Coastal Fisheries: Problems and Management

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Abstract

It is well known that fisheries are one of the important pillars in the development of an economy. Within various types of fisheries, coastal fisheries play an important role in the economy and the feeding of people. Different geographical parameters, like temperature, rainfall, increase of sea bed, directly affect fish production. In the present world, sudden climate change is the primary cause of decreased marine fishes' production. It directly affects their physical, physiological as well as reproductive character. Environmental problems include decrease of salination, discharge of different unusual materials to coastal water bodies etc. Many farms have been reported some environmental and socio-economic problems also. Now-a -days different management strategies of coastal fishes are developed by different organizations. Govt. of India also provided a guideline to the coastal states about the details of rules and regulations regarding production and management. This present study has been made based on the data collected from the other published journals.

Coastal fisheries include small-scale fisheries 50 km away from the coastline and down to 200m depth⁵. West Bengal has coastal parts which help in marine fish production¹. Approx. 2.15 lakhs marine fishermen depend on marine resources to earn money². Socioeconomic study directly related to coastal fisheries. Marine production is about 17.6% of the total fish production of West Bengal and 6.2% of India's total annual marine production². Besides this, coastal tourism is increasing day by day, which helps develop the world

economy². Though there were no proper harvest strategies⁹, people were only involved in fishing. The world's marine fish increased from 1950 to 1996 and then decreased. Now it maintained a stabilizing range.

The coastal ecosystem includes a wide range of habitats, species diversity and genetic diversity¹³. Fishes are good source of primary animal protein. Many people keep fishes in daily diet.

India has east and west shoreline

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where the maximum yield of coastal fisheries was reported. Exports of coastal fishes are equally important besides diet. During the late '50s marine fisheries sector has started to develop (Bay of Bengal program, 1990). Not only advanced science but also Govt sector has started technology to increase production. Hilsa shad (*T. ilisha*) is one of the most popular fish in the coastal region of West Bengal⁹. Not only in WB but also in Bangladesh, major coastal fisheries depend on *T. ilisha*.

The coastline of West Bengal :

Indian coastline touches nine states viz., Gujrat, Maharashtra, Goa, Karnataka, Kerala, Tamil Nadu, Andhra Pradesh, Odisha, West Bengal, two union territories- Daman & Diu and Pondicherry. Among all, Gujrat has the highest coastal areas in India. The coastal plain of West Bengal (Fig. 1) is located mainly in Purba Medinipur and South 24 Parganas district (Fig. 2) and has a coastline of 158 km long.

A large number of fish, crabs, prawns are collected from coastal water bodies of West Bengal. In the coastal part of West Bengal, temperature, salinity, and other physiochemical parameters help to produce fish². The growth of estuarine consumers depends on the supply of nutrients from land and organic detritus needed for their energy sources. Commercial estuarine fishes mature in that area, and other freshwater fishes spend some part of their life cycle². Estuaries play avital role in the maturation and production of fish.

Coastal fishes in West Bengal :

Based on the data from previously



Fig. 1: Coastal areas of West Bengal.



Fig. 2 : Areas of Sundarbans, major part of coastal region of West Bengal

published journals, different fish markets and laboratory experiments the updated list of fishes in Sundarbans are listed below (Table 1).

Fishing crafts and gear used in West Bengal:

Fisherman develop various methods to catch the fish. Depending on the types of fish and the nature of the river or sea bed, numbers of crafts and gears are used. Any instrument to catch fish is called gear, while crafts are used to carry fisherman.

Details of Fishing gears in West Bengal are mentioned below¹² and 14 .

