Exploration of fishing gear and fisheries diversity of Agunmukha River at Galachipa Upazila in Patuakhali District of Bangladesh

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Abstract

Agunmukha River is an important water body having plentiful aquatic resources. The fisheries communities in the river are familiar with a diverse range of fishing gear and crafts to catch fish. Therefore, the objectives of the present study were to explore fishing gear and fishing crafts, catch composition of the respective gearand identification of fish biodiversity of Agunmukha River. A step wise validated questionnaire was used for data recording from February 2015 to August 2015. In total, 19 types of fishing gear were identified under 9 major categories. On the other hand, in view of fisheries biodiversity, 47 fish species were listed covering 28 families of which Cyprinidae was found as the most dominant family which contains 9 species under 7 genera followed by Bagridae having 5 species belonging to 3 genera and Engraulidae also containing 3 species under 3 different genera. The study described 7 vulnerable, 5 endangered and 2 critically endangered species out of 42 finfish species. Diversity indexes were calculated for the present finding of which Margalef's index (d) was 5.13 for species available in the study area. Due to unawareness and indiscriminate fish caught with a small mesh size net, diversity of fish species in the river is under threat. Thus, public awareness and adequate knowledge on use of appropriate fishing gear with appropriate mesh size could contribute to sustainable fisheries diversity in the river and the improvement in livelihood of the fishermen in the adjacent area.

Keywords: Fish biodiversity, Fishing gears, Fishing crafts, Agunmukha River, Bangladesh.

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Introduction

Bangladesh is a land of rivers and the rivers are markedas the physiography of the nation. About 700 rivers including tributaries flow through the country constituting a waterway of a total length of around 22,155 km which bears a huge potential for the fisheries sector (DoF, 2015). Thus the country is rich in fish and other aquatic biodiversity. So, fishing is a widespread practice for the pastoral community to sustain their sources of revenue and to fulfill their nutrition demand. Due to the heavy demand on freshwaters fishes, different types of illegal, restricted and small mesh size gears were placed on different rivers throughout the last decade which caused indiscriminate killing of all aquatic species. Besides, the extensive irrigation designs for agricultural fields and arbitrary use of agrochemicals are changing the feeding, nursery and breeding grounds of many indigenous and commercial important fish species. Discharge of pollutants into water bodies from industries and over-fishing are highly responsible for the destruction of fish species throughout the country. As a consequence, many fish species have become listed as vulnerable, endangered and critically endangered. However, a total of 54 fish species have already been declared as threatened of which 12 are critically endangered, 28 endangered and 14 are vulnerable by IUCN (IUCN Bangladesh, 2000).

Almost all the rivers of Bangladesh originate from the Himalayas and flow into the Bay of Bengal. Galachipa upazila in Patuakhali district of Bangladeshis close to the Bay of Bengal south-west part and its center lies between 21°48' and 22°21'N latitudes and between 90°15' and 90°37'E longitudes (Banglapedia, 2014). Agunmukha River is one of the vital rivers of Galachipa upazila as an important fisheries resource. The river is situated at the side of Panpatty Union which is the meeting-point of several different rivers. There is a sluice-gate of 15 doors at Panpatty border making it a very special place in the rainy season and it is known as "Beauty with Danger" (Invitetobd, 2011).

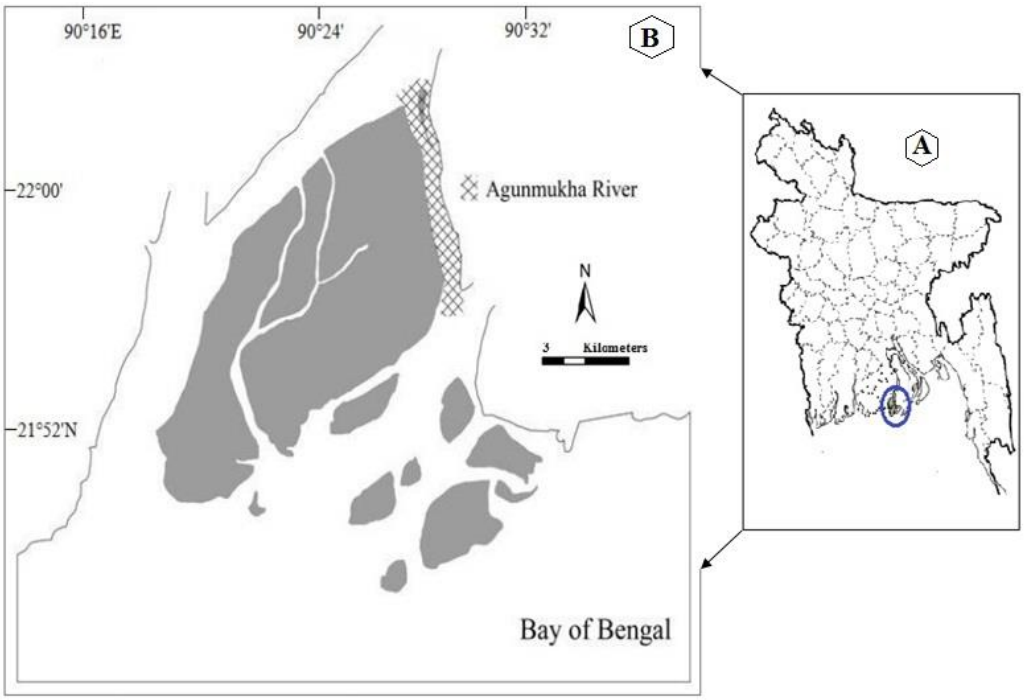
Several scientific investigations have been conducted on various aspects of fishing gear, fishing crafts, catch composition of gear, fish diversity, occurrence and conservation status of available fishes in numerous rivers of Bangladesh specifically: Rahman *et al.* (2015) in the Rabnabad channel, Islam *et al.*(2015) in the Payra River, Rubel *et al.* (2014) in the Lohalia River, Mohsin *et al.* (2014) in the Andharmanik River, Chaki *et al.* (2014) in the Atrai River, Flowra *et al*. (2013) in the Baral River, Khan *et al.* (2013) in the Tista River, Galib *et al.*(2013) in the Choto Jamuna River, Siddiqu *et al.* (2013) in the Meghna River estuary, Chakravartty and Subrata Sharma (2013) in the Assam, Siddiq *et al.* (2013) in the Dogger Beel, Rahman *et al*. (2012) in the Padma distributary of the Ganges River, Hossain *et al*. (2012) in the Meghna River, Chowdhury *et al*.

