

## Major groups of Marine (Pelagic) Fisheries in India

1. Indian Oil Sardine
2. Lesser Sardine
3. Anchovy
4. Whitebait
5. Indian Mackerel
6. Tuna
7. Seerfish
8. Ribbonfish
9. Carangids
10. Bombayduck

- 1. Indian oil sardine:** The Indian oil sardine, *Sardinella longiceps* belongs to the family, Clupeidae. This pelagic fish forms schools in coastal waters and is strongly migratory. Of the fifty species of clupeoid fishes inhabiting Indian seas, at least 25 species are found to be commercially important. These clupeoid fishes are of great economic importance as a source of food and oil. Among the several clupeoid fishes, oil sardine is the most abundant and important one. It contributes to nearly 15% of the total marine fish production of India. This fishery is characterized by remarkably wide fluctuations on a seasonal, annual and decadal scale. The success or failure of oil sardine fishery shows a remarkable influence on the socio-economic status of fishermen to a large extent.

### **Distribution**

**Global:** It is distributed in the northern and western parts of Indian Ocean only. It occurs along the coast of Somalia, Kenya, Seychelles, Middle East, Pakistan, India, Malaysia, Indonesia, Philippines and Vietnam. Very large shoals of oil sardines occurs along the Somalia coast.

**India:** It is distributed from Gujarat to Kerala on the west coast and Tamil Nadu, Andhra Pradesh and Orissa coasts on the east coast. Enormous schools, supporting the fisheries strike the Kerala and Karnataka coasts. Though it is available up to 50 m depth, the maximum abundance is found to be within 30 m. The optimum temperature and salinity ranges for distribution and abundance of oil sardine are 27 - 28°C and 22.8 -33.5 ppt respectively. Occasionally, they enter the estuaries along the southwest coast.

**Production trend:** The maximum landing of 3.01 lakh tonnes which formed 33% of the total marine catch was in 1968 and the minimum of 7,412 tonnes which formed 1 % of the total marine catch was in 1956. About 95% of the total oil sardine landings were reported only from the southwest coastal states of Kerala and Karnataka until 1980's. Catch was high in 1989 (2.89 Lakh t) and gradually declined thereafter till 1994 (47,000 t). However, since 1995, it started increasing. Since 1986, while oil sardine fishery declining along the southwest coast, there has been a phenomenal rise in the landings along the southeast coastal states of Tamil Nadu and Andhra Pradesh while in the northeastern states of West Bengal and Orissa, a new fishery has emerged from a position of almost no landings. It is a highly fluctuating fishery, contributing 10 to 20 % of the total marine fish landings of the country with an average of about 200 thousand tonnes.

**Recent production:** Pelagic fishes formed about 55 % of the total marine fish landings in general. Among the pelagic fishes, oil sardine alone contributed as high as 15.18 % of total landing in 2014 and as low as 4.44 % of total landing in 2018.

	2014	2015	2016	2017	2018
Oil Sardine landing (in Lakh tonnes)	5.45	2.67	2.45	2.37	1.55
% of total marine landing	15.18	7.85	6.72	6.19	4.44
Total Marine landing (in Lakh tonnes)	35.9	34.0	36.3	38.3	34.9

(Source: CMFRI, Annual Reports)

**Fishing season:** Fishing season for oil sardine varies from one place to another place. It starts soon after the outbreak of monsoon in June and continues till March - April along southwest coast. Fishing is usually done throughout year except during Mar - May in Kerala, Sep/Oct - Jan in Karnataka and Goa and July - Oct in Andhra Pradesh. Usually juveniles appear during July-August period along the coast and they form a large proportion of the catch during Sep - Dec. However, 1 year and above age groups appear during Jan - Feb.

**Mode of exploitation:** Oil sardine fishery has been exploited by the indigenous craft and gear from very early times. This fishery was exploited by employing Artisanal fishing gears mainly boat seines, beach seines, cast nets and small meshed gill nets were employed for catching oil sardines along the southwest coast till 1970's. This fishery was confined to a narrow coastal belt of 8 to 12 km within the 25 fathom line till 1975. Fishermen started employing larger fishing gears like purse seines in the late 70's and ring seines in late 80's. In south Kerala, oil sardines are mainly caught by the one-boat boat seine 'Thangu Vala' and gill net 'Ayila Vala' and some purse seines. In North Kerala, boat-seine 'Pattan Kolli' is the major gear, followed by the gill net 'Mathichala vala' and the cast net. The chief crafts employed in Kerala are dugout canoes, the bigger 'odam' and the smaller 'vanchi'. Out rigger boats are common crafts in Karnataka coast. In Tamil Nadu, pair trawlers are also operated at 12 -16 m depths in Pamban - Rameshwaram area while ring seines being used in the Palk bay. At present, purse seine fleet operates at 30 - 40 m depth almost throughout the year. Motorized ring seines target small pelagics like oil sardine and mackerel fish in inshore waters during the monsoon season also. Purse seine is the most important gear at present. However, shore seine (Rampani and Vendi) and cast net are the gears commonly used for catching oil sardine.

**Factors affecting fishery sardine:**

1. Periodical migration into offshore waters
2. Heavy natural mortality
3. Availability of the diatoms (*Fragillaria oceanica*, *Coscinodiscus* and *Pleurosigma*)
4. Overfishing
5. El-Nino
6. Water temperature
7. Rainfall
8. 8. Ocean current.

**Size composition:** Commercial fishery comprises mainly of '0' year and '1' year old fishes. Small sized oil sardines of 0 -year class, measuring 70 to 100 mm in length dominate the commercial catches—from August to November. The bigger sized fishes of 100 to 200 mm dominate the catches in the later months during the peak season which generally extends up to January.

**Food and Feeding:** It is predominantly a phytoplankton feeder, feeding mostly on diatoms like *Fragillaria oceanica*, *Coscinodiscus*, *Thalassiothrix* and *Pleurosigma*. However, *F. oceanica* is the most favourite food item. In addition to diatoms, they may also feed on copepods, dinoflagellates, ostracods, larval prawn, larval bivalves, fish eggs and some bluegreen algae. The presence of diatoms, *Fragillaria oceanica* in large numbers indicates the abundance of oil sardine in coastal waters.

**Age at first maturity:** It attains maturity at about the end of the first year at 150 mm size. Maturation is controlled by climatic factors like temperature and intensity of rainfall experienced by the pre-spawners.

**Spawning season:** It grows rapidly during the first few months and matures early within its life span of about two and half years. Just prior to spawning, the oil sardine leaves the inshore waters. It spawns only once a year and breeding season is rather short. Spawning season is prolonged with varying duration. On the west coast, peak spawning occurs during June - Aug, while on the east coast, intense spawning activity is observed during December to February. Juveniles are seen abundantly in the near shore waters during July-September.

**Fecundity:** It is a prolific breeder and liberates about 38,000 -80,000 ova at a time depending upon the age, size and condition of the fish.

**Market:** This fish is in good demand in local and distant markets and the fishery is fully exploited along the southwest coast. On the east coast, demand for local consumption is low and most of the catch is marketed in Kerala. During glut season, they are sun-dried and used for production of poultry feed. Frozen sardine is exported to countries like Japan, USA, Austria, Belgium, Spain, UK, China, Bahrain, Jordan, Kuwait, UAE, Australia, Kenya, New Zealand and SriLanka.

**Utilization:** A major bulk of the catch is disposed off in fresh condition. It also serves as a source for valuable by-products like sardine oil used in several industries and fishmeal for cattle and poultry feed production and as guano.

