

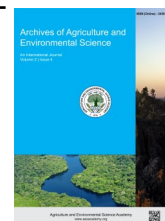


e-ISSN: 2456-6632

This content is available online at AESA

Archives of Agriculture and Environmental Science

Journal homepage: [journals.aesacademy.org/index.php/aaes](http://journals.aesacademy.org/index.php/aaes)



CASE STUDY



## Fish sanctuary as a sustainable management tool for recovering fish biodiversity, production and livelihood: A case study on Halti Beel tank sanctuary, Bangladesh

Md. Abu Bakar Siddique, Muhammad Afzal Hussain, Mohammad Manjurul Alam, Md. Ayenuddin Haque\*  and Fawzia Adib Flowra

Department of Fisheries, University of Rajshahi, Rajshahi - 6205, BANGLADESH

\*Corresponding author's E-mail: [ayenuddin41@gmail.com](mailto:ayenuddin41@gmail.com)

### ARTICLE HISTORY

Received: 01 October 2020  
Revised received: 03 December 2020  
Accepted: 21 December 2020

### ABSTRACT

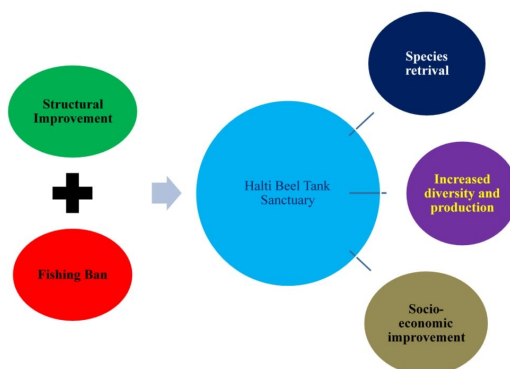
Fish sanctuary is a common tool for retrieving fisheries diversity in a threatened aquatic ecosystem. The present study highlighted a case study on sustainable management of Halti Beel tank sanctuary, Bangladesh (a part of Chalan Beel) established for the betterment of fisheries and fishermen community. The study was conducted for a period of 6 months from July to December 2017. Both primary and secondary data was used for a comparison before and after effects of Halti Beel tank sanctuary considering three parameters viz., fisheries diversity, production trends and socio-economic condition of fishermen community. During the study period, diversity in both native and exotic fish species (71) were increased where 62 species were native and 9 were exotic under 26 families of 11 orders. This number (71) was observed 97.22% higher than the number of species before declaring Halti Beel tank as fish sanctuary. Recovery rate was observed highest for the order Siluriformes (11) and the lowest for Channiformes (1). Cypriniformes was the most diversified order with 24 species (18 native and 6 exotic species). The observed data showed a dramatic increase in fish production from 8.77 to 37.50 metric ton within four fiscal years whereas the gradual production trend was recorded 10.12, 29.47, 35.10 and 37.50 metric ton, respectively in the year 2013-2014, 2014-2015, 2014-2015 and 2016-2017. The study was also showed a satisfactory improvement in financial and housing assets as socio-economic status of fishermen community involved in the management of Halti Beel tank sanctuary.

©2020 Agriculture and Environmental Science Academy

### Keywords

Chalan Beel  
Fish diversity  
Fish retrieval  
Halti Beel  
Sanctuary

### GRAPHICAL ABSTRACT



**Citation of this article:** Siddique, M.A.B., Hussain, M.A., Alam, M.M., Haque, M.A. and Flowra, F.A. (2020). Fish sanctuary as a sustainable management tool for recovering fish biodiversity, production and livelihood: A case study on Halti Beel tank sanctuary, Bangladesh *Archives of Agriculture and Environmental Science*, 5(4): 567-575, <https://dx.doi.org/10.26832/24566632.2020.0504021>

## INTRODUCTION

Fish sanctuary is defined as an area of public lands and water that is permanently set aside by the Government to have no human interferences round the year (DoF, 2016). Establishment of a fish sanctuary is an effective way to save the existing fish diversity in a water body and in some cases restoration of habitat. Many government and non-government organizations have taken initiatives to establish fish sanctuary in *Beels* and rivers of Bangladesh to improve stock structure of fish species (Ahmed and Ahmed, 2002). It was previously proved to be an effective management tools to ensure sustainability of natural water-body. Thus, as a consequence of decreasing fisheries resources of the largest wetland, Chalan *beel*, of Bangladesh, implementation and evaluation of fish sanctuaries become an urgent need. The abundance and distribution of fishes from Chalan *Beel* are decreasing day by day due to the environmental degradation and anthropogenic activities such as overfishing, indiscriminate use of chemicals, destruction of natural feeding and breeding ground of fishes etc. (Azher et al., 2007). As a result, the livelihood status of marginal fisherman is in massive danger (Khan et al., 2018). To save the fisheries species of Chalan *Beel* from further losses, different conservation approaches are highly required as it helps in improving fish production as well as maintaining diversity.

