OVERVIEW OF MARINE FISHERIES OF INDIA

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Introduction

India, with an extensive EEZ of 2.02 million square kilometres, and a coastline of 8129 km, has an estimated marine fishery potential of 5.31 million tonnes annum-1 (CMFRI-FSI-DoF, 2020). The marine fisheries sector in India contributes significantly to the food and nutritional requirements of its people, supports the livelihood of nearly 3.8 million coastal population by providing income and employment (Sathianandan et al., 2021), and earns an annual foreign exchange worth US$8.1 billion through marine exports (MPEDA, 2023). In recent years, the global marine capture fish production declined from 84.4 million t in 2018 to 78.8 million tonnes in 2020 (FAO, 2022). India ranks sixth in global marine capture fisheries production with a contribution of 4.7% in 2020. Since the early 2000s, global marine capture production has almost plateaued out, hovering around 80 million tonnes (Fig. 1) with an average annual production of 81.1 million tonnes during 2018-2020 (FAO, 2022). India's total marine capture production was 3.49 million tonnes in 2022, landed by a fishing fleet of 1,66,333. The gross value of India's marine fish production at the point of first sale is Rs. 582.47 million and that of the retail point is estimated at Rs. 798.67 million in 2022 (FRAEED, CMFRI, 2023). The quantity of marine exports from India in 2022 was 1.74 million tonnes worth Rs. 639.7 billion, which is estimated at 3.5% of the total exports from India. The share of marine fisheries in the country's GDP is 1.1%, which is about 5.4% of the total agricultural GDP of India. over the span of the last 70 years, marine fish catches in the country increased considerably from 0.6 to 3.5 million tonnes (Fig. 2).

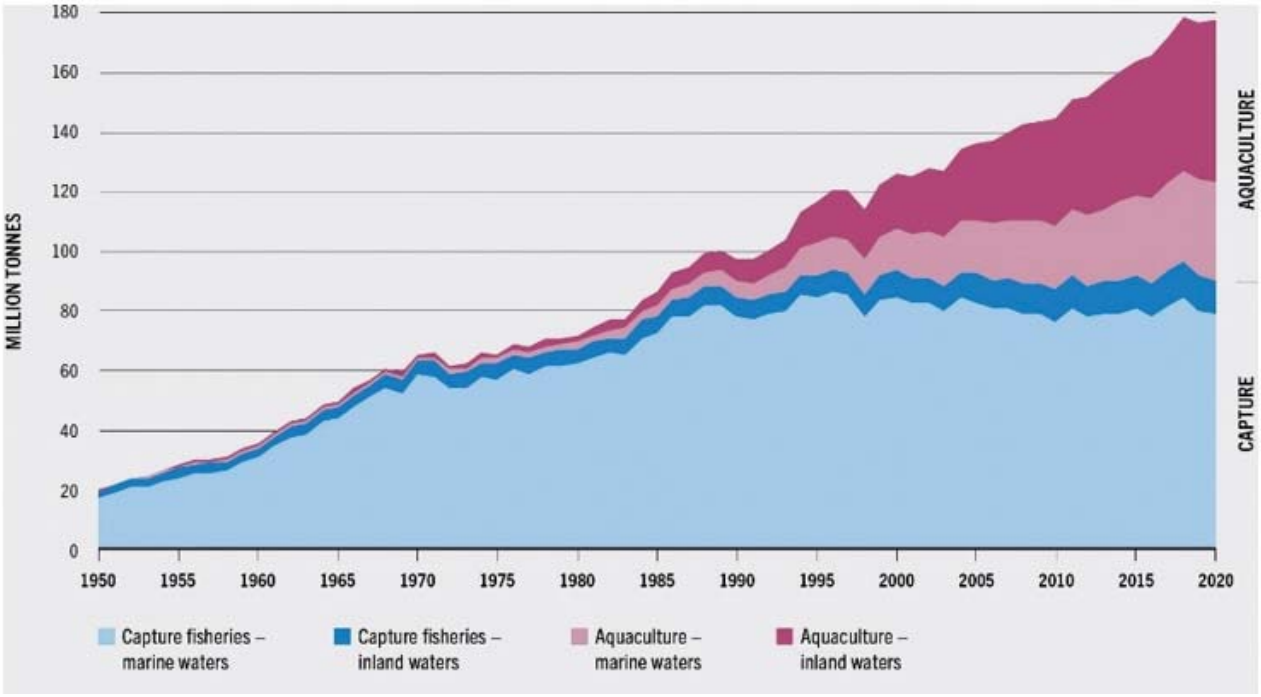

Fig. 1. Trends in global fisheries during 1950-2020 (Source : FAO, 2022)

