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Unloading of tuna catches from outboard gillnet fishing units at Tharuvaikulam Landing Centre

(Photo credit: Abdussamad, E. M.)

Marine Fisheries Information Service Technical and Extension Series envisages dissemination of information on marine fishery resources based on research results to the planners, industry and fish farmers and transfer of technology from laboratory to the field.

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From the Editorial Board

Warm greeting to all our esteemed readers

Post-Independence, the Indian marine fisheries sector surged ahead with perceptible growth in fish landings, which rose from less than 0.5 million t during the 1950s to nearly 4 million tonnes during the last decade. Technology adoption and infrastructure development has undoubtedly played a key role in this trend, but the emphasis from increasing production to sustaining the catches and from fisheries exploitation to fisheries management has also been tangible. The marine fisheries sector is particularly important for livelihood support of the sizeable coastal population in India who are employed in fishing and allied activities including processing, marketing and related activities including at the pre-harvest stage. While seafood exports of 1.38 million t were worth US$7081 million in 2017-2018, only around 10% of this was in value added form. This fact highlights need for remedial action and the prospects for additional income generation if a value chain is established. Ensuring access to technology and credit, developing marketing linkages and institutional support are key to a healthy and sustainable marine fisheries sector. The large pelagics are a typical low-volume, high value resources based fishery that need to be efficiently tapped and aspects of its fishery on the east coast of India is presented in this issue of MFIS.

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Status and prospects of Large Pelagics fishery in Tamil Nadu and Puducherry

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Abstract

The status of the landing of large pelagic fishery including the resource-wise contribution and their species composition in Tamil Nadu and Puducherry is presented based the on the estimated fish landings data for the period 2007-2019. The large pelagics landing in Tamil Nadu varied from 30,659 t to 83,620 t with an average of 45,330 t. In Puducherry, it varied from 254 t to 5,453 t with an average of 2,515 t. Various crafts and gears involved in the fishery are described while the future prospects and management issues are flagged.

***Keywords**: Large Pelagics, Tamil Nadu, Puducherry, fishery*

Introduction

The total marine fish landings in Tamil Nadu in 2019 was 7.74 lakh tonnes and state was ranked second in marine capture fish production in India. The upgrading in the craft and gear, change in fishing pattern, extension of fishing ground and market demand have played an important role in the increase in landings. These changes are visible in the large pelagic (LP) fishery also. Tunas, billfishes and seer fishes are the most important groups among large pelagics in terms of their importance in the domestic as well as export markets. Earlier the large pelagic coastal resources like seer fishes, coastal tunas, carangids, barracudas etc were targeted mainly but now there is a targeted fishery for oceanic tunas, billfishes which has made changes in the species composition of the landings. Except in the magnitude of landings, the fishery and the marine fisheries regulation of Puducherry are almost similar to Tamil Nadu. The status of the large pelagics fishery in Tamil Nadu and Puducherry based on the landings data for the years 2007-2019 provided by the Fisheries Resource Assessment Division of ICAR-Central Marine Fisheries Research Institute is detailed.

Fishery trends in Tamil Nadu

The large pelagic resources of Tamil Nadu-Puducherry coast comprise of tunas, billfishes, barracudas, seer fishes, queen fishes, dolphin fishes, rainbow runner, cobia and needlefishes. With a targeted fishery all along the coast the major fishing harbours and landing centres include Chennai, Cuddalore, Nagapattinam, Pamban, Rameswaram, Tharuvaikulam, Tuticorin, Chinnamuttom, Thengaipattinam and Colachel in Tamil Nadu; Puducherry and Karaikal in UT Puducherry. Various crafts and gears such as gillnets, hooks and lines, trawls and seines are deployed for fishing large pelagics.

1. Gillnetters: Gillnets are generally operated during late afternoon or night hours depending on the lunar phase. In general there is only one operation, but depending on the presence of fish shoals, more operations may be made. Based on the crafts and mode of operation they are categorized as

Non-motorized or motorized single day gill netters: These use small gillnets of about 1000 m length with mesh size of 65-100 mm targeting mackerel, scads, medium sized

tunas, seer fishes etc. They are operated from fiberglass boats of 9-10 m Overall length (OAL) and if motorized, are fitted with outboard motors of 10 -14hp and manned by five to six crews. They go for fishing in the afternoon or night and return the next morning.

Motorized double engine gillnetters: Relatively large gillnets of 1000-1500 m length and mesh size of 130-140 mm operated from FRP boats of 14 to 15 m OAL fitted with 2 OBM engines of 10 hp capacities. They are targeting manly tunas and seer fishes. The crew strength in these units is either five or six.

Drift gillnetters for Needle fish (*Murrel valai*): These are green coloured drift gill net of 50 mm mesh size known as '*Irupiruppu*' and 55 mm mesh size locally known as '*Muppirivu*'. The former targets smaller sized needle fishes and the latter one bigger needle fishes. Each piece of the net is 70 m long and 2.8 m wide and six to seven pieces of both nets in 50:50 ratio form one set. Each boat may carry 25 to 30 sets. These nets are provided with floats but do not have any foot rope and weight. When set, the net will be just floating on the surface. They are operated from wooden boats of 16 to 20 m OAL fitted with engines of 68 to 98 hp with separate space for fish hold and manned by 6 to 7 crews. They undertake single or multiday day fishing and are mainly based at Tharuvaikulam in Thoothukudi.

Multiday gillnetters: Gillnets of 9-10 km length and mesh size of over 120 mm targeting seerfishes, tunas and billfishes are operated from wooden boats of 20 to 23 m OAL fitted with inboard engines of 150 hp or more, with mechanical winches to haul the net and separate spaces for fish hold and net storage. These vessels are provided with GPS and communication systems and have crew strength of eight to ten (Fig.1). One fishing trip lasts for 5 to 20 days depending on the availability of the resource nearer or farther from the shore. Although gillnets are operated almost throughout the coast, gillnet based targeted fishing for large pelagics is mainly in places such as Chennai, Puducherry, Cuddalore, Nagapattinam, Rameswaram, Thoothukudi and Kanyakumari.

2. Hook and Line: Both long lines and trolls are operated targeting mainly large pelagic resources.

Long line: They are operated from Chennai coast mainly targeting seer fishes. FRP boats of 13 to 15 m OAL fitted with single or double 10 hp OBM with crew strength of five are used for fishing. In a basket, 800 to 1000 hooks of size number 7 are used. They generally undertake single day fishing and fishing occurs almost round the year. The most common bait used in the long lining is rainbow sardines.

Handlines: Hand line with hooks of size number 7-8 is used seasonally along the Kanyakumari coast, targeting yellow fin tunas. They are operated from multiday trawlers and the operation is similar to the trolling. The non-edible by-catch of previous day's trawling is used as bait. Once the tuna shoal is located, bait is broadcast into the sea and along with it the hand- line is also dropped into the water while the boat keeps moving slowly. The fishing ground is within the shelf area and the fishing season is February –April. Along the Gulf of Mannar, hand lines are operated from FRP boats targeting seer fishes, carangids, cobia etc. They use scads (*Decapterus* sp.) or caesionids as the bait which is single day fishing and operation is during day time.

3. Multiday Ring seiners: The ring seines have an overall length of 2000 to 2100 m and width of 100 to 120 m with mesh size of 110 mm each. They are operated from mechanized crafts of $>$ 23 m OAL with engine power of $>$ 500 hp. Each unit has crew strength of 50 to 60 men for fishing. Targeting tunas, they fish in deeper waters beyond 1000 m depth, approximately 90 to 140 km away from the shore along Cuddalore coast. Fishing days vary from 3 to 4 days.

4. Trawlers: Mechanized trawlers operated along the coast vary in their size and engine power. OAL of these crafts ranges between 14-25 m and engine power between 140-480 hp. Mostly, cod end mesh is 35 to 40 mm and in some areas it is as small as 20 mm. The total length of the net depends on the size of boat and engine power. The multiday trawlers from Chennai operate between off Kovalam in Chennai and off Nizamuddin in Andhra Pradesh at 20 to 25 nautical miles (nmi) away from the shore. The multiday trawlers from Cuddalore and Nagapattinam operate between off Chennai and off Nagapattinam in the Bay of Bengal in depth ranges from 50-200m depending on the availability and abundance of targeted fishes. The single day trawlers operate near the coast with those from Pamban operating in the Gulf of Mannar in southeast direction up to a distance of 60 nmi from the shore where the depth varies from 40–150 m. The mechanized trawlers operated from Palk Bay side go for fishing to a maximum depth of 16 m. The mechanized

Fig.1. A multiday gillnetter based at Thoothukudi (left) and Nagapattinam (Right)

trawlers from Thoothukudi operate between off Erwadi and off Kanyakumari, while those from Chinnamuttom and some from Colachel, mainly fish in the Wadge Bank area. In Chennai, Cuddalore, Nagapattinam and Colachel, both singe day and multiday trawling is practiced, Single day fishing is normally very near to the shore and large pelagic resources are not a significant component of these fish catches. The multiday fishing trip may vary from 3 to 20 days depending on the availability of the resources. In Tuticorin and Chinnamuttom, the trawlers are allowed to do one day fishing through token system and the boats have to leave the harbor by 5am and return by 9pm. In Rameswaram and Pamban also, trawling is permitted through token system and the fishing is allowed only three days in a week. The boats have to leave by morning and return the following morning.

Landings of large pelagics in Tamil Nadu during 2007 to 2019 ranged from 30,659 t in 2011 to 83,620 t in 2019 with an average of 45,330 t (Fig.2). While production remained almost steady till 2011 and increased to 46,344 t in 2012, subsequently catches fluctuated and reached the peak in 2019. The increase in the landing was mainly due to the increased contribution of barracudas, seerfishes and tunas. The average annual landings of different large pelagic resources showed that tuna was the major contributor (42%) with 19,115 t. The barracudas with 11,399 t constituted 25.2% followed by seerfishes (7,349 t) contributing 16.2%. The other groups were billfishes at 2563 t (6%), queenfishes 1,931 t (4.3%) and needlefishes at 1829 t (4%).

The outboard motor operated gillnets (OBGN) contributed major share (24.1%) of the LP landings followed by single day trawlers (MTN) with 22.8%. Mechanized gillnet (MGN-19%), multiday trawlers (MDTN -9.8%), Outboard hook and line (OBHL–8.9%), mechanized ringseine (MRS) and outboard

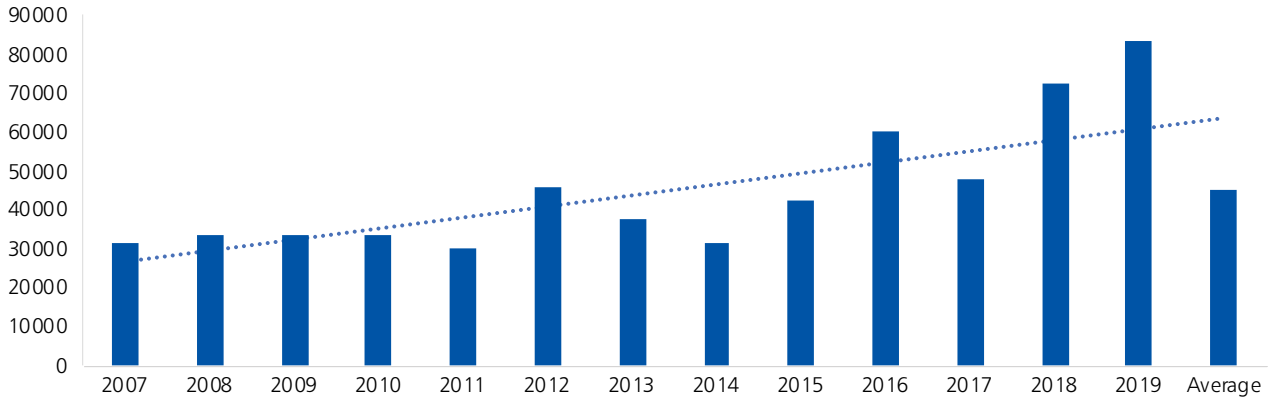

Fig.2. Annual landings (t) of large pelagics in Tamil Nadu (2007 -2019)

motor operated ringseine (OBRS) also contributed (Fig.3). In the case of barracudas and seerfish, major part of the catch during June to July-August was comprised of juveniles and were caught by trawlers. For tunas, billfishes and dolphinfish, MGN was the most important gear while other resources including seerfishes, mechanized trawlers dominated. LP fishery occurred throughout the year along the Tamil Nadu coast with two peaks noted during June-September (major) and January-March (minor) periods (Table 1).

