Article

Landing and distribution of captured fish in selected landing centers in Kishoreganj *haor*, Bangladesh

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Abstract: The present study illustrates species diversity, landing quality and catch composition of fish in 10 fish landing centers of 5 *haor* upazilas of Kishoreganj *haor* for 12 months from January 2018 to December 2018. A total of 15 different types of fishing gears were detected to harvest fish in different stations throughout a year. Most of the fishing (46.88%) was conducted by small groups of 2 – 5 fishers, while 24.87% of the fishing was conducted by 6 – 10 fishers. The average depth of water in *haor* associated rivers and inundated lands during monsoon period varied from 4.87±0.99 to 15.2±6.71 and 2.6±0.55 to 6.2±2.68 feet respectively. Fifty different types of fish species were landed in the selected 10 landing centers, where both cultured fish and captured fish were present. Fishes under the Cyprinidae family included 9 species, viz. *Labeo rohita. Gebelion catla, Cirrhinus cirrhosus, Labeo calbasu, Hypophthalmichthys nobilis, Hypophthalmichthys molitrix, Cyprinus carpio, Ctenopharyngodon idella, Labeo gonius* covered a maximum of 12450.61±468.32 MT. The second largest landed fish under the family Schilbeidae included 4 species *Silonia silondia, Mystus armatus, Mystus cavasius Pseudeutropius atherinoides.* Other fish species landed were identified as: 4 species under the family Mastacembelidae, 2 species under Siluridae, 3 species under Clupidae, 1 species under Ambassidae, 2 species under Palaemonidae, 3 species under Channidae, 1 species under Gobidae, 2 species under Bagridae and 1 species from each of the family Heteropneustidae, Pangasiidae, Clariidae, Ailiidae, Botiidae, Nandidae, Cichlidae, Anabantidae, Osphronemidae, Ambassidae, Notopteridae, Notopteridae,Belonidae and Gobiidae. Highest number 14 species landed were under catfish category, followed by 9 species of major carp. The captured total fish landed in 10 landing centers in 12 month period accounted 12,574±1029.64 MT, but the cumulative total landed fish, including pond fish, was 15,795±1666061.93 MT, as calculated by 45 Aratdars of 10 landing centers. About 88.35% fishermen sold the captured fish at local arat, but the rest (11.65%) were sold to large traders (paiker), retailers and consumers. A 56.6% of the fishermen cleaned the captured fish by river water, while 43.4% fishermen did not use water for washing fish before selling. After harvest, 45.62% fishers used clean utensils for carrying fish to arat and 54.38% used uncleaned utensils. Average harvest per fishermen per day was 23.9 kg, of which 22.26 kg was sold in the market and 1.64 kg was used for own family consumption. Out of total fish landed, a 45.2% was transported by fish hold of the country boat, 21.9% by bamboo basket and 14.8% by plastic crate. Relatively small quantity of fish was transported by insulated ice box (4.7%), aluminum container (2.7%) and gunny bag (3.2%). A 32.6% fisherman used ice and 67.4 % fishermen did not use ice after harvesting of fish. During fishing season, fish and ice ratio used by the transporters was 2.62:1. The highest number of auctioneers were found in Chamra Ghat of Karimganj, while lowest were in Nikli, with an area of 55±1.44 and 25±8.42 decimal area per auctioneers being used for fish business.

Keywords: Kishoreganj *haor*; fish landing centers; fish biodiversity; fish handling; fish quality

1. Introduction

Bangladesh is enriched with wide variety of huge open water bodies like numerous rivers, canal, beels, lakes and vast area of floodplains. Total area of the inland water body of our county is about 4.7 million hectors where inland open water body is about 3.9 million hectors including river and estuaries, sundarban, beel, kaptai lake and floodplain. In 2018-19 fiscal year, total fish production was 43.84 lakh MT. Inland open water fish production was 12.35 lakh MT of which floodplain fish production was 7.8 lakh MT which is 17.82% of total fish production (DoF, 2020). The *haor* basins are mainly located in the North-eastern region of Bangladesh covering about 1.99 million hectares of area (Alam *et al*., 2010; CEGIS, 2012; Nowreen *et al*., 2014) and accommodating about 19.37 million people (CEGIS, 2012). It covers more than 24,000 km² area, approximately 17% of the country's land area (Alam and Hasan, 2010) and stretches over parts of seven districts of the North-eastern region of Bangladesh, i.e. Sylhet, Sunamganj, Habiganj, Moulvibazar, Netrokona, Brahmanbaria and Kishoreganj (MoWR, 2010), though it does not have any defined territory. There are about 373 *haors* located in the districts of Sunamganj, Sylhet, Maulvibazar, Habiganj, Brahmanbaria, Netrokona and Kishoreganj, and covering an area of about 858,000 ha, which is around 43% of total area of the *haor* region (Master Plan of Haor Areas, 2012). Beel and haors covers an area 1.14 lakh ha and inundable floodplains 54.86 lakh ha (Ali, 1997) A *haor* is a back swamp or bowl shaped depression, between the natural levees of a river. *Haors* are flooded annually during the rains and they remain under water for several months of the year. When they drain out during the post-monsoon months, some permanent water bodies, or beels remain in the deepest parts of the haors (IUCN – Bangladesh, 2004). The *haors* of Kishoreganj covers an area of 121,590 ha perennial watershed. Although fisheries plays significant role in the economy of the country, haor fisheries is being faced threat to extinction. The main causes of declining of fisheries are the degradation of *haor* ecosystem, over exploitation, pollution and injudicious intrusion of human. Besides, lack of awareness about the sustainable management of *haor* water or open water fisheries convert this poor situation into worst. The multiplicity of traditional fishing, and/or illegal fishing practice and inappropriate post-harvest fishery management, along with socio-economic condition, geographical position, carelessness and lack of technical skill are marginalizing the livelihood of *haor* fishery communities, which is further being triggered by poor. It is therefore, almost certain than *haor* fishery communities are completely unorganized and fishery harvest and post-harvest management is inferior. The poverty of the communities is the cause and effect of bewildering fisheries of *haor* (Nowsad, 2019). Haor fishes are marketed throughout the country through 24 fish landing centers and about 200 aratdars in Kishorganj. In addition, landed fishes are locally sold by 220 fish markets scattered throughout the haor upzilas (DoF, 2015). The production of capture fisheries depends heavily on different open water resources such as rivers, beels, floodplains, and *haors*. In Bangladesh, *haors* contribute approximately 10% of the total capture fisheries production (DoF, 2018), however this amount has reduced over time. Fish and fisheries sector plays an important role in the national economy of the country. Diversity of fishes meet nutritional requirement and ecosystem balance. In the haor area of Kishorganj district, a total of 46 fish species were identified under 17 families and most of the fish species (15 species) belong to Cyprinidae family followed by Bagaridae (4), Channidae (4), Schilbeidae (3), Mastacembelidae (3), Centropomidae (3), Siluridae (2), Anabantidae (2), Palaemonidae (2) and others (8) (Hasan *et al*., 2017).

