Bangladesh J. Fish. (2018) **30**(1) : 73-81

Fishing gear efficiency and their effects on fish biodiversity in the Old Brahmaputra River, Mymensingh, Bangladesh

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Abstract. The old Brahmaputra River is one of the most important river systems of Bangladesh. With its rich biodiversity, it is an important source of open water capture fisheries resources. To ensure sustainable yield and rational use of this water resource, efforts were made to estimate fishing gear efficiency and their effects on fish biodiversity in this river over a period of 1 year from April 2011 to March 2012. A total of 19 types of fishing gears were recorded during this period. Seine net showed the highest catch per unit effort (CPUE) of 5.56 kg/gear/day with fishing effort 0.0224 gear/haul/day followed by push net and lift net. Among traps, CPUE and fishing effort were 3.74 and 0.0034, respectively while hook and line had 1.38 and 0.0048, respectively. Among all types of nets, highest CPUE of 2.44 kg/gear was found immediately before pre-monsoon during June and lowest of 1.49 kg/gear in dry season during January while in case of traps, highest CPUE of 3.0 kg/gear and lowest of 0.5 kg/gear were recorded during the same period. The highest biomass and number of fish species were also recorded during pre-monsoon (June) and lowest in January and February which showed a gradual rise during March through April, identified as pre-monsoon season. These results suggest that monsoon and occasional flood reduce fishing gear efficiency although the number of fishers increased during that period.

Keywords: Fishing gears, Fish biodiversity, Old Brahmaputra River

Introduction

Rivers, canals, lakes, flood plains, marshlands and estuaries are the major sources of inland open water capture fisheries of Bangladesh. These water bodies are rich in biodiversity and serve livelihood and nutritional security for a large group of fishers. Fishermen use different types of fishing gears like gill nets (particularly fine-meshed monofilament net), seine nets, cast net, life net, different types of fish traps and hook and line (Amin *et al*. 2008, Rahman *et al*. 2009, Saberin *et al*. 2013). Except *hilsa* fishery, little work has been done to ensure sustainability of fisheries resources in these water areas (Amin *et al*. 2002; Hossain *et al*. 2014, Shamsuzzaman *et al*. 2017). It has been proved that rational intervention and protective measures taken by government during fish breeding season could successfully recover fish stocks in the major river systems as observed from the experience of *hilsa* (Toufique 2015). As the abundance of fish in Bangladesh open waters decreases alarmingly, principally due to over exploitation, habitat degradation and pollution, to safeguard livelihood of fishers as well as conservation of aquatic biodiversity, systematic study is needed for appropriate planning that would ensure rational use of open water resources (Parsons 1996, Ghosh and Biswas 2017).

The old Brahmaputra River is one of the main flows of the Brahmaputra-Jamuna river system, and is considered as one of the oldest rivers in Bangladesh. It is a part of the Brahmaputra, the tenth largest river in the world by discharge, originating from the Angsi glacier of the Himalayas in Tibet, China. The river covers an area of 712,035 km^2 throughout its 3,848 km length flowing through India and Bangladesh, splitting into two channels *viz.,* the Jamuna and the Old Brahmaputra, before falling into the Bay of Bengal as the Meghna (Rao 1979, Ahmed *et al*. 2013). The riverbed is characterized by alluvial soil and due to the presence of numerous flood plain lakes, it possesses a favorable ecological condition for aquatic flora and fauna (Boruah and Biswas 2002, Mortuza 2007). We previously reported the availability of 41 dominant fish species in the lower stretch of the old Brahmaputra River at an approximately 11.20 km river length within Mymensingh sadar (Saberin *et al*. 2013) in Bangladesh. Due to relatively lower rate of industrial pollution in this area, large quantities of wild fishes get caught and supports livelihood of large number of fishers (Ahmed *et al*. 2013, Saberin *et al*. 2017). During 2015-16, an estimated 462 MT wild fish was captured from this river (BBS 2017). It is well known that the catch per unit effort (CPUE) is a measure of stock density, physical and financial productivity, and an indicator of the efficiency of a fishing operation (Ghosh and Biswas 2017). Considering the above circumstances, the present study was undertaken to quantify fishing gear efficiency, seasonal abundance of fish and impact of different fishing gears on fish abundance in the old Brahmaputra River basin in Mymensingh sadar of Bangladesh.

