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PRESENT STATUS, PROSPECTS AND CONSERVATION OF HILSA, *Tenualosa ilisha* (CLUPEIFORMES: CLUPEIDAE) FISHERY IN BANGLADESH

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ABSTRACT

Belonging to the family Clupeidae, hilsa shad *Tenualosa ilisha* (Hamilton, 1822) is an important fish species in the South and Southeast Asia, especially in Bangladesh. Due to its unique nature, the fish has gained national and international demands for its nutritional values, taste qualities, special aroma and high delicacy, and provides livelihoods to the millions of fishers directly or indirectly along the coastal and riverine stretches in its range of natural distribution. It is considered as the national and most important commercial fish species of Bangladesh and contributes significantly to the national economy. In this study, an attempt is made in evaluating the data currently available on hilsa to determine the impact of the current management approaches and improvement strategies of this important fishery. Hilsa is found primarily in marine and estuarine environments, but it has been declining gradually over the last 30 years, reaching a low point in 1991-1992 and continuing until 2002-2003. Recognizing the declining trend of hilsa, the government took action to increase production by implementing regulations on jatka (juvenile) catch and restrictions on brood hilsa catch during the breeding season. As a result, total hilsa catch increased from 2.55 million MT (metric ton) in 2003-04 to 3.94 million MT in 2015-2016. Under the Protection and Conservation of Fish Act of 1950, Hilsa production peaked in 2016-

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2017, with a total of 4.96 lakh metric tons. Hilsa management techniques contribute 12.9% of all fish produced, while in Bangladesh, the rate of increase in hilsa production is 25.69%. The annual increase of total hilsa production climbed from 3.5% to 9.0% after 2015 as a result of the government's general management activities, payments for ecosystem service (PES) and the environmental management strategies, resulting in annual total hilsa production of 5.50 lakh MT in 2019–2020. A number of recommendations for effective management of the hilsa fisheries that might be implemented into the national policy are elicited in order to improve the situation because the current hilsa management plan has an impact on the conservation of this important fishery to a greater extent in commensurate with its national and international demands.

Keywords: Hilsa fishery; management strategies; conservation measures; economic incentives; Bangladesh.

1. INTRODUCTION

"Hilsa, a member of migratory fish, is belonging to the genus *Tenualosa* under the Clupeidae family of the order Clupeiformes. The fish, locally known as Ilish, has been designated as Bangladesh's national fish" [1, 2]. "The body is strongly compressed and moderately deep, with a convex dorsal and ventral profile. There is a distinct median notch in the upper jaw. The metallic silver-colored body is covered with regular medium-sized scales and the body length can reach 60.0 cm, but most specimens are 35.0-40.0 cm in length" [2]. "A large hilsa weighs approximately 2.5 kg, and the females typically grow faster and are usually larger than males" [2, 3]. "The hilsa is a fast swimmer who reaches maturity in one to two years" [4]. "Hilsa has a wide distribution in marine, estuarine, and riverine environments and can be found in the Persian Gulf, the Red Sea, the Arabian Sea, the Bay of Bengal, the Vietnam Sea, the China Sea, the Satil Arab, the Tigris and Euphrates of Iran and Iraq, the Indus of Pakistan, the rivers of Eastern and Western India, the Irrawaddy of Myanmar, and the Padma, Jamuna, Meghna, Karnafully, and other coastal rivers of Bangladesh including all parts of the riverine habitat" [1, 3, 5]. Hilsa can grow up to 60.0 cm long and 3.0 kg in weight at the age four. However, they are most frequently found at a length from 35 to 40 cm with less than 1.0 kg in weight. Specifically, during the southwest monsoon and the ensuing river flooding, mature hilsa migrate upstream [6, 7].

"The larvae and juveniles make their way downstream to the sea during a period of 5-6 months feeding and growing on the way. At an age of about 6-10 weeks, the fry has grown to about 12.0-20.0 cm. (0.1 kg in weight). At this size, they are known as "jatka" and subject to heavy fishing mortality" [8]. "Maturity occurs between 6 and 12 months of age where the survivors undertake their first spawning migration upriver" [9–11].

