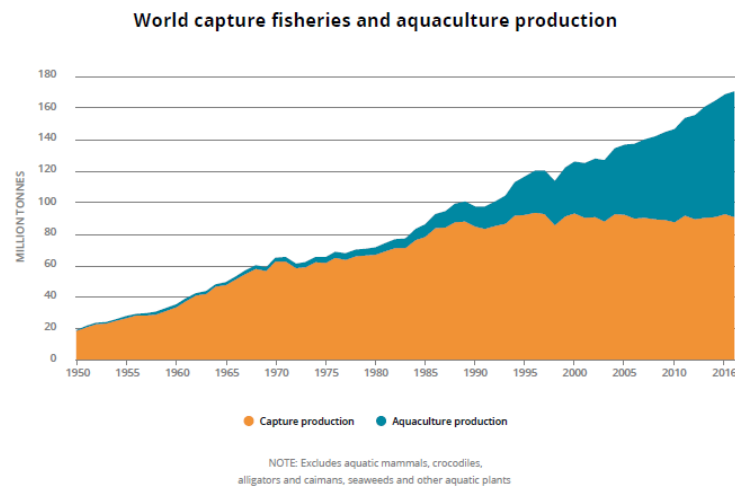


Major Cultivable Demersal Fishes and their Biology

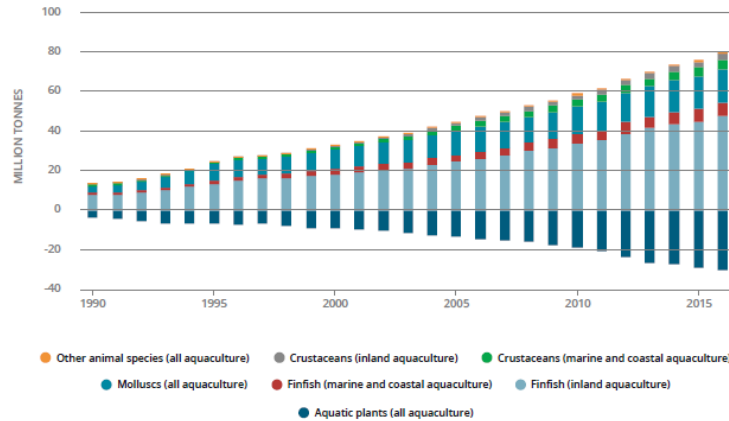
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Global fish production peaked at about 171 million tonnes in 2016, with aquaculture representing 47 percent of the total (and 53 percent, if non-food uses (including reduction to fishmeal and fish oil are excluded). Since the late 1980s capture fishery production has been relatively static and aquaculture has been responsible for the continuing impressive growth in the supply of fish for human consumption. (SOFIA, 2018)

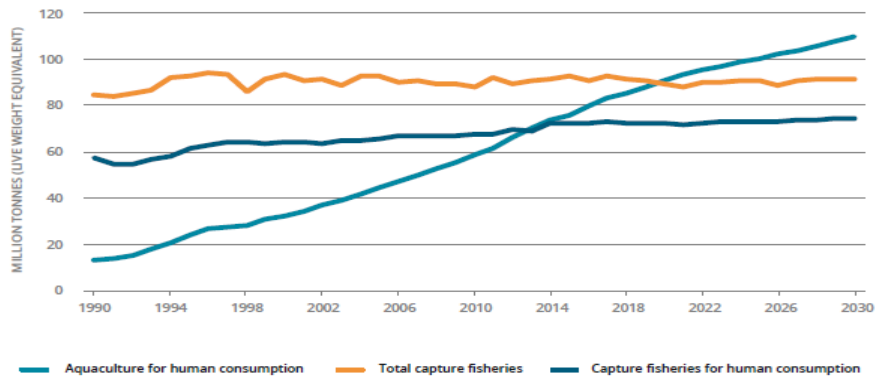


World aquaculture of food fish and aquatic plants, 1990-2016



With 5.8 percent annual growth rate during the period 2001–2016, aquaculture continues to grow faster than other major food production sectors, but it no longer enjoys the high annual growth rates experienced in the 1980s and 1990s. Also, the disparity in the level of sectoral development and uneven production distribution remain great among the countries within the regions and across the world.

