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Biodiversity and conservation status of Chalan Beel in northern Bangladesh: A study

Md. Hashibur Rahman*, Al-Amin, Sharmin Sultana Mukti, Asma Jaman
Bangladesh Fisheries Research Institute, Headquarters, Mymensingh, Bangladesh

Abstract
The status of Chalan beel and prospects for species conservation was taken into consideration for the assessment of the existing fishery resources focusing on existing ecological diversity. Instead of considerable degradation, it still supports an immense and diversified ichthyofauna of major importance to the local economy and people's livelihoods. The area incorporates about 21 rivers and 93 smaller seasonal beels of asymmetric size. As a result of agricultural encroachment, siltation and other anthropogenic activities most of the rivers and beels are at risk of partial declination. At least 19 fish species which once considered as abundant can now be classified as threatened with a possibility of local extinction. Commercially important indigenous fish species which were once available in large volumes are severely depleted and currently under threat from the study area. Several management strategies were suggested by the stakeholders, and the findings are discussed in the context of overall developments in the Chalan beel fisheries related to habitat and biodiversity management. Twenty-three (23) families under nine (09) different orders were documented from the study site. The Cypriniformes and cyprinidae were the richest order and family which consisting 45% and 39%, respectively. In study area, twelve common groups were enlisted during the reporting period. The number of threatened species were 26 (31%) among which the number of Vulnerable, Endangered and Critically Endangered were 12 (14%), 12 (14%) and 2 (3%) respectively. A significant and operative step should be taken to conserve the threatened species from the further extinction. The aim of the study was to reveal the present status of fish biodiversity to conserve the existing resources. The findings from the study also discusses the management strategies to be implemented for the conservation of freshwater fish diversity through conservation of habitat and conservation of fish stocks using the existing resource as a sanctuary.

Keywords: Chalan Beel, species diversity, management strategy, conservation

Introduction
The Chalan beel is a confluence for numerous smaller water ways that flow south, finally discharging into the Padma and Brahmaputra consisting four adjacent districts of Bangladesh *viz*; Rajshahi, Pabna, Sirajganj and Natore. An extensive area of Raiganj Upazila of Sirajganj district and Chatmohar and Bhangura Upazila of Pabna district covers the major part of the beel (Iqbal, 2006) [11]. It constitutes one of the largest watersheds composing a series of depressions covering an area of about 375 km^2 in North Central Bangladesh, interconnected by numerous channels that form more or less continuous sheet of water during inundation. During the dry season, the water area shrinks to a 52–78 km^2 residual cluster of smaller beels of different size. The Chalan beel is resided between 89.10° to 89.35°E and 24.35° to 24.70°N. In the form of ponds, natural depressions (haors and beels), lakes, canals, rivers and estuaries. it is virtuous with an enormous water resources covering an area of 4.56 million ha and 2,640 sq nautical miles area in Bay of Bengal. The great combined delta and flood plains crisscrossed by the numerous rivers and their tributaries in the country. Bangladesh has about 7,74,055 ha of inland closed waterbed and 46,99,345 ha of inland open water area (Sayeed *et al.*, 2014) [19].
Through improving basic management practices (e.g., proper execution of fish act; establishment of fish sanctuaries; maintaining minimum water depth in dry season) the fish production could be increased up to 46,000 MT (Karim, 2003) [13]. Prior to being greatly expanded by the inclusion of intemperate courses of the Karatoa and Atrai Rivers the beel was a back-swamp (the latter being former tributaries of the Jamuna River). Then the beel historically spreads over the 18 sub-districts (upazilas) of six districts, including Pabna (Chatmohor, Vangura and Faridpur); Rajshahi (Paba, Bagmara and Mohonpur); Natore (Sadar, Singra, Gurudaspur and Baraigram); Sirajgonj (Tarash, Ullapara, Raigonj and Shahjadpur); Naogaon (Manda, Raninagar and Atrai); and Bogra (Nandigram). Now, it spreads over only 10 upazilas including Singra, Gurudaspur, Boraigram, Chatmohar, Bhangura, Faridpur, Shahjadpur, Ullapara, Tarash and Raigonj, in the three districts of Natore, Pabna and Sirajgonj. From Tarash at the northeast to Narayanpur about 13 km of area, near the north bank of the Gumani is the greatest breadth of the beel. About 24 km from Singra to Kachikata on the Gumani is greatest length of the beel (Banglapedia, 2019) [3].
Nevertheless, Chalan beel retains a diversified group of fish, aquatic invertebrates, birds and others aquatic animals upon which about 5 million people of fishing communities depend on their economy and livelihood supports from using the existing resources. The provision of fish and aquatic products, agricultural crops, and