"Hilsa fish (*Tenualosa ilisha*) (Fig. 1) is famous for its unique taste and flavor among the Bengali communities throughout the world. The diadromous hilsa fish is Bangladesh's national fish and appears to be a very important aquatic resource, making up the country's single largest fishery" [1, 2]. According to the Department of Fisheries (DoF), hilsa fish production exceed 5.65 lakh tons in 2020–2021 and Bangladesh has been ranked at the highest production of hilsa in the entire globe [12]. "The hilsa fishery generates around 1% of Bangladesh's total fisheries sector GDP and also provide a significant support to the economy of the nation by foreign exchange earnings" [7, 8]. It accounts for roughly 12.9% of the nation's total fish production [13].

Fig. 1. Hilsa, *Tenualosa ilisha* (Clupeiformes: Clupeidae)

"The fish migrates from the Bay of Bengal to the Rivers Padma, Meghna and its tributaries for breeding and nursing purposes" [14, 15]. "Three species of hilsa fish, namely *Tenualosa ilisha*, *Hilsa kelee* and *Hilsa toil* are available in the Bay of Bengal, but the majority of them captured in our country is *T. ilisha*. Hilsa spends its early stage in the river channels and descends to the sea to attain sexual maturity and then the matured brood hilsa returns back to the sea again to complete its life cycle" [16]. "Hilsa spawns all the year round but Bengali months of Ashwin-Kartik (September-October) are considered as the major spawning season based on the full moon phase" [16, 17]. "Most of the brood hilsa has been caught during this period from the spawning grounds of the country. Around 60% of the total hilsa catch comes from Bangladesh, while the remaining part comes from India and Myanmar" [3].

"Hilsa fishery seems to be very remunerative in comparison with other profession but it is not always true as the fishing effort is risky and depends upon seasonal availability. The current problem is very detrimental as there is limited control of overfishing in artisanal fishery in Bangladesh. This could be harmful for future of the hilsa fishery as seen on other major fisheries in the world" [18]. "Among the 13 techniques practiced for the management of single species of the world" [19], only a few are implemented in Bangladesh.

There are no legal restrictions on fishing nationwide, despite the great demand for hilsa. Hilsa fishing looks to be a pretty simple way of life for Bangladeshi riverine residents. For a particular fish species, like the hilsa in Bangladesh, this study is an attempt in evaluating the data currently available to determine the impact of the current management activities and improvement strategies of this important fishery in a significant and sustainable manner.

2. PRESENT STATUS OF HILSA FISHERY

The Fisheries Department of Bangladesh reported that a record amount of 5.65 lakh tonnes of hilsa were harvested in the fiscal year (FY)-2020–2021, followed by 5.50 lakh tonnes in FY-2020, 5.33 lakh tonnes in FY-2019, 5.17 lakh tonnes in FY-2018 and 4.96 lakh tonnes in FY-2017 [12]. On the other side, the government conducts numerous campaigns each year to seize a sizable amount of jatka. However, those in charge, claim that a much greater number of jatka are really caught by fisherman each year and have increased to 474.42 tonnes in FY-2021 from 250 tonnes in FY-2017 [12].