(2011) in the Naaf River, Miah *et al*. (2010) in the Shitalakshya River, Chakraborti and Mirza (2010) in the Someswari River, Mohsin and Haque (2009) in the Mahananda River, Boseto *et al.* (2007) in the Choiseul Island and Solomon Islands. However, there no scientific management based investigation was conducted on fishing gear, fishing crafts and fisheries diversity in the Agunmukha River due to its remote geographical location. Therefore, it would be worth to conduct scientific investigation on available fishing gear, fishing crafts, catch composition of different gear and diversity of fishes in the river. Considering all the current issues, the objectives of the study were to identify fishing gear including their mesh size, market price, catch composition of different gear used, fishing crafts and the fisheries diversity in the Agunmukha River of Patuakhali district, Bangladesh.

Materials and method

Study area

The present study was carried out in the Agunmukha River adjacent to the Galachipa upzila under Patuakhali district of Bangladesh (Fig. 1). Its center lies between 22.0667°N latitude and 90.4333°E longitude. The study area was surveyed for a period of 7 (seven) months mainly from February 2015 to August 2015.



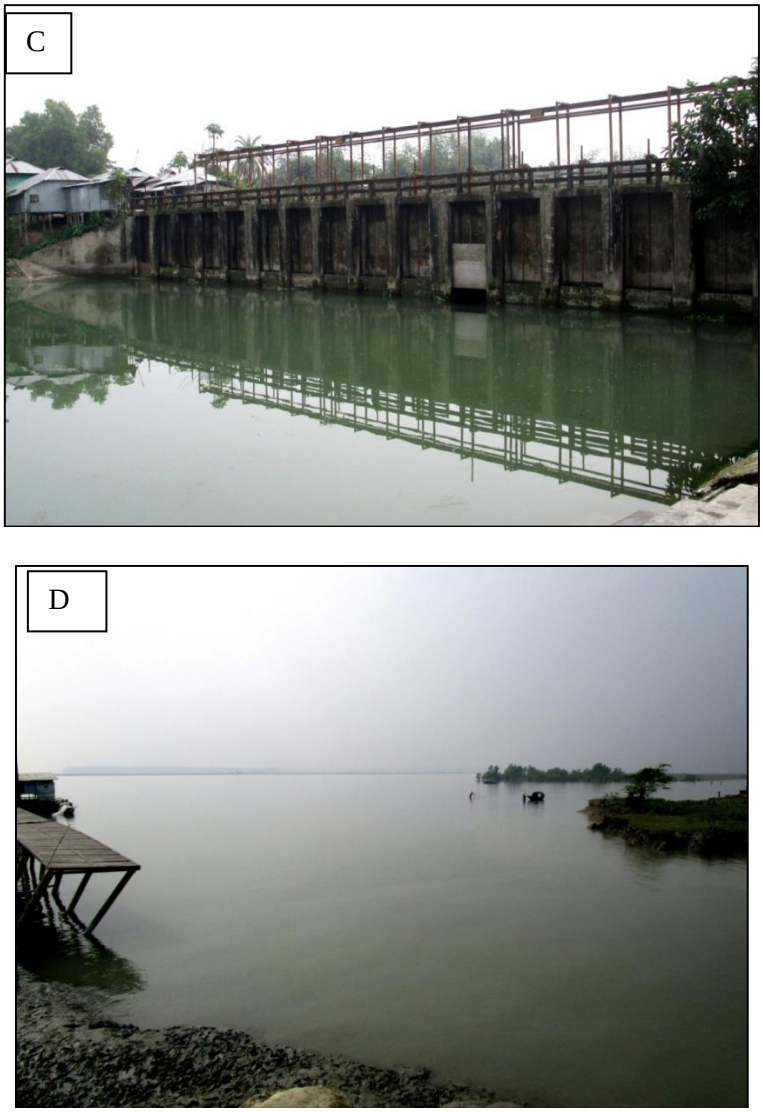


Figure 1: Location of study area; (A) map of Bangladesh, (B) geographical position of Agunmukha River, (C) sluice-gate on the river and (D) a representative part of Agunmukha River.

Data collection

A step wise prepared questionnaire was followed monthly by the researchers themselves to collect data for accuracy of information. The data was collected based on the availability of fish species, fishing gear and fishing crafts used by fishermen in the Agunmukha River. Recorded fishing gear was categorized followed by Ahmed (1971). Freshly caught unsorted samples were weighted by digital balance and pan balance to know the catch composition of different gear and expressed in kg.

The collected specimens of different fishes were identified based on the morphometric and meristic characteristics at the species level mainly following Rahman (2005), other related books like Bhuiyan (1994), and Talwar and Jhingram (1991) were also

used for more accurate information and identification of sampled specimens.

Red list study

IUCN Red list status was based on IUCN Bangladesh (2000).

Analysis method

Diversity Indexes were calculated using following formula:

i) Shannon-Wiener Index (H) for better understanding of fish biodiversity-

$$H = -\sum[(\frac{ni}{N}) \times ln(\frac{ni}{N})]$$

ii) Pielou's evenness-

$$E = H/Hmax$$

iii) Simpson's dominance index-

$$D = \sum[\frac{ni(ni-1)}{N(N-1)}]$$

iv) Simpson's index of diversity-

$$1 - D = 1 - \sum[\frac{ni(ni-1)}{N(N-1)}]$$

v) Margalef's index-

$$d = S-1/lnN$$

Where, *ni*= number of individuals or amount (e.g. biomass) of each species (the *ith* species) and *N* = total number of individuals (or amount) for the site, S= total number of species and ln = the natural log of the number.

