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Introduction

Fisheries support the world for the food, nutrition and employment of millions of people, many of whom struggle to maintain reasonable livelihoods. The total world fish production in 2016 reached an all-time high of 171 million tonnes, of which 88% was utilized for direct human consumption, owing to relatively stable capture fisheries production (FAO, 2018). Estimates by the Food and Agricultural Organisation indicates that capture fisheries employ over 27 million people worldwide, of which 85% live in Asia. Marine fisheries play an important role in food security and nutrition in developing countries. There is serious concern about the state of marine fisheries worldwide. While over-fishing is likely to have been the major cause of the serious setbacks, these have probably been exacerbated by habitat degradation. Fisheries sector plays an important role in the overall socio-economic development of India. The fisheries sector contributed 76,913 crores to the GDP during 2009-10 which is 0.96 per cent of the total GDP at factor cost and 5.4 per cent of the GDP at factor cost from agriculture forestry and fishing (Zacharia and Najmudeen, 2013). During 2015-16, the export of marine products from India reached over 9.45 lakh tonnes valued at Rs. 30,421 crores and US\$ 4.688 billion (MPEDA, 2017). India is one of major fish producing countries in the world contributing over 3 per cent of both marine and freshwater fishes to the world production with third position in capture fisheries and second in aquaculture.

The marine fishes, based on their depth-wise distribution may be grouped mainly as pelagic and demersal, the former occupying surface and subsurface waters and the latter the neretic areas in the continental shelf. Demersal fishes can be divided into two main types: Strictly benthic fish which can rest on the

sea floor, and benthopelagic fish which can float in the water column just above the sea floor.

Benthic fish, sometimes called groundfish, are denser than water, so they can rest on the sea floor. Benthic fish which can bury themselves include dragonets, flatfish and stingrays. Demersal finfishes are one of the major components in the marine fish landings along the Indian coast. The major gear which exploit the demersal finfish resources in India are bottom trawlnets. Demersal fish though generally occupy the seafloor; feeding on the benthic organisms and detritus, perform vertical and horizontal migration in search of their feeding and breeding grounds. Hence, the day and night catches in bottom trawl show differences, eg. catfish, rays, eels etc. In the inshore fishing activities below 50 m depth, occurrence of pelagics in bottom trawl and catfish, perches and penaeid prawns in pelagic net is common. Trawl catch consists of 76% demersal (finfish 38% and invertebrates -38%) remaining pelagic or column water fishes.

When compared to the pelagic resources, proper exploitation of the demersal finfishes in India has been initiated only three decades ago (Bensam, 1992). With the introduction of mechanized bottom trawling from the late fifties, the exploitation of demersal finfishes attained a 2.7- fold increase during late eighties. With the large-scale introduction of mechanized trawling, several environmental problems and stock-recruitment hazards to inshore fisheries have come up. Demersal fish groups such as the sharks, groupers, snappers, threadfins, pomfrets and Indian halibut are commercially valuable and contribute substantially to the economy of Indian marine fisheries. Some of these groups, especially of large-size, are targeted by the fishermen by using different craft and gear combinations. However, several other demersal finfishes are not targeted, but are landed as bycatch by shrimp trawlers (Vivekanandan, 2011). Recent changes in the ecosystem due to climate change coupled with intensive fishing pressure necessitates the formulation of policy measures to harvest the demersal fishery resources of the country at sustainable levels.

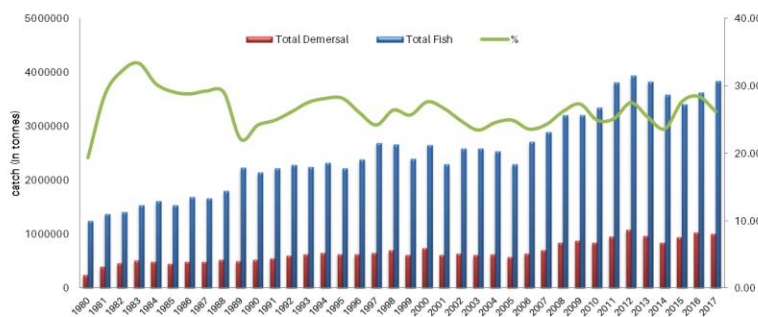


Figure 1. Trends in the landings of demersal finfishes in India during 1980-2017.