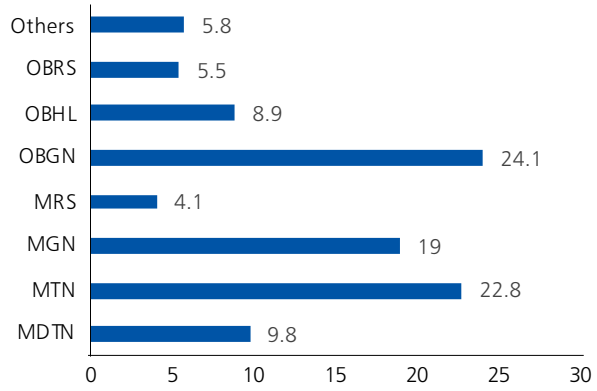

Fig.3. Average contribution (%) of large pelagic by different gears in Tamil Nadu

Fishery trends in Puducherry

The major landing centres are Puducherry and Karaikal Fisheries Harbours and fishing crafts and gears are similar to those deployed in Tamil Nadu. The LP landing during 2007 to 2019 ranged from 254 t in 2011 to 5,453 t in 2015 with an average of 2,515 t (Fig.4). Unlike Tamil Nadu, barracudas with a landing of 744 t are the highest contributor (30.4%) while other major contributors were seerfish 740 t (29.2%) and tunas 711 t (29%).

Table 1. Temporal dominance of different large pelagic resources in Tamil Nadu

Resource	% of catch	Months
Barracudas	73	June-November
Billfishes	75.1	March-April & July-September
Cobia	36.8	February, September & October
Dolphinfish	57.7	February-March & June-August
Needlefish	62.4	June-August & October-December
Queen fish	66.9	June-November
Seerfish	62.9	July-November
Tunas	68.5	March & June-September

The major gears contributing to LP landings were MDTN (52.6%), MGN (20.7%) and OBGN (10.7%) while MTN, OBH and OBRS contributed around 5% each (Fig.5). The MGN was the most important gear contributing to tunas, billfishes, dolphinfish and cobia landings while barracudas, queen fish and seerfish were mainly landed by mechanized trawlers. More than 95% of the needlefish landings were contributed by OBGN. The LP fishery occurred throughout the year. Two peak seasons occurred in the landing with the major one during June-September and minor during November or December.

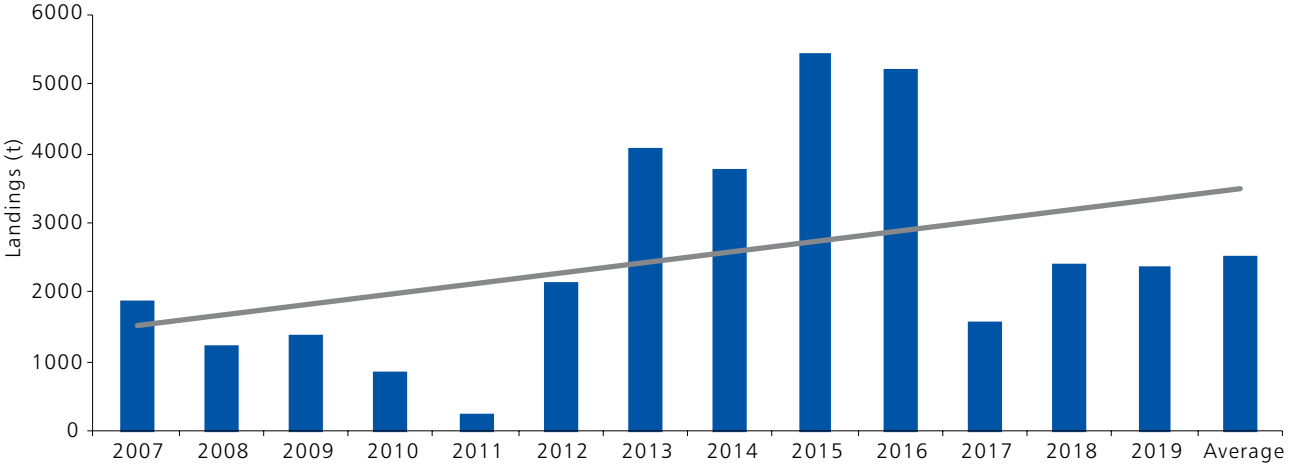

Fig.4. Annual landings (t) of large pelagics in Puducherry

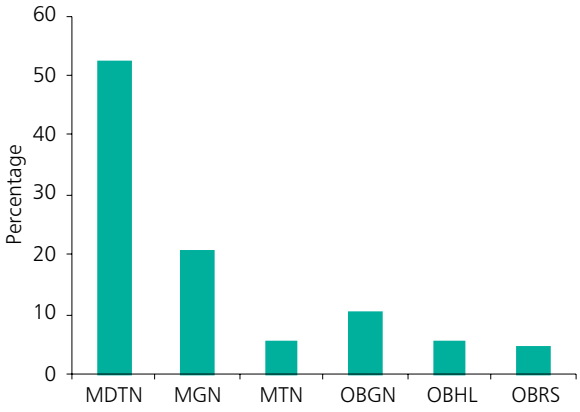

Fig.5. Average gearwise contribution to landing of large pelagics in Puducherry

Species composition in the tuna fishery indicated eight species, of which five species support regular fishery. *Euthynnus affinis* was the most dominant one forming 37.5% followed by *Thunnus albacares* (28.4%), *Katsuwonus pelamis* (24.7%) and *Auxis* spp. (7.5%). Occurrence of *Sarda orientalis, Gymnosarda unicolor* and *Thunnus tonggol* were very much seasonal. The fishery for barracudas comprised *Sphyraena barracuda, S.putnamae, S.obtusata, S.forsteri* and *S.jello*. *S.putnamae* was the dominant species (44.6%) followed by *S.barracuda* (30.5%), *S.obtusata* (24.4%) and *S.forsteri* (0.6%). *S.obtusata* and *S.forsteri* were mainly landed by trawl during June to September and were dominated by juveniles. Seerfish landings comprised of *Scomberomorous commerson, S.guttatus, S.lineolatus and Acanthocybium solandri.* While *S.guttatus* was mainly landed in trawl net, *A.solandri* was mainly landed by hook and line and drift gillnet operated in deeper areas. Queen fishes comprised *Scomberoides commersonianus, S.lysan, S.tol* and *S.tala*. Larger fishes were landed by hook and line and drift gillnets while juveniles were landed by trawlers and gill nets. Rainbow runner (*Elagatis bipinnulata)* was mainly landed by large meshed drift gillnets and hooks and lines targeting tunas and billfishes. Cobia (*Rachycentron canadum*) comprising mostly juveniles were landed in multiday trawlers and larger ones by hook and line. Dolphinfishes such as *Coryphaena hippurus* and *C.equiselis* were landed with the latter species only occasionally and in few numbers. The adults were landed mainly by drift gillnets and hook and lines. Among billfishes, *Istiophorus platypterus*, *Istiompax indica* and *Xiphius gladius* constituted the regular fishery by multiday deep sea gillnetters and long liners. *Makaira mazara, Kajikia audax* and *Tetrapterus anguistirostris* were also landed occasionally in small numbers (Table 2). Generally juveniles of *I.platypterus* and *X.gladius w*ere landed during June-September in surface gillnets (Fig.6).

By-catch in targeted large pelagic fishery varied with the type of gear, area of operation and season. The by-catch in major gears targeting large pelagics such as drift gillnets and hooks and lines were mainly mobulid rays, sharks, carangids etc. The ray *Mobula japonica,* different species of sharks including *Alopias* spp. with no regularity in landing or dominance of any particular species and carangids comprised of trevallies like *Caranx ignobilis, C.heberi, C.sexfasciatus, C.tille* and *C.melampygus* were recorded. In addition to these, other resources like catfish, milkfish (*Chanos chanos*), ten pounder (*Elops machnata*), Indo-Pacific tarpon (*Megalops cyprinoides*), Escolar (*Lepidocybium*

Table 2. Temporal dominance of different large pelagic resources in Puducherry

Resource	Average% of catch in LP	Dominant months
Barracudas	33.2	July, August & December
Billfishes	2.6	July-September
Cobia	0.6	August-September
Dolphinfish	2.9	January, May-July & December
Needlefish	0.5	July & December
Queenfish	3	August-September
Seerfishes	29.2	July-August & November
Tunas	28.0	January, June-August

Fig.6. Sword fish catch by a multiday gillnet unit landed in Nagapattinam

flavobrunneum), Triple tail (*Lobotes surinamensis*) also landed as by-catch in small quantities especially when the gear was operated in coastal grounds targetting seerfish.

The catch utilization depended on the species and the market demand. Seerfish being a highly sought after fish the landing centre price itself is very high. Barracudas are also in great demand in Tamil Nadu and hence sold in fresh condition within the state. Other resources like dolphinfish, needle fish, cobia etc are also sold locally after purchase by local merchants or from neighboring districts or state through public auction. In the case of tunas and billfishes, demand from domestic market within Tamil Nadu is almost absent. Hence catches are mainly taken by processing industries within the state itself and exported mainly as frozen loins, to countries like Tunisia, Middle East etc. Major share of these landings are bought by merchants either from Kerala or from Tamil Nadu and sent to Kerala for domestic market or export units. Of late, some big hotels in Chennai have shown interest in sword fish. Fishes which are landed in poor condition are sold locally to merchants engaged in dry fish business. The price of seerfish varied from ₹200 to 800 per kg depending on the freshness and size of the fish. Larger fishes especially those which weighed over five kilogram fetched very high price of ₹700-800 per kg at landing centre itself. The landing centre price for skipjack varied from ₹50 to 60 per kg and that of yellow fin tuna from ₹90 to 100. The landing centre price for billfishes ranged from ₹90 to 140 per kg. The price for dolphinfish, queenfishes and needlefish ranged from ₹40 to 60 per kg.

Future prospects

The multiday drift gill-netters from Nagapattinam and Chennai have extended their fishing ground beyond the traditional grounds. The drift gillnetters from Tharuvaikulam, Thoothukudi have increased the size of their boat and gear including fish hold capacity to 20 t since late 2016 aiming at extension of fishing ground and increasing the number of fishing days in a fishing trip. Recently, the deep sea multiday gillnetters from Chennai and Tharuvaikulam have introduced fishing net tracking buoys to enable a hassle free fishing. This installation also helps the fishermen to divide the net into two or more each consisting of 30 pieces instead as a single net consisting of 60 pieces. The IOTC (Indian Ocean Tuna Commission) has prohibited the use of large drift nets (gillnets that are more than 2.5 km in length) in the high seas. Multi-day ring seiners have already been introduced from 2018 in Cuddalore, to exploit oceanic tunas. In order to diversify the fishing from inshore to offshore waters, Tamil Nadu government introduced a scheme for the procurement of new long liner cum gillnetters during 2010-2011 period as part of phasing out of trawling in Palk Bay. With the assistance of the Government of India, Tamil Nadu has already initiated a scheme for the trawl owners of Palk Bay to purchase new long liners/drift gillnetters for exploiting oceanic tunas and billfishes. Fishing boats constructed under this scheme are in operation from Nagapattinam and Kochi (Kerala state) as a temporary arrangement. Construction of new harhours identified for berthing these in Gulf of Mannar is in progress. Construction of a dedicated landing centre for the multiday tuna drift gillnetters/long liners is also in progress near Chennai Fisheries Harbour. These developments have the prospects of augmenting the large pelagic landing, especially tunas and billfishes of the state in the coming years.

