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Landings of live Blue swimmer crab, *Portunus pelagicus* in Mandapam

Photo credit: Sakthivel, 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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MFIS
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From the Editorial Board

Warm greeting to all our esteemed readers

Globally, capture fisheries account for 80% of the seafood supply with the rest coming through mariculture. Improved management of wild fish stocks and adopting appropriate mariculture policies is vital for ensuring a sustainable seafood supply line. Spatial information plays a very important role in the management of living and non-living resources, terrestrial and aquatic. Introduction of a spatial data layer in the marine fish landings data collection model within the existing stratified multi-stage random sampling framework was recently evaluated by ICAR-CMFRI and the interesting observations are reported. It furthers our understanding of the intricacies and nuances of spatial data and its potential use for fisheries management. Enhancing fish production from mariculture systems remains a priority for fish farmers and results of an assessment of the growth performance of Indian pompano under various culture systems is reported. This issue of MFIS also includes notes on issues of contemporary interest, including invasive marine species, marine debris and need for tapping marine fishery resources in a sustainable way.

MFiS
Marine Fisheries Information Service
Technical & Extension Series

Contents

Enhancing the quality and utility of India's Marine Fish Landing Data Collection and Processing System using spatial information

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Abstract

The ICAR-Central Marine Fisheries Research Institute is mandated with the monitoring and assessment of marine fishery resources of India. The methodologies adopted for the collection and processing of fish landings data have undergone due changes in tune with developments in the relevant scientific fields. This paper discusses how the addition of spatial domain information explicitly to the present fish landings data collection process would be beneficial in analysing, visualizing and extracting additional information from the fish landings datasets.

***Keywords**: Spatial analysis, marine fish landing data, interactive map*

Introduction

In the universe, every phenomenon that occurs has a spatial dimension and any analysis of these, without a spatial dimension, is incomplete. Spatial information should form an integral part of the studies leading to the management of living natural resources. The inherent data linkages become more clear when spatial dimension is added. In the past, integration of spatial data to analytical process was not that easy as the required expertise and skill and software options necessary for the analysis was limited and costly. In the last decade, there has been an explosion in the spatial data realm in terms of software tools, data collection procedure and analysis, human expertise available for handling spatial data and how spatial information is used in the day to day life. Spatial information has been extensively used in almost all the fields of study, be it natural sciences, social sciences, archaeology, surveying, marketing and particularly in fish resource mapping elsewhere in the world (Previero *et al.*, 2018; Le´opold *et al*., 2014; Richards-Rissetto and Landau, 2014; Giacomo, 2019; Kaymaz et al., 2017; Llobera, 2011; Carocci *et al*., 2009).

Monitoring and assessment of marine fishery resources of India is one of the most important mandates of the ICAR-Central Marine Fisheries Research Institute (CMFRI) which the Institute has been doing since its inception in 1947. Towards this, the sampling design, data collection and processing system has been modified and upgraded from time to time (Srinath *et al*., 2005). As of now, spatial information such as depth of actual fishing area, distance from the landing centre in addition to the latitude and longitude of the landing centres are being collected. However, these spatial information are not fully utilized in the analysis, and thereby valuable information that could help in better management of the marine fish resources is being lost. Considering this, an attempt to passively georeference the fishing grounds using available spatial information and giving a spatial dimension to the data was made. For this, an App consisting of an interactive map was developed using ArcGIS, QGIS and Leaflet. This pilot study was a part of the LENFEST funded international collaborative project on 'Benchmarks for Ecosystem Assessment: Indicators and Guidelines for Practical Ecosystem Based Fishery Management' led by CSIRO, Australia.

Features of the tool

Geolocating of the Fishing Grounds

In 2018, CMFRI shifted from a paper and pencil method of fish catch data recording to an electronic tablet mode (Mini *et al*., 2020). For this, an App with an interactive map was designed and installed in the tablets used by the field staff for collection of the marine fish landings data for passively geolocating the fishing grounds, based on information collected through an enquiry from the fishers. The Chellanam (9.798805˚N and 76.275287˚E) fish landing centre in Ernakulam district, Kerala where only single day fishing crafts are being operated was selected for testing the App. The coastal waters up to a distance of 50 km from the Kerala coast was divided into 0.1º x 0.1º grids (which is approximately 11 km x 11 km grids) and this forms the basic mapping unit (smallest grid indicating a fishing area) of fishing grounds. The information on the average depth of each of the 0.1º x 0.1º grids was extracted and added to the grid layer. The attribute of the grid layer contains information like, grid identification code (GID), the central latitude of the grid, central longitude of the grid and the mean depth of the grid in meters and fathom. Upon clicking the grid cells, these information will be displayed in the tab. By the GID, one can identify the grid to know its coordinates and also the depth information which are the major spatial characteristics of the fishing grounds. The App also contains the locations of the landing centres and the administrative boundaries of Kerala. When clicked on the landing centres icon, a popup window provides details such as name, zone code, state and the serial number of the landing centre. Likewise, the users also get information about administrative boundaries. The depth contours of 5, 10, 20 and 30 m are also provided in the map to get an easy visual reference of the depth of the area. Panning and zoom control buttons are provided in the top left corner of the map for easy navigation through the map. A measurement tool provided on the top left corner of the map can measure the distance between two points and also estimate the area by joining the points to make a polygon. On the top right of the map window, the map layer list is provided and one can switch on and off any layer using the checkboxes provided. In the layer list window, there is a direction diagram for easy reference of the direction from the landing centres (Fig 1 and 2).

Data collection procedure

The FRAD (Fishery Resource Assessment Division) field observer can enquire with the fishers about the distance

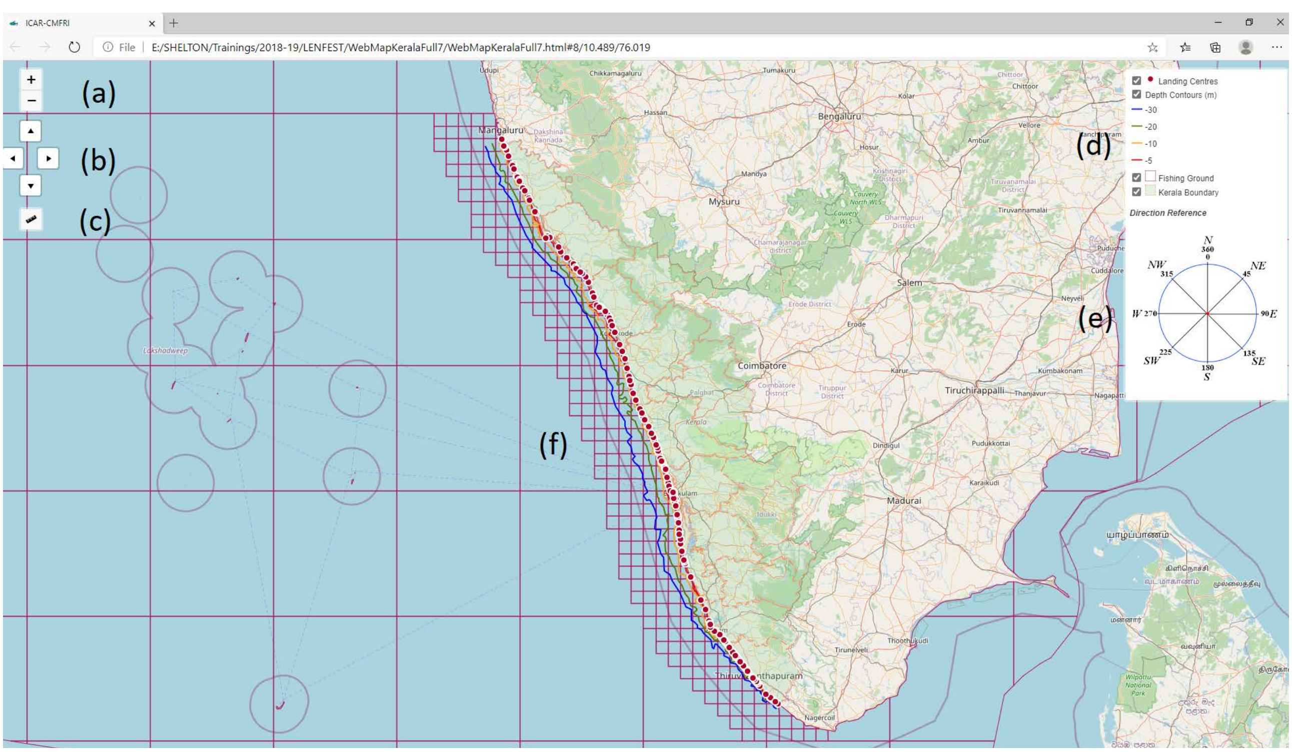

Fig. 1. Homepage of the interactive map showing zoom control buttons (a), panning buttons (b), measurement button (c), map layer list (d), direction diagram (e) and the fishing ground area (f).

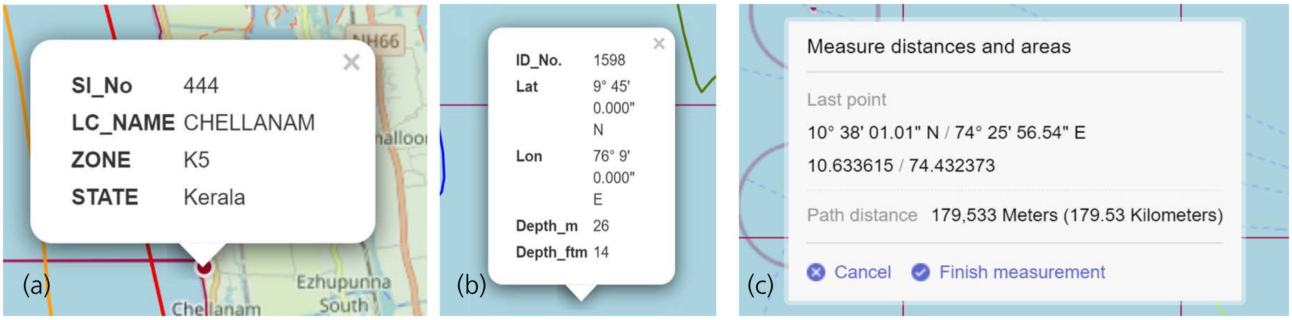

Fig. 2. Popup windows showing the landing centre information (a); fishing ground information (b) and the measurement tool window showing the distance information (c).

and direction of their fishing operation from the landing centre and also about the depth of the location at which the fishing activity was carried out. Using the measurement tool, direction reference and the depth information, he can identify the polygon in which the fishing activity was carried out (Fig 1 and 2). By clicking on the polygon, one can get the grid identification code (GID) of the polygon which he needs to enter in the datasheet along with the other information about fishery he collects usually from the landing centre. Using this GID, during the data processing phase, one can carry out a bunch of spatial data analysis which can throw better light on the fishery resources of the area. For this pilot study, the fish landing data collected were from the Chellanam fish landing centre on 16, 17 and 18 October, 2019.

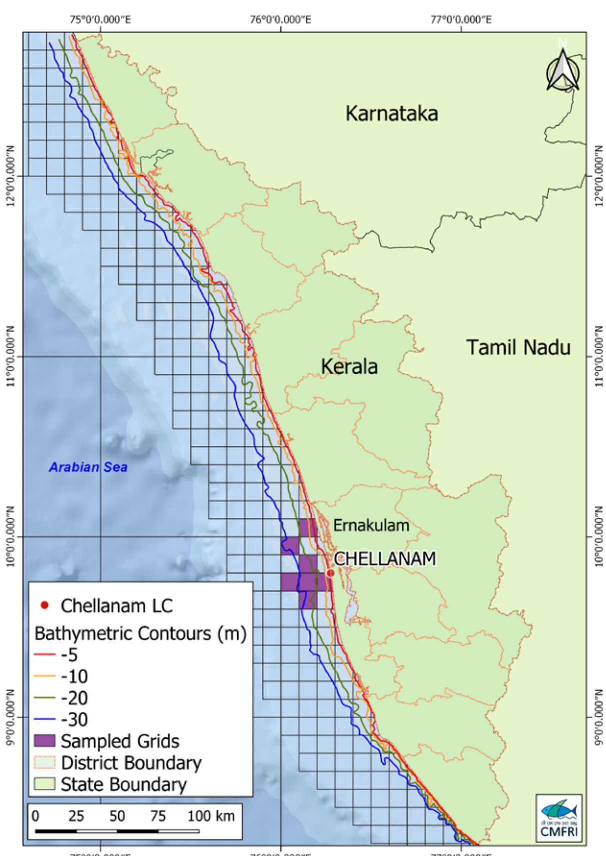

Fig. 3. Fishing grounds exploited by the crafts from Chellanam landing centre

Data analysis

On plotting the data in GIS platform, it was seen that the observed fishing crafts operated in 7 fishing ground polygons near the Chellanam landing centre. The farthest fishing ground was approximately 40 km north-west and the maximum depth of operation was 30 m (Fig. 3). The grid identification codes (GID) in which fishing operations were carried out were 50, 60, 72, 82, 83, 84 and 94. Out of the seven fishing ground polygons, five fishing crafts carried out fishing in two polygons (GID 83 and 84) and only one fishing craft each was found fishing in all the other fishing ground polygons. This indicates that the fishing grounds with the GIDs 83 and 84 has the maximum fish aggregation/fish production areas (Fig. 4).