Haor contains diversified flora and fauna especially reptiles, birds, fish species, amphibians etc., which play an important role in the existence of haor ecosystem (Choudhury, 2016). According to Pandit *et al*., 2015 local fishermen commonly caught over 84 species of fish in the *haor* region. Islam *et al*., 2008 recorded 108 species under 29 families of 10 orders from the *haor* region. Hence, the *haor* region has significant roles for fish production, maintaining biodiversity, meeting local and regional demand (Salauddin and Islam, 2011). However, the Kishoreganj *haor* region is famous for its richest SIS (Small Indigenous Fish Species) biodiversity, consisting of 30 species belonging to 7 orders and 15 families (Rownok *et al*., 2014). Kishoreganj is a low-lying 'Vati' district, characterized with inundation of 110,882 ha land as haor by flood water for 4-6 months. The district harvests highly popular "haor-fish" of about 50,600 MT per annum, with 20,000 fishers and traders involved in fishery business (DoF, 2012). Being wild harvest, the "haor-fish" are considered to be tastiest fish and highly relished by the affluent consumers in metropolitan cities country-wide (Nowsad, 2021). However, post-harvest handling situation of landed fish in Kishoreganj haor area is completely unknown, since no study has so far been conducted on post-harvest condition of valuable haor fishes. Because of remote and isolated locations of haor and limited access to government support services and GO/NGO extension facilities, haor areas of the country remain neglected in many cases, including fishing, fish landing, handling, marketing and distribution (Nowsad, 2016). Moreover, very limited research has been done on the species diversity, landing pattern and quality of fish in the floodplain areas except that of Nowsad *et al*., 2021a, 2021b, and 2021c.

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Therefore, the present study was conducted to assess the fish species diversity, landing pattern and quality and catch composition in 10 selected landing spots of Kishoreganj haor.

2. Materials and Methods
2.1. Study area and duration
The study was conducted at 10 fish landing spots in 5 *haor* Upazilas in Kishoreganj district (Figure 1). These were Chamra ghat matshya arat, Karimganj mach bazar and Morichkhali matshya arat in Karimganj upazila; Tarail matshya arat in Tarail upazila; Chouganga matshya arat in Itna upazila; Korgaon bazar matshya arat, Kotiadi matshya arat and Dhuldia matshya arat in Kotiadi upazila; Rodar podda matshya arat and Nikli notun bazar matshya arat in Nikli upazila. The study was performed for 12 months, from January 2018 to December, 2018.
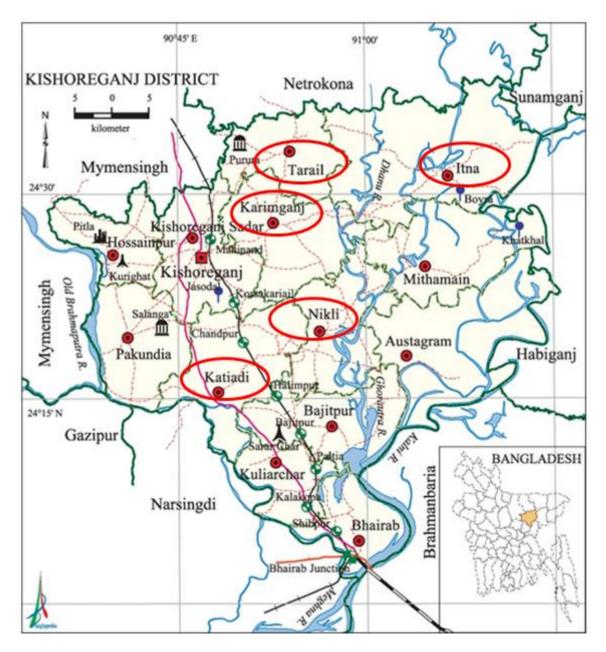

Figure 1. Map for showing the location of study area.

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2.2. Method of data collection

The study was based on the collection of primary data. From the selected study area, primary data were collected from 252 stakeholders through questioner interview, focus group discussion with intermediaries, cross-check interview with key informants and direct catch data from landing centers in 2018. A structured questioner form was developed by rigorous drafting, editing and field validating by the community. Primary data were validated by the secondary data collected from respective Upazila fisheries offices and District fisheries office of Kishoreganj.

2.3. Data Analysis

All the collected data were accumulated in Excel sheet and analyzed by Microsoft Excel 2016 and then presented in textual, tabular and graphical forms for easy understanding of present findings.

3. Results and Discussion

3.1. Status of gear used in Kishorgonj *haor*

A variety of fishing gears were used in Kishoreganj *haor*. A total of 15 different types of fishing gears were detected to harvest fish in different stations throughout a month (Table 1). Most fishing is conducted in small groups of 2 – 5 fishers (46.88%) in Kishoreganj *haor* with the 24.87% fishing is conducted by 6 – 10 fishers. Fishing as a part of single person is conducted by 22.28% and a small portion of fishing is conducted by larger groups (5.97%). Majority of the fishing is done by small group of fishers in all fish landing centers except Tarial and Chauganga. In Tarial and Morichkhali most of the fishing is conducted by single person and in Kotiadi and Chauganga above 50% fishing is done by medium group fishers (Figure 2). There are no such types of published report, so it is not possible to compare the present findings. Sayeed *et al.*, 2015 stated that 15 types of fishing gears of five major groups such as nets, traps, hooks and line, wounding gears and fish aggregating devices were operated for fishing by fishermen in Hakaluki haor, Moulvibazar. Rahman and Akhter, 2015 stated that a total of 34 different types of fishing gears where seine net, gill net, lift net, push net, cast net, fish trap and hooks and lines were 12 (34%), 4 (12%), 2 (6%), 4 (12%), 1 (3%), 7 (21%) and 4 (12%), respectively were used to catch fish from haors. Sayeed, 2010 reported that thirty four different gears in six categories were recorded in Chalan beel in greater Pabna and Natore districts. Holder, 2002 noted 9 types of gear, were classified into three groups as nets, traps and wounding gears, used in two beels (Doba and Chara) of Mymensingh sadar upazila, Mymensingh. BCAS, 1991 estimated about 30 different types of gears used by fishermen in Halti beel in Natore and Rajshahi districts.

Table 1. Different types of fishing gears used in Kishoreganj *haor*.

