



Marine fisheries and biodiversity management in Maharashtra: Status, challenges and opportunities

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Received: 27 March 2021; Accepted: 12 July 2021

ABSTRACT

Fisheries plays a pivotal role in the economy, food security, foreign exchange earnings and employment of the coastal population. Maharashtra is bestowed with a coastline of 720 km spread over 7 coastal districts, viz. Thane, Palghar, Mumbai city, Mumbai suburban, Raigad, Ratnagiri and Sindhudurg along the Arabian sea with rich marine fishery resources. There are 25 fishing zones in the seven districts with 173 fish landing centres. The total marine fish production from the state during 2018–19 was 4.6 MT valued at ₹6298 crores (DOF, Government of Maharashtra). The state offers huge potential for the sustainable utilization of the marine bioresources for fisheries, mariculture, coastal aquaculture and post-harvest development and exports. Maharashtra falls under the North-West coast which contributes the highest (32.8%) in the total catch during 2019–20. The major share is contributed by pelagic resources (39%), followed by crustaceans (31%), demersal comprising 22% and molluscs (7%). The prominent species/groupwise landings include non-penaeid shrimp (21%), penaeid shrimp (9%), Bombay duck and croakers (8.2%), Indian mackerel (6.9%), threadfin breams (5.9%), squids (5.1%), ribbon fishes (4.1%), golden anchovy (4%), horse mackerel (3.5%), cuttle fish (2.1%), silver pomfret (2.0%). The trawl fishing accounted for 55%, set bagnet (SBN/Dolnet) 23%, purse seines (15%) and gillnet (7%) (CMFRI Annual Report 2019).

Keywords: Aquaculture, Biodiversity, Fisheries, Maharashtra, Mariculture, Marine

There are several studies and reports in the past related to fisheries, fish taxonomy, biodiversity, resource management, and aquaculture (Bhat and Vivekanandan 2013, Adiga *et al.* 2016, Kulkarni *et al.* 2017, Pawse *et al.* 2017, Bhendarker *et al.* 2020).

Marine biodiversity management

Marine biodiversity is globally threatened and requires new management strategies to address increasing challenges of biodiversity loss at genetic and species level due to environmental and anthropogenic changes. Major threats to marine biodiversity of the world are environmental degradation and overfishing (Upton 1992).

The marine ecosystem in Maharashtra consists of coastal belts such as mangroves, mudflats, estuaries and seashores, and offshore ecosystems. The biodiversity is affected by anthropogenic impacts in terms of habitat destruction, bottom trawling, use of purse seine and other non-permitted nets, poaching of protected species, and lack of awareness about the conservation significance of marine biodiversity in general and endangered and protected species in particular.

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There are several organizations involved in research and management activities related to marine biodiversity and ecosystem of Maharashtra. These include the Zoological Survey of India, Regional Station, Pune; ICAR-Central Marine Fisheries Research Institute, Mumbai Regional Station; Fishery Survey of India; Central Institute of Fisheries Education; Institute of Science, University of Mumbai; Mangrove Foundation, Govt of Maharashtra; National Institute of Oceanography, etc. The ICAR Institutes (CMFRI, CIFE, CIFT and NBFGR) have been carrying out studies related to stock assessment, fishery biology, and traditional and molecular taxonomy studies of the marine aquatic fauna and flora, marine ornamental fish genetic resources utilization and development and

Table 1. Marine fishery resources and profile of Maharashtra

Resource	Area
Coastline	720 km
Continental shelf	112,000 km ²
Coastal districts	06
Major fish harbours	03
Fish landing centres	
Fishing villages	456
Fishermen families	81,492
Fisherfolk population	4.50 lakhs

processing of marine products etc. The barcodes of several marine fish species from Maharashtra are being generated for its use in accurate identification of fish as well as in sea food identifications for frauds (Lakra *et al.* 2011). The Fishery Survey of India is primarily involved in exploratory surveys of fishery resources in the EEZ including demersal, pelagic and oceanic tuna resources. The FSI also envisions to carry out investigations on coral reef ecosystem, large marine ecosystem approach for conservation and management of resources and preservation of the

environment. The National Institute of Oceanography, Regional Centre, Mumbai is mandated to study the marine environment of the Maharashtra coast and its impact on the coastal and marine ecosystem. India is a signatory to Convention on Biological Diversity (CBD) and is thus committed to achieving the Aichi Biodiversity Target 11 which prescribes conservation of 10% of coastal and marine areas. The National Biodiversity Authority has come out with detailed strategies and action plans (MOEF 2008).

