



Sixth sanctuary identification research and establishment strategy for enhancing production and conservation management of Hilsa (*Tenualosa ilisha*) in Bangladesh

Rahman M.A.¹; Pramanik M.M.H.^{1*}; Flura¹; Hasan M.M.¹; Ahmed T.¹; Alam M.A.¹; Hasan S.J.¹; Rahman B.M.S.¹; Haidar M.I.¹; Rashid M.H.¹; Zaher M.²; Khan M.H.¹; Mahmud Y.²

Received: April 2023

Accepted: August 2023

Abstract

Hilsa is the national pride of Bangladesh. In the last few decades, production of Hilsa has declined rapidly due to various natural and artificial factors (Reduced River erosion, environmental degradation, arbitrary erosion, and over-harvesting of Jatka). To overcome this Govt. of Bangladesh has taken some excellent initiatives; the sanctuary establishment is one of them. The present study was conducted from 2010 to 2015 at five sampling sites along the five (5) tributaries of the Meghna River in Barisal District, Bangladesh. In periodic months, data including length-weight, and CPUE of Hilsa fish (Hilsa Larvae and Jatka) were randomly collected from fisherman's commercial catch and BFRI's experimental catch at each sampling site. CPUE of Jatka was found to be gradually increased from 2.0 to 3.25 kg/100m net/Haul. The river water Temperature, dissolved oxygen (DO), Free carbon dioxide (CO₂), pH, Total hardness, Total alkalinity, Conductivity, and Ammonia were found suitable for the biodiversity of the River. It has been shown that the abundance of phytoplankton is high, which ensures the abundance of fish food. Based on the BFRI research results, it was recommended to establish the 6th (Six) Hilsa Sanctuary in the region covering a total area of 82 km which was declared by the Ministry of Fisheries and Livestock.

Keywords: Sanctuary, Conservation, Hilsa, Meghna River, CPUE

1-Bangladesh Fisheries Research Institute, Riverine Station, Chandpur 3602, Bangladesh

2-Bangladesh Fisheries Research Institute, Headquarter, Mymensingh 2201, Bangladesh

*Corresponding author's Email: mehedibfri@gmail.com

Introduction

The national fish Hilsa are the holders and carriers of our heritage. From time immemorial, fish have played a unique role in our national economy, employment, and food supply system. Hilsa contributes about 12.2% of the total fish production of the country. The annual production is about 5.65 lakh MT. The contribution of Hilsa fish to the GDP is about 1% (DoF, 2022).

In the last few decades, production of Hilsa has declined rapidly due to various natural and artificial factors (Reduced River erosion, environmental degradation, arbitrary erosion, and over-harvesting of Jatka). Several management strategies (Jatka conservation) prohibiting the collection of Hilsa fish in the peak breeding season and establishing a sanctuary are being implemented to maintain fish production to a bearable level (Miah, 2015).

Research like the on-board breeding trial of Hilsa, ban program implementation in established sanctuaries and breeding grounds, identification, and establishment of the new shelter (Sanctuary), assessing the impact of alternative employment, Hilsa habitat assessment is being conducted by Bangladesh Fisheries Research Institute, Riverine station, Chandpur (Amin *et al.*, 2002). Sanctuary is a safe habitat for fish where fish are at some stage of their life, live safely, reproduce, and grow by taking food. Fishing is prohibited at any specific time or throughout the year, to preserve safe fish habitats, in a particular part of a wetland. The main objectives of the Sanctuary declaration are: Protecting

fish from exploitation and creating opportunities for free reproduction and migration.

Through this, renewable production will be maintained along with increased production and preservation of biodiversity (Rahman, 2015; Mahmud, 2022). Small Hilsa fish up to 25 cm in size is usually called Jatka in our country. Due to the over-harvesting of Jatka, the Ministry of Fisheries and Livestock (MoFL) banned the capture and marketing of 25 cm size Hilsa. Study of RS, BFRI shows that since 1986, Hilsa fish have been overfishing indiscriminately (Arbitrarily catching Brood Hilsa) (Amin *et al.*, 2008). Because of this, the process of reintroduction of new generation of fish or probation was being disrupted (Arbitrarily catching of Jatka). To overcome this situation, in 2003-04, four sanctuaries (the main migration areas of the Jatka/juvenile Hilsa) were announced in the Meghna, Tetulia, and Andharamanik Rivers. Later 2010-2011, the 5th sanctuary (Abhyasram) was declared in the area of 20 km of Padma River situated in Vedarganj Upazila of Shariatpur district (Rahman *et al.*, 2017).