(149)

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Serial no.	Common Name	Scientific Name
1.	Barramundi	Lates calcarifer
2.	Clupeids	Hilsa ilisha
3.	Mullets	Liza parsia
5.	Mullets	Liza taede
6.	Bombay duck	Harpodonnehereus
7.	Striped eel-catfish	Plotosus canius
8.	Silver pomfret	Pompus argenteus
9.	Common guitarfish	Rhinobatus sp.
10.	Pangas catfish	Pangasius pangasius
11.	Threadfin fish	Polydactylens sp.
12.	Milkfish	Chanos chanos
13.	Indian salmon	Eleutheronema tetradactylum
14.	Paradise threadfin fish	Polynemous paradesious
15.	Croaker	Pama pama
16.	Slender bamboo shark	Chiloscyllium griseum
17.	Spade nose shark	Scoliodon laticaudus
18.	Milk shark	Rhizoprionodon acutus
19.	Blacktip reef shark	Carcharhinus melanopterus
20.	Brown numbfish	Narcine brunnea
21.	Dwarf whipray	Brevitrygon walga
22.	Cow tail stingray	Pastinachus sephen
23.	Sharp snout stingray	Telatrygon zugei
24.	Red sea white- spotted moray	Gymnura poecilura
25.	Tarpon	Elops machnata
26.	Moray eel	Gymnothorax sp.
27.	Eel	Congresox talabonoides
28.	Daggertooth pike conger	Muraenesox cinereus
29.	Purple spaghetti eel	Moringua raitaborua
30.	Giant mottled eel	Aquilla bengalensis
31.	Gizzard shad	Anodontostoma chacunda
32.	Indian river shad	Gudusia chapra
33.	Kelee shad	Hilsa kelee
34.	White sardine	Escualosa thoracata
35.	Sardine	Sardinella sp.
36.	Anchovy	<i>Coilia</i> sp.

Table-1. List of coastal fishes which are found in Sundarbans and adjacent regions³ and ¹¹ are mentioned below:

37.	Hairpin anchovy	Setipinna sp.
38.	Spined anchovy	Stolephorus tri
39.	Gangetic anchovy	Thryssa purava
40.	Wolf – herring	Chirocentrus sp.
41.	Smooth black- herring	Racondarus seliana
42.	Long finned herring	Opisthopterus tardoore
43.	Catfish	Plotosus sp.
44.	Gangetic ailia	Ailiacoila
45.	Catfish	Mystus sp.
46.	Sea Catfish	Arius sp.
47.	Engraved Catfish	Nemapteryx caelata
48.	Stinging Catfish	Heteropneustes fossilis
49	Unicorn cod	Bremaceros mcclellandi
50.	Zebra frog-fish	Antennarius hispidus
51	Banded needle fish	Strongylura sp.
52.	Needle fish	Tylosurus crocodilus
53.	Long billed halfbeak	Rhynchorhamphus georgii
54.	Ectuntio halfbeak	Zenachopterus sp.
55.	Eel	Macrognathus sp.
56.	Plain tail turkey fish	Pterois sp.
57.	Grey sting fish	Minous sp.
58.	Rough flathead	Grammoplites scaber
59.	Spiny flathead	Kumococius rodericensis
60.	Spotted flathead	Cociella crocodilus
61.	Bartail flathead	Platycephalus indicus
62.	Grouper	Epinephelus sp.
63.	Broad – banded cardinal fish	Ostorhincus sp.
64.	Three striped cardinal fish	Apogon sp.
65.	Snake headed fish	Channa sp.
66.	Oxeye scads	Selar sp.
67.	Longfin trevally	Carangoides sp.
68.	Red tailed mackerel scads	Decapterus kurroides
69.	Black pomfret	Parastromateus niger
70.	Queen fish	Scomberoides tol
71.	Moon fish	Menes sp.
72.	Short nose pony fish	Leiognathus sp.
73.	Pony fish	Secutor sp.

