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## Impact of fishing gear on fish biodiversity of *Hakaluki haor* in Bangladesh

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### Abstract

The present study was conducted to investigate the impact of fishing gears on fish biodiversity of *Hakaluki haor* for a period of 12 months. A total of 15 types of fishing gears such as nets, traps, hooks and lines, wounding gear and fish aggregating devices (FADs) were observed. The highest catch per unit effort (CPUE) was found in seine net ( $38.21 \text{ kg gear}^{-1}\text{hour}^{-1}$ ) during the month of January followed by push net and lift net. The lowest CPUE was  $0.1135 \text{ kg gear}^{-1}\text{hour}^{-1}$  in traps during June to October while in hook and line CPUE was  $0.2303 \text{ kg gear}^{-1}\text{hour}^{-1}$  during June to September. Major gears such as seine net, *current jal*, hand *borshi*, *katha* fishery, *koi jal*, *khora jal*, *thela jal* and different types of traps were used by the fishermen during the month of November to April. Catch composition of fish in the *haor* were Cypriniformes (36%), Siluriformes (23%), Perciformes (20%), Synbranchiformes (5%), Osteoglossiformes (4%), Clupeiformes (3%), Beloniformes (3%) Tetraodontiformes (2%) and Crustaceans (4%). On the basis of species composition, the dominant fish species were harvested by seine net, cast net, lift net, push net, *chai*, *dori* and hand *borshi*, which was considered as non-selective gears, while *koi jal*, *current jal*, and *borshi* were found as selective gears. This study revealed that the highest biomass of fish was caught in January while the lowest was recorded in July and August. Moreover, seine net and *current jal* were found to be harmful for most of the fish species in the *Hakaluki haor*.

**Keywords:** Fishing gears, CPUE, fish biodiversity, catch composition

### 1. Introduction

Inland water bodies have been supporting rich and diversified fisheries and thus, these are critically important to the people of Bangladesh for their food security and livelihood<sup>[1]</sup>. The most significant area is the large central depression that is the *haor* area (Sylhet depression) in the Northeast region, where large amount of small indigenous species (SIS) are available<sup>[2]</sup>.

*Hakaluki haor* is the largest fresh water wetland and mother fishery in the north eastern part of Bangladesh. The *haor* is located at Barlekha and Kulaura upazila of Moulavibazar district and partly under Fenchuganj and Golapgonj upazila of Sylhet district. Area of *Hakaluki haor* is  $181.15 \text{ km}^2$ , of which  $72.46 \text{ km}^2$  (40%) is within the territory of Barlekha Upazila<sup>[3]</sup>.

*Hakaluki haor* is a critical habitat and breeding ground for fish and other aquatic species and considered as one of the four major "mother fisheries" in Bangladesh. More than 100 fish species are available in the *haor*, one third of which are listed as endangered<sup>[4]</sup>.

Unplanned, indiscriminate and destructive gears are being used by the fishers of *Hakaluki haor*. The modern gears and technologies have negatively influenced the fish biodiversity. At present no sufficient information is available on the number of fishing gears used and their influence on fish biodiversity on the wetland. Therefore, this study was planned to investigate the impact of fishing practices on fish biodiversity and assess catch composition in the *Hakaluki haor* and recommend for sustainable development both stocked fingerlings and wild population.

### 2. Materials and Methods

#### 2.1 Location and description of the study area

An intricate ecosystem *Hakaluki haor* consists of more than 238 inter-connecting *beels* or *Jalmahals*<sup>[5]</sup>.

**It** lies between latitude 24°35' N to 24°45' N and longitude 92°00' E to 92°08' E. The total area of the *haor* is approximately 18,000 ha, including the area which is completely inundated during monsoon. It is bounded by the Kushiara River as well as a part of the Sonai-Bardal River at its north, by the Fenchuganj-Kulaura Railway at the west as well as at the south, and by the Kulaura-Beanibazar Road in the east. *Hakaluki haor* spreads over two districts (Maulvibazar and Sylhet) and five Upazilas (Barlekha, Kulaura, Fenchuganj, Golapganj and Juri).