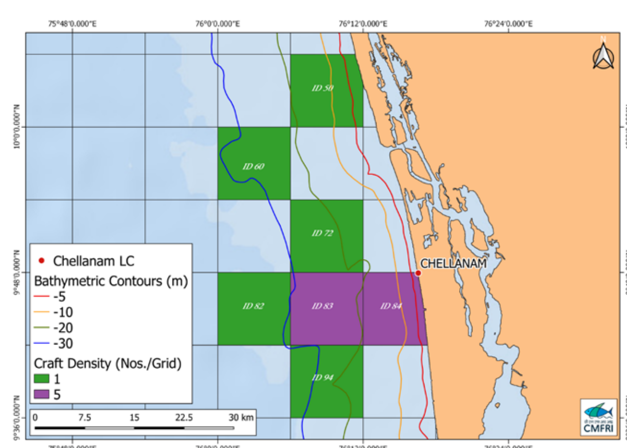

Fig. 4. Combined craft density map for the study period

The types of fishing fleets operated in the sampled area were outboard gillnets (OBGN), outboard hand trawlnets (OBHTN) and outboard ringseines (OBRS). Fishing ground polygons with GID numbers 50 and 82 were operated upon by OBRS only, while in the fishing grounds with GID 60, 72 and 94, only OBGN were used for the fishing activity. Both fishing gears *viz.* OBGN and OBRS were used in GID 83. Similarly, in GID 84, two types of gears namely OBRS and OBHTN were used (Fig 5). In terms of fish availability, the grids with GID 83 and 84 had the maximum number of species (Fig 6). Out of the nine species caught in the study area, four species were available in GID 83 and 84. The species caught from polygon 83 were *Sardinella gibbosa, Opisthopterus tardoore, Thryssa* spp. and *Rastrelliger kanagurta,* while the species caught from polygon 84 for were *Rastrelliger kanagurta, Cynoglossus* spp.*, Parapenaeopsis stylifera* and *Penaeus indicus.* The polygons with GID 50 and 72 yielded three species each (GID 50-*Ambassis* spp., *Rastrelliger kanagurta and Pampus argenteus;* GID 72-*Rastrelliger kanagurta, Opisthopterus tardoore and Thryssa* spp.The polygons with GID 60, 82 and 94 yielded one species each only (GID 60-*Rastrelliger kanagurta;* GID 82-*Sardinella gibbosa;* GID 94-*Rastrelliger kanagurta)*. The polygon with GID 82 reported the highest catch rate followed by GID 83. Gridwise details of species caught, number of fishing crafts operated, catch per unit effort (CPUE), catch per hour (CPH) and catch per grid (CPG) was recorded (Table 1).

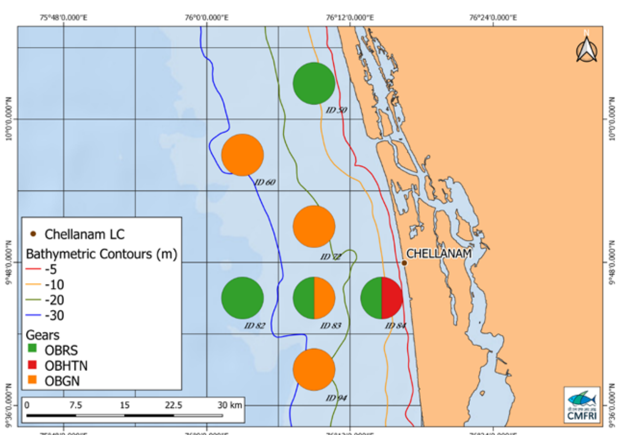

Fig. 5. Bubble map of gear distribution. (Size of bubble indicate the number of gears and the colour indicate the type of gears operated in the grid)

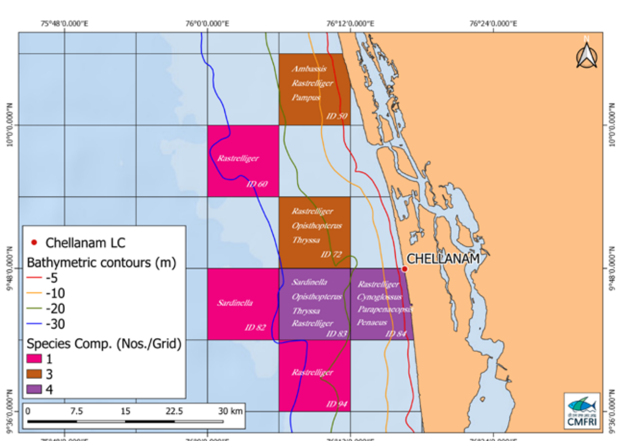

Fig. 6. Fish species caught from the fishing grounds

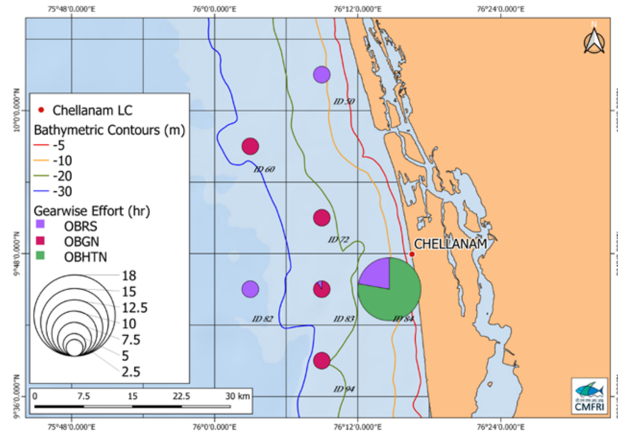

Fig. 7. Bubble map of gear-wise efforts (hr) off Chellanam on the observation days. Size of bubble indicate the magnitude of time (hr) expended by the gears in each grid and the colour indicate the type of gears operated.

Concerning the gear-wise effort in the fishing grounds, polygon with GID 84 reported a total effort of 18 fishing hours (OBHTN - 14 and OBRS - 4), while the GID 83 reported a total effort of 10.5 hrs (OBGN - 9.5 and OBRS - 1). All the other polygons were operated upon by single gears, either OBRS or OBGN and the fishing activity was carried out to a maximum of 2 hours of fishing (Fig 7). The polygon with GID 84 reported the highest total catch of 901 kg out of which 750 kg was caught by OBRS and 151 kg was caught by OBHTN. The next highest catch was from polygon 83 which reported a total catch of 625 kg out of which 360 kg was caught by OBRS and 265 kg was caught by OBGN. In polygon 82, the reported catch was 475 kg by OBRS (Fig 8). Rest of the polygon gear combinations gave < 100 kg catch.

The total fishing hours was more in polygon 84 (18 hours) followed by polygon 83 (10.5 hours) (Fig. 9) indicating that these two polygons were consistently

Table 1. Gridwise details of fishing effort and catch indices

GID	Species caught	Date of operation	Units Operated	CPUE (kg/effort)	CPH (kg/hr)	CPG Species-wise catch (kg)	Total Catch (kg)
50	*Ambassis spp.*	16-10-19	1	24	24	24	32
	Rastrelliger kanagurta	16-10-19	1	2	2	2	
	Pampus argenteus	16-10-19	1	6	6	6	
60	*Rastrelliger kanagurta*	17-10-19	1	53	35.33	53	53
72	*Opisthopterus tardoore*	17-10-19	1	2	1	2	21
	Thryssa sp.	17-10-19	1	1	0.5	1	
	Rastrelliger kanagurta	17-10-19	1	18	9	18	
82	*Sardinella gibbosa*	17-10-19	1	475	475	475	475
83	*Opisthopterus tardoore*	17-10-19	2	2.5	1.5	5	625
	Sardinella gibbosa	17-10-19	1	360	360	360	
	Thryssa sp.	17-10-19	2	1.5	0.75	3	
	Rastrelliger kanagurta	17-10-19	5	51.4	27.1	257	
84	*Cynoglossus spp.*	16-10-19	3	7.33	1.53	22	901
	Parapenaeopsis stylifera	16-10-19	3	42.67	9.3	128	
	Penaeus indicus	16-10-19	1	1	0.25	1	
	Rastrelliger kanagurta	18-10-19	2	375	187.5	750	
94	*Rastrelliger kanagurta*	17-10-19	1	95	47.5	95	95

visited by the fish schools and so the fishermen. But, a look at the gear-wise catch per hour indicated polygon 82 fared the best with catch per hr of 475 kg/hr using OBRS (Fig 10).

A comparison of the present and proposed method of fish landings data collection was also done which indicated the advantages of the proposed method of data collection over the existing method (Table 2).

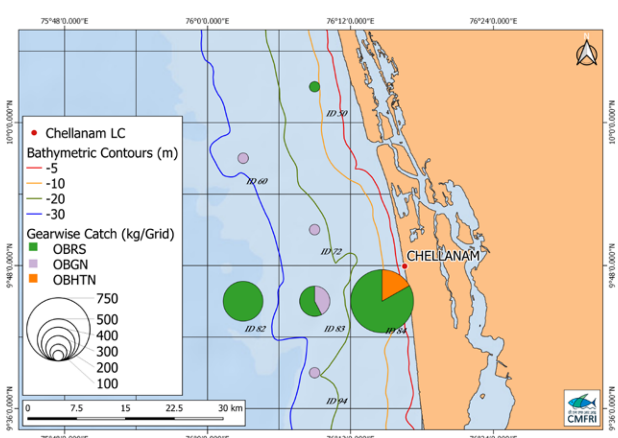

Fig. 8. Bubble map of gear-wise catch (kg/Grid). Size of bubble indicate the magnitude of the catch in kg obtained from each grid and the colour indicate the type of gears operated.

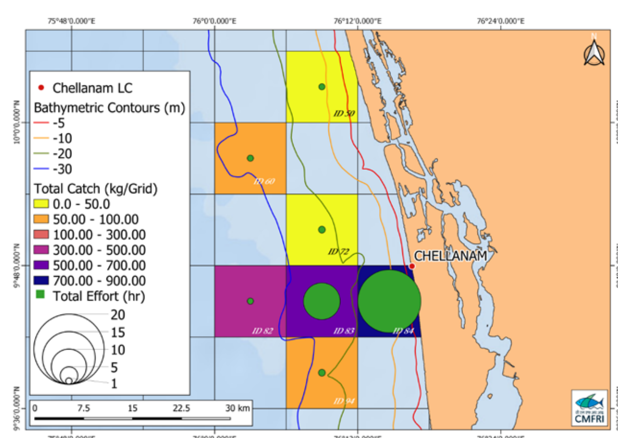

Fig. 9. Total catch and effort in the study area. Yellow to blue shading of the grid indicate the total catch in kg obtained from each grid and the size of the green bubble indicate the total time in hours expended by different gears in the grid.

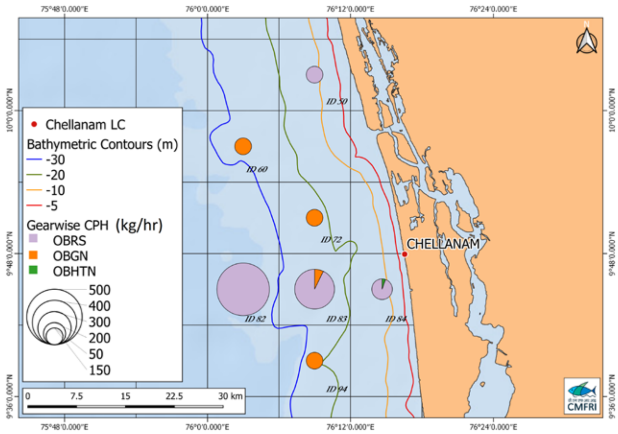

Fig. 10. Bubble map of gear-wise catch per hour.

Size of bubble indicate the magnitude of catch obtained per hour by the gears in each grid and the colour indicate the type of gears operated.

Conclusion

Adding spatial dimension to the fish landings data collection and processing can reveal a lot of additional information for the better management of fishery resources. In the new method proposed, the only additional information required is the polygon identification code (GID) that the field enumerator can collect from the fishers through enquiry and using the App. If the fishing craft is fitted with a GPS, the geographical coordinates collected by the device could be used for spatial querying to identify the GIDs. These operations can happen at the data processing and analysis stage. Adding spatial realm in the marine fish landing data can bring a sea change in the way we analyse, visualize and understand the marine fish landing data and making this change will be beneficial in the long run.

Table 2. Comparative evaluation of the current and proposed new method of fish landings data collection

Parameter considered	Current method of data collection and analysis	Proposed method of data collection and analysis
Fishing ground information	In terms of distance from landing centre, direction and depth	In terms of grid ids
Area-wise information on different catch parameters	Limited information can be derived after converting the direction and distance information to fishing ground locations	The information is available based on the grid ids
Amenability for spatial planning	Limited amenability after pre-processing	Readily amenable
Chance of error in locating the fishing ground	More	Less
Effort in collecting the data	-	No additional effort required after installing the App

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Integrated cage cum pond culture technology for Indian pompano

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Abstract

Indian pompano *Trachinotus mookalee* an important candidate species for aquaculture and can be cultured in different aquaculture systems. Integrated cage cum pond culture is one of the important methods for fish culture. An experiment was conducted to observe its growth performance o in cages integrated with pond farming and compare with the common pond culture. Two ponds of one-acre each were used for the study, in which one pond was stocked with 3000 numbers of *T. mookalee* and the other pond was used for integrated cage cum pond culture. The integrated cages were stocked with 4000 fishes @1000 nos/cage and 1000 fishes were directly stocked into the same pond. In the integrated cages, fishes were initially stocked at 40 numbers/m^3 and on growth advancement reduced to 10 numbers/m^3. The mean weight of the fish after 10 months of grow-out culture was 358±0.21g and 584±0.08g for pond and integrated cage respectively. The result revealed that the fishes cultured in integrated cage cum pond performed better compared to pond culture method. Therefore, integrated cage cum pond culture could be adopted as alternative methods for culture of Indian pompano to further enhancing the fish production.