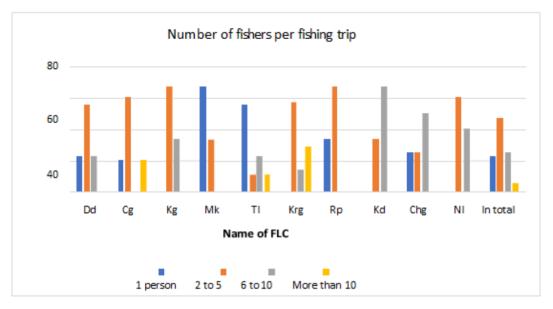| Sl no.	Name of gear	No. of gear used	Sl no.	Name of gear	No. of gear used
1	Kona ber jal	86	9	Borshi	399
2	Pai ber jal	23	10	Kora jal	152
3	Chonda ber jal	34	11	Chunga	80
4	Gorgoria jal	87	12	Bandor jal	8
5	Chap jal	64	13	Chai	33
6	Vim jal	47	14	Ber jal	10
7	Jhaki jal	207	15	Dak jal	97
8	Thela jal	142			

Figure 2. Number of fishermen per fishing trip in Kishoreganj *haor* basin.

3.2. Water Depth of the *haor*

The Water depth of river and land in Kishoreganj *haor* have been summarized in Figure 3 and 4 respectively. The average depth of water in river varied from 4.87±0.99 to 15.2±6.71 feet. The minimum depth of water varied from 4.87±0.99 feet in February to 6.9±4.45 feet in July-November. The maximum depth of water varied from 12.12±0.78 feet in February to 15.2±6.71 feet in July-November (Figure 3). The average depth of water in land varied from 2.6±0.55 to 6.2±2.68 feet. The minimum depth of water varied from 2.6±0.55 feet to 4.0±2.27 feet. The maximum depth of water varied from 4.8±0.45 feet to 6.2±2.68 feet (Figure 4). Salauddin and Islam, 2011 found that the water body in *haor* area remains at the zero level from January to March and then starts to increase and again go down from August. Mostly, in June and July, the water level reaches the highest point. According to NERP, 1995, almost all *haor* basins' are inundated for 7–8 months to depths of 5 m or more during the monsoon. This finding are more or less comply with present findings.
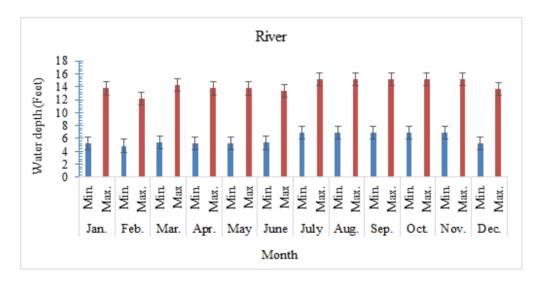

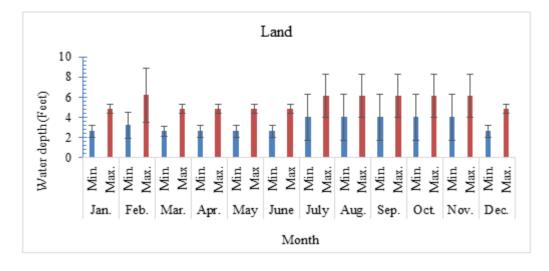**Figure 3. Water depth of river (feet) in Kishoreganj *haor*.**

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Figure 4. Water depth of land during monsoon (feet) in Kishoreganj *haor*.

3.3. Species diversity of fish in the study area

About 50 different types of fish species were recorded in selected *haor* area on the basis of the landed fish in the selected landing centers (Table 2). Table 2 shows the species wise and family wise landed fish (Metric ton) in different landing centers. Fishes under the Cyprinidae family included 9 species, viz. *Labeo rohita. Gebelion catla, Cirrhinus cirrhosus, Labeo calbasu, Hypophthalmichthys nobilis, Hypophthalmichthys molitrix, Cyprinus carpio, Ctenopharyngodon idella, Labeo gonius* covered a maximum of 12450.61±468.32 MT. The second largest landed fish under the family Schilbeidae included 4 species *Silonia silondia, Mystus armatus, Mystus cavasius Pseudeutropius atherinoides.* Other fish species landed were identified as: 4 species under the family Mastacembelidae, 2 species under Siluridae, 3 species under Clupidae, 1 species under Ambassidae, 2 species under Palaemonidae, 3 species under Channidae, 1 species under Gobidae, 2 species under Bagridae and 1 species from each of the family Heteropneustidae, Pangasiidae, Clariidae, Ailiidae, Botiidae, Nandidae, Cichlidae, Anabantidae, Osphronemidae, Ambassidae, Notopteridae, Notopteridae,Belonidae and Gobiidae. Highest number 14 species landed were under catfish category, followed by 9 species of carps. Suravi *et al.*, 2017 studied fish diversity of Dekar haor in Sunamganj, where they found 8 species of carps, 4 snakeheads, 3 eels, 11 catfishes and 1 minnow. More or less similar species diversities were also recorded in our study. Islam *et al.,* 2020 recorded a total of 79 species of fishes belonging to 27 families under 9 orders in kishoreganj *haor* on the basis of direct observation and using morphometric and meristic characteristics which is higher than present findings. The highest number of species (10) found under the family Cyprinidae and major carps and exotic carps were the highest in the Daudkandi floodplain fisheries (DFPF) landings (Nowsad, 2020).

3.4. Landing of fish in the study area

Trends and frequency of catch and landing of fish in 10 landing centers in Kishoreganj *haor* area have been presented in Tables 3 and 4. Fishermen generally catch fish in different natural water bodies including *haor* waters and rivers. The cumulative catch by the fishermen involved with the 10 landing centers accounts 12,574±1029.64 MT each year (Table 2). Quantity of landed fish in the landing centers are obviously different from that of the fishermen's catch, because the quantity of landed fish not only depend on wild harvest, but a significant portion also comes from the culture ponds or outsides. This phenomenon agrees well with the existing scenario since the total landed fish in the FLCs per annum was accounted to be 15,795±1666061.93 MT, as calculated by 45 Aratdars of 10 landing centers (Table 4). There is no government statistics on upazila-based or *haor*-based landed and harvested fish in Kishoreganj or elsewhere in Bangladesh. So, data could not be verified with any independent sources. This fishery statistical data was directly collected from the landing stations in Kishoreganj *haor.* According to the Fisheries Statistics of Bangladesh, 2018-19, total fish production in Kishoregonj district was 76410 MT where river, beel and floodplain production were 2403, 6781 and 42094 MT respectively which was much higher than our findings. Chandra *et al.,* 2010 noted that floodplain productivity tended to be somewhat higher and, in some cases, had been high as 6000 kg/ha. Highest catch was recorded in winter season (November to February) accounted 9804.78 MT, 8964.99 MT in pre-winter season (August to October) and 7865.31 MT in monsoon period (March to July) (Figure 5).

Table 2. Landing center-wise species composition of landed fish in Kishoreganj *haor* (Metric ton).