Maharashtra has a dedicated unit for mangrove and

Table 2. District-wise fish production of past 5 years (in tonnes)

Name of district	2014–15	2015–16	2016–17	2017–18	2018–19
Thane	104700	99520	97802	114399	99461
Greater Mumbai	181034	190813	202683	206333	216132
Raigad	41249	39053	41514	53338	58847
Ratnagiri	115042	87030	98443	80340	73738
Sindhudurg	21560	17699	22305	20582	19054
Maharashtra	463585	434115	462747	474992	467232

Table 3. Species/ groupwise fish production of past 5 years (in tonnes)

Species/groups	2014–15	2015–16	2016–17	2017–18	2018–19
Elasmobranchs	6126	6007	5593	11381	8028
Eels	1248	3051	2868	2644	1826
Cat fishes	15876	12946	14288	10397	10412
Chirocentrus	3036	2822	4819	5431	4048
Sardines	67132	47510	22001	18899	7926
Hilsa Illsha	1762	1479	1908	1459	3938
Anchoviella	20591	24503	19032	19354	22169
Thrissocles	7799	7703	8152	8942	7348
Other Clupeids	1617	2677	3426	641	233
Harpodon Neherus	50965	48681	39086	36228	34984
Perches	286	726	248	518	3042
Red Snapper	359	468	212	526	287
Polynomids	2668	2020	988	866	1241
Sclaenlds	7697	4255	2771	3471	2915
Otolithoides sp.	20245	20180	22324	23017	25402
Trichiuridae (Ribbon fishes)	20143	14372	16525	27209	22674
Caranx	2576	2852	4873	6312	12524
Pomfrets	12872	10990	10945	18826	15013
Black Pomfret	2100	2178	3405	2091	1053
Mackerel	15094	18570	42068	50379	31980
Seer fish	10365	9041	12169	12521	10825
Tunnles	3587	2106	8269	9562	8293
Bregamceros Macellendi	872	880	401	280	78
Soles	9404	9876	7943	6406	8171
Sphyraena sp. (Barracuda)	1048	771	1902	2981	3852
Leignathus	997	986	764	1284	1597
Upenaides sp.	13050	18454	20449	24353	23845
Penaeld prawns	47902	51595	55525	46211	46740
Non-penaeid prawns	55493	60898	62682	59275	63972
Lobsters	378	488	1488	835	789
Lactarius	3282	3611	6338	3308	3423
Cuttle fish	26305	17408	26643	22128	27334
Miscellaneous	30674	24011	32642	37257	51270
Total	463549	434115	462747	474992	467232

Source: DoF, Government of Maharashtra.

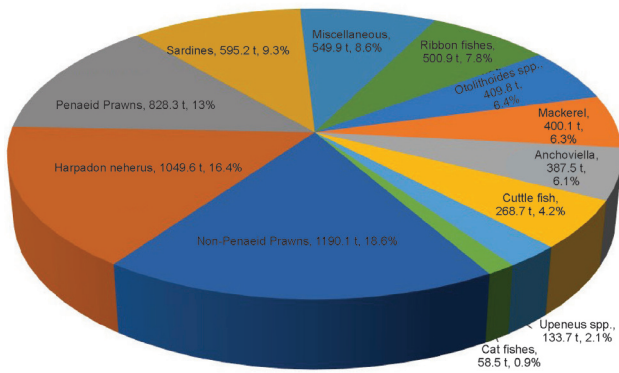


Fig. 1. Species-wise percentage of fish production during 2018–19.

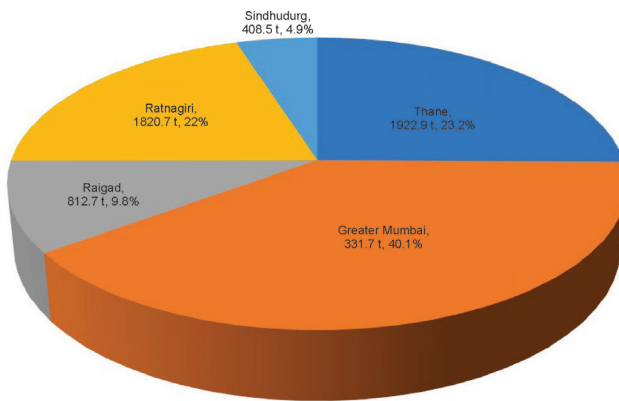


Fig. 2. District-wise fish production percentage during 2018–19.

coastal biodiversity conservation which is actively involved in various program related to biodiversity conservation and management including the establishment of a coastal and marine biodiversity center in Airoli, New Mumbai. It aims to support conservation education and awareness about the coastal and marine biodiversity. The Sindhudurg coast in the state has the richest marine biodiversity in Maharashtra especially for corals, dolphins and crustaceans. The Sindhudurg Coastal and Marine Ecosystem (SCME) is one of the 11 ecologically and economically critical habitats identified along the Indian coastline.