A tabular technique was applied for the analysis of the present findings by using simple statistical tools like averages and percentages. Processed data were transferred to a master sheet from which classified tables were prepared revealing the finding of the study. For processing and analysis purpose computer software MS Excel was used.

Results

Fishing gears

Table 1 showed different types of fishing gear including their mesh size, shape, price, major species caught and average catch composition recorded from Agunmukha River. From the results of the present survey, a total of nineteen (19) different types of fishing gear were listed under9 major groups described as Gill/Drift nets (Poa jal, Current jal, Ilish/Chandi jal, Pocket jal and Sutar jal), Seine net (Jagat ber jal), Fixed purse nets (Behundi jal and Badha jal), Cast nets (Jhaki jal and Bachari jal), Lift nets/Dip nets (Dharma jal), Drag/Push nets (Moia jal and Thela jal), Traps (Pangus Chai and Anta), Hook and line (Chhara Barshi, Chingri Barshi,Cast Barshi) and Wounding gear (Koach).

On the basis of use, Ilish jal was the most dominant gear used by the fishermen constituting 17.86% followed by Current jal at 13.39%. The result revealed that gillnets/driftnets were the highest constituents for use by the fishermen. The fishermen in the area of Agunmukha River also used Jagat ber jal, Poa jal, Trap, Pocket jal, Sutar jal, Barshi, Bachari jal and Wounding gear at the rate of 9.82%, 8.93%, 6.25%, 6.14%, 6.14%, 3.41%, 2.68% and 1.05%, respectively. Another 4 types of gears *viz.,* Moia jal, Behundi jal, Badha jal and Jhaki jal were used similarly by the fishermen comprising 5.36% of each. The lowest used gear observed were Dharma jal and Thela jal at same percentage of 1.79% (Fig.3).

Table 1: Illustration of fishing gear with their mesh size, shape, price, major species caught and average catch composition recorded from the Agunmukha river.

Gear types	Local name	Mesh size (Cm)	Shape of nets	Price of net ($)	Major species caught	CC/day/ Gear (Kg)
Gill/Drift nets	Poa jal	3-5	RS	127.84	*Otolithoides pama, Setipinna phasa, Thryssa purava,Labeo bata*	12
	Current jal	6	RS	447.43-1022.7	*Tenualosa ilisha, Glossogobius giuris, Pangasius pangasius, Sperata aor, Otolithoides pama, Thryssa purava, Ompok pabda, Labeo rohita, Rohtee cotio*	20
	Ilish/ Chandi jal	10	RS	447.43	*Tenualosa ilisha, Otolithoides pama, Setipinna phasa*	20
	Pocket jal	7.5	RS	255.67-767.02	*Tenualosa ilisha, Otolithoides pama*	13
	Sutar jal	6	RS	++	*Tenualosa ilisha, Otolithoides pama*	15
Seine net	Jagat ber jal	0.5-1	RS	255.67	*Chitala chitala, Lates calcarifer,Glossogobius giuris, Silonia silondia, Colisa fasciata, Gudusia chapra,Taenioides cirratus,Macrobrachium* sp.,*Puntius* sp., *Xenentodon cancila*	12
Fixed purse nets	Behundi jal	0.5-1	CS	102.27-319.59	*Otolithoides pama, Labeo bata, Anabas testudineus,Lates calcarifer, Pseudapocryptes elongatus,Macrobrachium* sp.,*Salmostoma bacaila, Gudusia chapra*	5
	Badha jal	0.5-1	RS	127.84-319.59	*Macrobrachium* sp.,*Mystus* sp., *Nandus nandus*	10
Cast nets	Jhaki jal	0.5-1	CS	38.35-51.13	*Anabas testudineus, Sperata aor, Mystus vittatus, Puntius* sp., *Macrobrachium* sp.,	1
	Bachari jal	2.5	CS	25.57-51.13	*Macrobrachium* sp., *Scylla serrata,Chitala chitala*	2
Lift nets/ Dip nets	Dharma jal	0.5-1	SS	15.34-25.57	*Macrobrachium* sp.,*Glossogobius giuris,Puntius* sp., *Mastacembelusarmatus*	2
Drag/ push nets	Moia jal	0.5	RS	12.78	*Macrobrachium* sp.,*Taenioides cirratus, Puntius* sp., *Gudusia, chapra,Pseudapocryptes elongates*,	3
	Thela jal	0.5-1	TS	6.39	*Macrobrachium* sp.,*Colisa fasciata, Chanda nama*	1
Traps	Pangus chai	MO: 20 cm	DS	6.39	*Pangasius pangasius,Monopterus cuchia*	3
	Anta	MO: 2.5 Cm	RS	3.84	*Anabas testudineus, Otolithoides pama, Puntius* sp.	1
	Chhara Barshi	-	-	2.56-6.39	*Otolithoides pama, Channa* sp., *Anabas testudineus, Lates calcarifer*,	1
Hook and line	Chingri Barshi	-	-	2.56	*Macrobrachium* sp., *Puntius* sp.	0.5
	Cast Barshi	-	-	5.11	*Lates calcarifer, Chitala chitala, Channa* sp.	1
Wounding gears	Koach	-	-	1.92	*Macrobrachium* sp., *Channa* sp.	1

Jal= Fishing Net, MO= Mouth Opening, RS= Rectangular Shape, SS= Square Shape, CS= Conical Shape, DS= Drum-Shape, TS= Triangular shaped, ++= Government Approved, CC= Catch Composition


1


2


3


4

Figure 2: Some fishing gear (1. Jhaki jal, 2. Moia jal, 3. Sutar jal,4. Current jal and 5. Pangus chai) found in the Agunmukha River, 2015.