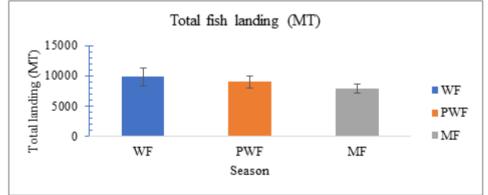| Category	Local Name	Scientific name	Family name	Tl	Kd	Krg	Kg	Dd	Cg	Mk	Chg	Nl	Rp	Total (Species wise)	Total (Family wise)
Carps	Rui	*Labeo rohita*	Cyprinidae	103.10±5.21	132.18±7.68	92.48±5.76	54.14±5.67	154.02±7.34	116.93±6.43	19.92±3.56	255.64±13.65	24.78±3.21	25.18±3.54	978.38±73.22	
	Catla	*Gebelion catla*		54.45±2.14	82.36±5.24	70.68±4.53	40.37±4.53	103.88±6.54	77.70±3.46	16.36±3.76	202.24±14.54	17.65±1.76	21.56±2.76	687.25±55.69	
	Mrigal	*Cirrhinus cirrhosus*		132.43±5.98	98.63±5.98	77.00±6.85	61.03±6.34	126.19±5.45	100.49±6.43	20.78±4.76	249.18±10.23	17.21±2.76	27.87±4.32	910.80±69.58	
	Kalibaus	*Labeo calbasu*		43.72±1.67	38.46±4.23	24.40±3.42	27.49±3.68	44.24±3.65	172.03±7.32	18.29±2.89	279.58±11.21	18.67±2.57	27.66±4.23	694.55±86.71	
	Bighead carp	*Hypophthalmichthys nobilis*		113.03±5.11	115.28±8.24	82.26±4.63	46.80±4.35	98.25±5.68	259.73±9.78	20.30±3.65	267.90±9.43	17.12±3.21	43.35±5.43	1064.03±90.23	
	Silver carp	*Hypophthalmichthys molitrix*		185.55±6.23	139.16±9.25	107.73±6.34	78.76±6.54	181.06±8.43	329.62±12.32	20.14±3.56	393.00±13.24	38.27±4.53	43.54±5.23	1516.81±125.24	12450.61±468.32
	Carfu	*Cyprinus carpio*		181.90±6.12	161.54±8.34	108.89±6.32	90.31±7.34	209.77±9.98	316.51±13.24	37.68±5.22	535.45±15.46	46.33±2.45	54.16±6.34	1742.55±163.27	
	Grass carp	*Ctenopharyngodon idella*		123.35±4.89	72.20±4.57	49.12±5.21	52.38±5.64	39.12±4.35	176.57±7.57	17.12±2.45	360.06±15.34	23.23±3.56	18.92±3.45	932.07±106.59	
	Ghonia	*Labeo gonius*		128.00±6.34	42.70±4.32	36.40±5.21	44.53±4.65	49.10±.34	293.92±9.45	41.04±3.87	412.79±7.67	25.63±4.67	39.74±4.57	1113.86±137.86	
Danionins	Chela	*Chela cachius*		37.24±1.12	2.58±1.76	1.52±.87	0.00	0.50±112	51.42±7.56	28.48±3.56	242.71±6.54	12.38±3.21	17.31±2.54	394.14±73.54	
Barbs and minnows	Sharpunti	*Puntius sarana*		65.13±1.97	33.76±1.12	20.25±1.12	23.84±3.23	34.36±3.23	194.33±8.65	7.57±1.45	222.97±9.43	12.83±3.54	17.69±3.29	632.74±78.54	
	Punti	*Puntius sophore*		178.85±7.23	19.35±2.46	22.23±3.54	54.44±6.34	20.93±4.21	419.24±18.24	32.02±4.67	784.58±16.56	50.25±5.32	48.09±4.65	1629.98±251.17	
Carplet	Mola	*Amblypharyngodon mola*		26.08±3.24	3.12±.80	12.07±2.32	6.95±1.21	9.04±2.34	41.92±4.65	5.06±1.54	42.31±3.65	4.49±1.21	2.44±.98	153.48±15.67	
Eel	Baim	*Mastacembelus armatus*	Mastacembelidae	34.03±1.86	5.11±1.47	6.68±.97	12.48±1.65	1.63±.78	87.19±3.78	11.77±2.4	303.65±8.56	16.59±3.76	17.89±3.54	497.02±92.63	
	Tara Baim	*Macrognathus aculeatus*		30.25±.89	3.96±-12	4.32±1.43	8.65±1.23	0.83±.32	106.72±6.45	17.16±3.89	224.55±6.56	14.56±3.45	10.50±2.69	421.50±71.25	1819.67±304.21
	Guchi baim	*Macrognathus pancalus*		16.40±1.10	7.23±2.32	5.14±1.23	11.62±2.14	0.37±.12	35.65±3.68	3.78±1.21	145.04±5.45	2.54±.96	6.32±2.42	234.08±43.93	
	Chikra baim	*Macrognathus pancalus*		73.48±5.67	13.66±3.56	15.45±2.65	26.47±3.65	15.40±3.21	115.58±7.45	27.19±4.56	329.15±7.85	27.84±4.53	23.14±3.62	667.36±97.74	
Catfish	Ayr	*Sperata aor*	Bagridae	38.35±.98	7.85±1.24	8.92±.79	16.23±3.24	4.27±1.21	87.91±8.57	15.38±2.87	372.35±11.34	22.49±4.32	19.26±4.21	593.01±112.65	665.91±128.60
	Baga ayr	*Bagarius bagarius*		7.30±.54	0.00	0.00	0.00	0.00	14.73±2.67	0.00	50.77±4.76	0.00	0.11±.08	72.90±16.04	
	Boal	*Wallago attu*	Siluridae	175.00±5.61	67.09±4.76	54.86±4.94	92.61±5.65	48.66±4.67	455.70±12.34	54.23±4.34	603.13±14.34	29.86±4.52	57.31±6.47	1638.45±199.77	1768.69±214.84
	Pabda	*Ompok pabda*		10.85±.87	11.91±1.89	6.42±1.32	1.47±.98	10.03±2.34	31.25±5.65	1.37±.98	49.85±5.34	3.93±1.21	3.16±1.28	130.22±15.62	
	Shing	*Heteropneustes fossilis*	Heteropneustidae	27.18±2.14	33.95±3.54	21.84±1.11	4.90±1.21	29.82±4.54	36.27±4.56	4.36±1.11	50.18±2.87	2.65±.97	4.49±1.23	215.64±16.70	215.64±16.70
	Pangus	*Pangasianodon hypophthalmus*	Pangasiidae	25.85±1.13	75.34±6.98	89.35±5.32	25.97±2.34	36.85±3.75	0.00	16.01±1.78	116.79±8.56	16.44±3.42	11.38±3.45	413.99±38.76	413.99±38.76
	Magur	*Clarias batrachus*	Clariidae	18.28±1.54	20.94±.97	4.97±1.15	7.28±2.34	3.31±1.21	17.30±4.85	2.06±.87	34.37±3.23	2.89±.98	2.17±1.28	113.58±10.90	113.58±10.90