**Conservation and management:** There is an inverse relationship between the occurrence of oil sardine and Indian mackerel, *Rastrelliger kanagurta*. Destructive fishing practices like using small meshed seines should be effectively controlled by enforcing mesh size regulation (minimum 18 mm), closed season and restricted fishing (June - Sep) besides strict licensing and optimum deployment of fishing units especially ring seines and purse seines. Present coastal fishery scenario demands responsible fishing by all sectors to sustain the fishery as well as ensure the socio-economic well being of the fishermen. Necessary steps should be taken to exploit the offshore grounds to have better catch.

**2. Lesser sardines:** The lesser sardines belong to the families Clupeidae and Dussmieridae. Though lesser sardines rank much lower than the oil sardines, they are of considerable importance. They are shoaling fishes, the longer shoals striking the coastal waters seasonally resulting in quite good catches. They occur commonly in the inshore waters along both the east and west coasts of India. The lesser sardines comprising several species of *Sardinella* other than *S. longiceps* show wide distribution in the tropics and are one of the major pelagic fishery resources of our country. They occur in the landings of all the maritime states. However, they particularly contribute to a lucrative fishery along the southeast and southwest coasts. Of the 15 species of lesser sardines in the Indo-Pacific region, 12 species occur in the Indian waters. They are *Sardinella jussieu* (Tembang), *S. gibbosa*, *S. fimbriata* (Fringe-scale sardine), *S. albello*

(Short-bodied sardine), *Amblygaster sirm* (Spotted sardine / Trenched sardine), *S. dayi*, *S. clupeioides*, (Bleeker smooth belly sardine) *S. melanura* (Black-tipped sardine), *S. sindensis*, *Kowala covala*, *Escualosa thoracata* (White sardine), *Dussumieria acuta* (common sprat / rainbow sardine) and *D. hasseltii*.

### Distribution

**Global:** It is widely distributed along the east coast of Africa, Mauritius, Seychelles, Madagascar, Arabia, India, Malay Archipelago, Australia, Polynesia, Micronesia, Phillipines, China, Taiwan, Pakistan and Sri Lanka. Some of the lesser sardine species may not be represented in these countries.

**India:** They occur along both the east and west coasts. However, catches are abundant in North of Cape comorin along the entire east coast.

**Production trend:** The catch of lesser sardines varied from 19,551 tonnes in 1962 (3.03% of total) to 1,112,117 tonnes in 1975 (7.88% of total) during 1958 -1979. They contributed 2.9 - 7.3% to the total annual marine fish production of the country during 1986-2000; 4.8% during 1996-2000. The east coast contributed 65% during 1986-2000 (average: 67,172 t); West coast - 35% (35,449 t). Tamil Nadu stood first in lesser sardine production (average: 42,263 t, 43%) followed by Kerala (22%); Andhra Pradesh (17%) and Karnataka (6%) in 2004.

**Species composition:** More than one species contribute to the lesser sardine fishery, forming a fishery throughout the year. In the Goa-Karnataka coast, *Sardinella gibbosa*, *S. dayi*, *S. fimbriata* and *S. albello* are abundant. Along the Kerala coast, *S. gibbosa*, *S. sindensis* and *Amblygaster sirm* dominate while *S. clupeioides*, *S. fimbriata*, *S. melanura* and *S. jonesi* occur occasionally. *S. albello* and *S. gibbosa* are dominant in the Palk Bay and the Gulf of Mannar regions while *S. sirm* is common between Vizhinjam and Tuticorin. Along the central east coast, *S. gibbosa*, *S. albella*, *S. dayi*, *S. sirm*, *S. clupeioides*, *S. fimbriata* and *S. gibbosa* are abundant.

### Recent production:

	2014	2015	2016	2017	2018
Lesser Sardine landing (in Lakh tonnes)	2.06	2.56	1.95	2.27	1.81
% of total marine landing	5.74	7.53	5.37	5.93	5.19
Total Marine landing (in Lakh tonnes)	35.9	34.0	36.3	38.3	34.9

(Source: CMFRI, Annual Reports)

**Size composition:** The lesser sardines do not grow to a big size. 0 and 1-year classes mainly sustain the lesser sardine fishery. Total length of the different species forming the fishery ranges from 4 to 20 cm.

**Fishing season:** Lesser sardines form a year round fishery in different regions of the country, but the fishing season, species composition and catch rates vary between and within regions. On the east coast i.e., along West Bengal, Orissa and Andhra Pradesh coast it extends from November to April-May and on the southeast coast of Tamil Nadu and Pondicherry, it is done throughout the year. On the west coast, it is from August to January/February in Kerala; Karnataka -September - November; Goa -September -February; Maharashtra -December and April.

**Mode of exploitation:** Traditional, motorised and mechanised boats are used for catching lesser sardines. Canoes and plank built boats with outboard engines are also operated. Seines (shore seines, boat seines, ring seines and purse seines), gillnets, bag nets and trawl nets are the gears commonly used for catching lesser sardines.

**Food and feeding habits:** Lesser sardines feed on a variety of phytoplankton and zooplankton. Phytoplanktonic organisms include Biddulphia, Coscinodiscus, Thalassiothrix, Fragilaria, Nitschia, Pleurosigma and zooplanktonic organisms include Dinophysis, Peridinium, Caratium, copepods, mysis, Lucifer, larvae of prawns and crabs, fish eggs, Acetes, fish larvae, crustacean larvae and molluscan larvae.

**Spawning season:** The lesser sardine species occurring along the two coasts show considerable variation in their spawning seasons. The spawning period for individual fish is of short duration, but the species as a whole breed over a prolonged period.

**Growth, maturity and spawning:** The lesser sardines exhibit fast growth, short life span (2-3 years) and high natural mortality. Most of the species attain 70% of their maximum length in the first year itself.

**Fecundity:** Fecundity of *Sardinella albello* is 10,000 - 13,000 in fish of 14.6 to 15.5 cm in length; Kowala coval -about 15,000 eggs.

Species	Growth	Age and size at maturity	Spawning season
1. <i>S. jussieu</i>	Max. 18 cm	11 – 12 cm - 1 <sup>st</sup> year	East coast: Off Waltair – Feb-June (Peak: Feb.-April)
2. <i>S. fimbriata</i>	Max. 14 cm	10 – 16 cm varying from region to region	Gulf of Mannar: Dec – Mar Tuticorin: Oct – Nov Malabar coast: Apr - June
3. <i>S. albella</i>	Max. 14 cm	10.5 – 15 cm - 1 <sup>st</sup> year, Fecundity: 10,000-13,000/ 14.5 – 15.5 cm	-
4. <i>S. melanura</i>	20 cm	-	-
5. <i>S. clupeoides</i>	20 cm	-	-
6. <i>Amblygaster sirm</i>	Max.: 25 mm in 1½ years	14 – 15 cm	West coast: Oct – Feb (Peak: Nov – Jan)
7. <i>Kowala coval</i>	12 cm	8 – 11 cm	West coast – Oct - Feb (Peak: Nov-Jan)
8. <i>Dussamieria hassellti</i>	18 cm	12 – 13 cm	Palk Bay and Goa – Mar.- Dec / Dec-March

**Marketing:** They are consumed in the fresh/frozen/dried/salted-dried form. Smaller sized fishes are used for making fish meal for preparation of poultry and fish feed.

**Conservation and management:** Exploitation of this small pelagic fish from the coastal waters is sustainable and they are easily vulnerable to the traditional sector. As no single species is harvested continuously, there is no excess fishing pressure at present on the lesser sardines.

- 3. Anchovy:** Anchovies belong to the family, Engraulidae. They are the small pelagic fishes and constitute one of the most important pelagic resources in the world. In India, anchovies form the artisanal fisheries and a major source of income for the traditional fishers.

#### Distribution

**Global:** Anchovies are distributed in the South Pacific Ocean, Northwest Pacific ocean, Mediterranean and Black sea, Western Central Pacific-Indian Ocean.