## 2.2 Experimental site and period of study

The study was conducted in three catchments areas situated in two districts from December, 2012 to November, 2013. The study sites were the Barlekha (Khataora), the Kulaura

(Shadipur) and the Fenchuganj (Gиласора) (Figure 1& 2). The *haor* is located in the villages of Khataora, Shadipur, Гиласора, Morshidabad Kora, Ahamodpur, Halla, Islampur, Shirampur and Boro Moydan. The villages mainly consisted of many small and large *beels*. Different areas of the *haor* and 3 harvesting spots were visited during the study period. The study was based on collection of primary and secondary data. Before collecting the primary data a questionnaire was developed which was pre-tested among few fishermen. During pre-testing, attention was given to any new information in the draft questionnaire in order to reach the objectives of the study. The questionnaire was finalized based on the information gathered during pre-testing of the questionnaire.

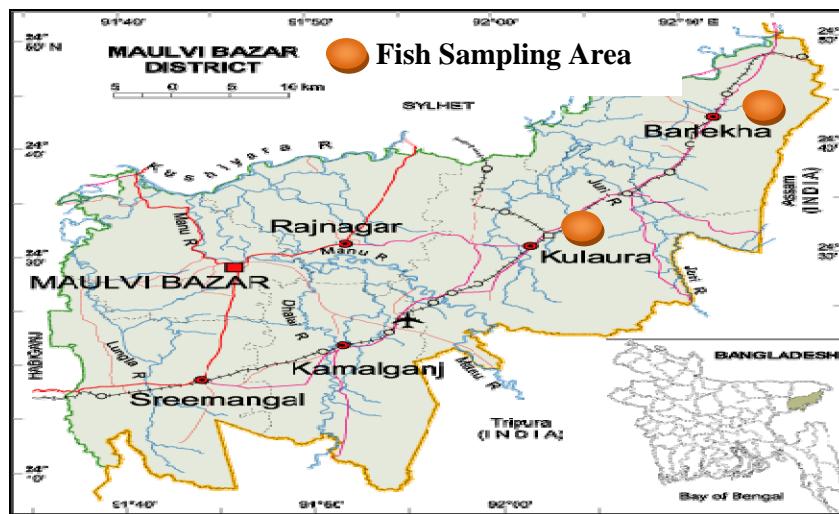


Fig 1: Location of the study area under Moulvibazar District

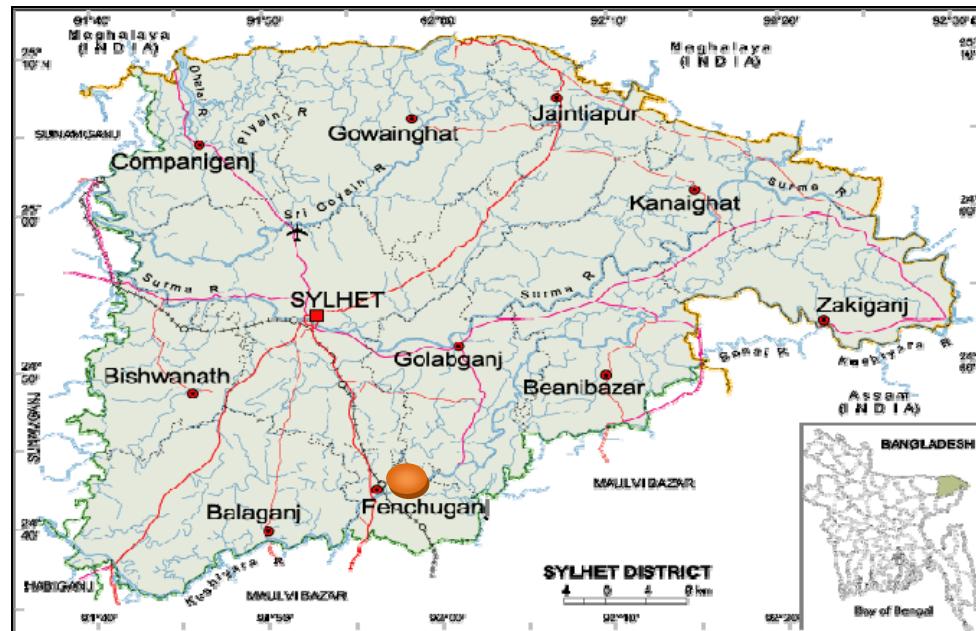


Fig 2: Location of the study area under Sylhet District

## 2.3 Survey and data collection

The types of fishing gears and the catch data were collected from fishermen at the fishing spot through sampling, interviews and Focus Group Discussions (FGDs). Catch Per

Unit Effort (CPUE) and Catch Assessment Survey (CAS) were conducted using a boat, starting from 6 am to 6 pm twice in a month, for 12 months. Each sampling was performed in the same sampling locations with three

replicates twice a month during December 2012 to November 2013. Sampling was carried out fortnightly at each sampling site. Different types of fishing gear were surveyed randomly by inspection, by interviewing fishers on each sampling day and name, number and weight of the catch were estimated to the nearest gram (g) using a single pan balance. Catch composition of each type of gear was recorded by physical examination of the total catch; however, sometime the total catch was purchased from the fishermen to study the species composition. The samples were also sorted out species wise and count number and weight of each species.