Materials and Methods

Study area: The study was conducted in Sadar Upzila, Mymensingh during April, 2011 to March, 2012. This area included Khagdahor, Shambhuganj, Kewatkhali, BAU Campus, Shesmoar, Sutiakhali and several vegetated islands within the Brahmaputra riverbank, locally called "Char" *viz., Char* Kalibari, *Char* Ishwardia, *Char* Vanga and *Char* Nilakshmia. Majority of these areas possess a dynamic environmental condition including erosion and occasional flooding during the monsoon season. Various forms of human activities, including agriculture, fishing, sand lifting from river beds etc. in the study area go on throughout the year.

Fish sampling: Catch compositions of each type of gear were recorded by physical examination of the total catch. Whole catch for small catch and a number of sub-samples for large catch was used for analyses. A minimum of one catch sample was taken for each fishing gear in every month. First, the total catch was purchased from the fishermen on the spot. For identification of fishes to species level, they were sorted out and numbers of individuals for each species were counted and their percentage composition was determined at the Laboratory of Fish Harvesting, Department of Fisheries Technology, Bangladesh Agricultural University, Mymensingh. In some cases, several specimens particularly the small indigenous species (SIS) and small prawns were preserved in 10% formalin for confirmation of identification (LGED 2013).

Estimation of catch per unit effort (CPUE): CPUE was estimated according to Harikrishnan and Kurup (2001). CPUE kg/gear/day was recorded for individual gear types, broad gear categories and user group categories.

Data collection and analyses: Data were collected at every 15-day interval during the study period using questionnaire, interview, group discussion and participatory rapid appraisal (PRA) through cross section of fishermen. Catch data were collected from fish landing centers, markets and the fishing spots individually. The catch data were also collected from fishermen at the fishing spot through interviews. Detailed description (mesh size, length, width, materials etc.) of each and every type of gear was also recorded from fishermen during fishing. Several visits were also made to the sampling sites to verify the accuracy of the information related to the study. Statistical analyses were conducted to determine the mean, standard deviation (SD), and degree of relationships with the help of MS Excel software (Microsoft Excel 2007).

Results and Discussion

Fishing gear efficiency and CPUE of gears in the old Brahmaputra River

In the present study the fishing gear efficiency using CPUE and fishing effort of the various fishing gears operated in the old Brahmaputra River was recorded and data were presented in Table I. The highest CPUE and fishing effort of 5.56 kg/gear/day and 0.0224 gear/haul/day was recorded for seine net followed by push net with CPUE and fishing effort of 0.25kg/gear/day and 0.0025 gear/haul/day respectively. It was observed that the CPUE for all active gears was proportionate to fishing efforts of the respective gears.

Table I. Fishing effort and CPUE for fishing gears

Gear type	Fishing Effort (gears/haul/day)	CPUE (kg/gear/day)
Seine net	0.0224	5.56
Gill net	0.0215	4.50
Cast net	0.0030	0.95
Push net	0.0025	0.25
Lift net	0.0042	0.78
Traps	0.0034	3.74
Hook and line	0.0048	1.38

In the old Brahmaputra River, seine net is an important types of gear used by the fishers which involves 5-10 fishermen. The net is very popular among the fishermen in Mymensingh region possibly due to its suitability of use in both inland and closed waters. CPUE value (5.56 kg/gear/day) observed for these nets is more or less similar to those reported for seine nets by Arshad-Ul-Alam and Azadi (2015) and Bhattacharjee

et al. (2017). However, for gill nets, Arshad-Ul-Alam and Azadi (2015) reported relatively lower values (0.418±0.15 to 1.008±0.25 kg/gear/day) of CPUE operated in the Halda River, Chittagong. Similar levels of lower CPUE values for gill nets were also reported by Bhattacharjee *et al.* (2017). In the old Brahmaputra River we observed CPUE value of 4.50 kg/gear/day for gill nets. This phenomenon is not well understood, but may be related to types of species available in this river. In the old Brahmaputra River, catfishes like *Wallago attu* and *Sperata aor* are the most abundant which are generally caught by gill nets and hook and lines (BBS 2017).

In case of traps the fishing effort and CPUE were 0.0034 gear/haul/day and 3.74 kg/gear/day, respectively but in hook and line the values were 0.0048 gear/haul/day and 1.38 kg/gear/day, respectively. The results obtained in the present study are in agreement with the finding of Ahmed (2008) in Titas flood plain where they reported that the seine net had the highest fishing effort (0.0233 gear/ha/day), while the set bag net had the highest catch per unit effort (15. 41 kg/gear/day).