Issues in the LP fishery development are also flagged. In the existing and newly introduced fishing fleets, use of ice remains the mode of preservation of catch. In multiday drift gillnetting, this often results in the deterioration of the quality of the tunas and billfishes caught and stored, especially those which are caught in the first few days of the fishing trip. These fishes command very low prices resulting in considerable economic loss to the fishermen. Hence, better preservation techniques should be adopted in the boats. At present, the marketing avenues are very much limited which acts as a major impediment in the expansion of LP fishery. Yellow fin tunas above 7 or 8 kg are rarely caught in drift gillnet and the government is advocating the use of longlines to target large sized yellow fin tuna. There is lukewarm response to this proposal from the fishermen who perceive it as economically unviable. So dedicated efforts to motivate fishermen to exploit larger yellowfin tunas combined with use of proper preservation techniques is needed. The State Government's move to restrict the size of the craft, engine power and size of the gear may curtail the capability of fishing vessels to venture for long duration distant water fishing for large pelagic resources like oceanic tunas and billfishes and thus affect LP production.

Status of Large Pelagics fishery in Andhra Pradesh

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Abstract

Large pelagics forms an important fishery along Andhra Pradesh coast, 26 species of large pelagics are caught in the state. This group accounts to an annual average of 9% of total states marine catches (2.5 lakh ton) since a decade and highest contribution of large pelagics to the total states landing was recorded in 2014 (12%). Tunas dominated the large pelagics landings, followed by seerfishes and barracuda. Gillnets are mainly employed to catch tunas, seer fishes, billfishes and queenfishes, trawls for barracudas and hook and line for Dolphinfish. Peak landing occurred during the December - March period. Among the large pelagics, seerfishes fetched the highest price in the market.

Keywords: *Large pelagics, Andhra Pradesh, fisheries*

Introduction

Andhra Pradesh has a coastline of 974 km with 9 costal districts and 353 landing centers besides two major fishing harbours (Visakhapatnam and Kakinada), along with medium and minor fishing harbours. Large pelagic fisheries form an important component of the marine capture fishery of the state, mainly exploited by small scale fishers operating motorised and artisanal boats.

Large pelagic resources and fishery trends

Among the landings of large pelagics in Andhra Pradesh, tunas represented by 7 species, followed by seerfishes (5 species), queenfishes (4 species), barracudas (4 species),

Fig 1. Coastal districts of Andhra Pradesh

billfishes (3 species) and needlefishs (3 species), Cobia and dolphinfish were observed (Table.1).

Large pelagic fishes are landed all along the coast from mechanized fishing vessels in major fishing harbours to small beach landing artisanal crafts. Non motorised and artisanal vessels mainly operate passive gears such as hooks and line, gill nets (multi meshed, drift), few are also involved in shore seine and ring seine operations. Most of the mechanised vessels targeting large pelagics are multi gear vessels carrying gill net (drift, bottomset) and trawl, based on the season and abundance of the fish with preference of the gear changing. Among the nine coastal districts major Fisheries Harbours are in Visakhapatnam and East Godavari, while all other districts have medium and minor harbours wherein both motorised and artisanal crafts land their catches and Nelllore, Prakasam and Guntur have only artisanal crafts which operate traditional gillnets and hooks and lines. Minor and beach landing centres in all districts are active throughout the year with a few operating only in certain months of the year based on catch intensity and seasonal abundance. The general trend of major gears operated and major groups targeted in different costal districts of Andhra Pradesh are given in Table 2. As technology developed, fishers have adopted to the changing technological innovations, in case of trawlers, high horsepower engines of 300 hp are being used in certain parts of Andhra Pradesh; also use of drum haulers for gill net operation is increasing (Fig.2).

Table 1. List of major large pelagic species landed in Andhra Pradesh

Group	Species	Family
Barracudas	*Sphyraena barracuda*	Sphyraenidae
	Sphyraena jello	
	Sphyraena obtusata	
	Sphyraena putnamae	
Billfishes	*Istiophorus platypterus*	Istiophoridae
	Istiompax indica	
	Xiphias gladius	
Cobia	*Rachycentron canadum*	Rachycentridae
Dolphinfish	*Coryphaena hippurus*	Coryphaenidae
Needlefish	*Ablennes hians*	Belonidae
	Strongylura strongylura	
	Tylosurus crocodilus	
Queenfish	*Scomberoides commersonianus*	Carangidae
	Scomberoides lysan	
	Scomberoides tala	
	Scomberoides tol	
Seerfishes	*Acanthocybium solandri*	Scombridae
	Scomberomorus commerson	
	Scomberomorus guttatus	
Tunas	*Auxis rochei*	Scombridae
	Auxis thazard	
	Euthynnus affinis	
	Gymnosarda unicolor	
	Katsuwonus pelamis	
	Sarda orientails	
	Thunnus albacares	

Fig.2. Gillnetters fitted with drum haulers in Nizamapatnam Fisheries Harbour

Table 2. Details of large pelagics landed in Andhra Pradesh

District	Gears operated	Period of operation	Major Large pelagics groups caught
Srikakulam	Gillnets, Hook & line, Ringeines	Throughout the year	Yellowfin, Skipjack tuna, Carangids, Barracuda, Seerfishes
Vizianagaram	Gillnets, Hook & line, Ringeines	Throughout the year	Seerfishes, Yellowfin, Carangids
Visakhapatnam	Trawls, Gillnets, Hook & line, Shoreseines	Throughout the year	Yellowfin tuna major landing besides all large pelagics
West Godavari	Gillnets, Hook & line, Shoreseines	Throughout the year	Seerfishes major landings, Carangids and tunas
East Godavari	Gillnets, Hook & line, Ringeines, Shoreseines	Throughout the year	Small tunas, Barracudas, Seerfishes

Large pelagics contribute an annual average of 9% to the total marine fish landings of the state. The peak landings were in 2014 (42,314 t) and average annual landing from 2010 to 2019 was 25,242 t (Fig.3). Gillnets accounted for 44% of all the large pelagic fishes landed, followed by hooks and lines (26%) and rest by trawl nets (15%) and seine nets (12%) (Fig.4). Annual landing trends of major gears involved in capturing large pelagics are given in Fig 5. In 2014, gillnets, hooks and lines and seine nets recorded the highest catch, while in trawls highest catch was in 2012. Minimum catch in gillnets was in 2017, while that of hooks and lines was in 2010, trawl nets in 2015 and seine nets was in 2018.

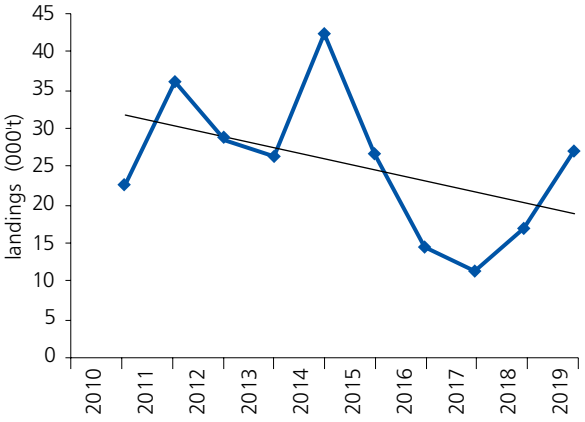

Fig 3. Annual large pelagic landings of Andhra Pradesh (2010-2019)

During the study period, tunas dominated the large pelagic catches followed by seerfishes and barracudas (Fig.6). Analysis of monthly large pelagics landing data during the 2012 -2016 period revealed marked seasonality with a major peak during December- March, minor peak during July to September and very low landings during April - June period.

Tuna catches were highest in 2014 (27,490 t), and lowest during 2017, with only 6,390 t of tunas being landed in the state. Among different species contributing to tuna landings, *Thunnus albacares* (Yellowfin tuna) and *Euthynnus affinis* (Little tunny or Kawakawa) contributed

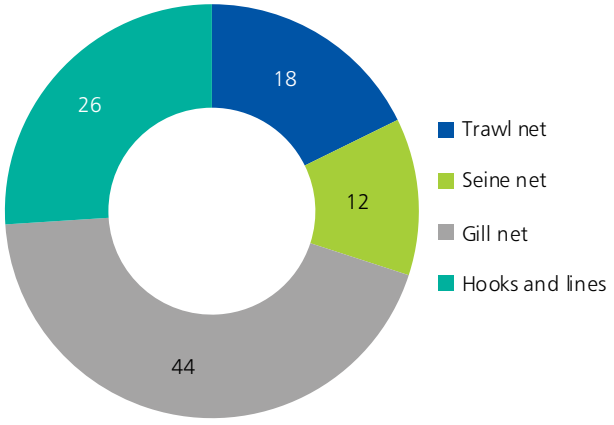

Fig.4. Gearwise contribution (%) to the large pelagics landings

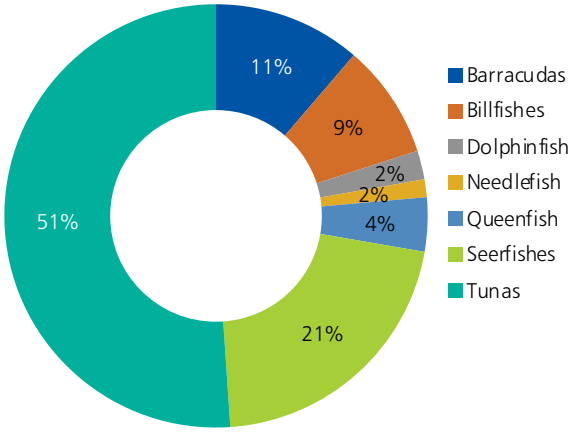

Fig.6 . Contribution by various groups of large pelagics

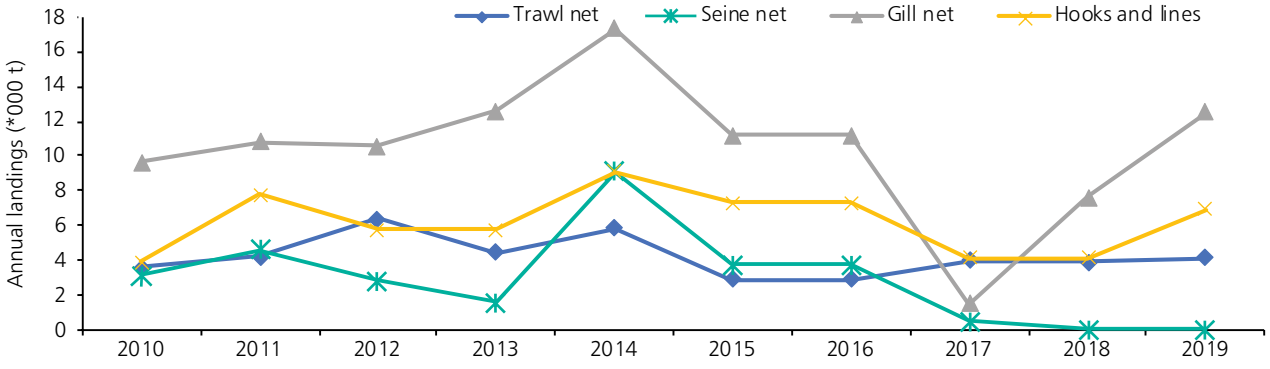

Fig 5. Annual gearwise large pelagic landings (2010-2019)