Global capture fisheries and aquaculture production, 1990–2030

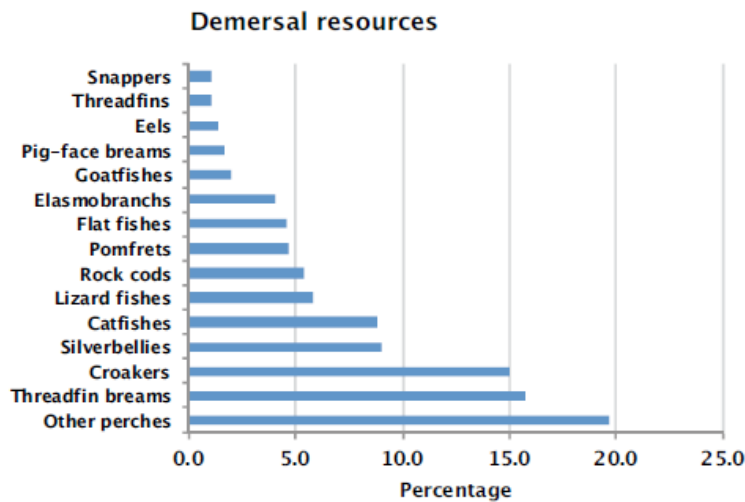


On the export front, frozen fish, the second largest export item, contributed 25.64% in quantity and 10.35% in earnings. However, the unit value realisation decreased to \$ 2.08 a kg in 2017-18 from \$ 2.27 in 2016-17. (MPEDA, 2019).

Fisheries is an important sector in India. It provides employment to millions of people and contributes to food security of the country. With a coastline of over 8,000 km, an Exclusive Economic Zone (EEZ) of over 2 million sq km, and with extensive freshwater resources, fisheries play a vital role. The gross value addition of the fisheries and aquaculture sector during 2016-17 was Rs. 1,33,492 Crores which is about 0.96% of the National Gross Value Added (GVA) and 5.37% to the agricultural GVA (2016-17). During the year 2017-18, the country has exported 13,77,244 tonnes fish and fisheries products worth Rs. 45106.89 crore (7.08 billion US \$). Presently India is the third largest fish producing and second largest aquaculture nation in the world after China. The total fish production during 2017-18 is registered at 10.8 million metric tonnes (MMT). The marine fishery potential in the Indian waters have been estimated at 5.31 MMT constituting about 43.3% demersal, 49.5% pelagic and 4.3% oceanic groups. Marine fisheries contributes to food security and provides direct employment to over 1.5 m fisher people besides others indirectly dependent on the sector. There are 3,432 marine fishing villages and 1,537 notified fish landing centres in 9 maritime states and 2 union territories. 2016.

Cage culture systems employed by farmers are currently as diverse as the number of species currently being raised, varying from traditional family-owned and operated cage farming operations (typical of most Asian countries) to modern commercial large-scale salmon and trout cage farming operations in northern Europe and the America. Commercial cage culture has been mainly restricted to the culture of higher-value (in marketing terms) compound-feed-fed finfish species, including salmon (Atlantic salmon, coho salmon

and Chinook salmon), most major marine and freshwater carnivorous fish species (including Japanese amberjack, red seabream, yellow croaker, European seabass, gilthead seabream, cobia, Rainbow trout, Mandarin fish, snakehead) and an ever increasing proportion of omnivorous freshwater fish species (including Chinese carps, tilapia, Colossoma, and catfish). However in southeast Asian countries, marine species being cultured are groupers and snappers. Looking at the demersal fish landings of India during 2018-19, we can see that perches form the dominant group; of this rockcods form over 5 percent, snappers 2 percent.