pasture lands for livestock are usually included in the evolved services. No systematic research or management strategies for the Chalan beel have yet been implemented to conserve the fishery resources in this area, instead of this ecological and socioeconomic importance (DoF, 2020) [5]. From the Jamuna River through the Baral and Gumani Rivers when inundation commences in the premonsoon period fish enter to the Chalan beel by up-stream migration (Sayeed, 2020) [20]. Then the beel serves as an excellent feeding, spawning and nursing ground for many important indigenous fish species (Ahmed and Singh, 1991) [1]. About 9818 individuals, representing 114 species from 29 families was recorded from the Chalan beel (Hossain *et al.*, 2008) [9]. The most abundant fish species groups were punti (*Puntius sophore* and *Puntius ticto*), followed by chanda (*Chanda nama* and *Parambassis ranga*). The third most abundant species was tengra (*Mystus vittatus*) in the Gumani River and chapila (*Gudusia chapra*) in the Baral and Katagang Rivers (Hossain *et al.*, 2008) [9]. A declining trend was observed in the variability of five species in the Baral River (*Punti, Chanda, Botia, C. garua, G. giuris*), six species in the Katagang River (*Chanda*; *Chela Cachius*; *Mystus Vittatus*; *B. Dario*; *C. Garua*; *G. Giuris*), five species of fish in the Gumani River (*Amblypharyngodon mola*; *Clupisoma garua*; *Chela cachius*; *G. giuris*; *A. coila*) (Hossain *et al.*, 2008) [9].

The study was undertaken and given emphasis to represent the species diversity indices and the present conservation status of of Chalan Beel. There were few works and less notable initiative on the conservation on ecological diversity of Chalan beel to make it compatible for the propitious development of the subsistent ecosystem. But there is no entire list of existing fish species with updated conservation status. For this reason, it is very cumbersome and anfractuous to understand the present status of fishes in Chalan beel. In-depth research work is much needed with updated checklist of the available fish species to take necessary management strategy to conserve the biodiversity. The specific objectives of the present study was intended to assess the fish biodiversity including threatened fishes in Chalan beel and to suggest for the improvement of the present status considering the global threats as well for the amelioration of the conservation status.

Materials and Methods

Data were collected on the basis of surveying from local farmers, local fishers and fish retailers of local markets from June-December, 2019. Field works were undertaken in each of the 10 upazilas over which the Chalan beel spread includes–Singra, Gurudaspur, Boraigram, Chatmohar, Bhangura, Faridpur, Shahjadpur, Ullapara, Tarash, and Raigonj, in three districts (Natore, Pabna, Sirajgonj). Data were collected from (i) interviews and focus group discussions with primary and secondary stakeholders; (ii) direct sampling; and (iii) secondary literature. Semi-structured and structured questionnaires were developed, pretested and adapted prior to the survey proper. Key issues addressed included; (i) present status of the various habitats under Chalan beel; (ii) fish biodiversity; and (iii) causes of habitat and biodiversity degradation and their possible mitigation measures.

Results and Discussion

1. Frequency Distribution of Fish Species under Different Orders

Frequency distribution of fish species under different Orders has been showed in the Fig. 1. A total of 85 fish species belonging 23 families and 9 orders were recorded during the study period. During the study period total 9 orders of fish were identified from the beel. The largest order recorded for Cypriniformes which contributed 45.88% (39 species) followed by Siluriformes which contributed 23.53% (20 species) respectively. The third largest species was Perciformes which contributed 11.76% (10 species).