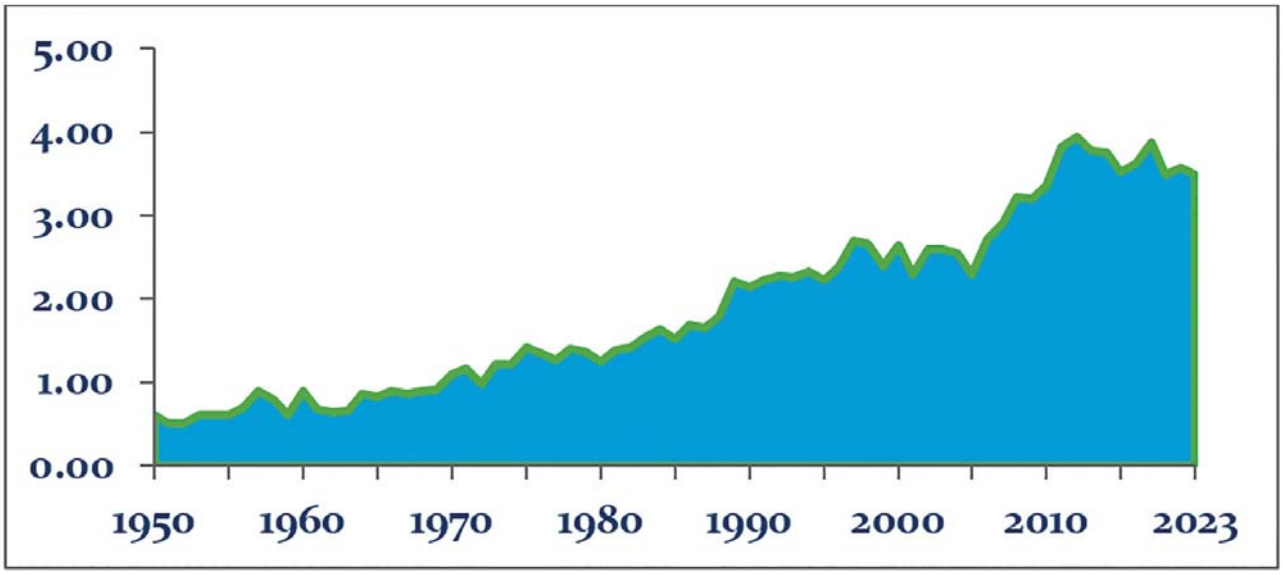

Fig. 2. Trends in marine fisheries of India landings in million tonnes during 1950-2022

Characteristics of Indian marine fisheries

Indian marine fisheries is a typical multi-species multi-fleet fisheries characterized by a heterogeneous fishery management system; formal and countless informal agreements and the conflict management systems that are in practice in the different maritime states of the country (Pido et al., 1996). State governments play a major in formulating fishery policies within their territorial waters up to 12 nautical miles rather than enforcing a uniform central fishery policy. The coastline of India is shared by nine maritime states, two union territories (UTs) and two island territories namely Andaman and Nicobar, and Lakshadweep Islands. The country's fishing fleet is classified into mechanised, motorised and traditional sectors. The various technical and economic traits and craft–gear combinations under these fishing sectors make the multi-fleet fishery highly complex. Mechanised fishing units use mechanical power for both propulsion and fishing. During the early 1980s, to compete with the highly efficient mechanised vessels, some of the traditional crafts were fitted with outboard engines and these were known as motorised crafts, thereby replacing human labour with mechanical power only for propulsion and fishing continued to be done by human labour. To harvest more and more quantities of fish from the open access coastal waters, these sectors innovatively introduced modifications to their fishing gear, most of which were operated within the 50m depth zone (Najmudeen, and Sathiadhas, 2008).

Many of the global fisheries have gone through a series of environmental shifts in recent decades resulting in collapses or fluctuations in the catch of dominant fish assemblages and as a result, many fisheries-dependent human communities have been affected (Hamilton and Otterstand, 1998). However, in a tropical country like India, wherein the marine fisheries are dominated by small scale subsistence based fishery and supported by multispecies assemblages, severe collapses in fishery are unlikely and the marine fish production of the country has been increasing from a meagre of 0.05 million t to 3.5 million tonnes over the last 63 years.

Major marine fishing sectors of India

The exploitation of marine fishery resources in India is carried out by five major gears namely trawlnets, magnets, gillnets, seines and hooks and lines. These are operated under three fishing sectors which are mechanised, motorised and non-mechanised. The motorised sector dominates in several crafts in the

fishery, however, in terms of catch contribution, the mechanised sector is the dominant fishing sector across the country. There are more than 25 craft-gear combinations which significantly contribute to the marine fisheries sector of India belonging to these three categories.

Table 1. Major fishing sectors and gears exploiting the marine fishery resources of India

Major Gears	Major Crafts
Trawl	Mechanized - 42656
Bag nets	Motorized - 95957
Gillnets	Non-motorised -25689
Seines	
Hook & Line	

Trawl fisheries

Trawl fishery is the most important among the various fishing methods in India and contributes about 52% to the total marine fish production in the country. Two types of trawling currently operate in the coastal waters of India, shrimp trawling and fish trawling. According to the Marine Fisheries Census 2016 (CMFRI-FSI-DoF, 2020), it was estimated that around 30,486 units of trawlers are operating in the country. During 2012-2022, more than 50% of the marine fish landing in India was contributed by trawl fisheries. Trawl landings in India showed an increasing trend over the last few decades. The estimated average annual fish catch from trawlers in India is about 2.027 million tonnes during 2022 forming about 58% of the total marine fish landings of the country.