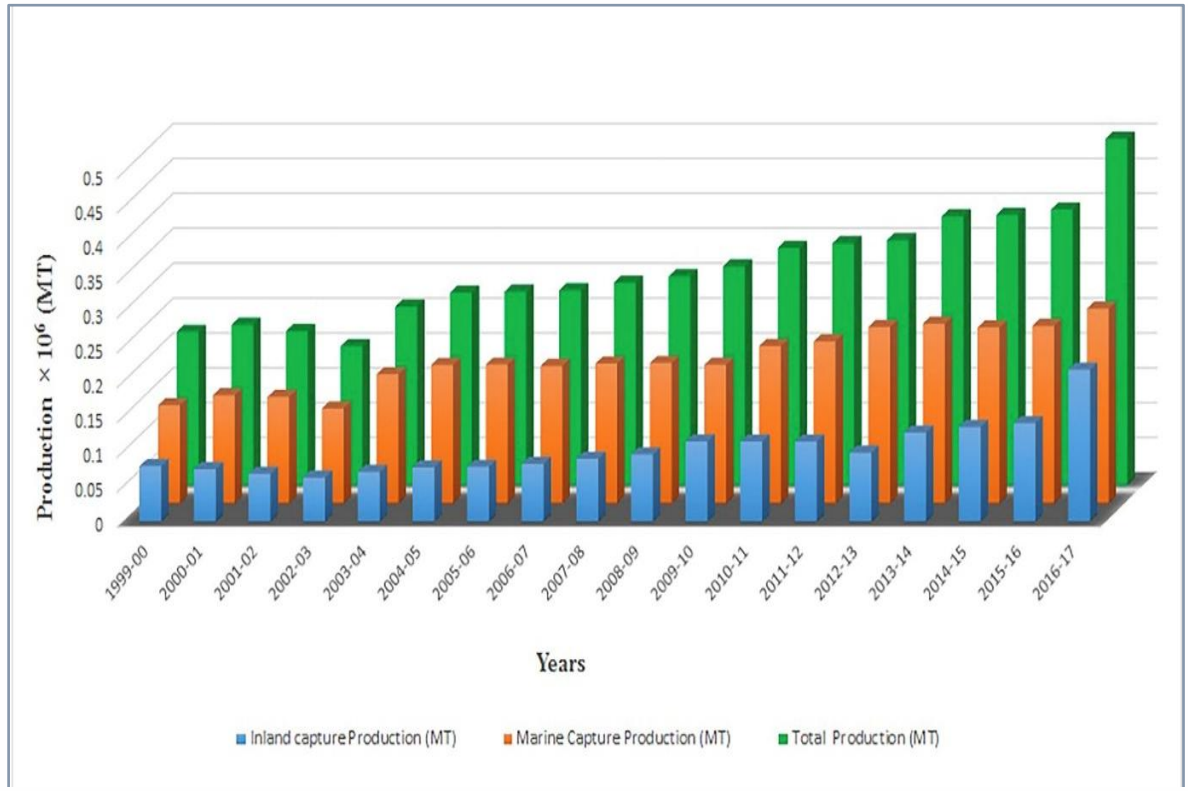

Fig. 2. The total production of hilsa (*Tenualosa ilisha*) in Bangladesh from 1999 to 2017 [22]

"Hilsa, the country's national fish, has been declared as a Geographical Indicator (GI) for Bangladesh" [20]. "About 12.9% of the country's total fish production comes from hilsa, and as a single species, it makes the highest contribution to the country's total fish production" [21]. Currently, the marine environment accounts for approximately 65% of Bangladesh's total hilsa catch. In Bangladesh, hilsa production has increased over the last 18 years (Fig. 2).

Hilsa's total production in 1999-2000 was 2.19 lakh metric tons, and in 2001-2002, the production was increased and reached at 2.20 lakh metric tons. Subsequently, a significant drop in output was occurred in 2002-2003. (1.99 lakh MT). Following a period of decline, output began to rise again, and there has been an overall increase from 2003-2004 to 2016-2017 [22]. The total hilsa catch has been increased from 2.55 million MT in 2003-2004 to 3.94 million MT in 2015-2016 (Fig. 2). Hilsa production peaked in 2016-2017, with a total of 4.96 lakh metric tons produced. The rate of increase in hilsa production is 25.69%.

The main export fish of Bangladesh and Myanmar is Hilsa. Bangladesh exports this fishery to more than fifty countries around the world such as Belgium, United Kingdom of Great Britain and Northern Ireland, the Netherlands, Germany, the United States of America, China, France, the Russian Federation, Japan Saudi Arabia etc., while Myanmar exports mainly to Asian countries such as China, Thailand, Malaysia, Singapore, Japan and the EU [23].