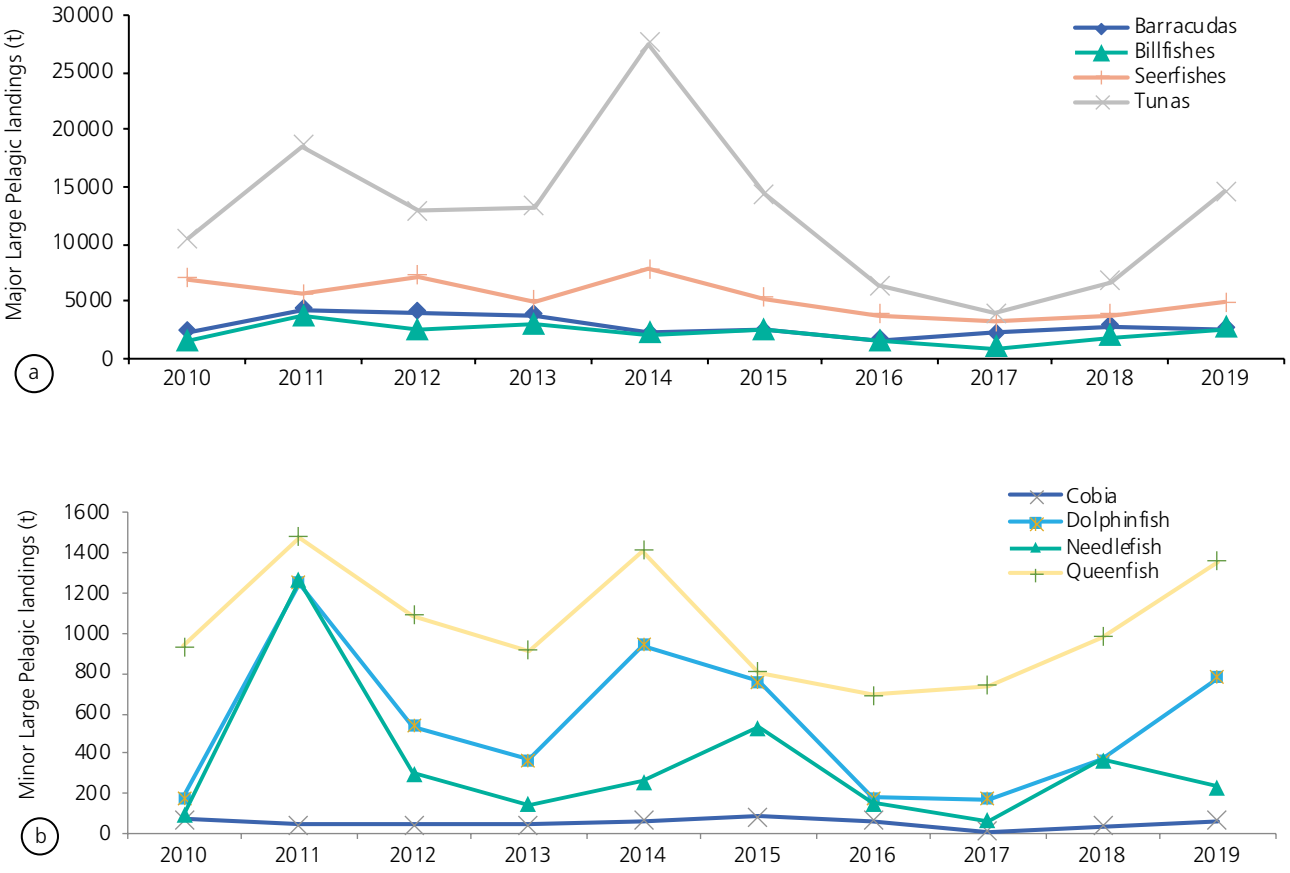

Fig 7. Annual trends in large pelagic landings (t) of Andhra Pradesh (2010-2019)

the highest with an average annual landings of 4,547 t and 4,100 t respectively, followed by *Auxis thazard* (Frigate tuna) 1,140 t, *Sarda orientalis* (Striped bonito) 98 t, *Auxis rochei* (Bullet tuna) 18.3 t and *Gymnosarda unicolor* (Dogtooth tuna) 0.14 t. Seine and gill nets were important gears which caught on an average of 36% and 32% of *E.affinis*, while *T.albacares* was mainly landed by gillnets and hook and lines which accounted on an average 49% and 35% of *T.albacares* landed at Andhra Pradesh. Overall gillnets accounted for 44% of tunas landed in the state, followed by hooks and lines and trawls, which contributed 25% and 18% respectively.

Seerfishes are the second largest contributors for the large pelagics with an annual average landings of 5,340 t, which is 22.4% of the total large pelagics landed in Andhra Pradesh. Seerfishes landings were highest in 2014 (7,738 t), and lowest in 2017 (3,237 t). *Scomberomorus commerson* (king seerfish) and *S.guttatus* (spotted seerfish), accounted for average annual landings of 2,861 t and 2,415 t respectively. Other species of seerfishes landed in the state in minor quantities was *Acanthocybium solandri* (wahoo). Gillnet accounted on an average 50% of the total seerfish resources landed in Andhra Pradesh, followed by trawlnets (20%). Species-wise landings indicated 60% of *S.commerson* was caught by gillnets and 18% by hooks and lines. For *S.guttatus*, gillnets and trawls contributed 36% each.

Annual average landings of barracudas were 2,842 t, which was 12.2% of all large pelagics landed in Andhra Pradesh. Highest barracuda landings were recorded in 2011 (4,339 t) and lowest in 2008 at 930 t. *Sphyraena barracuda* (Great barracuda), *S.obtusata* (Obtuse barracuda), *Sphyraena jello* (Pickhandle barracuda) and *Sphyraena putnamae* (Sawtooth barracuda) species were recorded in the landings. Trawl nets caught 65% of the total barracudas landed, followed by gillnets 14%. Billfishes contributed an annual average of 2201 t, which was 9% of the large pelagics landed in the state. Peak billfish landings was recorded in 2011 (3,625 t) and the lowest was in 2017 (903 t). *Istiophorus platypterus* (Sailfish), *Istiompax indica* (Black marlin) and *Xiphias gladius* (Swordfish) were the major species with annual average landings of 1,102 t,

971 t and 41.6 t respectively. Hooks and lines accounted for 50% of the catches of billfishes, followed by gillnets (30%). Hooks and lines accounted for, 41% of the *I.platypterus* landed, while for *I.indica* and for *X.gladius* it was 58% and 55% respectively. Gillnets landed 37% of *I.platypterus* and *X.gladius* and 21% of *I.indica*.

Average annual landings of queenfishes were 1,040 t, which was 4.4% of all large pelagics landed in the state. Highest queenfish landings was observed in 2011 (1,481 t) and the lowest in 2016 (690 t) as indicated in Fig.7. *Scomberoides commersonnianus* (Talang queenfish) was the dominant species with an annual average contribution of 58.5%, followed by *S.lysan* (Doublespotted queenfish), *S.tol* (Needlescaled queenfish), and *S.tala* (Barred queenfish) contributing 26.4%, 12.2% and 3% respectively. *S.commersonnianus* was mainly landed by gillnetters (42%) and by the non-motorised sector (38%), while *S.lysan* by gillnetters (67%) and hooks and lines (25%), *S.tol* by gillnetters (44%) and hooks and lines (47%) and *S.tala* by hooks and lines (67%) and non-motorised sector (24%). Overall gillneters contributed 46% of the all queenfishes landed in the state followed by trawlers (30%).

Dolphinfishes were represented by a single species, *Coryphaena hippurus*, with an average annual landing of 555 t, which was 2% of all large pelagics landed in the state. Highest dolphinfish landings was in 2011 (1,254 t) and lowest was in 2018 (36 t). Hooks and lines constituted 48% of dolphinfish landed, followed by gillnetters (28%) and non-motorised (22%). Average annual contribution of needlefishes to large pelagic catches was 342 t, which was 1.3% of all large pelagics landed in the state. Highest landings of 1,268 t was recorded in 2011 and lowest of 23 t in 2019. *Strongylura strongylura* (Spottail needlefish) dominated, with an annual average landing of 117 t, followed by *Ablennes hians* (Flat needlefish) with 37 t and *Tylosurus crocodilus* (Hound needlefish) with 1.2 t. *S.strongylura* and *A.hians* were caught mainly in seine netters which contributed 84% and 99% of these species respectively, while 69% and 13% of *T.crocodilus* was caught by non-motorised and gillnetters respectively. Cobia was represented by a single species, *Rachycentron canadum*, with an average annual landing of 54 t during the period accounting for 0.2% of all large pelagics landed in the state. Highest landings was recorded in 2010 (70 t) and the lowest in 2017 (9.5 t). Gillnetters contributed an average of 44% of the cobia volumes landed during the period, while hooks and lines and non-motorised units landed 29% and 18% respectively.

Elasmobranchs occurred as by-catch in large sized gill nets and longlines, with hammerhead sharks (*Sphyrna* sp), tiger shark (*Galeocerdo cuvieri*) and Carcharhinid sharks along with large sized pelagic rays recorded. Since these species have market demand they are preserved and sold in the landing centres. Large pelagics landed comprised of high valued fishes (> ₹200/kg), medium valued (₹100-200/kg) and low value fishes (<₹100/kg). On an average 63% of large pelagics landed were medium valued fishes, including tunas, queenfishes, billfishes, cobia and dolphin fishes, whose demand in local market is relatively less and are consumed fresh or frozen or are salt dried in lesser quantities, and the major portion of the catch goes to other states, mostly Kerala. High value fishes like seerfishes and barracudas forms 35% of large pelagics landed in the state, and during months of higher demands, prices shoot up to ₹700-800 /kg. Low value large pelagics comprise of 2% of large pelagics landed and include mostly the needlefishes.

Conclusion

Average landings of large pelagics during the period was 25224 t, the economic value of which was around ₹257 crores. The potential estimated for these resources from the state is 67600 t valued at ₹749.4 crores, which can be tapped by the fishers. Further, better onboard handling of tuna and qualifying for *sashimi* grade would result in better prices in international market. In this regard, conversion of multiday trawlers to longliners, trolling etc, and modification of deck for facilitating best practices in preserving and handling tuna is suggested.

Large Pelagics fisheries along Odisha coast – An overview

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Abstract

The large pelagics fishery along Odisha coast is supported by resources such as seerfish, queenfish, tuna, barracuda, cobia, needlefish, billfish, dolphinfish and rainbow runner. The annual landings of large pelagics during the period 2007-2019 showed marked fluctuations with a declining trend and average landings of 5711 tonnes. Seerfish contributed 43% of total large pelagic landings followed by queen fish (31%), tuna (14%) and barracuda (7%). Major gears contributing to the landings were long lines (36%), followed by trawl nets (24%), gill nets (22%) and ringseines (11%). The fishery for large pelagics peaks during January to March and October – December periods with lowest landings during the April -June months and coinciding with a monsoon fishing ban period. These fishes which have low demand in local markets due to its large size and high prices are mostly iced immediately after auctioning and sent to distant markets. The fishery is mostly restricted to nearshore coastal waters without any deep sea fishing vessels. There is need to explore options of introducing deep sea vessels with proper storage facilities, developing infrastructure facilities for landing and processing, skilling fishermen and developing marketing and export linkages.

Keywords: *Large pelagics, Odisha, seerfishes, queenfishes, catch utilisation*

Introduction

Odisha has a long coast line of 480 km and six coastal districts: Ganjam (60 km), Puri (155 km), Jagatsinghpur (67 km), Kendrapara (68 km) Bhadrak (50 km), and Balasore (80 km) with 605,514 fisher folk populations (CMFRI, 2010). The large pelagics fishery along Odisha coast is supported by seerfish, queenfish, tuna, barracuda, cobia, needlefish, billfish, dolphinfish and rainbow runner. The present study documents their landings trend, species composition, exploitation pattern, crafts and gears involved and marketing.

