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MARINE FISHERIES RESOURCES IN BANGLADESH: PRESENT STATUS AND FUTURE PROSPECTS

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ABSTRACT

Bangladesh is enriched with its diversified marine fisheries resources. The recent increase in the country's maritime area from its neighboring states, India and Myanmar, has opened a new window for fostering marine fisheries production in Bangladesh. This review aimed to discuss the present scenario of marine fisheries resources with their prospects in Bangladesh. The huge marine water area of 118,813 sq. km. supports many commercially important organisms, including 475 species of finfish, 36 species of shrimp, 16 species of crab, and 165 species of seaweed in Bangladesh. The marine water supplies 55.48% of country's total production of Hilsha in Bangladesh. Overall, marine fisheries contribute 15% of the total fisheries production of 4.621 million metric tons (MT) during 2020-2021. However, the sustainability of the marine fisheries resources is a great challenge to Bangladesh. Recently, climate change and the installation of coal-based power plants near the sea area have been the major concerns for maintaining the proper ecosystem of the marine water. Furthermore, due to a lack of stock assessment, lack of modern fishing vessel and scientific management strategies, marine fisheries resources have not yet been harvested rationally. Notably, the blue economy (BE) is an emerging concept in the country for the sustainable use of marine resources. In order to flourish the BE, sustainable conservation, management, and exploitation of these marine resources are necessary.

Keywords: Marine, fisheries, status, blue economy, prospect

Introduction

Bangladesh is one of the world's leading fish producing countries. The coastal and marine environments of the country are blessed with a tropical climate characterized by high rainfall and enriched with nutrients from the land having great fisheries production potential. Thus, the marine water body of Bangladesh has been highly productive with one of the richest ecosystems in the world (Hossain 2001, Islam 2003). Fisheries in Bangladesh contributing 3.57% to the Gross Domestic Product (GDP) of the country and almost one-fourth (26.50%) to the agricultural GDP (DoF 2022). The country's fisheries resources play an important role in fulfilling the demand for animal protein and the socio-economic development of the country. More than 12% of the population directly or indirectly rely on the fisheries sector for their livelihood, either on a full time or part-time basis (FAO 2014, DoF 2022). Of note, fish alone supplies about 60% of the total animal protein intake (DoF 2022). The marine fisheries resources of Bangladesh contributed about 15% of the total fisheries production of 4.621 million MT during fiscal year 2020-2021 (DoF 2022). Due to the recent increase in the country's maritime area (MoFA 2014), the marine fisheries sector has been crucial for the economy of Bangladesh.

Over the last three decades, the total fish production in Bangladesh has increased more than five times. According to DoF (2022), the total fish production in 1983-84 was 7.54 MT, which has increased six folds more (46.21 lakh MT) by the year 2021-22. On the other hand, marine production has not increased. According to Hussain and Hoq (2010), fish production from the Bay of Bengal (BoB) has increased over the last few decades, but its relative share of fisheries production has declined. The reason behind this is that the marine resources of Bangladesh have not been harvested rationally. There is no marine aquaculture currently practiced in the country and no marine or coastal finish are farmed. In the BoB,

both industrial and artisanal fisheries are exploited without any management plan. This is due to the unavailability of information needed to formulate management strategies and difficulties in implementing these strategies as well. Fishing without adequate information on the status of the stock leads to over-exploitation of inshore and under-exploitation of offshore fishery resources. Despite having a long coastline and a huge marine water area, the marine fisheries sector is underdeveloped compared to other industrial sectors in Bangladesh. Though fisheries production has increased over the years, marine production per hectare of water area has not yet attained to its optimum level.

The newly settled maritime boundary with neighboring states, Myanmar and India, up to 200 nautical miles from the coastline consists of 118,813 sq. km. of maritime water (MoFA 2014). Thus, the country has huge potential for marine fisheries in artisanal, industrial and coastal sub-sectors. A large part of the coastal area is suitable for finfish, shrimp, prawn, crab, and seaweed farming. Proper utilization of the marine resources can boost the total fisheries production of Bangladesh. Thus, scientific information on marine resources is essential for harvesting the marine resources rationally and for planning and implementing management strategies. Keeping these considerations in mind, authors aimed to review the marine fisheries resources currently available in Bangladesh and also to highlight the present situation, challenges, and future prospects for marine fisheries resource management in Bangladesh.

Present status of marine fisheries resources in Bangladesh

Fishery resources refer to elements of a natural aquatic resource (e.g., strains, species, populations, stocks, assemblages), that can be legally caught by fishing. It may sometimes include the habitat of such resources. The fisheries resources in Bangladesh is connected with three sub-sectors: inland capture, inland culture, and marine fisheries (DoF, 2022). The marine fisheries resources include fish and other aquatic organisms living in the sea.

Maritime area of Bangladesh

The International Tribunal for Law of the Sea (ITLOS) Judgment regarding Bangladesh-Myanmar maritime boundary of 2012 and the Arbitration Award on India-Bangladesh maritime boundary of 2014 have provided an opportunity for Bangladesh to share and use the maritime resources of the Bay of Bengal. Thus, the country could finally establish its sovereign rights on more than 118,813 sq. km. of territorial sea (Figure 1 A, B), 200 nautical miles (nm) of Exclusive Economic Zone (EEZ), and all kinds of animal and non-animal resources under the continental shelf up to 354 nm from the Chittagong coast (MoFA 2014). When there was no fixed maritime boundary between Bangladesh and India, the country was not entitled to explore and exploit certain areas because they were disputed.

A.



B.

Bay of Bengal (BoB)	Areas
Total maritime area	118,813 sq.km
With Myanmar	111,631 sq. km
With India	19,467 sq. km
The Territorial Water and Maritime Zones Act, 1974	165,887 km
Total Baseline	710 km
Areas Beyond National Jurisdiction including EEZ	354 nm (677 km)
Territorial water up to 10 fathoms (baseline) from the coastline	9,060 sq. km
Internal water up to 12 nautical miles from the coastline	25,140 sq. km

Figure 1 (A, B). Legitimate right on maritime boundary (Source: MoFA, 2014).

