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Impact of Fish Sanctuary on Fish Biodiversity and Livelihoods of Fishermen in Kolavanga *Beel* of Bangladesh

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Abstract: Fish sanctuary is a particular form of protected area in waters and considered to be an important and efficient managing device for protection, conservation and management of fisheries resources. The Kolavanga *beel* sanctuary in Barhatta upazila of Netrokona district is one of the initiatives of the Government established in 2011 that is continued till today. Therefore a survey was carried out to know the impact of the sanctuary on fish biodiversity, production and livelihood of the fishing communities in the area for three months from August to October 2015. To conduct the survey, various PRA tools such as questionnaire interviews, focus group discussion (FGD), catch monitoring and cross-check interviews were used to carry out the study. Result showed that total 45 fish species under 17 families were recorded in the study area where there were 38 species before establishment of the sanctuary. The highest number of fish species were caught in August (77.78%) and lowest (55.56%) in October from the Kolavanga *beel.* The fish catch analysis reveals that top ten species contributed 45.10% of the total catch by weight where the dominant fish species was Boal (*Wallago attu*) followed by Taki (*Channa punctatus*), Shol (*Channa striatus*) and Grass carp (*Ctertopharyngodon idella*), Common carp (*Cyprinus carpio*), Gonia (*Labeo gonius*), Koi (*Anabas testudinius*), Tit puti (*Puntius ticto*), Tengra (*Mystus vittatus*) and Gulsha (*Mystus cavasius*). About 7 native species (*Nandus nandus, Ompok bimaculatus, Channa marulius, Puntius sarana, Mystus aor, Botia dario* and *Labeo calbasu*) had been revived in the *beel* within 5 years of sanctuary establishment. The fishermen noticed that the sanctuary was effective for increasing the fish biodiversity and production in the *beel* which positively enhanced their livelihood conditions. The outcomes also suggest that careful planning, management and regulatory practices, along with active community participation, can have positive impact on fish biodiversity in any wetland.

Key words: Kolavanga *beel* · Fish sanctuary · Biodiversity · Fishermen · Livelihoods

INTRODUCTION

The total area of *beel* in Bangladesh was estimated to be 114161 ha covering about 27% of the inland freshwater resources [1]. Around 260 species of indigenous freshwater fishes, 24 species of prawns, 50 species of reptiles and 24 species of mammals are found in Bangladesh [2]. According to IUCN Bangladesh [3] about 54 species of fishes were found threatened whereas 12 species were critically endangered, 28 species were endangered and 14 were vulnerable. Fisheries is the second major export earning sector in Bangladesh which contributes about 3.65% to GDP and about 1.97% to foreign exchange earnings and this sector delivers the country with about 60% of animal protein intake [4].

In the past, the major source of fish production in Bangladesh was the inland open water capture fisheries. During the 1960s, it contributed about 90% of the country's total fish production [5]. But freshwater fisheries resources have declined during the past 30 years which has had significant negative impacts on fish biodiversity and the fishing community [6]. Natural inland fish stocks and biodiversity have been seriously negatively affected due to overfishing, use of harmful

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fishing gears and fishing systems, degradation and loss of fish habitats, obstruction of fish migration routes by construction of embankments and water-control structures, siltation of waterbodies and water pollution from industrial and agricultural sources [7]. *Beel* fishery of Bangladesh is declining day by day due to overfishing, indiscriminate use of chemical fertilizers and insecticides, destruction of natural breeding and feeding grounds, harvesting of wild brood fishes and many other causes [8]. Thus poor fishers' livelihoods have been adversely affected due to the gradual decrease of fish production from open waterbodies. In order to prevent the declining trend of fisheries resources and ensure sustainability of fish biodiversity and production, numerous measures have been implemented time to time.