Fishery trends

The annual landing of large pelagics during the year 2007-2019 along the Odisha coast has shown a declining trend (Fig.1). The large pelagics such as seerfish, queenfish, tuna, barracuda, cobia, needlefish, billfish and dolphinfish contribute to the fishery. Among them, the highest landings were of seerfish and queenfish whereas tuna, barracuda, cobia, needlefish, billfish, dolphinfish and rainbow runner were landed seasonally. The estimated marine fish landings of Odisha coast was 1.02 lakh tonnes (t) in 2019 in which the large pelagics constituted 5.3%.

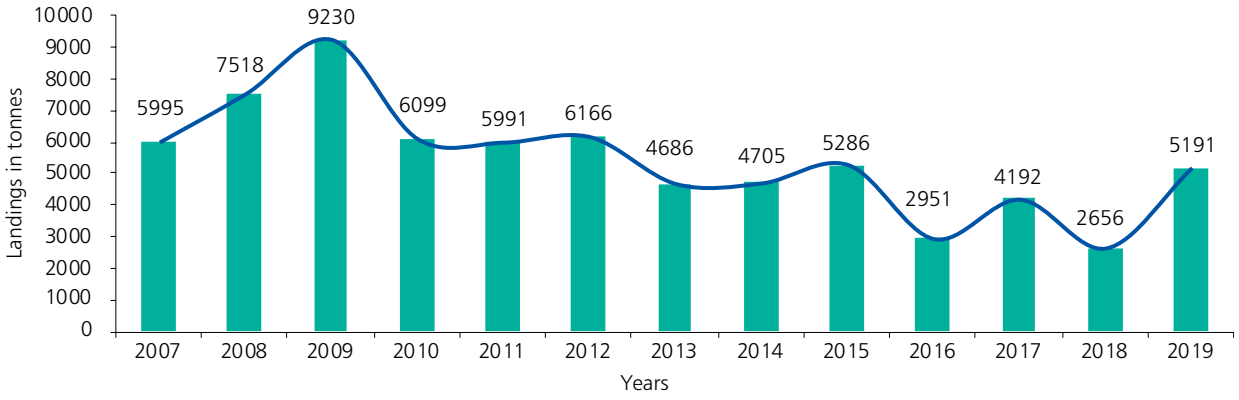


Fig.1. Trend of landings (t) of large pelagics along Odisha coast during 2007-2019

During the 2007-2019 period, seerfish was the most dominant group with an average landing of about 2321 tonnes, constituting 43% of total large pelagic landings along the coast (Fig.2). Seerfish landings have shown a declining trend with highest landing of 3150.5 t recorded in 2009 and lowest of 1643.2 t in 2019. The queenfishes, with an estimated average landing of 1697.8 t formed 31.2% while contribution of tunas to the total large pelagics was only 14% with an average annual landing of about 740.6 t. The estimated average landing of barracudas during the period was 383.2 t contributing 7.0% of total large pelagic landings, indicating a declining trend. Cobia landings also indicated a declining status, contributing 2% to the total large pelagic landings of the state, with average annual landings of about 125.8 t. Needle fish landings has shown an increasing trend with an average annual landings of 99.7 t contributing 1.8% of the total large pelagic catch and highest landing of 248.2 t was recorded in 2019 (Fig.3). The contribution of billfishes and dolphinfishes to the total large pelagic landings along Odisha coast is negligible at 0.7 and 0.5% and average annual landings at 39.3 and 28.2 t respectively during the period. Rainbow runner forms a fishery in certain years with highest landings of about 2.8 t recorded in 2019.

Different crafts were operated for fishing large pelagics in Odisha. Along the Ganjam coast, mostly outboard fibreglass boats (9 m Overall length (OAL) and 9-10 hp engine) were operated, followed by catamarans (6-7 m OAL) and inboard fibreglass boats (12-14 m OAL and 10-40 hp engine). On Puri coast, outboard fibre glass boats (9.6 m OAL and 9-10 hp engine), non-motorized plank built boat/fibre boat (5-6 m OAL) and a few trawlers (12-17 m OAL and 105-280 hp engine) were operated. Along Jagatsinghpur coast, highest number of outboard fibre glass boats (6.2-9 m OAL, 8-14 hp engine) were operated, followed by multiday trawlers (10-16 m OAL and 68-365 hp engine) and inboard plank built boats (10-14 m OAL and 9-26 hp engine). In Kendrapada coast, the major crafts were inboard plank built boats (9.5-15 m, 20-106 hp engine), followed by trawlers (11-16 m OAL, 68-350 hp engine) and outboard fibre boats (7.5-10 m OAL, 8-14 hp engine). On Bhadrak coast, inboard plank

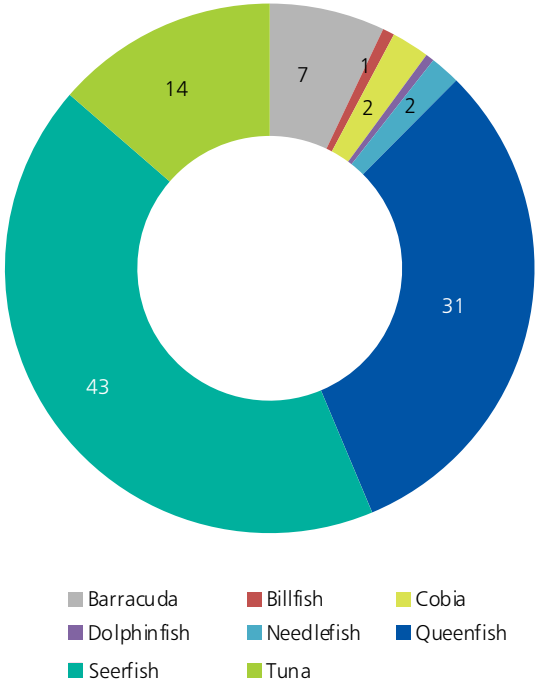


Fig.2. Average groupwise contribution to landings of Large pelagics (2007 - 2019)

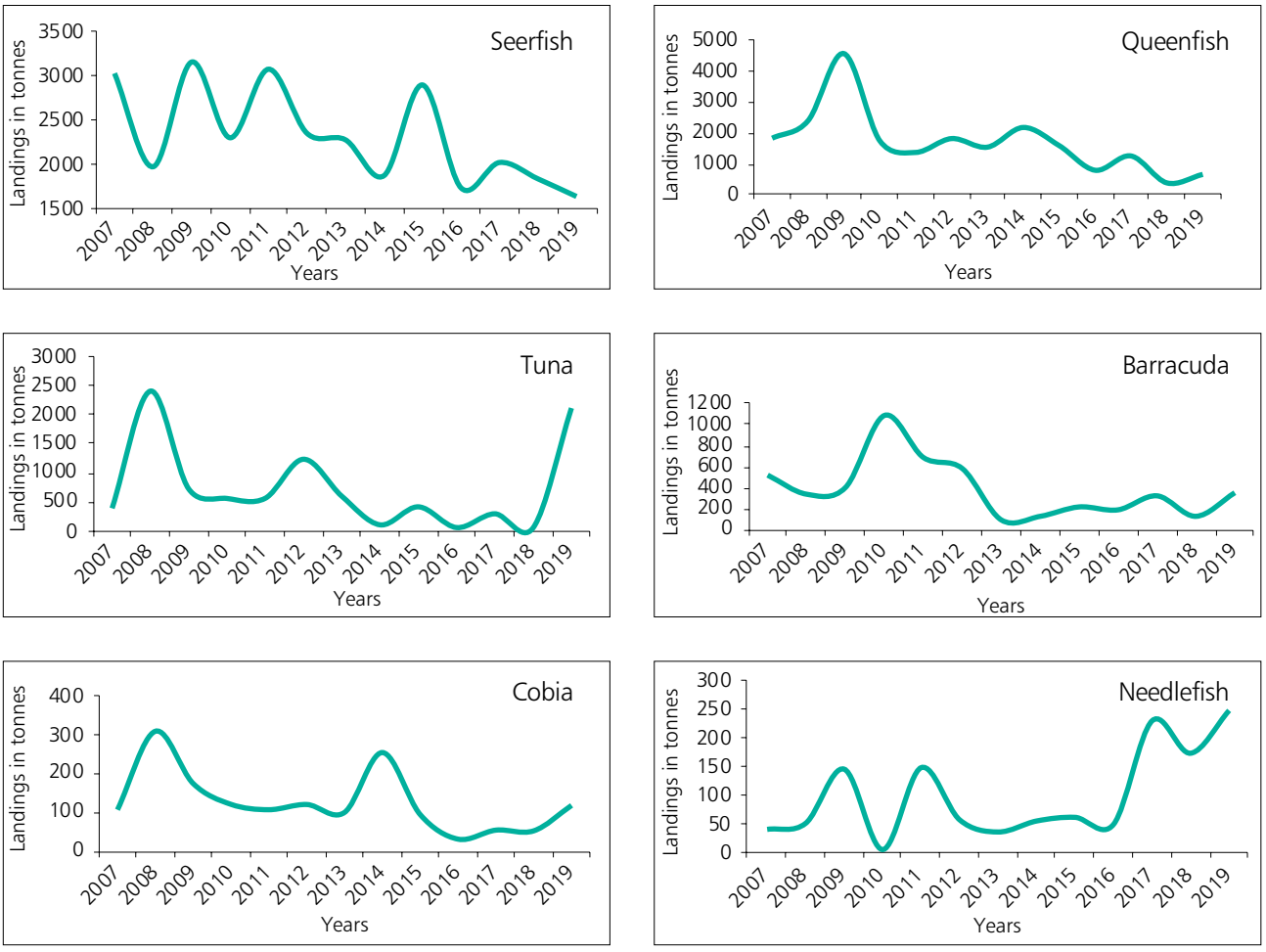


Fig.3. Trend of annual landings (t) of Large pelagics along Odisha coast during 2007-2019

built boats (9.8-14 m OAL, 10-245 hp) and multiday trawlers (11.5-16 m OAL, 68-350 hp engine) were the major crafts involved in the large pelgics fishery. Along Balasore coast, the major crafts were inboard plank built boats (7.5-16.8 m OAL, 10-350 hp engine), followed by multiday trawlers (10.6-18.4 m OAL, 68-450 hp engine) and non-motorized plank built boats (7-10 m OAL). Trawl nets, gillnets and long lines were used to capture large pelagics in almost all the coastal district of Odisha. However in Ganjam, trawling is not practiced, all other gears including ringseines are operated to capture large pelagics. Trawlers operate trips for 5-15 days duration while longlines and gillnets conduct both single day and multiday (2-5 days) voyages.

Along the Jagatsinghpur coast, multiday trawlers (7-15 days) operate at about 40-75 km away from the coast at water depths of 50-60 m from the surface whereas gillnetters (2-3 days) operate at 30-40 km distance at water depths of 30-45 m. Along the Puri coast, gillnetter cum liners operate at 25-50 km away from the coast at water depths of 15-35 m whereas multiday trawlers operate at 15-50 km distance and water depth of 20-35 m. Similarly, along Balasore and Bhadrak coast, trawlers operate at 22-55 km from the shore at water depths about 28-42 m whereas gillnetters operate at 7-40 km distance at water depth 6-28 m. Along the Kendrapada coast, the pattern of fishing and fishing ground is similar to Bhadrak. In Ganjam coast ringseines are operated at 5-50 km distance from the shore and at 10-40 m water depth from surface, gillnets at 5-50 km distance at 5-50 m water depth and long lines at 20-100 km distance at 50-100 m water depth. Along Ganjam coast fishing is mostly restricted to single day operations except for long lines where two days fishing is practiced. In multi-days fishing, fishes are iced on-board immediately after harvesting whereas in single day fishing, fishes

are brought directly to the landing centre without any preservation using ice.

