Decadal Trends of Indian Demersal Fisheries

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Abstract: Fisheries sector plays an important role in the overall socio-economic development of India. India is one of the major fish producing countries in the world contributing over 3% of both marine and freshwater fishes of the world production. Marine fishes, based on their depth-wise distribution are grouped mainly as pelagic and demersal, the former occupying surface and subsurface waters and the latter the neritic areas in the continental shelf. Demersal fishes are those fishes which can either rest on the sea floor or which can float in the water column just above the sea floor. The demersal fish resources of India include the elasmobranchs, eels, major perches, threadfin breams, silverbellies, sciaenids, lizardfishes, pomfrets, bulls eye, catfishes, flatfishes, goatfish and white fish. There is a significant contribution by the demersal fishes to the total Indian marine fish landings. When compared to the pelagic resources, proper exploitation of the demersal finfishes in India has been initiated since 1960-62 period. With the introduction of mechanized bottom trawling the exploitation of demersal finfishes attained a 2.7 fold increase reaching 0.52 million tonnes in the late eighties from 0.08million tonnes during the late fifties. In 2017, the demersal fish production of India reached new heights with a peak annual average landing of 1 million tonne which is almost an increase of 12.5 fold from the late fifties. The annual average landings of demersal finfishes along the Indian coast during 2010-2015 was accounted to 0.95 million tonnes contributing 26.32% to the total landings. 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 was in 1989.

Keywords. Indian fisheries, demersal finfishes, landings

1. Introduction

Fisheries sector plays an important role in the overall socio-economic development of India. India is one of the major fish producing countries in the world contributing over 3% of both marine and freshwater fishes o the world production (FAO, 2016). The continental shelf of Indian EEZ which extends up to 200 m depth is bestowed with a rich diversity of demersal finfish resources. Marine fishes, based on their depth-wise distribution is grouped mainly as pelagic and demersal, the former occupying surface and subsurface waters and the latter the neritic areas in the continental shelf (Zacharia and Najmudeen, 2017). Demersal fishes are those fishes which can either rest on the sea floor or which can float in the water column just above the sea floor. The word demersal derived from the Latin word 'demergere', which means to sink. The demersal fish resources of India include the elasmobranchs, eels, major perches, threadfin breams, silverbellies, sciaenids, lizardfishes, pomfrets, bulls eye, catfishes, flatfishes, goatfish and white fish. They inhabit rocky, sandy, muddy and coral areas feeding on the benthic organisms and detritus; also they carry out vertical and horizontal migration in search of their feeding and breeding grounds. There is a significant contribution by the demersal fishes to the total Indian marine fish landings. In the year 2017, the demersal finfishes contributed 26.8% to the total landings. They have high value both in local and export market and play an important role in the economy of Indian marine fisheries. The major gear which exploits the demersal finfish resources in India are the bottom trawl nets. According to Chidambaram (1953), trawling experiments were made in Indian waters even before the Second World War. S. T. Premier, S.

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T. William Carrick and S. T. Madras covered the Bombay waters during the years 1900, 1921-22 and 1923 respectively. The result of these initial trials were not encouraging and it appeared like trawling might not prove economically successful (Jayaraman et al., 1959). After that, a Japanese trawler Taiyo Maru No. 17 joined the trawling fleet in November 1951 and ventured on commercial scale operations which proved to be successful. The pilot Deep Sea Fishing Station at Bombay tried bull trawling during the year 1953-54, which was carried out under the Japanese technical supervision. All these attempts paved way to the recommendations of third Five- Year Plan (1961-65) in which there was an increased effort for mechanized commercial trawling, which in turn made a defining moment in the development of demersal fisheries in India. On the other hand, along with these developments several issues and constraints have surfaced, such as damage to bottom ecology and habitat degradation, discarding and juvenile fishing, overexploitation of resources in inshore areas, over capacity and over capitalization, inter and intra sectoral conflicts and other management-related concerns.

2. Decadal trends in demersal fish production

When compared to the pelagic resources, proper exploitation of the demersal finfishes in India has been initiated since 1960-62 period (Bensam, 1992). With the introduction of mechanized bottom trawling the exploitation of demersal finfishes attained a 2.7 fold increase reaching 0.52 million tonnes in the late eighties from 0.08million tonnes during the late fifties. In 2017, the demersal fish production of India reached new heights with a peak annual average landing of 1 million tonne (10,02,509 t) which is almost an increase of 12.5 fold from the late fifties (Fig.1).