The Department of Fisheries (DoF) of government of Bangladesh has established numerous fish sanctuaries in the entire Chalan *Beel* area by the days. A total of 40 fish sanctuaries were established by the Department of Fisheries (DoF) from 2006-2007 to 2016-2017 fiscal year in different parts of Chalan *Beel* area. Among them the highest numbers of fish sanctuaries are situated in Singra Upazila (08) followed by Noldanga Upazila (06), Boraigram Upazila (06) of Natore district and Bhangura Upazila (05) of Pabna district. Most of the fish sanctuaries (90%) having an area of 0.5 ha and only 10% (4) fish sanctuaries are within the area of 1.0 ha. However, most of these fish sanctuaries are not in good condition and some are almost destroyed by the local people.

However, Haldi *Beel* Tank fish sanctuary is one of the managed sanctuaries of Chalan *Beel*. This sanctuary was established in the year 2012 by the Upazila Fisheries Office (UFO), Noldanga, Natore. Published research works on the role of fish sanctuaries of Chalan *Beel* along with socio-economic condition of engaged fishermen in the Haldi *Beel* fish sanctuary are relatively scanty. In this context, this study was undertaken to explore the role of existing fish sanctuaries of Chalan *Beel* along with impact assessment of Haldi *Beel* tank sanctuary to increase the fisheries diversity and socio-economic condition of the fishermen through before-after comparison of sanctuary declaration. The specific objectives of the present study were to evaluate the recovery status of fish species by a before-after comparison, to determine the effect of sanctuary based on trends of fish production and finally to discover the socio-economic improvement of fishermen lead their livelihood on fishing.

## MATERIALS AND METHODS

### Location of the study area

The studied fish sanctuary was located in the Haldi *Beel* tank (24° C.48'N 89°.03'E) of Piprul Union (Figure 1) established by Noldanga Upazila Fisheries Office (Department of Fisheries, DoF), Noldanga, Natore. Haldi *Beel* is one of the largest depressions of Chalan *Beel* area spread over a wide area of Piparul, Khajurah, Madhanagar and Brahakpur Union of Noldanga Upazila of Natore district. From July to December 2017, the *Beel* area becomes submerged into 5 to 8 feet of water. Haldi *Beel* is famous for breeding places of native fisheries species. During winter months, the deepest part of the Haldi *Beel* is declared as a fish sanctuary and managed by Department of Fisheries (DoF) under CBFM. Haldi *Beel* fish sanctuary has been established in the 'L' shaped Haldi *Beel* Tank. It is a permanent fish sanctuary. Upazila Fisheries Office (DoF), Noldanga was excavated this tank in 2012 which having an area of 15.78 ha. However, among the total area, the area of fish sanctuary was 1.00 ha.

### Data collection

Data regarding fish species diversity and abundance was collected fortnightly. Both qualitative and quantitative data were collected for this study using semi-structure questionnaire, focus group discussion, personal observation and fish catch monitoring. Commercially harvested fisheries species in permitted area outside of fish sanctuary were considered as source of primary data. Followed by catching, fisheries species were identified based on their morphometric and meristic characters following Talwar and Jhingran (1991), Rahman (2005) and Rahman et al. (2009). After identification, fishes were systematically classified according to Nelson (2006). Measurement in weight was taken to find out the production status of fisheries species. Secondary data were collected from journal articles, textbooks, and reports of the Department of Fisheries (DoF), Noldanga, Natore. Data regarding fish production and diversity status before the declaration of Haldi *Beel* tank as a fish sanctuary were collected from Upazila Fisheries Office (UFO), Noldanga, Natore, who are responsible for regular assessment of the existing condition of production and fisheries diversity status of the studied area of the *Beel*.

### Data collection on socio-economic study

190 fishermen involved in the management of Haldi *Beel* Tank fish sanctuary were selected for socio-economic study. A planned questionnaire was developed containing both the closed and open-ended query to collect through face-to-face interview with respondents. The questionnaire was pretested and revised according to the feedback gained in the field level. The questionnaire was formed to obtain the relevant information on financial status and housing condition of the selected fishermen. Again, the secondary data from Upazila Fisheries Office (UFO), Noldanga, Natore were taken to collect pervious data of the respondent.