Trawl fishery is generally a multi-species fishery targeting several species and sizes simultaneously. The non-selective nature of trawl nets, and the broad range of substrates over which trawling occurs, results in a large number of finfish and shellfish species being taken. Its extensive combing of the sea bottom is causing widespread damage to marine biota and an urgent need for regulation in fishing is required so that fish production can be made sustainable (Devaraj and Vivekanandan, 1999). Based on the days of fishing, there are two types of trawl fishing operations in India; Single day operation: Fishing within 50 m depth zone. Multi-day operation: Started in the early 1980s, generally operated at a depth of up to 200m. From 1999, trawlers were employed for deep sea fishing up to 400 m depth. As the number of trawlers increased twice, the estimated efficiency (engine horsepower) also increased by nearly 4 times, from 951,200 hp (1980) to 3,448, 570 hp (1998) (Najmudeen, 2016). High-opening trawls shifted the target from shrimps to squid, cuttlefish and fish. Finfishes exploited by trawls belong to 21 major fish groups. Each region is characterized by the dominance of specific finfish groups. Northeast coast - sciaenids, catfish and pomfrets (together contributing 74.0% to the demersal landings). southeast coast - silver bellies and pigface breams; southwest coast - threadfin breams and other perches; northwest coast - sciaenids, catfish and threadfin breams.

Fig. 3. Catches from mechanised trawl nets

Seine fisheries

Purse seine and ring Seine (mini purse seine) are the most popular seining methods for pelagic finfishes in India especially along the southwest coast of India. Purse seine fishing is an active fishing method wherein schooling fishes are targeted using surrounding nets or encircling nets which can be "pursed" from the bottom of the net with the help of a "purse line". In India, this type of fishing is highly diverse in form and operational capacities along different maritime states and is known by different vernacular names in different parts of the country. Major species harvested by these gears are small pelagics such as oil sardines, lesser sardines, anchovies and mackerel. The estimated average annual fish catch from seines in India is about 0.77 million tonnes during 2022 forming about 22% of the total marine fish landings of the country. This includes catches from purse seines (8%), mechanised ring seines (5%) and outboard ring seines (3.8%).

Fig. 4. Fish catch from ring seines in Kerala

There are about 1,189 purse seiners and 943 mechanised ring seiners in operation in the country, of which 50% of the purse seiners are operating along the coast of Karnataka. In the states like Karnataka, Maharashtra and Kerala, distinct fisheries by the name 'purse seine fishery' (operating in deeper/offshore waters) and 'ring seine / mini-purse seine fishery' (operating in shallow coastal waters) exist parallelly. These gears are recognized as the most efficient means for harvesting the pelagic fishery resources abundant in Indian waters. The existing regulatory measures on these gears vary along different maritime states which include the dimensions of access control, spatial, temporal, gear-based, craft-based, crew management etc. Nevertheless, fishing conflicts involving purse seine/ring seine fishers and other traditional gear-operating fishers have been reported in several coastal regions along the coast of India. Implementation of regulations in the fishery for the sustained production from the sector has to take into account its impact on the livelihood of the considerably poor fisher population.

Gillnet fisheries

The gillnet catches which ranged from 1.0 lakh to 1.35 lakh t during the 1980s and 1990s, increased by more than 4 times in recent years. The estimated average annual fish catch from gillnets in India is about 0.40 million tonnes during 2022 forming about 11.5% of the total marine fish landings of the country. During the last 5 years, the share of mechanized gillnetters (MGN) has increased as compared to outboard gillnetters (OBGN). Gillnets exploit only a few species; up to 60 species recorded. Small meshed gillnets harvest mainly clupeids and croakers and large meshed gill nets catch sharks, seerfish, mackerels, catfishes, pomfrets, tunas and carangids. The average productivity of this gear - is estimated at 13.7 kg/h maximum on the southwest coast followed by the northeast. There are about 6502 mechanised gillnet units in operation in India, of which more than 50% are operated along the northwest coast.

Bagnet fisheries

Bagnets/dol nets are the major gear used by artisanal fishers along the northwest and northeast coasts.