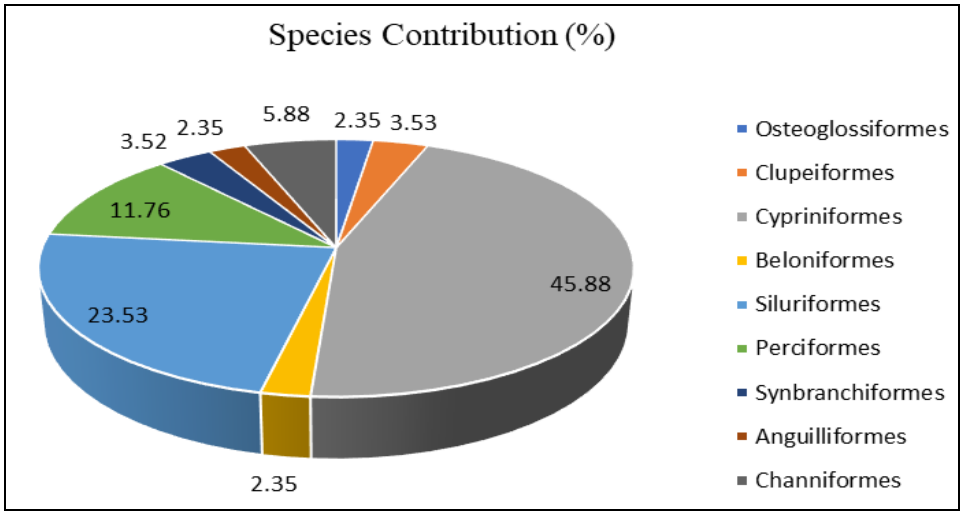


Fig 1: Frequency (%) of species distribution under different orders

The prevalence of other 6 orders was Osteoglossiformes, Clupieformes, Beloniformes, Synbranchiformes, Anguilliformes and Channiformes contributed 2.35% (only 2 species), 3.53% (only 03 species), 2.35% (only 1 species), 3.52% (only 3 species), 2.35% (only 2 species) and 5.88% (only 5 species), respectively.

2. Frequency Distribution of Species under different Families

Frequency of fish under different families recorded was calculated during the study period and (Fig.2). Total 23 families of fish were identified the beels. Among all the families Cyprinidae was the largest family which contributed 38.82% (33 species). The second highest families were Cobitidae which contributed 7.06% (6 species). The lowest dominant families were Belonidae, Chacidae, Pangasidae, Amblycipitidae, Gobiidae, Anabantidae, Badiidae, Nandidae and Ambassidae.

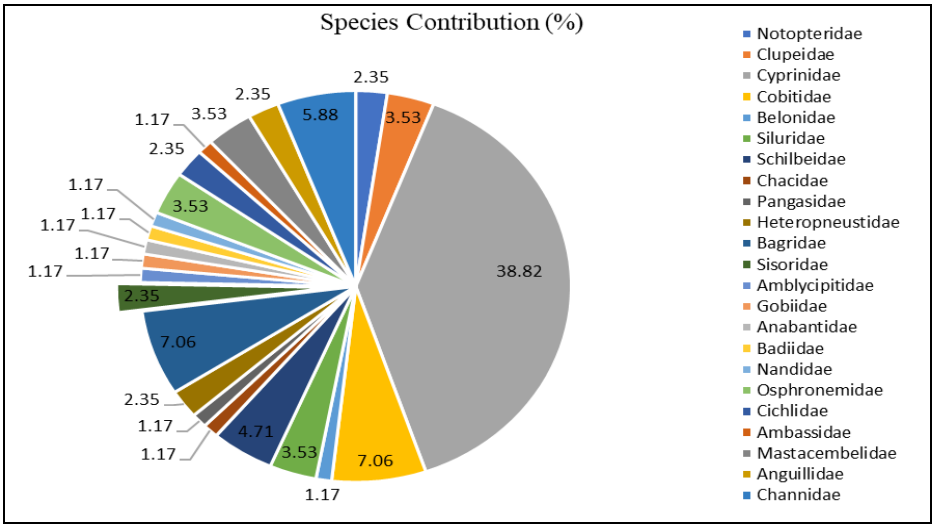
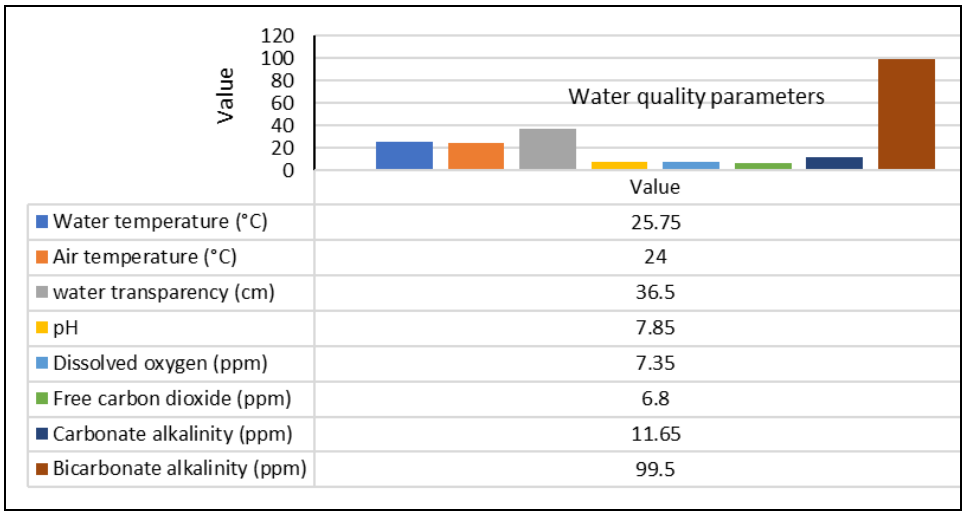