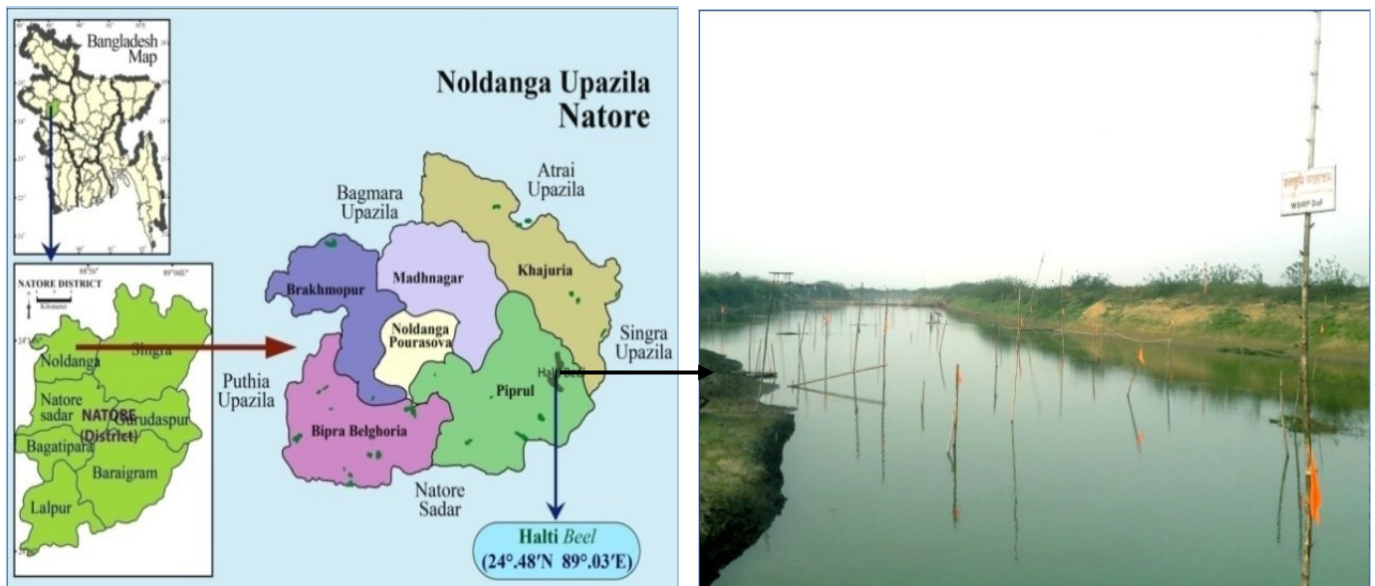


Figure 1. Location of the Halti Beel tank sanctuary, Bangladesh.

### Data analysis

Data collected during the study period were coded, summarized and processed for analysis. These data were verified to eliminate all possible errors and inconsistencies. The analysis of collected data was mainly based on tabular description technique. Tabular technique was applied for the analysis of data by using simple statistical tools like average, percentage and graphical presentation with the help of Microsoft Excel (version 2010).

## RESULTS AND DISCUSSION

### Recovery status of fisheries species

During the study period, a total of 71 fisheries species were recorded from Halti Beel Tank fish sanctuary (Plate 1). 62 species recorded were native and 9 were exotic species from 26 families of 11 orders, which was more or less similar to the findings of Hasan et al. (2013) and Mustafa and Ilyas (2012) who recorded a total of 73 and 79 fish species available in Baikka Beel and Ashura Beel fish sanctuary, respectively. Data reveals that before declaring as a fish sanctuary, a total of 36 (32 were native and 4 were exotic species) species were available in the Halti Beel Tank. However, after declaration as a sanctuary, 35 (native 30 and 5 exotic species) species were found newly available in the sanctuary area. Retrieval of fisheries species was also reported by Joadder et al. (2016) in Kumari Beel sanctuary (16 species) and Hasan et al. (2012) in Matshyarani fish sanctuary (32 species). Recovery rate in the present study was the highest for the order Siluriformes (11) followed by Cypriniformes (10), Perciformes (5), Osteoglossiformes (2), Cyprinodontiformes (1) and Channiformes (1) (Figure 2). Cypriniformes was the most diversified order with 24 species (18 native and 6 exotic species) followed by Siluriformes (total 17 species where 16 native and 1 exotic species), Perciformes (total 15 species, where 13 native and 2 exotic species), Channiformes (4), Decapoda (4), Osteoglossiformes (2), Beloniformes (1), Clupeiformes (1), Cyprinidon-

tiformes (1), Synbranchiformes (1) and Tetradontiformes (1). Mustafa and Ilyas (2012). also reported the dominance of Cypriniformes over other fish orders. Among the Cypriniformes, *Labeo rohita* played highest contribution (5.5%) in the production of Halti Beel tank sanctuary followed by *Catla catla* (4.5%), *Labeo bata* (4.1%) and *Amblypharyngodon mola* (3.5%). Dominance of carp species over the other species was also observed by Hasan et al. (2013) in Baikka Beel fish sanctuary.

It was also observed that among the native retrieved species, 17 species were common followed by 4 very common, 6 rare and 3 were very rare. Due to the adequate depth and water in dry season, proper supervision of sanctuary shelter and plenty of food, the unavailable fisheries species reappeared in a short time in the study area. Flura et al. (2015) observed 11, 16 and 47 fish species as very common, common and rare, respectively in the outside of Balla Beel fish sanctuary area which was slightly different from the present findings as because of the regain of some endangered (*Channa marulius*, *Eutropiichthys vacha*, *Chitala chitala*, *Badis badis*, *Monopterusuchia*, *Nandus nandus*, *Osteobrama cotio* and *Pangasius pangasius*) species in Halti Beel Tank fish sanctuary to a large extent that reduced the number of rare and very rare species. Moreover, before the declaration of the sanctuary, there were a total of 4 exotic fish species in that habitat, whereas after the declaration of habitat as fish sanctuary, 5 newly available fish species (*Ctenopharyngodon idella*, *Cyprinus carpio var. communis*, *Hypophthalmichthys molitrix*, *Oreochromis mossambicus* and *Pangasianodon hypophthalmus*) were found to appear in the sanctuary area (Table 1). That does not mean that those species are newly emerged in the Halti Beel Tank sanctuary. Basically, these species were recruited in the Chalan Beel area due to the flooding of aquaculture extension activities and different aquaculture intervention of Government in the rainy season (Galib et al., 2013). Therefore, the findings of the present study revealed that fish sanctuary not only enhanced fisheries diversity in Halti Beel Tank as well as in Chalan Beel.