Groupers

This group is abundant in the rocky grounds off the South west coast and south east coast of India and is exploited by, hooks and lines, traps and gill nets. All India landings of perches is 4.27 lakh tonnes. Around 42 species of groupers have been reported from different parts of India. Family Serranidae includes *Epinephelus malabaricus* (Malabar grouper), *E.tauvina* (Greasy grouper), *E.bleekeri* (Dusky-tail grouper), *E. areolatus* (Areolate grouper), *E. diacanthus* (Spring cheek grouper/ six-bandedreef cod), *E. epistictus* (Broken-line grouper), *E.fasciatus* (Red banded

grouper), *E.flavocaeruleus* (Blue and yellow reef cod), *E.latifasciatus* (Banded grouper), *E.morrhua* (Banded cheek reef cod), *E.undulosus* (Brown-lined reef cod), *E.merra* (Wire netting reef cod), *E.fuscoguttatus* (Brown marbled grouper), *E.chlorostigma* (Brown spotted grouper), *Cephalopholis sonnerati* (Red coral cod) and *C.boenack* (Blue-lined seabass).

a. Species cultured

A diversity of grouper species are cultured, but only a few are produced in hatcheries to any significant extent. *Cromileptes altivelis*, *Epinephelus fuscoguttatus*, *E. coioides*, *E. malabaricus*, *E. akaara*, *E. lanceolatus*, *E. tukula*, *E. areolatus*, *E. tauvina* and *E. polyphkadion* are reported (Rimmer, Williams and Phillips, 2000; Rimmer, Mc Bride and Williams, 2004) from hatcheries around the region and are expected to form the mainstay of grouper production in the future. Orange spotted grouper (*E. coioides*), greasy grouper (*E. tauvina*), Malabar grouper (*E. malabaricus*) and duskytail grouper (*E. bleekeri*) are cultured in cages in Myanmar using fry and juveniles caught from the wild. Most grouper grow out is conducted in cages located in marine estuaries or sheltered coastal areas. Groupers are generally sold alive at a size range of 0.5–1.2 kg per fish, with the average weight for table-size fish being 850 g, requiring ready access to markets. In Thailand, six species of groupers (*Epinephelus coioides*, *E. malabaricus*, *E. areolatus*, *E. lanceolatus*, *E. fuscoguttatus* and *Plectropomus maculatus*) are cultured. In Malaysia, interest in grouper culture has led to at least six species being introduced.

Biology: Groupers are protogynous hermaphrodites. The gonad lies ventral and slightly posterior to the swim bladder. The ovary is in the form of a bilobed sac that unites posteriorly to form a common oviduct. In a mature female, numerous oocytes are arrayed in lamellae surrounding a central lumen, with spermatogenic tissue in small dormant crypts on the periphery of the lamellae. After spawning as a female for one or more years, the grouper changes

sex and thereafter functions as a male. At sexual transition, the oocytes degenerate, the spermatogonia proliferate, and the ovary is transformed into a functional testis. Evidence of the ovarian origin of the testes are the remnants of oocytes and the ovarian lumen, which can be seen in cross-sections of the testes. This protogynous mode of reproduction is complicated in certain species by the occurrence of some large females that do not change sex and some small males that are mature at the same size as the smallest females. (Heemstra and Randall, 1993) Most fishes are gonochorists (Wootton 1991; Helfman et al. 1997), which means they are either born as males or females and reproduce only as one sex throughout life. But many species, including many serranids, exhibit several sexual patterns such as hermaphroditism (Sadovy de Mitcheson and Liu 2008). Hermaphroditism includes simultaneous and sequential hermaphroditism and the latter is further divided into protogyny and protandry (Sadovy and Shapiro 1987). *Epinephelus malabaricus* change sex between 97 and 113 cm TL with the length at 50% sexual maturity of female *Epinephelus malabaricus* reported to be 79 cm (7.5 kg) (Lydia and Ian 2013). *E. tauvina*, is a protogynous hermaphrodite and sexual transition is found to occur in individuals 55-75 cm in length, and is related to spawning activity. Fecundity estimates for *E. tauvina*, of length 35.1-42.3 cm ranged from 850-186 to 2 904-921. In the case of *E. tauvina*, lunar cycle has been shown to affect the reproductive cycle. The fish matures at 52 cm total length i.e. 4-5 years old whereas *E. chlorostigma* attains sexual maturity at 28 cm TL. Giant grouper (*E. lanceolatus*) is popular with farmers for its hardiness and rapid growth and is reported to grow to around 3 kg in its first year. The Serranidae exhibit both synchronous and protogynous hermaphroditism (Lavenda, 1949; Reinboth, 1962, 1970; Smith, 1965; Yamamoto, 1969; Atz, 1964; Bortone, 1977; Bouain, 1981) as well as the gonochoristic pattern. Van Oordt (1933) made the first observations on hermaphroditism in *Epinephelus* from the Java Sea. and since that time there have been several reports on sex transformation in this