Fig 2: Frequency (%) of species distribution under different Families

Family-wise species composition which consists of Notopteridae 2.35% (2 species), Clupeidae 3.53% (3 species), Cyprinidae 38.82% (33 species), Cobitidae 7.06% (6 species), Belonidae 1.17% (1 species), Siluridae 3.53% (3 species), Schilbeide 4.71% (4 species), Chacidae 1.17% (1 species), Pangasidae 1.17% (1 species), Heteropneustidae 2.35% (2 species), Bagridae 7.06% (6 species), Sisoridae 2.35% (2 species), Amblycipitidae 1.17% (1 species), Gobiidae 1.17% (1 species), Anabantidae 1.17% (1 species), Badiidae 1.17% (1 species), Nandidae 1.17% (1 species), Osphronemidae 3.53% (3 species), Cichlidae 2.35% (2 species), Ambassidae 1.17% (1 species), Mastacembelidae 3.53% (3 species), Anguillidae 2.35% (2 species) and Channidae 5.88% (5 species)

3. Ecology and characteristics of Chalan beel

The limnological parameters of the Chalan beel represent typical tropical conditions; although the winters are relatively cool (Hossain 2005) [10]. The mean annual ranges of water temperature varies between 11.5–40 °C, air temperature 8–40 °C, water transparency 18–55 cm, pH 7.2–8.5, dissolved oxygen concentration 5.1–9.6 ppm, free carbon dioxide 1.3–12.3 ppm, carbonate alkalinity 8.3– 15 ppm and bicarbonate alkalinity ranges between 82–117 ppm (Fig.3).



	Value
Water temperature (°C)	25.75
Air temperature (°C)	24
water transparency (cm)	36.5
pH	7.85
Dissolved oxygen (ppm)	7.35
Free carbon dioxide (ppm)	6.8
Carbonate alkalinity (ppm)	11.65
Bicarbonate alkalinity (ppm)	99.5

Fig 3: Limnological parameters of the Chalan beel

The mean annual precipitation was 1508 mm during the study period. The watershed characteristics, especially soil quality and depth, land use, and presence or absence of connecting canals between the river and beels, greatly influence the productivity of the beel (Biswas & Boruah 2000). Rivers, floodplains, beels and ponds

constitute distinct habitat types in the Chalan beel, as they do in other floodplains in Bangladesh (Craig *et al.*, 2004). The characteristics of the main habitat types, attributes of key stakeholders and their current management systems, are illustrated in Table 3 and Table 5, respectively. All the rivers and most perennial beels are owned by the government which, if not formally leased-out, can theoretically be fished by anyone throughout the year. In contrast, the floodplain lands and ponds are privately owned. During inundation, however, floodplains also become open-access resources for fishing. When most of the beels and floodplains dry up, several large rivers retain deeper pools. Most owners drain their ponds (kuas) late in the dry season in order to harvest the remaining fish. There is almost no aquaculture in the rivers, beels and floodplain, although pond owners culture carps (both India major and Chinese) over the 6 to 9 months period when the grow-out conditions are optimal. Professional and subsistence fishers catch fish throughout the year from rivers and beel, while other villagers mainly catch fish from the floodplain during the monsoon season. The waterbodies under Chalan beel in different season was depicted in Table-4 and the affiliated principal management was demonstrated in Table-6.
The species composition and their contribution based on orfer and family and the list of threatened fish species were enlisted in Table-1 and Table-2.