The landings of demersal finfishes India during 1980-2014 period shows that the catch is increasing steadily over the years from a meagre of 2,34,408 tonnes to nearly 10,76,789 tonnes in 2012, and thereafter declined to 8,42,199 tonnes in 2014. However, the catch share of demersal finfishes during the last 35 years indicates that the contribution of demersal finfishes to the total Indian marine landings is decreasing over the years. The maximum share was reported in 1983 with 33% contribution and the lowest share (21.7%) was in 1989. The region-wise average share of demersal finfishes along the Indian coast shows that the northwest region comprising of Gujarat and Maharashtra contributes the highest share, followed by southwest coast comprising Kerala and Karnataka and southeast coast comprising Tamil Nadu and Andhra Pradesh. The share of demersal finfishes to all India marine landings of India in 2017 was 26%.

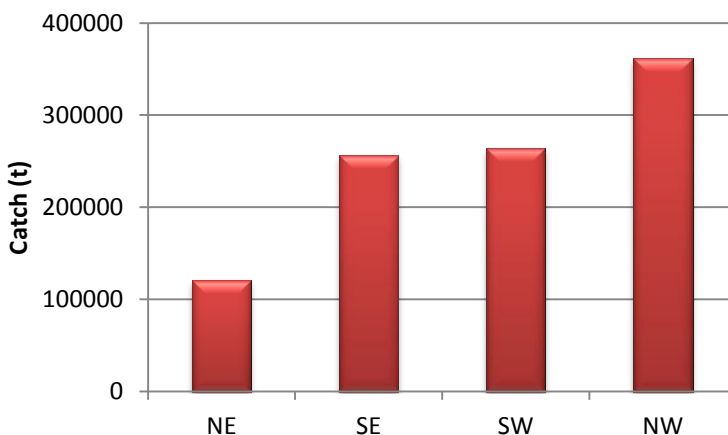


Figure 2. Region-wise landings of demersal finfishes during 2017.

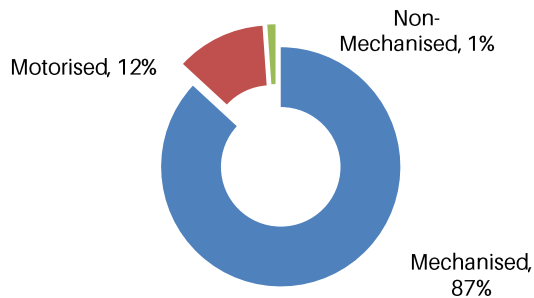


Figure 3. Sector-wise landings of demersal finfishes for the period 2007 - 2012.

The group wise composition of demersal finfish assemblages in Indian marine fish landings during 2016 indicate that the major contributors are the other perches including bulls eye (23%), followed by threadin breams (19%), croakers (18%), silverbellies and catfishes contributed 11% each, lizardfishes (7%) rock codes (6%) and soles (5%). The exploitation status of the important groups of demersal finfishes along the coast of India are briefly given below.

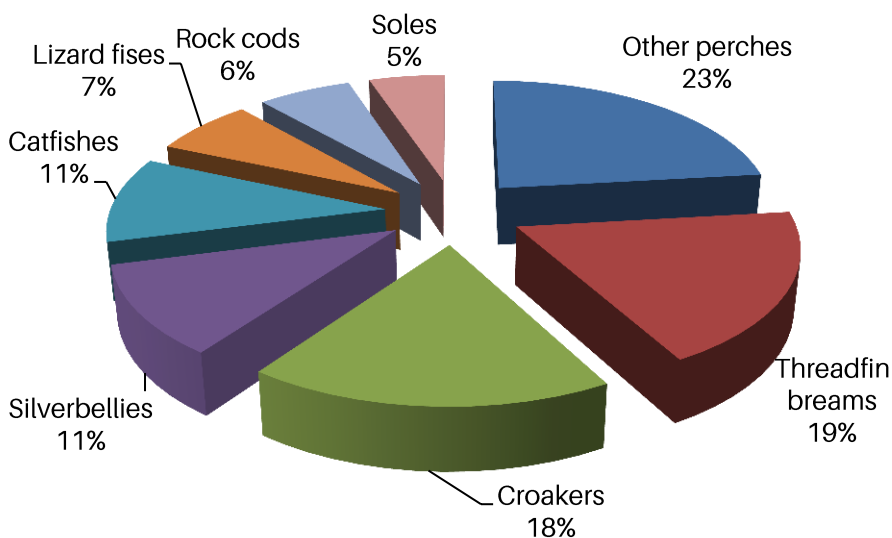


Figure 4. Demersal finfish composition in the marine fish landings of India during 2017