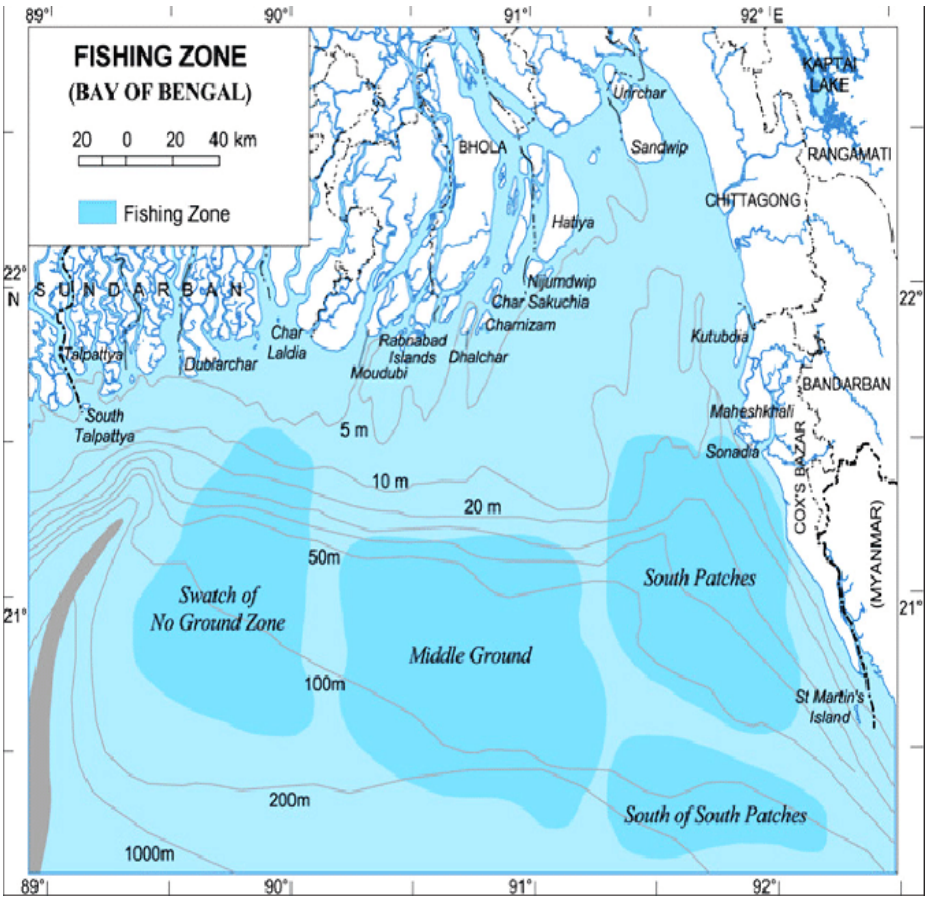
Commercial marine fishing grounds in Bangladesh

Although fish remain scattered in the BoB, they get concentrated and constitute important fishing grounds in some particular places. Until now, four fishing grounds have been identified (FAO 2010). They are the south patches, south of the south patches, middle ground, and swatch of no Ground (Figure 2 A, B).

Coastal and marine biodiversity

Marine fisheries is the capturing and culturing of fish in marine water. The BoB is enriched with a diverse range of marine organisms such as fishes, shrimps, molluscs, crabs, mammals etc. (Figure 3). Finfish have 475 species, while shellfish, seaweed, and shrimp have 350, 165, and 36 species, respectively (FAO 2014).

A.



B.

Name	Location	Major commercial species
South Patches	90°10'- 91'50'E 21°10'-21°40'N	Indian salmon, Hilsa, Pomfret, Ribbonfish, Bombay duck, Carangids, Eel, Jew fish, catfish, sharks and rays
South-west of South Patches (Middle ground)	90°30'-91°40'E 20°45'- 21°1 0'N	Pomfret, Red snappers, Ribbonfish, Silver Jew, Carangids, Shrimp
East of Swatch of No Ground	90°00'-90°40'E 21°00'-21°25'N	Indian mackerel, Snappers, Groupers, Jew fish,
Swatch of No Ground	89°00'-90°00'E, 21°00'-21°40'N	Shrimps, Hilsa, Pomfret, Ribbonfish Bombay duck, Jew fish

Figure 2 (A, B). Commercial fishing grounds in the BoB, Bangladesh (Source: FAO, 2010).