Fish sanctuary in Bangladesh was proved to be an important and efficient tool for management in protection and conservation of fishes and other aquatic organisms [9]. Sometimes, sanctuary is provided with tree branches and roots and fixed with bamboo poles and covered with water hyacinth. The structure is similar to Katha (Fish Aggregating Device: FAD) which generally used to aggregate and harvest the fish in the rivers and *beels* [10]. Under the Development and Management Scheme of Department of Fisheries (DoF), 23 sanctuaries were established in different floodplains during 1960-1965. Upon having good result of the established sanctuaries, 25 more sanctuaries were established under the same scheme of DoF during 1965-70. Afterwards 10 more sanctuaries were established in 1987 under the Integrated Fisheries Development Project of DoF. A total of 464 permanent fish sanctuaries covering an area of 1,746 ha were established in 2007 [9]. Among all measures, fish sanctuary has been apparently found most effective for fish biodiversity conservation, when other measures are difficult to implement in the present administrative and social contexts.

Kolavanga *Beel* is a large wetland in Barhattaupazila of Nertokona district in Bangladesh. This *Beel* covers an area of about 370 acres in the wet season, but in the dry season it covers a total area of less than 161 acres. More than 5000 people of 1300 households live in 6 villages (Monash, Koylati, Bagmara, Soygao, Chatta and Noyhati) surrounding the *beel*. Over 70 percent of those households are involved in fishing related activities in the *beel* for their livelihoods. For this reason, fisheries resources of this *beel* have to face excessive exploitation pressures by the users. Normally they have to face various socio-economic problems and many of them cannot fulfill their basic needs. To overcome these problems, Community Based Fisheries Management (CBFM) approach has been introduced in the *beel*. A permanent fish sanctuary under the supervision of Department of Fisheries (DoF) was established in the *beel*.

The Fish sanctuary of Kolavanga *beel* is managed by members of CBO (Community Based Organization). The CBO is comprised of several members from six villages including representatives of fishermen, local people and local leaders. They follow a management plan that was prepared through consultation with local people and approved by a committee comprised of local officials, the union parishad chairman and leaders of the community organization. The CBO recruited a man to guard the fish sanctuary full time, in order to prevent fish poaching by some dishonest fishermen in the fish sanctuary area. This study was aimed to realize the following objectives: 1. to know the fish biodiversity of Kolavanga *beel*; 2. to study the impact of fish sanctuary on fish biodiversity in Kolavanga *beel*; and 3. to evaluate the impact of fish sanctuary on livelihood conditions of fishermen neighboring Kolavanga *beel*.

MATERIAL AND METHODS

Description of the Study Site: The sanctuary of Kolavanga *beel* is confined at Barhattaupazila of Netrokona district and was selected for this study after discussion with UFO of Barhatta upazila (Fig. 1). The fish sanctuary was established in 2011 in the core of Kolavanga *beel*. The sanctuary area is about 1.2 acres. Water depth increases up to 8-25 ft during monsoon and goes down to 3-7 ft in dry months. The bottom topography is changing every year due to siltation and sedimentation during monsoon.

About six hundred bamboo poles were collected from the local market were used in the fish sanctuary construction. Branches of trees were purchased from the local area and placed in the bamboo of the sanctuary to create habitat and shelter for the aquatic organisms. Some of the branches were donated by local communities. Plastic pipes and cement pipes were used in the fish sanctuary to protect against poaching. Local communities are actively involved in the management and protection of the fish sanctuary of Kolavanga *beel*. They protect this sanctuary from other communities and outsiders.

Data Collection: This study was conducted for a period of 3 months from August to October in 2015. At first primary information was collected from Upazilla Fisheries