Species composition in each type of gear was analyzed to determine the species diversity. The percentage of species composition in the catch (by number) for each type of gear was calculated. The CPUE by gear types was also assessed. Data were analyzed using MS Excel 2010.

### 3. Results and Discussion

#### 3.1 Fishing gears used in the *Hakaluki Haor*

A total of 15 types of fishing gears under five major groups were found to be used by the fishermen for harvesting of fish in *Hakaluki haor* (Table 1). It has been reported that the fishermen used approximately 30 different types of fishing gears in the *Halti beel* [6], which is common phenomena of floodplain *beels* in Bangladesh. In this study, gears were classified into five major groups which are more or less similar to that reported by Saberin *et al.*, (2013) [7]. Besides these gears, fishermen were also found to catch fish by pump fishing and by hand picking.

**Table 1:** Fishing gears used in the *Hakaluki Haor*

Types of gear		
	English name	Local name
Fish net	Gill net	Koi jal Current jal Berjal
	Seine net	Mosharijal
	Lift net	Vassal/Khorajal Dharma jal
	Cast net	Jhakijal
	Dragged gear	Thelajal
	-	Chai
	-	Dori
Fish Trap	-	Kon
	-	Ronga
	-	Borshi
	-	Hand borshi
Wounding gear	-	Koach
Fiah aggregating devices (FADs)	-	Dhol

#### 3.2 Fishing effort and CPUE of different types of gears in the *Hakaluki haor*

The fishing gears efficiency using the catch per unit effort (CPUE) of the various fishing gears were recorded in this study (Table 2). The highest CPUE recorded in seine net in the Baralekha, Fenchugonj and Kulaura area were  $38.94 \text{ kg gear}^{-1} \text{ hour}^{-1}$ ,  $36.48 \text{ kg gear}^{-1} \text{ hour}^{-1}$  and  $39.20 \text{ kg gear}^{-1} \text{ hour}^{-1}$ , respectively. The CPUE of gill net were  $0.83 \text{ kg gear}^{-1} \text{ hour}^{-1}$ ,  $0.82 \text{ kg gear}^{-1} \text{ hour}^{-1}$  and  $0.80 \text{ kg gear}^{-1} \text{ hour}^{-1}$  whereas the CPUE of lift net were  $0.45 \text{ kg gear}^{-1} \text{ hour}^{-1}$ ,  $0.42 \text{ kg gear}^{-1} \text{ hour}^{-1}$ ,  $0.48 \text{ kg gear}^{-1} \text{ hour}^{-1}$  and CPUE of cast net were  $0.61 \text{ kg gear}^{-1} \text{ hour}^{-1}$ ,  $0.59 \text{ kg gear}^{-1} \text{ hour}^{-1}$ ,  $0.72 \text{ kg gear}^{-1} \text{ hour}^{-1}$  in Baralekha, Fenchugonj and Kulaura area, respectively. The CPUE of traps were  $0.11 \text{ kg gear}^{-1} \text{ hour}^{-1}$ ,  $0.10 \text{ kg gear}^{-1} \text{ hour}^{-1}$