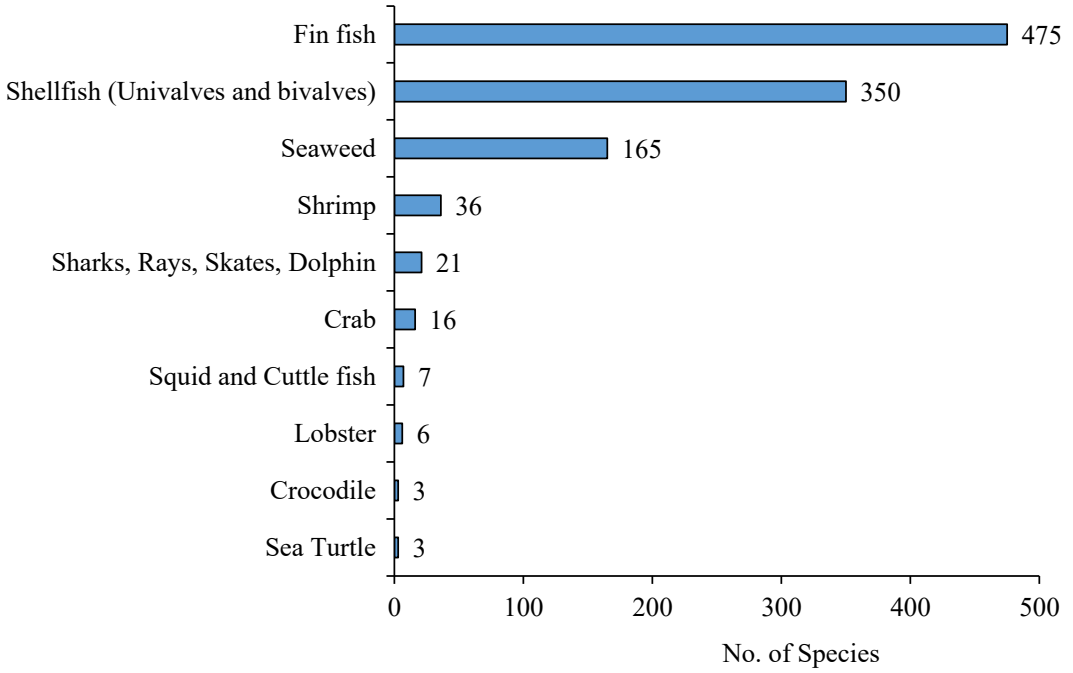


Figure 3. Coastal and marine fisheries resources in Bangladesh (Adapted from FAO, 2014).

Fish

A number of surveys were carried out to examine the status of marine fisheries resources between the 1970s and 1980s. However, no recent and comprehensive knowledge is available on the fishing stocks, systematics, and biological and ecological aspects of the coastal and marine fisheries in Bangladesh. A total of 475 species of fish belonging to 133 families have so far been identified from the coastal and marine waters of the BoB. Till date, the significant fish families are Sciaenidae, Ariidae, Nemipteridae, Carangidae, Mullidae, Synodontidae, Trichiuridae, Leiognathedae, Pomadasyidae, and Clupeidae (Table 1), which collectively constitute about 47% of the total biomass (DoF 2015).

Table 1. Abundance of commercial species (DoF, 2015)

Family	Common Name	Abundance (%)	Catch (%) *
Ariidae	Catfishes	11.9	3.02
Sciaenidae	Croakers	10.37	3.81
Nemipteridae	Threadfin breams	9.00	10.42
Trichiuridae	Hairtail/ Ribbon fishes	6.19	6.23
Carangidae	Jacks, Scads	5.77	4.09
Scombridae	Mackerels, Tunas	5.36	7.41
Clupeidae	Sardines, Shads	5.57	30.75
Rajidae	Skates, Rays	3.38	0.80
Pomadasyidae	Grunters	2.47	0.41
Stromateidae	Pomfrets	1.82	1.83
Cephalopods	Squid, Cuttlefishes	1.41	1.06
Harpodontida	Bombay duck	1.29	2.54
Lutjanidae	Snappers	1.07	0.37

*As per log of trawlers 2012-2013

Shrimp and prawn

In addition to a large number of fish species, the mangroves also support many species of shrimp and prawn, which have high commercial value. In Bangladesh, there are 56 species of shrimp and prawn belonging to five families available in Bangladesh. Four species of shrimp and prawn are commercially exported to different countries of the world, and 10 species are commercially exploited (Mondal 2013). However, the black tiger shrimp (*Penaeus monodon*) and giant freshwater prawn (*Macrobrachium rosenbergii*) outshine each other in terms of their commercial importance and availability. A list of the shrimp species of the coastal and marine waters of Bangladesh is shown in Table 2.

Crab

About 16 species of crabs have been identified in the coastal and marine habitats of the BoB, among which 11 are purely marine. Only three species, namely *Scylla serrata* (mudcrab or mangrove crab), *Portunus pelagicus*, and *P. sanguinolentus,* are reported as commercially important (Table 3) . The mud crab, *Scylla serrata,* is reported to be suitable for coastal aquaculture and abundantly available. The seeds of this species are also available throughout the coastal belt (Kamal 2000). However, no scientific report is available on the current stock of the crab resources in Bangladesh.

Table 2. List of commonly harvested shrimp and prawn in Bangladesh (Mondal, 2013)

Group	Bengali name	English name	Scientific name
Prawn	Golda chingri	Giant Freshwater Prawn	*Macrobrachium rosenbergii**
Shrimp	Bagda chingri	Giant tiger Shrimp	*Penaeus monodon**
	Baghtara chingri	Green tiger Shrimp	*Penaeus semisulcatus*
	Baghtara chingri	Kuruma Shrimp	*Penaeus japonicus*
	Chaga chingri	White Shrimp	*Penaeus indicus**
	Bagha chama	Blue-tail Shrimp	*Penaeus merguiensis*
	Horney chingri	Speckled Shrimp	*Metapenaeus monoceros**
	Nona chingri	Yellow Shrimp	*Metapenaeus brevicornis*
	Ghora chingri	Kadal Shrimp	*Metapenaeus dobsoni*
	Gura chingri	Roshma Shrimp	*Palaemon styliferus*
	Ruda chingri	Rainbow Shrimp	*Parapenaeopsis sculptilis*

* Indicates commercially exportable species

Table 3: List of economically important crab species in Bangladesh (Siddiqui and Zafar 2002)

Family	Bengali name	English name	Scientific name
Portunidae	Shila Kankra	Giant Mud Crab	*Scylla serrata**
	Sataru Kankra	Swimming Crab	*Portunus pelagicus**
	Tin Fota Kankra	Three-spot Swimming Crab	*Portunus sanguinolentus**
Grapsidae	Gasho Kankra	Paddler Crab	*Metopograpsus thukuhar*
	Gasho Kankra	Paddler Crab	*Metopograpsus messor*
	-	-	*Parasesarma plicatum*
	Kankra	Violet Vinegar Crab	*Episesarma versicolor*
Potamoniade	Kata Kankra	Freshwater Crab	*Potamon woodmasoni*
	Chimta Kankra	Spiny Crab	*Potamon martensi*
	Pati Kankra	Sartotina Crab	*Paratelphusa lamellifrons*
Ocypodidae	Holdepa Kankra	Fiddler Crab	*Uca urvillei*
	Kankra	Ghost Crab	*Uca annulipes*
	Lal Kankra	Horned-eyed Ghost Crab	*Ocypode ceratophthalmus*
Paguridae	-	-	*Anapagurus laevis*
Leucosiidae	-	-	*Ebalia cranchii*