Plate 1. An overview of the recorded fish species from Haldi Beel Tank sanctuary, Bangladesh.

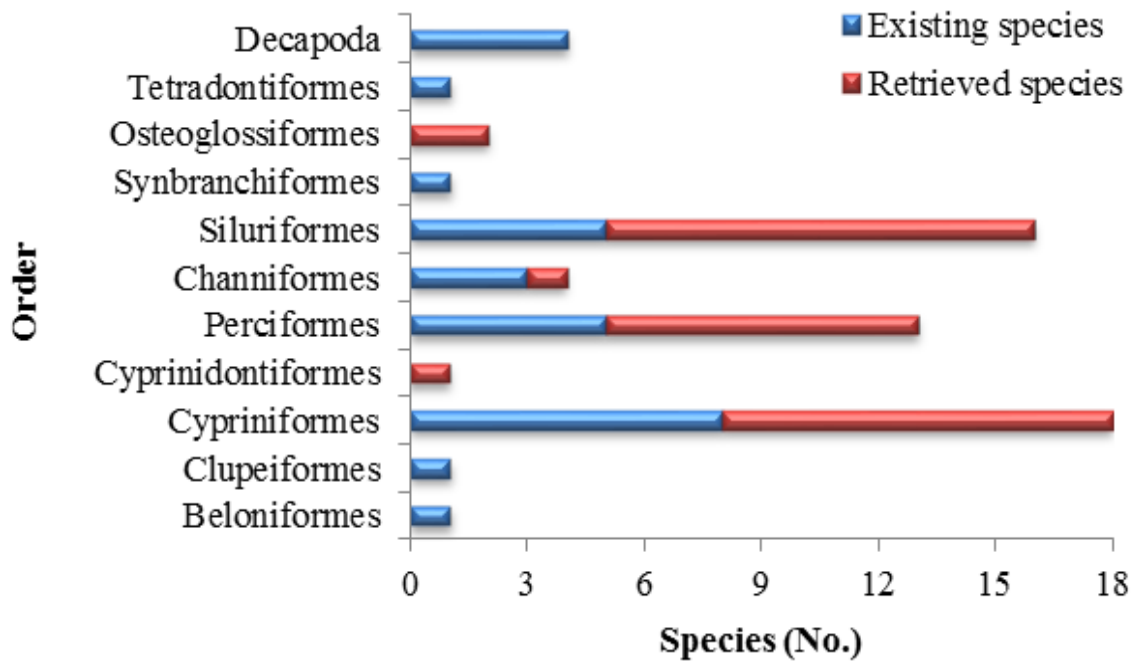


Figure 2. Existing and recovered fisheries species of Haldi Beel Tank sanctuary.

Table 1. Present status of fish species recorded from Halmi Beel tank sanctuary.

Order/Family	S.N.	Local name	Species name	Found		Abundance	Seasonal availability	Cont <sup>n</sup> (%)
				Before	After			
Native fish species								
Belontiiformes (Contribution in Beel Production 0.28%, Contribution in no. of species recorded 1.41%)								
Belontiidae	1	Kakila	<i>Xenentodon cancila</i> (Hamilton, 1822)	√	√	C	W	0.28
Clupeiformes (Contribution in Beel Production 1.3%, Contribution in no. of species recorded 1.41%)								
Clupeidae	2	Chapila	<i>Gudusia chapra</i> (Hamilton, 1822)	√	√	C	AS	1.3
Cypriniformes (Contribution in Beel Production 34.34%, Contribution in no. of species recorded 25.35%)								
Cyprinidae								
	3	Mola	<i>Amblypharyngodon mola</i> (Hamilton, 1822)	√	√	C	M	3.5
	4	Catla	<i>Catla catla</i> (Hamilton, 1822)	√	√	C	AS	4.5
	5	Mrigel	<i>Cirrhinus cirrhosus</i> (Day, 1878)	√	√	C	AS	3.15
	6	Tatkini	<i>Cirrhinus reba</i> (Day, 1878)	-	√	R	M	1.6
	7	Bata	<i>Labeo bata</i> (Hamilton, 1822)	-	√	C	AS	4.1
	8	Bhangon	<i>Labeo boga</i> (Hamilton, 1822)	-	√	VR	AS	0.27
	9	Calbaus	<i>Labeo calbasu</i> (Hamilton, 1822)	-	√	C	AS	0.75
	10	Rui	<i>Labeo rohita</i> (Hamilton, 1822)	√	√	VC	M	5.5
	11	Chola punti	<i>Puntius chola</i> (Hamilton, 1822)	-	√	VC	W	2.85
	12	Kanchan	<i>Pethia conchonus</i> (Hamilton, 1822)	√	√	C	PM	2.5
	13	Tit punti	<i>Pethia ticto</i> (Hamilton, 1822)	√	√	C	PM	2.85
	14	Sarpunti	<i>Systemus sarana</i> (Hamilton, 1822)	√	√	C	PM	0.35
	15	Dhela	<i>Osteobrama cotio</i> (Hamilton, 1822)	-	√	C	PM	0.17
	16	Chela	<i>Salmophasia bacaila</i> (Hamilton, 1822)	-	√	R	PM	0.4
Rasborinae	17	Darkina	<i>Esomous danricus</i> (Hamilton, 1822)	-	√	C	PM	0.3
Cobitidae	18	Bou mach	<i>Botia Dario</i> (Hamilton, 1822)	√	√	C	M	0.5
	19	Gutum	<i>Lepidocephalichthys berdmorei</i> (Blyth, 1861)	-	√	C	AS	0.25
	20	Gutum	<i>Lepidocephalichthys guntea</i> (Hamilton, 1822)	-	√	C	M	0.8
Cypridontiformes (Contribution in Beel Production 0.02%, Contribution in no. of species recorded 1.41%)								
Aplocheilidae	21	Pach chouka	<i>Aplocheilus panchax</i> (Hamilton, 1822)	-	√	R	PM	0.02
Perciformes (Contribution in Beel Production 11.57%, Contribution in no. of species recorded 18.31%)								
Ambassidae	22	Lal chanda	<i>Pseudambassis lala</i> (Hamilton, 1822)	-	√	C	PM	0.21

