

*Article*

## **A comparative study on fish biodiversity with conservation measures of the Bhairabriver, Jessore, Bangladesh**

Md. Ashraful Islam<sup>1</sup>, Abdulla-Al-Asif<sup>1,2\*</sup>, Md. Abdus Samad<sup>1,3</sup>, Baadruzzoha Sarker<sup>2</sup>, Meraz Ahmed<sup>2</sup>, Abdus Satter<sup>4</sup> and Amir Hossain<sup>5</sup>

<sup>1</sup>Department of Fisheries and Marine Bioscience, Faculty of Biological Science and Technology, Jessore University of Science and Technology, Jessore, Bangladesh

<sup>2</sup>Department of Aquaculture, Faculty of Fisheries, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh

<sup>3</sup>Department of Socio-cultural Environmental Studies, Division of Environmental Studies, The University of Tokyo, Japan

<sup>4</sup>Department of Aquaculture, Sheikh Fajilatunnesa Mujib Fisheries College (Bangamata Sheikh Fajilatunnesa Mujib Science and Technology University), Jamalpur, Bangladesh

<sup>5</sup>Department of Fisheries Biology and Genetics, Faculty of Fisheries, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh

\*Corresponding author: Abdulla-Al-Asif, Department of Aquaculture, Faculty of Fisheries, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh. Phone: +8801716838294; E-mail: jessoreboyhemel@gmail.com

Received: 07 September 2017/Accepted: 26 September 2017/ Published: 28 September 2017

---

**Abstract:** The present study was concerned to assess the present status of biodiversity in the Bhairab river, Jessore with its conservation measures. The study was based on primary observations, questionnaire interviews with 50 fishers, focus group discussions with river bank community members and cross-check interviews with key informants. The study was conducted for a period four months from May to August, 2016. The objective of the study was to assess the fish biodiversity in the Bhairab river, understand the existing fishing practices of the river and to identify proper management strategies for the conservation of fish biodiversity. Results of the study revealed that three kinds of fishers were engaged in the Bhairab river namely, professional fishers; seasonal fishers and subsistence fishers. Seven types of fishing gears like seine net, gill net, cast net, push net, lift net, trap and hook and line were operated to fish by the fishers during the survey. A total of 39 species of fish were identified in the catches of the Bhairab River. There are degraded ecosystems and declining biodiversity have found during the study. According to survey, fishing pressure and over fishing were responsible for almost 38% loss and pollution and siltation caused about 27% loss of ecosystem. Around 21% and 14% loss of ecosystem were caused by urbanization and human encroachment, and the recreational activities respectively. These have been created a great impact on river ecology. As a result, the water quality is deteriorating day by day and the availability of fish species and other aquatic biodiversity is decreasing gradually. During the survey, 20 species was found at a risk of being endangered. From the survey, it was found that the overexploitation of fish was responsible for the 40% losses of biodiversity in the Bhairab River and water pollution caused 35% loss of biodiversity. Henceforth, river course change and habitat degradation resulted in 15% and 10% loss of biodiversity of the river respectively. This study was identified possible ways to achieve a rich fish biodiversity in the Bhairab River with social, economic and environmental aspects. The specific recommendations are included community based fisheries management, establishment of sanctuary, control of pollution, maintenance of fishing gears and the implementation of fish act for conservation of fish biodiversity of the Bhairab River.

**Keywords:** fish biodiversity; conservation; critically endangered species; endangered species; vulnerable; Bhairab river