and  $0.12 \text{ kg gear}^{-1} \text{ hour}^{-1}$  but the CPUE of hook and line were  $0.21 \text{ kg gear}^{-1} \text{ hour}^{-1}$ ,  $0.20 \text{ kg gear}^{-1} \text{ hour}^{-1}$  and  $0.26 \text{ kg gear}^{-1} \text{ hour}^{-1}$  in Baralekha, Fenchugonj and Kulaura area, respectively. The least CPUE values recorded by the hook and lines and traditional traps were  $0.21 \text{ kg gear}^{-1} \text{ hour}^{-1}$  and  $0.12 \text{ kg gear}^{-1} \text{ hour}^{-1}$ . Comparatively higher CPUE was found in seine net followed by gill net, cast net, push net, lift net, hook and line, and traps (Table 2). It has been reported that the seine net had the highest CPUE while the gill net had the second highest CPUE *Hakaluki* floodplain [8]. Similar results found in the seine net, which had the highest CPUE  $15.41 \text{ kg gear}^{-1} \text{ hour}^{-1}$  in Titas floodplain [9]. In this study, the CPUE of the gear was much higher than the Titas floodplain that indicates that the fish biodiversity as well as fish production was much higher than other parts of the country.

**Table 2:** CPUE ( $\text{kg gear}^{-1} \text{ hour}^{-1}$ ) for the different types of gear at different sites

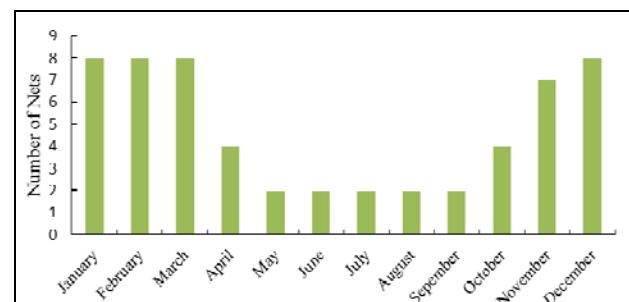
Gear type	Baralekha	Fenchugonj	Kulaura
Gill net	$0.8325 \pm 0.276$	$0.8256 \pm 0.274$	$0.8092 \pm 0.269$
Seine net	$38.941 \pm 9.743$	$36.487 \pm 8.866$	$39.2031 \pm 9.927$
Lift net	$0.4572 \pm 0.222$	$0.4228 \pm 0.190$	$0.4856 \pm 0.247$
Cast net	$0.6125 \pm 0.254$	$0.5964 \pm 0.246$	$0.7283 \pm 0.293$
Push net	$0.5089 \pm 0.323$	$0.5733 \pm 0.356$	$0.5850 \pm 0.360$
Traps	$0.1136 \pm 0.046$	$0.1023 \pm 0.042$	$0.1247 \pm 0.05$
Hook & Line	$0.2140 \pm 0.117$	$0.2098 \pm 0.111$	$0.2671 \pm 0.135$

(Mean  $\pm$  Standard deviation)