Jatka conservation through the establishment of sanctuaries has increased the overall production of Hilsa fish in the country (DoF, 2014). To determine the impact of sanctuaries on Hilsa and Jatka production, research is being conducted continuously from the BFRI, Riverine station, Chandpur. In this context, by establishing a new sanctuary in the river of Meghna in the Hizla area of the Barisal district, it will

be easier to successfully support the Jatka and keep up the pace of the production of Hilsa.

Hilsa sanctuaries establishment History

The context of the establishment of the First four Hilsa sanctuaries (in Meghna, Tetulia, and Andharamanik rivers)

Jatka is found in about 100 rivers within the country. Every year from November to May, the Jatka wandering season. But the highest amount (60-70%) of Jatka is caught in March and April (BFRI/RS 1994). The Jatka ban period is determined by considering the socio-economic status of fishermen, alternative employment, and other factors. Jatka fishing is banned every year by the government from March to April and November to January. For this purpose, a declaration of the sanctuary is required. Five sanctuaries in the country were established by the government through a gazette notification in 2005 to protect the Jatka. The fifth sanctuary was announced in a 20 km area of the Padma River in Vedarganj (Shariatpur District). All types of fishing, including Jatka, are prohibited in the five sanctuaries during certain times of the year. It increases the production of the Hilsa and enriches the biodiversity of the river. Fishing is prohibited at the following times in the sanctuaries (Table 1 and Fig. 1).

The foundation and context of the establishment of the 5th Hilsa Sanctuary in the Padma River

Bangladesh Fisheries Research Institute, River Station, had been conducting continuous research for three years. Standard experimental gillnets of 100 m length were used during March-April. Comparative abundance is estimated through Jatka caught (Experimental) from the Padma and Meghna Rivers. An hour's hauling found 2 to 31 Jatka from the Padma River. On average, eight (8) Jatka were found in the Padma River and 28 in the Meghna River at the same time. A maximum of 31 Jatka were found in the Tarabunia region in the lower Padma River of Shariatpur district and two (2) in Sureshwar (Table 2). Due to the lack of Jatka abundance, the Sureshwar region was not included in the sanctuary. Although the number of Jatka is relatively low in the mentioned areas, for a long time, fishermen and businessmen of the Padma River area had demanded a public declaration for a sanctuary to increase the production of fish in the river Padma. The 5th Sanctuary was announced along the 20 km area of Padma River in the Vedarganj area of Shariatpur district so that the Jatka abundance will increase further in that area. The 5th Sanctuary was established in 2010-2011. All types of fishing, including Jatka, are banned at the sanctuary every year from March to April (Rahman *et al.*, 2013).

Table 1: The facts on the first to fourth Hilsa sanctuaries under HFMAP in the first phase on Meghna, Tentulia, and Andharmanik rivers, the fifth on Padma River in the second phase, and the sixth Hilsa sanctuary on the Meghna River in the third phase; which are the research findings recommended by BFRI (With the time of the Fishing ban, River Name and Location).

Sanctuary No.	Sanctuary area	Area Length (km)	River	District	Established Link	Established Year	Fishing Prohibition Period
1	From Shatnol in Chandpur district to Char Alexander in Laxmipur district (100 km area of river basin)	100	Meghna	Chandpur-Laxmipur			March to April every year
2	From Madanpur/Char Elisha to Char Pial in Bhola district (90 km area of Shabazpur branch of Meghna River)	90	Meghna	Bhola	Hilsa Fisheries Management Action Plan (HFMAP)	2002-03	March to April every year
3	From Veduria in Bhola District to Char Rustam in Patuakhali District (about 100 km area of Tentulia River)	100	Tentulia	Patuakhali	Prepared by: BFRI Implemented by: DoF Supervised by: MoFL		March to April every year
4	40 km area of Andharamanik River in Kalapara Upazila of Patuakhali district	40	Andharmanik	Patuakhali			November to January every year

5th sanctuary announced and established in 2010-2011:

5	20 km area of lower Padma River located in Vedorganj Upazila of Shariatpur district	20	Padma	Shariatpur	Prepared by: BFRI Implemented by: DoF Supervised by: MoFL	2010-11	March to April every year
6	82 km area between three different River point of Barisal districts.	82	Meghna River Branch (Kalabador, Noyavanganj, Dharmaganj, Arial Khan River)	Boreal	Prepared by: BFRI Implemented by: DoF Supervised by: MoFL	2018	March to April every year
Source:	Sanctuary Number 1 to 5: Bangladesh gazette, 27 November 2014, MOFL through SRO 269-law/2014 Sanctuary Number 6: Bangladesh gazette, 13 September 2018, MOFL through SRO 268-law/2018						

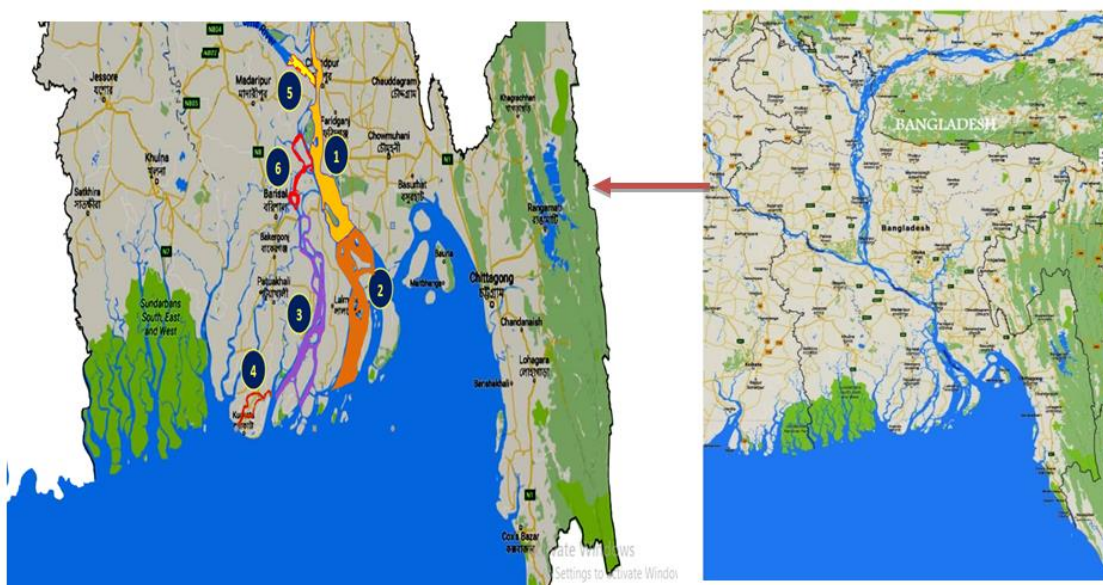


Figure 1: Hilsa sanctuary map: One to six number.

Materials and Methods

The research was conducted by Bangladesh Fisheries Research Institute, Riverine Station, Chandpur with the aim of establishing a sanctuary to increase the production of Hilsa (larvae and Jatka).

Site Selection

Five sample sites in the Barisal district along the tributaries of the Meghna River (Kalabador and Meghna River) at Hizla, Mehendigonj and Barisal Sadar were selected for the present study. BFRI Hilsa research team with a speedboat and research vessel 'MV Rupali Ilish' visited selected sites for extensive research. In periodic months, data including length-weight, and CPUE of Hilsa fish (Hilsa Larvae and Jatka) were randomly collected from fisherman's commercial catch and BFRI's experimental catch at each sampling site.

Study Duration

The present study was conducted from 2010 to 2015 at five sampling sites along the 5 tributaries of the Meghna River in Barisal District, Bangladesh.

Observation of Jatka abundance in the river

To determine the abundance of Jatka, the research team visited the area in February, March, and April every year, and collected regular sample data. Two types of experimental nets developed by BFRI, Riverine station, Chandpur have been used. One hour of hauling was done experimentally with two types of experimental standard nets namely:

- i. Spawn Jatka (Behundi net for catching Jatka of 1-3.5 cm length size)
- ii. Juvenile Jatka (10-25 cm length Jatka catch net)

One-hour of hauling is done experimentally with these two types of experimental nets.

River water quality monitoring

The Hilsa research team regularly collects samples and tests to determine the status of water quality criteria. River air and water Temperature, Transparency, Dissolved Oxygen, Free carbon dioxide, pH, Total hardness, Total alkalinity, Conductivity, and Ammonia were tested.