Table 1: List of collected fish species from Chalan Beel

Order	Family	Scientific Name	IUCN Conservation Status	
			BD	GB
Osteoglossiformes	Notopteridae	*Notopterus notopterus* (Pallas)	VU	LC
		Notopterus chitala (Hamilton)	EN	NT
Clupieformes	Clupeidae	*Gudusia chapra* (Hamilton)	VU	LC
		Gonialosa manmina (Hamilton)	LC	LC
		Corica soborna (Hamilton)	LC	LC
Cypriniformes	Cyprinidae	*Gibelion catla* (Hamilton)	LC	LC
		Cirrhinus cirrhosus (Bloch)	NT	LC
		Labeo calbasu (Hamilton)	LC	LC
		Labeo rohita (Hamilton)	LC	LC
		Labeo gonius (Hamilton)	NT	LC
		Cyprinus carpio var. specularis (Linnaeus)	NE	DD
		Cyprinus carpio var. communis (Linnaeus)	NE	DD
		Hypophthalmichthys molitrix (Hamilton)	LC	LC
		Aristichthys nobilis (Richardson)	LC	LC
		Ctenopharyngodon idella (Hamilton)	LC	**LC**
		Amblypharyngodon mola (Hamilon)	LC	LC
		Esomus daricus (Hamilton)	LC	LC
		Cirrhinus reba (Hamilton)	LC	LC
		Barbodes sarana (Hamilton)	NT	LC
		Puntius chola (Hamilton)	LC	LC
		Puntius phutunio (Hamilton)	LC	LC
		Puntius conchonius (Hamilton)	VU	LC
		Puntius ticto (Hamilton)	LC	LC
		Barbonymus gonionotus (Bleeker)	NE	LC
		Aspidoparia jaya (Hamilton)	LC	LC
		Aspidoparia morar (Hamilton)	VU	LC
		Chagunius chagunio (Hamilton)	VU	LC
		Chela cachius (Hamilton)	VU	LC
		Chela laubuca (Hamilton)	LC	LC
		Rasbora daniconius (Hamilton)	LC	LC
		Megarasbora elanga (Hamilton)	EN	LC
		Labeo ariza (Hamilton)	VU	LC
		Labeo bata (Hamilton)	LC	LC
		Labeo boga (Hamilton)	CR	LC
		Osteobrama cotio cotio (Hamilton)	NT	LC
		Puntius gelius (Hamilton)	NT	LC
		Puntius sophore (Hamilton)	LC	LC
		Raiamas bola (Hamilton)	EN	LC
	Cobitidae	*Lepidocephalichthys guntea* (Hamilton)	LC	LC
		Botia dayi (Hora)	EN	LC
		Botia lohachata (Chaudhuri)	EN	LC
		Botia rostrata (Gunther)	DD	VU
		Somileptus gongota (Hamilton)	NT	LC