There are different types of bag nets, in Gujarat and Maharashtra, the fixed variety of bag nets like dol nets, operate up to 40 m. 80% of the bag net fisheries come from the mechanized dol netters. The dominant catches are non-penaeid shrimps (Kiddi shrimp *Acetes indicus*), the mid-water carnivore Bombay duck (*Harpadon nehereus*), golden anchovy (*Coilia dussumeiri*) as well as penaeid shrimps and ribbonfishes. There are 3394 bag net/dol net units operating along the coast, of which more than 90% are from the northwest coast of India. The estimated average annual fish catch from gillnets in India is about 0.23 million tonnes during 2022 forming about 6.6% of the total marine fish landings of the country. The majority of the bag net catches are from mechanised dol net fisheries (78%). The major management issues and concerns about the bag net fisheries in India are that the gear exploits the resources indiscriminately owing to its small mesh sizes, which results in the growth over-fishing of one of the main species, the Bombay duck. The juveniles form 45 – 65 % of the catch of bag nets and *Acetes indicus* constitute the principal by-catch.

Hooks and line

Hooks and lines contribute about 2% of the Indian marine fish catch. They target the large pelagic fishes such as sharks, tunas and barracudas. The estimated average annual fish catch from hooks and lines in India is about 50,680 tonnes during 2022 forming about 1.5% of the total marine fish landings of the country. The majority of the bag net catches are from outboard hooks and line fisheries (80%). The fishing units undergo regional modifications and craft mechanisation for extending the fishing grounds in search of large pelagic and demersal finfish. There are many development schemes of the government targeting the promotion of Hooks and Line fisheries, particularly the modern version of long-line fishing for tunas. Many large shrimp trawlers on the northeast coast were converted to longliners.

Artisanal fisheries

The artisanal non-mechanised sector has dwindled with the advent of mechanization from 88 % in 1960 to 1 % recently. Many of the crafts were modified with innovative fishing gears, and to withstand competition from the mechanized sector, motorized their crafts, initially with outboard engines and lately with inboard engines as well. The estimated average annual fish catch from the artisanal sector is 36,485 tonnes during

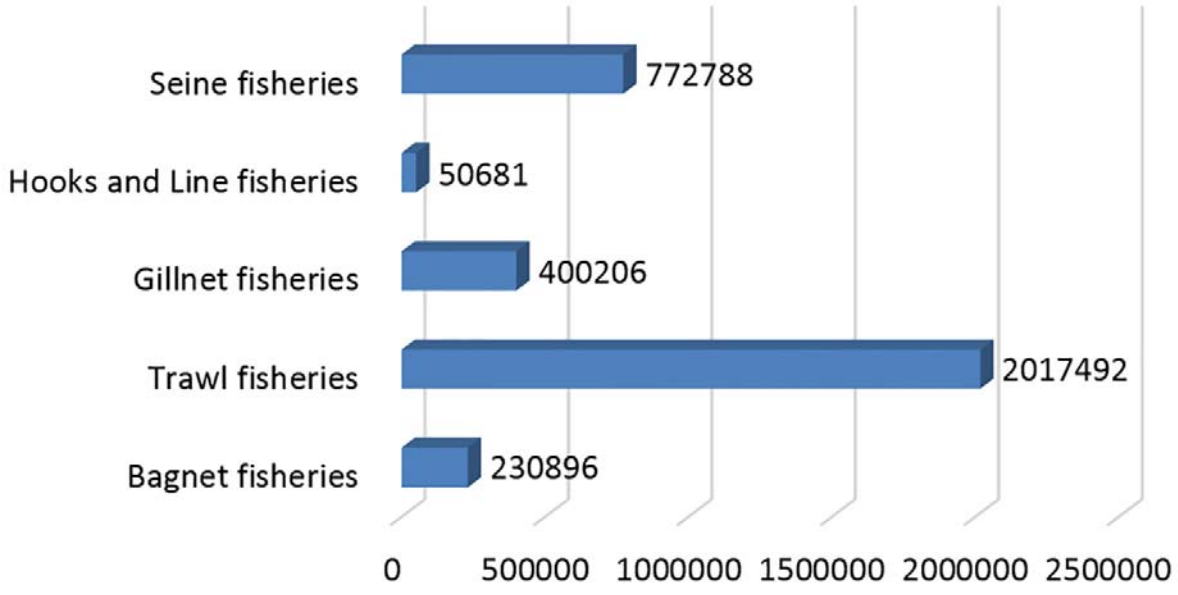

Fig. 5. Annual catches (t) from various types of fisheries in India during 2022

2022 forming about 1% of the total marine fish landings of the country. Now the prominent crafts include Catamaran and plank-built boats and beach seines which are not motorised.