It is reported that about 0.5 million traditional hilsa fishers' livelihoods (38% of the total capture fisheries employment) directly depend on the hilsa catch [20]. More than 4.5 lakh fishers directly depend on hilsa through transporting, marketing, net and boat making, and exporting [24]. The trend of annual hilsa production in Bangladesh during the last two and a half decades from 1990 to 2017 [20, 25] is depicted in Fig. 3.

If the price of 1 kg of the fish is evaluated at BDT 300, researchers at the Fisheries Department claim that the present size of the hilsa market is around BDT 16,000 crores. Nevertheless, they continued, the price of the fish ranges from BDT 350 to BDT 1,300 per kg, depending on size. They further added that 86% of the species' global supply comes from Bangladesh and that hilsa makes up 12.9% of the nation's entire fish supply in 2019-2020 [12].

Hilsa (*T. ilisha*) is the largest single-species fishery in Bangladesh which makes the highest contribution to the country's total fish production. As a result, hilsa production increased from 1.99 lakh MT in 2003-2004 to 5.50 lakh MT in 2019-2020. The growth rate of hilsa production is 3.31%. It should be mentioned here that hilsa has been declared as Geographical Indicator (GI) product of Bangladesh.

Total annual hilsa production showed a sharp decline in 2002-2003, but after 2005, due to the implementation of hilsa Fishery Management Action Plan (HFMAP), hilsa fishery production increased at the rate of 3.5% per year till 2014-2015. As a synergistic impact of the general management activities of the government and PES- the environmental management approach, the annual incremental total hilsa production increased from 3.5% to 9.0% after 2015, resulting annual total hilsa production of 5.50 lakh MT in 2019-2020.

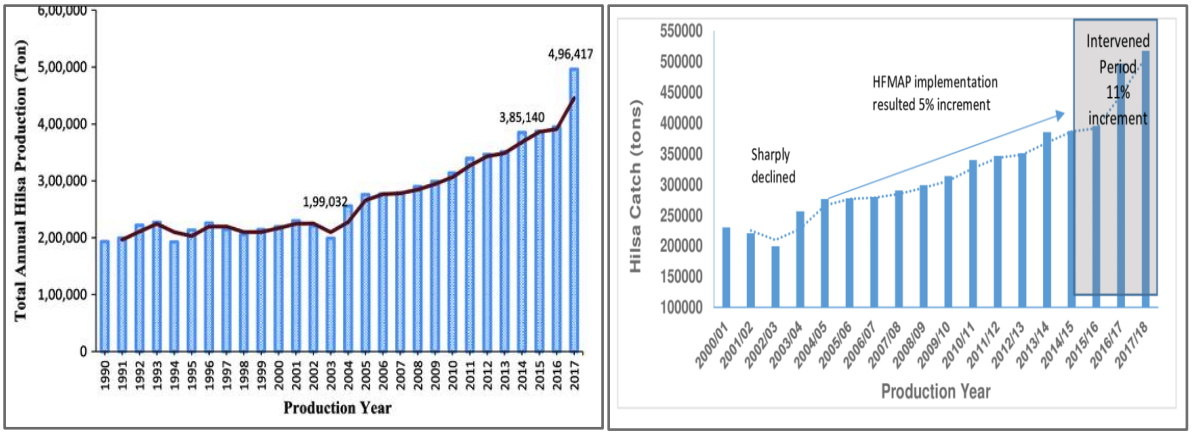

Fig. 3. Trend of annual hilsa production in Bangladesh during the last two and a half decades from 1990 to 2017. The trend line is fitted from the moving average [20, 25]