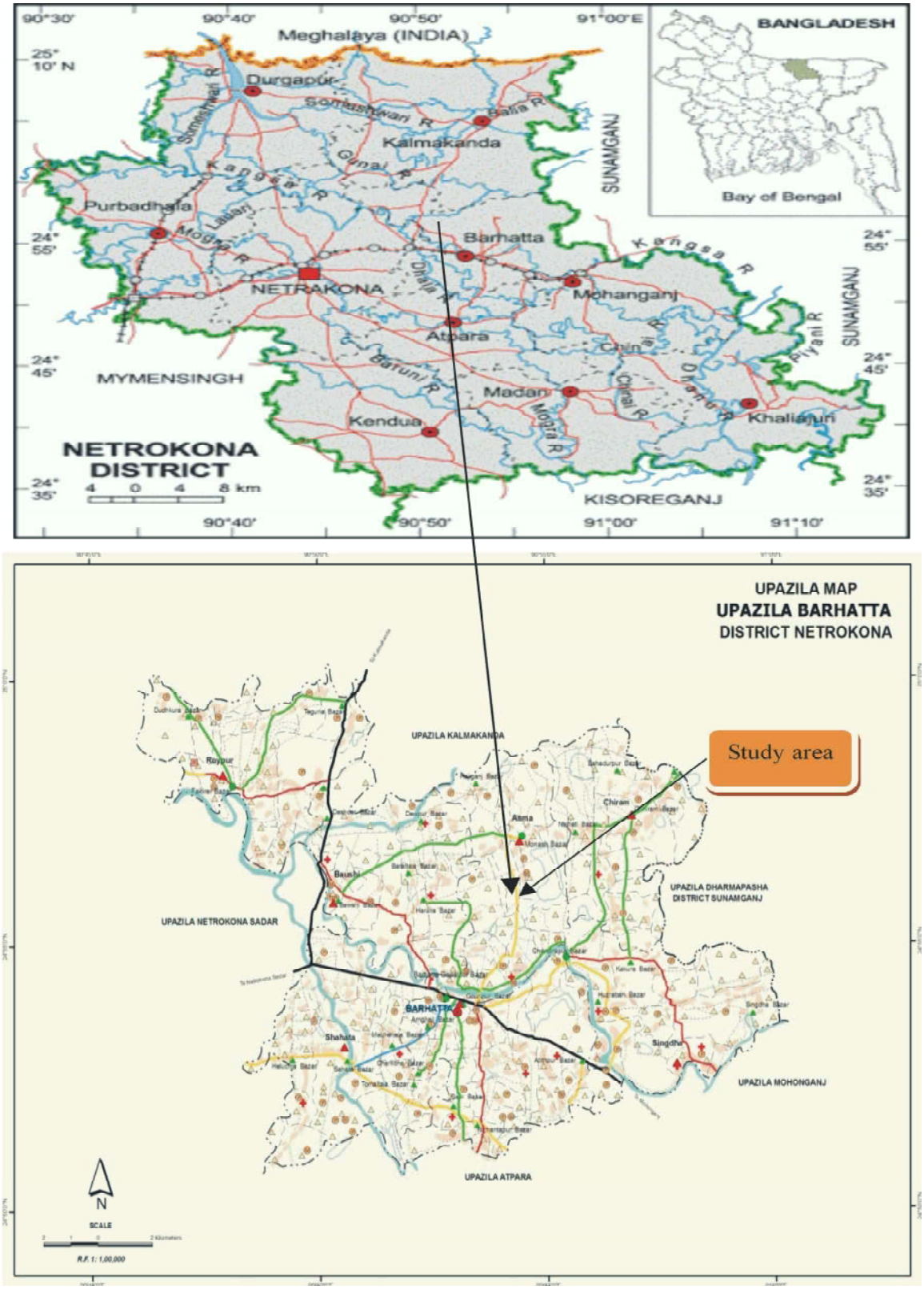

Fig. 1: Study area.

Office regarding the fisheries management, fish sanctuary and livelihood conditions of the fishermen. On the basis of this information a preliminary survey was conducted in the study area. Data were collected also from target groups by questionnaire interviews, focus group discussions (FGD) and cross-check interviews with key informants.

For data collection from the fishermen, a questionnaire was prepared in accordance with the objectives of the study. Before preparing the questionnaire, a draft questionnaire was developed and then pre-tested and finally applied in the study area. Questions were related to species availability before and after the establishment of fish sanctuary, abundance of critically endangered and endangered fish species, species wise catch composition of Kolavanga *beel*, fish biodiversity and socio economic condition of fishermen.