**India:** It is widely distributed along both east coast and west coasts of India.

**Production trend:** Anchovy resource contributed an average catch of about 133,000 t during 1991-2000. The species, which constitute the important fisheries, are *Coilia dussumieri*, *Stolephorus spp*, *Thryssa spp.*, *Thryssinna spp.* and *Setipinna spp.* On the west coast of India, Kerala (Avg.: 20000 t; -1998-200 I) is the leading state, followed by Gujarat (Avg: 24000 t; 1998-2001), Maharashtra (17,338 t; 1998 -200 I) and Karnataka (8,340 t; 1998-2001). On the east coast, Tamil Nadu is the leading state with an average of 20,596 t (1997-1999) followed by Andhra Pradesh, and West Bengal. The anchovy production is the least in Orissa (Avg.: 3000 t 1999-2001).

#### Recent production

	2014	2015	2016	2017	2018
Anchony landing (in Lakh tonnes)	-	1.46	1.41	1.45	1.74
% of total marine landing	-	4.29	3.88	3.79	4.99
Total Marine landing (in Lakh tonnes)	35.9	34.0	36.3	38.3	34.9

(Source: CMFRI, Annual Reports)

**Species-wise catch:** In Gujarat, *C. dussumieri* and *Thryssa spp.* constitute the fishery forming on an average 68% and 33% respectively. In Maharashtra, *C. dussumieri* contributes on an average of 79.4%, *Thryssa spp.* 19.6% *Stolephorus spp.* 1%. In Karnataka, *Stolephorus spp.* formed 64% and *Thryssa spp.* contributed 36% to the fishery. The fishery in Kerala too is supported mainly by *Stolephorus spp.*, (83%) and *Thryssa spp.* (17%). On the southeast coast *Stolephorus spp.* (60%), *Thryssa spp.* (35%) and *C. dussumieri* (4%) constituted the fishery in Tamil Nadu, whereas in Andhra Pradesh *Stolephorus spp.* (56%), *Thryssa spp.* (41%) and *C. dussumieri* (3%) form the fishery. On the northeast coast *Stolephorus spp.*, *Setipinna spp.*, *Thryssa spp* and *Coilia spp.* contributed 35, 34, 21 and 10% respectively in Orissa. In West Bengal *Coilia spp.* (51 %), *Setipinna spp.* (29%), *Thryssa spp.* (18%) and *Stolephorus spp.* (2%) constitute the anchovy fishery. More number of species of *Coilia* constituted the fishery in West Bengal and the notable among them are *C. ramacarti*, *C. neglecta* and *C. reynaldi*.

**Mode of exploitation:** Plank built Satpati boat (Maharashtra & Gujarat); Catamarans, small country crafts with or without outboard engines (Andhra Pradesh, Tamil Nadu, Kerala), plank built boat with outboard engines (Kerala and Karanataka) are the crafts commonly employed for exploitation of anchovies. Dol net with mesh size, 5 -25 mm (Maharashtra, Gujarat); Bag net (Orissa and West Bengal), Boat seine, Shore seine and Gillnet (Tamil Nadu, Andhra Pradesh, Kerala), Purse seine (Maharashtra, Goa, Kamataka, Kerala) and the Ring seine (Kerala, Karnataka) are the common gears used for the capture of anchovies.

### **Characteristics of some of the important species of Anchovies:**

**Peruvian anchovy, *Engraulis ringens*:** It is a filter feeder entirely dependent on the phyto and zooplankton. Diatoms alone constitute as much as 98%.

**Japanese anchovy, *Engraulis japonicas*:** It feeds on phytoplankton, viz. diatoms and dinoflagellates and zooplankton viz. copepods, ostracods, cladocerans, amphipods and euphausiids. The crustacean plankton accounts for about 60%.

**Golden anchovy, *Coilia dussumeiri*:** It is a pelagic and largely marine, but enters estuaries and rivers also. It feeds on copepods, ostracods, amphipods, fish and prawn larvae but prefers to feed on ostracods and *Acetes* spp. Spawning season is from January to May. The individual spawns only once in a year. It grows to 22 cm and has short life span of less than two years. Earlier, it was exploited mainly as bycatch in dol net. This species is consumed fresh and sun dried. Dry fish is bartered for rice in equal weight in Gujarat.

**Devis' anchovy, *Encrasicholina devisi*:** The species is widely distributed in Indo-Pacific tropical water 30° N - 24°S. It is the most abundant species among engraulids in India, and constitutes a fishery in Andhra Pradesh, Tamil Nadu, Karnataka and Kerala. The food of *E. devisi* comprised of copepods and other zooplankton. *E. devisi* breed throughout the year with peak during October -November. The species grows at a faster rate and attains the first year growth of about 110 mm. It is an important link in the food chain. It is consumed both fresh as well as sundried. Value added products like anchovy powder, sauce, etc. are prepared. It is also used as bait for hook and line fishery.

***Stolephorus waitei*:** It constitutes a minor fishery in Andhra Pradesh, Tamil Nadu, Karnataka and Kerala.

**Conservation and management:** The overall Maximum Sustainable Yield of all the commercially important species of genera *Coilia*, *Encrasicholina* and *Stolephorus* constituting fisheries in India, other than Orissa and West Bengal is estimated at 2,30,000 t whereas the present yield is about 1, 22, 000 t. During the last decade, the resources became vulnerable to the trawlers also. The impact of changing fishing pattern is the cause of concern in some states. However, they are annually renewable resources and hence their periodical removal is desirable to make full use of the fishery. There is scope to expand the fishing effort for targeting anchovies.

- 4. Whitebait:** They are the small pelagic fishes. Ten species of white baits occur in our seas - *Encrasicholina devisi*, *E. heterolobus*, *E. punctifer* (*Stolephorus buccaneeri*), *Stolephorus andhraensis*, *S. baganensis* (*S. macrops*), *S. commersonii*, *S. dubiosus*, *S. indicus*, *S. insularis* and *S. waitei* (*S. bataviensis*). Dominant species available throughout the coast are *E. devisi*, *S. bataviensis*, *E. punctifer*; *S. commersonii*, *S. indicus* and *S. baganensis*. However, *E. devisi* and *S. bataviensis* constitute the mainstay of the fishery along both coasts and other species occur seasonally. The availability and abundance of all these species indicate inter-annual variations. They are distributed mostly in areas with bottom depths of 10-50 m and indicate diurnal vertical migration. The seasonal movements of whitebaits are directly related to the transport of water masses.

### **Distribution**

**Global:** They are distributed in the Indo-Pacific region.

**India:** They are abundant in southern states like Andhra Pradesh, Tamil Nadu, Kerala and Karnataka. Very little catch is obtained from Maharashtra too.

**Production trends:** They show wide annual fluctuations. The production varied from 33,680 t in 1980 to 1 lakh t in 1988.

### Recent production

	2001	2002	2003	2004	2005	2006
<i>Stolephorus</i> (in tonnes)	44539	44209	41908	49155	27860	32704
% of total pelagic finfish landings	29	36	35	42	2.21	2.19
% of total marine landings	2.0	1.6	1.6	2.0	1.2	1.2

(Source: CMFRI, Annual Reports)

**State-wise contribution:** The landings of white baits from the southern states like Andhra Pradesh, Tamil Nadu, Kerala and Karnataka accounted for 75-97% of the total production of whitebait. Kerala, Tamil Nadu, Karnataka and Andhra Pradesh together contributed nearly 97% of the total production of white baits during the last decade. Kerala stood first (54.2%), followed by Tamil Nadu (19.9%); Andhra Pradesh (12.1%); Karnataka (11.3%); Orissa (1.4%); Goa (0.2%); Maharashtra (0.2%); West Bengal (0.1%) and Gujarat (0.003%) during 1981-2000.