Table 1. Continued.....

23	Chanda	Chanda nama (Hamilton, 1822)	✓	✓	C	PM	0.45
24	Tak chanda	Parambasis ranga (Hamilton, 1822)	✓	✓	C	W	0.35
25	Koi	Anabas testudineus (Bloch, 1792)	✓	✓	C	M	1.4
26	Balia	Glossogobius giuris (Hamilton, 1822)	✓	✓	C	W	1.75
27	Khalisha	Trichogaster fasciata (Bloch and Schneider, 1801)	-	✓	C	W	0.6
28	Lal khalisha	Trichogaster lalius (Hamilton, 1822)	-	✓	R	W	1.15
29	Chuna khalisha	Trichogaster chuna (Hamilton, 1822)	✓	✓	VC	W	0.25
30	Bheda	Nandus nandus (Hamilton, 1822)	-	✓	C	M	0.31
31	Sal baim	Macrognaathus armatus (Lacepede, 1800)	✓	✓	C	M	1.25
32	Guchi	Macrognaathus pancalus (Hamilton-Buchanan, 1822)	✓	✓	VC	M	2.5
33	Tara baim	Macrognaathus aculeatus (Bloch, 1786)	✓	✓	VC	PM	1.1
34	Napit koi	Badis badis (Hamilton, 1822)	-	✓	C	W	0.25
Channiformes (Contribution in Beel Production 6.16%, Contribution in no. of species recorded 5.63%)							
35	Cheng	Channa orientalis (Bloch and Schneider, 1801)	✓	✓	C	W	0.24
36	Gajar	Channa marulius (Hamilton, 1822)	-	✓	VR	W	0.75
37	Taki	Channa punctata (Bloch, 1793)	✓	✓	VC	W	3.5
38	Shol	Channa striata (Bloch, 1793)	✓	✓	VC	AS	1.67
Siluriformes (Contribution in Beel Production 26.57%, Contribution in no. of species recorded 22.54%)							
39	Gura tengra	Rama chandramara (Hamilton, 1822)	✓	✓	C	AS	3.15
40	Talla ayre	Sperata aor (Hamilton, 1822)	-	✓	VC	AS	3.47
41	Guijia ayre	Sperata seenghala (Sykes, 1839)	-	✓	C	AS	1.45
42	Bujuri tengra	Mystus tengara (Hamilton, 1822)	✓	✓	VC	W	1.35
43	Rita	Rita rita (Hamilton, 1822)	-	✓	C	W	0.75
44	Magur	Clarias batrachus (Linnaeus, 1758)	✓	✓	C	M	1.55
45	Shing	Heteropneustes fossilis (Bloch, 1794)	✓	✓	VC	M	2.55
46	Pangas	Pangasius pangasius (Hamilton, 1822)	-	✓	R	W	0.24
47	Ghaura	Clupisoma garua (Hamilton, 1822)	-	✓	C	M	0.75
48	Bacha	Eutropichthys vacha (Hamilton, 1822)	-	✓	R	W	0.45
49	Batashi	Neotropius atherinoides (Bloch, 1794)	✓	✓	VC	W	2.65
50	Madhu pabda	Ompok pabda (Hamilton, 1822)	-	✓	C	AS	1.8
51	Kani pabda	Ompok bimaculatus (Bloch, 1794)	-	✓	C	W	0.75
52	Boal	Wallago attu (Bloch and Schneider, 1801)	-	✓	VC	W	3.5
53	Kaua tengra	Gagata cenia (Hamilton, 1822)	-	✓	C	PM	1.91

Table 1. Continued.....