In respect of nets, the highest CPUE was found in June and lowest in January which was 2.44 kg/gear /day and 1.49 kg/gear/day, respectively (Fig. 1). In traps, the highest CPUE was found in June and lowest in January which was 3 kg/gear/day and 0.5 kg/gear/day, respectively. But in hook and line the highest of 1.5 kg/gear/day and lowest CPUE of 0.4 kg/gear/day was found in September and February. This variation in CPUE happens for nets, traps and hook and line are due to the variation of water level, current and flood conditions.

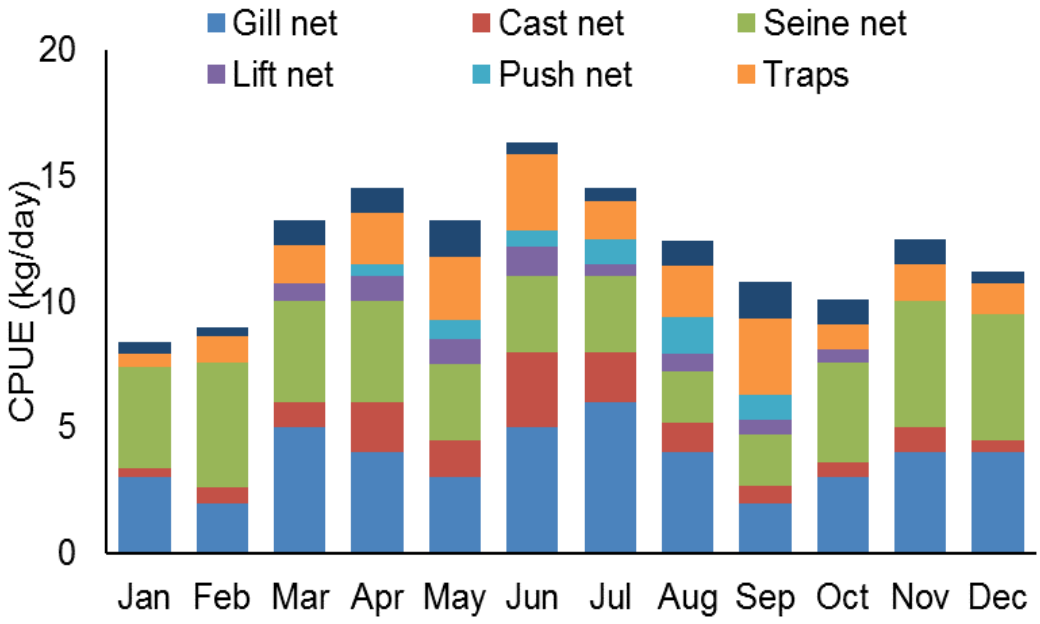

Fig. 1. Average catch per day for different types of gears during different periods.

Seasonal variations in relative gear dominance in the old Brahmaputra River

During the study period from April, 2011 to March, 2012, a total of 19 types of fishing gears were observed to be operated for harvesting fish in the river. Among them, 9 were fish nets, 6 were fish traps and 4 were hooks and lines and 1 was wounding gear (Table II). The major types of gill nets operated were locally called *koi jal*, *fash jal* and *current jal*. *Ber jal* was only net operated under the group of seine net while the major types of drag nets were *thela jal* and *moiya jal*. On the other hand, two types of lift nets namely *khora jal* and *dharma jal* were found in this river. The major traps operated were locally called *howra bair*, *sidi bair*, *dughair*, *vair* and *bitte* and the hooks and line operated were *koba borshi*, *chip borshi*, *hand borshi* and *chasra*.