A brief introduction about the objectives of the study was given to each of the selected groups and assured them that all information would be kept confidential. Fishermen were interviewed individually during catching fishes in Kolavanga *beel* and from 6 villages (Monash, Koylati, Bagmara, Soygao, Chatta and Noyhati) surrounding the *beel*. Participatory rural appraisal (PRA) tools namely 8 focus group discussions (FGD) were also conducted with the fishermen. After collecting the data through questionnaire interviews and FGDs, Cross-check interviews were conducted with key persons such as Upazila Fisheries Officer (UFO), Upazila Chairman, CBO leaders and local highly experienced fishers etc.

Data Processing and Analysis: Simple descriptive analysis and graphical presentation of data were carried out using Microsoft Excel (Version 2010).

RESULTS AND DISCUSSION

Fish Biodiversity of Kolavanga *Beel*

A number of fish species was identified from Kolavanga *beel* through catch monitoring data and data collected from fishermen engaged in fishing in the *beel*. During the study period, a total of 45 species under 17 families were identified from the Kolavanga *beel*. The number of fish species of different common groups named carps, catfishes, snakeheads, perches, eels, barbs and minnows, clupeids and miscellaneous species were 8, 8, 4, 5, 4, 7, 2 and 7, respectively (Table 1). Hossain [11] reported about 49 species of fish fauna from the Kolimar *haor* where 7 species of carps, 12 species of catfishes, 4 species of snakeheads, 5 species of perches, 3 species of eels, 8 species of minnows, 3 species of clupeids and 7 species of miscellaneous groups were assessed.

Fish Species Revived after Establishment of the Fish Sanctuary: According to the catch monitoring data and interviews with fishermen, seven native species (*Nandus nandus, Ompok bimaculatus, Channa marulius, Puntius sarana, Mystus aor, Botia dario and Labeo calbasu*) had disappeared from the *beel* due to mainly lack of sufficient water in dry season and overfishing. These seven unavailable species of fish were recorded during this study that the number of fish species had been increased from earlier 38 species to 45 species (18.42% revived) and commonly caught now in the study area (Table 2). Haque [12] reported 5 species (*Ompok bimaculatus, Puntius sarana, Nandus nandus, Labeo gonius and Chitala chitala*) were revived due to establishment of Baikka *beel* sanctuary. According to MACH project [13] the number of fish species found during the baseline year and final year was 71 and 85, respectively in Hail *haor* that indicated 14 revived species within 6 years. FFP [14] reported that after establishment of sanctuaries, 23 fish and some prawn species including some endangered species have increased their population in the command area of the project. All these studies supported the present investigation that establishment of fish sanctuary at the deepest part of the *beel* positively impacted on the restoration of aquatic species through providing suitable and safe habitat for them. This study exposed that community based management approach of sanctuary for *beel* management appeared to be effective for fish diversity enhancement which lead to increase in number and amount of various fish species.

Monthly Variation of Species Abundance: During study period, maximum number of fish species was found during the month of August (35) followed by September (29) and October (25) (Fig. 2). Normally the rainy season begins in Bangladesh in June or July and this is the peak breeding time for most of the fish species. The decline of biodiversity in different catch may be related to the seasonal fluctuation of water depth in the *beel*. In the wet season, species diversity is generally high through the *beel* because of frequent movement of fishes. In the winter season, the water level of the *beel* decreases and fishes enter into the deepest part of the sanctuary where fishing is prohibited. The gradual decrease of fish species in catch composition may be related to this phenomenon.