**Mode of exploitation:** Catamarans, small country crafts, shrimp trawler and plank built boat fitted with outboard motors are the crafts commonly used for catching whit baits. Boat seine (cod end mesh, 10 mm), shore seine (cod end mesh 10-20 mm), gill net (Netholi vala) of 15 mm mesh, shrimp trawls (cod end mesh, 15 mm), purse seine (cod end mesh, 14 - 20 mm) and ring seines are the common gears.

**Species composition:** In Karnataka, *E. devisi* (75.6%) dominated the catch during 1995 - 2000. This was followed by *S. waitei* (11.9%), *E. punctifer* (10.9%) and *S. baganensis* (1.3%). Principal gears employed were purse seine (51%) and trawl (47%). In Kerala too, *E. devisi* dominated the catch (48%), followed by *S. waitei* (30%), *S. commersonii* (16%), *S. baganensis* (3%), *E. punctifer* (2%) and *S. andhraensis* (1%). The gearwise catch was ring seine (53%), trawl (32%) and others (15%). However, along south east region i.e, in Tamil Nadu, *S. indicus* (96%) and *S. commersoni* (4%), but in northern areas *E. devisi* (60%), *S. waitei* (20%), *S. commersoni* (15%) and *S. indicus* (5%) supported the fishery. Principal gears used were trawl (36%), non-mechanised gill net (34%), shore seine (17%) and others the rest. A long the northeast coast, the main contribution was from Andhra Pradesh.

**Food and feeding:** Food of *E. devisi*, *S. waitei*, *S. baganensis* and *E. punctifer* mainly comprises of copepods, *Acetes* spp. mysids and other zooplankters.

**Spawning season:** *S. waitei* spawns intermittently throughout the year; *E. devisi* spawns almost throughout the year.

**Fecundity:** Fecundity is around 1700-6790 eggs for *E. devisi* of 60-95 mm and 300- 4800 eggs for *S. waitei* of 80 -120 mm during the course of multiple spawning.

**Utilization:** They are consumed fresh and in dried form. Large species like *S. commersonii* and *S. indicus* possess good demand; but they are seasonal in occurrence and not landed in good quantity.

**Conservation and management:** In the east coast, *S. commersonii* is under high fishing pressure while exploitation of *E. devisi* is at optimum level and *S. indicus* and *S. waitei* are underfished. In the west coast, in Karnataka, *E. devisi* is under high fishing pressure, but *S. waitei* is underfished. In Kerala, *E. devisi* and *S. commersonii* are exploited at optimum level and *S. waitei* is underexploited. As the potential yield of white bait is 2, 40,000 t, good scope is available to increase the present yield. Whitebaits are annually renewable resources and hence their periodic harvest during seasons of abundance is important to make full use of the fishery. Increasing the fishing pressure during the peak seasons of availability may be a practical option to enhance the whitebait production in the country. Since the whitebaits being a non-target species in most of the gears in which it is caught (except the Choodavala operated by ring seine units), the Maximum Sustainable Yield (MSY) and the effort required to obtain the MSY could be decided only in consideration with stock position of other resources caught in the gears.

**5. Indian Mackerel:** The mackerels are shoaling pelagic fishes belonging to the family, Scombridae. It is the second important species after the oil sardine in India. The well-being of the marine fishing industry of India is determined to a large extent by the sustaining yields from the mackerel fishery. The bulk of the mackerel landings are contributed by a single species, *Rastrelliger kanagurta* (Indian mackerel). In addition to this, species such as *R. brachysoma* (Short mackerel) and *R. faughni* (Island mackerel) have also been reported to occur in India. However, their occurrence is very rare.

### **Distribution**

**Global:** It occurs in coastal bays, harbours and deep lagoons in some turbid plankton rich waters. It is widely distributed in the tropical regions of the Indian and Pacific oceans, extending from the African coast to Australia i.e., between Latitude 300 North and 300 South and Longitudes 300 East and 1600 West. But it is only in Indian coast this species is highly exploited.

**India:** It occurs all along the east and west coasts of India from Karwar in the Northwest coast to Calcutta in the Northeast coast in the inshore waters up to 25 m. Dense shoals of Indian mackerel appear regularly from Sep - Mar along the west coast of India from Ratnagiri in the north to Kollam (Quilon) in the south. More than 75% of the total mackerel catch of the country comes from the west coast and the fishery until late 70's was mostly confined to a narrow coastal belt of a width of almost 10 nautical miles.

**Production trend:** It constituted on an average 8.6% to the total marine fish production in the country during 1985 - 2000. During the last decade (1990 -1999), the average annual catch of this species amounted to 0.19 million tonnes. Though distributed all along the Indian coast, the resource supports a fishery of high magnitude along the west coast where it contributed 10.2% of the total marine fish catch during 1985 -2000 whereas the east coast was only 4.9%. Along the west coast, on an average 84.6% of the total landings were made. Along the east coast from where 15.4 % of the catch is realized, Tamil Nadu and Pondicherry dominate. It contributed 6.78% in 2002 to 10% in 2005 % to the total pelagic fish landings in India during 2001 - 2006. Its contribution to the total marine fish production ranged from 3.64 % in 2002 to 5.52% in 2004 during 2001 - 2006.

**Recent production:**

	2014	2015	2016	2017	2018
Anchovy landing (in Lakh tonnes)	2.37	2.38	2.49	2.89	2.84
% of total marine landing	6.60	7.0	6.86	7.55	8.14
Total Marine landing (in Lakh tonnes)	35.9	34.0	36.3	38.3	34.9

(Source: CMFRI, Annual Reports)

**Fishing season:** It is from August to December along the west coast and from December to May (Peak: March -April) along the east coast.

**Mode of exploitation:** Beach seines, boat seines, drift net, gill net and cast net are the common traditional gears and dug-out canoes, canoe boats, catamarans and plank-built boats are the common crafts used for catching Indian Mackerels. However, bulk of the catch is mainly by large seines. Ring seines are very common in Kerala and purse seines in Karnataka and Maharashtra. Ring seines and purse seines together contribute bulk of the total mackerel catch in India. In other states, gill net is the dominant gear. Trawl net is slowly emerging as a main gear.

**Size composition:** The commercial fishery exploits mackerel of 18 cm size which are six months old. West coast catch comprises of size ranging from 110 to 150 mm and east coast from 175 - 215 mm. The major contribution to the commercial catch comes from 0-year class. About 80 - 90% of fish in the commercial catch comes from size below 22 cm.

**Food and feeding:** It is a plankton feeder feeding to a greater extent on small zooplankton (cladocerans, ostracods, larval polychaetes etc.) and comparatively to a lesser extent on the phytoplankton (diatoms). Adult individuals feed on macroplankton such as larval shrimps and fish.

**Size at first maturity:** It is found to be between 190 and 220 mm.

**Spawning season:** They start maturing by around December. They become mature and start spawning by February. Intensive spawning occurs from Apr/May - July. Spawning intensity increases and reaches a peak by May. Peak spawning period coincides with south-west monsoon along the west coast and with north-east monsoon along the east coast.

**Age and growth:** Maximum size recorded is 390 mm.

**Utilization:** It is consumed fresh or in cured conditions. More than half of the mackerel catches are dried with or without salt. Consumption of fresh fish started gaining momentum recently.

**Management:** Even though there is no sign of over exploitation, growth overfishing is bound to occur as fishes below 15 cm size form about half of the catch. Hence, it is necessary to increase mesh size of large seines to 35 mm.