Marine fish landings in India

The total marine fish landings in the country comprised 18.72 lakh tonnes of pelagic fishes, 8.74 lakh tonnes of demersal fishes, 2.23 lakh tonnes of molluscs and 3.73 lakh tonnes of crustaceans. The landings by various fishing crafts occur in 1269 designated locations, including fifty fishing harbours across the coastal regions of the country (CMFRI-FSI-DoF, 2020). Among the three different categories of crafts used for fishing the contribution by mechanized, motorised and artisanal sectors were 82%, 17% and 1%, respectively. Different gears which contributed to the mechanised sector were trawlnets, bag nets, seines and gillnets. In the motorised sector, ring seines contributed the major share. Region-wise estimates revealed that the southwest region comprising Kerala, Karnataka and Goa had the highest landings in 2022, with 1.43 million tonnes (41% of the national total), followed by 0.99 million tonnes (28%) in the southeast region, 0.75 million tonnes (22%) in the northwest region, and 0.32 million tonnes (9%) in the northeast region. Compared to 2021, the northwest region witnessed a decline in the total landings by nearly 20000 tonnes, whereas the southwest and southeast regions recorded a substantial increase in the fish landings (FRAEED CMFRI, 2023). The southeastern state, Tamil Nadu was in the top position in fish landings (7.22 lakh tonnes), followed surprisingly by Karnataka (6.95 lakh tonnes) and Kerala (6.87 lakh tonnes). The Gujarat state, which had been occupying the top two slots during the previous years, dropped to the fourth position (5.03 lakh tonnes) in fish landings.

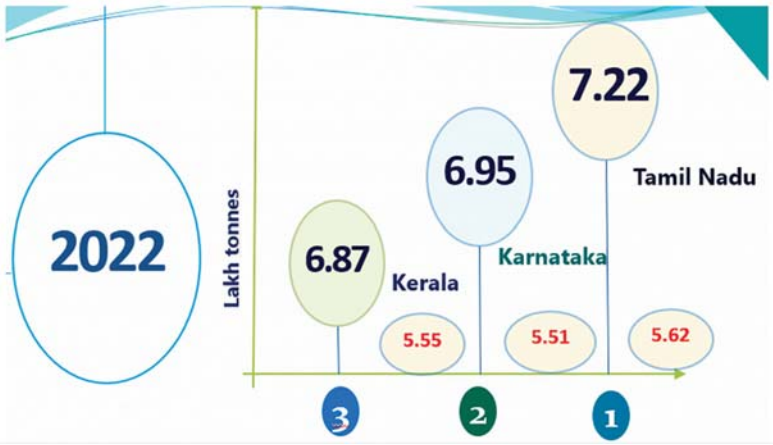

Fig. 6. Top three maritime states' performance in marine fish landings contribution in India during 2022

Among the major assemblages, pelagic finfish contributed 57% of the total marine fish landings in 2022 with Indian mackerel, oil sardine, ribbonfishes and lesser sardines dominating the catch. Indian oil sardines,

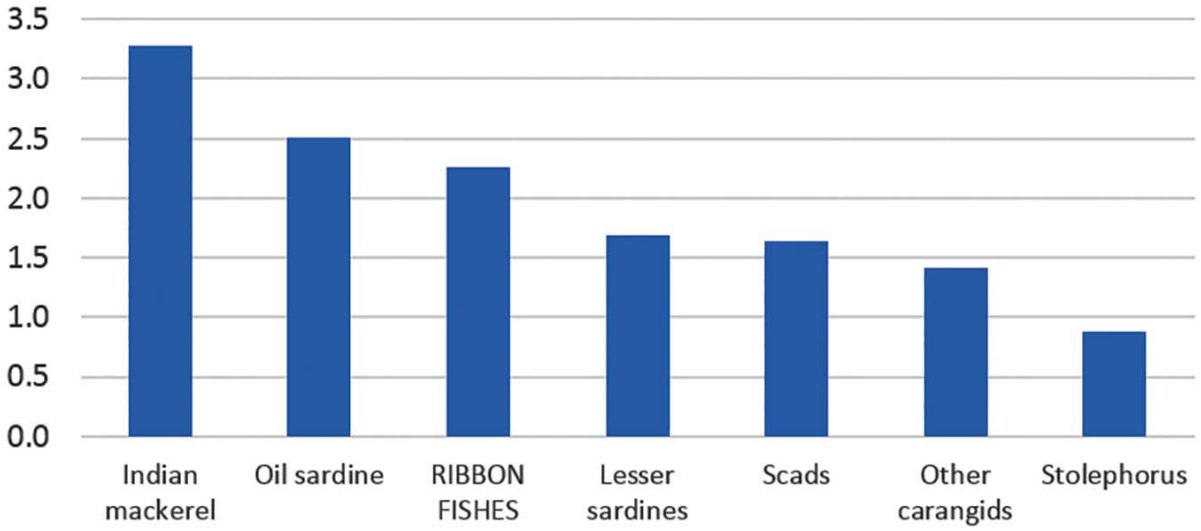

Fig. 7. Landings lakh tonnes of major pelagic finfish resources in India during 2022

mackerel, ribbon fish, lesser sardines, scads and other carangids contributed almost 68% of the pelagic fish landings in 2022. Among pelagic fishes, Indian mackerel alone accounted for 17.5%. Compared to the previous year, there was an increase in the landings of pelagic resources.

Demersal resources contributed around 26% of the landings with a major contribution from threadfin breams (22.8%) followed by other perches (15.2%), croakers (10.3%) and lizardfishes (8.7%). Crustaceans include high-value resources like prawns, crabs and lobsters and the contribution from this group was 12.6% with the dominance of penaeid prawns (43.8%) followed by non-penaeid prawns (39.5%) and crabs (13.5%). Molluscan resources accounted for the remaining 6%, which are dominated by squids (49%) followed by cuttlefishes (33%).