***Keywords**: Indian pompano, integrated cage culture, growth performance, Trachinotus mookalee*

Introduction

Finfish culture across the world is gaining importance to meet the global fish demand. Presently, marine finfishes are most commonly cultured in coastal ponds and sea cages; additionally, few other high-density culture methods are have been introduced in aquaculture for increasing productivity, including recirculating aquaculture system (RAS), in-pond race way recirculating (IPRS) culture systems (Wang *et al*., 2019). Among all, the pond-based culture uses low stocking density of up to 1 number/m^2, whereas other methods use high stocking density of 15-30 numbers/m^3 area. In spite of having several advantages, the high stocking density methods are having several issues like high cost of production and dependency on skilled manpower. An alternative aquaculture production system has been recently experimented for finfishes by integrating the concept of effective land utilisation and high production. One of such methods is the integrated cage cum pond culture system, in which fish culture in cages is integrated with semi-intensive culture of other or same fish species in open pond (Sipauba-Tavers *et al*., 2016). Fishes in cages are stocked at high density and fed with artificial diet; while, same species or other low value fishes are stocked in pond and fed at low rate or allowed to utilize natural food derived from the pond. This technique uses the niche optimization concept for feeding i.e. the fish stocked in cages installed in pond are fed sufficiently, while, those fishes in pond outside the cage are either fed at low rates or not fed at all.Characters like ease of breeding in controlled conditions, quick adaptability to different culture conditions, tolerance to wide range of salinities, fast growth rate; acceptance of artificial feed, good meat quality and high consumer preference (Ranjan *et al.,* 2018) makes Indian pompano *T. mookalee* a potential candidate species for mariculture. Standardised aquaculture practices for hatchery produced seed has been demonstrated in different culture systems such as cage, pond and recirculating aquaculture systems (RAS). Success in the fish adapting to different culture systems has paved way for attempting farming in integrated cage cum pond culture systems. The growth performance of the Indian pompano *T. mookalee* in integrated cage cum pond culture method was studied in detail during the culture period.

Integrated cage cum pond culture

The experimental fish culture was conducted at Bhavadevarapalli, Nagayalanka Mandal, Krishna District, Andhra Pradesh. Advanced fry (1.5 g) of Indian pompano *T. mookalee* were transported and stocked in 2 m x 2 m x 1 m *hapa* for nursery rearing in the pond. These were nursery reared with floating pelleted feed, for two months in the *hapa*. After reaching juvenile fish stage (35g) these were used in two different grow-out culture systems. Two one-acre ponds were used for the study, in which one pond was directly stocked with 3000 numbers of Indian pompano. In the second pond four cages were installed for integrated cage cum pond culture. The cages were stocked with 4000 fish @1000 numbers/ cage and another 1000 fish were directly stocked into the same pond. Initially, fish were stocked in 4 m x 4 m x 1 m cages @40 numbers /m^3 till the fish reached 250 g. Thereafter, the fish were stocked in 8 m x 8 m x 1 m cages @15 numbers /m^3 till 350g and then the stocking density was further reduced to 10 numbers / m^3 for the remaining culture period. Fish in the pond and as well as in cages were fed four times a day with pelleted feed containing 40-45% crude protein and 10% crude fat. Monthly growth was monitored for a period of 300 days and growth parameters estimated at the end of the culture.

The mean weight recorded for *T. mookalee* after 10 months of culture was 358±0.21 g, 584±0.08 g for pond and integrated cages, respectively (Fig.1). The growth performance in terms of absolute growth rate, AGR (g/day), specific growth rate, SGR (% /day) and feed conversion ratio, FCR were significantly ($p<0.05$) high for fishes cultured in integrated cage (2.91±0.025, 1.83±0.015 and 1.57±0.025) compared to that cultured in the pond (1.74±0.015, 1.53±0.15 and 1.92±0.03). The results showed that the fish stocked in integrated cage had gained 38.7% higher growth than that stocked in pond during the same culture period.

The integrated cages occupied about 11% of water spread area of the pond and produced 3.5 times higher production than the fish reared in pond at a low stocking density (Fig.2). Freshwater fishes experimented with higher stocking density of up to 100 numbers /m^3 in

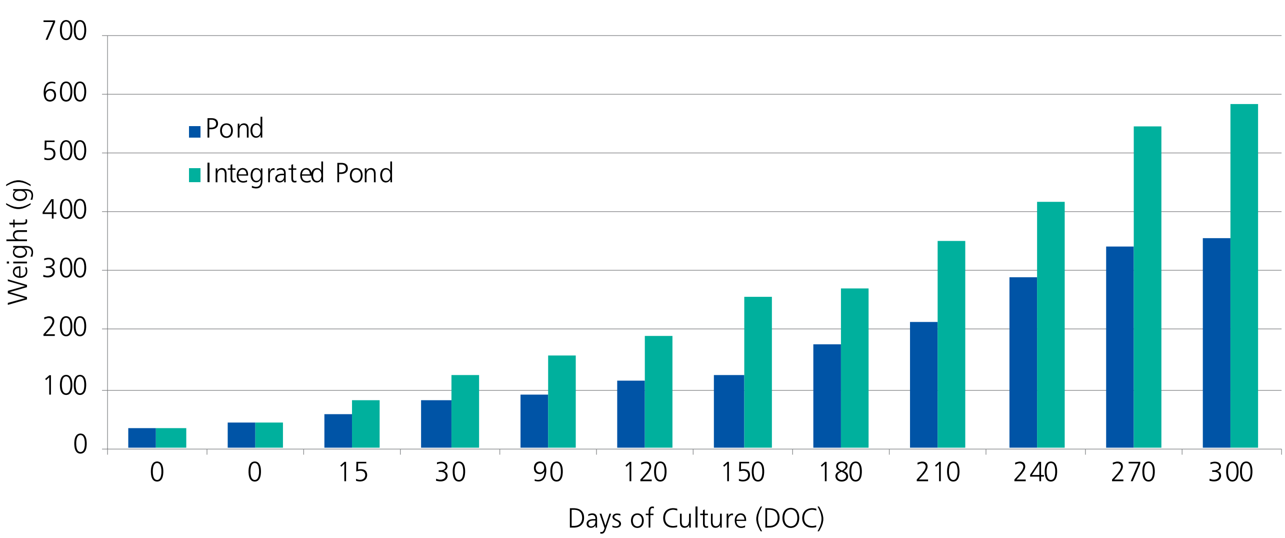

Fig.1. Growth performance of Indian pompano in integrated cages and open pond

Fig.2. Indian pompano sampling from integrated cages

integrated cage culture methods have reportedly attained the maximum production of 24 kg/m^3 by utilizing 20% of the pond area (Quagrainie *et al*., 2011).

Maximum production within limited area of culture by effective land utilisation and scope for polyculture of marine fishes using high value Indian pompano stocked in integrated cages and omnivorous fishes or shrimp in the pond was indicated in the study. However, it was observed that the fishes reared in this method were prone to mortality due to oxygen depletion. Therefore, effective aeration systems in culture pond are required, to avoid fish mortality. The study has revealed that Indian pompano adapted to culture in this novel method exhibited better growth performance than being reared in pond directly. The better growth performance of the fish is due to effective feed utilisation and also restricted movement of the fish within the integrated cages, which reduces energy loss by the fish. Additionally, fish monitoring during culture period is easier and batch harvest is possible with only minimum labour involved. The study suggests that the integrated cage cum pond culture is an innovative alternate method for India pompano culture and further studies to standardise different specific culture system parameters for the fish are required.

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An Account of Large Pelagic Fishery of Maharashtra

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Abstract

Large pelagic fishes are one of the preferred fishes in domestic and international trade. Information on their distribution, abundance and stock status are limited from the Maharashtra coast. Nine major groups are contributing to the fishery in Maharashtra and the major share is of seerfishes (38%). Gillnets contribute 48% of the landings of large pelagics. This group contributed 14% of the total pelagic fish landings during 2007-2019 period with August to December as the months of peak landing, contributing about 63% of the annual landings.

***Keywords**: Large pelagics, Maharashtra, fishery*

Introduction

Large pelagic (LP) fishes are apex predators in the marine ecosystem and most of them also have wide range of distribution and often undertake long distance migration. These resources are exploited by diverse gears off Maharashtra coast and landings showed the noteworthy growth since 1995, linked to the introduction of modern harvesting techniques like purse seines, mechanisation, and spatial extension of fishing areas.

Fishery trends

The LP landing was comprised of tunas, billfishes, barracudas, seerfishes, queen fishes, dolphinfishes, rainbow runner, cobia and needlefishes. Even though a seasonal targeted fishery for LP resources exists along the coast, mostly they occur as bycatch in various gears. The major landing centres for the resources are Naigaon, Sassondock, New Ferry Wharf, Revdanda, Mirkarwada and Malvan (Fig 1).

The average annual landings of different large pelagic resources from 2007-2019 indicated seerfish is the major contributor (38 %) with an average landing of 6,265 t followed by tuna (34%) with an average landing of 5,652t. The average landing of queenfish was 1564 t accounting 9% followed by barracuda (1030t, 6%) while other resources like billfishes (4%), Cobia (4%), Dolphinfish (3%), Needlefish (1.4%) and rainbow runner (0.4%) were recorded. Seer fishes locally called as "Surmai", constituted 38% of LP fishery in Maharashtra during 2007-19. Species such as Narrow-barred Spanish mackerel *Scomberomorus commerson* (57%), Indo Pacific king mackerel, *Scomberomorus guttatus* (32%), Streaked Spanish mackerel *Scomberomorus lineolatus* (10%) and Wahoo *Acanthocybium solandri* (1%) were recorded. Tunas or "Kuppa" was another major contributor to the fishery, accounting 34% of the landings. Species occurring in the landings were Kawakawa *Euthynnus affinis* (55%), Longtail tuna *Thunnus tonggol* (25%) Frigate Tuna *Auxis thazard* (3%), Bullet tuna *Auxis rochei* (2%), and bonito *Sarda*

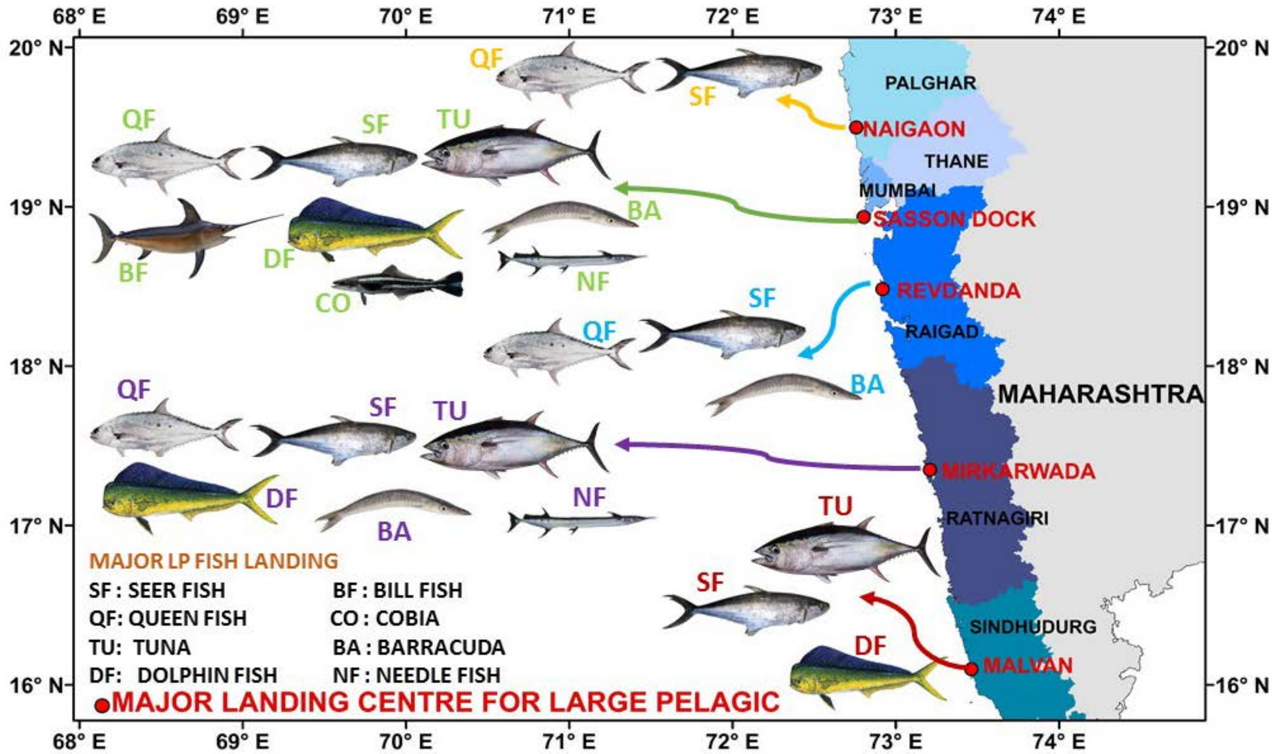

Fig. 1 Major landing centres for large pelagics in Maharashtra

orientalis (1%) among neritic tunas and yellowfin tuna *Thunnus albacares* (6%), skipjack tuna (*Katsuwonus pelamis*) and bigeye tuna *Thunnus obesus* (1%) among the oceanic tunas. Queenfishes locally called as " Dagol" contributed 9% with four species such as Double spotted queenfish, *Scomberoides lysan* (52%), Barred queenfish, *Scomberoides tala* (26%), Talang queenfish, *Scomberoides commersonianus* (14%) and Needle scaled queenfish, *Scomberoides tol* (14%) represented in the fishery. Barracudas known as "Badri/Ghalse" contributed 6% of the LP fishery with Pickhandle barracuda, *Sphyraena jello* (24%), Sawtooth barracuda *Sphyraena putnamae* (16%), Great barracuda, *Sphyraena barracuda* (8%), Obtuse barracuda *Sphyraena obtusata* (1%) and other *Sphyraena* spp. (51%). Billfishes were represented by five species such as Indo-Pacific sailfish, *Istiophorus platypterus* (53%), Swordfish, *Xiphias gladius* (32%), Black marlin, *Makaira indica* (11%), *Makaira* Sp. (Marlin, 3%) and *Terapturus* sp. (spearfish, 1%). Full beaks locally called as "Sumb/Tol", comprised by Flat needlefish, *Ablennes hians* (36%), Hound needlefish, *Tylosurus crocodilus* (10%), *Tylosurus* sp. (33%), Spottail needlefish, *Strongylura strongylura* (7%), Banded needlefish, *Strongylura leiura* (6%) and *Strongylura* sp. (8%) were recorded. Cobia *Rachycentron canadum* formed a minor fishery. Dolphinfishes were represented by two species *Coryphaena hippurus* and *C. equiselis* and fishery dominated by former. Rainbow runner was represented by a lone species *Elagatis bipinnulata*.