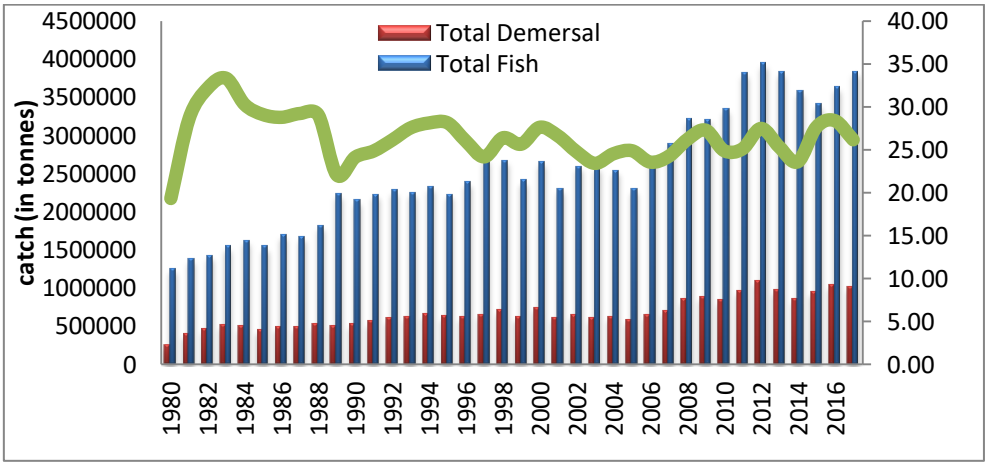


Fig.1. Decadal trends in fish production

The annual average landings of demersal finfishes along the Indian coast during 2010- 2015 amounted to 0.95 million tonnes contributing 26.32% to the total landings (Fig.2,Table1).

Table 1. Annual average landings along the Indian coast during 2010- 2015

Category	Landings (million tonnes)	%
Pelagic finfish	1.96	54.29
Demersal finfish	0.95	26.32
Crustaceans	0.47	13.02
Molluscs	0.23	6.37
Total	**3.61**	**100**

However, the catch share of demersal finfishes during the last 35 years indicate 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.

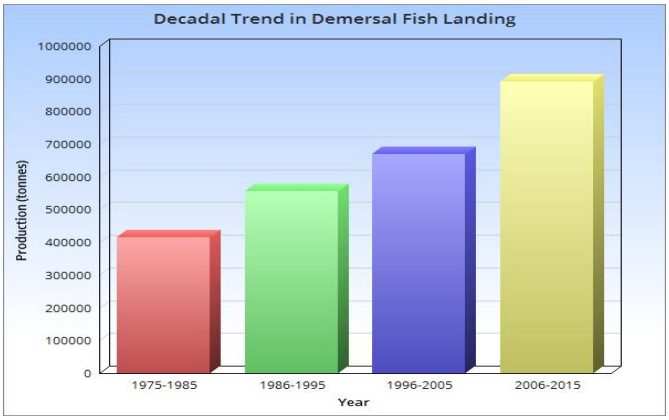


Fig.2. Decadal trends in demersal fish landing

3. Decadal trends in coast-wise landings

As reported by Sivakami (2004) the demersal fish production along the west coast during 1981-2000 showed an increase from 2,91,078 t in 1981 to 6,44,117 t in 1998 but declining subsequently to 4,34,890 t during 1999 and 5,48,884 t during 2000 with an average of 4,29,370 t . Along the east coast, the demersal fish catch improved from 1, 88,735 t in 1981 to 2, 35,669 t in 1998 but declined to 2, 39,588 t in 2000, the average being 2, 27,881 t. The contribution by the west coast and the east coast were 65.33% and 34.67% respectively. The region-wise average share of demersal finfishes along the Indian coast during 2010-2015 showed that the northwest region comprising of Gujarat and Maharashtra contributes the highest share 3,17,845 t, followed by southeast coast comprising Tamil Nadu and Andhra Pradesh, amounted to 243710.81 t, the southwest coast comprising Kerala and Karnataka with a share of 2,06,835 t. The contribution by northwest, southeast, southwest and northeast were 35.45%, 27.18%, 23.07% and 14.3% of all India demersal catch respectively (Fig.3, Table 2).

Table 2. Annual average demersal finfish catch (t) along the four regions during 2010-2015

Region	Continental shelf area (000 Km^2)	Catch (tonnes)	Catch (tonnes/Km^2)	% of all India demersal catch
Northeast	41	128202.42	3.13	14.3
Southeast	73	243710.81	3.34	27.18
Southwest	75	206834.75	2.76	23.07
Northwest	276	317844.70	1.15	35.45
Indian mainland Total	**465**	**896592.68**	**1.93**	**100**

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, lizardifishes (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 (Fig.3).