/4.	Tooth pony	Gazza minuta
75.	False trevally	Lactarious lactarious
76.	Blood snapper	Lutjanus sanguineus
77.	Dollfus' snapper	Uranoscopus guttatus
78.	Stargazer	Icthyscopus inermis
79.	Four barred tiger fish	Datnioides sp.
80.	Silverbiddy	Gerres sp.
81.	Ongspine seabream	Argyrops spinifer
82.	Pink perch	Nemipterus sp.
83.	Goatee croaker	Dendrophysa sp.
84.	Sharp nose hammer croaker	Johnius sp.
85.	Kathala croaker	Kathala axillaris
86.	Cuja croaker	Macrospinosa cuja
87.	Toothed croaker	Otolithes sp.
88.	Pama croaker	Otolithoides pama
89.	Panna croaker	Panna microdon
90.	Spotted croaker	Protonibea diacanthus
91.	Four finger thread fin	Eleutheronema tetradactylum
92.	Indian thread fin	Leptomelanosoma indicum
93.	Large scale archer fish	Toxotes sp.
94.	Spotted sickle fish	Drepane punctata
95.	Spadefish	Ephippus orbis
96.	Long arm mullet	Osteomugil cunnesius
97.	Green back mullet	Planiliza subviridis
98.	Mullet	Valamugil speigleri
99.	Mullet	Chelon sp.
100.	Stargazer	Icthyscopus sp.
101.	Stargazer	Uranoscopus sp.
102.	Sleeper goby	Butis sp.
103.	Tank goby	Glossogobius giuris
104.	Goby	Apocryptes bato
105.	Bumble bee goby	Brachygobius nunus
106.	Goby	Zappa sp.
107.	Goby	Pogongoibius planiformes
108.	Mudskipper	Periophthalmodon sp.
109.	Rubicundus eel goby	Odontamblyopus rubicundus
110.	Walking goby	Scartelaos histophorus
111.	Knight goby	Stigamotogobius sadanundilo

112.	Eel goby	Taenioidis buchanani
113.	Burrowing goby	Trypauchen vagina
114.	Arrow dragonet	Callionymus sagitta
115.	Spadefish	Ephippus orbis
116.	Barracuda	Sphyraena sp.
117.	Small head ribbon fish	Eupleurogrammus muticus
118.	Large head ribbon fish	Trichiurus lepturus sp.
119.	Savalani ribbon fish	Lepturacanthus savala
120.	Bullet tuna	Auxis rochei
121.	Mackerel	Scomberomorus sp.
122.	Indian lamp head	Kurtus indicus
123.	Javanese flounder	Pseudorhombus javanicus
124.	Commerson's sole	Synaptura commersonnii
125.	Zebra sole	Zebrias altipinnis
126.	Sole	Brachirus sp.
127.	Flounder	Pseudorhombus sp.
128.	Halibut	Psettodes sp.
129.	Tongue sole	Cynoglossus sp.
130.	Tongue sole	Symphurus trifasciatus
131.	Tongue sole	Paraplagusia bilineata
132.	Large tooth saw fish	Pristis microdon
133.	Short nose tripod fish	Triacanthus biaculeatus
134.	Tripod fish	Pseudotriacanthus strigilifer
135.	Trigger fish	Abalistes stellaris
136.	Puffer fish	Leiodon cutcutia
137.	Grunting toadfish	Allenbatrachus grunniens

Fishing gears made up of bamboo:

Ghuni: Trap-like fishing gear made of bamboo pieces cut into thin sticks and bound unitedly with nylon. It is a basket-shaped trap. This is placed into flowing water overnight. Fishes cannot move outwards if these enter once. Length is 91-122 and breadth 30 cm ¹⁴. *Channa, Clarius* are caught by this.

Dughore: Similar to ghuni. Length and breadth are more or less similar with ghuni. This is mainly used in shallower region. This is opened at one side for entry of fish.

Polo: This has one side opening, which is gradually widening downward. It is used in a shallow pond, flowing water etc. Its length is 76-91 cm, the base is 60 cm and radius of opening is 13 cm. This catches *Channa*, *Anabas* which stay in muddy areas.

Polui: Similar to polo and is mainly found in Birbhum. The neck region of polo is absent in polui. It is also used in a muddy pond. Jhuri: This round typed gears made up of split bamboo. This is placed underwater and lifted

suddenly. Moving water leaves the fishes within it. It is used to catch *Puntius, Chanda* etc.

