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Study on selectivity of fishing gears and its effects on fish biodiversity of Chalan *Beel* in Natore district

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Abstract

An investigation was conducted to know the present status of fishing gears used and their species selectivity, length selectivity as well as their effects on fish biodiversity of the Chalan *beel in* Natore district for a period of 6 months from July to December, 2012. Interview schedules were used in collecting data from different upazilas of Chalan *beel*. A total 27 types of fishing gears were found including 11 types of nets, 5 types of traps, 4 types of wounding gears, 5 types of hooks and lines and 2 types of Fish Attracting Devices. A total of 53 fish species were identified in the catches of different fishing gears used in the Chalan *beel*. The mode of operation, fishing duration and season, species and length selectivity of different gears for dominant fish species were determined. Considering the species composition and length selectivity of different fishing gears, seine nets, cast net, lift nets, traps were recorded as non-selective gears both for species and size. Among gill nets, Puti jal and Batashi jal; traps like Dohair and Bhair; hooks and lines like Daun borshi were recorded as more or less selective fishing gears. Current jal, hooks and lines were regarded as large species gears while Puti jal, Batashi jal, lift nets were found as small species gears. Considering the detrimental effects of different fishing gears it is suggested to restrict the use of these gears for certain period from July to October for effective management and sustainable production of the Chalan *beel*.

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Introduction

The *beel is* a Bengali term used for relatively large surface, static water body that accumulates surface run-off water through an internal drainage channel (Banglapedia, 2004). This type of shallow, seasonal water body is common in low-lying floodplain areas throughout Bangladesh (Hossain *et al.*, 2009). *Beel's* have a great biological and environmental importance in the fisheries sector of Bangladesh as it offers a unique habitat to support innumerable flora and fauna including the fish and shellfishes. (Das, 2002) also reported that the *beel's* are extremely rich in nutrients being reflected by rich in organic carbon and high levels of available nitrogen and phosphorus in the soil system. In the fiscal year of 2012-2013, the total fish production including inland and marine resources is 3410254 MT. The contribution of inland fisheries sector is 82.73% to the total fish production and among the inland capture fisheries the fish production form *beel* is 87902 MT (DoF, 2014).

Chalan *beel is* one of the largest inland depressions of marshy character and also one of the richest wetland areas of Bangladesh. It is the low-lying wetland area between the Barind tract and the Ganges river floodplains (Uddin, 2002). It is located between 24°10' North latitude and 89°10' to 89°35' East longitude. It is the largest *beel* of the country and comprises a series of depressions interconnected by various channels to form more or less one continuous sheet of water in the rainy season when it covers an area of about 375 km2 during monsoon from July to November and during the dry season it covers 52-78 km² (Hossain *et al.*, 2009). Historically, the *beel* spreads over the 18 subdistricts (upazilas) of six districts, including Rajshahi (Paba, Bagmara and Mohonpur); Pabna (Chatmohor, Vangura and Faridpur); Sirajgonj (Tarash, Ullapara, Raigonj and Shahjadpur); Natore (Sadar, Singra, Gurudaspur and Baraigram); Naogaon (Manda, Raninagar and Atrai); and Bogra (Nandigram) (Hossain *et al.*, 2009). The Chalan *beel* is famous for its richness in fisheries resources. It is very rich in biodiversity with a lot of aquatic flora and fauna. It contains about 100 plus fish species (Karim, 2003). Few decades ago, Chalan *beel* was abundant with variety of fishes but in recent years like other natural water bodies of Bangladesh, aquatic resources from this water body is decreasing to a large extent due to various man-made and natural causes. Indiscriminant, unplanned and destructive gears are being used by the fishers of Chalan *beel.* The harmful modern gears and technological advancement have negative impact over the situation. For this reason fish biodiversity are being declining day by day (Sayeed *et al.*, 2014). Though many researchers in Bangladesh have studied about the indiscriminate use of fishing gear and their harmful effect on the water body but there is no concrete data was found about the selectivity of fishing gears used and mitigate measures to overcome the present situation of *beel.* So that it is a national need to look at how this decline can be halted or even reversed, considering not only the importance of maintaining fish yields but also the need for judicious harvesting of the resources. Considering the above facts, the present research is designed to deliver an overview of the present fishing activities and gears used in the study area and to determine the species and size (length) selectivity of same fishing gears. However, the this paper is also significant to find out the effects of fishing gears and other probable reasons for sharp declination in the abundance of wild fish species from the *beel* as well as to formulate recommendations for protecting the fish biodiversity of the Chalan *Beel.*

Materials and Methods

Selection of the study areas

To carry out the present study, different spots of Chalan *beel were* selected considering the fishing spots of the *beel and* fish landing centre adjacent to the *beel.* The selected study areas were Natore Sadar, Singra, Gurudaspur and Baraigram.

Preparation of the interview schedule

To fulfill the objectives of the study, at first a draft interview schedule was developed. Then it was pre-tested by interviewing to the fish farmers in the study

area. After pre-testing a set of final interview schedule was prepared with necessary corrections and modifications. The survey schedule was elaborated according to the particulars of fishing gears (mesh size, length, breadth, materials etc.), fishing duration, mode of operation, species composition, number of species caught.