	Shilong	*Silonia silondia*	Schilbeidae	3.05±1.12	0.00	0.00	0.00	0.00	8.82±2.45	0.00	8.29±2.34	0.07±.01	0.74±.21	20.97±3.54	
	Tangra	*Mystus armatus*		111.40±4.25	12.57±3.46	11.51±.11	40.16±5.43	10.94±3.23	242.09±15.74	24.53±2.65	353.58±9.45	33.77±3.34	32.15±6.34	872.69±117.70	
	Gulsha	*Mystus cavasius*		55.10±3.54	9.62±3.49	8.02±1.12	27.08±2.43	13.01±1.98	114.07±7.86	15.24±4.32	351.39±8.45	19.49±3.78	17.89±3.21	630.91±106.31	2117.68±104.31
	Batasi	*Pseudeutropius atherinoides*		29.50±1.76	1.60±.97	1.32±.96	2.40±1.11	0.44±.13	163.83±6.45	22.73±3.56	256.63±7.84	6.77±2.31	13.27±4.32	498.49±87.86	
	Bacha	*Eutropiichthys vacha*		7.90±2.46	0.00	0.69±.21	0.00	0.00	16.88±4.65	2.19±.98	63.03±3.56	1.22±.63	2.70±1.02	94.61±19.55	
	Gharua	*Clupisoma garua*	Ailiidae	15.20±3.25	0.00	0.00	0.00	0.00	25.95±3.45	11.20±2.56	103.06±4.56	10.27±2.43	12.29±2.41	177.97±31.16	323.96±58.22
	kajuli	*Ailia coila*		8.58±.35	0.18±.18	0.18±.09	0.26±.07	0.79±.14	29.53±4.65	6.25±1.76	87.77±5.63	10.54±1.64	1.91±.98	145.99±27.23	
Snakeheads	Shol	*Channa striata*	Channidae	23.23±1.23	12.14±.99	5.89±.98	4.29±1.12	5.11±1.89	45.74±4.32	7.66±2.43	122.38±5.43	6.31±1.42	6.37±2.51	239.11±36.90	
	Gozar	*Channa marulius*		10.30±.76	0.69±.54	0.09±.02	2.02±.98	0.00	25.26±3.78	2.42±1.23	81.91±4.54	2.65±1.87	3.91±1.11	129.24±25.42	950.3±131.34
	Taki	*Channa punctata*		91.55±3.45	18.34±2.45	11.16±1.14	25.10±32	2.64±1.21	184.30±14.6	14.95±3.56	195.79±4.65	13.22±3.76	24.88±4.23	581.93±73.74	
Perches	Tilapia	*Oreochromis niloticus*	Cichlidae	48.03±2.12	80.64±5.34	64.40±3.54	40.10±4.32	115.39±5.78	89.17±3.86	18.31±2.13	157.67±7.65	20.39±2.54	14.38±4.65	648.47±46.66	648.47±46.66
	Koi	*Anabas testudineus*	Anabantidae	21.36±2.63	7.81±2.32	8.36±.89	10.41±1.67	7.89±2.32	31.11±2.46	9.31±1.76	41.26±4.65	2.54±.79	4.58±1.34	144.63±12.69	144.63±12.69
	Khalisha	*Colisa fasciata*	Osphronemidae	11.35±.80	0.78±.23	1.79±.02	3.78±1.56	3.00±1.21	16.78±2.34	2.60±.64	29.78±2.54	1.66±.89	1.25±.65	72.78±9.46	72.78±9.46
	Chanda	*Chanda nama*	Ambassidae	104.40±5.75	10.60±2.39	10.22±1.16	40.97±3.62	5.73±1.13	281.6±10.23	28.92±3.58	618.94±11.32	20.19±3.78	34.71±5.43	1156.30±195.50	1156.30±195.50
Featherbacks	Chital	*Chitala chitala*	Notopteridae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.67±2.34	0.14±.032	0.22±.12	12.02±3.68	
	Foli	*Notopterus notopterus*	Notopteridae	7.351±.76	0.00	0.00	0.00	0.00	8.93±3.45	0.00	24.63±3.54	0.00	0.67±.12	41.58±7.94	53.61±11.38
Needlefish	Kakila	*Xenentodon cancila*	Belonidae	17.75±1.11	4.11±1.28	4.55±1.25	13.80±1.78	0.15±.06	26.01±3.65	3.85±1.24	182.13±6.45	6.07±1.54	4.56±1.23	262.97±55.32	262.97±55.32
Goby	Balia	*Glossogobius giuris*	Gobiidae	68.48±1.54	4.11±1.28	6.7±1.13	30.96±3.76	5.82±2.75	68.5±5.63	35.64±3.45	435.95±8.76	20.33±2.95	32.61±5.79	713.17±130.14	713.17±130.14
Sprat	Kachki	*Corica soborna*	Clupeidae	60.90±2.89	12.24±3.12	19.34±1.46	82.93±5.74	6.36±1.27	286.44±9.87	53.76±4.56	470.41±9.54	39.25±5.43	54.37±6.62	1085.99±150.53	
Shad	Chapila	*Gudusia chapra*		10.75±1.16	5.57±1.56	6.15±1.21	17.66±2.13	6.42±1.21	71.15±4.65	13.69±4.54	309.20±7.54	9.53±3.64	13.79±2.43	463.92±94.37	1588.61±248.92
	Ilish	*Tenualosa ilisha*		2.98±.15	0.07±.01	0.07±.01	0.15±.09	0.00	8.09±1.11	1.57±.56	25.10±4.32	0.28±.19	0.39±.12	38.70±7.87	
Ioach	Rani mach	*Botia dario*	Botiidae	0.00	0.25±.14	0.25±.13	1.21±.78	0.00	0.83±.23	0.00	5.12±1.34	0.32±.12	0.25±.12	8.23±1.56	8.23±1.56
Leaffish	Veda	*Nandus nandus*	Nandidae	4.06±.98	0.25±.12	1.33±.42	0.81±.18	0.00	6.00±1.21	0.00	83.92±2.67	1.81±.97	2.04±1.11	100.20±26.03	100.20±26.03
Prawn	Golda chingri	*Macrobrachium rosenbergii*	Palaemonidae	12.84±1.19	0.38±.14	0.38±.12	4.31±1.23	1.61±.97	107.27±9.46	6.89±2.12	132.19±6.76	6.72±1.36	2.48±1.21	275.05±49.10	1045.9±164.72
	Choto chingri	*Macrobrachium malcomsonii*		74.28±2.43	5.50±1.23	3.12±.08	24.27±.32	1.06±.89	217.48±9.45	35.02±4.23	353.23±7.57	20.08±5.12	36.79±6.32	770.80±116.32	