Elasmobranchs

In India, there are about 110 species of elasmobranchs, of which 66 species of sharks, 4 sawfishes, 8 guitarfishes and 32 species of rays are landed in the

commercial catches. Among these, 34 species are commercially important. Some species of elasmobranchs are protected under the Wildlife Protection Act (10 species), which include, *Pristis microdon*, *Rhynchobatus djiddensis*, *Pristis zijsron*, *Carcharhinus hemiodon* (Pondicherry shark), *Glyphis glyphis*, *Rhincodon typus* (whale shark), *Urogymnus asperrimus* (Porcupine ray). 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 2013-17 was 48,735 tonnes, forms 6% of demersal catch. Trawl nets accounting for 48.8%, gillnets 35.6% and hook & line units 6% of the total elasmobranch landings of the country.

Sharks: Average annual shark landings in India during 2013-17 was 21,998 tonnes, which formed 45% of the total elasmobranch landings of the country. The major families appeared in the landings were Carcharhinidae, Triakidae, Sphyrnidae, Echinorhinidae, Hemiscylliidae, Alopiidae, Lamnidae, Centrophoridae, Squalidae and Stegostomatidae. The dominant species in the landings were *Carcharhinus falciformis* (37.25%), *Alopias superciliosus* (11.85%), *Sphyrna lewini* (11.53%), and *Alopias pelagicus* (8.53%). Most of the catch was contributed by multiday trawl nets (34%) followed by mechanised gillnet units (27%).



Figure 5. Heavy landings of sharks and rays at Cochin Fisheries Harbour, Kerala coast

Rays: The landing of rays in India during 2016 was 26,211 tonnes, which formed 51% of the total elasmobranch landings of the country. The major families in the landings were Dasyatidae, Mobulidae, Myliobatidae, Gymnuridae and Rhinopteridae

Skates/guitar fishes: All India landings of guitarfishes were estimated at 3627 tonnes, which constituted 4% of the total elasmobranch landings of the country. The major families of guitarfishes landed along the coast are Rhinidae and Rhinobatidae.

There are significant changes in the share of sharks and rays to total elasmobranch landings recent years. The all India Production Elasmobranchs during 1999-2010, shows that sharks were dominant in the catch with 49.7% share and that of the rays was 44.5%. However, the landings during 2013-17 indicate that the rays has emerged as the dominant group with 48% followed by sharks with 45% share.

Sharks are crucial to marine ecosystems. They maintain a balance in populations of prey species. They are in a global decline. Overfishing & Life history parameters has reduced many shark populations. Life history traits that make sharks vulnerable group of fishes. The shark's reproductive strategy is very different to most bony ocean fish that release millions of eggs in a lifetime. Long time to reach sexual maturity - dusky shark can take more than 20 years to reach sexual maturity and sharks have long gestation periods (one to two years). They have a small number of offspring (pups). Most shark species give birth to between 2 and 20 pups after a pregnancy of 8-12 months. They breed only every second or third year Females of many shark species rest between breeding cycles for at least one year. Most of the shark species have a tendency to form groups based on their age, sex and/or maturity. India is the second largest shark fishing nations of the world after Indonesia. Conservation and management measures for shark species are initiated in India. Already 10 elasmobranch species are protected in India under Wildlife Protection Act. There is a blanket ban on the export of shark fins from India. Unlike many other countries, the sharks are landed 'fin on' in India and there is a great demand for shark meat in the local markets in many parts of the country.