genus (Smith, 1965; Reinboth, 1968; Moe, 1969; Tan & Tan, 1974; Brusle & Brusle, 1975a,b; Chen et al., 1977, 1980).

Stages of the ovary (Nair et al., 2018)

Stage I -immature I - relatively small, translucent and white pinkish in colour.

Stage II - Mature resting female / maturing female stage II of larger than Stage I and white brownish in colour.

Stage III - is defined as the ovarian stage in which active vitellogenesis taking place in preparation for spawning in the mature active female/ripe female. The ovary occupies 2/3rd of the body cavity and is light yellowish in colour

Stage IV -Ovary occupies the gonad cavity -is pinkish in colour and is ready for spawning. Gonad weight is also increased.

Stage V -Spent -Gonads are flaccid -loose and shrunken -covered with blood shots and veins

Snappers:

The snapper is a demersal fish occurring on the continental shelf down to a depth of about 200 m, but most abundant in depths of less than 70 m. It lives on all kinds of bottom-sand, mud, rocks- There are several species of seabream cultured in Asia, mainly in more temperate parts of the region. These include squirefish (*Chrysophrys auratus*), goldlined seabream *Rhabdosargus sarba*), blackporgy (*Acanthopagrus schelgelii*) and redseabream (*Pagrus major*). In Thailand, *Lutjanus argentimaculatus* is the major species cultured. In Malaysia, Snappers (Lutjanidae) are next in importance; these include the yellow streaked snapper (*Lutjanus lemniscatus*), the mangrove red snapper (*L. argentimaculatus*), John's snapper (*L. johnii*) and the crimson snapper (*L. erythropterus*). Adult red snappers were primarily piscivorous, although in certain seasons, they fed heavily on tunicates. Juvenile red snappers fed primarily on crustaceans, but periodically took fish Biology: They are solitary and wary fish, rarely found in groups or schools except during spawning aggregations (Domeier et al., 1996). Snapper is a

serial spawner and releases many batches of eggs over a period of several months. Water temperature is the most important factor influencing the timing of the breeding period. Eggs are spherical, with a diameter of 0.85- 0.97 mm and a single oil droplet 0.1H, 25 mm in diameter. The yolk is non-segmented, Snapper eggs are planktonic and after fertilisation float freely in the sea until hatching, which takes from 36 to 54 hours, depending on temperature. The snapper's capacity to spawn many times during a season enables it to produce a very large number of eggs and is one of the reasons for its great success as a culture species. Snapper is a predatory fish and its food is extremely varied. Its ability to feed on almost any animal food available enables it to penetrate different habitats and is another reason for its great success as a species.

Commonly Cultivable species of Snappers: The family Lutjanidae collectively known as snappers, contains 17 genera and 105 species, which are mainly confined to tropical and subtropical marine waters, with few occurring in estuaries. In India, Rekha (2017) recorded 35 species under 8 genera of snappers. The major species observed in the all India landings of snappers were *Pristipomoides typus*, *L. argentimaculatus*, *Lutjanus gibbus*, *L. rivulatus*, *L. bohar*, and *L. lutjanus*.

Flatfishes:

Halibut: The name flounder is used for several only distantly related species, though all are in the suborder Pleuronectoidei (families Achiropsettidae, Bothidae, Pleuronectidae, Paralichthyidae and Samaridae).