		Botia dario (Hamilton)	EN	LC
Beloniformes	Belonidae	*Xenentodon cancila* (Linnaeus)	LC	LC
Siluriformes	Siluridae	*Wallago attu* (Bloch)	VU	NT
		Ompok bimaculatus (Bloch)	CR	NT
		Ompok babda(Hamilton)	EN	NT
	Schilbeide	*Ailia coila* (Hamilton)	LC	NT
		Pseudeutropius atherinoides (Bloch)	LC	LC
		Eutropiichthys vacha (Hamilton)	LC	LC
		Clupisoma garua (Hamilton)	EN	LC
	Chacidae	*Chaca chaca* (Hamilton)	EN	LC
	Pangasidae	*Pangasianodon hypopthalamus* (Sauvage)	DD	DD
	Heteropneustidae	*Heteropneustus fossilis* (Bloch)	LC	LC
		Clarias batrachus (Linnaeus)	LC	LC
	Bagridae	*Rita rita* (Hamilton)	EN	LC
		Sperata aor (Hamilton)	VU	LC
		Sperata seenghala (Sykes)	VU	LC
		Mystus bleekeri (Hamilton)	LC	LC
		Mystus tengara (Hamilton)	LC	LC
		Mystus vittatus (Bloch)	LC	LC
	Sisoridae	*Bagarius bagarius* (Hamilton)	CR	NT
		Hara hara (Hamilton)	LC	LC
	Amblycipitidae	*Amblyeeps mangois* (Hamilton)	LC	LC
Perciformes	Gobiidae	*Glossogobius giuris* (Hamilton)	LC	LC
	Anabantidae	*Anabas testudineus* (Bloch)	LC	DD
	Badiidae	*Badis badis* (Hamilton)	NT	LC
	Nandiade	*Nandus nandus* (Hamilton)	NT	LC
	Osphronemidae	*Colias fasciata* (Bloch and Schneider)	NT	DD
		Colisa Laila (Hamilton)	NT	DD
		Trichogaster chuna (Schneider)	NT	DD
	Cichlidae	*Oreochromis mossambicus* (Peters)	DD	LC
		Oreochromis niloticus (Linnaeus)	DD	NE
	Ambassiade	*Chanda nama* (Hamilton)	LC	LC
Synbranchiformes	Mastacembelidae	*Macrognathus aculatus* (Bloch)	NT	NE
		Mastacembelus armatus (Lacepede)	EN	LC
		Macrognathus pancalus (Hamilton)	LC	LC
Anguilliformes	Anguillidae	*Anguilla bengalensis bengalensis* (Gray)	VU	NT
		Congresox talabon (Cuvier)	DD	DD
Channiformes	Channidae	*Channa punctata* (Bloch)	LC	LC
		Channa marulius (Hamilton)	EN	LC
		Channa gachua (Bloch and Schneider)	LC	LC
		Channa striatus (Bloch)	LC	DD
		Channa orientalis (Bloch and Schneider)	LC	DD

Vulnerable (VU), Endangered (EN), Critically Endangered (CR), Not Evaluated (NE), Data Deficient (DD), Least Concern (LC), Near Threatened (NT), BD = Bangladesh, GB= Global.

Table 2: List of threatened fish species collected from Chalan Beel

Order	Family	Scientific Name	IUCN Conservation
Cypriniformes	Cyprinidae	*Aspidoparia morar* (Hamilton)	VU
		Chagunius chagunio (Hamilton)	
		Chela cachius (Hamilton)	
Oseoglossiformes	Notopteridae	*Notopterus notopterus* (Pallas)	
Clupieformes	Clupeidae	*Gudusia chapra* (Hamilton)	
		Puntius conchonius (Hamilton)	
		Puntius ticto (Hamilon)	
Siluriformes	Siluridae	*Wallago attu* (Bloch)	
		Sperata aor (Hamilton)	
		Sperata seenghala (Sykes)	
	Synbranchidae	*Monopterus cuchia* (Hamilton0	
Anguilliformes	Anguillidae	*Anguilla bengalensis bengalensis* (Gray)	
Cypriniformes	Cyprinidae	*Megarasbora elanga* (Hamilton)	EN

		Raiamas bola (Hamilton)	
	Cobitidae	*Botia dayi* (Hora)	
		Botia lohachata (Chaudhuri)	
Osteoglossiformes	Notopteridae	*Notopterus chitala* (Hamilton)	
Clupieformes	Cobitidae	*Botia dario* (Hamilton)	
Siluriformes	Suluridae	*Ompok pabda* (Hamilton)	
	Schilbeidae	*Clupisoma garua* (Hamilton)	
	Chacidae	*Chaca chaca* (Hamilton)	
	Bagridae	*Rita rita* (Hamilton)	
Synbranchiformes	Mastacembelidae	*Mastacembelus armatus* (Lacepede)	
Channiformes	Channidae	*Channa marulius* (Hamilton)	
Siluriformes	Siluridae	*Ompok bimaculatus* (Bloch)	CR
	Sisoridae	*Bagarius bagarius* (Hamilton)	