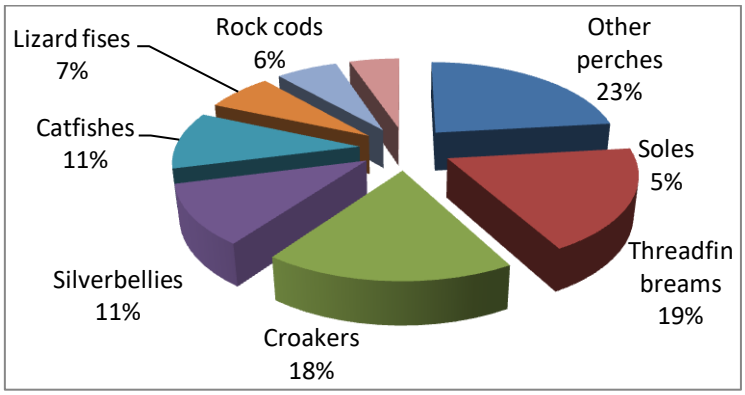


Fig.3. Demersal finfish composition in the marine fish landings of India during 2017

4. Decadal trends in the fishery of major demersal fishes

Elasmobranchs: In India, there are about 110 species of elasmobranchs, of which 66 species of sharks, 4sawfishes, 8 guitarfishes and 32 species of rays are landed in the commercial catches. Among these, 34 species are commercially important. However, the recent update on sharks in Indian waters accounts for 74 species (Table 3).

Table 3. Number of shark species occurring in the Indian waters

Order	Family	Common name	Occurrence	
			Genus	Species
Hexanchiformes	Hexanchidae	Cow sharks	2	2
Orectolobiformes	Hemiscylliidae	Bamboo sharks	1	5
	Stegostomatidae	Zebra sharks	1	1
	Ginglymostomatidae	Nurse shark	1	1
	Rhincodontidae	Whale shark	1	1
Lamniformes	Odontaspididae	Sandtiger sharks	2	3
	Alopiidae	Thresher sharks	1	3
	Lamnidae	Mackerel sharks	1	2
	Pseudocarchariidae	Crocodile sharks	1	1
Carcharhiniformes	Scyliorhinidae	Catsharks	4	4
	Proscylliidae	Finback catsharks	2	2
	Pseudotriakidae	False catsharks	1	1
	Triakidae	Hound sharks	2	3
	Hemigaleidae	Weasel sharks	4	4
	Carcharhinidae	Requiem sharks	10	26
	Sphyrnidae	Hammer headed sharks	2	4
Squaliformes	Squalidae	Dogfish sharks	1	1
	Centrophoridae	Gulper sharks	2	5
	Etmopteridae	Lantern sharks	2	2
	Somniosidae	Sleeper sharks	2	2
Echinorhiniformes	Echinorhinidae	Bramble sharks	1	1
Total			**44**	**74**

Source: Akhilesh K V et al (2014). Checklist of Chondrichthyans in Indian waters. *J. Mar. Biol. Ass. India*, 56 (1), 109-120.

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. Trawl net accounting for 48.8%, gillnets 35.6% and hook & line units 6% of the total elasmobranch landings of the country. The major shark 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%), *Alopias pelagicus* (8.53%)(CMFRI, 2016). Among rays landed, major families were Dasyatidae, Mobulidae, Myliobatidae, Gymnuridae and Rhinopteridae. 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 the total elasmobranch landings in recent years (Fig. 1). In India the average landings of elasmobranchs during the period 2010-2017 amounted to 48,961 tonnes. The all India estimated landing of elasmobranchs during 1999-2010, shows that sharks were dominant in the catch with 49.7% share and that of the rays were 44.5%. However, the landings during 2006 indicated that the rays have emerged as the dominant group with 51% followed by sharks with 45% share. Bensam (1992) pointed out that the elasmobranch fishing has reached the optimum level of exploitation (54, 000 t) and only a marginal increase is possible. The annual landings increased from 50,690 t in 1990 to a peak of 75, 304 t in 1994 and it reached the highest average landing decade (1990-2003) amounted to 63,010 t but thereafter showing a declining trend (Fig 4, table 3).