---

## 1. Introduction

Bangladesh is endowed with vast water resources and it is one of the most precious natural resources. About 800 rivers including tributaries flow through the country constituting a waterway of total length around 24,140 km (Encyclopedia Britannica, 2012). There are about 4.02 million ha open water in this country which contributes a lot to the fisheries sector (DoF, 2012). According to the World Bank (1991), Bangladesh has various water resources including rivers, floodplains, ponds, beels, haors and a long coastline, diverse aquatic wealth and climate suitable for high yields and considerable increase in fish production. Fisheries make crucial contributions to the world's well-being and prosperity. In the last five decades, world fish food supply has outpaced global population growth, and today fish constitutes an important source of nutritious food and animal protein for much of the world's population (FAO, 2012). Fish and fisheries are the indispensable part of life and livelihood of the people of Bangladesh too since immemorial time. It is an element of the country's cultural heritage (DoF, 2012). Total global capture production in inland waters has increased dramatically since the mid-2000s. Total production amounted to 11.2 million tons in 2010, an increase of 30% since 2004 (FAO, 2012). Bangladesh is one of the world's leading inland fisheries producers with an annual production of fish was 1.05 million metric tons which constituted 34.45% of total catch in 2011 (DoF, 2012). Riverine capture fisheries in the form of common property and open access resources constitute a vital component of the agro-ecosystem of rural Bangladesh (Blaikie and Sadeque, 2000). The Bhairab River is also playing an important role in the total fish production of the country. The Bhairab River begins from the Jalangi, river takes off few miles to the northern Karimpur. Then it turns to the east to Meherpur and its pass through Jessore town. The Bhairab River is about 160 kilometers long and wide about 71 meters. Its average depth is 1.2 to 1.5 meters with a normal water flow and plenty of silt (Fluharty, 2000). According to DoF (2012), about 289 freshwater fish species under 13 orders and 61 families are found in these rivers. The biodiversity of the Bhairab River is quite well and an important river of Bangladesh. The massive siltation has threatened the existence of this important river and it is gradually being turned into a canal. The Bhairab River has two main branches, the Khulna Ichamati and the Kapotakkho. The Khulna Ichamati forms a boundary between Bangladesh and India. The town of Khulna and Jessore are situated on the bank of the river. The Bhairab River has its blessings for Bangladesh providing fishing, communication and irrigation facilities but is now drying up. The fishers who have been living beside the river are facing difficulties and hardship due to lack of fish in the river. The term 'biodiversity' introduced in the mid-1980s for the total richness and variety of life on earth. The biodiversity of the Bhairab River is so diverse and community lives around this river depend mainly on this river for their livelihood (Hossain and Ahmed, 2008). The livelihood of a large number of people beside the river depends mainly on fishing in the Bhairab River. According to IUCN (2000), about 54 freshwater species are critically or somewhat endangered in the country. Among them 14 species are listed as critically endangered; 27 as endangered and 14 as vulnerable. Overfishing, rapid extraction of fish seed and broodstock, destructive and unregulated fishing practices, pollution, introduction of exotic species, loss of aquatic habitat due to siltation, dam construction, and other anthropogenic activities have been the major causes of fish species loss. Human activities are causing species to disappear at an alarming rate. Aquatic species are at a higher risk of extinction than mammals and birds. Losses of this magnitude impact the entire ecosystem, depriving valuable resources used to provide food, medicines, and industrial materials to human beings. Runoff from agricultural and urban areas, the invasion of exotic species, and the creation of dams and water diversion have been identified as the greatest challenges to freshwater environments (Allan and Flecker, 1993). Biodiversity and its conservation are regarded as one of the major issues of enabling sustainable use of natural resources and are essential for the Bhairab River. Conserving diversity also improves the likelihood of maintaining minimal viable populations of rare and late-successional species. Maintaining biodiversity is important because it is not always possible to identify which individual species are critical to aquatic ecosystems sustainability. The findings of the study will, in particular, be applicable to the management of the Bhairab River in Jessore. Moreover, the findings are expected to be useful to students, researchers and policy makers. This study may be helpful to stakeholders who are interested in conducting a similar study in other parts of the country, particularly the conservation of fish biodiversity. The overall goal of this study is to conserve fish biodiversity of the Bhairab River. The main objectives of the present study were to assess the availability of fish biodiversity in the Bhairab River; to understand the existing fishing practices of the Bhairab River and to identify proper management strategies for the conservation of fish biodiversity.

## 2. Materials and Methods

### 2.1. Study area and periods

The Bhairab River of Jessore region was selected for the present study area. The primary areas of questionnaire interview were Fultala, Rajarhat, and Nawapara in the Bhairab River (Figure 1). The study periods were from May to August, 2016.



**Figure 1. The study area of the Bhairab River in Jessore district.**

### 2.2. Target groups fishers

For data collection, the target groups were fishers and fishing community members of the Bhairab River. The total respondents were 50 fishers for questionnaire interviews. Sample target people were selected randomly from the study area in the Bhairabrivers in Jessore district especially from rajar hat, Nawapara and fultala area.

### 2.3. Data collection methods

The credibility of the results of a scientific research depends largely on appropriate methodology used in research. Data were collected from target groups by questionnaire interviews, Participatory Rapid Appraisal (PRA) tool such as Focus Group Discussion (FGD) and cross check interviews with key informants. Sample size was taken about 50% of individual interview, 30% of FGD and 20% of the cross-check interviews with the key informants of the study area. Samples were selected randomly.

### 2.4. Data processing and analysis

The collected data were summarized and scrutinized carefully before the actual tabulation. Some of the data were collected into local units due to familiarity for respondents. The processed data were transferred to a spreadsheet from which classified tables were prepared revealing the finding of the study. Then the data were tabulated into computer. Preliminary data sheets were compared with computer spreadsheets to ensure the accuracy of the data enter. After data entry, the data were analyzed with computer program Microsoft Excel.

## 3. Results

### 3.1. Fishing Practices

#### 3.1.1. Fishers

According to questionnaire interview, about 55% of the families living beside the river are more or less dependent on the fishing from the Bhairab River for their subsistence. According to focus group discussion it was roughly estimated that around 90% are male and 10% are female are involved in fishing in the Bhairab River. As per standard practice fishers are categorized into three groups. The professional fishers, who depend on fishing almost year round for their livelihood; seasonal fishers, who fish only during a part of the year as income earning; and subsistence fishers, who mostly fish for their own consumption.

