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Deployment of a coastal cage culture unit

Photo credit: ICAR-CMFRI

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.

Marine Fisheries Information Service
Technical & Extension Series

From the Editorial Board

Warm greetings to all our esteemed readers

The marine ecosystem provides several benefits and services through fisheries and tourism sectors to the coastal communities. As sinks for absorbing atmospheric heat and CO_2, they also play an important role in climate dynamics. Overfishing, pollution and climate change are key concerns that have emerged as talking points when discussing fisheries management, globally. In 2015, several member countries, including India adopted the concept of 17 Sustainable Development Goals (SDGs), proposed by the United Nations. Among these, SDG 14 specifically deals with 'life under water'. In India, among an estimated 3.77 million fisherfolk, nearly half are employed in capture fisheries, coastal aquaculture and allied activities. Of pivotal importance to nutritional security and livelihoods are healthy wild marine fish stocks combined with appropriate focus on mariculture activities. The management policies are to be aligned with local socio-economic realities and based on science. Interventions focussed on sustainability, resource efficiency, social and gender justice as well as good governance are urgently needed in the marine fisheries sector in India. In this issue of MFIS, research insights from marine capture fisheries sector and mariculture are presented to our esteemed audience.

MFIS

Marine Fisheries Information Service

Technical & Extension Series

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Determining target species for assessment in multispecies and multigear fisheries: insights from an expanded CMFRI-NMFDC database

Eldho Varghese, Somy Kuriakose, K. Sunil Mohamed, T. V. Sathianandan*, K. G. Mini, Sindhu K. Augustine, V. Sreepriya, A. R. Reshma, C. K. Athulya and Alphonsa Joseph
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Abstract

This paper highlights the richness of information available in an expanded ICAR-CMFRI-NMFDC fish catch and effort database for the state of Kerala. Strengthening of the database by digitizing data in the old paper data sheets was done under a multi-national project, ICAR-CMFRI-CSIRO-LENFEST Ocean Programme. The high diversity of fished taxa was classified according to the periodicity of its occurrence over this long period. Guidelines for determining the number of species for which stock assessment is to be carried out in the context of a multigear and multispecies fisheries sector were derived. This national-level database will be of immense use to researchers and policy makers for preparing fisheries management plans for the sustainable harvest of marine fishery resources.

Keywords: *Target species, NMFDC, Expanded database, Stock assessment*

Introduction

India is among the few countries where a system based on sampling theory is used to collect marine fish catch and effort data. The ICAR-Central Marine Fisheries Research Institute (ICAR-CMFRI) initiated the collection of marine fish landings data along the west coast of India by developing a stratified multistage random sampling design (SMRSD) in 1959 (Sukhatme *et al*., 1958). The sampling frame was prepared by collecting data on marine fishing villages, landing centres, fishing crafts and fishing gears etc. and was periodically updated to accomodate changes happening in the sector, through all India Frame Surveys. Species wise catch, fishing effort, details of fishing crafts and gears and other related information is collected following the scientific sampling scheme. The SMRSD, developed by ICAR–CMFRI is used to estimate landings and fishing effort each month for smaller non-overlapping geographical regions referred to as fishing zones, covering the entire coast. At present, there are 1269 landing centres (CMFRI-FSI-DoF, 2020) along the mainland coastline which is distributed in 9 coastal states (65 coastal districts) and two Union Territories (UT) under the SMRSD data collection.

In tropical countries where the diversity of marine fishery resources is very high, the most practical fishery data collection approach is a scientific sampling scheme as a complete enumeration of catches and logsheet method of data collection is impractical (Sathianandan *et al*., 2021). In the data collection system, dedicated technicians (harbour-based observers) with species identification skills visit the landing centres according to work schedules generated under SMRSD and record different aspects of the fishery from sampled boats. The data thus collected is stored in a database of the National Marine Fishery Resources Data Centre (NMFDC) maintained in ICAR-CMFRI headquarters at Kochi (Table 1).