Perches

This group was abundant in the rocky grounds off Kerala and Tamil Nadu and was exploited by drift nets, hooks and lines and traps. All India annual average landings of Perches during 2013-17 is 3.50 lakh tonnes and forms 36% of total demersal finfish landings. Among the different groups of perches landed along

the Indian coast, threadfin breams were the dominant group with 47% of the total perch landings, followed by other perches mainly composed of bull's eyes belonging to the family priacanthidae with 34% share, rock codes/groupers 12%, pigface breams 4% and snappers contributed 3% to the total annual catch.

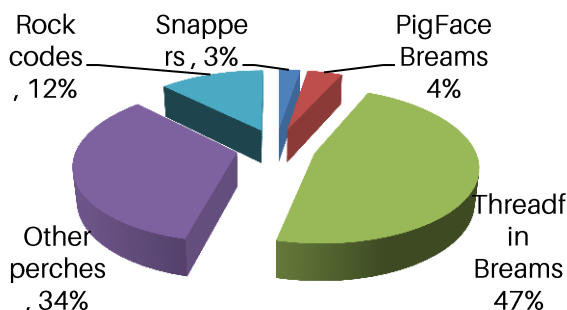


Figure 6. Composition of different groups to the total perch landings in India

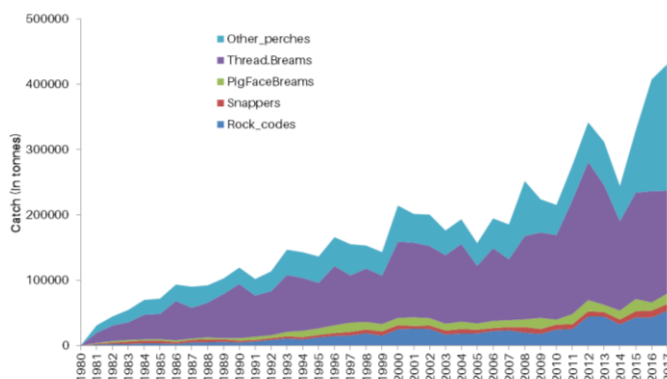


Figure 7. Trend in the landings of perches in India during 2013-2017

Threadfin Breams

Six species of threadfinbreams are known from the seas around India. *Nemipterus japonicus*, *N. randalli*, *N. bipunctatus*, *N. metopias*, *N. zysron*, *N. nematophorus*, *N. tolu*. Among these, *Nemipterus japonicus*, *N. randalli* are commercially important. Their abundance is influenced by upwelling and is known to move to inshore waters during monsoon period along the west coast. They are fractional spawners with protracted spawning periods. Spawning in *N. japonicus* takes place during October-April with a peak during October- December along Gujarat. In Kerala, *N. japonicus* and *N. randalli* spawn during monsoon and post monsoon periods with peaks during monsoon in the former and during post monsoon in the latter species. All India annual average landings of threadfin

breams during 2013-17 was 1.62 lakh tonnes, forms 17% of the total demersal finfish catch in India.