- 6. Tuna:** The tunas also known as the "tunnies" are fishes of the family, Scombridae. They are shoaling pelagic fishes. They constitute one of the economically important marine fisheries resources, but are caught mainly by small scale sector. The meat of tuna both in fresh and processed form is much in demand all over the world. They are tropical and subtropical in their distribution in the world oceans. They commonly occur in the oceanic waters beyond the territorial limits of the fishing nations than in the coastal waters. A few of them are neretic occupying shallow waters and are called coastal tunas. The coastal tunas are cheaper than the

oceanic tunas. Tunas are very popular as one of the best table fishes in western and other eastern countries whereas, in India, tunas are not relished as good as their counterparts like seerfish and mackerel. While comparing to other developed and developing countries involved in tuna fishing, the exploitation of tuna along Indian waters is limited to the coastal neretic zone and remain to be in its infant stage.

### Distribution

**Global:** Tuna is distributed in the tropical and subtropical regions of Pacific Ocean, Indian Ocean and Atlantic Ocean. Japan, Philippines, Indonesia, USA, China, Taiwan, Spain, Korean Republic, France, Mexico, Thailand, Venezuela and Maldives are the leading tuna producing countries in the world. Bulk of the Indian Ocean tuna are caught by Japan, USSR, Taiwan, Korea and other countries.

**India:** Tuna is distributed along the south-west and east coast and Lakshadweep. They are highly abundant in Lakshadweep islands, Goa, Vizhinjam and Ratnagiri coasts.

**Common tuna species:** The commonly occurring tuna species in the fisheries are *Euthynnus affinis* (Little tuna/Kawakawa), *Auxis thazard* (Frigate tuna), *A. rochei* (Bullet tuna), *Katsuwonus pelamis* (Skipjack tuna), *Thunnus tonggol* (Longtail tuna), *T. albacores*, (Yellowfin tuna) and *Sardo orientalis* (Striped bonito, Oriental bonito), *Gymnosarda unicolor* (Dogtooth tuna) and *Thunnus obesus* (Bigeye tuna).

**Production trend:** Tunas of the oceanic region remain underexploited in the Indian EEZ. Among the resources identified, the yellowfin tuna constitutes the major species in all the regions. Bigeye tuna dominates in the equatorial region, while skipjack tuna is abundant in the northwest region. The potential of coastal tuna resources and oceanic tuna resources from the Indian Ocean have been estimated at 2, 35,000 t and 50,000 t respectively. At present, tuna fishing is restricted to near shore waters only. Except the Lakshadweep group of Islands where organized fishery for skipjack tuna takes place, in other regions, there is no organized fishery for tuna. In India, the total annual catch is about 40,000 - 60,000 t, forming about 3.5% of the total pelagic fish production and 2% of the total marine production. Region-wise production indicated that the northwest coast contributed 24.1% south-west 41.2%, Southeast 16.6%, northeast 1%, Andaman-Nicobar Islands 2.5% and Lakshadweep 14.8% of the total tuna landings during 1985-2000. State-wise production indicated that among the maritime states, Kerala contributed 36 % of the total landings, followed by Gujarat 18.1%, Tamil Nadu 11.6%, Maharashtra 5.9%, Karnataka 5.3%, Andhra Pradesh 4.4%, Goa 2.2% and the rest by the Andaman-Nicobar and Lakshadweep islands during 1985 - 2000. Pre-monsoon and monsoon seasons are the productive periods along the southwest coast of India and the post-monsoon period along Maharashtra and Gujarat coasts. Productive periods for tunas in Lakshadweep is December - February and in Andaman - Nicobar islands is March -August.

### Recent production:

	2014	2015	2016	2017	2018
Tuna landing (in Lakh tonnes)	-	0.78	0.92	0.80	1.10
% of total marine landing	-	2.29	2.53	2.09	3.15
Total Marine landing (in Lakh tonnes)	35.9	34.0	36.3	38.3	34.9

(Source: CMFRI, Annual Reports)

**Species composition:** The tuna fishery is mainly dominated by *Euthynnus affinis* (about 50%),

followed by, *Auxis thazard* (16%), *T. albacores* (10%), *Katsuwonus pelamis* (9%), *Thunnus tonggol* (9%), *A. rochei* (3%) and *Sarda orientalis* (3%). *E. affinis* and *A. thazard* are the major species along both the coasts whereas *T. tonggol* and *T. albacares* are along the northwest coast. *Sarda orientalis* support a minor fishery along the southwest coast. *Gymnosarda unicolor* is mainly caught by handlines in Andomans and by pole and line at Lakshadweep.

**Mode of exploitation:** The pole and line with live bait is used in the traditional tuna fishery in the Lakshadweep islands. Principal gears employed are drift gillnets, hook and lines, purse seines, pole and lines and troll lines. Long line gear is employed in the fishery for yellowfin and bigeye tunas in the oceanic waters. Drift gill nets contributed 56%, hooks and lines 16%, pole and line 11 %, purse seine 9% and troll line 8% during 1985-2000. Purse seining has been introduced recently in the Indian Ocean which is the most important gear in this ocean. The live-baits commonly exploited for tuna pole and lining in Lakshadweep islands include the sprats, apogonids, caesionids, artherinids and pomacentrids.

**Fishing season:** Though tunas are caught throughout the year, the peak season extends from October -May for the most of the species. Fishing season of *Auxis thazard* is from August to December; *Sarda orientalis*; August. October; *Gymnosarda unicolor*: January -March; *Euthynnus affinis*: October -May; *Thunnus obesus*: October -May; *Thunnus albacores*: Oct -Jan and Skipjack tuna: December - March.

**Food and feeding:** Tunas are carnivores and the major food items include crustaceans (larvae, juveniles and adults of shrimps and crabs), cephalopods (juveniles and adults), eggs, larvae and juveniles of fishes, whitebaits and other small pelagics.

**Size at first maturity:** The size at first maturity of *E. affinis* is 43 - 44 cm; *A. thazard* - 30 cm; *A. rochei* - 23 cm; *K. pelamis* - 44 - 45 cm.

**Spawning season:** *E. affinis* spawns during the premonsoon (April- May) and Post-monsoon (October -November); *A. thazard* -August -November; *A. rochei* -August - October; Skipjack tuna spawns throughout the year with the peak from January - April. The spawning seasons of yellow fin tuna are January -May; November- April; December -June in different oceanic sectors of the Indian EEZ.

**Age and Growth:**

## Age and Growth

	Age and growth	Maximum size	Fecundity
1. <i>Thunnus orientalis</i> (Oriental blue)	830 mm – 4 years old 1720 mm – 8 years old 2300–2500 mm - 9 years old	Upto 3000 mm and 260 kg	Upto 10 million
2. <i>Thunnus alalunga</i>	650, 750, 830, 900, 980 1030 (3 - 8 years)	1280 mm; 93 lb	0.8 to 2.6 million
3. <i>Thunnus obesus</i>	9-10 years old – 2364 mm; 435 lb	2364 mm; 435 lb	2.9 to 6.3 million / 39-107 kg
4. <i>Thunnus albacares</i>	7.5 lb in 18 months 150 lb in 4 <sup>th</sup> year	1710 mm	2.37 – 8.59 million / 47-88 kg
5. <i>Thunnus tongol</i>	-	1050 mm	-
6. <i>Sarda orientalis</i>	-	800 mm	0.24 – 1.15 million
7. <i>Gymnosarda unicolor</i>	-	240 mm	-
8. <i>Katsuwonus pelamis</i>	410 mm / 1 year; 690 mm / 2 years; 790 mm / 3 years; 820 mm / 4 years	871- 880 mm (male); 721 – 773 mm (female)	0.15 million (418 mm) – 1.97 million (703 mm)
9. <i>Euthynnus affinis</i>	-	870 mm; 19 lb	0.79 - 2.5 million (418 mm)

### Factors affecting tuna fishery:

1. Temperature
2. Current velocity
3. Food availability

**Utilization:** In general, about 73% of the total tuna landed are iced and marketed fresh for consumption. 10% are used for Masmin production; Masmin is exported to Sri Lanka, Malaysia and Singapore. 9 % are frozen, chilled and exported chiefly to the Gulf countries. Yellowfin tuna, skipjack tuna and bigeye tuna are the main tuna species exported as frozen tuna. 4% of them are used for canning; 3% are salt dried for internal market.