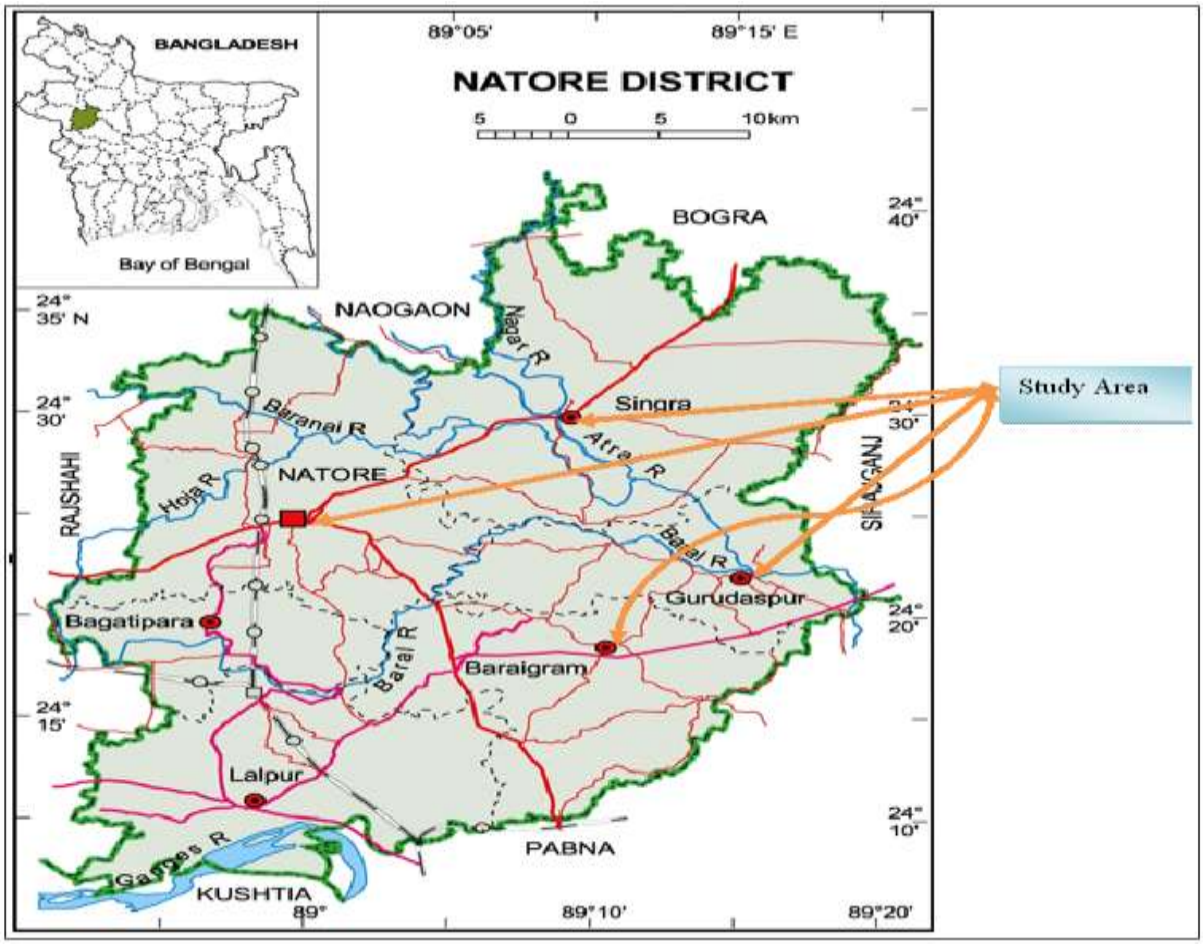

Fig. 1. Map showing the location of study.

Period of data collection

The study is conducted for a periods of 6 months from July to December, 2012.

Data collection

Data was collected fortnightly at fish landing centres and fishing grounds in respect to the types and characteristics of the fishing gears used. The particulars of the fishing gears (mesh size, length, breadth, materials, structure etc.) and the catch data were collected from fisherman at the fishing spot through interview. Then detailed description of each and every type of gear was recorded from the fisherman. Catch composition for each type of gear was recorded either by examining the total catch or 10-20% in case of large catch randomly.

Statistical analysis

Various types of models were used in the study to determine the length selectivity curve for most dominant species, $L_{50\%}$ value and selection range ($L_{25\%}$ -$L_{75\%}$) for each dominant species. The range of lengths of sample population was divided into 9 to 13 length intervals, depending on the population size. According to the intervals, cumulative frequencies were computed and then transformed to the percentage (relative) cumulative frequencies by using Microsoft Excel Program. The cumulative relative

frequencies were transformed to probits (Gujarati, 2003). Frequency curves and sigmoid curves were drawn for most dominant species caught by different gears and a linear regression analysis was done between length intervals (independent variable) and the probits (dependent variables) by using SPSS (Statistical Package for Social System) version 16.0. Using the length-probit regression equation, the length at probits which correspond respectively to 25%, 50% and 75% of the percentage frequencies were calculated as $L_{25\%}$, $L_{50\%}$ and $L_{75\%}$ by the following method (Gupta, 2004):

$$Q_i = L_i + \frac{\frac{iN}{4} - CF_i}{f_i} \times h$$

Where,

Qi (ith quartile) = Value of (iN/4) th observation.

(The class which contains (iN/4)th observation is known as ith quartile class).

N= Number of observations

Li = Lower limit of the ith quartile class of length

CFi = Cumulative frequency of the class preceding ith quartile class of length

fi = Frequency of ith quartile class of length

h = Class interval of length

i = 1, 2, 3

From the equation, Q1 = $L_{25\%}$, Q2 = $L_{50\%}$ and Q3 = $L_{75\%}$ can be calculated for the value of i = 1, 2, 3 respectively.

Results

Fishing gears in the study area

During the study period, a total of 27 types of fishing gears were found to be used in the Chalan *beel in* Natore district. All these types of gears were broadly classified into 5 major groups namely nets, traps, wounding gears, hooks and lines and other gears each of which were also be categorized into a number of sub-types. The recorded fishing gears include 11 types of nets, 5 types of traps, 4 types of wounding gears, 5 types of hooks and lines and 2 types of other (Fish Attracting Devices) gears (Table 1).

Table 1. Different types of fishing gears and period of operation used in Chalan *beel*.

