R., Rahman, M.A., (2003). Studies on the growth, survival and production of calbasu (*Labeo calbaus* Ham.) at different stocking densities in primary nursing. *Bull. Fac. Sci., Unv. Ryuyus, Jpn.* **76**, 245-255.

Rahman, M. S. (1992). *Water quality Management in Aquaculture*. BARC Prokashana, 66, Mohakhali, Dhaka 1212, Bangladesh 84 pp.

Saha, S. B., M. V. Gupta and M. Sahabuddin. (1988). Studies on the comparative efficacy of different fertilizers on the production of silver carp fry. *Bangladesh J. Fish*., **11(**2**)**,11-20.

Sarkar, S. U. (1993).Faunal diversity and their conservation in freshwater wetlands. In.: *Freshwater wetlands in Bangladesh- issues and approaches for management. IUCN*, Nisat A. Hussain Z. Roy M. K. and Karim A (eds.). The world Conservation Union. pp 105-122.

Stirling, H. P. (1985). *Chemical and Biological Methods of Water Analysis for Aquaculturist.* Institute of Aquaculture, University of Stirling, Scotland, UK. 119 p.

Sugunan, V.V. and B.K. Bhattacharya, (2000). *Ecology and Fisheries of Beels in Assam.* Bull. No. 104, CICFRI, Barrackpore-743101, West Bengal 66 pp.

Zaman, S. M. H. (1993). Agricultural development and sustainablility of wetlands. P 63-178 *In*: *Freshwater wetlands in Bangladesh: Issues and Approaches for management. IUCN*, A. Nishat Z. Hossain, M. K. Roy, and Ansarul Karim (eds.). Gland Switzerland. xii+283p.

Zar, J. H. (1984). Biostatistics. Prentice-Hall, Inc. Englewood Cliffs, New Jersey, USA. 718.