Species in Indian waters: *Psettodes erumei* or the Indian halibut: *P. erumei* is highly predacious benthic fish which lives on muddy and sandy bottom of the continental shelf down to about 100 meters depth and is predominantly piscivorous in habit. Body is oval and flat, but thicker than in most other flatfishes. Mouth large with strong teeth; maxillary extends well beyond hind edge of lower eye; both eyes are on left or right side; upper eye lying immediately below dorsal edge. Gillrakers are not developed. Dorsal fin origin is well posterior to eyes; anterior fin rays is spinous. Lateral line is almost straight. Body colour is usually brownish grey, sometimes with 4 broad, dark crossbars. Dorsal, anal and caudal fin tips black. Blind side is white to partially coloured. Diet is mainly fish with Molluscs and arthropods supplemented to some extent.

Rabbitfish: Rabbit fishes belong to the genus *Siganus* of the family Siganidae. *Siganus* species are all remarkably similar to each other in most of the features. All species possess thirteen dorsal fin spines, and seven anal fin spines. The genus *Siganus* is also unique among marine fish having two pectoral spines on each side which are separated by three soft rays. Along with these twenty-four spines, one procumbent spine is found in front of the first dorsal spine which is part of the proximal pterygiophore. It is completely embedded or sometime protrudes from a small groove and collectively makes up the main defense of fish. The spines are poisonous. The teeth are also remarkably similar to each other. The number of teeth and the overall shape are "identical." with a single row on top and the bottom jaw. They are very compressed and incisiform in shape. The teeth also overlap and are individually spadelike and pointed.

Species in Indian waters: *Siganus canaliculatus* (Park, 1797)

Distinctive Characters: Body compressed, fairly slender, with a head with a concave slope above eye. Snout is blunt, anterior nostril is with a long flap in juveniles (shortening with age, absent in old

fish); tip of flap reaching less than halfway to posterior nostril in specimens larger than 12 cm standard length. A forward-directed spine is present in front of dorsal fin; last dorsal spine the shortest, contained 0.5 to 0.6 times of the longest dorsal spine; last anal spine contained 1.2 to 1.5 times of the longest anal spine (usually the third). Caudal fin is almost emarginate in specimens under 10 cm SL, forked in larger fish. Scales minute with naked cheeks or with few to many very fine scales; 21 to 27 scale rows between lateral line and bases of leading dorsal spines. Colour in live fish is highly variable from greenish grey on dorsal side to silver on ventral side; numerous pearly blue matchhead size spots covering nape and sides, arranged more or less in horizontal rows. Caudal fin grey or with pale and dark grey bars; pectoral fins hyaline; dorsal, anal and pelvic spines and rays have same colour as adjacent areas of sides; fin membranes greyish in colour; after death fins usually with pale and dark grey, dorsal fin rays banded.

Biology: Common rabbit fish reported from India are *Siganus javus*, *S. canaliculatus*, *S. lineatus*, *S. stellatus*, *S. vermiculatus*. *S. canaliculatus* is generally found and its sizes vary from 20-25 cm, with a maximum of 45 cm TL. They are found in coral reef areas, mangrove swamps and shallow lagoons (Saoud et al., 2008) and are able to tolerate a wide range of salinity (17-37 ppt), low dissolved oxygen upto 2 ppm and pH upto 9 and high stocking densities and grow well in temperatures between 23 and 30°C. All these characters make this species suitable for culture.

Further reading

Nair, Rekha J and Mahesh, V and Ambarish, Gop P (2018) *Biology of some important Demersal Fishery Resources In: ICAR Sponsored Winter School on Recent Advances in Fishery Biology Techniques for Biodiversity Evaluation and Conservation, 1-21 December 2018, Kochi.*

Nair, Rekha J (2017) *Field Identification of Groupers and Snappers. In: Training Manual on Species Identification. CMFRI; Kochi, Kochi, pp. 60-87. ISBN 978-93-82263-16-6*