Table 1: List of fishes in the Kolavanga *beel*

Sl. No.	Family	Local Name	Scientific Name	Previous status	Present status	Production trend
Biodiversity of Carps						
1	Cyprinidae	Mrigal	*Cirrhinus cirrhosus*	Common	Common	Stable
2	Cyprinidae	Rui	*Labeo rohita*	Common	Common	Stable
3	Cyprinidae	Catla	*Catla catla*	Rare	Common	Increased
4	Cyprinidae	Kalibaus	*Labeo calbasu*	Absent	Common	Revived
5	Cyprinidae	Goinna	*Labeo gonius*	Common	Abundant	Increased
6	Cyprinidae	Carpio	*Cyprinus carpio*	Common	Common	Stable
7	Cyprinidae	Silver carp	*Hypophthalmichthys molitrix*	Rare	Common	Increased
8	Cyprinidae	Grass carp	*Ctenopharyngodon idella*	Rare	Common	Stable
Biodiversity of Catfishes						
9	Bagridae	Tengra	*Mystus vittatus*	Common	Abundant	Increased
10	Bagridae	Bujuritengra	*Mystus tengra*	Common	Abundant	Increased
11	Bagridae	Gulsha	*Mystus cavasius*	Rare	Common	Increased
12	Clariidae	Magur	*Clarius batrachus*	Common	Abundant	Increased
13	Siluridae	Boal	*Wallago attu*	Rare	Abundant	
Highly						
14	Siluridae	Kanipabda	*Ompok bimaculatus*	Absent	Common	Revived
15	Heteropneustidae	Shing	*Heteropneustes fossilis*	Common	Abundant	Increased
16	Bagridae	Air	*Mystus aor*	Absent	Common	Revived
Biodiversity of Barbs, Minnows and Clupeids						
17	Cyprinidae	Mola	*Amblypharyngodon mola*	Common	Abundant	Increased
18	Cyprinidae	Dhela	*Rohtee cotio*	Common	Rare	Decreased
19	Cyprinidae	Lamba chela	*Chela bacaila*	Rare	Rare	Stable
20	Cyprinidae	Jatputi	*Puntius sophore*	Common	Abundant	Increased
21	Cyprinidae	Titputi	*Puntius ticto*	Common	Abundant	Increased
22	Cyprinidae	Sharpunti	*Puntius sarana*	Absent	Common	Revived
23	Cyprinidae	Darkina	*Esomus danricus*	Common	Rare	Decreased
24	Clupeidae	Chapila	*Gadusia chapra*	Common	Abundant	Increased
25	Clupeidae	Kachki	*Corica soborna*	Common	Common	Stable
Biodiversity of Snakeheads						
26	Channidae	Taki	*Channa punctatus*	Common	Abundant	Highly Increased
27	Channidae	Cheng	*Channa orientalis*	Common	Rare	Decreased
28	Channidae	Shol	*Channa striatus*	Common	Abundant	Increased
29	Channidae	Gojar	*Channa marulius*	Absent	Common	Revived
Biodiversity of Eels						
30	Mastacembelidae	Tara baim	*Macrognathus aculeatus*	Rare	Abundant	Highly Increased
31	Mastacembelidae	Guchibaim	*Mastacembezus pancalus*	Common	Abundant	Increased
32	Mastacembelidae	Borobaim	*Mastacembelus armatus*	Rare	Common	Increased
33	Synbranchidae	Kuchia	*Monopterus cuchia*	Common	Common	Stable
Biodiversity of Perches						
34	Anabantidae	Koi	*Anabas testudineus*	Common	Abundant	Increased
35	Anabantidae	Khalisha	*Colisa fasciatus*	Common	Abundant	Increased
36	Ambassidae	Lalchanda	*Chanda ranga*	Common	Common	Stable
37	Ambassidae	Lombachanda	*Chanda nama*	Common	Common	Stable
38	Nandidae	Veda	*Nandus nandus*	Absent	Abundant	Revived
Biodiversity of Miscellaneous Species						
39	Gobiidae	Bailla	*Glossogobious giuris*	Common	Common	Stable
40	Belondiae	Kakila	*Xenentodon cancila*	Common	Common	Stable
41	Cobitidae	Gutum	*Lepidocephalus guntea*	Common	Rare	Decreased
42	Notopteridae	Foli	*Notopterus notopterus*	Rare	Common	Increased
43	Cobitidae	Rani	*Botia dario*	Absent	Rare	Revived
44	Cichlidae	Tilapia	*Oreochromis mussambicus*	Rare	Rare	Stable
45	Palaemonidae	Ichha	*Macrobrachium lumarre*	Common	Abundant	Increased