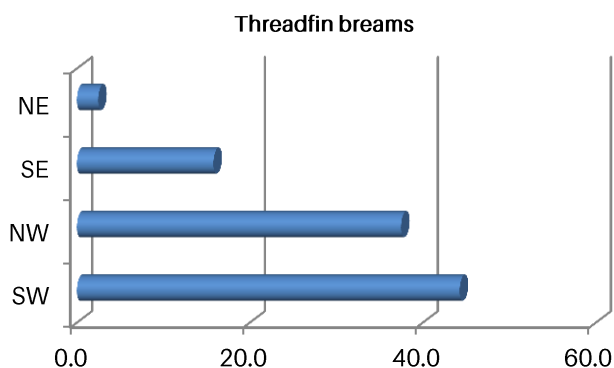


Figure 8. Region wise landings of threadfin breams in India during 2013-17

Groupers

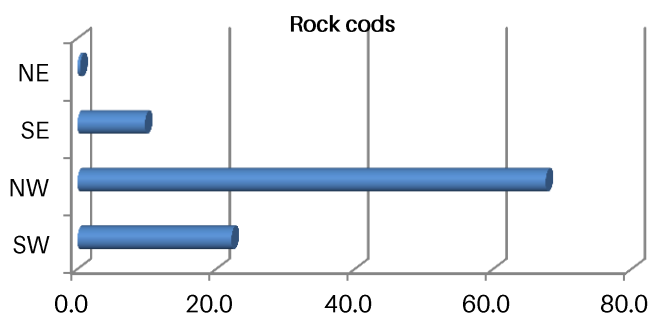


Figure 9. Region wise landings of groupers in India during 2013-17

Rock cods or groupers are protogynous hermaphrodites, initially maturing as females then reverting to males as they grow in age and size. The major species observed in the landings are *Epinephelus chlorostigma*, *E. diacanthus*, *E. areolatus*, *E. tauvina*, *E. morrhua*, *E. bleekeri*, *E. longispinnis*, *Cephalopholis argus*, *Aetheloperca rogaa*, *Variola louti*. The annual landings of groupers during 2013-17 in India was 43,156 tonnes, which formed 4.5% of the demersal finfish landings of India. North-west coast comprising Gujarat and Maharashtra dominate in the catch with 68% of the total grouper landings of the country.

Snappers

The major species observed in the all India landings of snappers were *Pristipomoides typus*, *L. argentimaculatus*, *Lutjanus gibbus*, *L. rivulatus*, *L. bohar*, and *L. lutjanus*. The annual catch of snappers during 2013-17 in India was 8,893 tonnes. Southeast coast of India contributed the majority of landings of snappers in India with 63% followed by northwest coast of India.

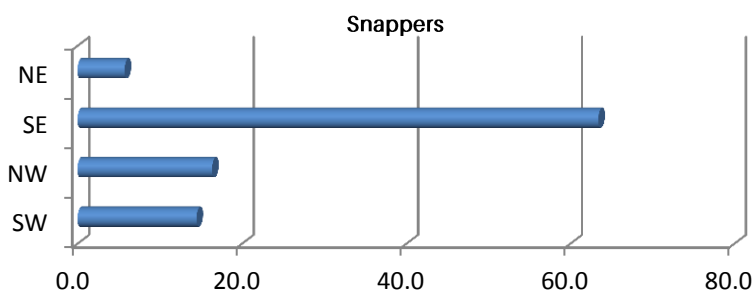


Figure 10a. Region wise distribution of snappers in India



Figure 10b. Snapper Landings in India

Bull's Eyes

The annual landings of Bullseyes during 2016 in India was 130740 tonnes, which formed 32% of the total perch landings of the country. They belong to a single family Priacanthidae. The major species observed in the landings are *Priacanthus hamrur*, *Oookeolus japonicus* and *Priacanthus Sagittarius*. From a mere 43,576 tonnes in 2015 its landings of bullseye has been escalated to a three- times-high of 1.3 lakh tonnes during 2016.



Figure 11. Catch of Bullseye, *Priacanthus* sp. and Emperor bream/ pigface bream

Pigface Breams

The major species observed in the landings of pigface breams/ emperor breams in India are *Lethrinus mahsena*, *L. lentjan*, *L. conchylatus*, *L. nebulosus*, *L. ramak*, *L. elongatus* and *Lethrinus miniatus*. The landings of Pigface breams in India during 2017 was 14,492 t, which formed about 1.5% of the total demersal landings of the country. Southeast coast of India contributed the major share of landings of pigface breams in India.

Lizardfishes

All India landings of lizardfishes are 68,329 tonnes, forms 7% of demersal catch 20 - 40 m depth up to 150-200 m depth. The species of lizardfishes landed along the west coast of India are *Saurida tumbil*, *S. undosquamis*, *Trachinocephalus myops*, *Synodus englemani* and that of East coast are *Saurida undosquamis*, *S. longimanus* and *S. micropectoralis*, *Saurida tumbil*, *Trachinocephalus myops*,

Synodus englemani. Spawning in *S. tumbil* occurs during September to March off Veraval and Bombay along North west coast; August to November off Cochin.



Figure 12. Lizardfish landings along the west coast of India

Catfishes

Catfishes are important demersal resources which have wide distributional range in the Indo-Pacific region. They are distributed all along the Indian coastal waters upto the middle shelf with preferential concentration on muddy grounds of 30-70 m depths. Catfishes migrate both vertically (diurnal migration) and horizontally (seasonal) in small schools to large shoals in response to seasonal climatic / hydrographic variations. Marine catfishes belong to the family Ariidae, of which 11 species appear in the commercial fisheries.