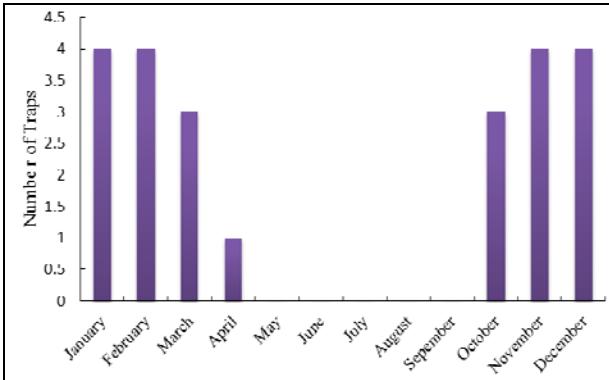
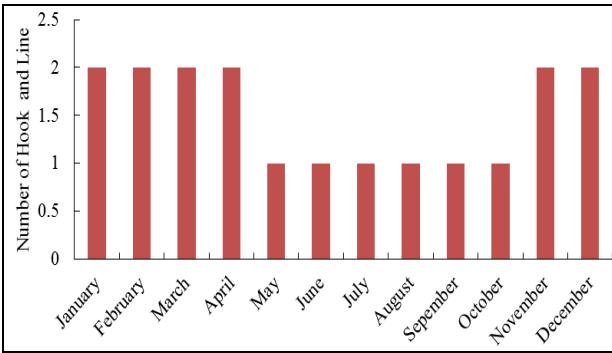
It is very alarming for fisheries resource of *Hakaluki haor* due to the highest CPUE of destructive seine net, which catches most of the SIS and juvenile of big fish (crabs & catfish). In this study, seine net contributes about 93.33% of the total CPUE and rest of the other gear is 6.67%. Our results are in agreement with those reported by Sayeed *et al.*, (2014) [10]. They reported that seine net (CPUE:  $48.99 \pm 12.34 \text{ kg gear}^{-1} \text{ hour}^{-1}$ ) is the most dominant and destructive fishing gear in *Chalan Beel* [10]. Therefore, its operation in the *haor* should be banned at any cost otherwise the *haor* will be barren in the near future.

#### 3.3 Monthly variation of different types of fishing gears used in the *Hakaluki haor*

The monthly variation of fishing gear in a floodplain fishery is dependent on the environmental cycles of monsoon and drying. The present study revealed that there is a low level of water in *Hakaluki haor* during October to April the period which may be considered dry season. At this time, the *seine net*, *current jal*, *hand borshi* and traps are mainly used. The month of July, August, September and October are rainy season and as a result the water level of the *haor* is also very high which restricted limited use of any types of gear (Figure 3, 4 & 5).



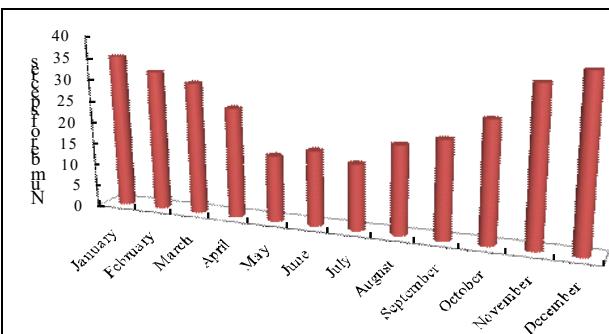
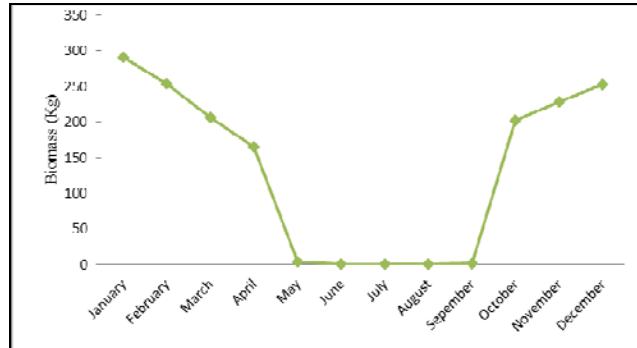
**Fig 3:** Number of nets used in different season of the year

**Fig 4:** Number of traps used different season of the year**Fig 5:** Number of hook and lines used different season of the year

During this period, only *current jal*, *khorajal*, *borshi* were mostly used. When the water level starts to increase day by day in rainy season and the river overflows inundate the surrounding areas, at that time the use of lift net, cast net, thela jal, various traps, dhol etc. decrease. At this time the wounding gears were also used in the shallow water due to the abundance of pelagic species. Wounding gears are generally not used for commercial purposes rather it is used by the subsistence fishermen.