Elasmobranchs are an important demersal fishery resource, which form about 3.3% of the total demersal finfish catch of the country and are of high conservation concern. There are about 110 species of elasmobranchs in India, of which 66 species of sharks, 4 sawfishes, 8 guitarfishes and 32 species of rays are landed in commercial catches. Among these, 34 species are commercially important. The majority of the species of elasmobranchs in the Indian seas are viviparous, some are oviparous and few are ovo-viviparous with very low fecundity. All India landings of elasmobranchs during 2022 was 28,474 tonnes. Trawl nets account for 48.8%, gillnets 35.6% and hook and line units 6% of the total elasmobranch landings of the country.

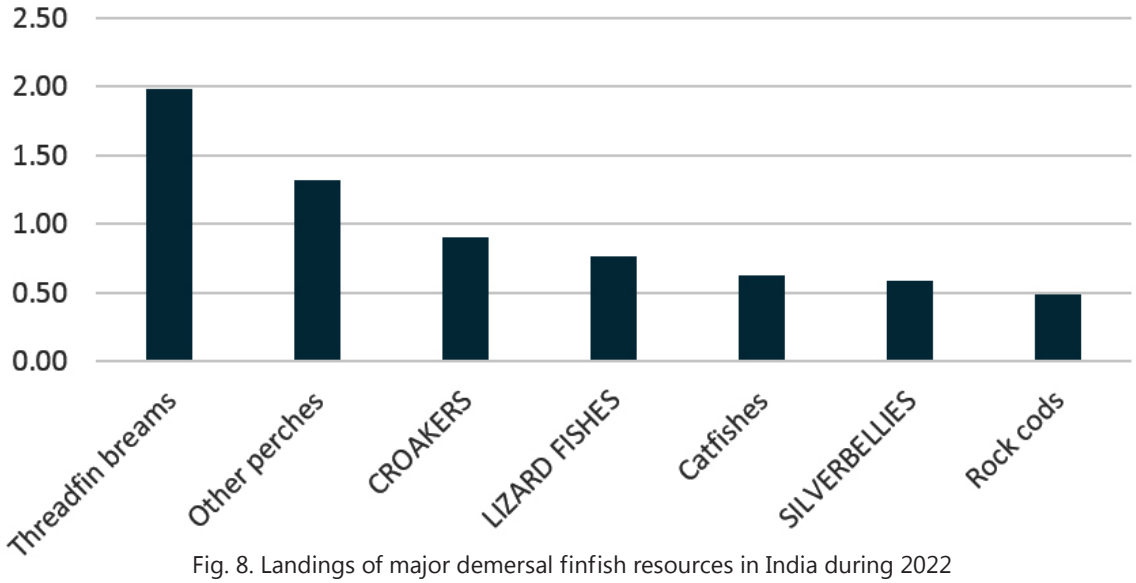

Fig. 8. Landings of major demersal finfish resources in India during 2022

Fig. 9. Landings of elasmobranchs (sharks and rays) at Cochin Fisheries Harbour, an important shark landing centre along the southwest coast of India

Deepsea fishing opportunities

Indian marine fishery mostly centres around coastal waters up to 100 meters depth and about 90% of the catch comes from up to 50 m until recently. Technological lag and financial constraints were the major constraints identified in venturing into deep-sea fishing by the fishermen of the country. However, the maritime states of Gujarat, Kerala and Tamil Nadu have already demonstrated their ability to harvest deep-sea fisheries resources in the Indian EEZ using vessels below 20 m without modernization of fishing crafts and gear. At present the contribution of the deepsea fisheries are mainly the larger pelagics like tuna and allied species. The tuna fisheries in the Indian Ocean have observed that resource availability is never a constraint in its development The exploration and exploitation of the fishery resources in this area over the past 3 decades have shown that the oceanic tuna resources in this area consist of the Yellowfin tuna (*Thunnus albacares*) the Bigeye tuna (*Thunnus obesus*) and the Skipjack tuna (*Kastuwonus. pelamis*). During 1989-90, a study was conducted wherein Vijayakumaran et al. (1992) stated that fourteen charter vessels (36m multifilament tuna long liners) operated 2000 hooks/day in the Indian EEZ and the estimated average catch per voyage (30 days/Voyage) was 28.78 tonnes. which consists of 69.26% Yellowfin tuna, 0.85 % Bigeye tuna, 0.11%, Skipjack tuna 6.5% Bill fishes, 23.28% Sharks and other fishes. There are few large deepsea shrimp trawlers, which exploit deepsea shrimps along the coast of Kerala. The estimated deepsea shrimp landings in Kerala were 9865 tonnes in 2021, which constituted about 21.2% of the total shrimp landings in the state.