Types	Group name	Local name	Target species	Period of Operation
Nets	Seine net	Ber jal	All	Aug- Dec
		Moi jal	All	Aug-Oct
		Indian net jal	All	Aug-Sep
	Gill net	Current jal	All	Aug-Oct
		Puti jal	Puti	Aug-Oct
		Batashi jal	Batashi	Aug-Oct
	Lift net	Dharma jal	All	Aug-Oct
		Khora jal	All	Jul-Nov
	Falling net	Khepla/jhaki jal	All	Aug- Dec
		Thela jal	All	Jul-Dec
		Hat badai jal	All	Aug-Oct
Traps	Fish traps	Polo	Lager fish	Nov-Dec
		Kholshun	SIS	Jul-Nov
		Bitti	SIS	Aug-Nov
		Dohair	SIS	Jul-Oct
		Bhair	SIS	Aug-Oct
Wounding gear	Wounding gear	Konch	All	Jun-Feb
		Ek kata	All	Jun-Feb
		Tin phala	All	Jun-Feb
		Tota	All	Jun-Feb
Hooks and Lines	Angling gear	Borshi/Chhip borshi	Carnivores	Jul-Dec
		Dhan borshi	Carnivores	Jul-Dec
		Basha borshi	Carnivores	Jul-Dec
		Pata borshi	Carnivores	Jul-Dec
		Daun borshi	Carnivores	Jul-Dec
Fish Aggregating Devices	Katha	-	All	Nov-Jan
	Kua	-	All	Dec-Apr

All the types of large and small fish; Carnivores, mostly catfish, snakeheads and eels; Koi, climbing perch (*Anabas testudineus*); Puti, (*Puntius sophore*) Puti, (*Pseudeutropius atherinoides*), Large fish, fish >25 cm total length; SIS, small indigenous species of fish < 25 cm total length at maturity.

Table 2. Checklist of fishes caught by different fishing gears in the study area.

Order	Family	Local name	Scientific name	Max. Length (cm)
Cypriniformes	Cyprinidae	Catla	*Catla catla*	40
		Silver carp	*Hypophthalmicthys molitrix*	40
		Grass carp	*Ctenophyngodon idella*	34
		Common carp	*Cyprinus carpio var. communis*	35
		Mirror carp	*Cyprinus carpio var. specularis*	30
		Mrigal	*Cirrhinus cirrhosus*	33
		Raikor	*Cirrhinus reba*	15
		Kalibaus	*Labeo calbasu*	45
		Rui	*Labeo rohita*	52
		Bata	*Labeo bata*	20
		Gonia	*Labeo gonius*	20
		Bhangon	*Labeo bhangon*	9.5
		Shorputi	*Puntius sarana*	16
		Puti	*Puntius sophore*	7
		Tit puti	*Puntius ticto*	5
		Chela	*Salmostoma bacaila*	9.5
		Darkina	*Esomus danricus*	5
		Mola	*Amblypharyngodon mola*	7.2
	Cobitidae	Gutum	*Lepidocephalus guntea*	9
		Puiya	*Lepidocephalus irrorata*	3
		Rani	*Botia dario*	7
Channiformes	Channidae	Shol	*Channa sriatus*	35
		Gajar	*Channa marulius*	45
		Taki	*Channa punctata*	22
		Cheng	*Channa orientalis*	12
Siluriformes	Clariidae	Magur	*Clarius batracus*	25
	Siluridae	Pabda	*Ompok pabda*	15
		Boal	*Wallago attu*	45
	Heteropneustidae	Shing	*Heteropneustes fossilis*	24
	Schilbeidae	Batashi	*Pseudeutropius atherinoides*	10
		Baspata	*Ailia coila*	10
	Pangasiidae	Pangus	*Pangasisus pangasius*	25
	Bagridae	Ayr	*Mystus aor*	30
		Tengra	*Mystus cavasius*	8
		Gulsha	*Mystus vittatus*	12
		Rita	*Rita rita*	60-80
		Guizza ayr	*Sperata seenghala*	120
		Bajari tengra	*Mystus tengara*	6
Osteoglossifores	Notopteridae	Chitol	*Notopterus Chitala*	40
		Foli	*Notopterus notopterus*	32
Clupeiformes	Clupiedae	Chapila	*Gudusia chapra*	15
		Kachki	*Corica soborna*	5
Mastacembiliformes	Mastacembelidae	Baim	*Mastacembalus armatus*	25-50
		Guchi baim	*Macrognathus pancalus*	12-15
		Tara baim	*Macrognathus aculeatus*	10-15
Perciformes	Anabantidae	Koi	*Anabas testudineus*	12
		Khalisha	*Colisha fasciatus*	8
	Gobiidae	Bele	*Glossogobius giuris*	15
	Centropomidae	Chanda	*Chanda nama*	5
		Lal Chanda	*Chanda ranga*	4.5
	Nandidae	Bheda	*Nandus nandus*	13
	Cichlidae	Tilapia	*Oreochromis mussanbicus*	11
		Nilotica	*Oreochromis niloticus*	11

Species selectivity of fishing gears

During the study period, a total of 53 species of different fishes were found in the catches of different fishing gears used by the fishermen in the Chalan *beel*. The local name and scientific name of fishes is shown in Table 2 and species compositions of different types of gears are shown in Figure 2, 3 and 4.