Major gears deployed that contributed to the landings of large pelagics were Hooks and lines (36%), followed by trawl nets (24%), gill nets (22%) and ringseines (11%). Non-mechanised gears (4%), shoreseines (1%) and other gears (2%) contributed the rest (Fig.4). Gear-wise catch data analysis during the year 2007-2019 revealed that a declining trend was observed for almost all gears (Fig.5). Seasonal landing trends during 2012-2019 indicated that the fishery attained its peak during the January to March and October – December periods with lowest landings during the April -June months and coinciding with the monsoon fishing ban period (Fig.6).

Narrow-barred Spanish mackerel *Scomberomorus commerson* contributed about 50% of the seerfish landings, followed by *S.guttatus* while Wahoo *Acanthocybium solandri* was only rarely recorded in the landings. Three

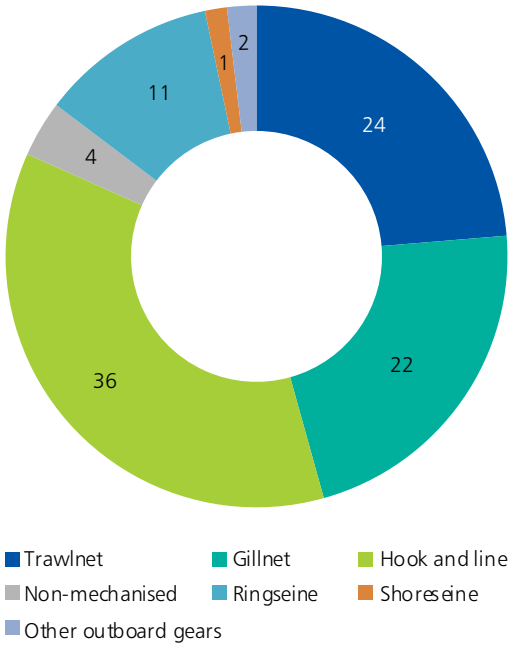


Fig.4. Average gearwise contribution% to large pelagics landings in Odisha during 2007 -2019

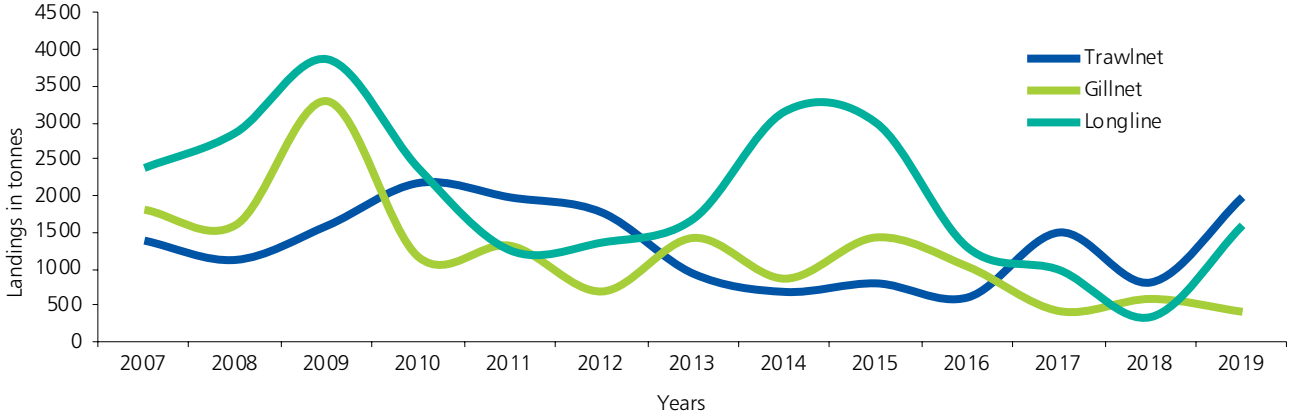


Fig.5. Annual landings trends of large pelagics in major gears along Odisha coast in 2007-2019

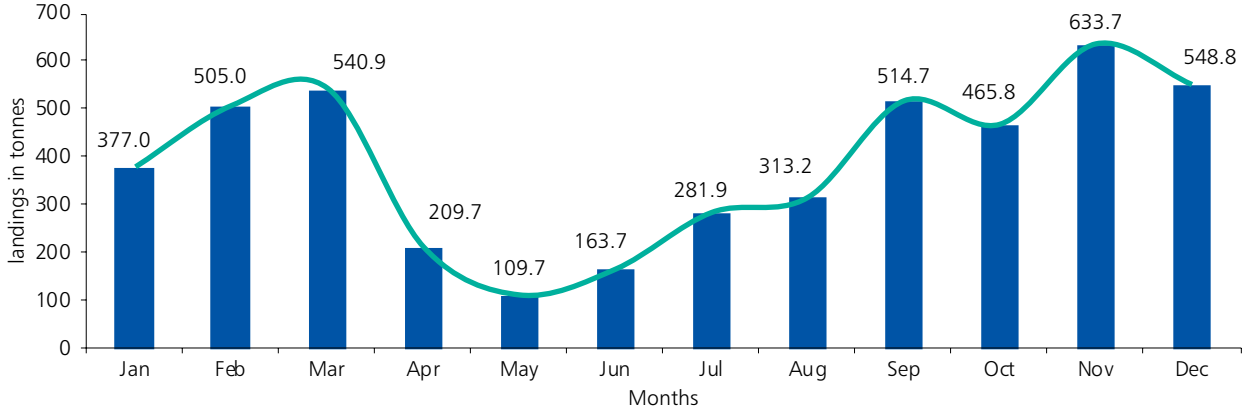


Fig.6. Seasonal abundance of large pelagics landings (Average 2012 -2019)

species of queenfish (*Scomberoides commersonnianus, S.tol* and *S.lysan*) were recorded and *S.commersonnianus* constituted more than 90% of the queenfish landings. Seven species of tunas, namely, *Euthynnus affinis, Auxis rochei, Auxis thazard, Katsuwonus pelamis, Sarda orientalis, Thunnus albacares* and *Thunnus tonggol* were recorded in landings. Among these species, *E.affinis* constituted more than 90% and formed a seasonal fishery only. Species such as *A.rochei, K.pelamis, S.orientalis,* and *T.albacares* were only rarely landed. Four species of barracuda (*Sphyraena putnamae, S.jello, S.forsteri* and *S.pinguis*) were recorded with *S.pinguis* forming more than 60% of the total barracuda landings followed by *S.putnamae*. *Sphyraena forsteri* that were recorded rarely in trawl catches. Four species of needlefish such as *Ablennes hians*, *Tylosurus crocodilus*, *Strongylura leiura* and *S.strongylura* were recorded in the landings with more than 90% contributed by *A.hians*. Cobia, *Rachycentron canadum* and dolphinfish, *Coryphaena hippurus* constituted the single species group with very low contribution to the large pelagic landings along the coast. Three species of billfishes such as *Istiophorus platypterus, Istiompax indica*, *Xiphias gladius* were recorded and all were landed occasionally as by-catch in long lines. Young ones of rainbow runner *Elagatis bipinnulata* occurred rarely in landings of certain years (Fig.7).

Major fish landing centres in various coastal districts are Gopalpur landing centre, Bada Arjipally fishing harbour, Sonapur landing centre, Ramayapatnam landing centre and Markondi landing centre (Ganjam District); Chandrabhaga landing centre, Pentokota landing centre and Astaranga Fishing Harbour (Puri District); Paradeep fishing harbour and Atharabanki landing centre (Jagatsinghpur District); Kharinasi landing centre (Kendrapada District); Dhamara fishing harbour and Chandinipal landing centre (Bhadrak District); and Bahabalpur landing centre and Balaramgadi landing centre (Balasore District).

In Odisha, large pelagics have little demand in local markets due to its large size and higher prices, except for Bhubaneswar market where some quantity of large pelagics were sold. Hence, most of the catches are iced immediately after auctioning and are sent to distant markets such as Howrah, Digha and Kolkata (West Bengal); Chennai (Tamil Nadu); Visakhapatnam (Andhra Pradesh); Bangalore (Karnataka); and Kerala. Small quantities of juveniles/small sized seerfishes, queenfishes, cobia, needlefishes and tuna are also marketed fresh in local markets. Due to the demand with better prices from the distant markets in India processing of such fishes for export is not practiced in recent years (Table 1). In terms of freshness, fishes caught in long lines and gill nets are of prime quality

Table 1 Price of large pelagics (₹/kg) at landing centre from various locations along Odisha coast

Species	Balasore	Jagatsinghpur	Puri	Ganjam
Scomberomorus commerson	90-120(<1kg) 450-500 (>1kg)	280-340(>1kg)	400-550(>1kg)	300-600(>1kg)
S.guttatus	80-90 (<1kg) 350-400 (>1kg)	80-120 (<1kg) 280-340(>1kg)	100-150(<1kg) 180-300(>1kg)	300-400(>1kg)
Scomberoides commersonnianus	400-450 (>1kg) 200-320(1-2 kg) 60-70(<1kg)	120-160(>2kg) 80-120(1-2kg) 40-80 (<1kg)	180-250(>1kg) 80-100 (<1kg)	100-150(>1kg)
S.tol	50-140	40-70	60-120	60-100
Euthynnus affinis	50-60	250-300	80-100	70-80
Sphyraena putnamae	60-70	40-70	80-120	100-120
S.jello	150-180 (>1kg)	120-180(>1kg)	120-200(>1kg)	120-200 (>1kg)
Ablennes hians	90-100 (>1kg)	70-90 (>1kg) 30-50 (<1kg)	90-130 (>1kg) 50-70(<1kg)	90-130 (>1kg)
Tylosurus crocodilus	150-180 (>1kg)	70-90 (>1kg) 30-50 (<1kg)	80-120 (>1kg) 50-70 (<1kg)	80-120 (>1kg)
Rachycentron canadum	200-300 (>1kg)	120-200(>1kg)	70-80 (<1kg) 150-250(>1kg)	200-300(>1kg)
Coryphaena hippurus	200-250	-	120-200	50-60
Istiophorus platypterus	-	-	80-120	-

Euthynnus affinis (Kawakawa)

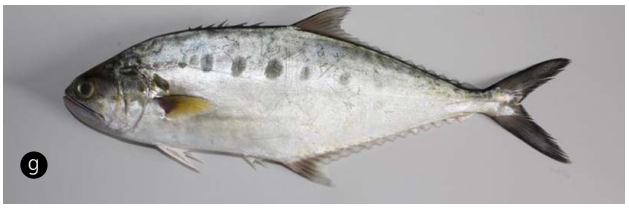
Thunnus albacares (Yellowfin tuna)

Thunnus tonggol (Longtail tuna)

Scomberomorus guttatus (Indo-Pacific king mackerel)

S.commerson (Narrow barred spanish mackerel)

Scomberoides lysan (Doublespotted queenfish)



Scomberoides commersonnianus (Talang queenfish)

Coryphaena hippurus (Common dolphinfish)

Ablennes hians (Flat needlefish)

Tylosurus crocodilus (Hound needlefish)

Sphyraena putnamae (Sawtooth barracuda)

Rachycentron canadum (Cobia)

Xiphias gladius (Swordfish)

Istiophorus platypterus (Indo-Pacific sailfish)

Fig.7. Selected large pelagic species recorded along Odisha coast

which fetches higher price than the trawl catch. Beach landing is the most prevalent method of landing along the Odisha coast as most of the places lack proper harbour facilities, infrastructure/shed for auctioning and handing of the fishes. Some of the landing places are also located in remote areas, which create issues of transportation.