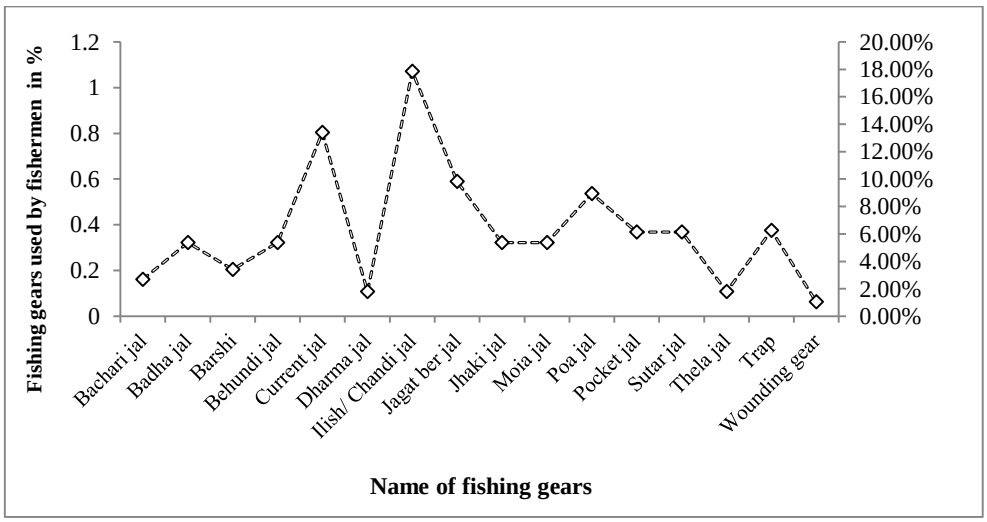


Figure3: Gears used by fishermen (percentage) in the Agunmukha River, 2015.

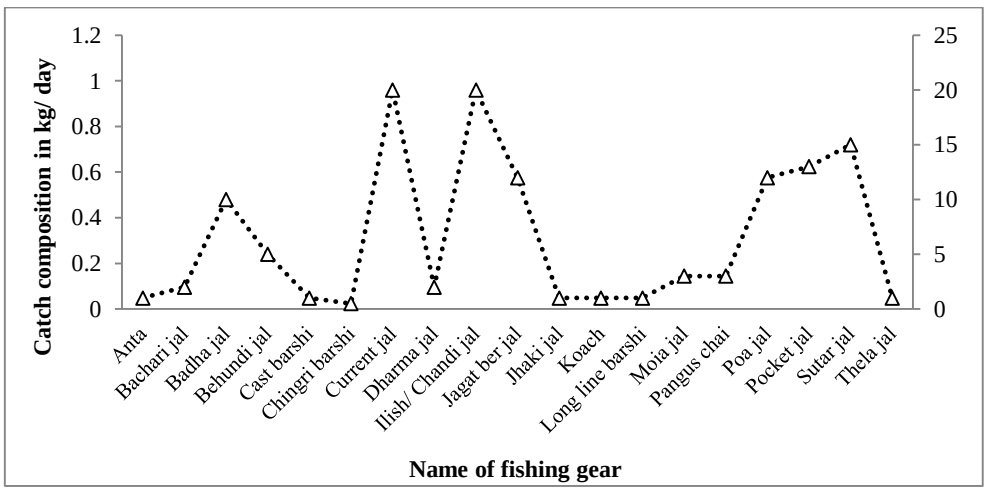


Figure4: Catch composition (kg/day) of different fishing gear in the Agunmukha River, 2015.

Maximum (10 cm) and minimum (0.5 cm) mesh size was found in case of Ilish jal and Moia jal under the group of gill/drift net and drag/push net, respectively.

The highest price was observed for Current jal (447.43-1022.7 $) followed by Ilish jal (447.43 $) and the lowest price were for Koach (1.92 $).

The highest catch composition found for both Current jal and Ilish jal was 20 kg/day. The catch composition of Sutar jal, Pocket jal, Poa jal, Jagat ber jal, Badha jal and Behundi jal was 15 kg/day, 13 kg/day, 12 kg/day, 12 kg/day, 10 kg/day and 5 kg/day, respectively which was lower than that ofgillnet/drift net and higher than any other gear used in the Agunmukha River. The lower catch composition was observed for Moia jal and Pangus chai (3 kg/day), Bachari jal and Dharma jal (2 kg/day), Jhaki jal, Thela jal, ChharaBarshi, Cast Barshi and Koach (1 kg/day for each) and Chingri Barshi (0.5 kg/day).

Fishing crafts

A total of three types of fishing crafts were documented from the study area namely fishing trawler, Dingi nouka and Vhela (raft)shown in Table 2.

Fisheries diversity

A total of 47 species (42 from finfish and 5 from shellfish) were recorded covering 28 families (Tables 3 and 4).

Table 2: List of fishing crafts with size, construction materials, durability and major used in the Agunmukha River, 2015.

Name of the Crafts	Size	Construction materials	Durability	Purpose
Trawler	Length: 15-40m, Breath: 12-15m.	Wood of breadfruit, crape myrtle, white teak, rock dammar, looking glass mangrove and bamboo etc. are used.	5-7years	To handle Behundi jal, Gill net and Seine net etc.
Dingi nauka	Length: 3 to 7m, Breadth: 2 to4m.	Mainly native tress like big leaf mahogany, rain tree,blackberry etc.	3-4 years	Jhaki jal, Moiya jal, Poa jal, Dharma jal, Pangus chai, Anta, Cast Barshi, Chai, Hooks and lines etc.
Vhela (raft)	Length: 3-5m, Breadth: 0.7-1.2m, Height: 0.2- 0.4m.	Banana trees, bamboo splits.	2-6 months	To operate Chingri barshi, Cast barshi, Koach, Long line, Trap, Jhaki jal, Dharma jal etc.

Table 3: Systematic position of finfish specieswith their English common name, habitat, life pattern and IUCN red list status recorded from Agunmukha River, 2015.