Figure 13. Catfish landings along the west coast of India

West coast of India landed 70% of the total catfish catch and the east coast 30%, northwest coast landed 90% of the west coast catch. All species of catfishes exhibit parental care - the male carrying the brood (25-120 eggs) in the oro-buccal cavity for 1 to 2 months' time until the juveniles (4-7 cm) are released. After spawning the brooding males segregate into shoals and move along the surface and prefer shallow water. The newly released juveniles of all species of tachysurids live in the shallow muddy grounds feeding on the bottom epi-and in-fauna - become easy target in fishing. The all India landings of catfishes is during 2016 was estimated at 80700 tonnes, which formed 8.4% of demersal finfish catch of India. Nearly 50% of the catch was from north west coast of India.

Flatfishes

These were abundant in muddy and/or sandy bottom up to about 80 m depth belonging to genera such as *Cynoglossus*, *Psettodes*, *Pseudorhombus*, *Bothus*, *Paraplagusia*, etc. and exploited by trawl nets, gill nets and other artisanal gears. The Commercial exploitation of flatfishes along the Indian coast varies widely with *Cynoglossus macrostomus* dominating in the West Coast and *Cynoglossus macrolepidotus* along the East coast. The Fishery of *Psettodes erumei* showed a decline in recent years. The all India landings of flatfishes during 2013-17 was 44,354 tonnes, which formed 4.6% of demersal finfish catch of India. Bulk of the landings of soles are contributed by northwest coast followed by southwest coast

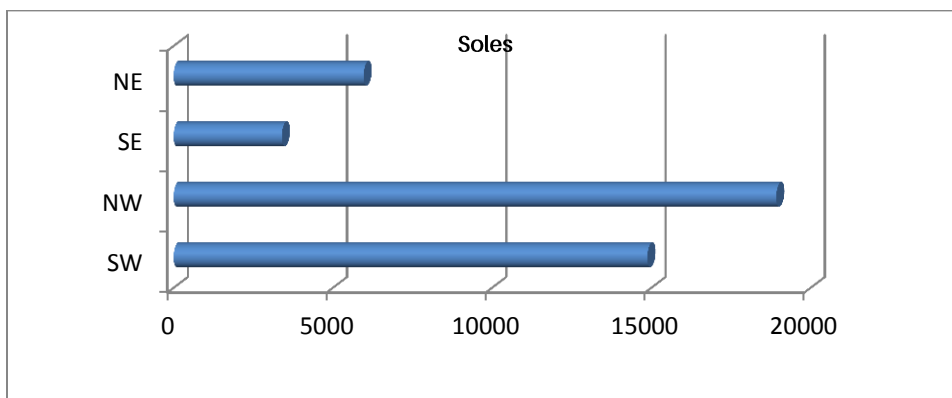


Figure 14a. Region wise distribution of soles in India



Figure. 14b. Landings of flatfishes

Sciaenids

Scienids include high value demersal resources like croakers, which are landed mainly from Gujarat and Maharashtra. The important gears used are trawls and gill nets. These fishes are caught mainly during October - December and January - March. They mainly consist of the species like *Pseudosciaena diacanthus*, *Otolithes* spp. and *Johneips* spp. *Protonibea diacanthus*, *Johniops macrorhynus*, *Otolithes cuvieri*, *J. dussumieri*, *J. glaucus*, and *O. ruber*. All India annual landings of Sciaenids during 2013-17 is 1, 61,177 tonnes, which formed 16.8% of demersal finfish catch of the country. Northwest region is the highest contributor followed by northeast region.