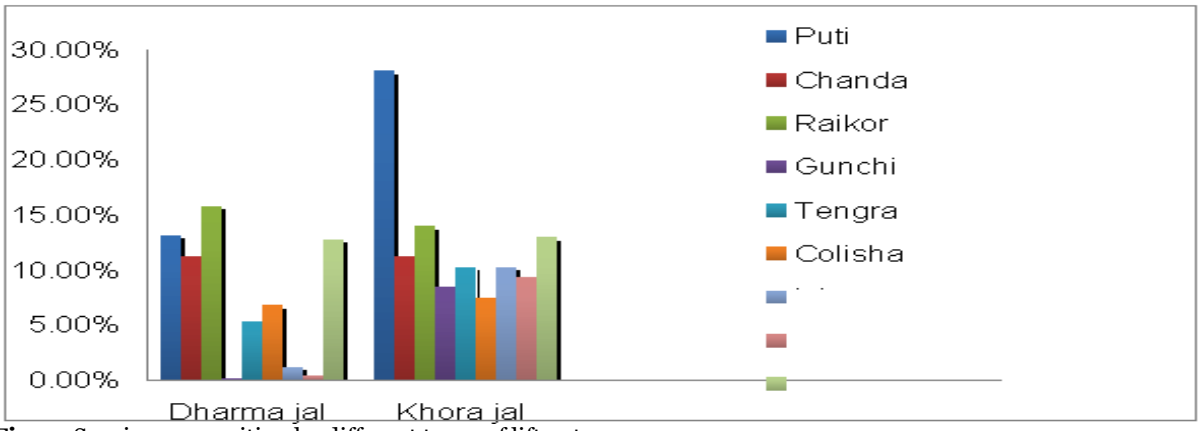

Fig. 2. Species composition by different types of lift net.

Length selectivity of fishing gears

In the present study, the length selectivity of different fishing gears for dominant fish species was determined to show the length range of fish caught and frequency of fish caught in different length class. The $L_{50\%}$ value and selectivity range ($L_{25\%}$-$L_{75\%}$) of different fishing gears were also calculated for dominant species which constitute at least 100 fish species in the sample but in certain cases less than 100 fish is considered as dominant species due to its less availability. The length selectivity of commonly used fishing gears are discussed below.

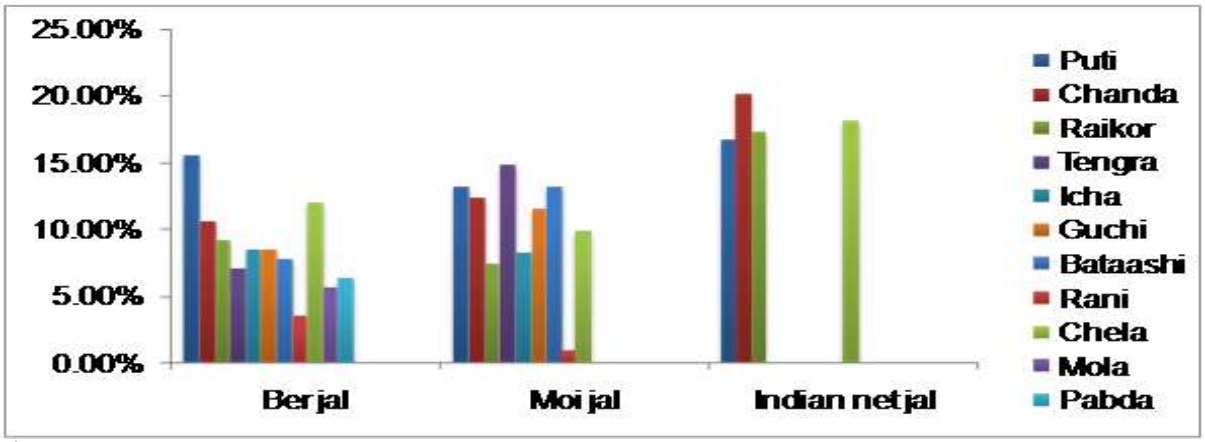

Fig. 3. Species composition by different types of seine nets.

Seine net

The length selectivity of Ber jal was shown for the dominant species puti and the length of fish caught ranges from 25-58 mm. The $L_{50\%}$ value and selectivity range ($L_{25\%}$-$L_{75\%}$) of Ber jal were 40.25 mm and 32.86-46.45 mm at the probits of 3.457 and 3.176-3.692, respectively (Fig. 5).

In case of Moi jal, the length selectivity was determined for the dominant species tengra and the length of fish caught ranges from 35-57 mm. The $L_{50\%}$ value and selectivity range ($L_{25\%}$-$L_{75\%}$) of this gear for tengra were 45.11 mm and 39.44-49.58 mm at the probits of 3.596 and 3.301-3.828, respectively (Fig. 6).

Gill net

In the present study, the most dominant species for Current jal was tengra. The length of the fish ranges from 35-80 mm. The $L_{50\%}$ value and selectivity range ($L_{25\%}$-$L_{75\%}$) for tengra of Current jal were 53.48 mm and 47.19-61.92 mm at the probits of 3.397 and 3.214-3.642, respectively (Fig. 7).

In Puti jal, the dominant species caught was puti and the length ranges from 32-62 mm. The $L_{50\%}$ value and selectivity range ($L_{25\%}$-$L_{75\%}$) of Puti jal for puti were determined as 46 mm and 38.63-50.83 mm at the probits of 3.531 and 3.217-3.739, respectively. For Indian net jal, the most dominant species was found as chanda and the fish were caught in the length of 26-45 mm.