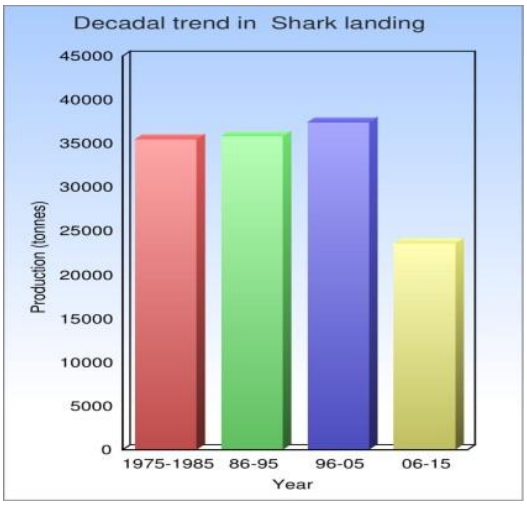


Fig.4. Decadal trend in shark landing along Indian coast

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 landings of perches accounted to 4.07 lakh tonnes and forms 40% of total demersal finfish landings. Among the different groups of perches landed along the Indian coast, threadfin breams were the dominant group with 42% of the total perch landings, followed by bullseyes belonging to the family priacanthidae with 32% share, rock codes/groupers 10%, snappers and pigface breams 3% each and other minor perch groups contributed 10% (Fig. 5).

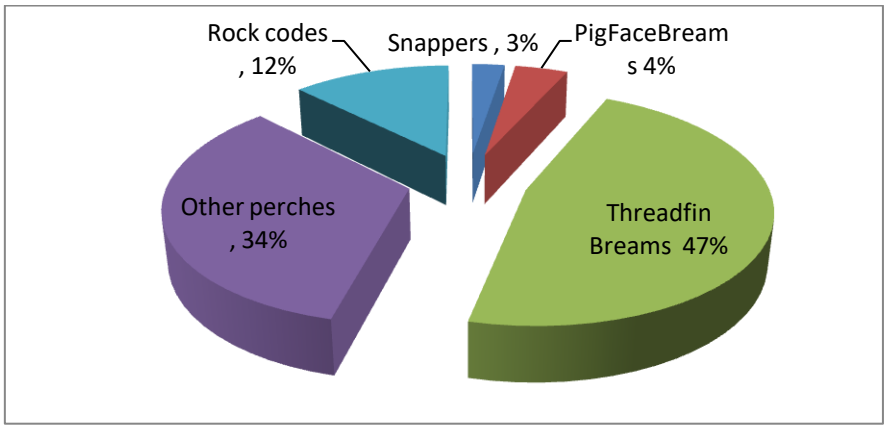


Fig.5. Composition of different groups to the total perch landings in India

Major perches

Groupers: 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 total landings of groupers during 2016 in India were 42781 tonnes, which formed 10% of the perch landings of India (Fig.6).

Fig.6. Landings of groupers along southwest coast of India

Snappers: The major species present in the landings were *Pristipomoides typus, L. argentimaculatus, Lutjanus gibbus, L. rivulatus, L. bohar*, and *L. lutjanus.* The catch of snappers during 2016 in India was 10,533 tonnes. Southeast coast of India contributed the majority of landings of snappers in India followed by southwest coast of India.

Fig.7. Emperor bream/ pigface bream landings along the Kerala coast

Pigface Breams : The major species observed in the landings of pigface breams/ emperor breams in India are *Lethrinus mahsena, L. lentjan, L. conchyliatus, L. nebulosus, L. ramak, L.elongates* and *Lethrinus miniatus.* The landings of Pigface breams in India during 2016 was 12,519 t, which formed about 3% of the total perch landings of the country. Southeast coast of India contributed the major share of landings of pigface breams in India. The average annual production during 1985-89 and 1990-2003 by major perches amounted to 28,777 - 30,000 t. However, during the 2010-2017 period, the average annual landing reached as high as 61,593 tonnes (Fig. 2,7).

Threadfin Breams: Six species of threadfin breams are known from the seas around India *Viz. Nemipterus japonicus, N. randalli, N.bipunctatus, N. metopias, N. zysron, N. nematophorus.* Among these, *Nemipterus japonicas* and *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. japonicas* 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 landing of threadfin breams in 2016 was 1.63 lakh tonnes, forms 17.3% of the total demersal finfish catch in India. A tremendous increase in the landing of threadfin breams is depicted in the period 2010-2017, with an average annual landing of 164781 t. It attained almost 4.7 fold increase in landings than the 1980-88 periods (Fig. 3). During the period (1990-2003), the average annual landing was 86940 t and Sivakami (2004) pointed out the potential yield as 1, 28,000 t while the yield (as on 2000) was 1, 16,680 t which was then within the permissible level (Fig. 8,9).