* Indicates commercially exportable species

Molluscs

Molluscs of a variety of forms are available in the BoB and coastal areas. They include bivalves, clams, oysters, scallops, snails and slugs, cuttlefish, squids, octopuses, etc. Ahmed (1990) reported 301 species of coastal and marine molluscs in Bangladesh. There is limited information available about their occurrence and biology. Two types of clams, called blood clams and the thick-shelled clam, are found in Bangladesh. Sarker and Alam (1988) identified two species of blood clams, namely *Anadara granosa* and *A. rhombea*. Oysters are sedentary animals that are found in the littoral and inter-tidal zones growing on gravel, rocks, tree roots, and hard objects. Three types of oysters are reported to occur in the coastal waters of the BoB, namely the edible oyster, the pearl oyster, and the window pane oyster. *Crassostrea* sp. is the most important group of edible oysters in Bangladesh. Cuttlefish and squid are reported to occur in plenty in the Bay of Bengal. Quddus and Shafi (1983) reported seven species of squids and two species of cuttlefish from the Bay of Bengal. *Caretta caretta, Chelonia* sp. and *Dermochelys* sp. are the three species of turtles that have been identified from the seawater of Bangladesh, and these species have been reported as commercially important (Quader, 1994).

Seaweed

The natural abundance of commercially important seaweed is reported to be very low in Bangladesh (Ahmed and Taparhudee, 2005). Only a small portion of the southeastern part of the mainland, covering about 30 kilometers of coastline, and St. Martin Island have rocky substratum suitable for natural seaweed growth. Taxonomical studies on the seaweeds in these areas reported that 20-22 species of naturally growing seaweed are available on St. Martin Island. Sarker (1992) reported that *Hypnea* sp. was the most abundant species. However, species level identification for most of the seaweeds has not yet been conducted. The commercially important seaweed species available in the BoB is listed in Table 4.

Table 4. List of commercially important seaweeds in Bangladesh (Ahmed and Tafarhudee, 2005)

Genus	Species	Type
Caulerpa	*Caulerpa racemosa*	Green
Enteromorpha	*Enteromorpha* sp.	Green
Gelidiella	*Gelidiella tenuissima*	Red
Gelidiella	*Gelidiella pusillum*	Red
Halymenia	*Halymenia discoidea*	Red
Hypnea	*Hypnea pannosa*	Red
Hydroclathrus	*Clathratus* sp.	Brown
Sargassum	*Sargassum* sp.	Brown

Coastal and marine fisheries production

According to DoF (2022), Bangladesh's total marine production in 2003-04 was 4.6 lakh MT, which has gradually increased to 6.8 lakh MT in 2020-21 (Figure

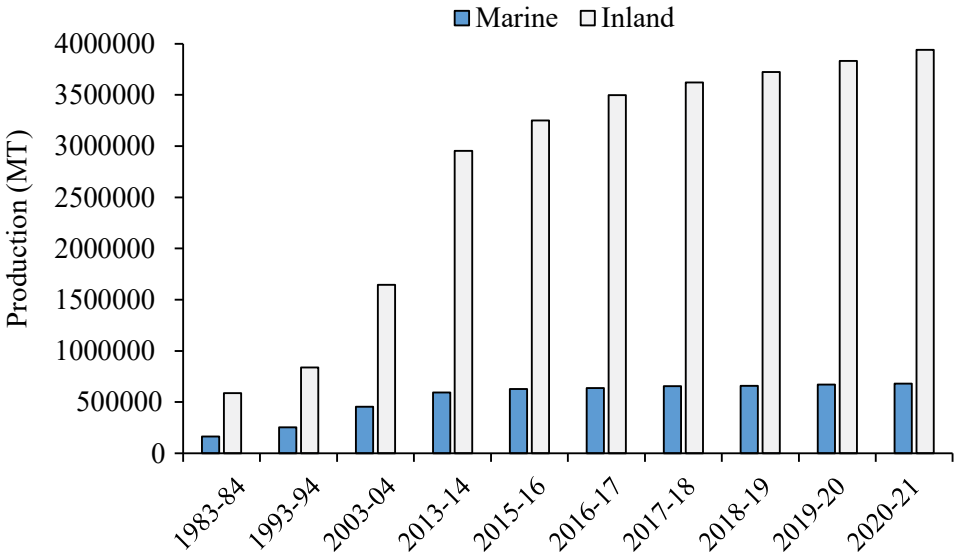


Figure 4. Trend in marine and inland fish production in Bangladesh (Adapted from DoF, 2022).

4). Whereas the total inland production of the country was 16.5 lakh MT in 2003-04 and has become 39.3 lakh MT by 2020-21. That means that the inland fish production of Bangladesh has more than doubled in the last decade, but marine production has not increased that much.