The data obtained was analyzed to determine the quality of river water in the declared new area. Good Water quality serves as the indicator of maintaining a safe and healthy environment for the fish.

Plankton observation of River water

The river water plankton has been collected regularly to monitor the status of natural foods in the water. There are two types of plankton:

- (1) Phytoplankton
- (2) Zooplankton

Samples were collected with a 50-micron plankton net. Abundant fish food serves as an indicator of the natural food quality of fish.

Determining the boundaries of the declarable area of the 6th (Six) Hilsa sanctuary

The GPS points and boundaries of the new declarable areas were determined by verifying and observing the data from Jatka CPUE, water quality, and plankton studies in the 60 km areas.

Result and discussion

BFRI, Riverine station, Chandpur conducted the research for five consecutive years to set up a new sanctuary in Hilsa. Research showed that the water quality of the river and the plankton of the river water were favorable for Jatka. The abundance of Jatka in the river was also substantial. Subsequently, the site selection and GPS quality were identified for setting up the sanctuary.

Observation of Jatka abundance in the river

The Hilsa research team collected regular sampling data from specific areas from March-April and October-November. In the first phase, Jatka with a length range of 0.9 to 3.5 cm and a weight range of 0.01 to 0.60+ g was observed using an experimental Behundi net. In the second phase, Jatka in the length range of 10 to 25 cm and weight range of 12 g to 160 g were observed with the experimental nets of 2.5 to 3.5 cm mesh size. In one hour of hauling, 3.25 kg CPUE of Jatka was obtained (Tables 2 to 4).

Water quality observation of river

The river water temperature, river water clarity, dissolved oxygen, free carbon dioxide, pH, hardness, total alkalinity, conductivity, and ammonia were tested continuously from 2010 to 2015 by the Hilsa research team. Analyzing the obtained data, it was found that the values of all the parameters tested were suitable for the biodiversity of the river (Table 5).

Plankton observation of river water

Plankton of river water is regularly collected and tested with 50-micron plankton nets to monitor natural food availability in the water. Phytoplankton

and zooplankton, these two types of food particles have been tested and it has been shown that the abundance of phytoplankton is high, which ensures the abundance of fish food (Tables 6 and 7).

Table 2: Enumeration of Spawn Jatka caught with experimental standard Behundi nets for monitoring Jatka (length Range: 1-3.5 cm) abundance in Meghna and Meghna tributaries at the Hizla-Mehendiganj region of Barisal.

Sl. No.	Spawn Jatka (1-3.5 cm)						Period: 2010-2015 (annually)		
	Length Range (cm)	Weight Range (g)	Single Juvenile Jatka				Number of fish caught /Haul	Used Net	Duration
			Maximum length (cm)	Minimum length (cm)	Maximum Weight (g)	Minimum weight (g)			
1	1-1.5	0.01-0.15					20-25 25-30	BFRI, RS	October-November
2	1.5-2	0.10-0.20					30-35		
3	2-2.5	0.20-0.30	3.85	0.90	0.60	0.01	35-40	Experimental Juvenile Jatka Net	March-April
4	2.5-3	0.30-0.40					40-45		
5	3-3.5	0.40-0.50					40-45		
6	3-3.5	0.50-0.60					45+		
7	3.5+	0.60+					45+		

Table 3: Enumeration of Spawn Jatka caught with experimental standard BFRI, RS Experimental Juvenile Jatka Gill net and professional fishermen Gill nets (Nylon/Monofilament, Gill Mesh: 25-65 cm) for monitoring Jatka (length Range: 10-25 cm) abundance in Meghna and Meghna tributaries at the Hizla-Mehendiganj region of Barisal.

Sl. No.	Jatka (10-25 cm)						Period: 2010-2015 (annually)	
	Length Range (cm)	Weight Range (g)	Single Juvenile Jatka				Operation and data collection time	Used mesh
			Maximum length (cm)	Minimum length (cm)	Maximum Weight (g)	Minimum weight (g)		
1	10-15	10-40					March-April	BFRI, RS Experimental Juvenile Jatka Net and Nets used by professional fishermen
2	15-20	40-90						
3	20-25	90-160	25	10	160	12		

Table 4: Enumeration of Spawn Jatka caught with experimental standard BFRI, RS Experimental Juvenile Jatka Gill net (Nylon/Monofilament, Gill Mesh: 25-65 cm, Net Length: 100m) for monitoring Jatka (length Range: 10-25 cm) CPUE (100m Net/Haul/Kg) in Meghna and Meghna tributaries at the Hizla-Mehendiganj region of Barisal.