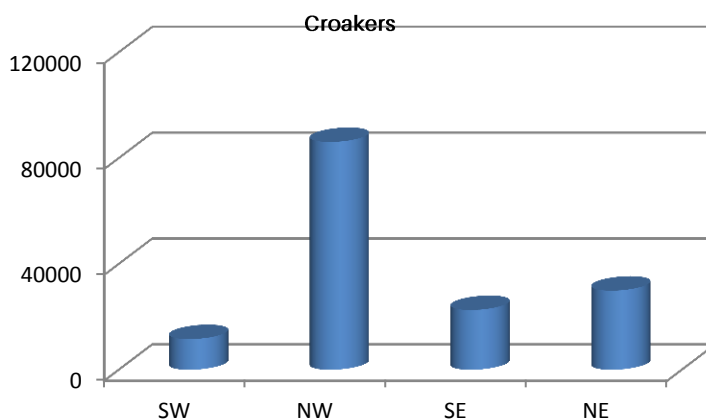


Figure 15. Region wise distribution of croakers along the Indian coast

Pomfrets

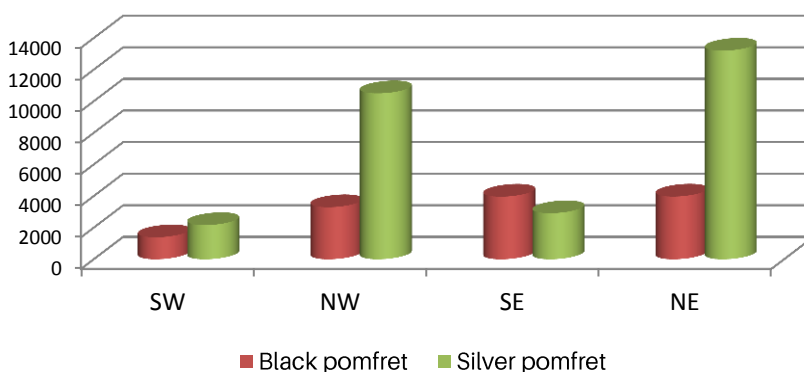


Figure 16. Region wise distribution of pomfrets along the Indian coast

Pomfrets belong to two families, the black pomfret *Parastromateus niger* is coming under the family Carangidae and the silver pomfret *Pampus argenteus* belongs to the family Stromateidae. They are landed abundantly in Gujarat and Maharashtra. The black pomfret landings in India during 2013-17 was 15,400 tonnes, and that of silver pomfret was 27,800 tonnes, which formed 3.3% of demersal finfish catch of the country.



Figure 17. Black pomfret *Parastromateus niger* and the Silver pomfret *Pampus argenteus*

Silverbellies

Silverbellies belonging to the family Leiognathidae. Exploited by trawl nets and anisalan gears, this group formed about 11% of demersal finfish production. The major species landed along the coast of India are *Leiognathus splendens*, *L.*

equlus, *Gazza minuta*, *L. bindus*, *L. dussumieri*, *L. jonesi*, *Secutor insidiator*. All India annual landings of silverbellies was 1, 08,200 tonnes, which formed 11% of demersal finfish catch of India and most of the catch is contributed by southeast coast of India.

Whitefish

This resource is also called buttefish and known to be depleted or overexploited by the mechanised trawl operations along the near-shore waters of west coast of India. Although distributed all along the coastline, it has been supporting notable fisheries along the southwest and southeast regions. All India landings of whitefish is 6,260 tonnes, forms 0.7% of demersal catch *Lactarius lactarius* is the only species available in this family. Whitefish production in India shows wide fluctuation. Shows steady fall except spurt in 1983 and 1985. In Karnataka it fluctuated between a low of 37 t in 1964 and highest of 2,930 t in 1988. East coast shows a steady decline from 4,738 t in 1960-69 to 8,88 t in 1990-99. West coast showed an increase from 2,901 t in 1960-69 to 12,354 t in 1980-89 then steep decline to 6,109 in 1990-99.



Figure 18. Whitefish *Lactarius lactarius* landings along the coast of India

Goatfishes

This group has three important genera in India, *Upeneus*, *Parupeneus* and *Mulloidichthys*. These were exploited by trawls and traditional gears mostly in Tamil Nadu, Andhra Pradesh, Kerala, Kamataka and Maharashtra. Dominant species along the east coast of India include *Upneus taenipterus*, *Upeneus bensasi*, *Upenues sulphureus*, *Upeneus sundaicus*, *Parupenus indicus* and *U. molluccensis*. All India landings of goatfishes during 2016 was 30,276 tonnes, which formed 3.2% of demersal finfish catch of the country.