Table 1. Summary of data stored in NMFDC

National	The entire coast of the mainland India but excluding Lakshadweep, Andaman & Nicobar Islands
Region	The mainland along the coast is categorized into four regions namely North-East (West Bengal, Odisha), South-East (Andhra Pradesh, Tamil Nadu and Puducherry), South-West (Kerala, Karnataka and Goa) and North-West (Maharashtra, Gujarat and Daman & Diu)
State	The entire coast is divided into nine coastal states and these are West Bengal, Odisha, Andhra Pradesh, Tamil Nadu, Kerala, Karnataka, Goa, Maharashtra and Gujarat
UT	The union territories under the central government along the coastline are Puducherry and Daman & Diu.
District	These are distinct subdivisions covering the coastal region belonging to the coastal state and UT (65 coastal districts)
Fishing Zone	These are non-overlapping exclusive subdivisions of coastal districts (75 fishing zones).
Sector	Categorization based on the fishing craft: The fishery is divided into three sectors namely, Mechanized, Motorized and Non-motorized
Gear/Fleet	Different craft/gear combinations used for harvesting from the sea are placed under this. There are more than 25 craft-gear combinations and some of the major fleets are Mechanized Trawlnets, Mechanized Gillnets, Mechanized Hooks & lines etc. under the mechanized sector. Outboard Gillnets, Outboard Ringseines, Outboard Hooks & lines under the motorized sector. Besides, several gears are being operated in the non-motorized sector/ artisanal sector.
Assemblage	The four categories based on species assemblage are Pelagic, Demersal, Crustacean and Molluscs
Species group	The species landed are summarised into 83 resource groups for presentation in theabular form based on their dominance in the fishery and commercial importance
Taxonomic Resolution	1950-1968: All species aggregated into 15 groups 1969-1981: All species aggregated into 43 groups 1982-1985: All species aggregated into 63 groups 1985-2006: All species aggregated into 83 groups 2007 onwards: Species-level

Need for expanding the NMFDC database

Species composition data are very important to understand the changes happening in the ecosystem due to fishing, particularly in biodiversity-rich tropical regions. Besides, fished taxa information is vital to decide on the species to be assessed in a multispecies scenario to derive fishery management strategies and plans. In the past, aggregation of the collected species-level information into resource groups (Table 1) was followed for ease of reporting. However, the aggregated information in the earlier data format cannot be disaggregated electronically. Earlier studies have indicated the high number of fished taxa in India's marine fish landings (Sathianandan *et al*., 2013). In highly biodiverse fisheries, it is very difficult to determine the target and bycatch from among the hundreds of fished taxa in each gear. Besides, a large number of craft-gear combinations (fleets) makes the problem more complicated. Target species in the Mediterranean trawl were defined as those caught by fishers primarily due to its high unit cost or those caught in high quantities while Bycatch was unwanted/ unintended species caught during fishing operations (Stergiou *et al*., 2003). An objective method for distinguishing target and bycatch species is necessary for devising management strategies and the expanded NMFDC database for the state of Kerala that contains data on 884 species landed during the period 1985- 2019, provides such an opportunity. The expansion of the digital database initiated for the state of Kerala was under the ICAR-CMFRI-CSIRO-LENFEST project on "Benchmarks for ecosystem assessment: Indicators and guidelines for ecosystem-based fisheries management (EBFM)". One of the major objectives of the project was the development of models for ecosystem-based fishery management suitable for tropical conditions where fish species diversity is very high and multiple gears are operated for harvesting the resources. Even though fish landings data at species level was available in the NMFDC since 2007, a longer time series was required for modelling studies.

Methodology

Processing species-level information available in old paper records maintained in ICAR–CMFRI was a time consuming and manpower demanding task. The old data paper records (~4000 basic data sheets) were digitized with approximately 100 man-months to accomplish it. The digitized records were processed for estimation and further converted to a database. An objective criterion was developed to select the species for stock assessment from the large number of species that are caught in multiple gears. The criteria used for deciding the number of species to be assessed was based on the cumulative frequency distribution of the quantity of catch as well as the unit price of the resources. The species were arranged in the descending order from 1 to *n* (n being the total number of species) based on the quantities landed. Q_i denote the cumulative percentage of the ordered species in the *i*th position based on quandity landed and Pi represent the cumulative percentage of the ordered species in the *i*th position based on the unit price of the resource. The target species for the assessment was made considering both the cumulative percentages Q_i and P_i. The species falling within 95% of the cumulative percentage, within each gear, either based on the quantity landed or based on the price were selected for assessment (i.e., either Q_i or $P_i \leq 95$ %).