Order	Family	Scientific name	Common English name	Habitat	Life pattern	IUCN red list status (2000)
Beloniformes	Belonidae	*Xenentodon cancila* (Hamilton, 1822)	Freshwater garfish	MW, FW, BW	Amphidromous	NO
Clupeiformes	Clupeidae	*Tenualosa ilisha* (Hamilton, 1822)	Hilsa shad	MW, FW, BW	Anadromous	NA
		Gudusia chapra (Hamilton, 1822)	Indian river shad	FW, BW	Potamodromous	NO
		Setipinna phasa (Hamilton, 1822)	Gangetic hairfin anchovy	FW, BW	Amphidromous	NO
	Engraulidae	*Thryssa purava* (Hamilton, 1822)	Oblique-jaw thryssa	MW, BW	Oceanodromous	NO
		Coilia dussumieri (Valenciennes, 1848)	Pointed tail anchovy	MW, FW, BW	Amphidromous	NA
	Pristigasteridae	*Ilisha filigera* (Valenciennes, 1847)	Coromandel ilisha	MW, FW, BW	Anadromous	NT
Cypriniformes	Cobitidae	*Lepidocephalus guntea* (Hamilton, 1822)	Guntea loach	FW, BW	Potamodromous	NO
	Cyprinidae	*Puntius sophore* (Hamilton, 1822)	Pool Barb	FW, BW	Amphidromous	NO
		Puntius ticto (Hamilton, 1822)	Ticto barb	FW, BW	Potamodromous	VU
		Puntius chola (Hamilton, 1822)	Swamp barb	FW	Potamodromous	NO
		Salmostoma bacaila (Hamilton, 1822)	Large razorbelly minnow	FW, BW	Potamodromous	NO
		Labeo bata (Hamilton, 1822)	Bata	FW	Potamodromous	EN
		Labeo rohita (Hamilton, 1822)	Rohu	FW, BW	Potamodromous	NO
		Gibelion catla (Hamilton, 1822)	Catla	FW, BW	Potamodromous	NO
		Rohtee cotio (Hamilton, 1822)	Cotio	FW	-	EN
		Amblypharyngodon microlepis (Bleeker, 1853)	Indian carplet	FW	-	NO
Osteoglossiformes	Notopteridae	*Chitala chitala* (Hamilton, 1822)	Clown knife fish	FW	-	EN
Perciformes	Ambassidae	*Chanda nama* (Hamilton, 1822)	Elongate glassy perchlet	FW, BW	Potamodromous	VU
	Channidae	*Channa punctatus* (Bloch, 1793)	Spotted snakehead	FW, BW	Potamodromous	NO
		Channa striatus (Bloch, 1793)	Striped Snaked	FW, BW	Potamodromous	NO
	Elotridae	*Eleotris fusca* (Forster, 1801)	Dusky sleeper	MW, FW, BW	Amphidromous	NA
	Gobiidae	*Glossogobius giuris* (Hamilton, 1822)	Tank goby	MW, FW, BW	Amphidromous	NO
		Pseudapocryptes elongatus (Cuvier, 1816)	Lanceolate goby	FW, BW	Amphidromous	NA
		Taenioides cirratus (Blyth, 1860)	Whiskered eel goby	MW, FW, BW	Amphidromous	NT
	Latidae	*Lates calcarifer* (Bloch, 1790)	Giant perch	MW, FW, BW	Catadromous	NA
	Nandidae	*Nandus nandus* (Hamilton, 1822)	Mottled nandus	FW, BW	-	VU

Table 3 continued:

Order	Family	Scientific name	Common English name	Habitat	Life pattern	IUCN red list status (2000)
	Osphronemidae	*Colisa fasciata* (Bloch and Schneider, 1801)	Banded gourami	FW	-	NO
	Sciaenidae	*Otolithoides pama* (Hamilton, 1822)	Pama croaker	MW, FW, BW	Amphidromous	NA
	Anabantidae	*Anabas testudineus* (Bloch, 1792)	Climbing perch	FW, BW	Potamodromous	NO
		Mystus vittatus (Bloch, 1794)	Striped river catfish	FW, BW	-	NO
		Mystus cavasius (Hamilton, 1822)	Gangetic mystus	FW, BW	Amphidromous	VU
	Bagridae	*Mystus tengana* (Hamilton, 1822)	Tengara catfish	FW	Potamodromous	NO
		Sperata aor (Hamilton, 1822)	Long-whiskered catfish	FW	Potamodromous	VU
Siluriformes		*Rita rita* (Hamilton, 1822)	Rita	FW, BW	Potamodromous	CR
	Heteropneustidae	*Heteropneustes fossilis* (Bloch, 1794)	Stinging catfish	FW, BW	-	NO
	Pangasiidae	*Pangasius pangasius* (Hamilton, 1822)	Yellowtail catfish	FW, BW	Potamodromous	CR
	Schilbeidae	*Silonia silondia* (Hamilton, 1822)	Silond catfish	FW, BW	Amphidromous	EN
	Siluridae	*Ompok pabda* (Hamilton, 1822)	Pabdah catfish	FW	Potamodromous	EN
Synbranchiforme	Mastacembelidae	*Mastacembelus armatus* (Lacepède, 1800)	Zig-zag eel track eel	FW, BW	Potamodromous	VU
	Synbranchidae	*Monopterus cuchia* (Hamilton, 1822)	Swamp eel	FW, BW	-	VU
Tetraodontiforme s	Notopteridae	*Chitala chitala* (Hamilton, 1822)	Clown knife fish	FW	-	EN

Anadromous fish are born in freshwater, and then migrate to the ocean as juveniles where they grow into adults before migrating back into freshwater to spawn. **Catadromous** fish are born in saltwater, then migrate into freshwater as juveniles where they grow into adults before migrating back into the ocean to spawn. **Amphidromous** fish are born in freshwater/estuaries and then drift into the ocean as larvae before migrating back into freshwater to grow into adults and spawn. **Potamodromous** fish are born in upstream freshwater habitats, then migrate downstream (still in freshwater) as juveniles to grow into adults before migrating back upstream to spawn. **Oceanodromous**fish are born near spawning grounds, then drift on ocean currents as larvae before settling as juveniles to grow into adults before migrating back to spawning grounds.
MW=Marine Water, FW=Fresh Water, BW=Brackish Water, CR=Critically Endangered, EN=Endangered, VU=Vulnerable, NT=Near Threaten, NO=Not Threatened, NA=Not Assessed.