Tl = Tarail, Kd = Kotiadi, Krg = Karimganj, Kg = kargaon, Dd = Dhuldia, Cg = Chouganga, Mk = morich khali, Chg = chamra ghat, Nl = Nikli, Rp = Rodar podda, spp. = species.

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Table 3. Trends in fish catch by the fishermen involved in FLCs of Kishoreganj, 2018.

Sl	FLCs	Upazila	Source of catch	Catch/ day (kg)	Catch duration (mon/y)	Catch Duration (day/mon)	No. of Fishers	Total fish catch (MT)
1	Chamraghat	Karimganj	Haor	25.7	10	27	535	3513.68
2	Morichkhali	Karimganj	Haor	7.33	7	28	250	340.89
3	Mach Mohal	Karimganj	Haor	30.94	11	23	70	545.33
4	Dhuldia	Kotiadi	Haor	5	12	24	80	112.80
5	Korgaon	Kotiadi	Haor	39.64	8	26	175	1441.09
6	Kotiadi Bazar	Kotiadi	Haor	21.58	12	28	220	1576.39
7	RodarPodda	Nikli	Haor	17.17	8	26	250	904.17
8	Nutun Bazar	Nikli	Haor	26	9	25	160	907.88
9	Chowganga	Itna	Haor	12.5	7	27	350	856.41
10	Tarail Mach Bazar	Taril	Haor	21.67	11	30	345	2375.57
	Total			**207.53±11.30**	**93**	**263.19**	**2435**	**12574.21±1029.64**

Table 4. Fish landing in different FLCs of Kishoreganj *haor* as perceived by the Aratdars.

Sl	Name of FLCs	Upazila	Seasonal landing/day (Kg)		Average landing/ day (Kg)	Av. landing/ month (Kg)	Total landing /year (Kg)
			Peak season (Jun-Oct)	Lean season (Nov-Jan)			
1	Dhuldia	Kotiadi	4400	2684.64	3542.32	106269.6	850156.8
2	Chamraghat	Karimganj	26977.78	22163.24	24570.51	737115.3	5896922
3	Mach Mohal	Karimganj	2630	1234.37	1932.18	57965.55	463724.4
4	Morichkhali	Karimganj	944.44	458.72	701.58	21047.4	168379.2
5	Taril Mach Bazar	Taril	11464.29	6356.23	8910.26	267307.8	2138462
6	Korgaon	Kotiadi	4266.66	3457.36	3862.01	115860.3	926882.4
7	Rodar Podda	Nikli	2914	2176.43	2545.21	76356.45	610851.6
8	Kotiadi Bazar	Kotiadi	9040	8754.23	8897.11	266913.5	2135308
9	Chowganga	Itna	9250	5485.12	7367.56	221026.8	1768214
10	Nutun Bazar	Nikli	5500	1468.83	3484.41	104532.5	836259.6
	Total (Kg)		**77387.17±75470.64**	**54239.17±64248.53**	**65813.17±6941.92**	**1974395±208257.75**	**15795161±1666061.93**

WF = Winter fishing, PWF = Pre-winter fishing, MF = Monsoon fishing, MT = Metric ton

Figure 5. Landed fish in different fishing season.

3.5. Status of harvested fish

The harvested fish in Kishoreganj *haor* is sold by fisherman to local arat, local paiker and the retail market. In total, about 88.35% fisherman sell their captured fish at local arat and rest of the fishers (11.65%) sell fish to paiker, retail market and consumption. About 100% fishermen sell the captured fish to local arat in Dhuldiya, Tarial, Rodar podda, Kotiyadi and Nikli. Only 13.55% fisherman sell the harvested fish to local paiker and a large portion of fisherman (86.45%) give the fish to seasonal paiker. Only 14.78% fisherman take their captured fish in local fish market for selling but 85.22% fisherman give their fish to paiker who come from different

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places (Table 5). Hossain *et al.,* 2013, stated that fisherman catches fish independently and sells to the Aratder. Paiker purchases from the Aratder (98%) and fisherman (2%). Fisherman sells 80.5% of the fish to the Aratder and consumer (10%). Aratder sells fish to the secondary Aratder (75%), paiker (10%), processor (5%), wholesaler (8%) and retailer (2%). Paiker sells to wholesaler (95%) and retailer (5%). These findings are mostly complying with present findings. In Kishoreganj *haor,* 56.6% fisherman clean the captured fish by water and 43.4% fisherman do not use water for washing fish before selling (Table 5). Nowsad, 2010 reported that only giant prawn, penaeid shrimp and some other marine high valued species were found to be washed adequately (75-100%), while washing of most of the freshwater species before marketing were in 20-40% range. After harvesting, 45.62% fishers use fresh utensil for carrying fish to arat and 54.38% use contaminated utensil. 100% fishers use fresh container and contaminated container in Dhuldiya and Rodar podda respectively (Table 5). Table 6 shows that everyday a fisherman harvest in an average 23.9 kg of fish in Kishoreganj *haor* area. Among these, fisherman sales in an average 22.26 kg of fish per day at arat, paiker and retail market and keeps only 1.64 kg for their daily consumption. Among the landing centers, the fisherman harvest more than 30 kg of fish per day in karimganj, kargaon and Nikli area as well as less than 10 kg of fish is collected in Dhuldia (5 kg) and Morichkhali (7.3 kg). The consumption rate of fish by fisherman household is comparatively high in Korgaon (3.3 kg) and Nikli (2.6 kg) and low in Dhuldiya (.75 kg) and Morichkhali (0.6 kg). There is no such types of recorded data, that why it's not possible to compare.

Table 5. Status of harvested fish (%).

FLC	Selling to						Washing by water		Transporting with fresh utensil	
	LA		LP		RM					
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Dhuldiya	100	0	50	50	0	100	100	0	100	0
Chamta ghat	60	40	10	90	10	90	40	60	33.33	66.67
Karimgonj	88.89	11.11	22.22	77.78	55.56	44.44	66.67	33.33	55.56	44.44
Morichkhali	88.89	11.11	0	100	0	100	55.56	44.44	44.44	55.56
Tarial	100	0	33.33	66.67	22.22	77.78	33.33	66.67	33.33	66.67
Kargaon	85.71	14.29	0	100	0	100	57.14	42.86	42.86	57.14
Rodar poddar	100	0	0	100	0	100	66.67	33.33	0	100
Kotiyadi	100	0	0	100	0	100	66.67	33.33	66.67	33.33
Chouganga	100	0	20	80	40	60	40	60	40	60
Nikli	60	40	0	100	20	80	40	60	40	60
In total	**88.35**	**11.65**	**13.55**	**86.45**	**14.78**	**85.22**	**56.6**	**43.4**	**45.62**	**54.38**

LA = Local arat, LP = Local paiker, RM = Retail market

Table 6. Status of harvested, selling and consumed fish per fisherman.