Tati: It is made up of branches of trees as well as bamboos. These are arranged both horizontally and vertically and then united to form a fencing-like structure. A pit is made beside the gear. When placed in flowing water at first, fishes avoid entering, but finally, they are jumped into the gears through the pit. These are mainly used in flowing water, canals, overflowed water. These are used to catch *Channa, Heteropneustes, Puntius.*

Ciyara: Bamboo sticks are arranged vertically and 2-3 sticks are placed horizontally. It is of 2 types. Small one is used with Torodung gears. Big one is mainly used in overflowing areas.

Fishing gears made up of hooks :

Fulkuchi: It is made up of bamboo and iron rods. The length of the bamboo handle is up to 90-120 cm, and the iron rod is 45-60 cm. This is used in the river with clear water. When the fish passes under the water fisherman hits the fish with this gear. It is directly inserted into the fish body and caught. It is used to catch *Mastacembelus, Amphipnous* etc.

Barshi: It is one of the traditional gears used to catch small to medium-sized fish. At the time of fishing, a small amount of food is placed in the hook placed underwater. By this, fisherman can easily attack fishes. This is used all over India, but people call it by its regional names.

Geras made up of bamboo and net (used in rivers and lakes) :

Bhasal: It is mainly used in lakes and rivers. Bamboo frames are used to fit the net. Bamboos are placed into the river, and a net is tied up with the bamboos. The net is dipped into the river. When a shoal of fish enters the net, the fisherman pulls the gear.

Hotchajal: It is made up of bamboo and fined net-like mosquito net. Three pieces of bamboo are placed triangularly, and the net is placed within this triangle.

Chankajal: The bamboo stick is cut into two pieces and bend to join to form a circular structure with a net tied to it.

Gears which are made by net (used in rivers and lakes) :

Khaplajal: It is made up of only the net. When placed in water, it spreads, covering a wide area. The net has a radius of 270- 300 cm¹⁴. It is mainly used to catch crabs, prawns etc. *Puthijal:* It is one type of long net to catch indigenous fish. It is placed in flowing water and spread it from bottom to top. *Puntius, Amblyopharyngodon* etc, are caught by this gear.

Purse net: Migratory fishes (such as *Hilsa*) is caught by a rectangular net looking like a purse. This is made up of tanned cotton twine and is rectangular with large mouth. Two curved, flexible bamboo sticks from the upper and lower lip of the mouth are hinged at the two angels. A vertical bamboo is attached to lower lip and passes through a ring in the upper lip so that the mouth of the net can be opened or closed as desired by fishermen. The net is suspended from the boat by rope and the mouth is kept open, and the boat is moving downstream. Fish migrating upstream enter the mouth and are easily caught.

Cast net: It is circular like umbrella with a

strong rope attached to it. A number of weights of iron or lead are attached along the margin. The fishermen throw the net from the boat and the rope is maintained by hand. The net sinks to the bottom due to weights attached to the bottom, and small fish and prawns are entangled into it easily.

Fishing crafts :

Various types of open boats are mainly used for fishingin West Bengal viz., "*Nauka*," "*Dinghies*." Each is made of planks of wood joined together with palm leaf fibers, and is without ribs or frames, and it may be about 10 m long.

Now large-sized mechanized boats using motor and large steel vessels are used with electromagnetic equipment (such as echosounders, refrigeration facilities etc.) for fishing in distant places where small boats cannot reach. Modern boats are light and strong, made up of fiberglass, reinforced plastics instead of wood and steel. The speed of these boats is high than the primitive boats.