Jatka (10-25cm)		
Sl. No.	CPUE range of harvested Jatka (kg)	Year
1	2.0-2.40	2010
2	2.20-2.50	2011
3	2.50-2.70	2012
4	2.60-2.90	2013
5	2.80-3.10	2014
6	3-3.25	2015

Table 5: Water quality monitoring of Meghna and Meghna tributaries Rivers in the Hizla-Mehendiganj region of Barisal district.

Parameter	2010	2011	2012	2013	2014
Air Temperature ($^{\circ}\text{C}$)	23-31	22-30	22.1-30	22.5-30	17.5-30.5
Water Temperature ($^{\circ}\text{C}$)	22-29	21-30	21-28	21.1-28	17-30
Water Transperancy (cm)	18-32	16-36	18-38	21-40	22-40
Oxygen (mg/litre)	5.5-6.8	5.5-7	5.5-7.2	5.2-7.2	5.6-6.8
Free carbon-dioxide (mg/L)	6.56 -11	6.5-12	8.5-13.5	8.9-16	8.5-11.7
pH	7.5-8.2	7.5-8.5	7.5-9.0	7.8-9.5	7.5-9.0
Total Hardness (mg/L)	60-101	40-70	49-92	45-100	50-98
Total Alkalinity (mg/L)	35-86	30-75	28-69	35-76	32-78
Conductivity ($\mu\text{S}/\text{cm}$)	170-200	160-200	175-185	175-210	185-220
Ammonia (mg/lL)	0.0	0.0	0.0	0.0	0.0

Table 6: Monitoring of the plankton abundance in Meghna and Meghna tributaries at the Hizla-Mehendiganj region of Barisal district

Sl. No.	Year	Total Plankton	Phytoplankton	Dominating Phytoplankton	Zooplankton	Dominating Zooplankton
1	2010	350×10^2	328×10^2		22×10^2	
2	2011	420×10^2	386×10^2		34×10^2	
3	2012	433×10^2	387×10^2	<i>Ulothrix</i>	30×10^2	<i>Brachionus</i>
4	2013	428×10^2	389×10^2		39×10^2	
5	2014	450×10^2	418×10^2		32×10^2	

Table 7: List of phytoplankton and zooplankton found in Meghna and Meghna tributaries at the Hizla-Mehendiganj region of Barisal district.

Phytoplankton	
Group	Genus Name
Bacillariophyceae	<i>Coscinodiscus sp.</i> , <i>Melosira sp.</i> , <i>Biddulphia sp.</i> , <i>Cyclotella sp.</i> , <i>Striatella sp.</i> , <i>Cosmarium sp.</i>
	<i>Climacosphenia sp.</i> , <i>Cymbella sp.</i> , <i>Nitzschia sp.</i> , <i>Synedra sp.</i> , <i>Diatoma sp.</i> , <i>Tabellaria sp.</i> , <i>Skeletonema sp.</i> , <i>Hannaea sp.</i> , <i>Navicula sp.</i>
Chlorophyceae	<i>Oedogonium sp.</i> , <i>Ankistrodesmus sp.</i> , <i>Microspora sp.</i> , <i>Tetraspora sp.</i> , <i>Mougeotia sp.</i> , <i>Raphidonema sp.</i> , <i>Spirogyra sp.</i> , <i>Volvox sp.</i> , <i>Staurastrum sp.</i> , <i>Closterium sp.</i> , <i>Tetrapedia sp.</i> , <i>Sorastrum sp.</i>
Myxophyceae	<i>Oscillatoria sp.</i>
Cyanophyceae	<i>Microcystis</i> , <i>Phormidium sp.</i>
Mediophyceae	<i>Stephanodiscus sp.</i>
Cryophyceae	<i>Uroglena sp.</i>
Euglenophyceae	<i>Phacus sp.</i>
Centrohelea	<i>Acanthocystis sp.</i>
Zooplankton	
Rotifera	<i>Tricocera sp.</i> , <i>Lecane sp.</i> , <i>Brachionus sp.</i> , <i>Asplancha sp.</i> , <i>Tetrasiphon sp.</i>
Protozoa	<i>Euglena sp.</i> , <i>Diffugia sp.</i> , <i>Arcella sp.</i> , <i>Monostyla sp.</i>
Copepoda	<i>Cyclops sp.</i>
Ostracoda	<i>Cyclocypris sp.</i>
Ciliophora	<i>Paramecium sp.</i>
Cercozoa	<i>Euglypha sp.</i>