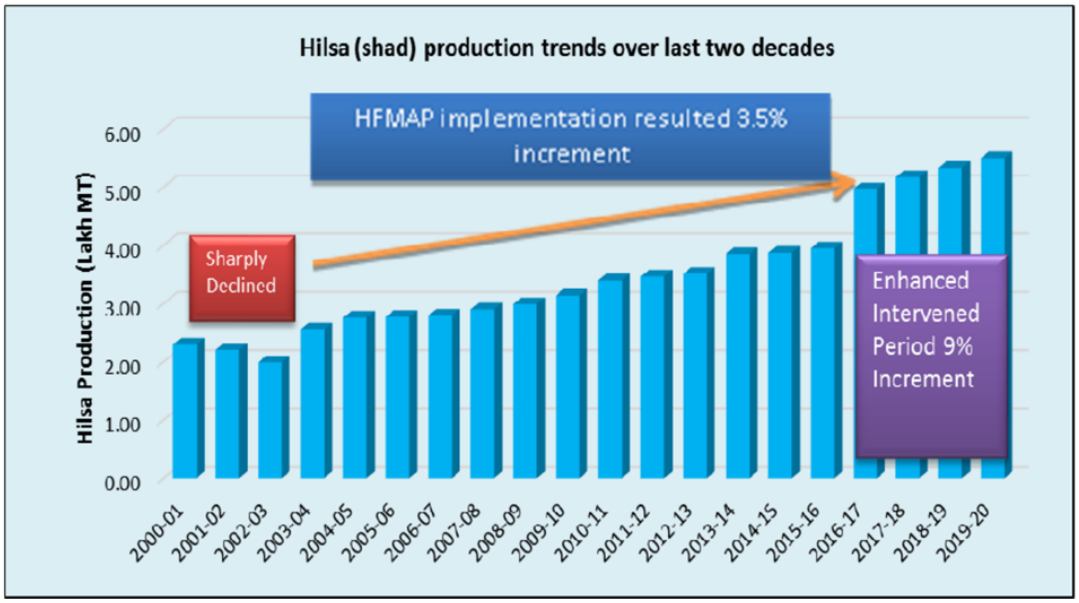

Fig. 4. Hilsa production trends over the last two decades [26]

Hilsa production in Bangladesh has almost doubled over the 12 years, by taking the government's efforts, including its ban on catching brood fish and fries, implementation of jatka conservation program, management of fish sanctuary, and implementation of hilsa spawning protection activities. About 12.9% of the country's total fish production is generated by this fishery. The hilsa production trends are increased gradually year after year, which are shown in the following graph (Fig. 4).

3. PROSPECTS OF HILSHA FISHERY

The Department of Fisheries reports that Bangladesh's hilsa output is growing at a pace of about 10% annually. In the past nine years, hilsa production has risen by 66%. Bangladeshi hilsa has already established herself as a main player on the world stage. One of Bangladesh's significant cultural achievements is its recognition as a geographical indicator or GI product. Hilsa is now the product of Bangladesh.

As a saltwater fish, hilsa eventually exits the saltwater and settles in freshwater at some point in its life cycle. It is an adaptable fish. The sea is off-limits to all forms of fishing from May 20 to July 23. This moment is equally crucial. However, around that time, large Indian trawlers come into our waters and fish for hilsa. The purpose for why we are not catching hilsa is thereby compromised, claim the fishermen.

Hilsa has made an inestimable contribution to our culture and economics. Of Bangladesh's total yearly fish production, hilsa makes up around 11% in 2016-2017 [3, 20]. Bangladesh is the country that produces 75% of the world's hilsa. Hilsa is produced not just in Bangladesh but also in India, Pakistan, and Myanmar. A total of 35 lakh (3.5 million) citizens are employed in some capacity in the hilsa fish sector. To further improve the hilsa industry's protection, growth, and economic potential, and numerous actions are needed. In particular, rivers must be protected from contamination and be navigable.

A sustainable and efficient decision regarding production and netting the fish from both the sea and rivers must be made in light of more recent research in order to maintain the production of hilsa. It's important as we work gradually on the 100-year delta plan and anticipate success in the blue economy. The areas of the sea where hilsa are most likely to be found must be specifically investigated. At the hilsa roaming areas, there should be no trawler zone guaranteed. Climate has a significant impact on hilsa output as well. All research and planning must put the backdrop of climate change front and center. If each of these materializes, it can be said that we are looking at even wider and brighter future of hilsa production in Bangladesh, which will surely take us to an unimaginable field of prosperity. (https://www.thedailystar.net/english).