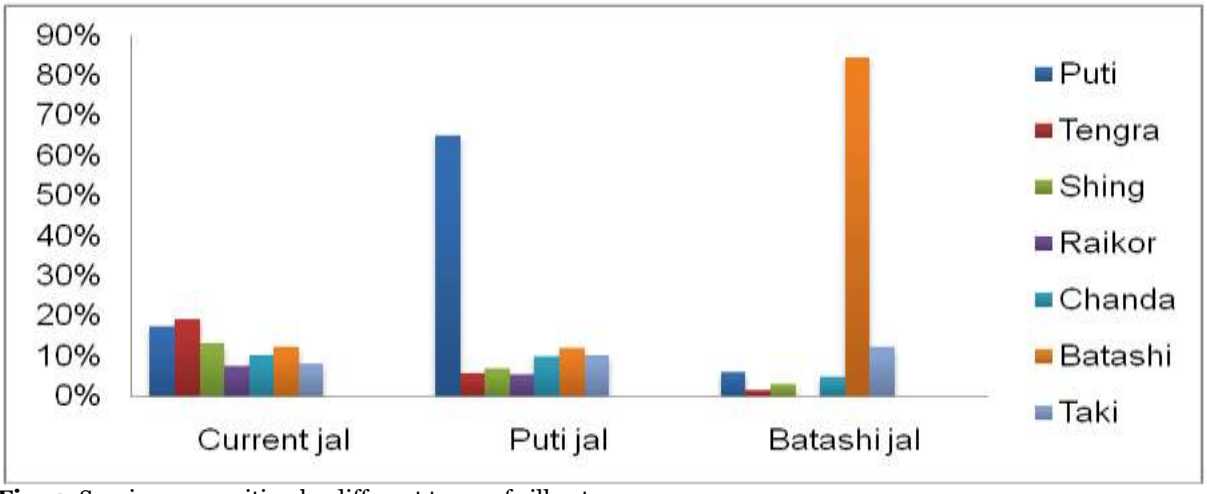

Fig. 4. Species composition by different types of gill nets.

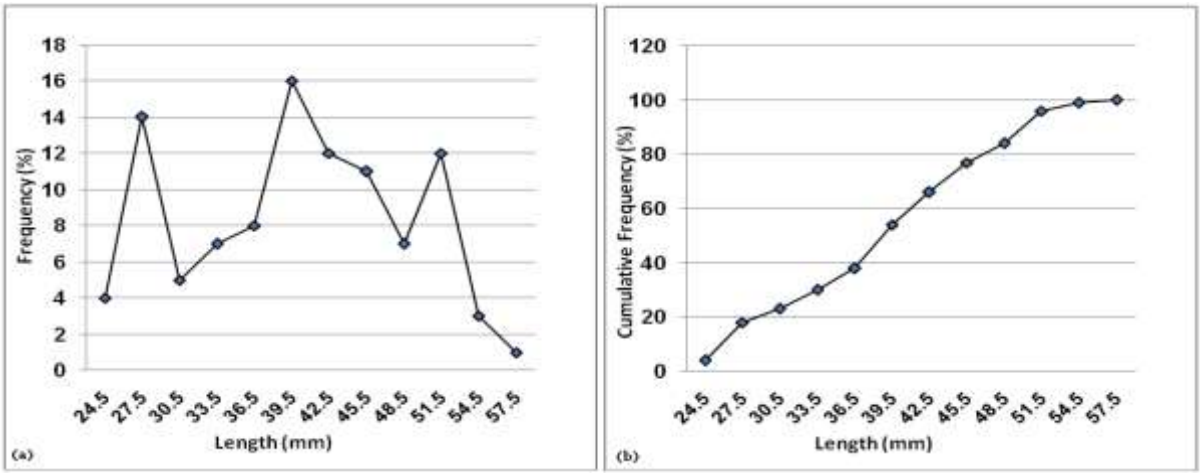

Fig. 5. Frequency curve (a) and sigmoid curve (b) for puti caught by Ber jal.

The $L_{50\%}$ value and selectivity range ($L_{25\%}$-$L_{75\%}$) recorded for chanda were 33.3 mm and 29.09-38.56 mm at the probits of 3.562 and 3.309-3.878, respectively. (Fig. 8).

Lift net

During the study period, the dominant species caught by Khora jal was puti. The length of puti caught by this gear ranges from 40-62 mm and the L50% and selectivity range (L25%-L75%) values were determined as 46.4 mm and 43-51.25 mm at the probits of 3.561 and 3.422-3.76, respectively (Fig. 9).

Cast net

The most dominant species caught by Khepla jal was recorded as puti and the length ranges from 40-68

mm. The values of $L_{50\%}$ and selectivity range ($L_{25\%}$-$L_{75\%}$) of Khepla jal for puti were 54.69 mm and 50.18-62 mm at the probits of 3.561 and 3.236-4.087 respectively (Fig. 10).

During the study period, the length selectivity was determined for the dominant species chanda by Thela jal and the length range of fish caught was 18-53 mm. The $L_{50\%}$ value and selectivity range ($L_{25\%}$-$L_{75\%}$) for this gear were 34.86 mm and 29.26-41.5 mm at the probits of 3.394 and 3.153-3.678, respectively. For drag net, only Hat badai jal was recorded and the dominant species was found Chela, the length of which ranges from 45-100 mm.

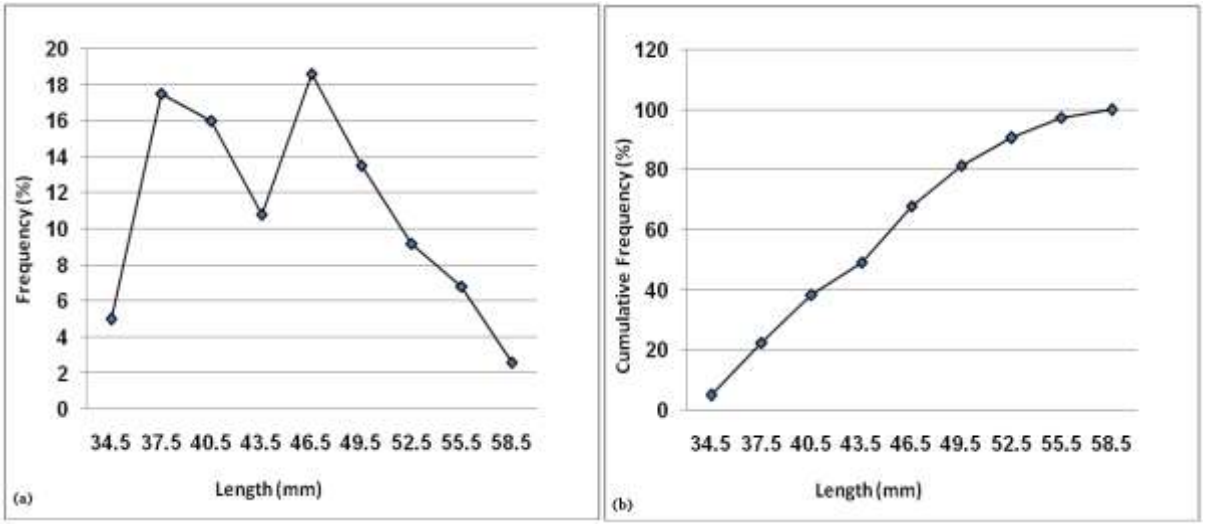

Fig. 6. Frequency curve (a) and sigmoid curve (b) for tengra caught by Moi jal.