Fig.8. Landings of threadfin breams at Munambam fisheries harbour, southwest coast of India

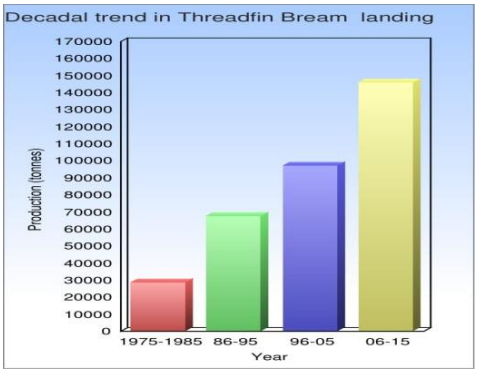


Fig.9. Decadal trend in threadfin bream landings

Bullseyes: The landing 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*, *Cookeolus japonicas* and *Priacanthus sagittarius.* From a mere 43,576 tonnes in 2015 the landings of bulls eye has been escalated to a 3 times high of 1.3 during 2016. The landings again hiked to 1.4 lakh tonnes t in 2017. Bulls eye was considered as a non-conventional fishery resource earlier and rich abundance of this resource was reported by Sudarsan (1993) during the exploratory surveys conducted along the

Indian EEZ. The potential estimated then was 2,75,00 t in the waters of 50- 500m depth especially off south west coast of India.

Lizard fishes: All India landing of lizardfish is 94, 817 tonnes, forms 8.3% of demersal catch, from a depth range of 20-40 m up to 150-200 m. 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 from September to March off Veraval and Bombay along northwest coast; August to November off Cochin. In 2010-2017, the average annual landing is 61384 t which is almost 2.3 fold increase than the previous decade (1990-2003) (Fig. 10).

Fig.10. Landings of lizard fish

Catfishes: Catfishes are important demersal resources which have wide distributional range in the Indo-Pacific region. They are distributed on the muddy grounds within a depth range of 30-70 m along the coast. 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.

Fig.11. Catfish landing along Kerala coast

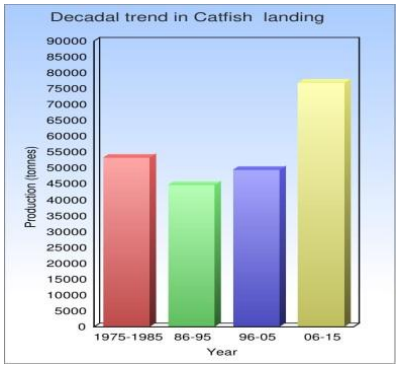


Fig.12. landing of catfish along Indian coast during the four decades

West coast of India landed 70% of the total catfish catch and the east coast 30%; northwest coast contributed 90% of the total west coast catch. All species of catfishes exhibit parental care in which the male carrying the brood (25-120 eggs) in the oro-buccal cavity for 1 to 2 months until the juveniles (4-7 cm) are released. After spawning the brooding males segregate into shoals and move along the surface and prefer to dwell in 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 landing of catfishes during 2016 was estimated as 80,559tonnes, which formed 8.9% of demersal finfish catch of India (Zacharia and Najmudeen, 2017). In 2017, the landing of catfishes has increased and reached 88,177 t. The production indicated an increasing trend from 46,012 t during 1990-2003 to 84,757 t during 2010-2017 (Fig. 5). However, James et al., 1989 has reported a declining trend in the catfish landings with the average production of 8,060 tonnes during 1979-83 to only about 4,070 tonnes during 1984-87 (Fig. 11,12).

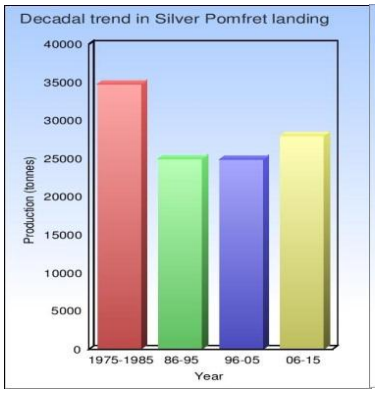
Flatfishes: These were abundant in muddy and/or sandy bottom up to about 80 m depth belonging to genera such as *Cynoglossus, Psettodes, Pseudorhombus, Bothus, Paraplagusia,* etc. and exploited by trawl nets, gill nets and other artisanal gears. The commercial exploitation of flatfishes along the Indian 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 2016 was 43,828 tonnes, which formed 4.7% of demersal finfish catch of India. The production indicated an increasing trend from 44764 t during 1990 -2003 to 50778 t during 2010-2017 (Fig. 13).