#### 3.1.2. Fishing seasons

Seasons affect the availability of fishes, water quality of water bodies, abundance of food for the fishes and also the using of gears. Time and season of fishing varied greatly with geographic distribution, weather condition, lunar effect, rainfall, types of habitat and food availability in the water body. Pre-monsoon season, this season starts from April and end in June. It is the moderate season. The fish catch is the lowest in this season; monsoon

it combines with the month of July, August and September. Fishing gears are widely used in that season due to presence of current and high water level. iii. Post-monsoon. The season starts from October and end in December. It is the moderate peak season of fishing because most of the fishes are breed in post-monsoon and dry season, this season combines with the month from January to March. The performance of fishing is less during dry season because the water level is very low. Wounding gear is widely used in that season. Besides this there are mainly two seasons for fishing. The peak season from July to September and lean season is about three month and that is January to March.

### 3.1.3. Fishing gears

Various types of fishing gears were found to operate in the study area, they were mostly of traditional type and some of them were unique for the particular locality. From the survey it was found that only 7 types of fishing gear were operated by the fishers in the Bhairab River (Table 1). These gears are classified into three groups, such as; 1) net, 2) wounding gear and 3) trap.

**Table 1. Types of fishing gears used in the Bharab River.**

Group name	Name of Gears		Description of the gears
	Local Name	English Name	
Net	Berjal	Seine net	Rectangular shape has two border lines. Upper borderline contains float, lower borderline contains sinkers. Sometimes it is as long as 250m.
	Current jal	Gill net	Bag like net. Fastened at the corner of four diagonal H poles. Lift pole is tied at the centre and act as like as liver.
	Thelajal	Push net	Rectangular net of single wall. Upper border contain float and lower border may or may not contain sinker. Mesh size varies from 2.5 cm to 10.0 cm and even 20.0 cm for larger fishes.
	Jhakijal	Cast net	Free moving (drifted) or fixed. Conical shaped. The hauling string of the net is fixed at the narrow apical end of the cone. The lower end is folded and attached to the net at
	Kheplajal	Throwing net	Circular outline. Generally made up of fabrics and iron made weight.
Wounding gear	Borshi	Hook and line	Made of iron or brass. The manner of capture fish is to offer real or artificial bait on a single hook or tri hook to allure them to eat.
Traps	Bair/Borong		Made of split bamboo and cane materials. Tubular shaped basket like trap. Set against water current.

### 3.1.4. Fishing duration by different gears

In the study area, the highest and the lowest fishing duration were recorded in borshi (hook and line) and current jal (gill net) which were 9.33 hours and 3.35 hours per day respectively. The jhakijal (cast net) is the most common gear used at all area of the Bhairab River compared to other gears. Fishing duration of other gears recorded were berjal (seine net) at 4.10 hours, thelajal (push net) at 4.94 hours, Dharmoal 6.5 hours (lift net) at 4.55 hours Jhakijal at 6.75 hours (Figure 2).

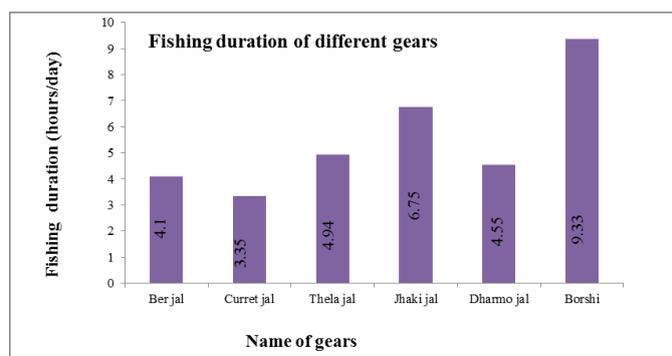


Figure 2. The average fishing hours of different gears in the Bhairab River.

### 3.1.5. Catch Composition

The fishers mentioned that they use different gear to catch those fish tend to be dominant to get caught by specific gear like *Macrobrachium lamrrei*, *Amblypharyngodon mola*, *Puntius sophera*, *Chanda ranga*, *Puntius ticto*, *Esomus daricus*, *Glossogobius giuris*, *Chada nama*, *Channa putatus* etc were the dominant species to catch with the help of seine net. *Putius sophera*, *Mystus vittatus*, *Labeo rohita*, *Cirrhinus cirrhisu*, *Labeo calbasu* were tend to be dominant by current net. The catch composition of different species is given in (Table 2).

Table 2. Catch composition of the Bhairab River.