Table 2: List of revived species and their present status

Local name	Scientific name	IUCN status	Present status
Veda	*Nandusnandus*	Vulnerable	Abundant
Kanipabda	*Ompokbimaculatus*	Endangered	Common
Gozar	*Channamarulius*	Endangered	Common
Sarputi	*Puntiussarana*	Critically endangered	Common
Air	*Mystusaor*	Endangered	Common
Rani	*Botiadario*	Endangered	Rare
Kalibaus	*Labeocalbasu*	Endangered	Common

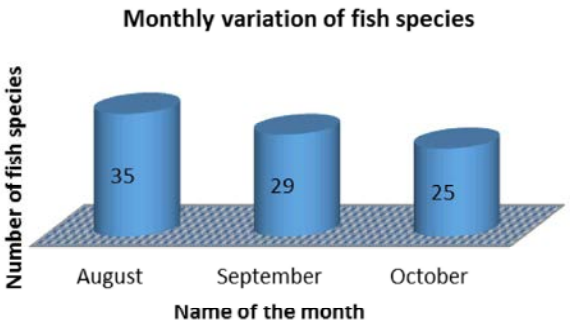

Fig. 2: Number of fish species recorded from catch monitoring data.

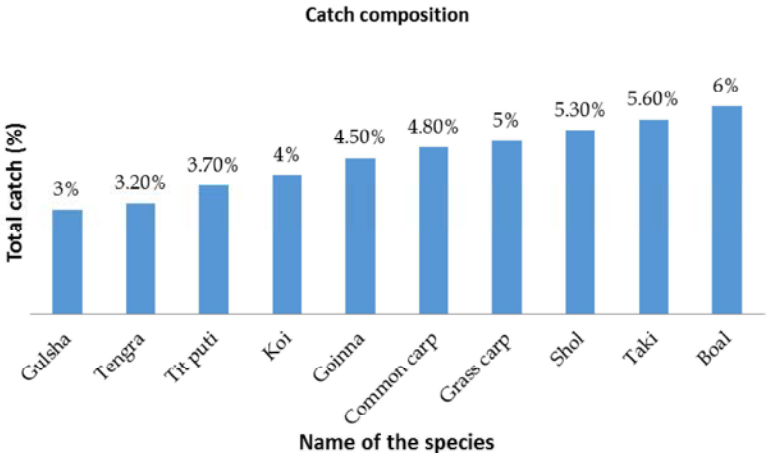

Fig. 3: Percentage contribution to total catch of the 10 main species in Kolavanga *beel*.

According to Haque [12] 31 species of fish were recorded in Balla *beel* and 24 species were recorded in Sixty Two *beel*. The maximum number of species in both wetlands was found during the month of August. So, the impact of fish sanctuary on fish biodiversity in Kolavanga *beel* was closely related with the study of Baikka *beel* fish sanctuary.

Catch Composition Based on Catch Monitoring Data: Top 10 species were ranked according to their overall contribution to the total catch in Kolavanga *beel*. Common fish species caught with percentage in total catch were Boal (6%), Taki (5.6%), Shol (5.3%), Grass carp (5.5%), Common carp (4.8%), Gonia (4.5%), Koi (4%), Tit puti (3.7%), Tengra (3.2%) and Gulsha (3%) (Fig. 3). This analysis reveals that 10 main species contributed 45.10% of the total catch by weight where Boal and Gulsha were the highest and lowest contributory species, respectively to the total catch of Kolavanga *beel*. Haque [12] reported top 10 species (Boal, Taki, Shol, Foli, Common carp, Grass carp, Gonia, Koi, Jatputi and Meni) contributed 58.7% of the total catch by weight after the sanctuary establishment in Baikka *beel*.

Gear Efficiency: Use of different fishing gears and traps can also serve as a rough indicator of the availability of different fish species. Some gears found available in the *beel* were gill nets, traps, hook and lines and long lines.