Gillnets, purse seines and trawlers were major contributors to the LP landings, while bag net and hook & line were nominal (Fig. 2). In trawls, LP were mostly caught as bycatch along with other targeted groups. Gillnets mainly target seer fish, tuna, billfishes, cobia and queen fishes. Both the motorised and mechanized crafts made up of wood and FRP are engaged in the fishery. The colour of the net changes according to the season and targeted fish. The introduction of purse seining has significantly improved the LP landing and contributes 33.9% of total groups landing. Trawl net contribute 14% of LP landing comprising seerfish, tunas, barracudas, queenfish and Rainbow runner. Bag nets contributed 3% of LP landing and the major species caught were seer fishes, tunas and barracudas mostly being incidental or non-targeted catch. Hook and Line operated from motorised boats target large seer fishes, cobia, billfishes and queen fishes. The multiday bag netters operates about 40 to 50 nautical miles (nmi) away from the coast at 30 m depth zone. The purse seiners and gillnetters operate at 30 to 70 m water depth about 15 to 40 nmi away from the coast. The purse seiners operate up to 80 m water depth and 10 to 40 nmi away from the coast.

LP landings with an average contribution of 14% to the total pelagic fish landings ranged from 18054 t in 2007 to 13653 t in 2019 with an average of 16553 t (Fig.3). They show high seasonal fluctuation, and peak period is during August to December, contributing 63% of the annual landings while January to May is the lean season (Fig.4). Large pelagic fishery itself is considered as a bycatch except for tuna in some parts of Maharashtra. The gill nets, purse seines and trawl nets are mainly targeting rays, sharks and clupeid, and large pelagics often occur as bycatch. The LP landings mainly go to local markets for domestic consumption either in fresh or dried form. The

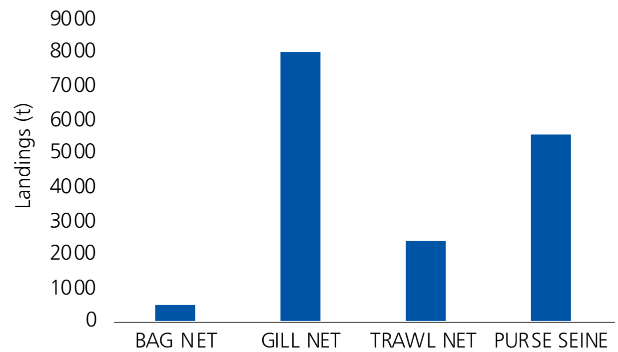

Fig. 2 Gearwise landings of large pelagics

billfishes, cobia, needle fishes, queen fishes, dolphin fishes and rainbow runner are mainly transported to the interior market in a frozen/ iced condition. Barracudas, seer fishes and tunas are mainly exported and rest traded in domestic markets. Only the major landing centres in Maharashtra have facilities like

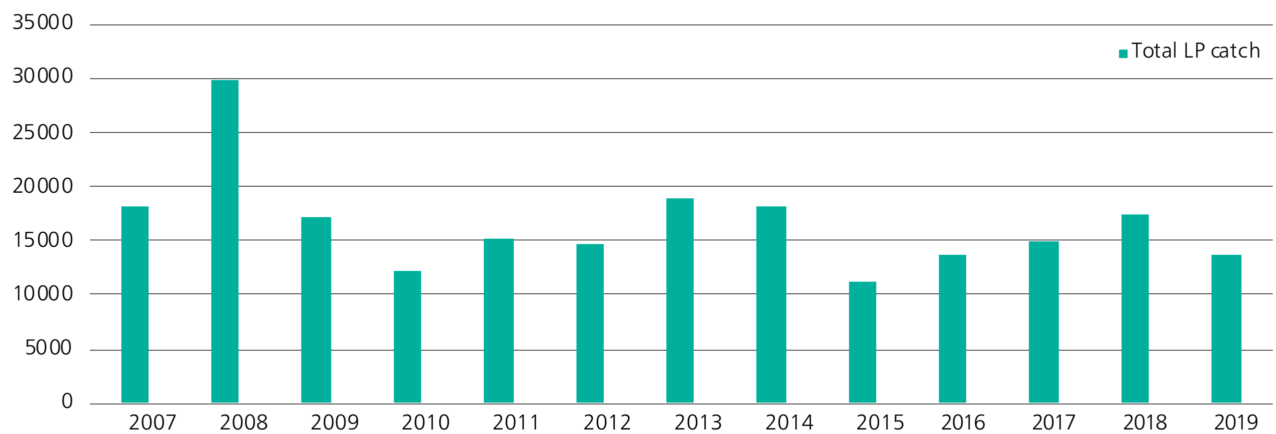

Fig. 3. Trend of annual landings (t) of large pelagics in Maharashtra

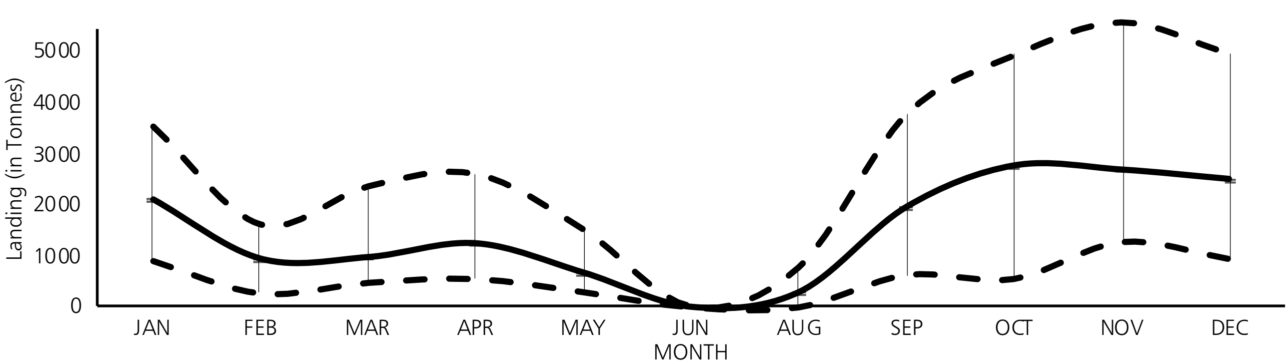

Fig.4. Seasonal landing trends (t) of large pelagics in Maharashtra (average 2007 -2019 with upper and lower limits)

continuous ice supply, and water etc. Refrigerated vehicles are mostly concentrating operations from major landing centres due to assured fish supply and better connectivity. In other minor landing centres, infrastructure is limited and the landings are mainly channelled for domestic consumption. Prices depend on the size and quality of fishes landed with lower quality grades sold in domestic markets in fresh or dried forms. Marketing channels indicate catch is sold to traders/ agents through competitive auction at the landing points. The sorted fishes according to the quality channelled for export industries or to local traders.

Future prospects

There are several minor and beach landing centres and log sheet maintenance for recording fish catch in fishing vessels are mostly absent. Stock assessments of the resources are also limited but required for science-based management advisories. The economic loss incurring at post-harvest stage due to quality concerns is huge but demand for marine fish is increasing and there is scope for value-added and properly stored and processed products from LP. Central Government programmes such as *Pradhan Mantri Matsya Sampada yojana* (PMMSY) to develop infrastructure facilities to handle a large number of fishing vessels and improving supply chains appear promising.

Fishery for the Large Pelagic resources in Gujarat

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Abstract

Large pelagic fishery resources contributed about 4% of total marine fish landing in Gujarat. Tunas dominated among LP resources, followed by seerfishes, queenfish and dolphinfish. They are targeted by mechanized gillnetters and the multiday trawlers with region between Veraval and Porbander as the major fishing zones. Mainly limited to the shelf areas within 200 m depth, the operations extended to oceanic areas beyond 200m during summer months. Poor handling and onboard storage effect the quality of the fishes and market value realised by the fishers. Mainly dried products of LP are traded within the country as well as abroad like Sri Lanka, Tunisia and Thailand.

***Keywords**: Large Pelagics, fishery, Gujarat, tunas*

Introduction

Gujarat's Large Pelagics (LP) fishery accounting 0.31 lakh tons constituted 11% and 4% of the total pelagic fish and marine fish landing respectively during 2018 (CMFRI, 2019). Tunas are the dominant group in the LP fishery followed by seerfishes, queenfish and dolphinfish. The large pelagics are principally tapped by the large mesh drift gillnets and to a limited extend by multiday trawl nets and a brief about the fishery trends is presented.

Fishery trends

Tunas followed by the seer fishes are the major groups constituting the large pelagic resources landing in Gujarat. Queen fishes, barracudas and mahimahi (dolphin fishes) are the other major groups in the fishery (Fig.1). Basically two types of gillnet crafts are involved (i) small FRP canoes of 9-12m OAL fitted with outboard or inboard engine and (ii) Wooden or FRP boats of 6-17m with inboard engine and fish-hold (4-6 t). Voyages of outboard crafts generally last for 3-5 days and mechanized units up to 10 days. The length of the net varies according to the size of the crafts. There has been progressive increase in lengths of the net and have almost reached up to 7000 meters. There has been an increased rate of replacement of smaller vessels with larger ones since 2008, which resulted in improved catch of the target species like the

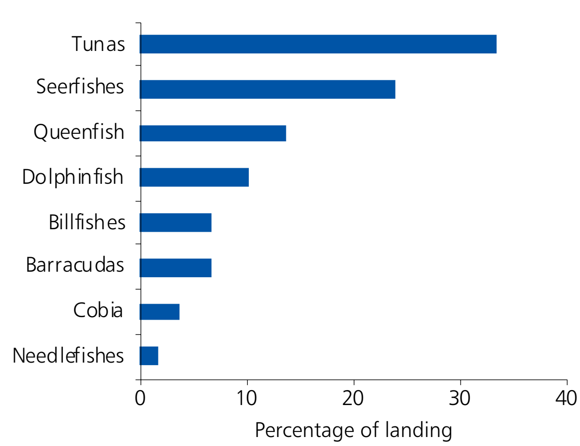

Fig.1. Composition of large pelagics in the landing along Gujarat coast.

longtail tuna. Most of the motorised boats also operate troll line for tunas, mahimahi, seer fishes, cobia, billfishes etc. The composition of gillnet catches varied with the season and the area of operation. The catch comprised tunas, seerfishes, and queen fishes besides barracudas, billfishes, dolphinfish and cobia. The trawl catch of large pelagics are mainly limited to the juveniles or smaller species of certain barracudas (*Sphyraena obtusata*, *S. putname,* etc), queen fishes and seerfishes .