A recent decision of the Government of Maharashtra on Angria Plateau or Angria Bank in Sindhudurg district as a designated area under Maritime Zones Act 1976 is a major boost to marine biodiversity conservation. The Angria Bank is not only a stronghold for marine life within the northern Indian Ocean but also bears an immense potential to act as a source habitat for populations of several ecologically important marine species. In addition to this, the Maharashtra Government has plans to conserve the oceanic dolphins along its 720 km coastline in line with the Centre's Project on Dolphin Programme. Another very innovative scheme of Government of Maharashtra is to reward the fishermen who save rare marine species. The fishermen receives ₹25000 everytime a turtle, dolphin, shark or any other endangered or protected marine species is caught in their fishery nets.

Coastal and marine aquaculture

Maharashtra is endowed with 720 km of the sea coast with 54 creeks and their tributaries with an area of about 65,500 ha under coastal saline soil/water. These resources offer huge potential for coastal aquaculture and marine cage culture. The Khar Land Research Station of Dr BSKKV at Panvel has been working on the utilization of vast area of the saline soils in the state for agriculture and aquaculture during the past several decades.

The Marine Products and Export Development Authority (MPEDA) initiated a pilot project on crab farming in Sindhudurg District in 2014 forming a farmer self help group. This project on farming of mud crab (*Scylla serrata*) was funded by Maharashtra State Forest Department, and the seeds were supplied by the Rajiv Gandhi Centre for Aquaculture (RGCA) of MPEDA. The RGCA has established a crab hatchery at Thodvai village in Nagapatnam district of Tamil Nadu and the crabs are supplied to research institutes, State Govts and the farmers. Another coastal aquaculture project named the open-water integrated multi-trophic aquaculture (IMTA) in Sindhudurg District initiated by ICAR-Central Institute of Brackishwater Aquaculture and funded by the Mangrove Cell of Maharashtra Government has demonstrated that brackishwater cage culture system under IMTA mode a viable option for alternative livelihood and to increase the income of fishers. IMTA is the farming of species from different trophic levels with complementary ecosystem functions such as farming of diverse species, viz. fishes, bivalves, shrimps and crabs catering to different ecological niches. The ICAR-National Bureau of Fish Genetic Resources has recently established a marine ornamental fish (Clowns) hatchery at the coastal and marine biodiversity centre of Mangrove Foundation, Department of Forest, Govt of Maharashtra at Airoli, Thane.

The ICAR-Central Marine Fisheries Research institute is primarily mandated for the development of marine aquaculture in India. The Institute has successfully demonstrated the viability and potential of mariculture of fish, shellfish and sea weeds. The recent research and success in developing breeding and mariculture technologies especially the establishment of broodstocks, induced spawning and seed production and open sea cage culture of cobia (*Rachycentron canadum*), sea bass (*Lates calcarifer*), silver pompano (*Trachinotus blotchii*), snapper (*Lutjanus argentimaculatus*), grouper (*Epinephelus tauvina*) and capacity building of the coastal fishers have opened new vistas for blue revolution through marine aquaculture (Gopakumar *et al.* 2007).