Table II. Fishing gears used in the Old Brahmaputra River

Common name	Vernacular name	Dimension	Mesh size (mm)	Effective gear area (sqm)	Period of operation
Seine net	*Ber jal*	50 m × 5 m	10-15	250	Oct to Apr
Gill net	*Koi jal*	10 m × 0.5 m	20	5	Jan to Dec
	Fash jal	40 m × 3 m	25	120	Jul to Oct
	Current jal	90 m × 3 m	20-25	270	Oct to Apr
Cast net	*Jhaki jal*	10 m × 8 m	10-20	80	Apr to Sep
Push net	Thela jal	0.5 × 1 m × 2 m	5-10	1	Jul to Oct
Lift net	*Dharma jal*	3 m × 3 m	5-10	9	Mar to Oct
	Khora jal	0.5 × 8 m × 8 m	5-10	32	Jul to Oct
Drag net	*Moiya jal*	6 m × 2 m	10-12	12	Oct to Apr
Hook and line	*Chip borshi*	-	-	-	Oct to Apr
	Koba borshi	-	-	-	Jan to Dec
	Chasra	-	-	-	Apr-Oct
	Haat borshi	-	-	-	Jan to Dec
Fish trap	*Howra bair*	3 × 1.5 × 1 m	-	4.5	Jul to Oct
	Sidi bair	3.75 × 1.5 × 2.5 m	-	14	Jul to Oct
	Dughair	3 m × 2 m	-	6	Jul to Oct
	Vair	1× 0.75 × 1.2 m	-	0.9	Jul to Oct
	Bitte	0.5 × 0.75 × 0.3 m	-	0.10	Jul to Oct

In the present study we observed a low level of water in the old Brahmaputra during October to April and this may be considered as dry season. At this time, the seine net, *current jal,* and hand *borshi* were mainly used. The month of July, August, September and October were rainy season and as a result the water level of the river was also very high which restricted limited use of any types of gear. During this period, only *fash jal*, *khora jal*, *thela jal* and different types of traps were mostly used. When the water level started to increase day by day in the rainy season and the river overflows inundating surrounding areas, at that time the use of fish nets decreased. It is a common phenomenon in the inland water bodies of Bangladesh as reported by Bhattacharjee *et al.* (2017) and Galib *et al.* (2009). Wounding gears were generally not used as commercial purposes rather it was used by the subsistence fishermen. From this study, it was revealed that the seasonal variation of fishing gear in the old Brahmaputra River was dependent on the environmental cycles of monsoon and drying.

Seasonal variation of fish abundance in the Old Brahmaputra River

Study was also conducted on the seasonal variation of fish abundance during different periods of the year using different fishing gears in the old Brahmaputra River. Fish species composition during that study period was also calculated. A total of 41 fish species were recorded in the catches of different gears (Table III).

Table III. Fish species recorded in the catches by different gears

Order	Family	Scientific name	Local name
Cypriniformes	Cyprinidae	*Labeo rohita*	Rui
		L. calbasu	Kalibaush
		L. gonius	Gonia
		L. bata	Bata
		L. boga	Baighna
		Catla catla	Catla
		Cirrhinus mrigala	Mrigal
		Puntius sarana	Sharpunti
		P. sophore	Jatpunti
		P. ticto	Titpunti
		Amplypharyongdon mola	Mola
		Esomus danricus	Darkina
		Chela cachius	Chela
	Cobitidae	*Botia dario*	Bou-mach
		Lepidocephalus guntea	Gutum
Siluriformes	Siluridae	*Ompok pabda*	Pabda
		Wallago attu	Boal
	Schilbeidae	*Eutropiichthys vacha*	Bacha
		Pachypterus atherinoides	Batashi
	Bagridae	*Sperata aor*	Air
		Mystus tengara	Tengra
		M. vittatus	Gulsa tangra
		Rita rita	Rita
	Sisoridae	*Bagarius bagarius*	Baghair
Perciformes	Channidae	*Channa punctatus*	Taki
		C. striatus	Shol
	Ambassidae	*Chanda nama*	Chanda
	Gobiidae	*Glossogobius giuris*	Baila
	Nandidae	*Nandus nandus*	Bheda
	Anabantidae	*Anabas testudineus*	Koi
	Osphronemidae	*Colisa fasciatus*	Kholisa
	Sciaenidae	*Otolithoides pama*	Poa
Beloniformes	Belonidae	*Xenentodon cancila*	Kakila
Synbranchiformes	Mastacembelidae	*Mastacembelus armatus*	Baim
		Macrognathus pancalus	Guchi
		M. aral	Tara baim
Clupeiformes	Clupeidae	*Gadusia chapra*	Chapila
		Corica soborna	Kachki
Tetraodontiformes	Tetraodontidae	*Tetraodon cutcutia*	Potca
Crustacea	Palaemonidae	*Macrobrachium rude*	Kuche chinghri

Cypriniformes was found to be the most dominant order caught in this river followed by Siluriformes, Perciformes, Beloniformes, Synbranchiformes, Clupeiformes, Tetraodontiformes and Crustacea. We recorded a total of 41 fish species during the study period among them few species were either threatened or not abundantly available. The major fish species abundantly available were: *Sperata aor*, *Wallago attu*, *Mystus tengara*, *Mastacembelus armatus*, *Macrognathus pancalus*, *Nandus nandus*, *Puntius sarana* and *Glossogobius giuris*.