Marine fisheries from the Bay of Bengal :

About one million people depend on the marine fisheries sector. The country has a fishing fleet consisting of 58,9111 mechanized craft, 75,591 motorized craft, and 104270 nonmotorized craft⁶. Coastal fisheries production will stagnate because of overfishing, unregulated fishing, habitat destruction, pollution etc¹⁶. Though fishermen utilize vast resources, fishing is mainly restricted in coastal areas of 100 m depth. Data of deep-sea and oceanic fishing is not so much reported. Within 0.54 million tonnes of landed marine fishes 42.1% are caught by the artisanal shore seines, gillnets, bag nets, hooks, lines, encircling nets, dip nets etc. and 16.6% by other mechanised gears such as inboard Pablo gill nets, drift nets, hooks and encircling nets⁴.

The mechanical sector, especially trawlers in Tamil Nadu, Orissa, Andhra Pradesh, are reported to increase fish production. Besides this mechanical sector, West Bengal coast mainly follows traditional methods. Pump-fed drainable farms are well-practiced in the Coromandel coast. The extensive and intensive culture production rate exceeds 10 tonnes/ ha/crop³.

Electric current is a low voltage known to catch fish¹². Two electrodes are placed into water. An anode is placed in a fishing net, and the cathode is placed near the boat. When the current is on, fish respond to it, swim towards the positive pole, and catch it easily. Fishes that are under the rocks or stones and escape netting are easily caught by using electric current. To improve this method, it is needed to design proper training and necessary precautions.

Fish production is much greater on the west coast than the east coast. There is also regional variation in the catch composition along the west coast. The west coast produces many commercially important fishes¹²; such as sardines, mackerels, pomfrets, polynemids, prawns, Bombay duck etc. The east coast does not support any commercially significant fisheries. However, a substantial quantity of several small fisheries is included¹², such as perches, sharks, silver bellies, flying fishes, *Cybium, Pellona, Engraulis, Trichiurus* etc.

Nearshore fisheries :

This is a subtype of coastal fisheries, including intertidal and estuarine fisheries with shallow waters (depth not more than 10m). An estuary is formed along the coast near the river's mouth and contains brackish water, a mixture of fresh and seawater. West Bengal has the highest percentage of brackish water area in the country. This includes open estuaries and embanked estuaries. Open estuaries are always connected with the sea and located at the mouth of the river and lake. These may be perennial, being filled with the river's water allyear-round or seasonal in which the river water dries up during summer and filled with water in the rainy season. The water of estuaries has high salinity, rich in nutrients of organic and inorganic matters from the ocean, contains algae & aquatic plants, and plankton production of fishes is high in these regions. Hooghly estuary is one of the large estuaries of India. Intertidal fishes move in and out with the tide in the intertidal zone. These fishes are found mainly in salty water and easily adopted in a volatile environment. Crabs, shrimps etc., are found temporarily in these regions.

Problems : Man-made problems :

Different ecological, environmental parameters are creating hindrances in coastal fisheries. Such as mangrove wetlands have started to convert in the normal plain; modern civilization is convert in agricultural fields to many industries; discharge of untreated effluents from industrial belts to coastal water bodies etc. These man-made problems decrease the growth and production of fish. Many times, fishermen collect undesirable seeds from coastal water bodies. These are not usable in a fish market. So, it creates a harmful impact on the production of fish. Many diseases are transmitted easily to the postlarvae, juveniles, sub-adults. One diseased fish transmitted a maximum number of fishes in a shoal of fish.

Overfishing and unregulated fishing are other factors that reduce the number of juvenile and adult fishes in coastal water bodies. In many places, there is not so much awareness among fishermen.

Problems due to climate change :

Greenhouse gases in the atmosphere increase the temperature of an environment directly related to the increase of sea surface temperature. It leads to a rise in humidity and thermal expansion. Ice caps are melting due to the rise of temperature. The historic sea level rise was for 2 cm in the Cochin coast in the last century¹⁰ and⁷. It leads to a rise of sea level up to 30 cm in near 50 years⁸. An increase in sea level affects wave height which reduces littoral drift. Sea Surface Temperature (SST) increases 0.2°C along North West (NW), South West (SW), North East (NE) coasts and by 0.3°C along South East (SE) coast¹⁷ from 1961 to 2005.