Conclusion

Most of the large pelagics (oceanic tunas, sailfish and dolphinfish) are highly migratory. While larger adult fishes are found in deeper waters, juveniles are mostly found in the coastal waters. The fishery of Odisha is presently restricted to nearshore coastal waters and no deep sea fishing vessels are deployed, unlike in states like Kerala, Tamil Nadu, Maharashtra and Gujarat. Introduction of deep sea vessels with proper storage facilities, establishing infrastructure facilities for landing and processing, skill development for fishers and marketing support are options available to develop the fisheries for large pelagics along the Odisha coast.

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Decadal status of Large Pelagic fishery in West Bengal

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Abstract

The marine landings of the state have fluctuated widely over the years with the maximum of 4 lakh tonnes recorded in 2011. Pelagics dominate the marine fishery and contribute around two-third of the marine landings. Major large pelagic resources landed were seerfishes, queenfishes, tunas and cobia. Sporadic landings of barracudas, billfishes and dolphinfish were observed in certain years. Average annual landings of large pelagics during 2010 – 2019 were 6,131 t forming 2.65% of the total state landings. More than half of the landings were contributed by seerfishes, followed by queenfishes. Major gears contributing to the landings were gillnets (60%) and trawl nets (38%). *Scomberomorus guttatus* formed 95% of the seerfish landings and were landed by both trawl nets and gill nets, whereas *Scomberomorus commerson* landed only by gillnets. Among queenfishes landed by trawl nets and gill nets, *Scomberoides lysan* dominated followed by *S.tala* and *S.commersonianus*. Tunas landed mostly in gillnets was constituted by *Auxis thazard* (50%) followed by *Euthynnus affinis* (37%).

Keywords: *Large pelagics, decadal trends, West Bengal*

Introduction

West Bengal with a coastline of 158 km has two maritime districts *viz*, South 24 Parganas and Purba Medinipur bordering the northern Bay of Bengal. According to the Department of Fisheries, Govt. of West Bengal, inshore (up to 10 fathom depth) fishing zone covers 777 km^2, offshore (10-40 fathom depth) fishing zone covers 777 km^{2}and the continental shelf (up to 100 fathom depth) covers 17,049 km^2. The state has 59 marine fish landing centres with a marine fisherfolk population of 3.8 lakhs. The dominant large pelagic resources landed in West Bengal are seerfishes, queenfishes, tunas and cobia.

Fishery trends

Average annual landings of large pelagics during 2010 – 2019 were 6,131t. Around 6,370t were landed in 2010 which increased to 8,619t in 2011, after which the landings gradually decreased and reached an all time low of 520 t in 2014. Post 2014, the landings have again increased and in 2019, it was 9,227t (Fig.1). Large pelagics formed around 2.08% of the marine fish landings of the state in 2019. The average contribution of the state in the landings of large pelagics to that of the country during 2010 – 2019 was 2.65%. It varied from a minimum of 0.26%

Fig.1. Trend in the landings (tonnes) of large pelagic resources in West Bengal (2010 - 2019)

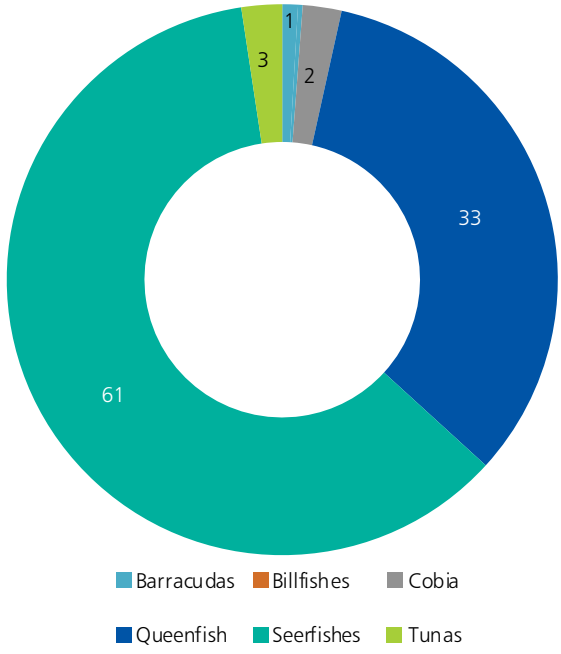

Fig.2. Average species composition of large pelagics landed during 2010 - 2019

in 2014 to a maximum of 4.65% in 2011 being 2% during the 2018 -2019 period.

During 2010 – 2019, on an average, more than half of the landings of large pelagics was contributed by seerfishes followed by queenfishes (Fig.2). Major gears contributing to the landings of large pelagics were gillnets (60%) trawlnets (38%) and Hooks and lines 2% (Fig.3). Trend in landings in major gears is depicted in Fig.4. The landing of large pelagics in gillnets was highest (5,743 t) in 2017. Generally, landings in gillnets were higher during 2010 – 2011 (4,522 t annual), 2013 (3,659 t) and 2015 (3,792 t). In trawlnets, landings were high in 2010–2011 (2,951 t annual) and again during 2016–2019 (3,091t annual). Lowest landings in gill nets (458 t) and trawl nets (31 t) were recorded in 2014.

Seerfish was the dominant large pelagic landed with an annual average landing of 3,204 t, forming more than half of the catch of large pelagics. Landings were high in most of the yeras. Highest landing of 7,388 t was recorded in 2011. Lowest landing of 320 t was in 2014. Other years with appreciable landings were 5,202 t in 2010 and 5,443 t in 2017. During 2010 – 2012, contribution of seerfish to the landings of large pelagics was significantly high, around 81.62%, with the highest contribution of 85.72% in 2011. Mechanised gillnetters and mechanised trawnets were the major gears exploiting, with a contribution of 57.57% and 42.43%. From 2010 to 2017, gillnet was the dominant gear, however, in 2018 and 2019, trawlnet was found to be major gear exploiting seerfishes. *Scomberomorus guttatus* formed 94.57% of the landings and were landed by both trawlnets and gillnets, whereas *S.commerson* formed the rest and were landed only in gillnets. Significant contribution of *S.commerson* was only observed between 2016 and 2019 (14.79%), in rest of the years, *S.guttatus* dominated.

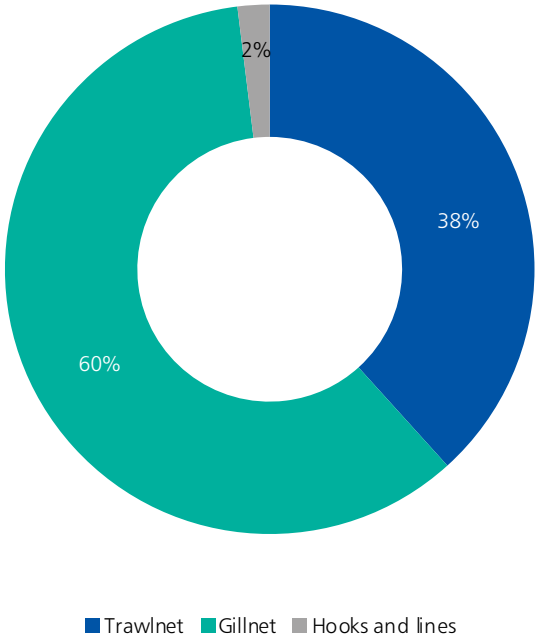

Fig.3. Gearwise contribution to the landings of large pelagics during 2010 – 2019

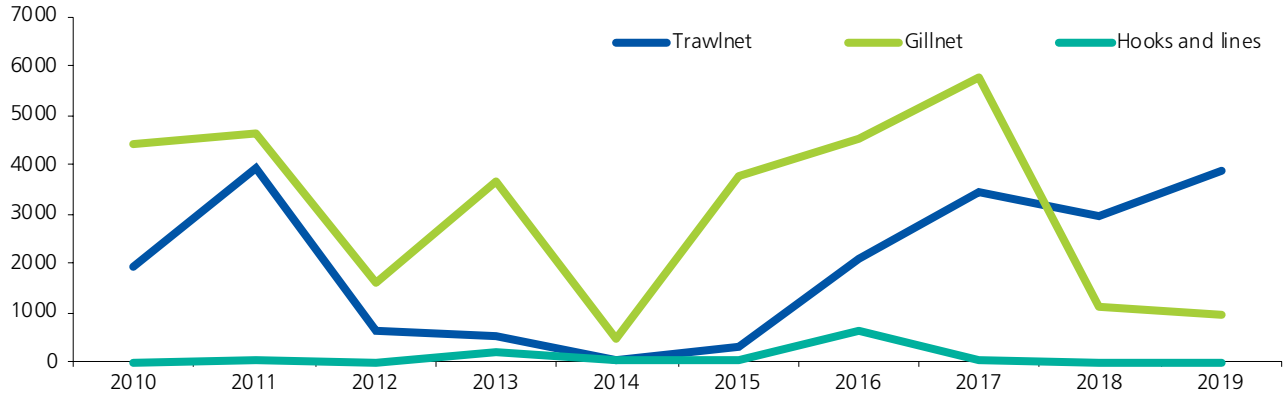

Fig.4. Gearwise landings (t) of large pelagics during 2010 -2019.

Highest landing was in October, forming 21.2% of the annual catches, followed by November with 14.9% of the annual catches.

Annual average landings of Queenfish during 2010 – 2019 were 1,646 t, and fluctuated widely over the years, with the highest landings recorded in 2013 and 2015–2017. The landings in 2013, 2015, 2016 and 2017 were 2,217 t, 2,685 t, 3,091 t and 3,127 t. Lowest landing of 169 t was in 2014. In 2013 and 2015, contribution was exceptionally high, wherein it formed 50.0% and 64.7% of the landings of large pelagics. Mechanised gillnetters contributed 83.11% to the landings and mechanised trawlers contributed 16.89%. Four species were represented in the landings viz., *Scomberoides commersonianus*, *S.lysan*, *S.tala* and *S.tol*. *S.lysan* was landed in both trawlnets and gillnets, whereas the rest were landed only in gillnets. The landings were contributed by *S.lysan* (38.38%), followed by *S.tala* (29.93%) and *S.commersonianus* (22.93%). Contribution of *S.lysan* was very high during 2010 – 2013 (95.39%), after which it gradually decreased and in 2019, it contributed only 8.96%. When landings of *S.lysan* were low, increase of *S.tala* (2016 and 2017) and *S.commersonianus* (2015, 2018 and 2019) was observed.

Average landing of tunas during 2010 – 2019 was 154 t, forming roughly 2.0% of the landings of large pelagics. Highest catch of 429 t was recorded in 2019. Catches were minimal during 2012 – 2016, with an average landing of 21.3 t, constituting less than 1% of the landings of large pelagics. Around 96% of the landings were from gillnetters and the rest (4%) from mechanised trawlers. Around half of the landings (50.1%) were constituted by *Auxis thazard*, followed by *Euthynnus affinis*(37.45%). The rest was contributed by *Thunnus albacares* (0.51%), *Thunnus tonggol*(8.22%) and *Katsuwonus pelamis* (3.72%). *A.thazard* dominated the tuna fishery, contributing somewhere between 60% and 80%, in 2010 (249 t) and 2011 (154 t) and again, in 2017 (159 t) and 2018 (137 t). There was no landing in 2013. The contribution of *E.affinis* was highest in 2019, wherein 267 t was landed forming two-third of the tuna caught. There was no landing in 2010 and 2014. Other years in which it contributed significantly were 2011 and 2017, wherein close to 100 t was landed. *T.tonggol* was the dominant resource in 2014 contributing 79.5%. Significant landings were recorded during October – January, wherein two-third of the annual landings was caught. Highest landing was recorded in October (23% of annual).