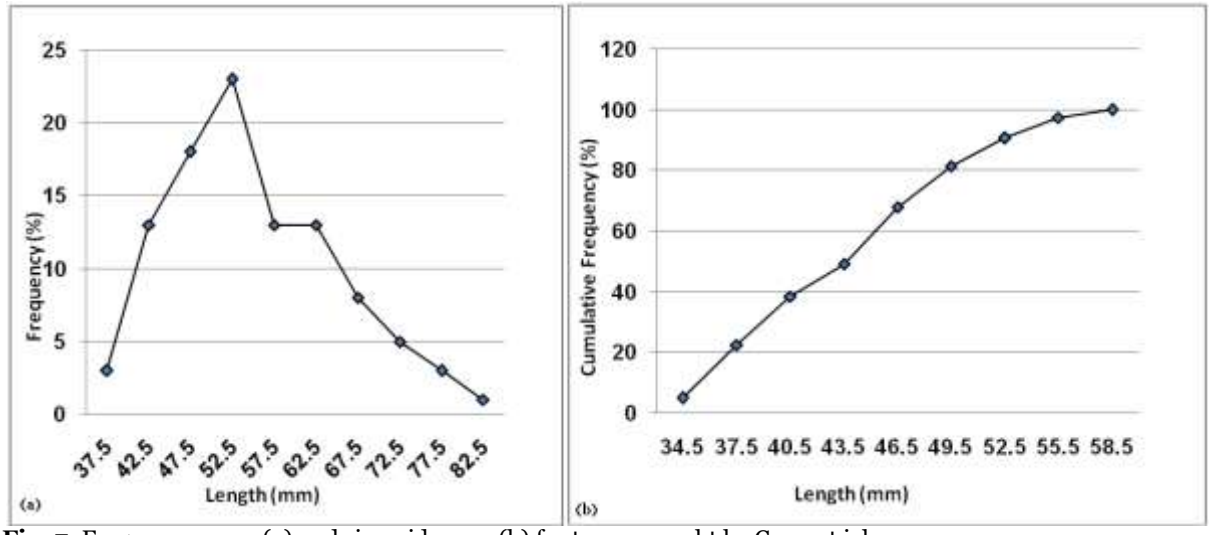

Fig. 7. Frequency curve (a) and sigmoid curve (b) for tengra caught by Current jal.

The $L_{50\%}$ value and selectivity range ($L_{25\%}$-$L_{75\%}$) of chela for Hat badai jal at the probits of 3.380 and 3.334-3.514 were 54.83 mm and 50.61-67 mm, respectively. Among the traps, Kholshun was most commonly used in the study area and the most dominant species was found guchi and the length ranges from 95-155 mm. The values of $L_{50\%}$ and selectivity range ($L_{25\%}$-$L_{75\%}$) of guchi by Kholshun were calculated as 118.5 mm and 107.08-132.81 mm at the corresponding probits of 3.342 and 3.170-3.556 respectively. However, the length selectivity was not determined for wounding gears because of the small number individuals for each species.

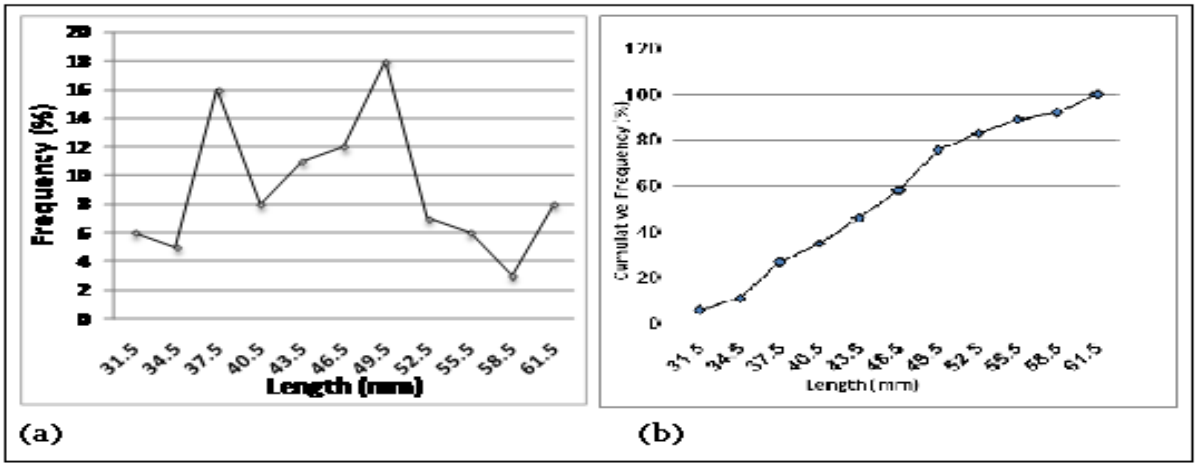

Fig. 8. Frequency curve (a) and sigmoid curve (b) for puti caught by Puti jal.