Sl no.	Species			% of catch
	Group name	Local name	Scientific name	
1	India major carp	Rui	<i>Labeo rohita</i>	4.6
2		Catla	<i>Catla catla</i>	2.94
3		Mrigal	<i>Cirrhinus cirrhosus</i>	4.88
4		Kalibaush	<i>Labeo calbasu</i>	3.24
5	Minor carp	Bata	<i>Labeo bata</i>	3.29
6	Barb	Jatpunti	<i>Puntius sophore</i>	4.33
7		Tit punti	<i>Puntius ticto</i>	3.24
8		Kanchanpunti	<i>Puntius conchoni</i>	2.29
9		Sharpunti	<i>Puntius sarana</i>	3.29
10		Darkina	<i>Esomus danricus</i>	1.65
11	Snake head	Taki/Lata	<i>Channa punctatus</i>	8.54
12		Shol	<i>Channa striata</i>	3.27
13		Piplashol	<i>Channa barca</i>	2.29
14	Loach	Bowrani	<i>Botia Dario</i>	1.65
15		Kajuli	<i>Ailia coila</i>	1.65
16	Molacarpulet	Mola	<i>Amblypharyngodon mola</i>	2.94
17		Tengra	<i>Mystus vittatus</i>	6.53
18		Gulsa	<i>Mystus cavasius</i>	4.24
19	Cat fish	Buzuritengra	<i>Mystus bleekeri</i>	3.6
20		Rita	<i>Rita rita</i>	3.24
21		Boal	<i>Wallago attu</i>	2.94
22		Kutakanti	<i>Hara hara</i>	1.33
23		Cheka	<i>Chaca chaca</i>	1.33
24	Mullet	Kachki	<i>Sicamugilcascasia</i>	4.53
25	Gourami	Kholisa	<i>Colisa fasciata</i>	3.6
26	Spiny eel	Guchibaim	<i>Mastacembelus pancalus</i>	4.53
27		Tara baim	<i>Macrognathus aculeatus</i>	1.97
28	Climbing	Koi	<i>Anabus testudineus</i>	3.24
29	Perch	Napit koi	<i>Badis badis</i>	2.29
30	Tank goby	Bele	<i>Glossogobius giuris</i>	2.29

### 3.2. River ecosystem

#### 3.2.1. The Bhairab River ecosystem

An ecosystem is a community of living organisms (plants, animals and microbes) in conjunction with the non-living components of their environment (things like air, water and mineral soil), interacting as a system. These components are regarded as linked together through nutrient cycles and energy flows. As ecosystems are defined by the network of interactions among organisms, and between organisms and their environment, they can come in any size but usually encompass specific, limited spaces although it is sometimes said that the entire planet is an ecosystem. The ecosystem of the river viewed as a system operating in its natural environment, and includes biotic (living) interactions amongst plants, animals and micro-organisms, as well as abiotic (non-living) physical and chemical interactions. In the Bhairab River, abiotic factors includes the water flow, light, temperature, concentration of nutrients, oxygen, carbon dioxide, ammonia, dissolved salt, PH and substrates like fine particles, autumn shed leaves, submerged wood and moss. On the other hand, biotic organisms includes different types of fish, other aquatic animals like insects, crabs, snails, oysters, mussels, aquatic birds, frogs and snakes. This also includes different types of aquatic plants which provide oxygen for aquatic animals in the river. In addition, another important living factor is micro-organisms which help in decomposition and make the nutrient cycle continuous.

### 3.3. Biodiversity

#### 3.3.1. Fish biodiversity

Survey with fishers shows that among these varieties of fish, the highest amount of fish caught by the fishers was catfishes at about 16.62%. However, the lowest amount catch constituted the minor carp of about 1.29%. After the catfish, the second highest catch was 12.9% of small prawn. Another dominant group major carps contained 11.26% and barb remained at 11% of the catch and the loaches constituted 1.3% of the total catch. In addition other groups like molacarplet 4%, mullet 4.10%, gourami 2.20%, spiny eels 5.86%, climbing perch 4.10%, tank goby 3.53%, minnows 5.10%, freshwater garfish 3%, perchlet, 3.30% and river shad, 2.86% were found in the Bhairab River (Figure 3).

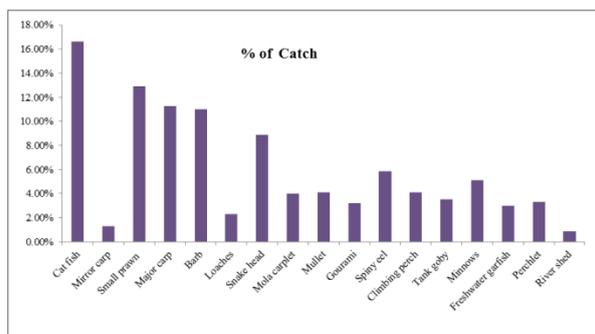


Figure 3. Percentage of different fish group.