Annual average landings of cobia during 2010 – 2019 were 121 t, forming 2% of the large pelagic landings. Landings were highest in 2016, wherein 652 t was landed contributing 8.98% to the catches of large pelagics. Substantial catches were also recorded during 2017 – 2019 (130 t annual). Around 78.12% were landed in mechanised hooks and lines and 21.77% in mechanised trawlnets. Prior to 2016, the landings of barracudas occurred sporadically in 2010, 2014 and 2015 and peaked during 2016–2019. Almost, all the barracudas (98.97%) were landed by multiday trawlnets and rest in gillnets. Seasonal abundance revealed landings to be highest during September – October and also marginally higher during August and November. *Sphyraena jello* formed 17.7% of the barracuda landings. Billfishes were landed only in 2016 (62.3 t), 2017 (80.3 t) and 2018 (67.9 t) and formed 0.82% of the large pelagic landings in these three years. Billfishes were landed only in multiday trawlnets and observed in September only. *Istiophorus*

platypterus formed 43.23% of the billfish landings, the rest (56.77%) being contributed by *Makaira* sp.

High value large pelagics landed in appreciable quantities, like seerfishes and queenfishes are iced and packed to major domestic markets in the state and are sold at premium prices. They are carried in insulated containers, mostly to Kolkata. A part is sent to processing units located nearby and is processed and sent to different domestic markets or exported. Other large pelagics such as tunas, cobia, barracudas, billfishes and dolphinfishes, whose landings are intermittent and irregular are consumed by the coastal communites when landed in small quantities or when there is a glut in the landings, is sent for processing as there is not much domestic demand in the state.

Conclusion

The sustainability of fisheries for large pelagics has recently become a concern and ecosystem-based management approaches are proposed to manage these resources. More detailed studies at the species level are required, with reference to reproductive and feeding dynamics to arrive at the required biological reference limits and subsequent formulation of management plans for sustainable fisheries.

Cage Designs for rearing of Hilsa

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Successful cage farming of fishes in open waters depends largely on the design of the cage as it should suit the behavior of the fish and its hydrodynamics in the location, besides the economics, and operational factors. In view of the above, an experimental cage culture unit for nursery rearing of Hilsa (*Tenualosa ilisha*) was established in Ukai reservoir, Gujarat. The multi-purpose reservoir having a catchment area of 62255 km^2 with a water spread of 52,000 ha has a mean depth of 11.8 m. Based on extensive surveys, the reservoir was found suitable for cage culture of hilsa, as it supported a landlocked population of hilsa and young ones of stockable sizes were available in sizeable quantity. The site selected for cage installation was devoid of macrophytes and water turbulence at a depth of about 10m (Latitude: 21°20'39" N and longitude: 73° 49'13" E). Nursery rearing trials were performed with two types of cage designs, considering the fast-moving behavior of the fish. One was a rectangular cage (15x5m) and the other, was a circular cage (6m diameter) with depth of 3m each. The fabricated cages for nursery rearing were made up of High Density Polyethylene (HDPE) and PP net was used as an outer predatory and as an inner net for stocking the fish. A bird net for the top cover to avoid predation by birds was also provided. The cage frames were made up of 140mm HDPE pipes (PE 100 PN 10). Cat-walk and handrails were made of 90mm HDPE pipes (PE 100 PN 10) for the safety of the workers while feeding the fishes and on routine management (Huguenin, 1997). The bottom of the net cage was provided with a ballast made of HDPE pipe filled with weights for keeping the net cage in shape and volume. The collars *viz*., horizontal, diagonal, and vertical base brackets, were made up of HDPE material. A pair of floatation pipes made of HDPE, filled with expanded polystyrene, was used to give adequate structural strength and buoyancy for floatation of the cage structure. The ballast pipes were provided with holes for the free flow of water and for increasing its weight. Considering the size of the hilsa seeds to be stocked, the mesh size of the inner net was fixed at 8mm. To prevent predatory fishes and also to provide security to the inner net, an outer net having 25mm mesh was used. The bird net provided on top of the cages was of 35mm mesh. The cages were anchored individually using a single-point revolving mooring system with 80 grade long-linked alloy steel chain. RCC blocks of two tonne weight installed at the reservoir bed served as an anchor and a revolving shackle of three tonne capacity was provided to allow free rotation of the cages (Fröyaringen, 2003; Kristiansen and Faltinsen, 2012).

Tenualosa ilisha being a fast-swimming fish and a plankton feeder, its behaviour concerning swimming depth and speed was studied in both, rectangular and circular cages. It was observed, that the fish moved at a fast pace inside the rectangular cage, in straight lines, and frequently dashed against the walls of the net cage resulting in fatal injuries on their snouts. In the circular cage, though the fish moved speedily, it followed the circular shape of the cage and slowly got acclimatized to the cage environment. The acclimatization of hilsa juveniles collected from the wild, during nursery rearing in the cages and their survival were better in circular cages. Taking a clue from the above, similar circular cages were fabricated and installed for grow-out culture, which ensured high growth rate and survival of the cultured fish. This highlights the need for adequate studies on the behaviour of the various fish species in cages for their successful cage aquaculture operations.

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Moulting anomalies in Scalloped spiny lobster

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Scalloped spiny lobster, *Panulirus homarus* (Linnaeus, 1758) is a commonly available and commercially important spiny lobster species along Gulf of Mannar, on the southeast coast of India. Specimens caught in the bottom set gillnet fishery were collected from Manapad fish landing centre, Thoothukudi District and after 30 days of holding period, a lobster (body length 145 mm; weight 98 g) with anomalies in the carapace and right antenna was recorded. The lobster maintained along with other healthy lobsters and fed *ad libitum* with pellet diet (Protein 40% and Lipid 8%) showed normal biological activity including feeding until it succumbed after 28 days of observation period. Another lobster (body length 92 mm; weight 24.2 g) collected from model sea cage farm at Sippikulam Sea, Thoothukudi and reared in the marine research aquarium, showed similar abnormality after few days of acclimation similar to the earlier lobster. This lobster succumbed to predation by another lobster.

In both the specimens, lower end of carapace shows deformity and completely exposing the gills (i.e., arthrobranchs) on both sides. The gills were initially pale yellow later turns to dusty brown in colour. The carapace and abdomen joint region was pliable as the shell uncovered in the body. In addition the first lobster showed a deep indentation at the middle point of the right side antenna and few twists at the distal end towards the tip. It was reported that such deformities may be associated to problems with chitin production and shedding of exuvia. The role of nutrient deficiency or culpable shedding of exuvia due to stress or infection is also to be explored further.

Fig.1. Dorsal view of spiny lobster showing deformed antenna and exposed gill region

Report on cetaceans stranded in the Gulf of Mannar

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A dead female dolphin identified as Spinner dolphin, *Stenella longirostris* (Gray, 1828) was found washed ashore at Dhanushkodi near Rameshwaram, Ramanathapuram district, Tamil Nadu along the coast of Gulf of Mannar (09.1836111 N; 79.4061111 E) on 24th August 2020. Morphometrics recorded are given in Table 1.

Table 1. Morphometric measurements of the Spinner dolphin

Morphometric	Measurement (cm)
Length, snout to melon	: 16
Length, snout to angle of mouth	: 24
Length, snout to blowhole	: 29
Length, snout to center of eye	: 28
Length, snout anterior insertion of dorsal fin	: 74
Length, snout to tip of dorsal fin	: 85
Length, snout to fluke notch (total length)	: 152
Length, snout to anterior insertion of flipper	: 36
Length, snout to center of umbilicus	: 80
Length, snout to center of genital aperture	: 108
Length, snout to center of anus	: 114
Length, notch of flukes to center of anus	: 40
Length of flipper: anterior insertion to tip	: 26
Length of flipper: axilla to tip	: 17
Width of flipper: Maximum	: 8
Fluke span	: 27
Width of flukes	: 12
Depth of fluke notch	: 2
Height of dorsal fin	: 24
Width of dorsal fin	: 15
Base of dorsal fin	: 26
Girth: axillary	: 64
Girth: maximum (at anterior insertion of dorsal fin)	: 74
Girth: at the level of anus	: 33
Blubber thickness: ventral	: 2
Total number of teeth on one side of upper jaw	: 47
Total number of teeth on one side of lower jaw	: 42

The specimen was relatively lean with slender head at the apex of the melon. The melon was slightly convex and the flippers were slender and recurved. The dorsal fin was relatively wide-based and falcate in shape. The tail stock was relatively deeper with enlarged keel (post-anal hump). The total numbers of teeth in each half of the upper jaw were 47 and lower jaw were 42. The necropsy was performed on the same day. There were no significant external injuries or lesions except few abrasions which might be due to physical damage after death. The actual cause of death could not be determined as most of the internal organs were in advanced stage of decomposition.

Two adult sea cows (*Dugong dugon*), were found stranded along the Gulf of Mannar coast at Pudumadam (09.273446 N; 78.996251 E) and at Singivalai Kuchi near Vedhalai (09.274886 N; 79.062368 E). This included a female sea cow on 24th August 2020 and a male on 04th September 2020, respectively (Fig.2 a & b). The morphometric parameters recorded are given in Table 2.

Fig.1. Stranded Spinner dolphin, *Stenella longirostris* in the Gulf of Mannar

Fig.2. Dugongs found ashore in Gulf of Mannar. (a) Female and (b) Male sea cows

Table 2. Morphometric measurements (cm) of *Dugong dugon*

Morphometric parameters		Female	Male
Tip of snout to fluke notch	:	295	270
Tip of snout to center of anus	:	220	211
Tip of snout to center of genital aperture	:	205	198
Tip of snout to center of umbilicus	:	182	171
Tip of snout to anterior insertion of flipper	:	75	72
Tip of snout to center of eye	:	39	35
Tip of snout to external ear	:	51	49
Center of eye to ear	:	12	10
Distance between centers of eyes	:	33	33
Center of eye to center of nostril (same side)	:	22	20
Flipper length, anterior insertion to tip	:	55	48
Flipper length, axilla to tip	:	42	37
Maximum width of flipper	:	29	24
Girth at umbilicus	:	202	180
Girth at axilla	:	152	146
Length, Muzzle (anterio-posterior)	:	25	24
Breadth, Muzzle (lateral)	:	24	22
Length, Chin	:	16	15
Breadth, Chin	:	17	17
Sex	:	Female	Male
Weight (approximate)	:	300 kg	300 kg

The necropsies were performed on the same days of stranding. No significant external injuries or lesions on the female cetacean except few abrasions and sloughed off patches of skin which might be due to physical damage after the death of animal was noted. The body of male cetacean was relatively robust with loss of one fourth of the ventral skin along with blubber from the abdominal region of the body. The male animal was comparatively more damaged than the female. The internal organs of both the specimens did not reveal any significant abnormalities and cause of death could not be ascertained as they were in advanced stages of decomposition. Sea cows are sluggish animals and prefer shallow protected bays. They are herbivorous marine mammals mostly relying sea-grasses.

A note on Green turtle found on Thikkody beach

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The carcass of a green turtle (*Chelonia mydas*) was found on Thikkody beach which is only 10 kms from the regular nesting area 'kolavipalam' located in Kozhikode, northern Kerala. Found on 27.2.2020, observations indicated that the turtle was entangled in a gillnet and had injury to the head. The semi decomposed specimen was 84 cm in total length and weighed approximately 45 kg. Carapace length and width were 72 and 70 cm respectively. Globally, the Green turtle has an endangered status in the IUCN Red List and population is decreasing. In India, the species is listed in Schedule-I part (2) of the Indian Wildlife (Protection) Act, 1972 for conservation purposes. The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) has recorded it in Appendix-I and the Convention on Migratory Species has included it in Appendices I and II.

Fig.1. Green turtle found on Thikkodi beach

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