Table 3: Categorization of key stakeholder groups and their roles in study

Stakeholders	Number	Stakeholder role	Involvement in study
Fishers	25	Depend on Chalan beel resources for livelihood	Interview and FGD+
Fish farmers	25	Collection of wid fish fry and fingerling	Interview and FGD
Upazila fisheries officers	10	Implement fish acts; involved in leasing process and motivation people for fish conservation and habitat restoration to increase fish production	Interview and FGD
Local leaders	20	Advocacy on conservation, conflict resolution, policy involvement in local level	FGD
Housewives	18	Assist fishers	FGD
Upazila Agriculture Officre	10	Regulate agrochemical use	Interview
Crop farmer	16	Fishing, crop farming	Interview and FGD
Fish traders	14	Invest in fishing business, promote figh transportation	Interview and FGD

+ FGD- focus groub discussion: target driven informal discussions with small groubs (six to 100 of people, generally with same profession or belonging to same stratum of communithy.
kua-small, but deeper, part of floodplain where people fix brush pile to attrct fish during monsoon season, and catch them dry season

Table 4: Waterbodies under Chalan beel and their area

Type waterbody	Number	Dry season	Monsoon
River	21	709	3300
Beels	93	2227	9164
Floodplain	-	-	22369
ponds	12817	2293	2617
Borrow pits	214	-	50
Total		5229	37500

Source: Upazila fisheries Offices

Table 5: Distribution of rivers in Chalan beel, illustrating water area and depth during dry and monsoon seasons

		Water ares (ha)		Water depth (m)	
Name of river	**Nature of river**	**Dry season**	**Monsoon**	**Dry season**	**Monsoon**
Gur	Large	302	1875	1.22	5.49
Baral	Large	163	518	0.91	4.57
Gohala	Large	16	68	1.83	9.14
Koratoa	Large	16	134	1.83	6.10
Barnoi	Medium	16	25	1.52	4.88
Nagor	Medium	17	48	1.52	4.88
Bangonga	Medium	17	54	1.22	6.10
Vadrabati	Medium	37	70	0.61	4.88
Nandakuza	Medium	40	160	0.91	4.57
Khubjipur	Small	15	40	0.91	4.57
Beshani	Small	8	20	0.91	4.57
Vadai	Small	15	52	1.22	5.49
Godai	Small	10	36	0.91	4.88
Fulzor	Small	8	20	1.83	6.10

Muktahar	Small	6	10	1.52	4.88
Ischamoti	Small	1	102	0.30	6.10
Shutkidah	Small	2	15	0.61	3.66
Shalika	Small	4	19	0.91	4.27
Katagang	Small	6	12	0.61	4.57
Tulshi	Small	4	9	0.91	4.57
Chechua	Small	6	13	0.91	4.57

Source: Blackwell publishing pty Ltd

Table 6: Principal management of chalan beel habitats

Variable	Rivers	Beels	Floodplains	ponds
property rights/ownership	Everybody has rights to fishing, but desinatet jolmohals have been leased through existing government leasing policy	About 25 -30% private, many were converted into crop lands, public beels have been leased through exiting government leasing policy	Mostly private, but anyone can fish in the fishing season	Mostly private few are public
Aquatic vegetation	Aquatic vegetaions in shallow water (if any), and floating weeds from upstream	Water hyacinths-dominant aquatic weeds	Aquatic weeds available	Almost free from aquatic weeds
Water retention situation	Almost all revers are dried at post monsoon season, except for few large revers (Gumani, baral, etc.)	Maximum are dried up, except deeper part (15%-18% of the total) area	Water exists only 3-4 months, dependent on degree of flood	Mostly perennial; few seasonal household kus
Aquaculture	No aquaculture, except extensive carp culture in a leased portion of Baral river	No aquaculture	No aquaculture	Stocking based polyculture practice in shallow ponds, sild fish with minimum management kept in deeper ponds (kua), and harvested in late dry season
Fishing	Both professional and subsistence fishermen use various gears catching fish though drying the waterbody also common	Both professional and subsistence fishermem use various gears, including full drying up for water body	Professional and subsistence fishermen and villagers use various gears	Pond owners harvest fish for household consumption, and at end of culture period, for seling