Determining the boundaries of the declarable area of the sixth Hilsa sanctuary (Location selection and identification)

The research was carried out in the area of Nachakati, Harinathpur, Dhulkhola Point of Hizla Upazila of Barisal District, and Bhashanchar Point of Mehendiganj Upazila covering an area of about 70 km.

The boundaries of the new declarable areas were determined by verifying and checking data from Jatka CPUE, water quality, and plankton studies.

Based on the 1st, revised 2nd, and final proposals sent by BFRI to MFOL, the boundary map of the 6th (Six) sanctuary (Abhayashram) has been specified by research to declare and establish (Fig. 2).

Institutional initiatives for implementation in the 6th Sanctuary

Later, in 2016, a meeting on the sixth sanctuary was held at the Department of Fisheries. According to the decision of the meeting, representatives of MOFL, Bangladesh Fisheries Department, World Fish, and Bangladesh Fisheries Research Institute visited the site. Collectively, it was decided to set up a

sixth sanctuary covering an area of 70 km.

Later, after surveying the ground, a proposal was presented to set up the sixth Hilsa sanctuary in a total area of 70 km in revised form by adding Kalabadar/Ariyal Khan River and adding another 10 km area. In a further review in 2017, the length of the sanctuary was increased from 70 km to 82 km considering into the account the geographical conditions of the area, fishing population, and Jatka fishing base. Later, a proposal was submitted by BFRI to MOFL to establish a 6th (Six) Hilsa Sanctuary in a revised form covering a total area of 82 km.

Based on the recommended proposal of BFRI, in a notification issued by MOFL on 17 April 2018, the 6th sanctuary was added in SRO107-law/2018 as number 06. Two months allowed for no objection clearance/consultation (if any) regarding sanctuary. (Fig. 2-B). Later, 13 September 2018, MOFL through SRO 268-law/2018 finally declared the 6th (Six) sanctuary with a length of 82 km. (Fig. 2-C).

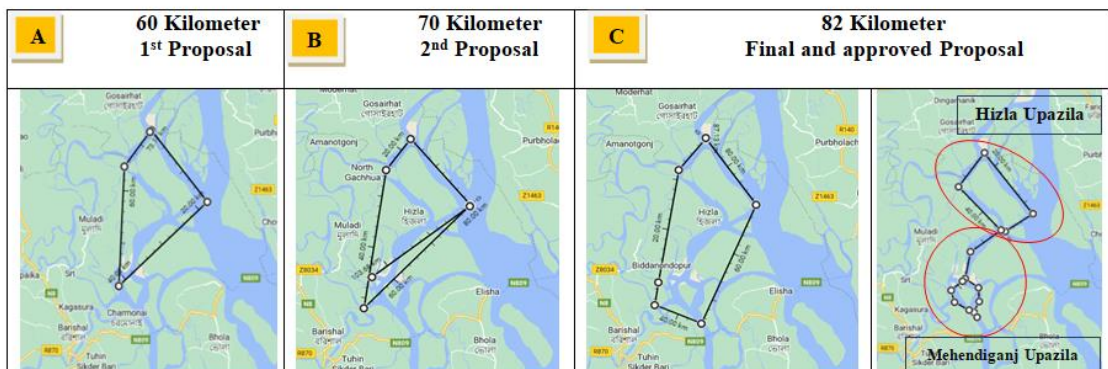


Figure 2: Based on the 1st (A), revised 2nd (B) and final proposals (C) sent by BFRI to MFOL, the 6th (Six) Sanctuary (Abhayashram) demarcated map.