Fish

Hilsha (Ilish), Sardine, Bombay Duck, Salmon, Pomfret, Jew Fish, Sharks, and Rays are the dominant species among others captured from marine and coastal water areas (Figure 5A) (DoF, 2022). Hilsha alone contributes to around 12% of the country's total fish production. The economic value of the contribution is around 1% of the country's GDP. According to the Fisheries Statistical Report of Bangladesh (2020-21), the country's total Hilsha production is 565,183 MT, of which 251,590 MT (44.52%) from inland sources and 313,593 MT (55.48%) from marine catches. The trend of the country's Hilsha production over the last decade is illustrated in Figure 5B. To conserve the country's national fish supply and increase its production, the government has declared 432 km of Hilsha habitat across six river zones, as sanctuaries. The annual production of Bombay duck, Jew

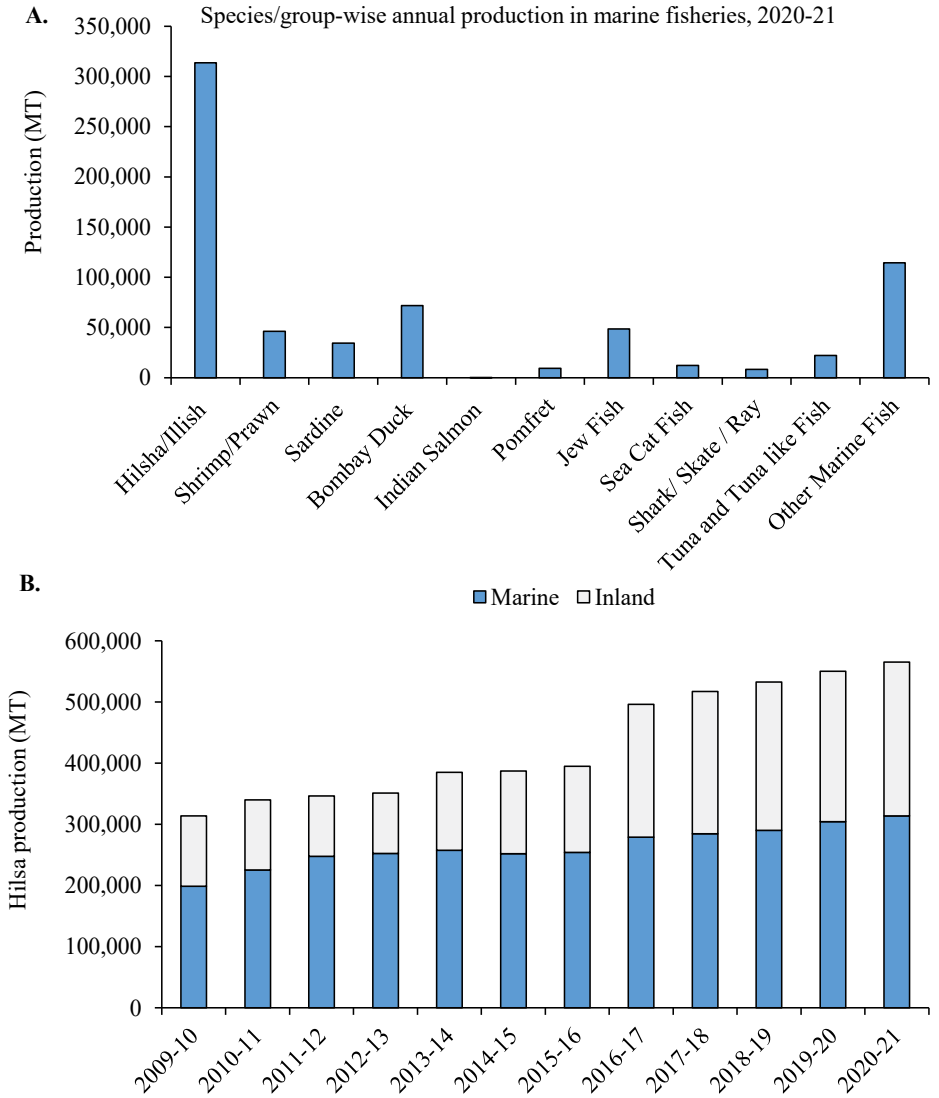


Figure 5A. Species-wise annual production in marine fisheries during 2020-21 in Bangladesh, and **B.** Hilsha production over the last decade in Bangladesh (Adapted from DoF, 2022).

fish, Sardine, Tuna and Tuna like fish was 71,912 MT, 48,665 MT, 34,519 MT and 22,130 MT, respectively, during the period of 2020-21 (DoF, 2022).

Shrimp/Prawn

Shrimps and prawns are mainly produced in coastal districts such as Khulna, Satkhira, Barisal, Patuakhali, Bagerhat, Vola, Chittagong, and Cox's Bazar. The production costs are very low, and the ecology of coastal areas and the climatic conditions of Bangladesh are extremely suitable for shrimp culture. As a result of increasing demand and price, shrimp culture started to expand in the 1970s aiming mainly at the export markets (Mazid and Gupta, 1997). Shrimp culture area has expanded from 217,177 ha in 2005-06 to over 272,717 ha in 2016-17 (DoF, 2018) and production has increased from 186,418 MT in 2009-10 to 251,964 MT in 2020-21 (Figure 6) (DoF, 2022). Approximately 46,297 MT (18.3%) of shrimp/prawn were produced from marine sources during 2020-21. In the Khulna region, shrimp is cultured in a modified rice field called 'gher'. In Cox's Bazar, shrimp and salt are produced alternately. Shrimp culture technology in Bangladesh has been intensified over the last few years, but the production level has not increased satisfactorily. One of the main reasons for that is irregular and unscientific input supply. The average production in the shrimp farms is about 904 kg/ha (DoF 2018). On the basis of degree of management and fry stocking rate, the shrimp culture techniques that exist in Bangladesh are traditional or extensive, semi-intensive, and intensive (Karim and Aftabuzzaman 1995, Deb 1998). During the last 20 years, shrimp culture practices have changed from "traditional" to "improved traditional" and there is an increasing emphasis now on semi-intensive systems (Islam 2003).

Crab

Among the available species, the mud crab *Scylla serrata* is the only species that is cultured on a small scale. Mud crabs are also collected from natural sources like mangrove areas and shrimp gher (Istiaque 2018). According to Joarder (2014), Khulna accounts for 60% of mud crab landings, Satkhira accounts for 30%, and Bagerhat accounts for 10%. In Bangladesh, about 19,408 hectares of water bodies were used to produce crab. In the 2015-16 fiscal year, the total production of mud crab was 13,160 MT, which had reached 14,421 MT in 2016-17 (DoF 2018). Crabs are mainly exported in live and frozen form.