	54	Telchitta	Glyptothorax telchitta (Hamilton, 1822)	-	✓	C	PM	0.25
Synbranchiformes (Contribution in Beel Production 0.4%, Contribution in no. of species recorded 1.41%)								
Synbranchidae	55	Kuchia	Monopterusuchia (Hamilton, 1822)	✓	✓	C	W	0.4
Osteoglossiformes (Contribution in Beel Production 4.4%, Contribution in no. of species recorded 2.82%)								
Notopteridae	56	Chital	Chitala chitala (Hamilton-Buchanan, 1822)	-	✓	VR	W	1.15
	57	Foli	Notopterus notopterus (Pallas, 1769)	-	✓	VC	PM	3.25
Tetradontiformes (Contribution in Beel Production 0.35%, Contribution in no. of species recorded 1.41%)								
Tetradontidae	58	Potaka	Tetraodon cutcutia (Hamilton, 1822)	✓	✓	C	AS	0.35
Decapoda (Contribution in Beel Production 4.89%, Contribution in no. of species recorded 5.63%)								
Palaemonidae	59	Small prawn	Macrobrachium dayanum (Henderson, 1893)	✓	✓	C	AS	4.89
	60	Small prawn	Macrobrachium lamarrei (Edwards, 1837)	✓	✓	C	M	
	61	Small prawn	Macrobrachium malcolmsonii (Edward, 1844)	✓	✓	C	AS	
	62	Giant prawn	Macrobrachium rossenbergii (De Man, 1879)	✓	✓	R	PM	
Exotic Fish Species								90.28
Cypriniformes (Contribution in Beel Production 7.07%, Contribution in no. of species recorded 8.45%)								
Cyprinidae	63	Bighead carp	Hypophthalmichthys nobilis (Richardson, 1845)	✓	✓	C	AS	0.75
	64	Grass carp	Ctenopharyngodon idella (Valenciennes, 1844)	-	✓	C	AS	0.82
	65	Common carp	Cyprinus carpio var. communis (Linnaeus, 1758)	-	✓	C	AS	1.6
	66	Scale carp	Cyprinus carpio var. specularis (Lacepède, 1803)	✓	✓	C	AS	1.15
	67	Silver carp	Hypophthalmichthys molitrix (Valenciennes, 1844)	-	✓	C	AS	2.1
	68	Thai Sarpunti	Barbonymus gonionotus (Bleeker, 1849)	✓	✓	C	AS	0.65
Perciformes (Contribution in Beel Production 1.50%, Contribution in no. of species recorded 2.82%)								
Cichlidae	69	Telapia	Oreochromis mossambicus (Peters, 1852)	-	✓	C	AS	0.75
	70	Nilotica	Oreochromis niloticus (Linnaeus, 1758)	✓	✓	C	AS	0.75
Siluriformes (Contribution in Beel Production 1.15%, Contribution in no. of species recorded 1.41%)								
Pangasiidae	71	Pangas	Pangasianodon hypophthalmus (Sauvage, 1878)	-	✓	C	W	1.15
								9.72



### Trend of fish production

During the year 2012-2013, fish production from 14.78 ha area of Haldi Beel Tank was 8.77 metric ton (MT). However, after the declaration of Haldi Beel Tank as fish sanctuary during the year 2013-2014, gradual increase in fish production was observed with a production of 10.12, 29.47, 35.10 and 37.50 MT during the year 2013-2014, 2014-2015, 2014-2015 and 2016-2017, respectively from the given catchable area of fish sanctuary (Figure 3). Therefore, increases in fish production indicated the positive impact of Haldi Beel Tank sanctuary. Along with fish sanctuary, other management interventions such as excavation, seasonal closing of fishing and dewatering, reduction in the use of destructive fishing by current *jal* (gill net) might also be the factors that contributed to the improvement in fish production. Intervention of fish sanctuaries to increasing fish production also recorded by Azher et al. (2007) in Dopi Beel fish sanctuary, whereas they reported a total production was increased of 1059 kg/ha within the period of 2003 to 2005. Mustafa and Ilyas (2012). estimated 117.26 kg/ha higher fish production from the base line survey data in their study area. Data also revealed that yearly fish production in Haldi Beel tank sanctuary increased 327.59% from the year 2013-2014 to 2016-2017, which was more or less similar to the findings of Ali and Thompson (2006), where they recorded 348.00% increasing of fish production in the sanctuary adopted in Turag Bangshi river. During the study period, establishment of fish sanctuary worked as a safe zone for successful breeding of fish species that might help in the increment of fish production in Haldi Beel Tank.

### Socio-economic development of fishermen

#### Financial status

Financial status of fishermen during the study period is shown in Figure 4. Before the declaration of fish sanctuary, monthly income for the majority (89.47%) of the fishermen were in the category of >BDT 3000 (35 USD), whereas 7.89% and 2.64% fishermen were in the category of BDT 3001-8000 (35-94 USD) and >BDT 10000 (118 USD), respectively. However, after the implementation of the sanctuary, majority of the fishermen (81.59%) entered into the monthly income category of BDT 3001-10000 (35-118 USD). Furthermore, 13.15% and 5.26% fishermen moved into the monthly income category of BDT

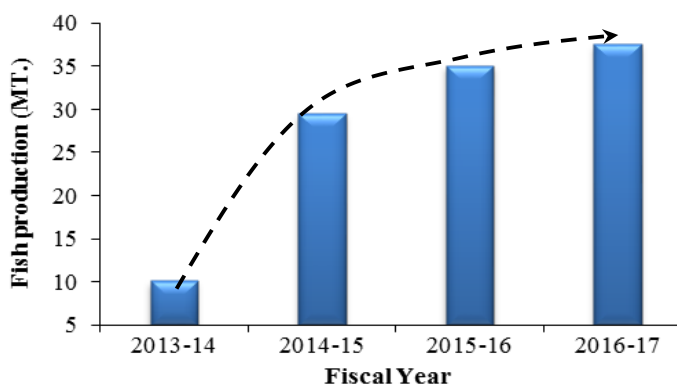


Figure 3. Fish Production Trends in Haldi Beel Tank sanctuary (Source: UFO, Noldanga, Natore).