FLC	Quantity of Harvest (Kg/Day)	Quantity of Sale (Kg/Day)	Quantity of Consume (Kg/Day)
Dhuldia	5±0	4.25±0.4	0.75±0.4
Chamta	23.7±27.1	22.4±26.2	1.4±1.4
Karimganj	39.5±30.7	37.8±29.5	1.7±1.7
Morichkhali	7.3±4.8	6.7±4.7	0.6±0.3
Tarial	21.6±18.4	19.9±17.7	1.7±1.1
Korgaon	41.1±10.1	37.6±11.4	3.3±1.7
Rodarpudda	17±13	15.7±12.4	1.3±0.8
Kotiadi	22.5±7.3	20.8±6.6	1.7±1.2
Chowganga	15.9±8.4	14.6±7.3	1.3±1.72
Nikli	45.4±32.4	42.8±30.9	2.6±1.5
In total	**23.9±13.96**	**22.26±13.23**	**1.64±0.81**

3.6. Fish transportation

After harvesting, various types of equipment are used for transportation of fish from water body to arat. Table 7 shows that average 45.2% fish is transported by boat, 21.9% by bamboo basket, and 14.8% by plastic crate. A small portion of fish is transported by ice box (4.7%), aluminium pot (2.7%) and gunny bag (3.2%). In Dhuldia 100% fish is transported by boat. Above 50% captured fish is carried away by boat in Morichkhali and Chowganga. 54.5% fish is carried away by bamboo basket in arat after harvesting from *haor*. During transportation, ice box is used only in Chamta ghat (6.7%) and Rodarpodda (40%) along with plastic crate and

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plastic drum. Boat, plastic crate and bamboo basket are available in all fish landing centers after harvesting of fish. Nowsad, 2010 stated that most of the fishes are transported by bamboo baskets of different shapes and sizes, with or without hogla mat or polythene covered and with or without ices. Fish are also being transported by plastic drum, steel made half-drum, country boat partitioned by hogla mat, aluminium container with or without lid, fibre glass crater, plastic crater, styrofoam box and ideal ice boxes. Ilish landed in Barguna-Barishal coast are mainly transported in water-ways by country boat. These are mostly complying with our finding. It is found from Kishoreganj *haor* basin that 32.6% fisherman use ice and 67.4 % fisherman do not use ice after harvesting of fish. Only 7% fisherman use ice in fish immediately after harvesting. About 15.6% and 6.3% fisherman use ice within 4 to 8 hours and 1 to 3 hours respectively after harvesting. About 3.7% fisherman use ice after 8 hours later. After arrival of fish at arat only 29.6% ice is still remaining and 70.4% ice is melted before arrival. 100% ice is melted before reaching of fish at arat in Karimganj, Morichkhali, Kotiadi, Chawganga and Nikli. In Kargaon and Rodar podda 100% used ice in fish is still present after reaching at arat (Table 8, Figure 6). There is a variation in quantity of fish transportation according to season and off-season. In fishing season about 681.73 kg fish was daily transported by traders. On the other hand, 370.65 kg fish was daily transported by traders in off-season in haor. In this study found that, 91.3% traders use ice for fish preservation in fishing season where 89.1% traders use in off-season. About 8.7% and 10.9% traders did not use any ice in season and off-season respectively. In fishing season about 37.68 kg ice used in fish preservation per day where 25.2 kg used in off-season. In this survey found that there is available ice for preservation of fish (Table 9). Table 10 shows that, during fishing season about 3972.3 kg of fish was transported with 1517.13 kg of ice which ratio is 2.62:1. On the other hand, during off-season about 2092.48 kg of fish was transported with 959.96 kg of ice which ratio is 2.18:1. Among the fish landing centers, the amount of ice used was lowest in Chamta ghat during fishing season where Morichkhali was highest. On the other hand, during off-season, the amount of ice used was lowest in Karimganj where Morichkhali was highest. Nowsad, 2010 noted that only 12% fishermen use very minimal quantity of ice in fish (ice-fish ratio of 1:3 or 1:4) and 88% fishermen and 77% fish farmer do not use ice in fish at all. All wholesalers/transporters use ice in fish but only 12% of them use an ice-fish ratio of 1:1 and 44% use a ratio of 1:2 but most of wholesalers, retailers and vendors use an ice:fish ratio of 1:3 to 1:5, which is quite negligible. Ice are used in inland fish transport in fish boxes or trucks and on board mechanized boats which carry fish more than a day. Sixty to eighty cans of ice (4.8-6.4 tones) are generally used on 7/8-day trip to ice 5-6 tons of ilish (Nowsad *et al*., 2012)

Table 7. Fish transportation (%) in arat.

| FLC | Equipment used after harvesting | | | | | | | |
	Boat	Ice Box	Bamboo Basket	Steel Drums	Plastic Drums	Plastic Crate	Aluminum Pot	Gunny Bag
Dhuldia	100	0	0	0	0	0	0	0
Chamta	40	6.7	20	0	20	13.3	0	0
Karimganj	30	0	30	0	10	20	0	10
Morichkhali	53.8	0	7.7	0	0	7.7	15.4	15.4
Tarial	35.3	0	29.3	0	5.9	11.8	11.8	5.9
Korgaon	41.7	0	33.3	0	0	25	0	0
Rodarpudda	40	40	0	0	0	20	0	0
Kotiadi	9.1	0	54.5	9.1	0	27.3	0	0
Chowganga	62.5	0	25	0	0	12.5	0	0
Nikli	40	0	20	0	30	10	0	0
Average (%)	45.2	4.7	21.9	0.9	6.6	14.8	2.7	3.2

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Table 8. Ice used in fish during transportation (%).

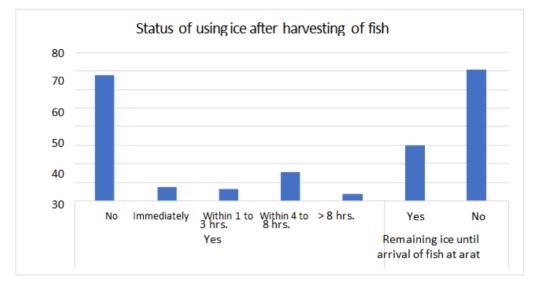| FLC	Use of ice in fish transportation					Remaining ice until arrival of fish at arat	
	No	Yes				Yes	No
		Immediately	Within 1 to 3 hrs.	Within 4 to 8 hrs.	> 8 hrs.		
Dhuldia	100	0	0	0	0	0	0
Chamta ghat	72.7	9.1	9.1	9.1	0	33.3	66.7
Karimganj	77.8	0	22.2	0	0	0	100
Morichkhali	0	0	0	83.3	16.7	0	100
Tarial	66.7	11.1	22.2	0	0	33.3	66.7
Korgaon	83.3	16.7	0	0	0	100	0
Rodar podda	66.7	33.3	0	0	0	100	0
Kotiadi	66.7	0	0	33.3	0	0	100
Chowganga	60	0	0	20	20	0	100
Nikli	80	0	10	10	0	0	100
In Total	**67.4**	**7**	**6.3**	**15.6**	**3.7**	**29.6**	**70.4**

Figure 6. Status of using ice in harvested fish in haor basin.