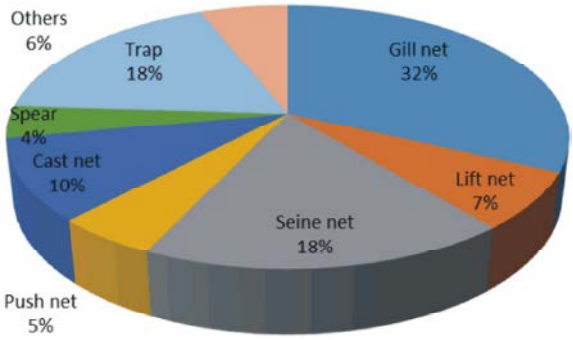

Fig. 4: Proportion of catch by different gear types in Kolavanga *beel*.

After assessing the efficiency of each gear, it has been observed that gill nets resulted the highest catch during the study period in the *beel* (32%) while fish traps (18%) and seine net (18%) produced the second highest catch in Kolavanga *beel* (Fig. 4). Haque [12] reported gill net was resulted in the highest catch during the study period in Balla *Beel* (29%) and Sixty Two *Beel* (36%), while fish traps produced the second highest catch in both Balla *Beel* (23%) and Sixty Two *Beel* (28%).

Perceptions of Fishermen Towards The Effectiveness of The Fish Sanctuary: Most of the fishers mentioned that the number fish species was decreasing day by day before establishing the fish sanctuary and only 38 species were available in the Kolavanga *beel*. During the study period, a total of 45 fish species were recorded in Kolavanga *beel*. Out of the 30 respondents, fourteen respondents (46.67%) indicated that this sanctuary played an effective role in increasing fish biodiversity. Ten respondents (33.34%) responded that it is effective in regards to increasing fish production and only six responds (20%) noted that the sanctuary was effective in regards to both increasing fish production and diversity (Table 3).

One fisherman from Bagmara village said: "*Fishes are not only the asset of government but also of common people, so it is also our duty to save the fishes by managing the fish sanctuary properly"*. About 60% of the respondents in *Beel* Kumari indicated that fish sanctuary is very effective in regards to increasing fish biodiversity, 30% reported that it is effective to increasing fish catch and only 10% responded that the sanctuary was effective in regards to both increasing fish catch and improving fish biodiversity [15]. Haque [12] reported 47.5% responded to increasing fish biodiversity, 35% responded to increasing fish catch and 17.5% responded to increasing both fish catch and fish biodiversity due to establishment of fish sanctuary that highly supported the present study. Most of the fishers believed that community based management approach involving fishermen and government is the possible best management option for operating the sanctuary in a sustainable way.

Impact of Fish Sanctuary on Livelihood Conditions of The Fishermen In Study Area: Fishermen living around the Kolavanga *beel* harvest the fish almost round the year without any prior investment except fishing gear. The establishment of fish sanctuary in Kolavanga *beel* had positive impact on local fishermen by catching more fish from the *beel*.

Annual Income of The Fisherman from Kolavanga *beel*: In the present study, annual incomes of fishermen were increased than previous years by catching more fishes from the *beel* possibly due to fish sanctuary establishment in Kolavanga *beel*. Annual incomes of the fishermen were found to vary from BDT 30000 to BDT 70000. The selected fishermen were grouped into two categories based on the level of annual income and it was found that about 66.67% of the fishermen had annual income between BDT 3000 to BDT 45000 and 33.33% of the fishermen had income in the range of BDT 45001 to 70000 (Table 4). The income profile is the main economic indicator of national development. In most cages the income of the fishermen in Bangladesh is below poverty line [14].

Perceptions of Fishermen About Impacts of Fish Sanctuary on their Livelihoods: Livelihood conditions of fishermen mostly depend on fisheries resources. Fishing is the main source of income of the *beel* adjacent

Table 3: Perceptions of local community towards effectiveness of fish sanctuary

Perceptions	Number of respondents
Fish sanctuary is very effective to increase fish biodiversity	14 (46.67%)
Fish sanctuary is very effective to increase fish production	10 (33.34%)
Fish sanctuary is effective in both increasing fish production and improving fish biodiversity	6 (20%)

Table 4: Annual incomes of the fishermen from Kolavanga *beel*

No. of fishermen (n=30)	% of fishermen	Income level (BDT)
20	66.67	30000-45000
10	33.33	45001-70000