Fig.13. Malabar sole landing at Munambam fisheries harbour

Sciaenids: Sciaenids 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 *Johneiops* spp. *Protonibea diacanthus, Johniops macrorhynus, Otolithes cuvieri, J. dussumieri, J.glaucus,* and *O. ruber.* All India landings of sciaenids during 2016 is 1, 57, 793 tonnes, which forms 16.5% of demersal finfish catch of the country. In 2017, the average annual landing of sciaenids reduced to 150241 t (Fig. 7). However, the production indicated an increasing trend from 1,02,900 t during 1979-87 to 1,56,280 t during 1990-2003 and 1,81,959t during 2010-2017.

Pomfrets: Pomfrets belong to two families; the black pomfret, *Parastromateus niger* comes under the family Carangidae and the silver pomfret *Pampus argenteus* belongs to the family Stromateidae. They are caught mainly in trawl, gill net and dol net. They are landed abundantly in Gujarat and Maharashtra. The black pomfret landings in India during 2016 was 13,924 tonnes, and that of silver pomfret was 26,012 tonnes, which formed 3.3% of demersal finfish catch of the country. In 2017, the average annual landing of pomfrets increased to 46,877 t (Fig.

8). The production indicated an increasing trend from 40312t during 1990-2003 to 49236 t during 2010-2017 (Fig 14, 15 &16).



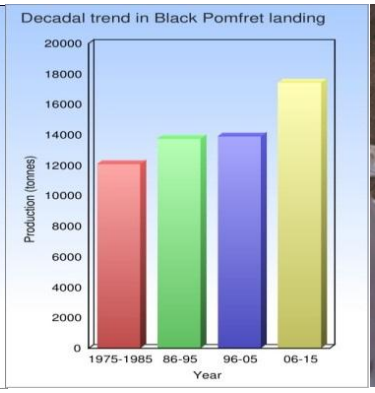


Fig.14. White pomfret landings **Fig.15** Black pomfret landings **Fig. 16.**Pomfret landing

Silver bellies: Silver bellies belonging to the family Leiognathidae are exploited by mainly by trawl nets and artisanal gears which contributes about 12% of demersal finfishes 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 landing of silverbellies is 92,764 tonnes, which forms 10.4% of demersal finfish catch of India. The landing of silverbellies shows a fluctuating trend over the decades. The average annual landing during 1979-83 was 69,000 t then it moved through a declining phase (1990-2003) with 57,823 t and finally hiked to 1,03,150 t in 2010-2017.

Whitefish: This resource is also called butterfish and known to be depleted/ 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 landing of whitefish is 6,312 tonnes, forms 0.8% of demersal catch. *Lactarius lactarius* is the only species available in this family. Whitefish production in India shows wide fluctuations with a steady fall except spurt in 1983 and 1985. In Karnataka it fluctuated between a lowest 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 888 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. The production indicated an increasing trend from 6346t during 1990-2003 to 7651 t during 2010-2017.

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, Karnataka and Maharashtra.

Fig. 17. Goatfishes fish landing

Dominant species along the east coast of India include *Upneus taenipterus, Upeneus bensasi, Upenues sulphureus, Upeneus sundaicus, Parupenus indicus* and *U. molluccensis.* All India landing of goatfishes during 2016 was 30,276 tonnes, which formed 3.2% of demersal finfish catch of the country. In 2017, the landing decreased and reached 20,306 t (Fig. 17). However, the goat fish landing is showing an increasing trend over the decades with 8, 000 t in 1985-89 to 15, 432 t in 1990-2003 and to a hike of 27, 541 t in 2010-2017.

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, up to 100 m depth and also 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). Compared to the average annual landing during 1985-89, it attained a 2.3 fold increase reaching 11378 t in 2010-2017 (Fig. 18).

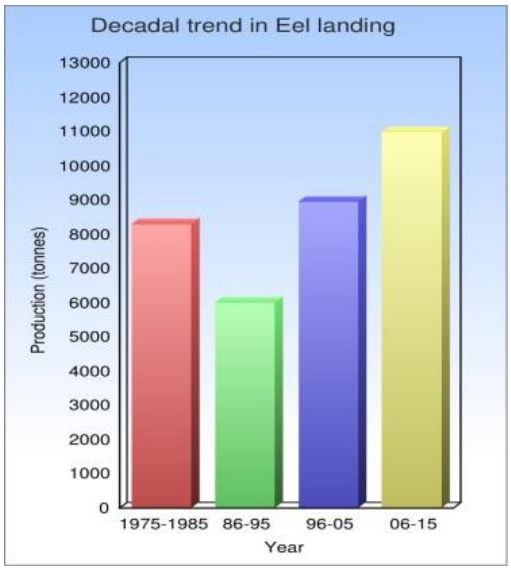


Fig.18. Decadal trend in goatfishes landings

5. Decadal Trend in the landing of Major Demersal Fishes

Rockcods, snapper, pigface bream, threadfin bream, lizard fish, sciaenid and sole are showing an increasing trend in all the four decades and the production has reached an all-time high on the