Challenges and opportunities

The stagnation of capture fisheries in Maharashtra for the past several years is reported all along the coast. One of the major threat frequently reported by the fishermen is the competition from fishermen of other states namely Gujarat, Goa and Kerala who carry out fishing in Maharashtra waters. The lack of basic infrastructure at several landing

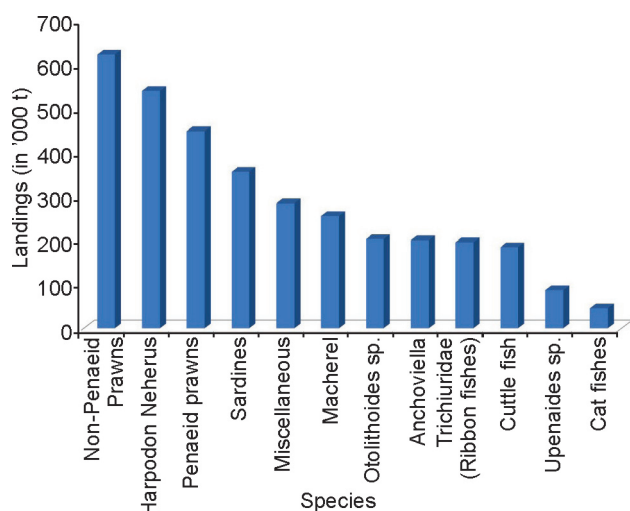


Fig. 3. Landings of top 12 fish and shellfish groups

centres, increasing reduction in catch, fish species and their size, use of non-permitted mesh-size nets, overfishing, juvenile fishing, bottom trawling, fishing during banned period, increased diesel and labour cost, and pollution, climate change-frequent cyclones etc are the key challenges of the capture fisheries.

The coastal and marine aquaculture development is primarily constrained due to lack of seed, feed and technology skills of the desired species used in mariculture. Presently, there is no shrimp or marine fish hatchery in the state. The lack of confidence amongst the coastal fishers and anticipated risk in open sea cage farming are other major issues. The preliminary trials on lobster fattening and sea bass cage culture by the Mumbai Research Centre in Thane and Raigad district are encouraging. However, the future trials need to be done involving the stakeholders fishers as partners in the form of self help groups/ FPOs so that the fishers are motivated to take up sea cage farming as an alternative livelihood activity.

The institutional strength covering both state and central government organizations provides a great opportunity for human resource development, new research and development innovations and improved management of the resources for the livelihood of the traditional fishers.

Conclusion

It is evident that the diversity of marine fish and shellfish fishes is increasingly threatened and management strategies have to vigorously monitor gears and catches affecting biodiversity and fisheries. The ecosystem approach to management over single species management is imperative for sustainability. Educational and research organizations can play a pivotal role in creating the required awareness in the public besides research that the impacts of human beings on habitat degradation and biodiversity loss is minimized.

Recommendations for improved and enhanced marine fisheries and aquaculture

- Adoption of ecosystem based approach to marine fisheries management.

- Exploitation of deep sea fisheries through the application of modern vessels and technology including space technology and capacity building.
- Modernization of landing centres for improved hygiene, efficient handling and sorting.
- Strengthening value chain all along the coast line for improved harvesting and post-harvesting and processing.
- Coastal aquaculture and mariculture development of finfish, shellfish, ornamental fish and seaweeds through technology development, dissemination, credit and policy support including leasing policies for mariculture.
- Establishment of Fisher Farmer Producer Organizations.
- Harmonizing fish catch data of Central and State agencies/departments for reliability and accuracy.
- Capacity building of coastal fishers in marine and coastal aquaculture for sustainable livelihoods.
- Establishment of marine fish and shrimp hatcheries for local seed supply to promote coastal aquaculture and mariculture.
- Establishment of feed mills for marine and coastal aquaculture development.
- Bioresource based entrepreneurship and skill development promoting exports.
- Creating a state level fisheries training institute for regular refresher and training programs for the state officials and technical staff.
- Creating a centre for marine biodiversity and aquaculture with State and Central funding for harnessing the rich bioresources.
- Development of a master plan for marine fisheries and aquaculture development in the state.
- Improved governance and implementation of rules and regulation by the relevant state departments.

ACKNOWLEDGEMENT

Financial support from National Bank for Agriculture and Rural Development (NABARD) is thankfully acknowledged.

REFERENCES

- Adiga M S, Ananthan P S, Divya Kumari H Y and Ramasunbramanian V. 2016. Multidimensional analysis of marine fishery resources of Maharashtra, India. *Ocean and Coastal Management* **130**: 13–20.
- Bhatt J R and Vivekanandan E. 2013. Coastal and marine biodiversity conservation in India. Proceedings of Regional Symposium on Ecosystem Approaches to Marine Fisheries and Biodiversity, October 27–30, Kochi.
- Bhendarkar M P, Brahmane M P, Gaikwad B B and Singh N P. 2020. The status and prospects of fisheries and aquaculture in Maharashtra, India. *Indian Journal of Geo Marine Sciences* **49**(4): 567–75.
- Bohnsack J A and Ault J S. 1996. Management strategies to conserve marine biodiversity. *Oceanography* **9**(1): 73–82.
- Chavan K N, Rajput B P and Kadrekar S B. 1984b. A note on