Average tuna landing during 2010-19 was 11105 t (Fig.2). Tuna landings occurs throughout the year with peak during post monsoon months, accounting 65% of annual landing. Outboard gill netters are the major contributor (61%) of tuna followed by Multiday gillnet (34%). *Thunnus toggol* and *Euthynnus affinis* are the dominant species in the fishery. Seerfish landings varied from 9057 to 7462 tonnes during 2010 to 2019 with an average of 9841t during the last 10 years and unusually high catches of 2014 and 2015 (Fig.3). *Scomberomorus guttatus* and *S. commerson* are the two species occurring in the fishery with almost equal share. Fishing season starts from September to April with the peak during October-December. The outboard gill netters is the major gear which contribute 40% of the landing followed by multiday trawlers (32%),

Billfishes formed only 2.5% of the LP landing during 2010-19 with an average landing of 983t. Species contributing to the fishery are Sailfish (*Istiophorus platypterus) (*89%), Marlins (1%) (Black marlin, *Istiompax indica* and blue marlin *Istiompax mazara);* and swordfish (*Xiphias gladius*) (10%). Nearly 60% of the landing was by the mechanized multiday gillnetters followed by outboard gillnetters. Mahimahi, *Coryphaena hippurus* landings have been decreasing since 2017 after the peak landing of 5007t. Landings occurred throughout the year with a peak during November - December and major contribution was by multiday trawlnet (43%), outboard gillnetters (19%) and mechanized gillnetters (12%). Average queenfish landing during 2010-19 was 3997t forming nearly 12.3% of the total LP landing

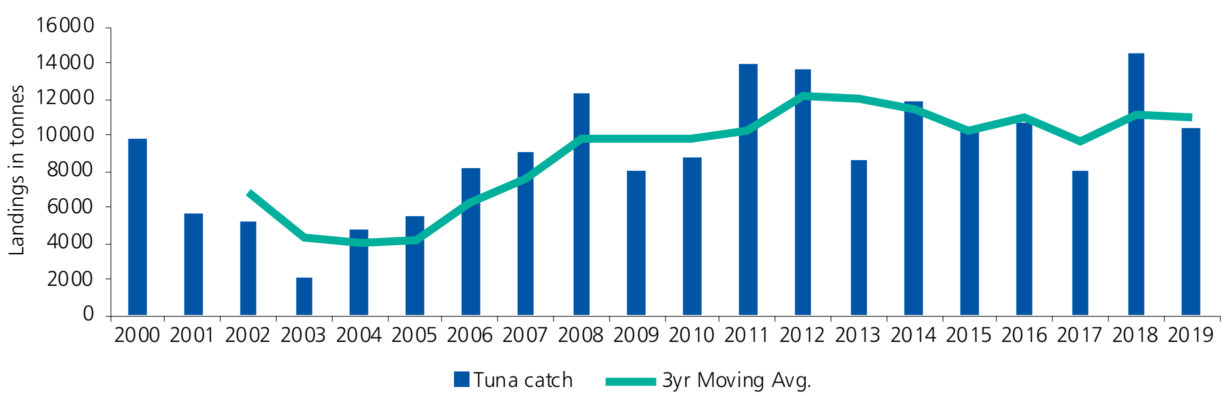

Fig.2. Trend of tuna landings (t) along Gujarat coast

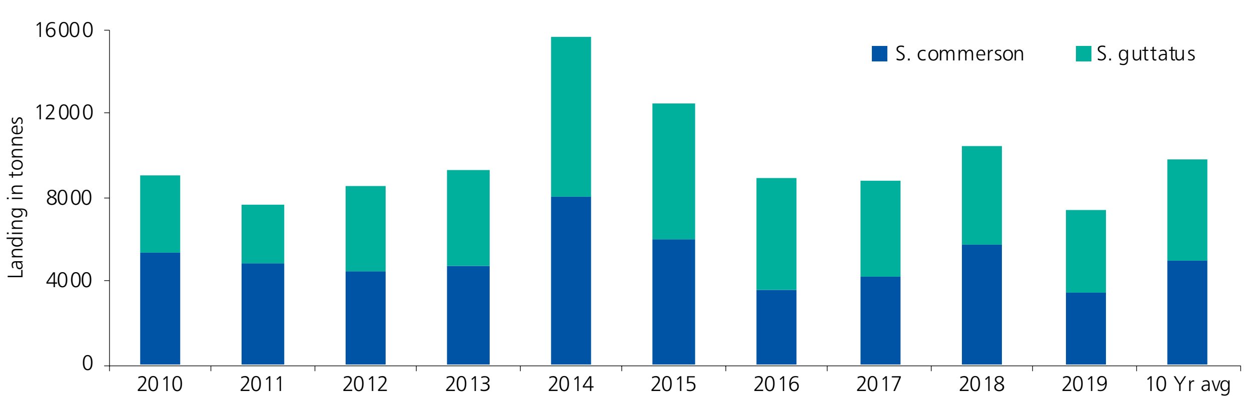

Fig. 3. Trend of seerfish landings (t) along Gujarat coast

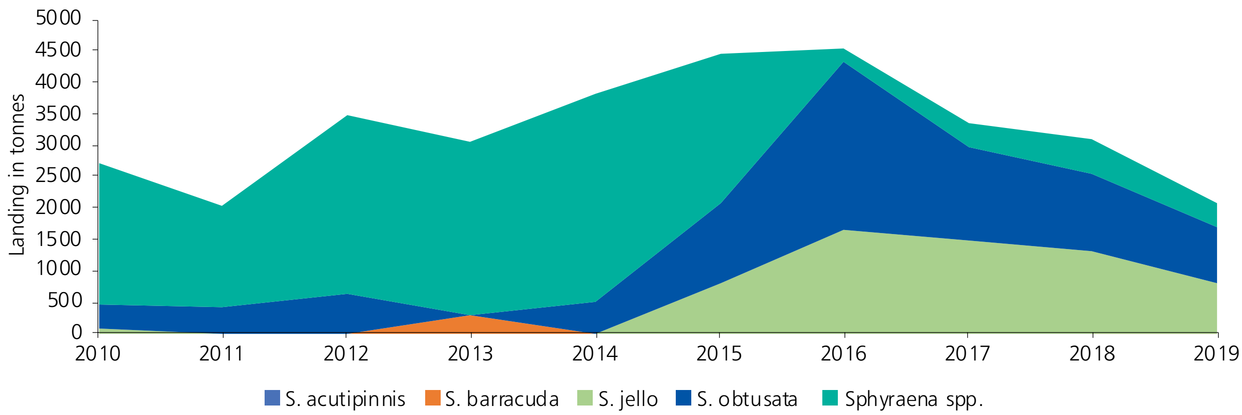

Fig. 4. Species wise trend of annual barracuda landings (t) during 2010 to 2019

in the state. The species supporting the fishery are *Scomberoides lysan* (40%), *S. tol* (5%), *S tala* (1.16%) and *S. commersonianus* (0.73%). They were landed round the year with peak during October-March. Outboard gillnets are the major contributor (39%) followed by multiday trawlnet (32%) and mechanized gillnetter (19%). Barracudas formed about 9% of LP landing during 2010 to 2019 with an average of 3259t. The major species landed are *Sphyraena obtusata, S. jello, S. barracuda* and *S. acutipinnis* with the first two species together constituting over 50% of barracuda landings (Fig.4). Its landed throughout the year with a peak during October to January. Multiday trawlers account for nearly 75% of the barracudas landed followed by outboard gillnetters. Cobia (*Rachycentron canadum*) landings occurred throughout the year with the peak during February-March. Multiday trawlers landed major

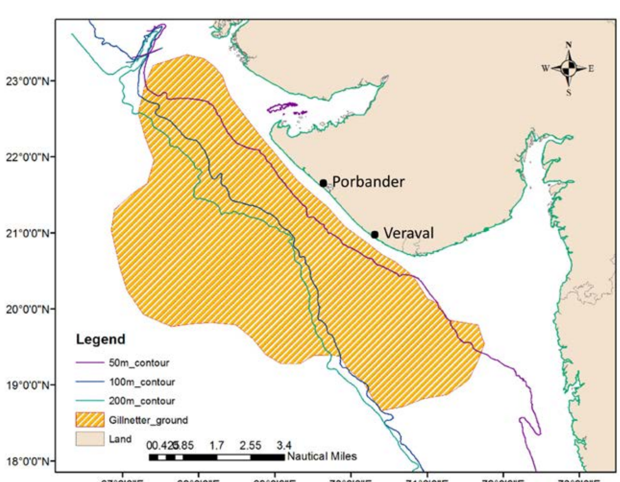

Fig. 5. Fishing grounds of gill netters targeting large pelagic fishes

share (38%) followed by outboard gillnetters (32%) and the mechanized gillnetters (22%). Fishing grounds for the large pelagics is limited mainly to the shelf areas with depth ranging from 14 to 200 m, especially off the Saurashtra coast between 20ºN and 22ºN latitudes with area between Veraval and Porbander being major fishing zones (Fig. 5). The. Fishing operations in the oceanic areas (beyond 200m) are mainly during the summer months (March-May). Occurrence of oceanic tunas and billfishes in the catches from inshore areas during winter months indicates its movement to inshore areas during this period .

Historically, Veraval is known for trade of dried and salted fish products to domestic markets and other neighbouring countries. Queen fishes, seer fishes, billfishes, tunas etc are exported to Sri Lanka in salted form even these days. Domestic fresh fish sales and export in frozen form are prevalent trends. There are several fish processing plants in Gujarat of which a few process the tunas for export in whole or gilled and gutted form; principally for canneries in various parts of the world, especially, Tunisia and Thailand. There is increasing demand for other LP like mahimahi in the export market in the recent years. Owing to the poor handling and storage onboard (inadequate ice-fish ratio, physical damage due to pressure of stacking, increased duration of storage etc) quality of fishes landed are low. There is potential for development of fisheries for oceanic tunas by deploying advanced tuna fishing vessels with modern facilities. Integration of collector vessels that can freeze and store the catch in view of the distance to the fishing ground due to the wide continental shelf off Gujarat is desirable. Gillnet based fishery for coastal tunas and other LP on the shelf may be continued with the existing fleet.

Infestation of rhizocepalan barnacle in the Blue swimmer crab

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The parasitic rhizocephalan barnacle, *Sacculina* spp. were observed in the live Blue swimmer crab, *Portunus pelagicus* while collecting broodstock for crab seed production. Rhizocephalans have been reported from different aquatic habitat like the deep ocean to pelagic, intertidal, brackish water habitat and a few species occur in freshwater also. An infection of rhizocephalan barnacle *Sacculina* spp. in the Blue swimmer crab can be distinguished by an external brood sac (Fig.1A and B) under the host's abdomen, which closely resembles the egg mass of crab. The host will have one or two external brood sac, but these multiple sacs are smaller than a single

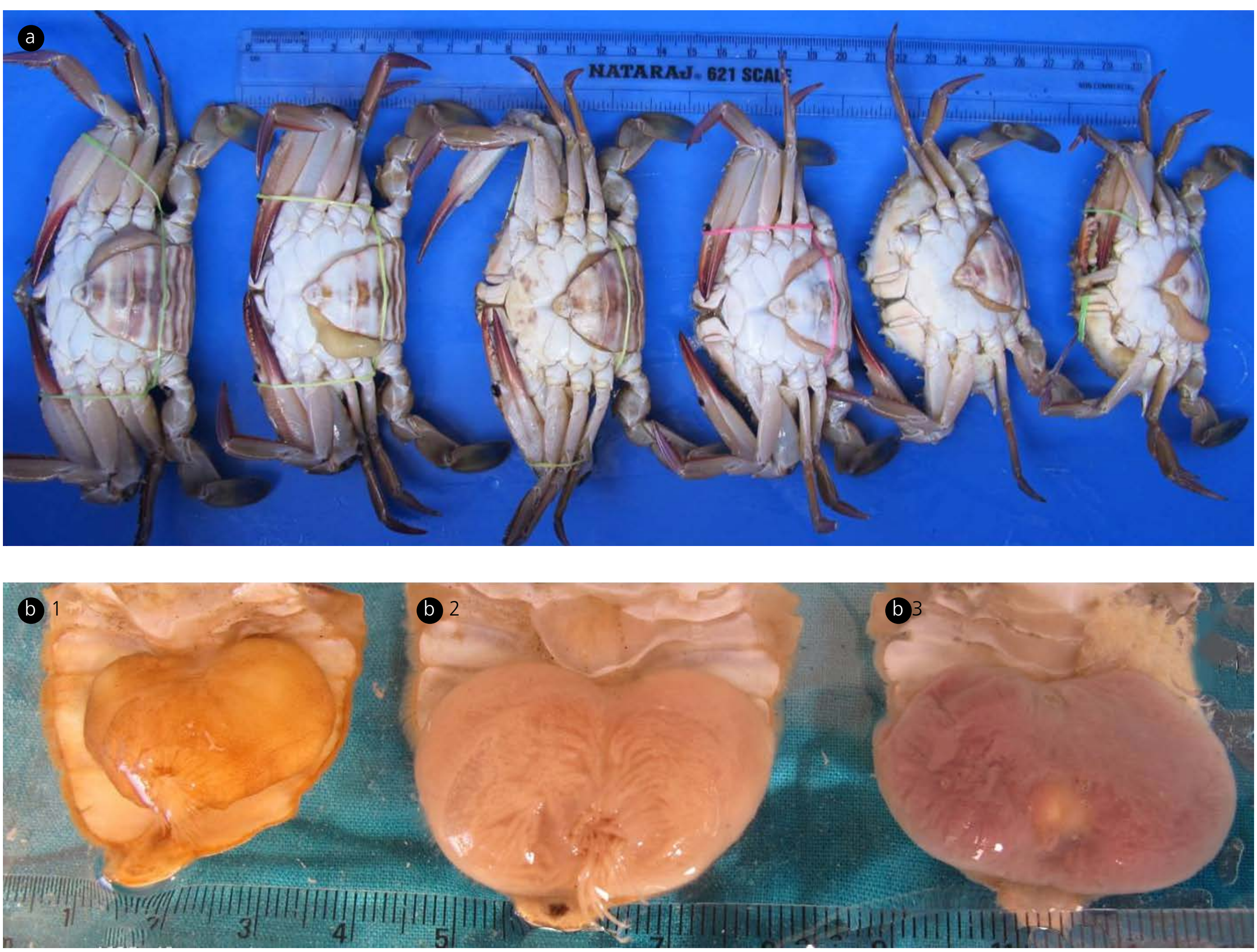

Fig.1.A. Different sized *P. pelagicus* specimens infested with parasitic barnacle *Sacculina spp.*; B. *Sacculina spp.* externae attached on the abdomen of *P. pelagicus* with different maturity stages (B1- Premature, B2- Maturing and B3-Ripe)

one (Fig 3B). As the nauplii within the externa develop, the color of the sac appears brownish to dark brown or purplish until the larvae are released. There are reports that the rhizocephalans can cause "parasitic castration" of their hosts and the secondary sexual characteristics of the host may be altered. Parasitized male and sub-adult female crabs may have a broadening of the abdomen which lead to behavioral modifications like grooming and caring of the externae of rhizocephalan barnacle *Sacculina* spp., as that of females would do for her developing egg mass. In such cases, morphological changes in their abdominal segments resembles abdomen of a normal mature female instead of narrow T-shaped abdomen, deformed abdomen or total loss of pleopods (Fig. 2 and 3).