Table 5: Perceived benefits from fish sanctuary

Direct benefits	Frequency (n=30)	Percentage (%)
Increased fish catch	20	70
Increased income	11	36.67
Increased fish consumption	18	60
Saved money	17	56.67
Indirect benefits		
Improved housing facilities	15	50
More food available	18	65
Improved sanitation facilities	12	40
Better health facilities	16	53.34
Improved education facilities	17	56.67

fishermen household. Fishermen community is deemed to be one of the most vulnerable communities in terms of their livelihood opportunities in Bangladesh. The present fish catch in the study area was, on average, 2.3 kg per fisherman per day and it was increased than previous years. Twenty respondents (70%) believe that their fish catch has increased due to the establishment of the fish sanctuary, 18 respondents (60%) reported that they have benefited from a better food supply, 17 respondents (56.67%) reported that they have benefited by saving money and 11 respondents (36.67%) reported that they have benefited by increasing their income (Table 5). According to the report of IPAC [16] the daily fish catch by individual fisherman was, on average, 2.83 kg per fisherman per day that was nearest level to the present study. About 75% fishermen believed that their fish catch has increased due to the establishment of the fish sanctuary and 18 respondents (65%) reported that they have benefited from a better food supply nearest result was found by Haque [12]. According to MACH [13] the overall fish consumption increased significantly in all sites including the Hail *haor*. Major findings indicate that small *beel* and wetland resident fish and prawns constitute the main fish consumed for all households and particularly among poorer households. So fish sanctuary was found very effective to increase livelihood conditions of fishers living around the Kolavanga *beel*.

Socio-Economic Constraints of the Fishermen: Fishermen have faced different types of problems. The main problem was identified as injustice by the local extortionist; other problems were inadequate credit facilities, lack of fishing gear and disturbances by bandits, thieves etc. Most of the fishermen are very poor and they have to resort to credit for buying nets and other fishing equipment. Most of them are illiterate and live from hand to mouth. Being very poor their children often go for fishing rather than to school. As a result, generation after generation they remain illiterate and not being able to contribute for the betterment of their community. Another socio-economic constraint is the onset of natural disaster that has to be faced by the fishermen almost every year.

Problems and Recommendations: The most important part of a fish sanctuary is its management, especially protection against poaching. As fishes have become more abundant around the fish sanctuary it has been more attractive for poaching by the outsiders that it was a major problem for fish sanctuary of Kolavanga *beel*. Using brush piles, pipes or other structures in the fish sanctuary to prevent such practices by creating obstacles was found effective. Another potential problem is that naturally occurring extreme drought or the pumping of water out of the fish sanctuary for agriculture which reduce the water depth and area of the *beel*, resulting in heavy natural mortality and degradation of water quality and increasing the likelihood of fish disease outbreaks.

The use of current net needs to be reduced during the peak breeding season and high dependency on only fishing of the local community must be reduced.

Siltation is another issue which results in a raised bottom of the *beel* and therefore the overall water level of the sanctuary drops. Excavation of the *beel* around the sanctuary site is the best remedy for this problem.

Community participation and co-management have proven to be more effective than traditional approaches. Precautionary measures should have to be taken to protect major species and to maintain the sustainability of the Kolavanga *beel* resources.

CONCLUSION

The present study was conducted to know the impact of the fish sanctuary on fish biodiversity, production and livelihood conditions of fishermen. The fish sanctuary has proved its positive impact on a significant biodiversity improvement and gradual enhancement of socio-economic conditions of the fishermen. Many of the endangered and critically endangered fishes were found in the Kolavanga *beel* after establishment of the fish sanctuary.

From the data collected from the *beel* and also from perception of local fishermen dependent on the *beel*, it is clear that the fish sanctuary was quite effective in terms of promoting the restoration of fish biodiversity and

production. It indirectly affects the livelihoods of the surrounding communities. The management practices on this fish sanctuary are based on a community approach. This approach can be replicated in other parts of the country. This study also identified some issues that need to be addressed.

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