Table 4: Systematic position of shellfish species with their common English name and habitat recorded from Agunmukha River, 2015.

Order	Family	Scientific Name	Common English Name	Habitat
Decapoda	Portunidae	*Scylla serrata* (Forsskål, 1775)	Mud crab	FW, BW
	Penaeidae	*Metapenaeus monoceros* (Fabricius, 1798)	Speckled shrimp	MW, FW, BW
	Palaemonidae	*Macrobrachium rosenbergii* (De Man, 1879)	Giant river prawn	FW
Palaemonidae		*Macrobrachium malcolmsonii* (H. Milne Edwards, 1844)	Monsoon river prawn	FW
	Decapoda	*Macrobrachium lanchesteri* (De Man, 1911)	Riceland prawn	FW

MW= Marine Water, FW= Fresh Water, BW= Brackish Water

Table 5: Diversity Indexes of different fish groups in Agunmukha River, 2015.

Fish Groups	Species number	Specimens number	(H)	(E)	(D)	(1-D)	(d)
Herrings	6	913	1.78	0.91	0.17	0.83	
Catfishes	9	1336	2.17	0.85	0.11	0.89	
Perches	10	1936	2.17	0.72	0.10	0.90	
Snakeheads	2	306	0.69	0.99	0.50	0.50	
Carps	9	1699	2.04	0.58	0.15	0.85	
Needle Fishes, Featherbacks, Loaches and Puffer fishes	4	469	1.33	0.90	0.33	0.67	5.13
Eels	2	244	0.68	0.92	0.52	0.48	
Others	5	901	1.58	0.91	0.21	0.79	
Total	47	7804					

Among the different families Cyprinidae was found as most dominant having 9 species under 7 genera followed by Bagridae (5 species belongs to 3 genera), Engraulidae (3 species having 3 genera), Gobiidae (3 species under 3 different genera), Clupeidae (2 species in 2 different genera), Channidae (2 species under single genus), Decapoda (2 species belonging to a single genus) and the rest of families (Ambassidae, Anabantidae, Belonidae, Cobitidae, Elotridae, Engraulidae, Heteropneustidae, Latidae, Mastacembelidae, Nandidae, Notopteridae, Osphronemidae, Pangasiidae, Pristigasteridae, Schilbeidae, Sciaenidae, Siluridae, Synbranchidae, Teraodontidae, Palaemonidae, Penaeidae and Portunidae) constitutea single species under a single genus (for each).

The present finding suggested that Clupeiformes fishes are mostly marine water habitat but Siluriformes and Cypriniformes prefer fresh water. In addition, most of shellfish are found in freshwater habitat.

Among 42 species of fin fishes vulnerable, endangered, critically endangered and near threaten were 7, 5, 2 and 2, respectively.

Diversity indexes

Different fish group wise values of Shannon- Weiner index (H), Pielou's evenness (E), Simpson's dominance index (D), Simpson's index of diversity (1-D) and Margalef's index (d) was shown in Table 5.

Shannon-Weiner index (H) was found highest (2.17) for catfishes and perches but lowest (0.68) for eels (Fig.5). Pielou's evenness (E) was the maximum (0.99) in the case of needle fishes, feather backs, loaches and puffer fishes and minimum (0.58) for carp species. The highest occurrence of Simpson's dominance index (D) was 0.52 for eels and lowest (0.10) for perches. In the study area, greatest (0.90) 1-D was found for perches and minor (0.48) in case of eels (Fig. 6). Margalef's index (d) was recorded as 5.13 for all fish population available in the study area.

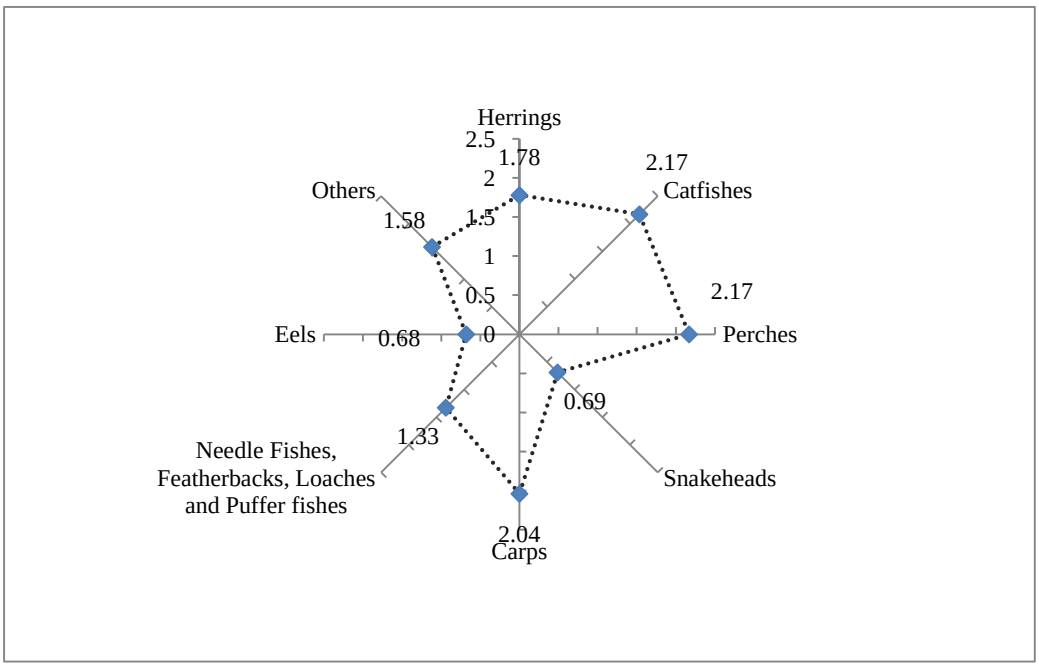


Figure5: Shannon-Weiner index for different fish groups in Agunmukha River, 2015.