4. CONSERVATION OF HILSA FISHERY

The artisanal fishery plays the most important role in our national economy because it lands nearly all of the marine catch and employs the vast majority of fishermen. However, from a management standpoint,

it is the most difficult sector to manage because fishermen are dispersed along the shores, entry into the fishery is free, and fishing is typically their primary source of income. There is noticeable employment in coastal fishing communities. The Bangladesh fisheries authority, such as Bangladesh Fisheries Research Institute (BFRI), Department of Fisheries (DoF), Enhanced Coastal Fisheries in Bangladesh (ECOFISHBD) and other non-governmental organizations collaborate to conserve hilsa fishes [27].

4.1 Existing Marine Resource Policy

There was no clear goal for the development of the fisheries sector from the early 1970s to the 1990s. This deficiency prompted the creation of the "National Fisheries Policy" in 1998. The policy is divided into five major sections, one of which is a "policy for the exploitation, conservation, and management of marine fisheries resources to implement and support the National Fisheries Policy." The "National Fisheries Strategy (NFS)" was developed by the government. There are eight sub strategies in total. One of them is the "marine sector sub strategy." There is no separate segment for artisanal hilsa fishery management. On the basis of this policy and other fishery regulations, some activities and management measures are implemented to conserve the hilsa fishery [5].

4.2 Restrictions on Fishing Gears

The Fish Act was established in 1950. The catch of jatka (smaller than 10 inches or 25 cm) was prohibited in Bangladesh under this act. The use of current jal (monofilament gillnet) with mesh sizes smaller than 4.5 cm was prohibited in 1988. The use of gill nets with mesh sizes less than 100 mm is illegal in the artisanal hilsa fishery, but fishermen continue to use smaller mesh sizes. To avoid jatka, the government has set a minimum mesh size of 6.5 cm for hilsa nets [5].

4.3 Limited Fishing Time

During the peak breeding season, 60-70% of hilsa are caught in Bangladesh and nearly 70% of them are sexually matured. Every year from 15 to 24 October (peak spawning season), catch of brood hilsa has been prohibited in all major spawning grounds for ten days to ensure uninterrupted spawning. A mother fish can produce eggs, ranged from 2.5 lakh to 23 lakh [5].

4.4 Restricted Fishing Area

Under the "Protection and Conservation of Fish Act 1950", four sites in the country's coastal areas have been designated as hilsa sanctuaries in order to achieve the desired development of the hilsa fishery. All types of fish catches are prohibited in these four hilsa sanctuaries (Meghna, Tetulia, Padma and Andharmanik) during certain times of the year. Three of the sanctuaries are closed from March to April, while the fourth (Andharmanik River) is closed from November to January [5].

4.5 Zone Limitations

The Marine Fisheries Ordinance of 1983 established guidelines for the management, conservation, and development of marine fisheries in bodies of water deeper than 50 meters. This is used to reduce or avoid potential conflicts between industrial vessels and artisanal fishermen. Small-scale fisheries are restricted to bodies of water less than 50 meters deep. All trawlers are permitted to fish within Bangladesh's 200 nautical mile maritime boundary and for every voyage, each trawler must have to obtain sailing permission from the Directorate of Fisheries [5].

4.6 Additional Income-generating Activities (AIGA)

The majority of hilsa fishermen rely solely on fishing for living. The Government of Bangladesh, in collaboration with other organizations, has taken steps to reduce fishers' reliance on fishing during the ban period by diversifying their income sources and providing support for alternative income-generating activities [28]. This initiative provides fishers with vocational training and credit in order to diversify their income. In sanctuary areas, an average of 1000 fishers from each upazila (sub-district) were given alternative income options such as rickshaws, goats, cows (for fattening), sewing machines, and cash for small businesses such as net mending, cage culture, poultry and nursery. A total of 20,000 fishermen and women received financial assistance. At the start of the program, approximately BDT 20 million (USD 244,000) was allocated for incentive support in cash and in kind, but the support was gradually increased. In the fiscal year 2010-2011, the allocated fund was increased to BDT 59 million (USD 719,000) [29]. In comparison to rice distribution, AIGA assistance was provided to a smaller number of fishermen [30].