### 3.4 Monthly variation of species abundance in the Hakaluki haor

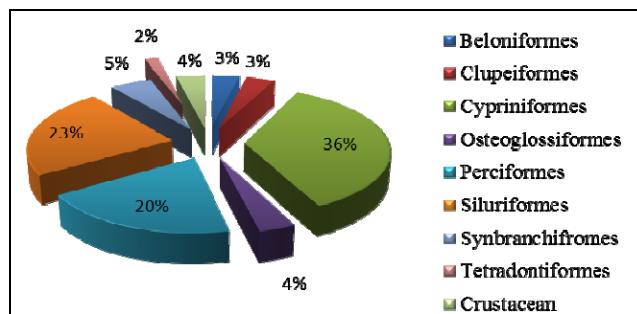
Study was also conducted on the monthly variation of species abundance in different season by different types of fishing gears used in the *Hakaluki haor*. In respect of nets, the highest catch per unit effort (CPUE) was found in January and lowest in July and August. In traps, the highest catch per unit effort (CPUE) was found in February and lowest in June to October. But in hook and line the highest and lowest catch per unit effort (CPUE) was found in December to February and June to September (Figure 6 & 7).

**Fig 6:** Monthly variation of species caught in *Hakaluki haor***Fig 7:** Monthly variation of fish biomass in the *Hakaluki haor*

This variation in CPUE happens for nets, traps and hook and line are due to the variation of water level, current and flood conditions.

### 3.5 Fish species composition in the *Hakaluki haor*

*Hakaluki haor* is important sources of fisheries resources for the country. Air, Boal, Gozar, Chela, Pabda and Chapila are the main fish species of the *Haor*. There are frequent upstream movements of fish towards the *beels* and tributaries of *Hakaluki haor* from the Kushiyara. *Beels* in *Hakaluki haor* provides the winter shelter for the mother fisheries and in early monsoon these mother fisheries produce millions of fries for the entire downstream fishing communities (Figure 8).

**Fig 8:** Catch composition of fish in the *Hakaluki haor*

From this study, it was found that Cypriniformes was the most dominant order; Siluriformes is 2<sup>nd</sup> highest next to Cypriniformes followed by Perciformes, Synbranchiformes, Osteoglossiformes, Clupeiformes and Beloniformes. Cypriniformes represented by 20 species belonging to 14 genera of 4 families; Beloniformes was represented 2 species belonging to 2 genera of 2 families; Clupeiformes contains 2 species belonging to 2 genera of 1 families; Perciformes includes 11 species belonging to 8 genera under 7 families; Siluriformes contain 13 species belonging to 10 genera under 7 families; Synbranchiformes by 3 species belonging to 2 genus of a single family. Whereas, another study also noticed that Order-wise average catch composition that found in *Hakaluki haor* were Clupeiformes (11%), Cypriniformes (54%), Perciformes (13%), Channiformes (8%), Chingri (8%) and other orders (6%) [8].