Discussion

Fishing gears

The present study reveals a total of 27 types of fishing gears were found to be used in the Chalan *beel* which were broadly classified into 5 major groups namely nets, traps, wounding gears, hooks and lines and others way of fishing. The most commonly used gears were Ber jal, Current jal, Khepla jal, Khora jal, Borshi, Kholshun and Konch. (Chakraborti, 2011) found lift net, current jal, cast net, traps, hooks and lines to be used by fisherman in Punuria *Beel*. (Khan *et al*,. 2005) identified various types of nets and wounding gears used in capturing major carps in the Kaptai Reservoir. (Saha *et al.,* 2005) classified 7 different types of gear into 3 categories (nets, traps and wounding gears) used by 2 categorized fishers in the Gawha *Beel* in Nawabganj. (Ahmed *et al*., 2002) found 3 kinds of gill nets, 14 kinds of seine nets, 5 kinds of long line and hook and 4 kinds of spears in the floodplain of the River Titas, Brahmaputra during survey.

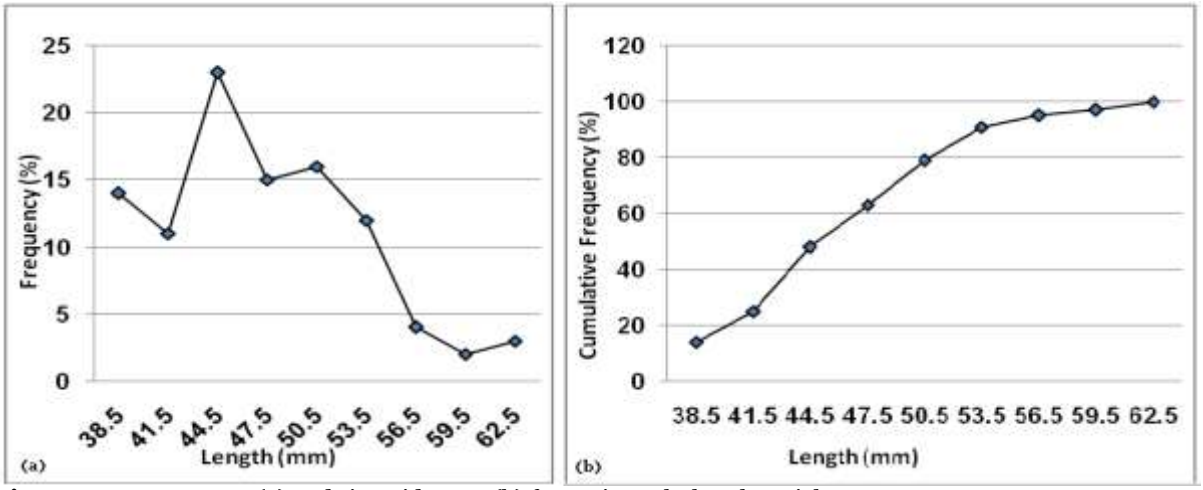

Fig. 9. Frequency curve (a) and sigmoid curve (b) for puti caught by Khora jal.

Before survey they categorized the fishing gears into 10 types of which 35 kinds of gears were found. (BCAS, 1991) also reported that fishermen use approximately 30 different types of fishing gears in Halti *beel*. (Dewan and Mazid, 1994) classified fishing techniques that are in use among the fishermen of Bangladesh listed into netting, angling, trapping, spearing, de-watering and hand picking. They also reported that about 91 gears are used in different water bodies of the country. Among the gears, they

found 28 gill nets, 21 seine nets, 8 drag and bag nets, 8 lift nets, 5 clasp, cast and push nets, 6 hooks and lines, 5 traps and 5 spears or harpoons. In the study area, nets were the dominating fishing gear followed by traps and wounding gears and the use of different types of fishing gears varies with the seasonal variation of water level in the *beel.* In the present study, it was also found that the mode of operation and fishing duration largely depends on habitat type, water level and fish availability. The maximum and minimum fishing duration were observed in gill net and Thela jal for 5-6 hours and 0.5-1 hr/day, respectively.

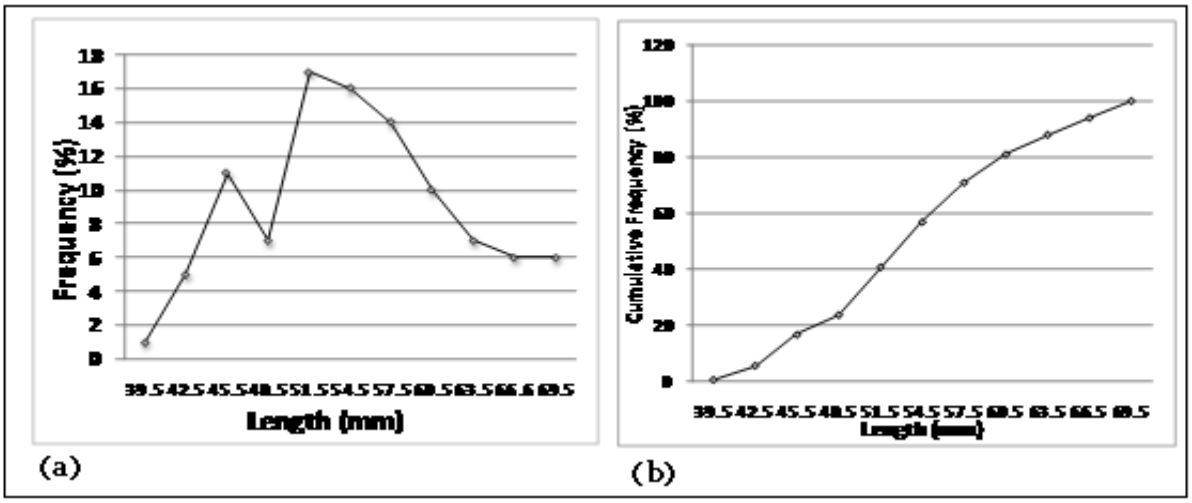

Fig. 10. Frequency curve (a) and sigmoid curve (b) for puti caught by Khepla jal.