10000-12000 (118-141 USD) and BDT 12001-15000 (118-177 USD), respectively which two income categories were absent before the sanctuary declaration of the study area. Increase in financial status of fishermen benefited by the establishment of sanctuary was also reported by Haque et al. (2012), where they found out that individual annual household income of 92% fishermen in Ghagot river fish sanctuary was increased due to their engagement in the catchment area of sanctuary.

#### Housing condition

Study reveals that before declaration of fish sanctuary, housing condition of 94.74% fishermen were in the category of *Katcha* tin shed (houses made with mud and tin as roof), whereas 3.63% and 1.58% had *Semi paka* (houses made with brick) and *Paka* tin shed (houses made with brick and tin shed as roof top), respectively (Figure 5). But after declaration, improvement in the housing condition was observed through the increasing use of *Semi paka* tin shed (26.32%) and *Paka tin shed* (21.05%) housing categories. Percentage of fishermen (52.63%) with the housing condition of *Kacha tin shed* were also found decreasing from the value observed before the study area was declared as fish sanctuary. Housing condition of the fishermen in the Chalan beel area was dominated by *Katcha* and *Semi paka* house (Kostori, 2012). Not only was that, housing condition of the fishermen of Bangladesh was not improved enough as evident from the findings of Paul et al. (2013), Farid et al. (2013), Kabir et al. (2013) and Rahman et al. (2016). However, improvement of the housing condition of the fishermen engaged in Hatil Beel Tank sanctuary justified the necessity of sanctuary for the betterment of the fishermen.

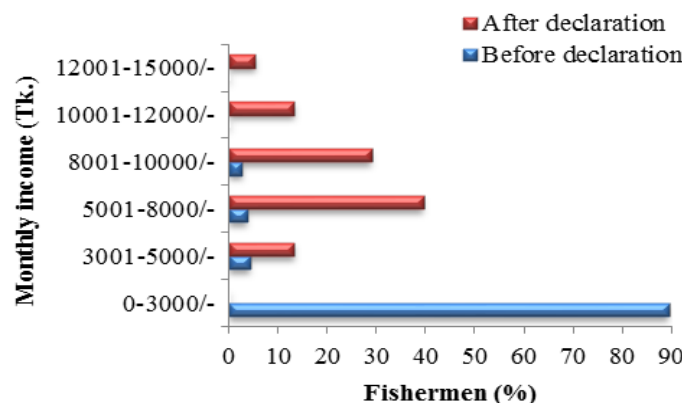


Figure 4. Before-after monthly income statuses of the fishermen from Haldi Beel Tank fish sanctuary.

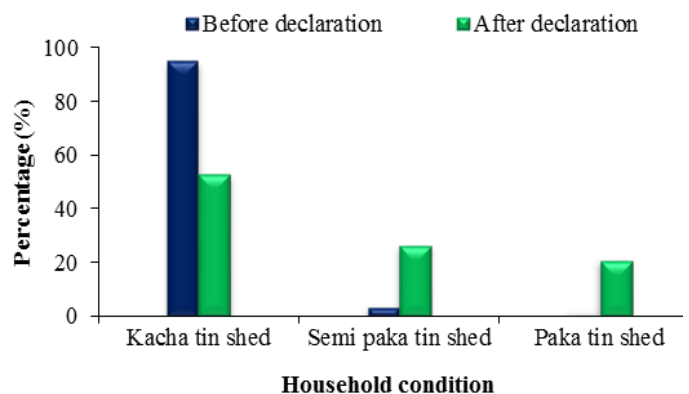


Figure 5. Before-after housing condition of the fishermen from Haldi Beel Tank sanctuary (n=190).



## Conclusion

To prevent the extinction of existing fisheries diversity and also in retrieving unavailable species establishment of fish sanctuary is necessary. Establishment and management of Haldi *Beel* Tank sanctuary resulted in the retrieval of 35 (native 30 and 5 exotic species) species which become newly available in the sanctuary area. Moreover, proper management of this sanctuary increased 327.59% fish production from the year 2013-2014 to 2016-2017. Besides, positive changes were being noticed in case of socio-economic condition of the involved fishermen.

**Open Access:** This is an open access article distributed under the terms of the Creative Commons Attribution NonCommercial 4.0 International License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author(s) or sources are credited.