Male crabs have two pairs of pleopods, that functions as copulatory organ while females have four pairs of pleopods, to which the eggs are attached during spawning and remain there till hatching. In case of total loss of pleopods in *Sacculina* spp. infected male and female *P. pelagicus* there will be reduction in the reproductive ability eventually leading to a reduction in population over a period of time. Generally, crabs with egg mass do not moult, and also crabs infested with *Sacculina* parasite, therefore, inhibiting the subsequent growth.

Percentage of sexually infested *P. pelagicus* by *Sacculina* spp. was recorded during various months. It has been reported that the sacculinid parasite internally infest the host before the spawning season

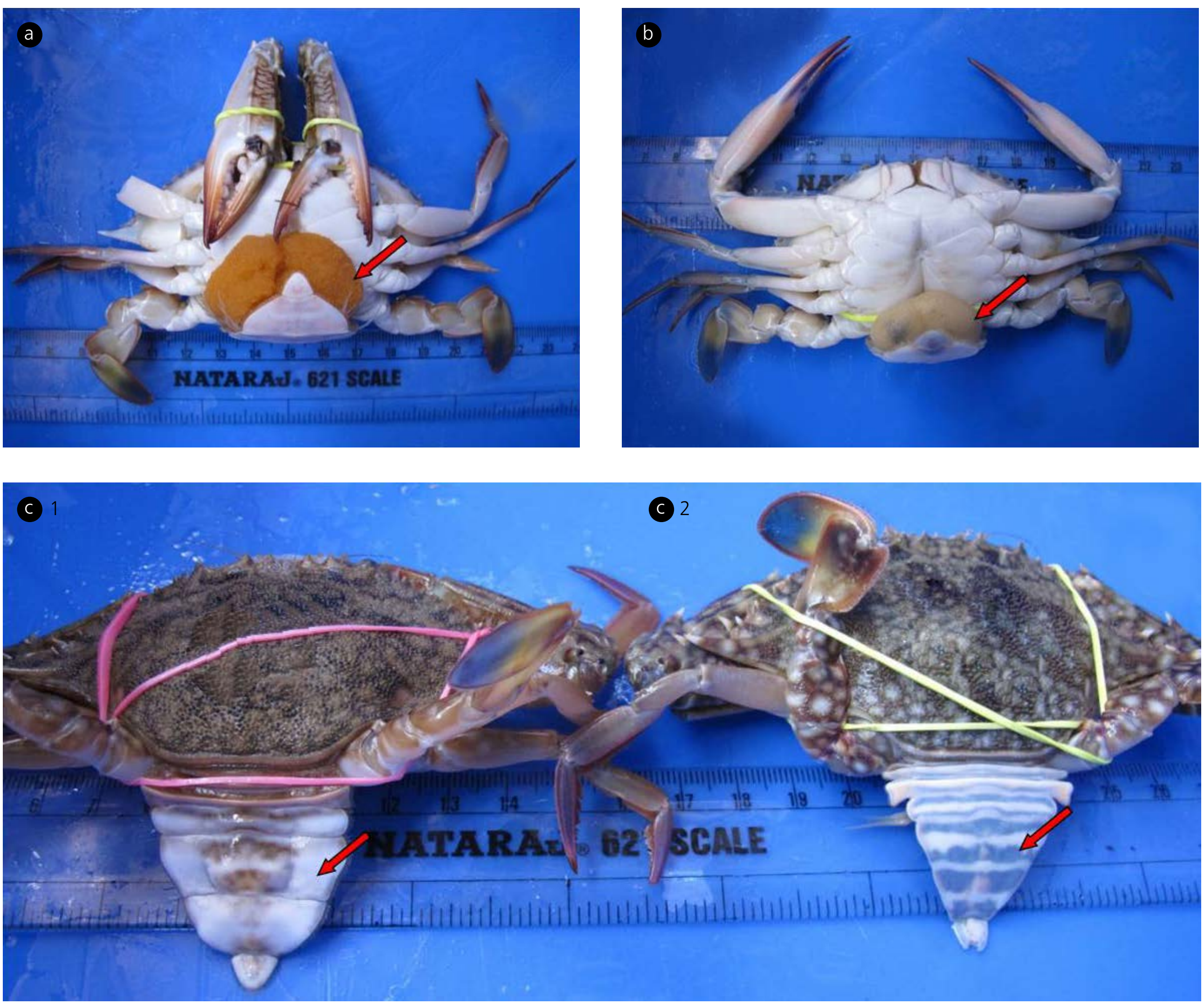

Fig. 2.A. Normal (Non-infected) berried female; B. An infected female crab showing externa in the abdomen; C. C1-An infected sub-adult female with round shaped abdomen (like a normal berried female abdomen). C2- Normal sub-adult female with triangular shaped abdomen.

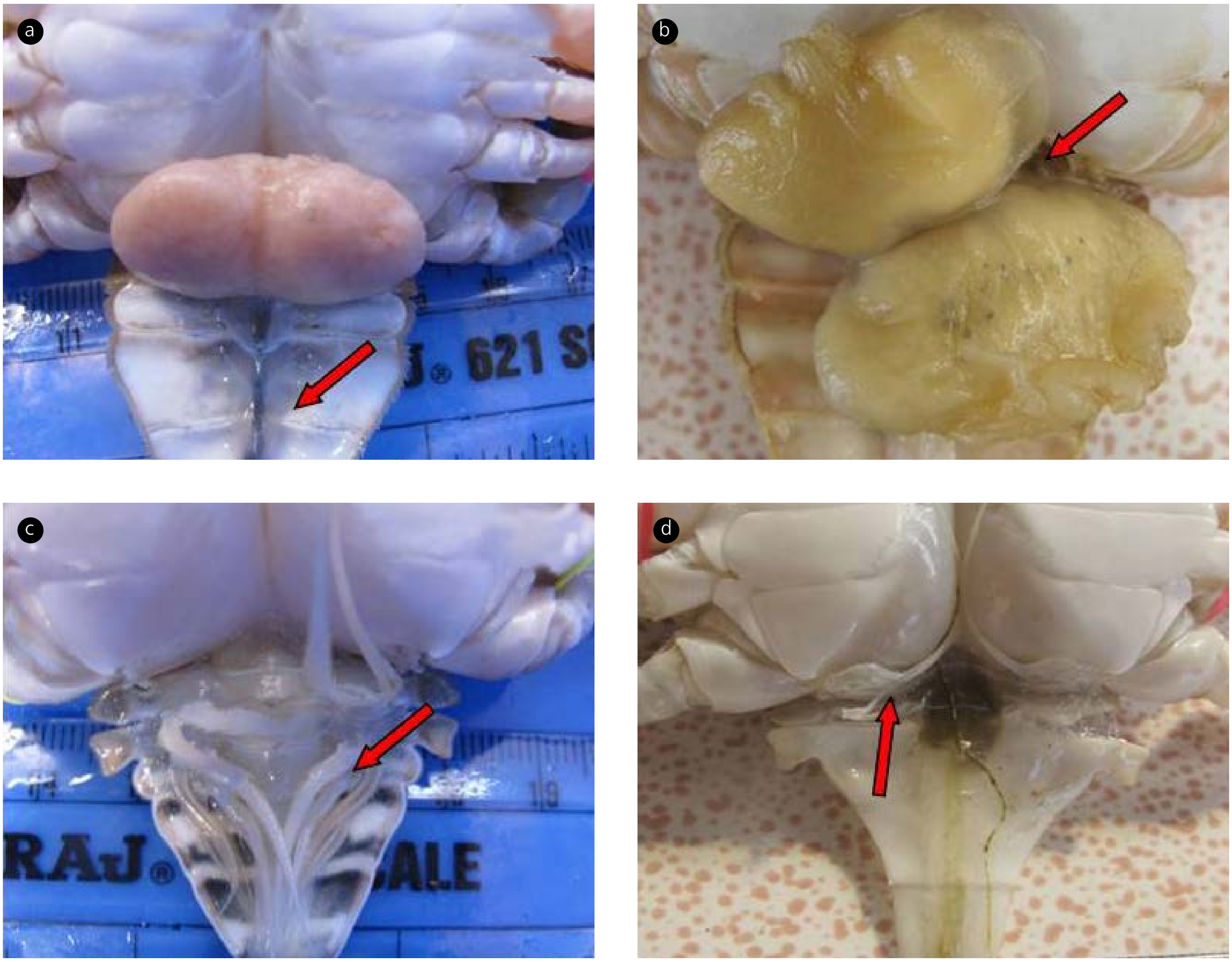

Fig. 3.A. Infected sub-adult female exhibiting one externa on the round shaped abdomen and total loss of pleopods (Arrow indicating area); B. Infected sub-adult male exhibiting two externae on the round shaped abdomen (Instead of inverted 'T' shaped abdomen) and total loss of pleopods (Arrow indicating area).C. Normal (Non-infected) sub-adult female with four pairs of pleopods and triangular shaped abdomen (Arrow indicating area). D. Normal (Non-infected) sub-adult male with two pairs of pleopods and inverted 'T' shaped abdomen (Arrow indicating area).

and the production of externae is synchronized with the spawning season of crab. In the present study, externae were found in both sexes, in all the five months of observation. One percentage of the crabs was also observed to possess two "externa" (Fig.3B). Female crabs showed a higher infestati on rate by *Sacculina* spp. when compared to males, with the size range of 48 to 115 mm (carapace width). Infestation rate was 2 to 3 per cent in male *P. pelagicus* during all the observed months. Not much variation in the rate of infestation was noticed in male crabs which were sexed based on the shape of abdomen.

Rhizocephalans reportedly cause castration, stunting and increased mortality to their crab hosts, and by affecting the reproductive ability, growth and reducing the future recruitment can impact crustacean fisheries. The present study provided baseline data on the parasitic *Sacculina* spp. occurring in *P. pelagicus* population in Mandapam region and highlights future studies required on the effect of *Sacculina* spp. on health, growth and reproduction of *P. pelagicus* stocks.

A call for spatial management approach to control exploitation of juvenile sharks

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Historically in the Indian coastal regions, elasmobranchs have been caught, traded, and consumed for centuries. In some regions (including non-coastal, high-altitude and interior regions), there is a high preference for certain elasmobranch species, products, and cuisines. While India has banned international trade of shark fins since 2015, and extended protection to ten species of sharks under the Wildlife (Protection) Act,1972, there is no restriction on the harvest, domestic trade, and consumption of elasmobranchs. Maharashtra accounts for 8.2 % of the average annual (2014-19) estimated elasmobranch landings in India that show a declining trend from 5779 tonnes in 2014 to 1786 tonnes in 2019.Here, unusual landing of neonatal and juvenile sharks dominated by carcharhinids are observed in the landings by the nearshore (operated within 10-30 m depth zone) monofilament gillnet (10-20 cm mesh size) or trawl fishery, soon after resumption of fishing activities in August after the mandatory annual monsoon fishing ban period of 45 -60 days. The landing of juvenile sharks extends for 2-3 months, the quantity fluctuates and declines over the period (Fig.1). After this the fishery usually shifts to other species and locations. These operations in nearshore regions, are mostly with gillnets and its local variants or specialized nets for sharks, called as "*mushichi jal*" or "*dharey*". Juvenile shark landing is mostly observed from gillnet fisheries operated off northern Maharashtra (off Murud) and trawl, gillnet and hook and line fisheries in southern Maharashtra (mostly operated off Dandi, Malavan, Harne) with minor variation in species composition, size class and quantity. In southern Maharashtra, non-motorised or motorised gillnetters (OAL 8-10 m) operating in April-September also catch shark juveniles which are sold at a high price.

Sharks belonging to Carcharhinidae and Sphyrnidae families were observed in the nearshore gillnet landing during August regularly for the last three years (2017-2019) at one of the regular fishery monitoring locations, Sassoon Dock, Mumbai (Table.1). Each boat (wooden/FRP 10-16 m OAL) landed ~120-800 kg sharks. Interestingly, the total number of rays observed in this particular seasonal fishery was less than 1%. In 2018, the estimated gillnet landing at Sasson dock, Mumbai was 274 tonnes, where *S. laticaudus* accounted for 56% sharks landed, followed by *C. brevipinna* (8.3%) and *C. limbatus* and *Sphyrna lewini* (7.3%), with monthly average 70 kg/unit, ranging from 1.6 kg/unit in June to 157 kg/unit in August. Though diverse sharks and rays are caught and landed in Maharashtra, the species composition of these nearshore

Fig. 1. Juvenile shark landings in Maharashtra in A) September 2014, Sassoon Dock; B) October 2015, Sassoon Dock; C) August 2017, Sassoon Dock; D) July 2018, Malvan; E) April 2019, Harne; F) August 2019, Sassoon Dock; G & H) August 2020, Malvan; I) August 2020, Sassoon Dock

Table.1. Sharks occurring in the gillnet fishery landings in August at Sassoon Dock, Maharashtra (2017-2019)

			Biological details *			IUCN Red List Assessment status (Global)	IUCN Red List Assessment Arabian Sea Region**
Scientific name	Common name	Size range (cm)	Size at birth (cm)	Size at Maturity (cm)	Maximum length (cm)		
Carcharhinus amblyrhynchos	Grey reef shark	49-105 (n=165)	45-75	♀120-142, ♂110-145.	255	Near Threatened	Endangered
C. amblyrhynchoides	Graceful shark	52-112 (n=22)	50-60	♀167, ♂140.	178	Near Threatened	Vulnerable
C. brevipinna	Spinner shark	65-106 (n=202)	60-81	♀170-220, ♂159-203.	283	Near Threatened	Vulnerable
C. leucas	Bull shark	76-185 (n=13)	55-81	♀180-230, ♂157-226.	340	Near Threatened	Endangered
C. limbatus	Blacktip shark	60-116 (n=85)	38-72	♀120-190, ♂135-180.	258	Near Threatened	Vulnerable
C. melanopterus	Blacktip reef shark	84-89 (n=3)	33-52	♀96-120, ♂91-113.	<200	Near Threatened	Vulnerable
C. macloti	Hardnose shark	38-100 (n=12)	38-50	♀70-89, ♂69-81.	110	Near Threatened	Near Threatened
C. sorrah	Spottail shark	51-116 (n=153)	45-60	♀110-118, ♂103-128.	<180	Near Threatened	Vulnerable
Lamiopsis temminckii	Broadfin shark	63-140 (n=26)	42-65	♀143, ♂136.	178	Endangered	Endangered
Rhizoprionodon acutus	Milk shark	40-90 (n=32)	25-40	♀70-81, ♂68-72.	178	Least Concern	Near Threatened
R. oligolinx	Grey sharpnose shark	35-87 (n=25)	20-30	♀32-41, ♂29-45.	90	Least Concern	Near Threatened
Scoliodon laticaudus	Spadenose shark	26-73 (n=83)	12-15	♀33-35, ♂24-36.	75	Near Threatened	Near Threatened
Sphyrna lewini	Scalloped hammerhead shark	40-110 (n=89)	40-57	♀200-250, ♂140-198.	420	Critically Endangered	Endangered

*Source : Ebert et al. 2013; Jabado & Ebert, 2015 ** Jabado et al 2017

gillnet fisheries remain mostly unchanged (Table 2). The presence of neonates and juveniles suggests that these could possibly be nursery areas and there is a need for dedicated studies to ascertain the same.