Mollusc

Very little is known about the production and management of clams. Clams are reported to be found in the intertidal and mangrove areas up to a depth of 10m in the sea (Pagcatipunam 1982). The blood clams are utilized in lime production, animal feed industries, and shell handicrafts. Recently, the blood clam is the only bivalve

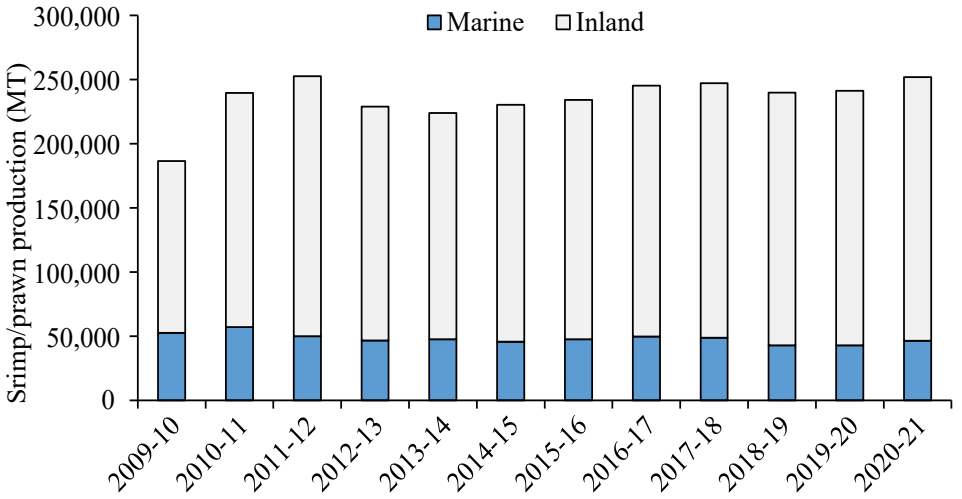


Figure 6. Production of shrimp/prawn from 2009-10 to 2020-21 (Adapted from DoF, 2022).

exported from Bangladesh and cultured in experimental trials (Alam and Sarker 1986). No published information on the amount of catch is available on clams, but the annual production is roughly estimated to be 80–100 t (Kamal 2000). Pagcatipunan (1982) reported that the highest natural abundance of edible oysters occurs in the Cox's Bazar and Teknaf areas. No published report is available on the production and utilization of the oyster in Bangladesh except the report of Sarker and Alam (1988), who reported an annual production of shell weight of 50–70 MT in 1984. There is no report available on production and stock size of cuttlefish and squid in Bangladesh.

Seaweed

Very little is known about the utilization of seaweed in Bangladesh. Kamal (2000) reported that mainly *Hypnea* sp. are collected during February–April for commercial purposes. In St. Martin Island, the fishermen, women, and their children are engaged in collecting seaweed. The collected weeds are dried in the sun spreading on the open beach. Currently, there is no industrial set up for seaweed processing and utilization in Bangladesh. Therefore the dried seaweeds are sold to the marketing agents, and it has been reported that about 200 tons (t) of dried seaweed are disposed of from Bangladesh to Myanmar through various marketing intermediaries (Kamal 2000).

Fishing gears and fishing vessels

Marine capture fisheries are further subdivided into artisanal and industrial fisheries. Artisanal fisheries contribute about 95% of the total marine production. Artisanal fisheries include a number of different types of fishing gear and crafts, which are mainly traditional. Only a few of the gears are operated by mechanized boats, but mostly with country boats. Some are even operated without any boat. The gear types include different types of set bag nets (estuarine set bag net, marine set bag net, and large mesh set bag net), gillnets (drift gillnet, large mesh gillnet, fixed gillnet, bottom set gillnet, and mullet gillnet), trammel net, beach seine net, bottom longline, and many others scattered throughout the coast and estuaries (Table 5). The total production from the artisanal sector is contributed by drift net and gill nets. The estuarine set bag net (ESBN) catches primarily juvenile fish and other aquatic animals. The two types of set bag nets are operated in the deeper areas with an average depth of 10 to 30 meters. The smaller one is operated in the estuarine areas as well as in the river, where the tidal effect is high. Hook and line fishing is a seasonal practice and is limited to mainly the winter season when the sea becomes calm. The seine nets are operated at very close range and used for catching small fish (Shamsuzzaman *et al*. 2017).

Table 5. Fishing gear used in the costal/marine water in Bangladesh with target species and depth of operation (Source: Khan *et al*., 1997)

Gear		Target species	Depth (m)
A.	**Industrial**		
1.	Shrimp Trawler	Penaeid shrimp	40-100
2.	Fishing Trawler	Pomfret, Grunter, Croaker, Catfish, Salmon, Jewfish, Ribbon fish etc.	40-100
B.	**Artisanal**		
1.	Gillnet (Drift gillnet, Fixed Gillnet, Large mesh Driftnet, Bottom set net, Mullet gillnet)	Hilsa Shad, Sharks, Indian Salmon, Grey Mullet,	5-30
2.	Set bag net (Estuarine set bag net, Marine set bag net, Large mesh set bag net)	Shrimp, croaker, Ribbonfish, Bombay duck, Clupeids, Anchovies, etc.	5-10
3.	Trammel net	Seabass	10-30
4.	Bottom long line	Shrimp, Croaker, Catfish	10-30
5.	Beach seine	Croaker	10-30
6.	Char pata net	Clupeids	8-10
7.	Cast net	Anchovies, Ribbonfish	> 10
8.	Push net	Shrimp	> 10
9.	Fixed bag net	Shrimp	> 10
10.	Dragnet	Shrimp	> 5