Table 9. Transportation of fish by fish traders.

	Quantity of fish Transportation (Kg/Day)	Use of Ice (%)		Quantity of Ice Use (Kg/Day)	Ice Availability (%)	
		Yes	No		Yes	No
Season	681.73	91.3	8.7	37.68	100	0
Off-Season	370.65	89.1	10.9	25.2	100	0

Table 10. Ratio of ice used during transportation of fish in Kishoreganj.

FLC	Season			Off-season		
	Transport of fish (Kg)	Amount of ice used	Ratio	Transport of fish (Kg)	Amount of ice used	Ratio
Dhuldiya	80.71	38.29	2.11:1	69.29	34.86	1.99:1
Chamta ghat	1090	202	5.39:1	231.67	153.67	1.51:1
Karimgonj	267.95	52	5.15:1	235	46.91	5.00:1
Morichkhali	221.43	165.43	1.34:1	232.14	179.71	1.29:1
Tarial	594.29	257.71	2.31:1	223.71	89.14	2.51:1
Kargaon	349.17	128	2.73:1	173.33	72	2.41:1
Rodar poddar	131.67	67.83	1.94:1	86.17	51	1.69:1
Kotiyadi	140	62.2	2.25:1	97	36	2.69:1
Chouganga	163.75	37	4.43:1	77.5	30	2.58:1

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| Nikli | 933.33 | 506.67 | 1.84:1 | 666.67 | 266.67 | 2.50:1 |
| **In total** | **3972.3** | **1517.13** | **2.62:1** | **2092.48** | **959.96** | **2.18:1** |

3.7. Status of arat

In Kishoreganj *haor* basin, average 18.7 arat with an area of 41.11 ± 9.77 decimal is found in each fish landing center. The highest number of arat is present in Chamta ghat with an area of 55±1.44 decimal and lowest in Nikli with an area of 25±8.42 decimal (Table 11). In fishing season, everyday about 88 ± 25 and 410 ± 97 number of fishermen selling captured fish in each arat and fish landing centers respectively (Table 11). The number of fishermen selling fish in arat per day is higher (226) in Morichkhali and Kargaon and lower (8) in Tarail and Rodar podda (Table 11). In fish landing centers, more than 1000 fisherman selling fish in Chamta ghat per day. In total, 92% fishermen selling fish at arat and only 8% at paiker (Table 11, Figure 7). Among the fish land centers, more than 90% fishermen selling their fish in arat except Karimganj (81%), Tarail (85%) and Chouganga (83.75%). The highest 19% fishermen selling their harvested fish in paiker at Karimganj and lowest in Nikli (0%) (Table 11). It is seen from the findings that average 617 kg and 7739 kg fish is sold by fishermen in each arat and fish landing center every day in fishing season respectively. The highest 1013 kg fish are sold at arat per day in Nikli and lowest 330 kg in Chouganga. The highest 26978 kg fish are sold at fish landing center per dat by fishermen in Chamta ghat and lowest 2630 kg in Karimganj. There is no published record or study report that showed the status of arat in Kishoreganj haor area. Therefore it was not possible to compare the present findings with any dependable previous sources.

Table 11. Status of arat.

Name of FLC	No. of arat in FLC	Area of FLC (dec.)	No. of fisherman selling fish		Selling fish by fisherman (%)		Amount of fish selling by fisherman (kg) (In hundred)	
			Arat/day	FLC/day	In arat	In paiker	Arat/day	FLC/day
Dhuldiya	11	26.4 ± 1.57	96 ± 37	220 ± 37	93 ± 3.74	7 ± 3.74	10 ± 2.42	44.0 ± 6
Chamta ghat	51	55 ± 1.44	43 ± 8	1148 ± 232	95.56 ± 4.44	4.44 ± 4.44	6.22 ± 2.44	269.78 ± 127.95
Karimgonj	7	44 ± 4	70 ± 25	173 ± 47	81 ± 6.40	19 ± 6.40	4.75 ± 1.45	26.30 ± 7.10
Morichkhali	12	24.78 ± 5.37	226 ± 11	431 ± 35	98.44 ± 0.29	1.33 ± 0.33	5.05 ± .92	9.44 ± 2.31
Tarial	25	29.13 ± 3.29	8 ± 1	149 ± 27	85 ± 8.02	15 ± 8.02	5.71 ± 2.87	114.64 ± 57.36
Kargaon	12	11 ± 0.87	226 ± 11	431± 35	93.33 ± 3.33	5.83 ± 3.27	4.29 ± .62.72	42.67 ± 6.64
Rodar poddar	11	40 ± 4.18	8 ± 1	149 ± 27	97 ± 2	3 ± 2	3.33 ± .87	29.14 ± 6.95
Kotiyadi	10	122 ± 33.41	76 ± 47	659 ± 241	92 ± 5.83	8 ± 5.83	8.90 ± 2.26	90.4 ± 25.37
Chouganga	42	33.75 ± 4.73	63 ± 17	368 ± 79	83.75 ± 5.54	16.25 ± 5.54	3.30 ± .92	92.5 ± 38.97
Nikli	6	25 ± 8.42	67 ± 45	377 ± 136	100 ± 0	0 ± 0	10.13 ± 6.71	55 ± 15.55
In total	**19±5**	**41.11 ± 9.77**	**88 ± 25**	**410 ± 97**	**92.01 ± 2.07**	**7.99 ± 2.08**	**6.17 ± .82**	**77.39 ± 23.85**

Figure 7. Status of selling fish in arat and paiker by fishermen in Kishoreganj *haor*.

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4. Conclusions

Kishoreganj haor is one of the richest sources of captured fish in Bangladesh. As understood by the study, a wide variety of fishes are available in this water body. Thousands of people are directly or indirectly depended on this water body for their livelihood. Kishoreganj *haor* fishes are transported to the capital and other metropolitan cities. Through this study, the species diversity, catch composition, production season, landing pattern, handling and quality conditions and transportation of Kishoreganj *haor* fishes have been understood. Further studies are required to explore detailed information on species biodiversity, vulnerability in landing due to overfishing fisheries, value chain analysis and improvement, etc.

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Conflict of interest

None to declare.

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