#### 3.3.2. Other aquatic species

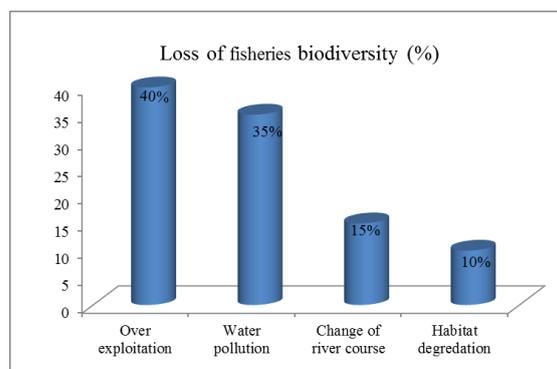
Besides the variety of fish, there are also so many other aquatic animals are found in the Bhairab River. The questionnaire interviews with the fishers show there are plenty of other animals like aquatic birds, crabs, snails, mussels, turtles, snakes, dolphins and frogs. Fishers mentioned two species of aquatic birds, one species of crab, three species of mussel, one species of snail, one species of turtle, one species of snake, and one species of frog (Table 3). They also mentioned that the turtle is hardly seen in the river nowadays.

Table 3. Other aquatic animals those are found in the Bhairab River.

Sl. No.	Species		
	Group name	Local name	Scientific ame
1	Aquatic bird	MaachrangaBok	<i>Alcedo atthis, Grus grus</i>
2	Crab	Mud crab	<i>Scylla serrata</i>
3	Snail	Apple shamuk	<i>Pila globosa</i>
4	Mussel	Jhinuk	<i>Lamellidens marginalis, L. jenkinsianus</i>
5	Turtle	Kossop	<i>Melanochelys tricarinat</i>
6	Snake (aquatic)	Guisaap	<i>Varanus bengalensis</i>
7	Frog	Kuno bang	<i>Bufo melanostictus</i>

### 3.3.3. Threats to Fisheries Biodiversity

Biodiversity is the degree of variation of life forms within a given species, ecosystem, biome, or an entire planet. Biodiversity is a measure of the health of ecosystems. Biologists most often define as the totality of genes, species, and ecosystems of a region. The threats to fisheries biodiversity can be grouped under four interacting categories. Overexploitation, water pollution, change of river course, destruction or degradation of habitat. Due to the increasing population, fishing pressure and overexploitation is increasing day by day. The river course is changed because of dam, bridges which are the main causes of drought, flood. The combined and interacting influences of these four major threat categories have resulted in population declines and range reduction of the Bhairab River biodiversity. From the survey it was found that the overexploitation of fishes was 40% responsible for the biodiversity destruction in the Bhairab River and water pollution caused 35% loss of biodiversity. Henceforth, river course change resulted in 15% of loss and habitat degradation caused 10% of biodiversity loss of the river (Figure 4).



**Figure 4.** Threats to the fisheries biodiversity in the Bhairab River.

During questionnaire survey with that the many fish species once abundant in the Bhairab River, but now become rare (Table 4). From the survey 20 species have been found at a risk of being endangered. Among those fishes all are ecologically important but a few fishes like mohashol, khorola, baghayre, chitol, foli, pabda and kanipabda are as well as commercial important. But they become completely extinct from the Bhairab river according to survey data.

**Table 4.** The threaten species of Bhairab river.

Sl. No.	Species Name		Ecologically Important Species	Commercially Important Species
	Local Name	Scientific Name		
Critically endangered species				
1	Mohashol	<i>Tor tor</i>	√	√
2	Khorola	<i>Rhinomugil corsula</i>	√	√
3	Lalkholisha	<i>Colisa labius</i>	√	
4	Chitol	<i>Chitala chitala</i>	√	√
5	Foli	<i>Notopterus notopterus</i>	√	√
6	Pathorchata	<i>Barilius tileo</i>	√	
7	Kanipabda	<i>Ompok bimaculatus</i>	√	
Endangered species				
8	Bacha	<i>Eutropiichthys vacha</i>	√	
9	Baghayre	<i>Bagarius bagarius</i>	√	√
10	Gajar	<i>Channa marulius</i>	√	√
11	Pabda	<i>Ompok pabda</i>	√	√
12	Bashpata	<i>Ailia coilia</i>	√	
13	Gonia	<i>Labeo gonia</i>	√	
14	Gutum	<i>Lepidocephalus guntea</i>	√	
Vulnerable				
15	Dhela	<i>Osteobrama cotio</i>	√	
16	cheka	<i>Chela laubuca</i>	√	
17	Bata	<i>Labeo bata</i>	√	
18	Bou Rani	<i>Botia dorio</i>	√	
19	Kajoli	<i>Ailichthys punctata</i>	√	

### **3.4. Conservation measures**

#### **3.4.1. Community based fisheries management**

It is a strategy undertaken through the active participation of an organized community. According to survey, respondent mention that CBFM can play a great role in the following sector-improvement of biodiversity; maintenance of fishing gears; fish production improvement; impacts on social stability; impacts on poverty alleviation; fish species availability; management of pollution and siltation and management of river basin and water quality.