In Bangladesh, the term "industrial fisheries" indicates large-scale fisheries. Industrial trawling, mainly for demersal fish, is used in the offshore waters of Bangladesh. Industrial trawling began in 1972 with the introduction of 10 trawlers. Commercial trawler fishing for deep sea fish began in 1972, when the Bangladesh Fisheries Development Corporation (BFDC) introduced 11 modern fishing trawlers. Furthermore, three more trawlers were added in 1974. In response to a promising abundance of Penaeid shrimp resources, shrimp trawling on the continental shelf was introduced in 1978 after the Mitsui Tayo survey in 1976-1977 (Rashid 1983). At present, about 158 trawlers and 45,377 mechanized and non-mechanized boats are engaged in fishing (DoF 2012). Pelagic and deep-sea resources are still unutilized. Like the other fisheries, the large-scale marine fisheries also suffer from uselessness; each trawler lands only about 86 tons of shrimp and 154 tons of fish per hour of trawl (FAO 1991). It is high time to expand the industrial fisheries in the deep sea, but it is not advisable to develop large-scale industrial fisheries in deep sea waters currently. No country has yet found a way to make large-scale fisheries sustainable (FAO 1995).

Acts and regulations for marine fisheries in Bangladesh

Marine fisheries resources in Bangladesh are exploited without any appropriate management plan due to the unavailability of scientific data and difficulties in the implication of management strategies. Most of the fishing gears used are harmful to the growth, reproduction, and maintenance of the biological cycle of the marine population. Due to indiscriminate use of those fishing gears, our coastal fish stocks are being overexploited year by year. Therefore, it is necessary to assess precisely the extent of fishing pressure and the level of exploitation by different gears in order to estimate the impact on sustainable management. The Marine Fisheries Ordinance, 1983, is the main legal instrument for the purpose (DoF 2016). Recently, Bangladesh's Maritime Zones Act 2018 has been approved, aimed at unlocking the huge potential of the blue economy and checking crimes on the sea (MoFA 2018). Relevant sections of the marine fisheries ordinance, 1983 and Bangladesh Maritime Zones Act 2018 are presented in Table 6.

Prospects of marine fisheries resources in Bangladesh

Bangladesh is rich in coastal and marine resources. Utilization of the marine resources by implementing proper management strategies will develop an economic zone in the southern part of Bangladesh. It will create employment opportunities and other income-generating activities, develop other social services and security services, and improve the overall standard of life for the local people in coastal areas.

Blue economy

In Bangladesh, the term "blue economy" refers to all economic activities related to the ocean, sea, and coast (Hasan *et al.* 2018). A "blue economy" means the extraction of resources from the sea for the growth of an economy. Seaborne trade and industrial profiles can be lifted by increasing food security, improving nutrition and health, alleviating poverty, creating jobs, generating alternative energy, lifting seaborne trade and industrial profiles, while protecting ecosystem health and biodiversity (Hussain *et al*. 2017, MoFA 2019). The major sectors related to the blue economy are shown in Figure 7. Through the recent settlement of maritime boundary disputes with Myanmar and India, Bangladesh has acquired 118,813 square kilometers of the BoB. According to expert opinion, Bangladesh would be able to extract about 1.2 billion dollars from its huge marine resources. Bangladesh could be a developed country by 2041 if the resources are properly extracted and adequately used. It is possible to acquire 5 percent of the country's GDP by 2030 from the resources of the sea. The development of the blue economy will open a new window for the development of Bangladesh.

Biotechnology and marine genetic resource

Marine bio-tech has the potential to address a suite of global challenges such as sustainable food supplies, human health, energy security, and environmental remediation. Marine genetic resources like bacteria are a rich source of potential drugs. In 2017, there were over 36 marine-derived drugs in clinical development, including 15 for the treatment of cancer (MoFA 2019). One area in which marine bio-tech can make a critical contribution is the development of new antibiotics for medical science (Hunt and Vincent 2006).

Table 6. Important acts and regulations for marine fisheries in Bangladesh (Source: DoF 2016 and MoFA 2018)

Ordinance	Sections	How to implicate fisheries
The Marine Fisheries Ordinance, 1983	Section-7	Government may, by notification in the Official Gazette, specify types, classes and no. of fishing Vessels
	Section-15	Fishing vessels not to interfere with navigation/in established shipping routes
	Section-17 &18	Local fishing vessels to be registered and hold valid certificate of inspection from MMD for License
	Section-20	No entry for foreign fishing vessels in BD EEZ except with license
	Section-22	Foreign fishing vessels liable to fine and forfeiture if found in BD fisheries water illegally
	Section-28	Government may declare marine reserves
	Section-33	Authorized officer may enter premises, size, vessels, etc. without warrant
	Section-42	Willful damage to fishing vessels
	Section-55	Power to make Rules
Marine Fisheries Rules, 1983		They regulate the issuance and conditions of fishing licenses for national and foreign fishing vessels, determining license conditions, allowed fishing gear, mesh size, depth of operation etc.
Bangladesh Maritime Zones Act, 2018		This will act for determination of the boundaries of the territory of Bangladesh and of the territorial seas, internal waters, continental shelf, contiguous zone and Exclusive Economic Zone between Bangladesh and its neighboring coastal States (India and Myanmar) in the territorial sea. It will act to suppress maritime terrorism and unlawful acts against the safety of maritime navigation. It will provide guide on international law applicable to armed conflicts at sea and to give conscious effect of the intrinsic, ecological, social, economic, scientific, educational, values of ocean governance, armed conflicts at sea and its *components* and protection of marine environment.