Status of Indian marine fish stocks

The health of marine fish stocks has declined globally, with only 65.8% of assessed stocks being fished within biologically sustainable levels in 2017; a drop from 90% in 1974 (FAO, 2020). However, it was also seen that effectively managed fisheries have shown increases in biomass while those which have under-developed management systems are still in poor shape (FAO, 2020). Hence improving fishery management systems has proven to aid in improved biomass and consequently improved economic returns to stakeholders. Asian countries were the source of 70 per cent of the world's fisheries and aquaculture production of aquatic animals in 2020. Most fisheries in the developing countries of Asia are experiencing conflicts arising from excess fishing capacity. Conflicts over resource use in fisheries have been escalating all over the world. The appealing concept of optimal harvesting is often used in fisheries to obtain new management strategies. However, optimality depends on the objective function, which often varies, reflecting the interests of different groups of people. Maximum sustainable yield aims to extract the greatest amount of food from replenishable resources in a sustainable way (Sumaila *et al.,* 2007). Stock status information is generally scarce and available only for a few coastal stocks in certain areas. Most of the stocks monitored by FAO are assessed based on catch trends and other ancillary information rather than analytical stock assessments or fishery-independent data. Therefore, the state of stocks in the region is considered highly uncertain and should be treated with caution (FAO, 2022). Most of the marine fish stocks of the country are assessed as healthy (CMFRI, 2023). In a recent study which assessed 70 marine fish stocks in India, 91.2% were healthy, indicating that the current management measures are adequate in the prevailing scenario (CMFRI, 2023). For this purpose, stock assessments were carried out using length-based micro-analytical models, for commercially significant species which include the stocks of e49 finfishes and 21 shellfishes. However, the marine realm is always under threat from several factors including climate change, pollution, unplanned coastal development, etc. which could change things dramatically. To be ready for any potential upheavals in the future, we need to use innovative methods that are holistic and use a more integrated approach incorporating spatial, temporal, environmental and technological dimensions for better management of fish resources and marine ecosystems.