2006-15 periods. Landings of Sciaenids and threadfin breams has reached new heights with a peak annual average landing of 1, 67,978.4 t and 1, 45,895.6 t respectively during 2006-15. There is 5.1 fold increase in the landing of threadfin breams from 1975-85 period. Landing of shark has exposed a decrease after the 1996-05 period, the fishery had a decrease from 37,404.2 t (1996-05) which was highest annual average recorded among the last four decades, to 23,625.4 t. Skate, ray, halibut, goatfish and eel landing are showing a fluctuating trend during the last four decades. Catfish landing was high during the 1975-85 decade amounting to 53,319.4 t then decreased to 44700.2 t in 1986-95 and in 1996-05, the landings slightly increased to 49,361.2t. However, during 2006-15 the catfish landing reached a peak annual average of 76,923.9 t. In the case of silver pomfret, the peak annual average landing was recorded way back in 1975-85 period amounting to 34,743 t, thereafter showing a declining trend of 24,991.8 and 24,932.5 t in the decades 1986-1995 and 1996-2005 respectively. However, the landing has increased during the 2006-15 to 28,041.5 t (Fig 19).

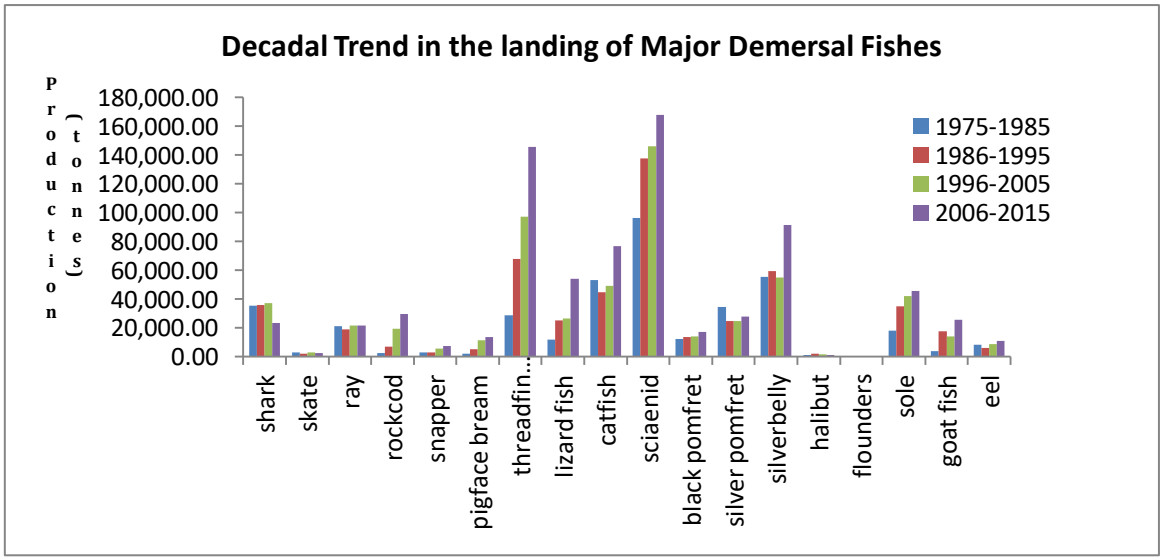


Fig.19. Decadal trend in major demersal fish landings

6. Region-wise distribution of species

Finfishes exploited by trawls belong to 21 major fish groups, which are mostly demersals (Zacharia and Najmudeen, 2017). Each maritime region of India is characterized by dominance of specific demersal fin fish groups. Among northeast coast, sciaenids, catfishes and pomfret are dominant whereas \the southeast coast is characterized by silverbellies, pigface breams. Along the southwest coast of India, threadfin breams and other perches are the important demersal groups while northwest coast is dominated by sciaenids, catfish, pomfrets and threadfin breams (Fig.20).