4.7 Encouragement by Raising Awareness

The DoF along with other organizations has undertaken different programs for raising awareness as an important component of hilsa conservation. The programs' goal is to educate fishermen and other stakeholders about hilsa conservation. Among the programs are rallies and seminars held during the

jatka and brood hilsa fishing bans, as well as the distribution of posters and leaflets. District and upazila fisheries offices also organize boat rallies, road rallies, sell rallies, meetings, workshops, and seminars to help with implementation and to raise awareness among fishery-dependent people and other communities in the sanctuary areas. Short theatrical performances about the importance of hilsa fisheries conservation are also staged in the auditoriums of the upazila complexes. About BDT 4 million was allocated for activities related to raising awareness during the 2010-2011 financial year [15, 30, 31].

4.8 Fishing Vessel Regulations

Amendment 92 of the Marine Fisheries Ordinance of 1983 established a licensing system for mechanized boats. Since January 1, 2000, all non-mechanized boats have been subject to the licensing system. All fishing vessels in the artisanal hilsa fishery are subject to registration fees, which are paid when the vessels are commissioned for the first time, and vessel and fishing licenses are paid annually. Registration fees are intended to keep track of how many vessels enter the industry and to collect revenue, whereas license fees are intended to control entry to some extent, to keep track of how many vessels are actively engaged in fishing activities each year, and to collect revenue [5]. The only way to control the vessels (mechanized and non-mechanized boats) in the artisanal fishery is through registration. The Mercantile Marine Department is in charge of vessel registration. During the fishing season, this department also keeps an eye on these vessels. Every fishing unit in the artisanal gillnet hilsa fishery must obtain a license after registering, which is renewable each year. If a license is not renewed within two years of its issuance, a new license must be obtained [5]. The cost of a fishing vessel license varies according to vessel size and engine capacity. All of these biological management measures cannot predict the collapse of a fishery, provide the optimum level of the fishery, or even provide any indication of the profit-maximizing level. Despite all of the management measures in place, fishing effort continues to rise, and many more new entrants want to join the fishery. The fisheries authorities are not currently issuing new licenses for artisanal hilsa fishing, but there is increasing pressure from those who want to join the fishery. The decision to stop issuing new licenses for the hilsa fishery stems from concerns that the fishery is unsustainable. As a result, it is now necessary to assess the current state of hilsa and devise a policy that maximizes economic benefits while ensuring the long-term development of the country's hilsa resources [5].

5. IMPLICATIONS FOR MITIGATION POLICIES

The Meghna, Padma, Jamuna/Brahmaputra, and a few minor coastal rivers including the Tetulia, Ilisha, Baleshwari, and Andermanik are among the major rivers that contain the hilsa fish [31]. The Meghna estuary and adjacent coastal rivers are among the approximately five important breeding and nursery sites in both the Meghna and Padma rivers. Among them Meghna River is home to Hilsa's biggest nursery area [3]. These spawning grounds make up the protected areas where fishermen are paid for not being able to fish during specific times. Recently, the fifth "Jatka Sanctuary" with an area of 60 km^2 has been established in Chandpur. Inhibitory fishing nets on migratory routes, river siltation, construction of barrages, dams, and sluice gates, pollutant discharge from industries, sewerage, agricultural inputs, poison fishing, ship breaking, climate change, and natural disasters are some of the factors that cause obstacles to hilsa migration.