### 3.6 Decline of fishes in the *Hakaluki haor*

*Hakaluki haor* is in danger of losing nearly 32 fish species out of 107 because of over fishing by the lessee. This is a serious threat to fish stocks in the *haor*. These fishes are: *Eutropiichthys vacha* (Bacha), *Rita rita* (Rita), *Bagarius*

*bagarius* (Baghair), *Notopterus chitala* (Chitol), *Botia dario* (Bou-mach), *Osteobrama cotio* (Dhela) (Figure 9). Few causes were identified for declination of fishes in this *haor*. Among them, due to natural reasons like siltation, shrinkage of genetic base and manmade causes like water pollution as pesticide and agriculture wastage destroy the feeding, breeding and nursery ground of fishes and indiscriminate use of fishing gear. Siltation of the river probably as a serious threat that cause reduction of water flow which resulted in reduction of nursery and spawning ground. It is reported that, among 54 threatened freshwater fish species in Bangladesh, 12 are critically endangered (CR), 28 are endangered (EN) and 14 are vulnerable [11].

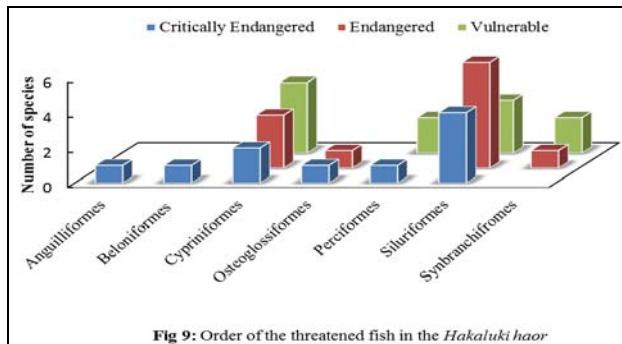


Fig 9: Order of the threatened fish in the Hakaluki haor

Fig 9: Order of the threatened fish in the Hakaluki haor

In 1994, a total of 130 native fish species reported to be existing in the open water fisheries habitats in this region [12]. Whereas, a total of 107 fish species reported to be found in the *Hakaluki haor* in a survey conducted during October 2001 to May 2002 [13]. It was recorded that a total of 152 fish species under 86 genera from January 1987 to August 2000 in the Brahmaputra river [14]. It was also stated that as much as 158 species in the river systems, in floodplains with water current as 134 and without water current as 83 species [15]. Another study found that 107 species in three *beels* in the northwest Bangladesh that is comparable with the present findings [16].

It was observed that 32 nationally threatened fish species among the 107 fish species found in the *Hakaluki haor*. Among 117 freshwater fish species, large fish species were 39; medium 26, small 42 and very small fish species were 10 in number [2]. This is a very bleak scenario for the *Hakaluki haor*- a major mother fishery of Bangladesh.

#### 4. Conclusions and Recommendations

*Hakaluki haor* is one of the largest wetland ecosystems in Bangladesh both national and international aspects. The highest number and biomass of fish appears in January and the lowest biomass of fish was recorded in the rainy season during May to September but a gradual rise was recorded during October to March. As per local fishers of *Hakaluki haor* there is a declining trend in production and abundance of biodiversity. Over harvesting of resources results in rapid depletion of productivity and biodiversity of the *haor*. Besides these, use of destructive fishing gears and dewatering of wetlands in the dry season makes the fish and other aquatic organisms vulnerable to extinction.

Suggestions put forward by the stakeholders/resource users/local elites in relation to biodiversity conservation, habitat restoration, uplift livelihoods of fishers as well as increased fish production are as follows:

- Regulation of selective fishing gears and mesh sizes;
- To enforce fish protection and conservation act for completely stopping of seine net like *kafri jal*;
- The use of FADs like *katha fishing* and fishing by dewatering should be prohibited;
- A motivation/training program should be extended to fishers to create awareness of the factors affecting the health of the fisheries and the rationale for the restrictions on a particular fishing gear in a particular season;
- Sufficient number of fish sanctuaries should be established in suitable location (minimum for 25 years);
- Control/rational use of pesticides, inorganic fertilizers and industrial effluents that can damage wildlife and habitat;
- Establishment of Community-based Organizations by local fishers (CBOs);
- Arrangement of alternating income generating activities for fishermen during ban and lean fishing period and also controlling over fishing; and
- Easy term institutional credit with low interest may be introduced for poor fishermen.

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