#### **3.4.2. Fishing gears maintenance**

In studied area from the focus group discussion, 7 different types of fishing gears were found to operate in the river like berjal, jhakijal, current jal, thelajal, kheplajal, bair and borshi. Fishers mentioned that before establishing of CBFM approach, they used their fishing gears without understanding their proper use, what type of fishing gears are usable in case of different depth, species, and season, which indicate improper fishing. Even they did not follow any fishing rules other than profit. As such fishing was done indiscriminately and in most cases, it was over fishing by using the destructive fishing gears. That improper fishing caused reduction of fish species from the water body, barrier to proper growth and development of the fishes.

#### **3.4.3. Sanctuary establishment**

From the survey it is found that to overcome this endangered situation, Fish sanctuary is to establish. They maintain a particular demarcated protected area in the water body as a permanent shelter for the protection of fish for natural propagation, where targeted fish will not be disturbed or captured. Fishers suggested that establishing of aquatic sanctuary is one of the effective tools for conserving fish stock, preserving biodiversity and increasing fish production. In some cases restoration as well as conservation of habitat may be possible by establishing aquatic sanctuary.

#### **3.4.4. Pollution control**

Survey shows that agricultural runoffs, oil spillage from mechanized boat, human waste, domestic garbage are the main causes of water pollution of the Bhairab River. Toxic waste entering the water bodies, disturb the food chain and so the aquatic ecosystem. Fishers also mentioned that Pollution of river water is the highest threat to the ecosystem of the Bhairab River and it is the main cause of losing fisheries biodiversity. Most of the villagers of the riverside area are unconscious. Moreover, the fishing community is also unaware about pollution. According to survey, public awareness especially fishers and riverside people must be aware of the effect of pollution.

#### **3.4.5. Implementation of fishing acts and regulations**

In this study, we observed that, fishers have no training from any institution. If they got training from any institution, they will aware for protecting their own resources. Because of their unconsciousness they often break the rules and regulations such as, use of illegal fishing gear like current jal, catch of undersize and brood fish. So, with the discussion with fishers it has found that the implementation of rules and regulation should be strict by Government and make the fishers aware of sustainable yield and conserving ecosystem.

### **4. Discussion**

In this present study, it was found that on average 52% of fishers are involved in fishing daily in the Bhairab River and the rest 48% are engaged in fishing seasonally. They are involved in other jobs like day labor, rickshaw pulling, agriculture and others during the lean season. The relative proportion of those engaged in capture fisheries within the sector actually decreased from 87 percent in 2010 to 70 percent in 2015, while the proportion of those engaged in fish farming increased from 13 to 30 percent. In fact, in the last five years for which data are available, the number of people engaged in fish farming has increased at 5.5 percent per year compared with a mere 0.8 percent per year for those engaged in capture fisheries. It is apparent that, in the most important fishing nations, the share of employment in capture fisheries is stagnating or decreasing (FAO, 2012). According to DoF (2012), the total number of the fishers in Bangladesh is 12.8 million including 7.7 million inland fishers and 5.1 million marine fishers. Fisheries sector creates 1.4 million full time employment and part time employment of nearly 11 million people. A large portion of rural family members are engaged in part time fishing from the beels (Kabiret *et al.*, 2012). From the survey it has found that there are four seasons for fishing like premonsoon, monsoon, post-monsoon and dry season with two major season and they are peak season and lean season. According to Encyclopedia (2012), fishing seasons are set by countries or localities to indicate what