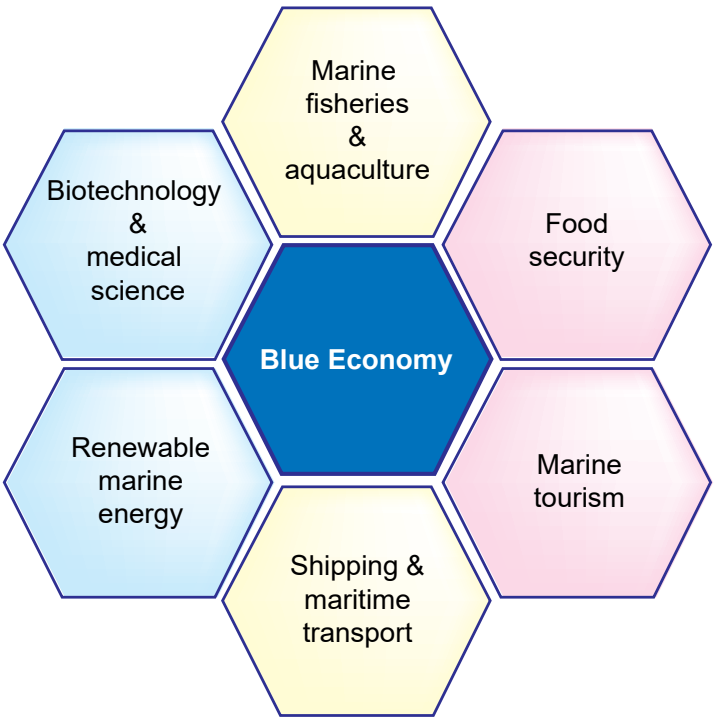


Figure 7. Different sectors related to blue economy in Bangladesh (Adapted from Hussain *et al*. 2017).

Research

Freshwater fish production is higher compared to marine fish production in Bangladesh (DoF 2018). Research work related to marine fisheries resources and their production performance is very limited in the country. Recent settlement of maritime areas with India and Myanmar provides the country with a huge marine water area, which has diversified fisheries resources. Therefore, appropriate research work on marine fisheries is absolutely required.

Challenges of marine fisheries resources management in Bangladesh

Climate change

The Sundarban mangrove forest, located in the Gangetic delta (Ganges-Brahmaputra-Meghna) of India and Bangladesh, is the most prevalent single chunk of incessant mangrove forest in the world. About 120 species of fish are normally caught by commercial fishermen in the Sundarbans area. This world's biggest mangrove can be smeared out by a one-meter rise in sea level (World Bank 2000). The mangrove similarly supports offshore and deep sea fisheries by playing a noteworthy part as a nursery ground for many deep sea fishes and shrimp, including the *P. monodon*, which is the foremost species in the industrial bottom trawl fishery of Bangladesh. Thus, sea level rise due to climate change may abolish the marine fish nursery ground in the Sundarban (Chowdhury *et al.* 2010). Climate change effects may reduce pH and increase CO_2 levels in the sea, which can affect the survival of marine fish, eggs and larvae.

Installation of Rampal power station and Matarbari coal power plant

The Bangladesh government has decided to establish a 1320 MW coal-fired power plant at the mouth of the Sundarban under Rampal upazila of Bagerhat district beside the Poshur river. This coal-based power plant would affect the ecosystem of the Sundarbans and surrounding areas permanently (Chowdhury *et al.* 2017) and thereby affect the marine fish nursery ground in the Sundarban. Furthermore, the Matarbari coal power plant in Moheshkhali upazila of Cox's Bazar would be another threat to the marine ecosystem, which in turn may affect the marine organisms, including fishes and turtles (Chowdhury 2018).

Other challenges:

The following challenges need to be addressed to increase the marine production in a sustainable manner, which will have tremendous and long-term impact on livelihoods of the coastal people (Mazid 2002, Shamsuzzaman *et al*. 2017).

a. Lack of awareness about modern aquaculture techniques like cage culture.
b. Lack of appropriate technology for marine and coastal aquaculture.
c. Inadequate facilities in relation to information, communication, transportation and market.
d. Lack of skilled manpower in this field
e. The areas for Mariculture not yet demarcated by the government
f. Lack of financial support and loan facilities to the sector.

Possible solutions against challenges of marine fisheries resources management in Bangladesh

a. The government of the Bangladesh should develop appropriate policy and take proper initiatives for protection and conservation of marine fisheries resources, which may fall under threat to climate change.
b. The government should not consider for installing any harmful power plant nearby or in the sea, which may disturb the ocean ecosystem.
c. Others recommended that the following initiatives need to be taken by the government and private sector in collaboration with the regional and international networks (Mazid 2002, Shamsuzzaman *et al*. 2017). These are:

i. Capacity building relating to the Marine aquaculture, in terms of-

- Develop appropriate technologies for coastal and marine aquaculture, which will be best fit for Bangladesh considering its climatic, market and social conditions.

- Develop knowledge and management skills of the human resources who will be involved in coastal and marine sector.
- Plan for the demarcation of coastal areas using Geographic Information System (GIS).

ii. Development of infrastructures

- Road for transportation of both inputs and outputs
- Developing the educational or training facilities
- Develop communication system to rapid access to information.

iii. Development of networks

- Develop organizations and networks for information, better management, and access to finance.
- Develop and coordinate with the regional and international networks for update technological, markets and other relevant information and support.

Conclusion

This review paper provides information about the present scenario of marine fisheries resources in Bangladesh. However, recent information is still limited, which strongly suggests the need for conducting new studies on marine fisheries resources with their production potential in Bangladesh. Marine fisheries resources have great potential and huge prospects for the economic development of the country. Importantly, the concept of "blue economy" has recently increased the prospects of marine resources in various ways, such as marine aquaculture, nutritional security, biotechnology, marine tourism, and transport etc. Despite the huge prospects and potentialities, a number of reasons (climate change, installation of coal-based power plant nearby the sea, lack of scientific information and skilled manpower, poor implementation of acts and rules related to marine fisheries, etc.) limit the marine fisheries resources with their production performance. Thus, marine-related research and proper management strategies, execution and implementation of acts and rules with appropriate government policy are required for protection and conservation of marine fisheries resources and also for sustainable marine fisheries production.

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