Species selectivity

In the present study, a total of 53 fish species were recorded in the catches of different fishing gears. Species selectivity includes species composition of different fishing gears which constitute percentages of fish caught. The fish which constitute a major percentage of total catch is considered as the most dominant species. Three types of seine nets were recorded in the study area among which Ber jal was found to be a multi species gear. The catch of which was composed of 11 major fish species but the most dominant fish was puti which constitute 15.6% of total catch. In case of Moi jal and Indian net jal the dominant species were tengra (14.94%) and chanda (20.22%), respectively. (Akhanda, 2004) recorded 22 fish species in the catch of Ber jal in Baila *beel* including *Macrobrachium lamrrei* (icha, 34.88%), *Amblypharyngodon mola* (mola, 8.14%), *Chanda ranga* (chanda, 7.27%), *Puntius sophore* (puti, 6.98%), *Puntius ticto* (tit puti, 6.40%), *Esomus danricus* (darkina, 5.25%), *Chanda nama* (chanda, 4.36%). (BCAS, 1991) recorded 19 species of fish other than shrimp and small size fishes in Chanda *beel* , whereas (Rahman *et al.,* 1993) recorded 18 species of fish in Halti *beel* in the catches of seine net. In the study area, three types of gill nets were found which were more or less selective among these Batashi jal is mainly used to catch batashi which constitue major portion (84.4%) of the total catch. Similarly, Puti jal was found to catch puti (64.94%) whereas current jal because of its larger size was mainly used to catch large and medium sized fish but the most dominant fish was tengra (19.09%). (Akhanda, 2004) recorded a total of 13 species of fish in the catch of Current jal in Baila *beel* . Lift nets namely Khora jal and Dharma jal were used to catch different species of fish. For Khora jal and Dharma jal puti (28.04%) and raikor (15.79%) were found as dominant species respectively. (Akhanda, 2004) recorded a total of 20 fish species in the catch of Dharma jal whereas darkina was the dominant species (18.08%) and the lowest catch was shing (0.82%). Only one type of cast net locally known as Khepla jal was most commonly used and puti (17.04%) was dominant species but the

contribution of dominant species in the catches of this gear recorded by (BCAS, 1989b) in Arial Khan *beel* were puti (30%), pabda (5%), taki (5%), baila (10%), baim (5%), shol (10%) and others (30%). The percent composition of dominant species recorded by (Rahman *et al.*, 1993) were 13.17-49.59% in tengra, 20.28-40.72% in punti and 3.4-24.5% in baila during their study in Halti *beel* from August to March. In case of Thela jal (push net) and Hat badai jal (Drag net) chanda (18.03%) and chela (23.41%) were dominant species respectively. Among the traps species composition was recorded only for Kholshun as this gear was most commonly used in the study area and the dominant species was guchi (13.73%).

Length selectivity

Length selectivity was determined for commonly used fishing gears in the study area. The $L_{50\%}$ value and selectivity range ($L_{25\%}$-$L_{75\%}$) of puti for Ber jal, tengra for Moi jal and chanda for Indian net jal were 40.25 mm and 32.86-46.45 mm; 45.11 mm and 39.44-49.58 mm; 33.3 mm and 29.09-38.56 mm, respectively. (Rahman *et al.*, 1993) recorded $L_{50\%}$ value and selectivity range ($L_{25\%}$-$L_{75\%}$) for chanda as 3.3 cm and 2.98-3.62 cm and for tengra 6.21 cm and 5.07-7.36 cm, respectively. For Current jal and Puti jal, the values of $L_{50\%}$ and selectivity ranges were 53.48 mm and 47.19-61.92 mm for tengra, 46 mm and 38.63-50.83 mm for puti, respectively. (Rahman *et al.*, 1992) recorded the values for puti of Puti jal as 7.74 and 7.09-8.40 cm which were higher than the values of the present study. (Paul *et al.*, 1993) recorded $L_{50\%}$ value and selectivity ranges of current jal for catla as 24.15 cm and 22.03-26.27 cm in Halti *beel* . In case of Khora jal (lift net), $L_{50\%}$ value and selectivity ranges were 46.4 mm and 43-51.25 mm for puti and in Khepla jal (cast net) the values were 54.69 mm and 50.18-62 mm for puti. The $L_{50\%}$ value and selectivity range of lift net determined by (Paul *et al.*, 1993) in Halti *beel* were 10.86 cm and 8.75-13.0 cm for rui and 10.57 cm and 8.11-13.0 cm for mrigal. The length selectivity values recorded by (Rahman *et al.*, 1992) for puti of cast net were 5.08 cm and 4.46-5.7 cm which were close to the values recorded in the present study.

Conclusion

From the present study, it can be concluded that people use all possible types of fishing gear, ranging from bare hand to sophisticated seine and gill nets to catch fish and prawn from floodplains for decades. They caught fish indiscriminately which declines the fish production alarmingly. So, the guideline of using fishing gear is a crying need to pass legislation banning the use of harmful gear. Besides, extension program is necessary for the fishermen which will enhance the fish production. Considering the detrimental effects of different fishing gears it is suggested to restrict the use of these gears for certain period from July to October for protection of fish biodiversity of the *beel*.

Several problems were also recorded responsible for the loss of fish biodiversity in Chalan *beel* including fishing by blocking the migration path, construction of flood control embankment and roads, use of agrochemicals in *beel* surrounding crop field etc. For the protection of fish biodiversity of Chalan *beel the* following measures are recommended:

- Use of illegal fishing gears should be banned and the mesh size should be controlled to protect the fish from depletion.
- Over fishing should be controlled strictly during spawning season to maintain the fish biodiversity.
- Fish sanctuary should be established in various points of Chalan *beel* and proper management of sanctuary must be ensured.
- Flood control embankments, roads or such types of structures should be established with proper planning so that fish can move easily through the structures.
- Public awareness about the detrimental effects of destructive gears should be developed for effective management of Chalan *beel.*

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