kinds of fish may be caught during sport fishing (also known as angling) for a certain period of time. Fishing seasons are enforced to maintain ecological balance & to protect species of fish during their spawning period during which they are easier to catch. Jennings and Rice (2011) recorded that the statutory coarse fish close season applies between 15 March and 15 June (inclusive) in United Kingdom. It applies on all rivers, streams and drains in England and Wales, and to some canals and some still waters. There is no close season on most canals and most still waters. Various types of fishing gears were found to operate in the study area and they were classified into three groups; such as net, trap and wounding gear. The gear like seine net, gill net, cast net, push net, lift net, trap and hook and line operated in the Bhairab River. Sayeed (2010) recorded a total of 34 different types of fishing gear including nets (11), traps (11), hook and lines (4), wounding gears (4), FADs (3) and hand fishing (1) from Chalanbeel. Similar study was done by Galib (2008) who recorded that the fishing gears used by the fishermen in Chalanbeel included 12 types of nets, 5 types of traps, 6 types of hooks and lines, 4 types of wounding gears and 2 types of other fishing methods. Hossain and Ahmed (2008) recorded different types of fishing gears broadly classified into three groups such as nets, traps and wounding gears were found to be operated by the fishermen in the Kolimarhaor. The ecosystem of the Bhairab River viewed as a system operating in its natural environment, and includes biotic (living) interactions among plants, animals and micro-organisms, as well as abiotic (non-living) physical and chemical interactions. Kabiret *et al.* (2012) mainly stressed on the assessment of the livelihood status and constraint faced by the fishers and stated that the Bhairab River, in Jessore especially at nawapara, is one of the most important ecosystems with much aquaculture potential. This flood fishery plays a very important role in alleviation of rural poverty and supplying food to the poor fishing community. Edward and Plaganyi (2011), assessing actual and potential biodiversity of river-floodplain ecosystems on the basis of policy and legislation concerning endangered and protected species is necessary for consistency between different policy goals. It is thus a prerequisite to sustainable and integrated river management. According to Halwart (2006), many of the aquatic organisms found in river ecosystem play an important role as the biological control agents of vectors and pests. They can be of both public health and agricultural significance, and are acknowledged elements of integrated Pest Management (IPM). During questionnaire survey with fishers, most of them reported that there were plenty of different fishes available from the Bhairab River 10-20 years back. According to Samadet *et al.* (2013), the availability of small indigenous species (SIS) of fish declined to a great extent over the years and many of them are rare or endangered due to death of rivers and baors were brought under aquaculture. The fishers also reported that the diversity and overall availability of fishes are declining day by day. In the Bhairab River, 30 fishes under 17 groups have been found from the Questionnaire interview with 50 fishers where as they found 60 to 65 fish species during their old days, 10 to 12 years ago. An experiment by Galib (2008) showed that about 12 species were critically endangered, 20 were endangered and 14 species were vulnerable in our country. According to the IUCN (2000), about 54 freshwater species are critically or somewhat endangered in the country. Among them 14 species are listed as critically endangered; 27 as endangered and 14 as vulnerable. The questionnaire interviews with the fishers show there are plenty of other animals like aquatic birds, crabs, snails, mussels, turtles, snakes and frogs. Fishers mentioned two species of aquatic birds, one species of crab, three species of mussel, one species of snail, one species of turtle, one species of snake and one species of frog. IUCN (2010) mentioned Tanguar Haor is a globally significant wetland with a unique ecosystem, located in the Tahirpur and Dharma pasha upazillas, north-east Bangladesh. Tanguar Haor is known for its diverse species of wildlife; it is also a vital fish breeding ground and provides a refuge for at least half a million migratory birds each year. There are 10 species of pearl bearing bivalves, 12 species of edible tortoise and turtle, 15 species of crab and 3 species of lobster (Azim and Asaeda, 2005). Survey shows that the fishers emphasize on the community based fisheries management, fishing gear maintenance, sanctuary establishment, pollution control, implementation of fishing acts and regulations as the conservation measures of fish biodiversity. Ahmed *et al.* (2007) demonstrated about 13 fish sanctuaries of the rivers and beels scattered all over the country. The fishers of those relevant sanctuaries have reported that the production of fish from have increased up to 239.4 kg/ha whereas the production was 120 kg/ha yearly before the project was started. Moreover, number of the fish species increased up to 85%. In these sanctuaries 24 fish species is now abundant which was considered as locally extinct and the number of regenerated fish species is 1 to 7. Furthermore, 23 threatened fish species are now available in those fish sanctuaries that have been considered as rare as a whole income of the fishermen have increased in various rates. At the last it can be said that fish sanctuary is now an urgent need for protection of wild fish stock, sustainable development of fisheries resources and for conservation of fish species and genetic diversity. A report by FAO (2003) on biodiversity and the ecosystem approach in agriculture, forestry and fisheries showed the ecosystem approach of the convention on biodiversity. These biodiversity programmes use ecosystem approaches to stimulate community level education and experiential learning by rural people. The same approaches educate national

policy makers to fulfill commitments made to environmental treaties. Raj (2002) reported freshwater fish biodiversity and conservation measures in India. He suggested taking necessary actions like establishment of sanctuary, determination of the environmental requirements of the species etc. Among the projects implemented in Bangladesh, Community Based Fisheries Management (CBFM) has become a common strategy for managing open water bodies and for empowering local communities by involving community stakeholders, recognizing local needs, using local knowledge and establishing common property regimen (Ostrom, 1990 and Berkes *et al.*, 1998).

## 5. Conclusions

In the present study, it revealed that the Bhairab River is famous for its rich reserve of aquatic life. A large number of rural people live in the North-South of the riverbank, whose livelihoods culture and daily activities are related and adapted to its aquatic environment but nowadays the biodiversity of the Bhairab River is in great threat due to fishing pressure, overfishing, pollution, siltation, urbanization and human encroachment. These have been created a great impact on river ecology. As a result, the water quality is deteriorating day by day and the availability of fish species and other aquatic biodiversity is decreasing gradually. The complete drying up in many parts of the river Bhairab is a common scenario during lean season, which is detrimental to fish populations and ecosystem. A total of 30 species of fish were identified in the catches of the Bhairab River. From the present study, the threats to fisheries biodiversity was grouped under four interacting categories. Overexploitation, water pollution, changes of river course, destruction or degradation of habitat.

## Conflict of interest

None to declare.