The practical implementation of shark conservation measures is often limited due to complex and challenging issues. Many commonly suggested management measures like gear modification, live release, and blanket ban on exploitation are impossible in the mixed-species fishery of India where diverse craft and gear combinations are operated in the same fishing locations. The possible and suitable solution to address this recurring juvenile bycatch is spatial conservation planning in consultation with all the stakeholders. The immediate challenges of spatial management will be identifying the geographic range, spatial movement of aggregation, if any, and the duration. Juvenile sharks are generally caught in the nearshore waters from April to October along the Maharashtra coast. Considering the high quantum of juvenile landings in August and their decreasing numbers in the succeeding months any conservation spatial planning should be made with detailed ecosystem, species habitat preference information and migration details.

Though shark consumption is common and there is a good local demand for juvenile sharks in Maharashtra, the entire landed quantity is not wholly used in the state. The juvenile sharks are normally sold at ₹150-350 per kilogram (except *S. laticaudus,* which fetches a lower price in comparison to other species) and traded to different parts of the country. Even though this type of short-term juvenile shark harvest is a source of income for gillnet fishers, the fishers are not solely dependent on shark fisheries, and most of them are willing to change their fishing patterns if proper incentives are provided by the government. During multiple awareness programs and stakeholder consultation meetings organised by ICAR-CMFRI in Mumbai, several fishermen had agreed to share information on juvenile aggregation grounds of exploited fishes, to consciously

Table.2. Estimated shark landing in the seasonal gillnet fishery of 2018 at Sassoon Dock

Species	Estimated landing (kg)
C. amblyrhynchoides	6549
C. amblyrhynchos	13612
C. brevipinna	22794
C. leucas	1700
C. limbatus	20059
C. macloti	907
C. melanopterus	488
C. sorrah	19587
C. arabicum	573
G. cuvier	953
L. temminckii	748
R. acutus	6112
R. oligolinx	5659
S. laticaudus	152923
S. lewini	20110
Other sharks	1013
Total landings (kg)	273785
Units	4024
Hours	110791
CPU (kg/unit)	70

avoid fishing in such areas and move towards spatial or other conservation measures. However, the support and cooperation of all fishers is required and a challenge to achieve this is a general trend of reasoning "*if I do not catch it, someone else will, so why should I lose my opportunity?*". A common regulatory approach with scientific support, for all crafts and gears effecting temporal and spatial closures, demarcation of no-fishing zones and simultaneous intensive awareness programs among all the stakeholders is highlighted.

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Brief Communications

Rapid Assessment of marine debris in the coastal waters of Kerala

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Marine debris are any manmade materials released into marine ecosystem as a result of various human activities and main sources include maritime and fishing activities, riverine inputs, storm water and urban run-off, tourism and beach activities, industrial and domestic sources and oil rigs. The debris also causes problems to fishermen as they get caught in their gear and causes damages to it and also affects their work efficiency. Kerala is one of the most densely populated states in India and with a coastline of 590 km and 1.2 lakh marine fishermen families who depend on the sea for their livelihood it is imperative to assess the marine debris load of the coastal waters of Kerala.

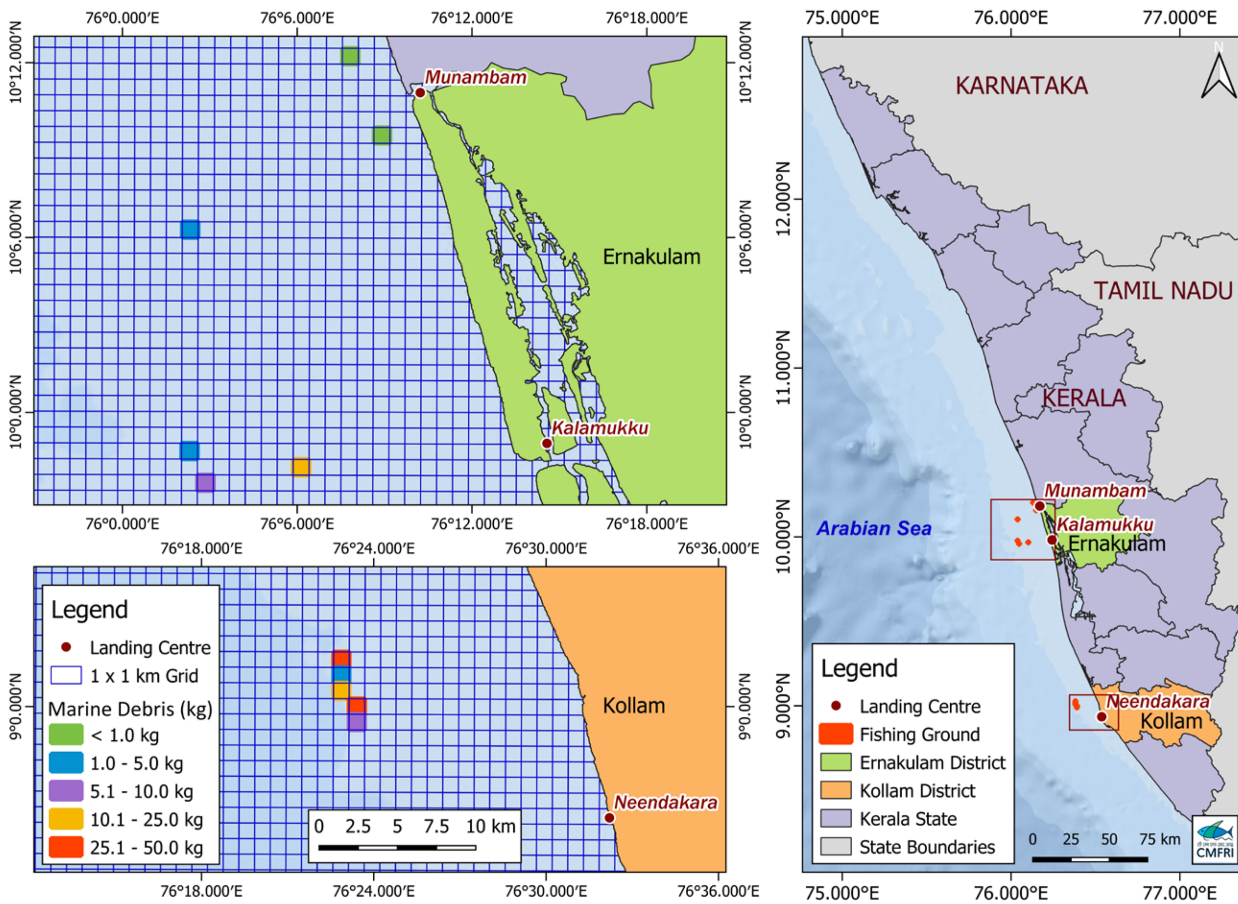

Fig. 1 Sampling locations and the quantity of marine debris obtained from the fishing grounds

A rapid assessment of the abundance of marine debris in the selected fishing grounds of Kerala coast was carried out through trawl fishery based surveys from three fisheries harbours; Vypin & Munambam in Ernakulam district and Shakthikulangara in Kollam district. The debris that were caught in the trawl net during the fishing operation were collected, sorted and classified according to UNEP guidelines (Cheshire *et al.,* 2009) followed by counting and weighing. Based on the direction, distance and depth of fishing operation from the landing centre, the approximate location of fishing operation and the area from where the debris were collected were identified and mapped. The map of coastal fishing grounds was prepared and divided into 1 km^2 grids. If the approximate location of the fishing activity falls in a grid, that grid was identified as the fishing ground for that particular fishing activity. The major contributor to marine debris in terms of numbers was plastic bags (PL07) followed by plastic bottles (PL02) and food containers. In terms of weight, the plastic bags were followed by plastic sacks (PL24) and plastic bottles (PL02). Overall, it was observed that the plastics were the major constituents of marine debris, both in terms of number and weight. It could also be seen that the fishing grounds off Kollam area had highest quantity of debris (37.5 kg/km^2) while that of Munambam reported the least quantity of debris (0.3 kg/km^2) out of the sampling locations studied along the Kerala coast. The rapid assessment study indicates that the coastal waters of Kerala has substantial presence of marine debris and appropriate management measures should be initiated immediately while existing programmes like *Suchitwa Sagaram* Mission should be reinvigorated, to save the marine ecosystems.

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The invasive mussel *Mytella strigata:* Impacts on fisheries and farming

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An alien species of mussel, the American brackish-water mussel *Mytella strigata* native to Central and South America has established recently in backwaters of Kerala, blocking nets in fish or cage farms. This species was recently reported from the Philippines, Singapore and Thailand, where its population has expanded exponentially in the last two years. *M. strigata*, the newly introduced marine invasive species was recorded from various places in Kerala such as Vembanad Lake, Kadinamkulam, Paravur, Edava-Nadayar, Ashtamudi Lake, Kayamkulam, Chettuva and Ponnani. Mytilids typically have a high fecundity, rapid growth rate, are filter feeders and are tolerant to a wide range of environmental conditions The *M. strigata* was initially reported from major ports, establishing the route of introduction to new areas through ballast waters transport or hull fouling on ships. It is a potential

Mussel spat along with *M strigata* in Chettuva estuary threat to lucrative bivalve aquaculture as they could out-compete native mussels as well as cage farming. Hence the Molluscan Fisheries Division initiated a focussed drive on creating awareness among the stakeholders regarding the invasive mussel and its impacts on the fisheries as well as farming activities. A webinar was organized for stakeholders that included the mussel / clam / oyster pickers, fish farmers, crab farmers, Farmer's Association Leaders and fisheries department officials from Kerala, Karnataka and Goa. Dr. K. K. Appukkuttan, Advisor to the Fisheries Department of Kerala suggested eradication / prevention of spreading of this non-native mussel species through the combined efforts of the Fisheries Departments, the local communities, scientists and local governing bodies. Incentives to farmers / cooperative societies involved in the eradication drive as well as an economic evaluation of its impact on fisheries and farming was also proposed. Measures suggested for preventing the establishment of non-native species that may cause ecological and economic havoc were as given below:

- All-out efforts should be taken to prevent, control and eliminate *M. strigata* from establishing in our waters.
- Since the species is edible (though not as tasty as green mussel) they can be heavily fished and consumed.
- It can also be utilized as ingredient in fish /animal feed
- *M. strigata* should not be used for farming, as it will promote further spreading. Strict monitoring should be done by the Department of Fisheries to ensure that this species is not used for any farming activity.
- If found attached to cages/nets or any other materials they should be removed and kept out of the water body to ensure its eradication.
- Boat hull fouling by *M. strigata* is a major concern. Periodic scrapping of biofoulers from boat should be undertaken outside the water body

M strigata attachment on fish culture cage units

A note on mass mortality of Bloch's gizzard shad at Dhanushkodi lagoon, Tamil Nadu

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Mass mortality of Bloch's gizzard shad, *Nematalosa nasus* (Bloch, 1795) was observed around 5 km shore area of the lagoon from Ottathalai to Thavukadu near near the Kothandaramar Temple, Dhanushkodi, Ramanathapuram District, Tamil Nadu on 19th October 2019. An estimated 3 tonnes of *Nematalosa nasus* were washed ashore and water samples collected from the site were analysed indicated Dissolved oxygen (2.17ppm), pH (7.83ppm), salinity (40ppt), temperature (30.6°C), ammonia, nitrite and nitrate (0.1, 0.2 and 0.43 ppm respectively). The lagoon stretches 15 km from Rameswaram Puthuroad to Arichalmunai with average breadth of 2 km and 0.46-0.6m depth. The strong currents in the Gulf of Mannar during April-October drift the sand and sediments through narrow channel between Arichalmunai and offshore sand dunes to the shallow Palk Bay. These deposits strengthen the sand bar between the intertidal region and open sea, leaving vast tidal areas dry. During the onset of north easterly wind (November-March), the weaker portion of the sand bar breaks and seawater enters through these narrow channels and a shallow lagoon is formed. As the winds become stronger, more channels are formed which triggers the fishery in the area. It has been found that when about 22-25 such channels are formed, sufficient mixing of water between lagoon and sea that helps to maintain key hydrological parameters such as temperature, dissolved oxygen, pH and salinity at optimum levels required by the various biotic communities to flourish.The local governing body, Cherankottai Grama Panchayat leases out the entire lagoon area to each village annually. The lessee engages fishers from Vedalai village, Ramanathapuram District as they are skilled to operate small bag nets (*Thangoosivalai* and *Illuppuvalai*), to fish for mullets, milkfish, crab, shrimp, silverbiddies and gizzard shad etc available in the lagoon for six months. On this particular occasion, it was found that only two channels were active and shoals of *N. nasus* entered the lagoon immediately after the influx of water and got trapped in the lagoon during low tide and could not escape. A rise in water temperature (32.1°C) was noticed in the lagoon on 18th October 2019. The resulting warming up of the shallow lagoon, associated with limited mixing and declined dissolved oxygen level probably led the fish shoal to stress and mortality. Incidentally, this year the fishers from Vedalai were also not engaged for fishing, otherwise the fish shoal would have been captured.