- simultaneous culture of rice and fish in the coastal saline soils. *Journal of the Indian Society of Coastal Agricultural Research* **2**(2): 95–96.
- Deshmukh V D. 2013. Responsible marine fisheries reflections from Maharashtra. Winter School on ICT-oriented Strategic Extension for Responsible Fisheries Management. CMFRI Publication, pp. 113–117.
- Deshmukh V D. 2014. *Increasing fish production by mariculture in Maharashtra*. Training Manual on Cage Culture of Marine Fish and Shell Fish in Open Sea. pp. 5.
- Gopakumar G, Abdul Nazar A K, Tamilmani G, Sakthivel M, Kalidas C, Rammooorthy N, Palanichamy S, Maharshi S A, Rao K S and Rao G S. 2011. Broodstock development and controlled breeding of cobia *Rachycentron canadum* (Linnaeus 1766) from Indian seas. *Indian Journal of Fisheries* **58**(4): 27–32.
- Gopakumar G, Abdul Nazar A K, Jayakumar R, Tamilmani G, Kalidas C, Sakthivel M, Rameshkumar P, Hanumanta Rao G, Premjothi R, Balamurugun V, Ramkumar B, Jayasingh M and Syda Rao G. 2012. Broodstock development through regulation of photoperiod and controlled breeding of silver pompano, *Trachinotus blochii* (Lacepede 1801) in India. *Indian Journal of Fisheries* **59**(1): 53–57.
- Gopakumar G, Manmadhan Nair K R and Kripa V. 2007. Mariculture research in India: Status, constraints and prospects. *Status and Perspectives in Marine Fisheries Research in India*. CMFRI Diamond Jubilee Publication, pp. 316–361.
- Kulkarni B, Babar A, Jaiswal A and Kolekar R. 2017. Present status of intertidal biodiversity in and around Mumbai (West Coast of India). *Transylvanian Review of Systematical and Ecological Research* **19**(1): 61–70.
- Kurian A and Kurup K N. 1992. Stock assessment of Bombay duck *Harporodon nehereus* (Ham.) off Maharashtra coast. *Indian Journal of Fisheries* **39**(3&4): 243–48.
- Lakra W S, Verma M S, Goswami M, Lal K K, Mohindra V, Punia P, Gopalakrishnan A, Singh K V, Ward R D and Hebert P. 2011. DNA barcoding of Indian marine fishes. *Molecular Ecology Resources* **11**(1): 60–71.
- Ministry of Environment and Forests. 2008. National Biodiversity Action Plan pp. 66.
- Morgan Gary. 2004. Country review on the west coast fisheries of India, FAO.
- Pawse A S, Metar S Y, Sawant M S, Barve S K, Akhade R R and Pai R. 2017. Studies on growth, mortality and stock assessment of Indian mackerel *Rastrelliger kanagartha* (Civier, 1817) from Ratnagiri coast of Maharashtra, India. *Indian Journal of Geo Marine Sciences* **46**(11): 2382–85.
- Ranjan R, Megarajan S, Xavier B, Ghosh S, Santosh B and Gopalakrishnan A. 2018. Broodstock development, induced breeding and larval rearing of Indian pompano, *Trachinotus mookalee* (Cuvier 1832): A new candidate species for aquaculture. *Aquaculture* **495**: 550–57.
- Singh R K, Vartak V R and Balange A K. 2005. Occurrence of the mud crab, *Scylla tranquebarica* from west coast of India. *Journal of Bombay Natural History Society of India* **102**(2): 250–51.
- Srinath M, Varughese J, Kanakkan A, Mani P T and Karbhari J P. 1987. An appraisal of the marine fisheries in Maharashtra. CMFRI Special Publication Number 37, pp 46.
- TERI. 2013. Participatory rural appraisal study in Devgad and Malvan Blocks, Sindhudurg District pp. 126.
- Upton H F. 1992. Biodiversity and conservation of the marine environment. *Fisheries* **17**: 20–25.
- Vartak V R and Belsare S G. 2004. The natural seed collection of sea bass (*Lates calcarifer*) and its traditional culture practices in konkan region of Maharashtra. *Fishing Chimes* **24**(3): 62–63.