## References

- Ahmed K KU, SU Ahmed, KR Hasan and MG Mustafa 2007. Option for formulating community based fish sanctuary and its management in beel ecosystem in Brahmanbaria.
- Allan JD and AS Flecker, 1993. Biodiversity conservation in running waters. Bioscience, Research Library, 1: 43.
- Azim ME and T Asaeda, 2005. Periphyton structure, diversity and colonization. In. ME Azim, MCJ Verdegem, AA van Dam, MCM Beveridge (Editors), Periphyton—Ecology, Exploitation and Management. CABI Publishing, Wallingford. pp. 15–33.
- Berkes F, D Fenny, BJ McCay and JM Acheson, 1998. The benefit of the common Nature. pp. 340.
- Blaikie P and SZ Sadeque, 2000. Policy in High Places. Environment and Development in the Himalayan Region. ICIMOD, Kathmandu, Nepal. 209 p.
- DoF, 2012. Saranica, Matsya Pakhya Sankalan, Annual Report, Ministry of Fisheries and Livestock. The Government of Peoples Republic of Bangladesh 12: 319-328.
- Edwards C and ÉE Plagányi, 2011. Protecting old fish through spatial management: is there a benefit for sustainable exploitation? Journal of Applied Ecology, 48: 853- 863.
- Encyclopedia Britannica, 2012. Encyclopedia Britannica Online. Encyclopædia Britannica Inc., (accessed on 7th June 2012).
- FAO, 2003. Fisheries Management. 2. The ecosystem approach to fisheries. FAO Library Rome, Italy. pp. 112.
- FAP 6 1994. Fisheries Specialist Study. Main Report. North East Regional Water Management Project. Canadian Interational Development Agency. Government of Bangladesh. pp. 301.
- FAO, 2012. Workshop on Fishery Stock Indicators and Stock Status, Tehran, Iran. Food and Agriculture Organization of the United Nations (FAO). Rome, Italy. pp. 46.
- Fluharty D, 2000. Habitat protection, ecological issues, and implementation of the sustainable fisheries act. Ecological-Applications. Ecological Society of America. Washington, USA 10: 325-337.
- Galib SM, 2008. A study on Fish Diversity and Fishing Gears of Chalan Beel with Reference to Preservation of Catch, MS Thesis. University of Rajshahi, Rajshahi.
- Galib SM, 2008. A Study on Fish Diversity and Fishing Gears of Chalanbeel with Reference to Preservation of Catches. 4th year Thesis Submitted to the department of Fisheries, University of Rajshahi.
- Halwart M, 2006. Biodiversity and nutrition in rice-based aquatic ecosystems. Journal of food consumption and analysis, 19: 747-751.
- Hossain ARM and ZF Ahmed, 2008. Establishment of a community based fish sanctuary. Biodiversity and livelihood of the fishers, Report on a DeLPHE funded research Project.

- Hossain MY and ZF Ahmed, 2008. Some biological aspects of the river sprat *Coricaborna* (Pisces: Clupeidae) in the Mathabanga River (SW Bangladesh). Fish Biology Congress Abstract, Portland, Oregon, USA: 1-114.
- IUCN-International Union for Conservation of Nature 2000. IUCN Red List update. <http://www.globalpost.com/dispatch/news/science/wildlifeneews/120619/iucn-red-list-update-2000>.
- IUCN-International Union for Conservation of Nature, 2010. IUCN Red List update. [en.wikipedia.org/wiki/Lists\\_of\\_IUCN\\_Red\\_List\\_near\\_threatened\\_species](http://en.wikipedia.org/wiki/Lists_of_IUCN_Red_List_near_threatened_species).
- Jennings S and J Rice, 2011. Towards an ecosystem approach to fisheries in Europe: a perspective on existing progress and future directions. Fish and Fisheries, Wiley-Blackwell. Oxford, UK, 12: 125-137.
- Kabir KR, RK Adhikary, MB Hossain and MH Minar, 2012. Livelihood status of Fishermen of the old Brahmaputra River, Bangladesh. World Applied Sciences Journal, 16: 869-873.
- Ostrom E, 1990. Governing the commons: the evolution of institutions for collective action. Cambridge: Cambridge University Press.
- Raj AJA, 2002. Conservation of threatened species by induced breeding techniques. Ph. D. Thesis. Centre for Aquaculture Research and Extension (CARE), Research Dept. of Zoology, St. Xavier's College.
- Samad MA, BMS Rahman, AA Asif and RK Adhikary, 2013. Availability and Potentiality of Small Indigenous Species of Fish throughout the Year in South-Western Region of Bangladesh. IDOSI Publications, African Journal of Basic & Applied Sciences, 5: 167-173.
- Sayed MA, S Hashem, MA Salam, MAR Hossain and MA Wahab, 2014. Efficiency of fishing gears and their effects on fish biodiversity and production in the Chalanbeel of Bangladesh. Eur. Scient. J., 10: 294-309.
- World Bank 1991. Bangladesh Environment strategy Review. World Bank, Washington DC, USA. pp. 55.