## REFERENCES

- Ahmed, K. and Ahmed, M. (2002). Fish Sanctuary: Necessity, Concepts, Practices and Prospects, pp.136.
- Ali, M.L. and Thompson, P. (2006). MACH (Management of Aquatic Ecosystem through Community Husbandry). Wetland Protection and Enhancement through Sanctuaries in Bangladesh. Technical Paper 4. Dhaka. pp.1-22.
- Azher, S.A., Dewan, S., Wahab, M.A. Habib, M.A.B. and Mustafa, M.G. (2007). Impacts of fish sanctuaries on production and biodiversity of fish and prawn in Dopi beel, Joanshahi haor, Kishoregonj. *Bangladesh Journal of Fisheries*, 30: 23-36.
- DoF (Department of Fisheries). (2016). Fish Week Compendium. DoF, Ministry of Fisheries and Livestock, Government of Bangladesh: Dhaka. pp.1-148.
- Farid, B.M.S.A.B., Mondal, S., Satu, K.A., Adhikary, R.K. and Saha, D. (2013). Management and socio-economic conditions of fishermen of the Baluhar Baor, Jhenidah, Bangladesh. *Journal of Fisheries*, 1(1): 30-36.
- Flura, M., Alam, M.A., Rahma, M.A., Ahmed, T. and Roy, K.C. (2015). Ecology and water quality parameters of Balla *Beel* in Moulvibazar district of Bangladesh. *Asian Journal of Medical and Biological Research*, 1(2): 198-208.
- Galib, S.M., Naser, S.M.A., Mohsin, A.B.M., Chaki, N. and Fahad, F.H. (2013). Fish biodiversity of river choto Jauuna, Bangladesh: present status and conservation needs. *International Journal of Biodiversity and Conservation*, 5(6): 389-395.
- Haque, A.S.M., Nahiduzzaman, M., Hossain, M.A.R., Watton, C.C. and McWilliam, R. (2012). Impact of fish sanctuaries on rural poor community people in the Ghagot river, Rangpur, 5th Fisheries Conference and Research Fair, Dhaka, Bangladesh. pp.110.
- Hasan, M.A.N.G.M., Lucky, N.S. and Hossain, M.A.R. (2012). Natural food abundance and SIS biodiversity of Matshaya Rani Fish Sanctuary. *Journal of Environmental Science & Natural Resources*, 5(1): 319-328.
- Hasan, M.R., Kabir, M.R., Alam, M.M. and Reza, M.A. (2013). Present biodiversity status of freshwater loaches of Bangladesh. *Bangladesh Research Publication Journal*, 8(3): 203-214.
- Joadder, M.A.R., Alam, M.B., Siddique, M.A.B. and Naim, J. (2016). Present status of fish diversity in the Beel Kumari in relation to fish sanctuary and fishing gears. *Journal of Fisheries*, 4(2): 390-396, <http://dx.doi.org/10.17017/jfish.v4i2.2016.172>
- Kabir, K.M.R., Adhikary, R.K., Hossain, M.B. and Minar, M.H. (2013). Livelihood status of fishermen of the old Brahmaputra River, Bangladesh. *World Applied Sciences Journal*, 16(6): 869-873.
- Khan, M.A.R., Ali, M.M., Salam, M.A., Kunda, M. and Pandit, D. (2018). Impact of fish sanctuary on fish biodiversity and livelihoods of fishermen in Kolavanga *Beel* of Bangladesh. *World Journal of Fish and Marine Sciences*, 10(5): 46-54, <http://dx.doi.org/10.5829/idosi.wjfm.2018.46.54>
- Kostori, M.F. (2012). Socio-economic condition of fishermen of the Chalan Beel under Tarash thana of Sirajganj District in Bangladesh. *Bangladesh Research Publication Journal*, 6(4): 393-402.
- Mustafa, M.G. and Ilyas, M. (2012). Community based fish sanctuaries: improving fish biodiversity and protects inland fisheries of Bangladesh. pp 115-128. In: Wahab, M.A., Shah, M.S., Hossain, M.A.R., Barman, B.K. and Hoq, M.E. (eds.), Advances in Fisheries Research in Bangladesh: I. Proc. of 5th Fisheries Conference & Research Fair 2012. 18-19 January 2012, Bangladesh Agricultural Research Council, Dhaka, Bangladesh Fisheries Research Forum, Dhaka, Bangladesh. pp.246.
- Paul, B., Faruque, H. and Ahsan, D.A. (2013). Livelihood status of the fishermen of the Turag River, Bangladesh. *Middle-East Journal of Scientific Research*, 18 (5): 578-583, <http://dx.doi.org/10.5829/idosi.mejsr.2013.18.5.81139>
- Rahman, A., Alam, M., Mainuddin, K., Ali, L., Alauddin, S.M., Rabbani, M.G., Miah, M.M.U. Rabiuzzaman, M. and Amin, S.M.A. (2009). The probable impacts of climate change on poverty and economic growth and the options of coping with adverse effect of climate change in Bangladesh. Support to monitoring PRS and MDGs in Bangladesh, Planning Commission, Government of the People's Republic of Bangladesh & UNDP Bangladesh.
- Rahman, A.K.A. (2005). Freshwater fishes of Bangladesh (2nd ed.). Zoological Society of Bangladesh, Department of Zoology, University of Dhaka, Dhaka-1000.
- Rahman, M.B., Hoque, M.S., Mukit, S.S., Azam, M. and Mondal, M. (2016). Gears specific Catch Per Unit Effort (CPUE) with special reference to declining causes of ichthyofauna in the Kajal River of Southern Bangladesh. *International Journal of Fisheries and Aquatic Studies*, 4(2): 382-387.
- Talwar, P.K. and Jigran, A.G. (1991). Inland Fishes of India and Adjacent Countries. Oxford and IBH Publishing Company, Volume No. 2, New Delhi. pp.936-1023.
- Nelson, J.S., 2006. Fishes of the World, 4th Edition. New Jersey: John Wiley & Sons Inc.