Key Findings of the BFRI Study and Establishment of the Sixth sanctuary

- (a) There is an abundance of Jatka in the Rivers of the sanctuary area.
- (b) The abundance of plankton is also observed which ensures abundant fish food.
- (c) All river water quality levels are suitable for river biodiversity. Based on the overall results, the environment of the area is favorable for Jatka.
- (d) Overall, the environment of the area is favorable for Jatka.
- (e) BFRI Riverine station conducted research for 5 years from 2010-2015 with the aim of sustainable production of Hilsa fish. Based on the research results, it is recommended to establish the 6th (Six) Hilsa Sanctuary in the region.
- (f) Based on the recommended proposal of BFRI, in a notification issued by MOFL on 17 April 2018, the 6th sanctuary was added in SRO107-law/2018 as number 06. Two months allowed for no objection clearance/consultation (if any) regarding sanctuary.
- (g) Later on, 13 September 2018, MOFL through SRO 268-law/2018 finally declared the 6th (Six) sanctuary with a length of 82 km.

Conclusions

Hilsa is the national pride for Bangladesh which is now globally recognized as GI product. To conserve and manage sustainably the following should be done:

- i) To increase the production of Hilsa, excess exploitation of brood Hilsa and Jatka should be stopped.
- ii) It is essential to create and maintain opportunities for the free reproduction of fish.
- iii) Measures should be taken to preserve the biodiversity of the river.
- iv) Relevant research should be continuously conducted.

Acknowledgement

The authors are sincerely grateful to the concerned staff of BFRI, Chandpur Riverine Station such as Field Assistant, Lab Technician, Computer Operator.

Funding Statement

This research work was supported by the Ministry of Fisheries and Livestock (MoFL, Government of the People's Republic of Bangladesh) and funded by 'Jatka Conservation, Alternate Income Generation for the Jatka Fishers and Research Project (BFRI Part) (2008-2015)' of Bangladesh Fisheries Research Institute (BFRI), Bangladesh.

References

- Amin, S.M.N., Rahman, M.A., Haldar, G.C., Mazid, M.A. and Milton, D., 2002.** Population dynamics and stock assessment of Hilsa shad, *Tenualosa ilisha* in Bangladesh. *Asian Fisheries Science*, 15(2), 123-128. DOI: 10.33997/j.afs.2002.15.2.003
- Amin, S.M.N., Rahman, M.A., Haldar, G.C., Mazid, M.A. and Milton, D.A., 2008.** Catch per unit effort, exploitation level and

- production of hilsa shad in Bangladesh waters. *Asian Fisheries Science*, 21(2), 175-187. DOI: 10.33997/j.afs.2008.21.2.004
- BFRI/RS, 1994.** Bangladesh Fisheries Research Institute, Riverine Station. Hilsa Fisheries Development and Management. Annual Report. BFRI/RS 94.
- DoF, 2014.** Fishery statistical yearbook of Bangladesh. Fishery Resources Survey System, Department of Fisheries, Ministry of Fisheries and Livestock, Bangladesh. 56P.
- DoF, 2022.** National Fish Week Compendium (in Bengali), Department of Fisheries. Ministry of Fisheries and Livestock, Bangladesh. 92P.
- Mahmud, Y., 2022.** Hilsa Fisheries Research and Development in Bangladesh. Bangladesh Fisheries Research Institute Ministry of Fisheries and Livestock. 322P.
- Miah, M.S., 2015.** Climatic and anthropogenic factors changing spawning pattern and production zone of Hilsa fishery in the Bay of Bengal. *Weather and Climate Extremes*, 7, 109-115. DOI: 10.1016/j.wace.2015.01.001
- Rahman, M.A., Rahman, B.M.S., Hasan, S.J., Flura, Ahmed, T. and Haider, M.I., 2013.** Impact of eleven days fishing ban in the major spawning grounds of Hilsa (*Tenualosa ilisha*, Hamilton) on its breeding success. *Bangladesh Research Publications Journal*, 9(2), 116-122.
- Rahman, M.A., 2015.** Status of conservation and migration of Hilsa in the Meghna River Estuary and its potential of breeding for stock enhancement and aquaculture. ECOFISHBD Project. 1st Year Annual Research Progress Report, BFRI, RS, Chandpur. 145P.
- Rahman, M.A., Pramanik, M.M.H., Flura, Ahmed, T., Hasan, M.M., Khan, M.H. and Mahmud, Y., 2017.** Impact assessment of twenty-two days fishing ban in the major spawning grounds of *Tenualosa ilisha* (Hamilton, 1822) on its spawning success in Bangladesh. *Journal of Aquaculture Research and Development*, 8(6), 1-12. DOI: 10.4172/2155-9546.1000489