Figure 19. Goatfish landings along the coast of India

Eels

Eels are long-bodied, snake like fishes, having a crevice dwelling or sediment-burrowing mode of life, though some live in the pelagic realm of the open oceans. Traditionally marketable species of eels are caught from conventional fishing grounds of northwest and northeast coasts of India and are largely a by-catch. Pike congers belonging to the family Muraenesocidae occur in tropical waters in the soft bottoms upto 100 m depth and in estuaries. Four species are recorded in Indian waters and they grow to a maximum length of 80 cm (*Congresox talabon*) (Cuvier, 1829), 250 cm (*C. talabonoidies*) (Sleeker, 1853), 180 cm (*Muraenesox bagio*) (Hamilton-Buchanan) and of 80 cm (*M. cinereus*) (Forsskal, 1775).



Figure 20. Eels belonging to the family Muraenesocidae landed along the Kerala coast

Regionwise Distribution of Species

Finfishes exploited by trawls belong to 21 major fish groups, which are mostly demersal groups. Each maritime region of India is characterized by dominance of specific demersal finfish groups. Along the northeast (NE) coast, sciaenids, catfishes and pomfrets (74.0% to the demersal landings) are dominant. The southeast coast is characterised by the abundant landings of silverbellies and pigface breems. Along the southwest coast of India, threadfin breems and other perches are the major demersal resources and the northwest coast is characterised by the dominance of sciaenids, catfish, pomfrets and threadfin breems.

Existing Management Practices

Seasonal closure of fishery: The regulations for "closed season were notified for the Eastern Arabian Sea from 1988 onwards.

Mesh size regulation and Minimum Legal Size: Minimum mesh size for different species was recommended for avoiding juvenile bycatch. Square mesh size of 40 mm showed that it provides better opportunity for the juveniles to escape and it is recommended for cod end of trawls. Minimum Legal Size (MLS) for 58 species of finfishes and shellfishes including demersal finfishes have recommended by the Central Marine Fisheries Research Institute which have been enacted by Gazette notification by Govt. of Kerala.

Restriction of fishing areas: In the context of persistent conflicts between artisanal and mechanized vessels in the inshore waters. Under this act, the trawl boats have been banned from fishing in inshore areas, which have been assigned exclusively to the artisanal craft. Community participation in the formulation of the management actions are yielding good results in some parts of the country.

Protected species and Marine Protected Areas (MPAs): Several species are protected under Wildlife Protection (1971) Act. Capture or trade on these species is prohibited under the act. Releasing sharks after finning is prohibited under a notification. Under this act, fishing for whale shark is prohibited. There are 31 MPAs along India's coastline that have been officially declared for conserving and protecting coastal and marine biodiversity (SCBD, 2006)

Table 1. Minimum Legal Size (MLS) recommendations for the selected demersal finfish species in the fishery along the coast of Kerala.

| S.No. | Species Name | Common Name | Recommended MLS (cm) |
|-------|--------------------------------|--------------------------|----------------------|
| 1. | <i>Cynoglossus macrostomus</i> | Malabar sole | 9 TL |
| 2. | <i>Saurida tumbil</i> | Lizardfish | 17 TL |
| 3. | <i>Johnius sina</i> | Croaker | 11 TL |
| 4. | <i>Nemipterus japonicus</i> | Threadfin bream (Yellow) | 12 TL |
| 5. | <i>Lactarius lactarius</i> | White fish | 10 TL |
| 6. | <i>Nemipterus randalli</i> | Threadfin bream (red) | 10 TL |
| 7. | <i>Saurida undosquamis</i> | Lizardfish | 10 TL |
| 8. | <i>Pampus argenteus</i> | Silver pomfret | 13 TL |
| 9. | <i>Parastromateus niger</i> | Black pomfret | 17 TL |
| 10. | <i>Priacanthus hamrur</i> | Bulls eye | 14 TL |
| 11. | <i>Otolithes ruber</i> | Tiger toothed croaker | 17 TL |
| 12. | <i>Epinephelus diacanthus</i> | Spiny cheek grouper | 18 TL |
| 13. | <i>Gymnura poecilura</i> | Butterfly ray | 29 DW |