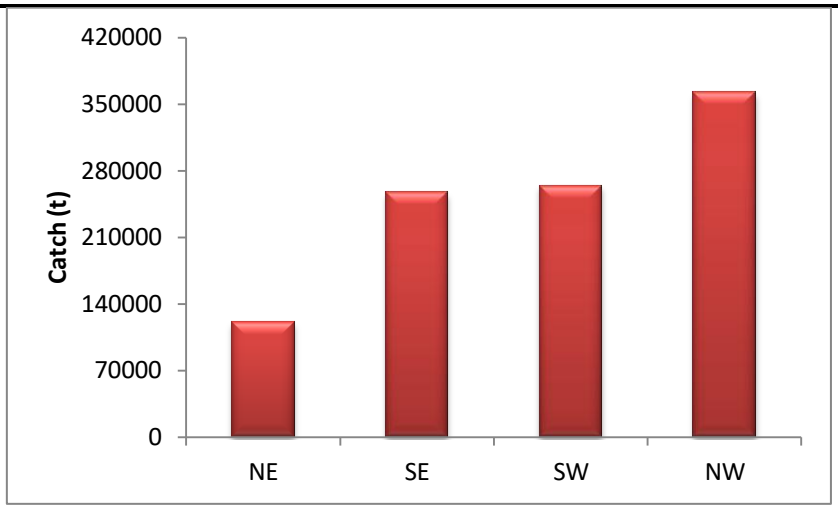


Fig.20. Region-wise landings of demersal finfishes during 2017

7. 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 were 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 Gazatte notification by Govt. of Kerala (Table 4).

***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 4. Minimum Legal Size (MLS) recommendations for the selected demersal species in fishery along the coast of Kerala

No.	Species Name	Common Name	Recommended MLS (cm)
1	*Cynoglossus macrostomus*	Malabar sole	9 TL
2	*Saurida tumbil*	Lizardfish	17 TL
3	*Johnius sina*	Croaker	11 TL
4	*Nemipterus japonicus*	Threadfin bream (Yellow)	12 TL
5	*Lactarius lactarius*	White fish	10 TL
6	*Nemipterus randalli*	Threadfin bream (red)	10 TL
7	*Saurida undosquamis*	Lizardfish	10 TL

8	*Pampus argenteus*	Silver pomfret	13 TL
9	*Parastromateus niger*	Black pomfret	17 TL
10	*Priacanthus hamrur*	Bulls eye	14 TL
11	*Otolithes ruber*	Tiger toothed croaker	17 TL
12	*Epinephelus diacanthus*	Spiny cheek grouper	18 TL
13	*Gymnura poecilura*	Butterfly ray	29 DW

8. Trophic levels of Demersal fishes

Vivekanandan (2011) consolidated available data on the trophic level (the position of each functional group within the food web) of 707 species of pelagic and demersal finfishes and shellfishes collected from FishBase and several other sources. Of these, 417 species are demersal finfishes. The trophic level of demersal finfish ranged from 2.42 (mullets) to 4.40 (Indian halibut) (Table 5). Nearly 50% of the demersals are mid-level carnivores (trophic level: 3.01 to 3.50) and 47% are high-level carnivores (trophic level: 3.51 to 4.00). There are too few demersal omnivores and top predators. Thus 97% of the demersal finfish have resorted to carnivory and occupy a narrow horizontal spread in the food web, consuming mostly small finfishes and crustaceans that are low in trophic level, and form the food of top predators, many of which are large pelagics. Hence, the demersal fish stocks cannot be understood, quantified and managed without a thorough knowledge of their associates in the sea, especially of their prey and predators.

Table 5. Trophic level of commercially important demersal fish groups along the Indian coast

Group	Species* (Number)	Trophic level	Standard error	Coefficient of variation (%)
Mullets	11	2.42	0.157	6.5
Silverbellies	12	3.17	0.163	5.1
Whitefish	1	3.20	0.000	0.0
Pomfrets	2	3.20	0.000	0.0
Minor perches	114	3.20	0.043	1.3
Unicorn cod	1	3.30	0.000	0.0
Soles	18	3.39	0.039	1.2
Flounders	10	3.42	0.050	1.5
Catfishes	14	3.44	0.085	2.5
Sciaenids	32	3.50	0.086	2.5
Threadfin breams	14	3.53	0.008	0.2
Goatfishes	5	3.54	0.150	4.2
Threadfins	7	3.55	0.163	4.6
Rays	28	3.58	0.102	2.8
Pigface breams	14	3.61	0.089	2.5
Eels	9	3.84	0.140	3.6
Snappers	60	3.88	0.055	1.4
Groupers	18	3.90	0.083	2.1
Sharks	42	4.00	0.066	1.7
Lizardfishes	4	4.30	0.196	4.6
Indian halibut	1	4.40	0.000	0.0

* Number of species for which information on diet and/or trophic level estimates are available

Source: Vivekanandan E, Gomathy, S., Thirimilu, P., Meiyappan, M M, Balakumar, S K (2009). Trophic level of fishes occurring along the Indian coast. *J. mar. biol. Ass. India*, 51: 44-51.

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