**Conservation and management:** The use of improved gear and mechanisation resulted in the increase in production of bullet tuna (*A. rochei*) from southwest coast, longfin tuna (*T. tonggol*) and young yellowfin tuna (*T. albacares*) along the northwest coast. Similarly, strategy should be adopted in other parts of Indian coast also. However, mostly tuna fishing is done only in the inshore region and there are no well organised tuna fisheries. Hence, most of the tuna landed are of small species and juveniles. The major resources are exploited by foreign fleets. Hence, it is necessary to utilise the deep sea oceanic resource by using purse seine.

7. **Seerfish:** Seerfishes or Spanish-mackerels (Family: Scombridae) are one of the commercially important marine shoaling pelagic finfish resources of India of high commercial value. Some of the species grow to very large size. The fishery is sustained by four species such as the king seer (*Scomberomorus commerson*), the spotted seer (*S. guttatus*), the streaked seer (*S. lineolatus*) and

the wahoo (*Acanthocybium solandri*). Of these, the first two species are more common than the last two species. They usually hunt solitary and swim in shallow water along coastal slopes. They are known to undertake lengthy long shore migrations, but permanent resident populations also seem to exist.

### Distribution

**Global:** It is distributed in Red sea, east coast of Africa, India, Srilanka, Burma, Malaya to Australia, Fiji and Western Pacific Ocean along Sunda archipelago, Thailand, Phillipines, Taiwan and Japan.

**India:** It is distributed along the east and west coasts and in the Andaman and Laccadive islands. King seer is dominant along the mid-eastern (Orissa, Andhra Pradesh), southeastern (Tamil Nadu), south-western (Kerala) and mid-western (Karnataka, Goa) coasts. The spotted seer is dominant along north-east coast (West Bengal) and northwest coast (Maharashtra, Gujarat).

**Production trend:** The potential of seer fish resources has been estimated as 50,000 tonnes. The average annual catch was 14,954 t during 1990-99. Along the east coast, Tamil Nadu stood first in production, contributing 38%, followed by Andhra Pradesh (35%), Orissa (16%), West Bengal (6%), Andamans (4%) and Pondicherry (1%). Along the west coast, Gujarat contributed 40%, followed by Maharashtra (25%), Kerala (20%), Karnataka (7%), Goa (6%) and Lakshadweep (0.3%). King seer contributed 62.8% and spotted seer, 36.6% during 1995-1999. In 2000, production was 50,376 t, which formed just 1.85% of the total marine fish production.

### Recent production

	2014	2015	2016	2017	2018
Seerfish landing (in tonnes)	-	56104	55011	48675	45185
% of total marine landing	-	1.65	1.52	1.23	1.29
Total Marine landing (in Lakh tonnes)	35.9	34.0	36.3	38.3	34.9

(Source: CMFRI, Annual Reports)

### Species composition

*Scomberomorus commerson*,  
*Scomberomorus guttatus*,  
*Scomberomorus lineolatus*,  
*Acanthocybium solandri*,

**Size composition:** Mean size of king seer was 40.6 cm. and 39 cm for spotted seer during 1996-2000.

**Fishing season:** Fishing season is influenced by the monsoons along both the coasts. Along the west coast, the season is from October to May with a peak during November -December. In Tamil Nadu, the season is from March -October while it is February to May in Andhra Pradesh.

**Mode of exploitation:** Gill net (major gear); trawls, boat seines, shore seines and purse seines are the gears commonly used for catching seer fish. Owing to their high unit value and economic returns, they support artisanal fisheries and are a major source of income for gill net and hook and line fishermen of the country. In recent years, they are also caught in appreciable quantities

by trawl from the deeper waters, enhancing the financial returns to the boat owners.

**Food and feeding:** They are carnivorous and predominantly piscivorous. They occasionally feed on prawns, squids and cuttlefishes. The piscivorous tendency is more pronounced in larger fishes. They prefer sardines and whitebaits.

**Minimum size at first maturity:** The minimum size at first maturity in *S. guttatus* is 480-520 mm. *S. commerson*, *S. guttatus* and *S. lineolatus* mature at 750 mm, 405 and 700 mm in length respectively.

**Fecundity:**

*S. commerson*: 0.70 -3.5 million /2- 5 years

*S. guttatus*: 0.56 -2.1 million /2 -4 years

*S. lineolatus*: 0.39 -1.1 million /2 -4 years

**Spawning season:** All the three species, the king seer, streaked seer and spotted seer have a protracted spawning season that extends from January - August with a peak in April -May in the Indian waters.

**Age and growth:** The king seer grows very rapidly during the first year of its life reaching an average size of 93 cm and attains 122 cm, 131 cm, 135 cm and 136 cm at the end of 2nd, 3rd, 4th and 5th year. The length at ages of one to four years for spotted seer is 51 cm, 65 cm, 69 cm and 74 cm respectively. The total life span in the fishery is 5+ years for king seer and 4+ years for spotted seer.

**Marketing and utilization:** They are very much in demand both in fresh and cured condition. They fetch very high price, ranging from Rs. 80 - 200 per kg. They are consumed, mostly in fresh form. Smaller fishes are easily handled and sold in the local markets; larger fishes are transported in ice to bigger cities. A part of the catch is exported in the form of frozen fish.

**Conservation and management:** The stock size of king seer has been reduced over a period of time due to continuous increase in exploitation by different gears. Similarly, the stock of spotted seer has also been reduced to some extent, but not as king seer. Gill nets and multi-day trawls at present heavily exploit seerfish stocks and there is need to reduce the effort of these gears. It is necessary to increase the minimum size at first capture by increasing the mesh size to a minimum of 130 mm to avoid recruitment over fishing. The hooks and line and large meshed gill nets target mostly larger sized seerfishes and other pelagics like tunas, barracudas and sharks. These gears need to be encouraged for sustainable catch in the inshore fishing grounds. Operation of these gears needs to be extended to deeper waters.

**8. Ribbonfish:** The ribbonfishes (Hair-tailor Cutlass) are shoaling pelagic fishes. They belong to the family, Trichiuridae. They are primarily marine, but occur in the estuaries too. This group is comprised of *Trichiurus lepturus* (Grey ribbonfish), *T. russelli* (Short tailed hair tail), *T. gangeticus* (Ganges hairtail), *Lepturacanthus savala* (Silver ribbonfish), *L. pantuli* (Coromandel hairtail), *Eupleurogrammus intermedius*, *E. muticus* (Small head hairtail) and *E. glossodos* (Long tooth hairtail). Of these species, *Trichiurus lepturus* is the most common ribbonfish species. They are caught almost all along the Indian coast. They form an exclusive fishery of considerable importance in Andhra Pradesh, Tamilnadu and Kerala.

## Distribution

**Global:** They are distributed in the Atlantic and Indo-Pacific regions.

**India:** They are distributed all along the coast with abundance in the northwest and central east coasts.

**Production trend:** The ribbonfish extends all along the coasts of India with varying intensity in the different maritime states. The ribbon fish landing in India has shown an increasing trend with considerable annual fluctuations. On an average, it formed 4.4% of the total fish landings and 7% of the pelagic landings during 1956-2000. They are exploited all along the coast of India and the bulk of the landings during 1956-2000 came from Gujarat and Maharashtra, followed by Kerala, Tamil Nadu and Andhra Pradesh. The contribution by other states was less than 10%. In the nineties, nearly 39% of the ribbonfish landings came from Gujarat, followed by Maharashtra (27%) and Kerala (11%). The contributions by other states were much less. Juveniles of *T. lepturus* measuring less than 30 cm are normally discarded, since there is no market value. Plenty of juveniles are landed along with the trash fishes by the trawlers during the recruitment season.