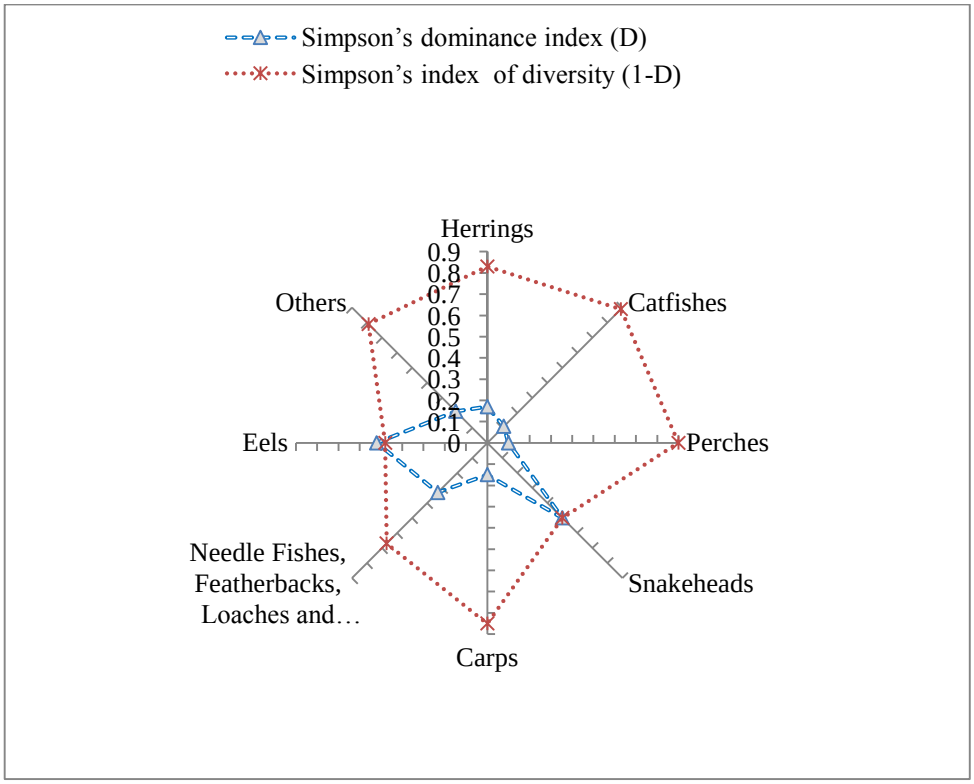


Figure 6: Relationship between (D) and (1-D) of different fish groups in Agunmukha River, 2015.

Discussion

Generally fishing gear is that equipment which is mainly used for capturing of aquatic organisms especially fishes. This maiden study on Agunmukha River recorded a total of 19 different types of fishing gear under 9 major groups of gear. No previously conducted experiment of fishing gear of the river was available and thus comparison of the present findings with previous ones was not possible. However, 8 major types of fishing gear including Gill net, Seine net, Set bag net, Lift net, Cast net, Push net, Trap and Hook and line were detected in the Ramnabad River (Ali *et al.*, 2015). Furthermore, a total of six types of fishing nets such as Moshari ber jal/Ladi jal, Dur jal/Bindi jal, Veshal jal, Khora jal/Khoda jal, Current jal and Moiya jal were recorded from Shitalakshya River (Miah *et al.*, 2010), Rubel *et al*. (2014) identified 8 types of nets as Behundi jal, Jhaki jal, Ber jal, Moia jal, Thella jal, Current jal, Tana jal and Sain jal and 2 types of traps as Chai and Borshi in the Lohalia River, Khan*et al.* (2013) recorded total 7 gear namely Current jal, Cast net, Jhayetjal, Thela jal, Dharma jal, Borshi and Long line in the Tista River, Siddiq*et al.* (2013) identified 5 types of nets (Current jal, Ber jal,Thela jal, Jakhi jal and Dharma jal), 3 traps (Unta chai, Bittechai and Icha chai), 2 hooks (Chip borshi and Chara borshi), 2 spears (Teta without hooks and Teta with hooks) from Dogger beel.

Fishermen engaged in fishing by using different gearare shown in Fig. 3. Most of the fishermen exploitedfish by Ilish jal and Current jal due to the availability of Ilish fish all the year round as well as with the highest catch composition. Ali *et al.* (2015) also found the highest use for Seine net and Gill net comprising 60% and 20%, respectively and the lower uses were found for Lift net (0.6%), Cast net (1.2%), Push net (1.8%) and Trap (0.6%) from Ramnabad River which support similar results obtained from the present study.

Among the 9 different groups of fishing gear, Drift/Gill net, Seine net and Fixed purse net were larger in size, and mesh size, and higher in price and catch composition than other gear identified in the research area. Mesh size of the gear fluctuated depending on target fish species. But a ready to use fishing gear price varied depending on size of the net, water body, season and the personnel engaged to operate the gear. The maximum size and price of Current net and Ilish net was correlated with the maximum catch composition (20 kg/day). The result suggested that Gill net/ Drift net, Seine net and Purse net are considered for commercial fishing and Cast net, Lift net, Drag/Push net, fish trap and Wounding gear are considered foreconomic/ subsistence fishing. The results obtained from this study supported the findings of Siddiqu *et al.* (2013) who found mesh size 2.2 to 3.5 cm for Punti jal, 4 to 4.5 cm for Ilish net, 3.5 cm for Poa jal, 0.5 to 2.3 cm for Jagat ber jal, 0.5 to 1.25 cm for Behundi jal, 0.625 to

1.25 cm for Jhaki jal and 0.5 to 2 cm for Dharma jal in the Meghna River estuary. Siddiqu *et al.*, (2013) also reported construction cost of different nets such as 6.39 to 63.92$ for Punti jal, 3835.11 to 5113.48$ for Ilish jal, 63.92 to 1278.37 $ for Poa jal, 2556.74 to 3835.11$ for Jagat ber jal, 2556.74$ for Behundi jal, 63.92 to 127.84$ for Jhaki jal and 63.92 to 639.19$ for Dharma jal in the Meghna River estuary.