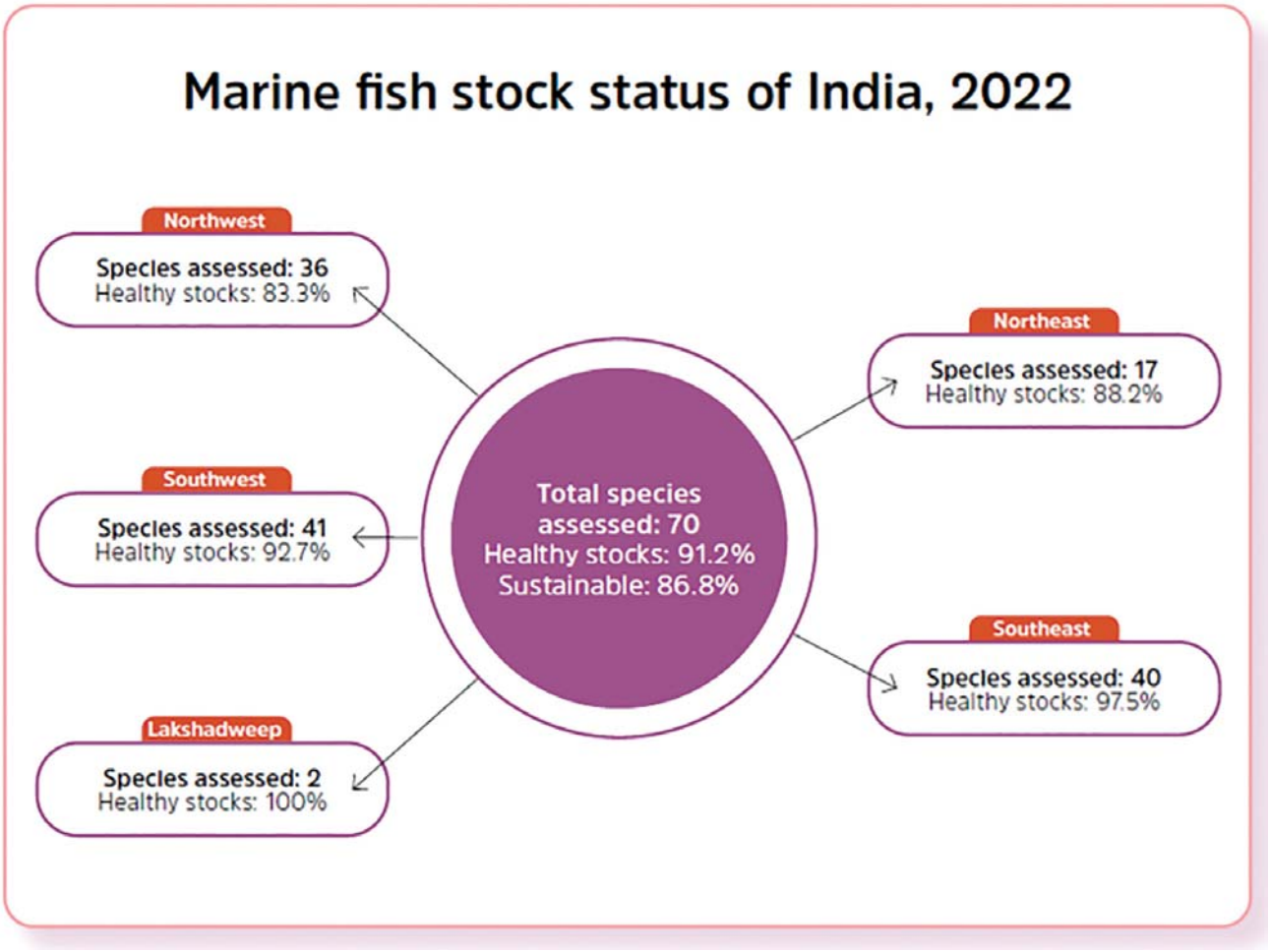

Fig. 10. Marine fish stock status of India along four maritime regions in 2022 (source: CMFRI, 2023)

Enforcement of minimum legal size and impact on fishery

Reports on over-exploitation and the consequent threat to the long term sustainability of several fishery resources created serious concern among resource managers and stakeholders. One of the major causes attributed to the above is indiscriminate juvenile exploitation. In this context, ICAR- Central Marine Fisheries Research Institute (CMFRI), suggested enacting and enforcement of minimum legal size (MLS) in the fishery, as an effective tool to protect juvenile fishes, which is expected to aid in enhancing yield, yield quality and maintaining high spawning stocks in the ecosystem. The MLS specifies the smallest size of any species which can be legally caught for food or any purpose, is expected that this will minimise the destruction of immature fishes, ensure adequate spawning population, improve the size and quality of the fishes in the landings and enhance economic benefits and values of the landing. Minimum Legal Size (MLS) has been notified for selected fish species in the states of Kerala (58 species), Karnataka (19 species) and Goa (20 species) with the primary aim of preventing juvenile fishing, based on the recommendations by ICAR-CMFRI. Recently in 2023, the state of Maharashtra also notified Minimum Legal Size for 54 commercially important fish species to ensure sustainable fishing practices in the state.

The biological and economic impact of MLS implementation in the fishery along the coast of Kerala were assessed based on the data collected by ICAR-Central Marine Fisheries Research Institute during the pre-MLS implementation period as well as the post-MLS implementation period. Even after the notification of MLS regulations in the state in 2017, considerable landings of juveniles of some selected commercially important fishery resources continued with varying intensities, especially the demersal resources by

mechanised trawlers and pelagic resources by inboard and outboard fishing vessels. However, the landings below MLS decreased significantly for the major species during 2018-2022 compared to that of preceding years. The number of juvenile landings reduced by 34% in 2018, 57% in 2019 and 40% in 2020 compared to the preceding years. Of the total juvenile fish landings of the state, the highest percentage was contributed by the squid *Uroteuthis photololigo duvauceli* (27% of the juvenile landings of the state), followed by Indian mackerel *Rastrelliger kanagurta* (21%), especially in 2018, threadfin bream *Nemipterus randalli* (18%), lizardfish *Saurida undosquamis* (14%). The size composition analysis indicates a significant decline in the juvenile component of 20% of the species studied and marginal improvement was observed in 37.1% of the species. No impact was noticed in 40% of the species and the situation worsened in 3%. The annual mean length of the major species which contribute to growth overfishing has also improved during the 2017-2022 period compared to that of the preceding years.

The biological impact studies on MLS implementation on the stock of the threadfin bream *N. randalli* indicate that the spawning stock biomass increased by 30% and the standing stock biomass by 27% during the post MLS implementation period compared to that of Pre MLS implementation period. The recruitment numbers in the fishery improved by 64% and the total yield in the fishery increased by 41%. Though there are many factors which influence the changes in stock biomass and recruitment of a fish species, a decrease in growth overfishing is also one of the reasons attributable to the changes in these stock parameters, especially in the context of the implementation of MLS to reduce growth overfishing. Profit analysis of mechanized trawlers indicates that, due to the reduction in the landings of low-value juvenile fishes owing to MLS enforcement, there is an increase in unit value realization and increased profitability for the mechanized trawlers during the post-implementation period MLS regulation along the region.

In addition to size-based output controls, several generic measures such as mesh size /type regulations, closed fishing seasons, closed areas like MPAs and fleet size regulation, among others, are in existence in regulating the marine fisheries of India. However, the strict implementation and proper enforcement of these regulations with the involvement of stakeholders need immediate attention. Apart from these, research is being focussed on assessing the vulnerability of different species to climate change, and studies are ongoing to monitor changes in fishing grounds of fish stocks due to climate change effects and habitat degradation aiming at vulnerable stocks. Significant promotions have been given in recent years to divert fishing pressure from inshore areas to offshore waters to harvest the non-conventional deepsea resources and potential resources like oceanic squids, and oceanic tunas.

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