## Recent production

	2014	2015	2016	2017	2018
Ribbonfish landing (in Lakh tonnes)	2.09	1.77	2.17	2.39	1.94
% of total marine landing	5.82	5.21	5.98	6.24	5.56
Total Marine landing (in Lakh tonnes)	35.9	34.0	36.3	38.3	34.9

(Source: CMFRI, Annual Reports)

**Species composition:** Of the several species of ribbon fishes, *Trichiurus lepturus* is the dominant species forming more than 95% of the total ribbon fish landings. Other species are caught in less numbers. These are mostly reported from northeast coast (Andhra Pradesh and Orissa) where they together constitute about 14% of the ribbonfish catch. The contribution of species other than *Trichiurus lepturus* is only 5% of the total ribbonfish production in India.

**Size composition:** The maximum size of ribbon fishes ranges from 50 cm (*T. gangeticus*) to 234 cm (*T. lepturus*), grows to larger size and fish measuring > 1 m total length are common along the Indian coast. Fishes of one year old and above dominate in the fishery along the west coast and their mean length ranges from 58 to 69 cm. In the east coast, the fishery depends on 0-year class fish having the mean length varying from 42 to 50 cm.

**Fishing season:** The ribbonfishes move to the inshore areas of the continental shelf during monsoon, remain close to the shore in areas less than 60 m depth in the post monsoon period and contribute abundantly to the fishery. This migration is mainly for feeding purposes. The place where the continental shelf is narrow and gradient is steep the stock becomes unavailable to the fishery leading to an off-season. The place where the continental shelf is narrow and gradient is steep the stock becomes, unavailable to the fishery leading to an off-season. If the continental shelf is wider and gradient is low, it always remains in the fishing ground and is accessible to the fishing gears throughout the year. Hence, ribbon fishes are landed round the year in both the coasts. In southeast coast and Gulf of Mannar, the shelf is narrow, leading to a seasonal fishery, restricted to a few months in the monsoon and post monsoon periods. The ribbon fish has a prolonged fishing season, extending from July to April but the peak varies from area to area. In West Bengal, it is from November -February whereas in Orissa, July to November. In Andhrapradesh, the season is from August to December while it is from November to January in

Tamilnadu and September to December in Maharashtra. The peak production in the national level is generally from October –December.

**Mode of exploitation:** The principal gear is trawl net. This gear landed 74% of the catch during 1991-2000. The other gears are dolnet, drift gill net, boat seine, shore seine, etc. The mechanized sector (trawl net, gill net, purse seine and others) contributed about 85% and the rest is from the non-mechanised and outboard-motorized sectors.

**Food and feeding:** All the species of ribbonfishes are highly carnivorous, predominantly piscivorous and occasionally cannibalistic too. They are voracious feeders, feeding both during day and night. They prefer small and medium size fishes, prawns and shrimps.

**Size at first maturity:** The size at first maturity of the most common species, *Trichiurus lepturus* is 46 -47 cm when it is about 1 year old. It is 30cm in *E. intermedius* and about 43 cm in *E. muticus*.

**Spawning:** *T. lepturus* has a prolonged spawning in some areas. On the west coast, the peak spawning is in April - June. In the east coast, it spawns during February to June with peak in May. Another short duration spawning also has been reported in November -December.

**Fecundity:** *T. lepturus* is found to lay up to 1, 34,000 ova depending on the size and age. It is from 4000 (42 cm) to 16,000 (60 cm). The fecundity of *E. intermedius* varies from 2349 (40.9 cm) to 9950 (45cm). In *E. muticus*, it is from 1327 (49.5cm) to 2087 (55.lcm) and in *L. savala* it varies from 9178 (37 cm) to 17347 (54 cm).

**Utilization:** In India, three decades ago, they were low priced fishes preferred only by the poor. Large fishes were consumed fresh and transported even to the interior markets, but the smaller ones, in excess of the local requirements, were usually sun-dried on the beach. But at present, they are significantly important in the export market. Currently, large quantities of ribbon fishes are exported in the frozen form to China, Japan and other Southeast Asian countries. During 2000-01, it formed 30% of the total seafood exported and 63% of total frozen finfish exported. This shows that the ribbon fish resource plays a key role in the marine product export of India. Only undamaged fresh fish are considered for export. Ribbonfish formed 56% of total frozen fish export (quantitywise) - 81720 tonnes; valuewise - 35% (Rs. 638.7 crores). Ribbonfish stands first position in the export of frozen fish -both valuewise and quantitywise. The local people consume large sized fresh fish while the undersized are sun-dried. A portion of the dried fish is sold in the interior markets and the rest is exported to Southeast Asian countries like Sri Lanka, Malaysia, Singapore, Thailand, etc. The under-sized fish brought ashore goes with the trash and are utilized in fishmeal production.

**Conservation and management:** In a multispecies fishery, it is impractical to regulate the exploitation of a single resource like the ribbon fishes. The ribbonfish landings have been showing annual fluctuations but still it has been maintaining an increasing trend of slightly higher-magnitude in recent years. This is due to resource abundance on one hand and increased exploitation on the other. The export market has paved the way for targeted fishing of this resource recently leading to certain degree of over exploitation in major centres, especially along the east coast. It is necessary to control the exploitation during the period of abundance through various regulatory measures.

**9. Carangids:** The carangid fishes in general include horse mackerels, round scads, queen fishes, trevallies, leatherjackets and pompanos. They belong to the family, Carangidae. They have

emerged as one of the important resources especially in the mechanised sector but also exploited by motorized and non-motorised sector. Carangid fishes in India is represented mainly by 36 species (21 genera) such as *Alectis indicus* (Indian thread-fin trevally), *A. ciliaris* (Redfin trevally), *Alepes djedaba* (Djedaba trevally), *A. para* (Golden scad), *Alepes kalla* (Trevally), *Atropus atropus* (Kuwest trevally), *Atule mate* (One-fin let scad), *Caranx sexfasciatus* (Dusky trevally), *C. carangus* (Black-tailed trevally), *C. ignobilis* (Yellowfin trevally), *C. melampygus* (Bluefin trevally), *C. para*, *Coryphaena hippurus* (Dolphinfish), *Carangoides armatus* (Longfin trevally), *C. malabaricus* (Malabar trevally), *C. oblongus* (Coach-whip trevally), *C. chrysophrys* (Long-nose trevally), *C. ferdau* (Ferdau's cavalla), *Decapterus russellii* (Round-scad), *D. kurroides* (Scad), *D. dayi* (Day's scad), *Elegatis bipinnulata* (Rainbow runner), *Megalaspis cordyla* (Horse mackerel), *Parastromateus niger* (Black pomfret), *Rachycentron canadus* (Black kingfish), *Scomberoides lysan* (Talang leather-skin), *S. commersonianus* (Talang queen fish), *S. tala* (Deep queenfish), *S. tal* (Slender queenfish), *Selar hoops* (Banded scad), *S. crumenophthalmus* (Bigeye scad), *Seriolina nigrofasciata* (Black-banded kingfish), *Selaroides leptolepis* (Yellow - strip trevally), *Trachinotus blochii* (Sub-nose pompano) and *T. botla* (Russel's pompano). Other species occur in stray catches.

### Distribution

**Global:** They are distributed in the warm waters of Indo-Pacific regions and Atlantic Ocean.

**India:** They occur along both the east and west coasts of India. However, they are highly abundant in southern most states like Tamil Nadu and Kerala. They are confined in their distribution to shallow waters upto about 10 fathoms depth, where they breed.