Despite the reputation of hilsa as an anadromous fish, evidence suggests that it actually migrates back and forth between the ocean and rivers, or is a diadromous fish. The monsoon migration, which runs from August to November and peaks in September and October, and the winter migration are two peak seasons of hilsa migration (January - February). The hilsa often migrates in groups called schools, though they can also migrate alone or in small groups. Whether the hilsa migration occurs during the monsoon or the winter affects the factors that cause it. Rainfall, a significant freshwater input, a decrease in temperature, and a decrease in salinity are all triggering elements for the monsoon migration. On the other hand, increased upstream warmth, reduced river velocity, rising salinity, rising upstream food organisms and plankton population are all triggering elements for the winter migration [32].

Several organizations are involved in enforcing the brood hilsa ban, including the DoF, local government, river police, navy, coast guard, and RAB (rapid action battalion) [3]. All of these organizations temporarily move extra staff to the coastal districts during this time in order to better carryout this ban. The following actions are/will be performed in addition to enforcement to ensure the success of this program:

- Grains should be available throughout the duration of the prohibition.
- The government should offer enough subsidies, at least 30 kg of rice per month for each fisherman.

- ❖ All fishermen should be included in incentive-based programs.
- ❖ The continuous use of monofilament nets and other damaging nets, as well as their production must be prevented. The government ought to stop granting permits to make these nets.
- ❖ For the hilsa fisheries, river siltation is a big issue. To keep the hilsa migratory path clear, a project of dredging river channels, particularly the Meghna waterway, should be started.
- ❖ To allow fisherman to use the Bollatia River (a portion of the Meghna River), the government should discontinue leasing the river. The notion of giving fisherman access to specific stretches of the river should be investigated by the government. This would promote environmentally sound conservation methods.
- ❖ At the upazila and district levels, motivational gatherings and awareness campaigns are held in fishing settlements, fish landing facilities, and various public locations.
- ❖ Awareness is raised via television, radio, and newspapers.
- ❖ During the ban, ice factories in the coastal region are kept closed, and mobile courts are used to strictly enforce the law.
- ❖ The District Fisheries Officer (DFO) and Upazila Fisheries Officer (UFO) send letters requesting compliance with the ban's regulations from merchants and fishermen's organizations.
- ❖ The departments responsible for enforcing the prohibition hold frequent meetings to coordinate efforts and exchange information.
- ❖ Local elites, leaders of the fishermen's society, fish traders, and local political officials (MP, Upazila Chairman and Union Parishad Chairman) are urged to participate in this initiative [30].

The following changes to government policy can be implemented to enhance the social, economic, and ecological sustainability of the hilsa fishery:

1) Dredging the river channels, reducing pollution and industrial effluent discharge, installing fish passes or fish-friendly structures in the dams and barrages, increasing water flow from the upstream, building sizable reservoirs to store water during the dry season, and maintaining normal river flow.
2) Ensuring a methodical and equitable process for the establishment of AIGAs, promoting the establishment of a fishers' organization and its representatives, and locating regional service providers. In order to prevent middlemen from taking advantage of fisherman, more of them need be connected to marketplaces. Thus, it is possible to optimize the social capital of the hilsa fishing villages.
3) Starting regional cooperation among three close neighbors, viz. Bangladesh, India, and Myanmar. As a result, the management capacities of hilsa fishery would be considerably enhanced.
4) Executing a research program that aims to comprehend the current incentive-based hilsa conservation, specifically the management's advantages and disadvantages. The demands for hilsa fish for domestic use in Bangladesh should have to be studied [15].

6. CONCLUSION

In order to maintain the hilsa stocks as well as its sustainable utilization and management, it is very necessary to reduce overfishing, enforce the current policy and outlaw IUU fishing equipment. Improvement of the livelihood situation of fishing communities and jatka conservation are required to prevent indiscriminate fishing, overfishing pressure, and illegal fishing. By offering alternate income-generating facilities, fishing pressure may be minimized. The government has taken steps to make up the revenue loss of the fishermen by supplying rice, but the amount is so insufficient to them, given that they live below the poverty line and are struggling to make the ends of it, while also maintaining food security, nutrition, health, and hygienic conditions. However, the government cannot assume sole responsibility for this; instead, a number of social, cultural and research organizations can take the necessary steps to work together for achieving this goal in a significant manner and worthwhile manner.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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