Effect on fishes :

Some fishes face regional extinction due to the rise of sea surface temperature and sea level. Many fishes have changed their habitat mainly to higher latitudes. Untreated effluents contain high organic matters, high BOD, COD, H₂S, Nitrogen, Phosphorus, Trace elements³. These decrease Dissolved oxygen and increase algal blooms. This problem mainly found in Coromandelcoast with low rainfall, no riverine habitat, low tidal amplitude, formation of sand bar which decrease water exchange between system and sea³. These effluents also create an impact on phenological changes. The rise of sea surface temperature affects eggs' development and size of egg¹⁵. Though fishes are growing faster in warmer years, their growth rate decreases at a particular temperature hike. In the case of coastal fisheries, there is sufficient competition among fishermen and states for the use and exploitation of this unclaimed resource to get maximum benefit. Due to primary economic reasons such as the cost of protecting or defending the resource, it has no individual ownership. Even after the declaration of an Exclusive Economic Zone (EEZ) of 200 nautical miles (370 km) by many maritime nations, the sea resources are still largely under the standard property concept. However, the state has sovereignty over these resources¹². However, it has to face severe problems due to vast resources in marine areas. Such as, no individual can efficiently manage enormous resources that have no boundaries. Sometimes opacity creates significant problems in fishing activities. When any fisherman can take away as much fish caught by him, this leads to overfishing and unregulated fishing. That is another cause of the depletion of total stock.

Management :

Management strategies are collected from journals, Govt. gazettes etc. Department of Fisheries & Cooperation, Ministry of Food and Agriculture, Govt. of India, Indian Council of Agricultural Research, Central Marine Fisheries Research Institute, Fisheries Survey of India, Integrated Fisheries Project, Department of Fisheries of Marine states, Union Territories, Bay of Bengal Programme shared guidelines for management of coastal resources. The Central Marine Fisheries Research Institute has initiated low-cost techniques for culture and capture⁴ for bivalve molluscs which molluscan fishes up take.

Guidelines are given to avoid confrontation between mechanical and artisanal sectors rather than an intimation of suitable regulatory measures. The guidelines are-

- 1. Non- mechanical artisanal craft is used for a distance of 10 km from the coastal region.
- 2. Small mechanical boats beyond 10 km distance from coast.
- 3. Vessels of OAL 20m and above used for 23 km from coast.
 - As per Govt rules,
 - 1. Discharge of effluent from factories
 - 2. Harvesting with 200m of HTL is now prohibited. From 200-500 m zone is only used for the manual purpose.
 - 3. The Ministry of Environment and forests and The Govt. of State, Union Territories recruited people to monitor coastal areas.

The MSY (Maximum Sustainability Yield) is one of the guiding principles of resource management¹². There are two simple ways of obtaining an MSY regularly – through a fixed quota and a fixed effort. In "fixed quota MSY harvesting", the same amount, the MSY, is taken away

from the population every year. In "fixed effort harvesting", an effort is made to maintain a constant harvest through a constant harvesting effort. Thus, more effort does not give better economic returns, though it may give higher fish catch.

Maximum economic yield (MEY) is the yield of the fishery based on the principle of cost economics in the fishery¹². MEY is usually less than the MSY as in most cases MSY may be profitable but uneconomical.

MSY may not be able to meet the expenses incurred or to compete with the market price. It is much more economical to catch 300kg of shrimp than 3000kg of catfish or ribbonfish. The maximum economic yield is less complex than the concept of maximum sustainable yield.

The optimum catch is that which can be removed by fishing effort without deteriorating the equilibrium biomass. The yield in fishery at this level is called Optimum Sustainable Yield (OSY). The OSY of a given fishery or region will be carefully defined to respond to the unique problems of that fishery.