**Production trend:** This group stood 9th position with a production of 1.11 lakh tonnes, constituting 4.1 % of total marine fish production in India during 2000. Similarly, it ranked fourth among the pelagic fishes. Kerala contributed the highest (40.2%), followed by Tamil Nadu (16.5%), Karnataka (12.5%), AndhraPradesh (7.2%), Gujarat (6.4%), Goa (5.2%), Orissa (1.2%), Pondicherry (0.9%), West Bengal (0.6%), Andaman and Nicobar Islands (0.5%) and Lakshadweep (0.1%) during 1964 - 2000. Among the four major groups, the most dominant is the scads forming about 40%, followed by the horse mackerel 13%, leather jackets 5% and the rest 42% by other carangids during 1983 -2000.

### Recent production

	2014	2015	2016	2017	2018
Carangid landing (in Lakh tonnes)	2.10	2.43	2.46	2.96	3.20
% of total marine landing	5.85	7.15	6.78	7.73	9.17
Total Marine landing (in Lakh tonnes)	35.9	34.0	36.3	38.3	34.9

(Source: CMFRI, Annual Reports)

**Species composition:** In general, the small sized scads such as *Decapterus spp*, Horse mackerel, *M. cordyla* and bigeye scad, *S. crumenophthalmus* constitute a fishery all along the Indian coast. The species composition in the catch depends on the selective properties of the gears employed. *Decapterus dayi* (43.5%) dominated in the trawl catch. This was followed by *D. macrosoma* (6.7%), *Selar crumenophthalmus* (8.9%), Horse mackerel, *M. cordyla* (6.9%), trevally *Caranx para* (9.8%), *C. carangus* (3.6%), *Selaroides leptolepis* (1.5%) and the remaining 19.1% is constituted by a number of other species. *Megalaspis cordyla* (37.3%) dominated in the gill net landings followed by *Carangoides gymnostethus* (6.2%), *Caranx sexfasciatus* (4%),

*Scomberoides spp.* (8.1%), *Elagatis bipinnulata* (3.1%), *S. crumenophthalmus* (2.8%), *Scomberoides tala* (1.7%), *Alepes djedaba* (0.7%) and the rest 36.1 % by other species collectively. The purse seine landed very few species of carangids and in that *A. djedaba* was the dominant species (42.7%) followed by *C. para* (16%), *D. macrosoma* (16%) and *M. cordyla* (2.4). More number of species occur at Tuticorin due to the unique biodiversity supported by 21 coral islands in the Gulf of Mannar.

**Mode of exploitation:** Carangids are caught as by catch along with other fishes in the gears such as Trawls, drift gill nets, bottom set gillnets, hooks & line, purse seine, ring seine, shore seine, boat seine and bag nets. However, the trawls, gill nets, hooks & line, purse seine and boat seine exploit the carangids more effectively than the other gears. This group is exploited mainly by mechanized sector rather than motorized and non-motorised sector.

**Food and feeding:** They are piscivorous feeding mostly on fishes like anchovies, sardines, *Thrissocles spp.*, *Apogon spp.*, silver bellies and ribbon fish among fishes, squids' and cuttlefishes among the molluscs and prawns and crabs among the crustaceans. The young ones feed more on prawns, squids and anchovies and the adult mostly on fishes, prawns, crabs and molluscs.

**Age and growth:** Almost all the species exhibit faster growth and have a short life span varying from 2 to 6.6 years. Small growing species like *Selaroides leptolepis* attain a maximum of 185 mm where as queen fishes and jacks grow to 1 - 2 m. The smaller species usually occur in large schools in shallow waters. Owing to their faster growth, prolonged spawning and continued recruitment, these species are able to withstand the higher fishing pressure prevailing at present.

**Conservation and management:** Many carangid species form only a bycatch in almost all the gears except in small meshed drift gill nets, boat seine and shore seine. The landings by these gears are negligible. Hence, it is difficult to propose any specific regulatory measures exclusively for judicious exploitation of carangid resource. Fishery is sustained by many fast growing species with short life span and that provides them better scope to compete with other resources in the process of species succession. The study on some of the carangids suggests that there is scope for further increase in carangid production in the future.

**10. Bombay-Duck:** The Bombay-Duck, *Harpadon nehereus* belongs to the family, Harpadontidae. It is supported by this single species only. It forms a commercial fishery in the northwest along Gujarat and Maharashtra coast; also available in northeast coasts of India. It exerts a pronounced influence on the livelihood of men and women engaged in this labour intensive sector in Maharashtra and Gujarat.

#### **Distribution**

**Global:** It is distributed along Tanzania to China coast; India, Pakistan, East Pakistan, Burma and straits of Malacca coasts.

**India:** It is discontinuously distributed along the Indian coasts.

**Discontinuous distribution:** Bombay duck occurs in large quantities on the west coast of India from Ratnagiri in the south to Jaffrabad in the north in the Gulf of Cambay. On the east coast, it is taken in small numbers north of Chennai and along the Andhra coast. But there is a good Bombay-duck fishery exists in the estuaries of the rivers in Orissa and West Bengal.

**Production trend:** It is abundant along the northwest coast of India contributing around 90% of all India landings of this resource followed by West Bengal and other states. This species

contributes about 5% of all India marine fish landings. The Bombay duck catch ranged from 51, 570 (1972) to 1, 26, 044 t (1979) during 1958 -1979 constituting 5.02% to 14.01%. The present average annual landing has been estimated at 1.1 lakh tonnes by traditional and industrial sector along the northwest (88%) and northeast (12%) coasts of India.

### Recent production

	2014	2015	2016	2017	2018
Bombayduck landing (in Lakh tonnes)	-	1.10	1.45	1.45	1.13
% of total marine landing	-	3.24	3.99	3.79	3.24
Total Marine landing (in Lakh tonnes)	35.9	34.0	36.3	38.3	34.9

(Source: CMFRI, Annual Reports)

**Size composition:** Larger and older fishes are usually scarce in commercial catches. Fishes ranging from 30-330 mm, in total length support the fishery. Indeterminate and immature fish below total length of 208 mm constitute seventy percent of the landings.

**Mode of exploitation:** Stationary bag net / fixed bag net is the principal gear used for the capture of Bombay- Duck. This gear is known as dol in Gujarat and Maharashtra and as beenjal/ behundijal or thorjal in West Bengal. Boat seines are used on the Andhra -Orissa Coasts.

**Food and feeding:** They are piscivorous and to some extent cannibalistic. They feed on the juveniles of their own species, other fishes and non-penaeid prawns. The crustaceans like *Acetes indicus* and *Palaemon tenuipes* and fishes like *Coilia dussumieri*. *Polynemus* species and *Heptadore typus* form the main constituents of diet.

**Minimum size at maturity:** Minimum size at maturity in the female is between 200 -240 mm. They normally attain maturity at the end of second year.

**Spawning:** It is a continuous spawner but the individuals are out of phase with each other. However, two peak spawning periods, May-July and November-December commonly occur.

**Fecundity:** It ranges from 15,000 to 1, 50,000 based on the size and age.

**Utilization:** The catches are sold fresh. As the yield is low in these days, commercial drying on bamboo scaffoldings which was very common in the past, does not take place now. It is also a valuable export item in dried or laminated form. Fresh extracts have considerable medicinal properties. It is a highly perishable fish due to high water content. Hence, it has to be disposed off quickly if it is to be consumed fresh.

**Conservation and management:** The area of production (offshore) and area of harvest (coastal water) differs. This renders projection of total availability complicated not only by the mobility of the species but also by the reaction of the species to coastal environmental factors and intensity of fishing effort. Therefore, the fluctuations in yield are likely to be a reflection of changes in the 'catchability'. The Bombay- duck has been exploited with a mixture of success and failure in the past. Large- scale landings of indeterminate and immature fish have been a source of concern since long. Hence, it is necessary to regulate the mesh size.