4. Impacts of different factors on Chalan beel fisheries

Gradual habitat degradation and overexploitation are key drivers of biodiversity degradation and declining aquatic production in Chalan beel. Habitat degradation results from increased siltation rates, construction of flood control embankments and roads, uncontrolled use of pesticides, insecticides and chemical fertilizers on croplands, excessive removal of surface water and extraction of groundwater for irrigation, diversion of water courses, unregulated discharge of untreated industrial and aquafarms effluents, fish harvesting by dewatering, etc. These factors, which also contribute to already significant reductions in the areal extent of Chalan beel, are pushing many indigenous species to the verge of extinction (Shahnaz 2005) [18]. Due to the lack of a proper flood action plan, several Chalan beel restoration projects have exhibited little positive impact. The width of the embankments often has been narrowed, subjecting them to periodic breaching, while the siting of sluice gates and other water management structures has been poorly planned, and their installation poorly executed. Despite these problems, the Chalan beel still constitutes ≈18% of the country's total beel area. Most of the literal and floodplains areas are cultivated with rice and other crops, providing multiple annual harvests. Thus, government policy has always prioritized cereal food production functions. Consequently, most development initiatives in the Chalan beel have focused on crop cultures, rather than biological management of this rich floodplain system for fish production, ignoring the needs of poorer people for access to renewable protein sources. Among the identified orders from the present study 9 orders under 23 families of fish species were recorded. According to frequency of fish species under orders, the largest orders were Cypriniformes and Siluriformes. There was a distinct variation in the abundance of fish species by months. Every fish species was not available in all the months. The highest abundance was found in November. The lowest numbers of species were found in the month of January. The dominant species among 85 were *Labeo calbasu, Labeo rohita, Labeo gonius, Cyprinus carpio, Esomus daricus, Barbodes sarana, Puntius phutunio, Puntius ticto, Barbonymus gonionotus, Puntius sophore. Colias fasciata, Mystus tengara, Amblypharyngodon mola, Labeo bata and Mystus vittatus*.

At the present study there were 85 species under 9 orders and 23 families were recorded which was similar to the result of (Galib *et al.*, 2013; Masai *et al.*, 2001; Rahman *et al.*, 2010; Mohsin *et. al.*, 2013 and Emmanuel, 2010) [8, 14, 16, 8, 6]. Overall positive changing trends were observed in the studt area. From a case study it was known that before establishment of sanctuary the fish diversity and production was gradually decreased day by day whereas it was started to increase after establishing the sanctuary (Azhar, 2009) [2]. After establishing the sanctuary bigger size carp (such as Rui, Catla, Boal) production was decreased however the SIS production was increased. That might be due to the development of suitable feeding and spawning ground for SIS (Rahman *et al.*, 1992) [17]. Among the threatened fishes as described by IUCN (2000) [12], 14.11% of endangered, 14.11% vulnerable and 2.35% critically endangered species were found in Chalan beel during the study. After establishment of the sanctuary species richness was increased in Chalan beel (FFP, 2005) [7]. There were 26 threatened species the highest fish diversity was found in the month of November which might be due to high abundance of fish, suitable water level and good weather condition for fish and fishing. The abundance and production of fish species were bound to the flooding pattern during the study. Catch composition and species composition was differed with seasons or months. Similar result also reporpted by Bobori and Salvarina (2010) [4].

Conclusion

The Chalan beel comprises twenty-three (23) families under nine (09) different orders were documented from the study site. The Cypriniformes and cyprinidae were the richest order and family which consisting 45% and 39%, respectively. In study area, twelve common groups were enlisted during the reporting period. The number of threatened species were 26 (31%) among which the number of Vulnerable, Endangered and Critically Endangered were 12 (14%), 12 (14%) and 2 (3%) respectively. Among all the families Cyprinidae was the largest family which contributed 38.82% (33 species). The second highest families were Cobitidae which contributed 7.06% (6 species). The findings from the study also disclosed the management strategies to be implemented for the conservation of freshwater fish species through conservation of habitat and by ascertaining some defined area as fish sanctuary. The initiation of natural shelter based on species richness indices might be the effective tools to improve the fish biodiversity as well as increasing fish production.

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