Modernization of Fishing Methods :

Primitive methods are used in maximum fishing where time is wasted in reaching the actual place, and they return with a small number of fish. Fishing boats are heavy which is not able to travel distantly. Now to improve catch it is essential to modernise the crafts and gears as well as the methods of fishing. New boats are in large sized, light in weight, faster than the previous one, and travel distantly. Fishing nets are synthetically made, strong, and resistant to rotting. Boats are made up of ferro-cement and fiberglass. Purse seine, Rampani net, and trawl net are used by fishing vessels.

Echosounders can transmit echoes up to a depth of 4000 m¹². The echosounders can sense the presence of fish in the path of its sound pulses between the transducer and the bottom. Efficient methods of identifying fish echoes lead to the development of more sensitive echosounders. It can differentiate the echo of fish from the echo of the bottom.

Sonar is another aquatic equipment that is a part of modern technology. This can locate shoals of fish. It has a range of 2500m around the vessels in all directions and traps fish¹². Facilities for quick preservation and refrigeration on fishing vessels and near the shore have also revolutionized the fishing industry.

This paper has discussed the management and problems regarding the development of coastal fisheries. Impact of climate change with references to temperature increase, the rise of sea level, hike of wave etc. are mentioned here. Though Gujrat has the highest coastal area in India, west Bengal has initiated developing the coastal fisheries sectors. Fisheries are one of the important export sectors in India by which fishermen maintain their livelihood. Fish growth, abundance, and catch are also affected by the rise of temperature, sea level increase, *etc.* So, climate change is a major problem in abundance of some fishes. It is also a major challenging environmental condition that is faced by all over the world. Man-made problems also area part of climate changes. But strategies are initiated to improve the supply of fish in coastal areas. Different adaptive measures have started to reduce the impact and develop the production of fish. Besides this awareness of fishermen is also a vital part to conserve fisheries as their active participation is mandatory for fishing.

Reference :

- 1. Bandyapadhyay, P., B. Swant and S. Chakraborty (2003) *FC*, *23*(1): 146-153.
- 2. Bhattacharya, M., (2011) *IJCR*, *3*(12): 286-291.
- Behera, T.K. (1997) An Approach to Coastal Fisheries Management in India (A review in the Bay of Bengal Region, India).
- 4. Behera, T.K. (1997) Coastal Aquaculture Related Fisheries Management Problems.
- Chuenpagdee, R., L. Liguori, M, L.D. Palomares and D. Pauly (2006) ISSN, *14*(8): 1198-6727.
- CMFRI (2006) Marine fisheries Census (2005), Central Marine Fisheries Research Institute, Cochin, India: 104.

- Das, P. K. and M. Radhakrishna (1993) Proc. Indian Acad. Sci, 102: 175-183.
- Dineshkumar, P.K. (2000) Studies on the Impact of Selected Sea Level Rise Scenarios on the Coast and Coastal Structures around Cochin, PhD Thesis, Mangalore University, Mangalore, India: 125.
- 9. Dutta, S., K. Chakraborty and S. Hazra (2015) *Proc Zool Soc* : 0138-7.
- 10. Emery, K.O. and D.G. Aubrey (1989) J. *Coast. Res.* 5 : 489-500.
- Habib, K.A., A.K. Neogi, N. Nahar, J. Oh, Y. Lee and C. Kim (2020) JoTT, *12*(1): 15154-15172.
- Khanna, S.S. and H.R. Singh (2002) A Textbook of Fish Biology and Fisheries, ISBN 978-93-84337-12-4: 431-443.
- 13. Mozumder, M.H.M. and M. Shamsuzzaman (2018) IJGMS, *47* (11): 2287- 2295.
- 14. Samajdar, I. and S.K. Saikia (2014) IJTK, *13* (1): 187-194.
- Vidal, E.A.G., F.P. DiMarco, J.H. Wormoth and P.G. Lee (2002) *Glob. Change Biol*, *3*(1): 23-28.
- 16. Vivekanandan, E. (2009) CMFRI (Anonymous)
- 17. Vivekanandan, E. and M. Rajagopalan (2009) *ICAR* (Anonymous).