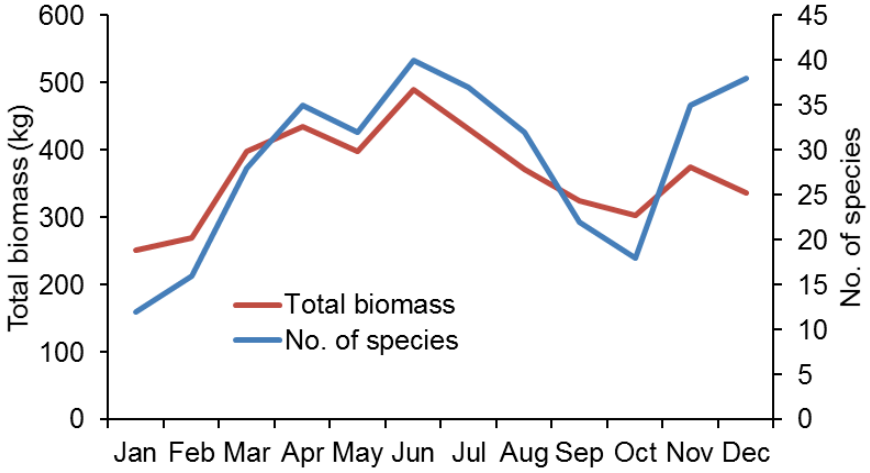

Fig. 2. Total biomass and abundance of fish species during different periods.

The total biomass caught by different types of fishing gears were also estimated. Fig. 2 shows that total estimated weight of fish caught by fishing gears over a period of 1 year in the old Brahmaputra River was 4170 kg. The estimated weight of fish caught by gill net, seine net, cast net, lift net, push net, traps and hooks and lines were 1350, 1320, 435, 187.5, 162, 621 and 312 kg, respectively. The highest catch with combined gear was recorded in June 490.5 kg and the lowest of 252 kg was recorded in January. The highest amount of 1350 kg fish was caught by gill net and 1320 kg by seine net. However, the lowest amount of 162 kg fish was caught by push net (Fig. 2). The total biomass was found to be proportionate with the number of monthly variations of fish species and were positively correlated ($p < 0.05$). The number of fish species was highest in June which was recorded to be 41. This value is rather low compared to those reported by Bhuiyan *et al.* (1992) and Islam and Hossain (1983). Bhuiyan *et al.* (1992) published a checklist of the fishes of Rajshahi, which included 133 species while Islam and Hossain (1983) provided an account of the fishes of the river Padma near Rajshahi and mentioned 110 species of fishes. Such low number of species may be related to various anthropogenic factors including overfishing, sand lifting, habitat destruction and use of destructive fishing method like fish aggregating device (FAD) locally called '*katha fishery*'. The '*katha fishery*' generally lasts for 5-7 months each year (Sep to Mar) when the water level decreases and rivers become calm. They are

usually constructed with branches from bushy trees such as the *Barringtonia* sp., *Eugenia* sp. and *Acacia* sp. (Ahmed *et al*. 1999) that attract fish in large numbers. Then they are encircled with a seine net and fish are collected after removal of all the branches and bushes. Considering the bad effects of this type of FAD, it is suggested that it should be prohibited in the river (Galib *et al*. 2009).

Implication for fisheries management

The ecological dynamics of the Old Brahmaputra is quite complex. As a large number of commercial and subsistence fishers are dependent on this river for their livelihood, appropriate approach need to be adopted for sustainability based on empirical knowledge. The seasonal pattern observed in the abundance of fish fauna of the Old Brahmaputra reflects the response of different fish species to various physico-chemical parameters as well as fishing activities. Therefore, to increase total fish production, and improve socio-economic status of the fishers, immediate actions like establishment of fish sanctuaries, strict enforcement of "Fish Conservation Act" are needed.

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(Manuscript received 22 May 2018)