Gross examination of dead fish did not show any parasitic infestation nor specific lesions indicative of bacterial infection. The pink discolouration may be attributed to the autolysis of this fatty clupeid. Examination of internal organs also did not reveal any bacterial or parasitic infection. The gut content analysis of the dead fish revealed 85% had empty stomachs and remaining indicated poorly fed stomachs. All the fishes were adults in the size range of 192-228 mm total length and each weighing between 72 -110 g with gonads in spent condition. It is inferred that increased temperature in the shallow water, osmotic imbalance and declined dissolved oxygen level led to the mass mortality of fishes.

Cuttlefish fishery using FADs in Sothikuppam, Cuddalore District.

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Hand jigging by the artisanal fishermen for cuttle fish and squid is an important fishery along Gulf of Mannar in Tamil Nadu. These jigs are operated to fish from open shoals and not practiced along Coromaondel Coast. However, a seasonal fishery for cuttlefish using jigs around Fish Aggregating Devices (FADs) in Sothikuppam in Cuddalore district started some four years ago, and became more widely prevalent in 2020. These FADs are made using the branches of Casuarina plants. A big bundle comprising around 40-42 branches of casuarinas is used by one boat. A bag full of sand is attached to each branch as a weight and two to three plastic bottles of 1 litre capacity is attached to it as float. They are taken to the fishing ground and deployed with the help of GPS, in three to four places at a distance of around 15 to 20 m away from each other. The fishing grounds which are 10 to 15 km away from the shore where the depth varies from 10 to 12 m. According to the fishermen, the aggregation starts after 3 to 4 days and the fishing starts after this. The fiberglass boat of 8 m OAL with 10 hp motor carries 4 to 5 fishermen for fishing. The jig resembles a shrimp with bright colours and hooks numbering around 18 in two rows are attached to the tail region. A small lead weight is also attached to the lower part of the lure near the eye. Each jig tied to a nylon rope is rolled on a wooden frame. The fishing is done usually during December- January months. They go for fishing by 5 AM and return after 2 PM and the fishing is near their own FADs only. There are around 42 units engaged in this fishing from here and each day 20 to 40 units go for fishing. The catch of cuttlefish in a unit varied from 30-85 kg and the landing centre price varied from ₹220-280 per kg. Though there is trawling in this area, so far there are no objections either from the trawlers or from any other group.

Fig.1. FAD stacked in the boat

Fig.2. Jigs used by fishers

Fig.3. Cuttlefish catch landed

Heavy landings of Black pomfret post lockdown

Following the outbreak of COVID-19 pandemic there was a complete lockdown in the fisheries harbours and the fish landing centres in India. for more than two months which affected fishing operations and fishers' livelihoods. The triple lockdown enforced in the Thiruvananthapuram district of Kerala affected fishing activities in all of the major fishing harbours like Thazhampally, Perumathura, Anjengo, Vizhinjam etc. as these were in the containment zone and only after 07/08/2020, the fishing activities resumed. During the period in the end of month of May end and early June, several fishery resources including Indian oil sardine *Sardinella longiceps* landed along the coast. However, soon thereafter the entire coastal belt was affected by the pandemic and with the announcement of a lockdown by the government, fishing activities stopped. Post-lockdown, a lot of unusual landings were recorded including that of Black pomfret (*Parastromateus niger*) and Seerfishes (*Scomberomorus* spp.). Unusual heavy landings of black pomfret at Marianad Landing Centre, on 19 August, 2020 were reported. Thirty two boat seiners reportedly caught 500 to 3200 kg of black pomfret which were sold at the rate of ₹ 210 to 350 per kg. The catch was auctioned for ₹ 800000. Similar unusual landing of *P. niger* was reported at Anjengo (N) Landing Centre on the very same day and the maximum auctioned price per boat was ₹ 1400000. Similar landings occurred during September and October 2020. Black pomfret catch of 1000 -2000kg and 2000-4000kg was recorded by boat seines and ring seines respectively at Thazhampally and Perumathura fisheries harbours. The fishes caught were in the length range of 14 - 39 cm with mean size at 32 cm and weighing 86 - 1340g each. The recommended Minimum Legal Size (MLS) for landings of *P. niger* along the Kerala coast is 17 cm total length (TL) and more than 90 % of the catch landed was above MLS. The catch was marketed locally and also transported to neighbouring districts.

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Tiger shark landed at Mookaiyur Fisheries Harbour, Tamil Nadu

A large sized male Tiger shark *Galeocerdo cuvier* measuring 288 cm in total length (TL) and weighing 261 kg was landed at the Mookaiyur Fisheries Harbour on 22nd October 2020. The shark was caught in a tuna longliner of 22.7 m OAL fitted with 200 hp engine which had fished in the Arabian Sea, close to the Lakshadweep islands. Although size ranges of 95 and 100 cm TL are regularly observed in the fishery in the southern Gulf of Mannar, the fishermen reported that they have not got a Tiger shark of this size earlier. While tiger sharks have been reported in the fishery all along the Indian coast, Cochin Fisheries Harbour has been a major hub for landings of this species, where it formed 7% of the total shark landings during 2012-2016 (*CMFRI Annual Report 2016-2017*, p. 107). It is not protected under the Indian Wildlife (Protection) Act, 1972 and as of now there is no restriction on fishing in India. Trade of its fins is, however, barred under the blanket ban on shark fin trade enforced by the Ministry of Commerce & Industry, Government of India in 2015.

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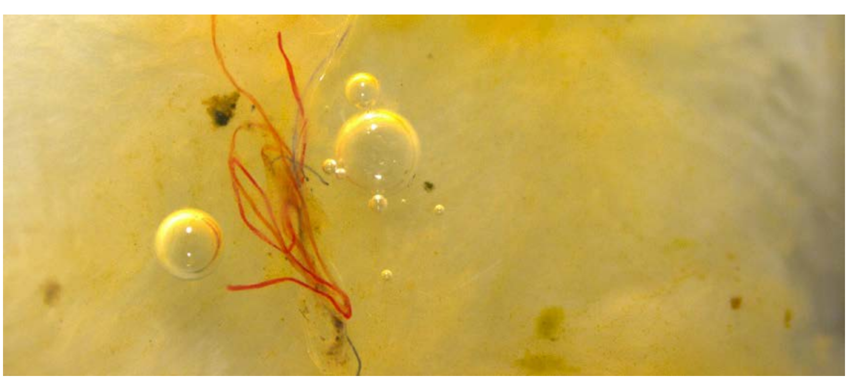
Microplastics in guts of short neck clam



The Short neck clam, *Paphia malabarica* Chemnitz, 1782, fished from Muthalapozhi estuary, located in northern part of Kerala is regularly marketed in Karnataka, Goa and Maharashtra. The fishery is regularly monitored since 2017 by sampling clams from Azhoor for biological analysis. During 2018-2019, 720 clams were subject to microscopic examination of tissue smear to assess the gonadal maturity of the species. The occurrence of microplastic (plastic materials or fragments of less than 5 mm size) fibres in gonadal tissue was observed on two different occasions in images captured using a Carl Zeiss Discovery V8 Stereomicroscope with an Axio-Cam digital camera. Since the bivalves are filter feeders, these fibres which are a common marine pollutant, could have entered through feeding. Since this bivalve is eaten as whole tissue, unlike dressed fish, transfer of microplastics from lower to higher tropic level is possible. These risks are to addressed through proper land run-off and marine pollution management.

(**P. Gomathi*, M. K . Anil, B. Raju, P. M Krishna priya, O. Salini and Geetha Sasikumar** | Vizhinjam Regional Centre of ICAR-CMFRI)

Record size *Psettodes erumei* and *Upeneus vittatus* reported from Mandapam

Record sized Right-eyed Indian halibut *Psettodes erumei* (Bloch & Schneider, 1801) and Yellow-striped goatfish, *Upeneus vittatus* (Forsskal, 1775) were recorded in the fish landings at Mandapam. The Indian halibut measuring 60 cm in Total length (TL) and weighing 3.25 kg was found in the Pamban Therkuvadi Fish Landing Centre on 24th November 2017. A fish trawler operated at a distance of 18 km from the land at a depth of 23 m brought it along with other demersal finfishes. *U. vittatus* measuring 29 cm TL and weighing 360 g was landed on 15th December 2017 by a commercial fish trawler of 14.2 m OAL operated at depth of 15 m at a distance of 15 km off Pamban. Even though the Gulf of Mannar is said to be rich in goatfish abundance and diversity, the occurrence of *U. vittatus* in the commercial fish trawl landings is rare. The morphomertic measurements and meristic counts of both fishes were recorded.

(L. Remya*, C. Sudhan, U. Rajendran and A. K. Abdul Nazar | Mandapam Regional Centre of ICAR-CMFRI)

Spanner crab *Ranina ranina* recorded off Puducherry coast

The Spanner crab or Red Frog crab *Ranina ranina* (Linnaeus, 1758) a true brachyuran crab is the only extant species of its genus in the Family Raninidae. The species characteristically has an elongated, anteriorly broad, reddish brown carapace covered by low rounded scale like spines. Geographically they are distributed in the Indo Pacific region in sandy substrata at depths between 10 and 70 m and are commercially exploited in Hawaii, Japan, Seychelles and parts of Australia mainly using baited traps. The present specimen occurred among the catch by bottom set gillnets operated at a depth of 25-30 m at a distance of 13 km from the shore and landed at Nallavadu Landing Centre, Puducherry on 23.01.2021. Though the species is said to be available in sandy substrata, in the present case the gear was operated in rocky area and ten numbers each weighing around 300 g were recorded. The length of the carapace varied from 8.5 cm to 9.2 cm and length of abdomen from 5 cm to 5.6 cm. The females were berried. Since the species was seen for the first time here, the fishermen were doubtful of its edible status.

(S. Pradeep, P. G. Vishnu, P. T.Sarada* and R. Narayanakumar | *Madras Regional Station of ICAR-CMFRI)

Long-beaked common dolphin beached off Srikakulam, Andhra Pradesh

A dead dolphin was washed ashore at Bethalapuram, Srikakulam district, Andhra Pradesh on 17th June 2020. Based on morphological features, it was identified as Long-beaked common dolphin, *Delphinus capensis* Gray, 1828 (Fig.1). Characterized by a slender body and a long beak separated by a crease from the melon. It has a long and thin rostrum with 49 numbers of small, sharp teeth on each side of each jaw. The prominent dorsal fin is falcate, and the flippers taper to a pointed tip. The back is dark including the dorsal fin, tail flukes, beak and flippers and the belly is white. Juvenile has an hourglass pattern which form V shape below dorsal fin and usually juveniles are darker than adult. A black stripe from the black patch surrounding the eye to the front of the melon and another from the chin to the flippers is observed.The dolphin measured 137 cm in total length and weighed approximately 35 kg while length of beak was 13.50 cm. Reporting of stranding instances of Endangered, Threatened and Protected (ETP) species that includes marine mammals, is done by ICAR-CMFRI that is useful for developing appropriate conservation measures.

(Ashok Maharshi, Pralaya Ranjan Behera*, Loveson L. Edward, R. Jeyabaskaran, Shubhadeep Ghosh and Raghu Prakash | *Visakhapatnam Regional Centre of ICAR-CMFRI)

Rare occurrence of cusk eel, *Brotula multibarbata*

Fig.1. *Brotula multibarbata* landed in New Ferry Wharf

A single specimen of cusk eel, *Brotula multibarbata* (Temminck & Schlegel, 1846) commonly known as Goatsbeard brotula, was landed by a multiday trawler on 8th May 2019 in New Ferry Wharf. The trawl was operated at a depth of 50 m off Mumbai. The specimen measured 284 mm in total length and weighed 176 g. The species comes under family Ophidiidae under order Ophidiiformes. Adults of the species are bottom dwelling, on the continental shelf and slopes; while early stages are pelagic and found in reef areas. The morphometric measures were recorded (Table 1).

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Table 1. Morphometric measurements (in mm) of *Brotula multibarbata* landed in New Ferry Wharf

Standard length	268
Snout to anal origin	112.13
Body depth	50.96
Head length	50.22
Upper jaw length	24.19
Snout length	10.6
Orbit length	11.25
Interorbital	5.4
Longest pectoral ray	21.18
Pectoral base	12.74
Longest Length of pelvic rays	30.26
Postorbital eye distance	28.55
Pre dorsal fin length	55.99
Pre pelvic length	29.82
Pre anal fin length	116.14
Depth of the anal fin origin	49.86
Pectoral fin length	21.18

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