Catch composition (kg/day) of different fishing gear in the Agunmukha River are presented in Fig.4. The result revealed the lower catch composition influenced lower uses of those respective fishing gear by the fishermen (Fig.3). On the other hand, maximum uses of Gill net/ Drift net (Current jal and Ilish jal) were correlated with the maximum catch composition of the net. Sayeed *et al.* (2014) alsoobserved the mean CPUE from Gillnet, Jhakijal, Seine net, Thela jal, Lift net, Traps, Wounding gear, Moijal, Hook and line and Sutijal as 2.83±0.92, 2.05±0.81, 48.99±12.34, 2.60±1.56, 2.66±1.46, 4.69±2.11, 1.83±1.07, 3.03±1.76, 3.11±1.76 and 224.54±126.89 kg, respectively in the Chalan beel.

In total three types of fishing crafts werere cognized used for operating different fishing gear in the Agunmukha River of which trawler is a mechanical vessel and is used for commercial purposes. The fishing trawler found has a length of 15-40m and breath 12-15m. Different native trees were used to prepare these trawlers, having durability about 5-7 years. Numerous nets like gill nets, and seine nets are operated by this craft (Table 2). Another fishing craft is Dingi nauka, a commonly used craft witha smaller size hull and bottom. The bottom is curved like structure rather than flat. The deck is generally made of splinted bamboo, wooden plank or splinted betel nut trees. A large number of fishing gear like Current jal, Poa jal, Sutar jal etc.is operated by using this craft. The last but important craft is Raft(locally called Vhela), made by banana tree or of a wooden floating log, bamboo etc. It is usually 2-4m wide and about 3-8m long driven by a bamboo made log. Eight to ten banana trees are used to prepare a raft in which bamboo splits are used to join them together. The front portion of the craft is pointed so that it can move easily. A long bamboo pole (locally called logi) is used to operate the vessel. Jhaki jal, Line fishing etc. is done by this fishing craft.

The following study depicted total 47 species (42 from finfish and 5 from shellfish) in 28 families. Similar outcomes were detected by Rahman (2000), who found a total of 47 species of fish from BSKB beel (floodplain), but a higher number of specieswas recorded by Chakraboty and Mirza (2007), at about70 species of fishes from the Gharia beel, Ehshan *et al.* (2007) reported a total of 40 species of fish including three exotic species in Chanda beel which was lower than the present findings.

Most of the fishes under the order Siluriformes were observed as vulnerable, endangered and critically endangered followed by Cypriniformes, but Rahman *et al.* (2015) identified 7 vulnerable, 7 endangered and 2 critically endangered species from Rabnabad channel. Galib *et al.* (2013) also recorded 10 vulnerable, 10endangered and 6 critically endangered species from river Choto Jamuna which was higher than that of the current study. Two species such as *Ompok pabda* and *Chitala chitala* which were marked as endangered species by the IUCN red list status of Bangladesh (2000) were found in good quantities in the Agunmukha River. These species are also decreasing in number day by day from the river due to over exploitation. Again, sluice-gate made in the Agunmukha River provides restriction of normal movement of fish species which causes breeding hamper.

Diversity indexes area mathematical measure of species diversity in a community which provides more information about community composition. The Shannon- Weiner diversity index (H) is commonly used to describe species diversity in a community. Shannon- Weiner index (H) accounts for both abundance and evenness of the species present in an area. When all species that make up a population community are equally abundant, diversity is shown as higher. The value of Evenness (E) varied between 1 and 0. The closer to 1 the more even the populations of fish that form the community. The bigger the Simpson's dominance index (D) value which usually ranges from 0 to 1, the smaller the biodiversity. The Simpson's index of diversity (1-D) value also ranges between 0 and 1, the greater the value, the greater the sample diversity. Among the diverse groups of fishes Perch was found as dominant followed by Catfish, Carp and Herrings in the Agunmukha River. The present findings were supported by Shukla ans Shing. (2013) who studied three stations in Aami River and showed Shannon-Weiner index (H) in site-1 as 0.0213 followed by site-2 (0.0088) and the lowest in site-3 (0.00422). The Simpson's dominance index (D) value as high at site-1 (.064) and site-2 (0.0280) and low at site-1 (0.0133). Simpson's index of Diversity (1-D) for site 1 was 0.936, 0.72 for Site 2, and 0.986 for Site 3. Galib *etal* (2013) also calculated diversity, richness and evenness indices as 3.717, 6.954 and 0.897, respectively from Choto Jamuna River fish populations.

In conclusion, the Agunmukha River is very important fisheries resources in the southern part of Bangladesh. The river plays a vital role for maintaining the fisheries diversity in the southern district of Bangladesh. Under the group of gill net/drift net, Current jal and Ilish jal were the most available and prominent fishing gear used by the fishermen. Among the different fishing gear, Current jal and Ilish jal could be considered as commercial fishing gear due to their maximum catch

composition and being higher in size and price. However, different smaller mesh size and non-selected fishing gear especially Current jal, Jagat ber jal and Badha jal were responsible for destroying fishing habitats in the river. As a consequence, biodiversity of the Agunmukha River is decreasing gradually. Proper initiatives should be taken into consideration for effective fisheries diversity management of the Agumukha River in the southern district of Bangladesh.

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