Results

Species number trends

The average annual number of species landed during the period was 300 and the minimum (192) and maximum (471) species were observed in 1987 and 2016 respectively. The steady increase in species number could be due to the expansion of fishing grounds. The number of species recorded in the landings from 1985 to 2019 and the percentage contribution of major species in the total landings from 1985 to 2019 is given (Fig. 1 & Fig. 2)

Species categorization

In virtually all ecological communities around the world, most species are represented by few individuals which mostly belong to a few of the most common species. This trend is very clear from the frequency of occurrence of species over time (Fig. 3).

It showed that a maximum number of species (138), which is 15.61% of the total 884 species, occurred only in one of the 35 years. The number of species that occurred in all the 35 years is 78 (8.8%). The frequency of species occurrence decreased with an increase in years. Based on this information, the species were classified into 5 categories, very rare (occurring <10 years); rare (occurring between 10 and 19 years); often (occurring 20-29 years); common (occurring 30-34 years) and most common (occurring in all years) (Table 2). The rarity cutpoint however is often a subjective decision in conservation literature and depends on the data distribution. The

Table 2: Categorization of species based on the frequency of occurrence of species in the landings during 1985-2019 (35 years)

Category	Criteria	Number of species	Importance
Very Rare	<10 years	522	Biodiversity monitoring
Rare	10-19 years	137	
Often	20-29 years	97	
Common	30-34 years	50	Fisheries monitoring
Most common	All 35 years	78	
Total		884	

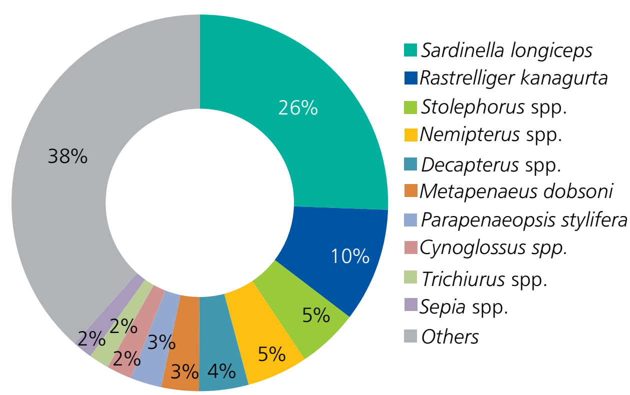

Fig.2. Percentage contribution of ten major species in the total landings during 1985 to 2019

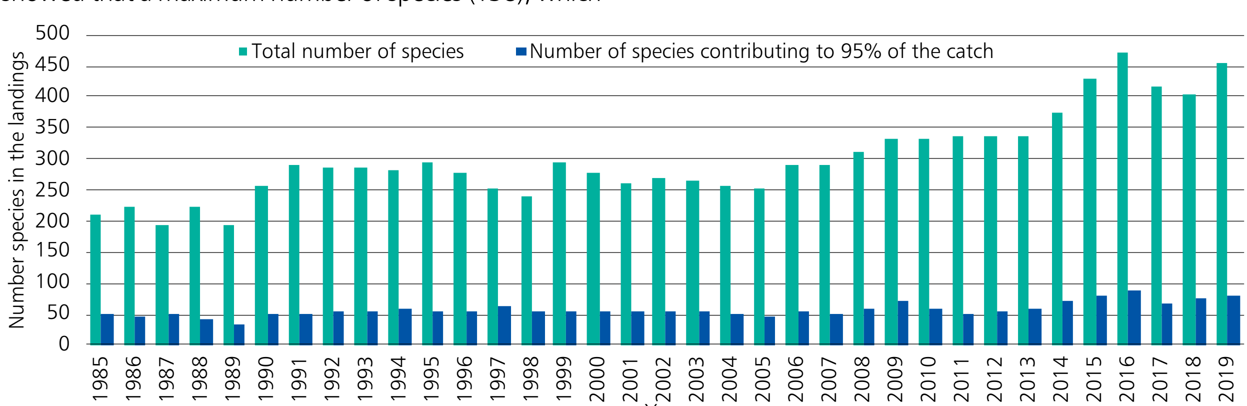

Fig.1. The number of species recorded in the landings from 1985 to 2019 (35 years).

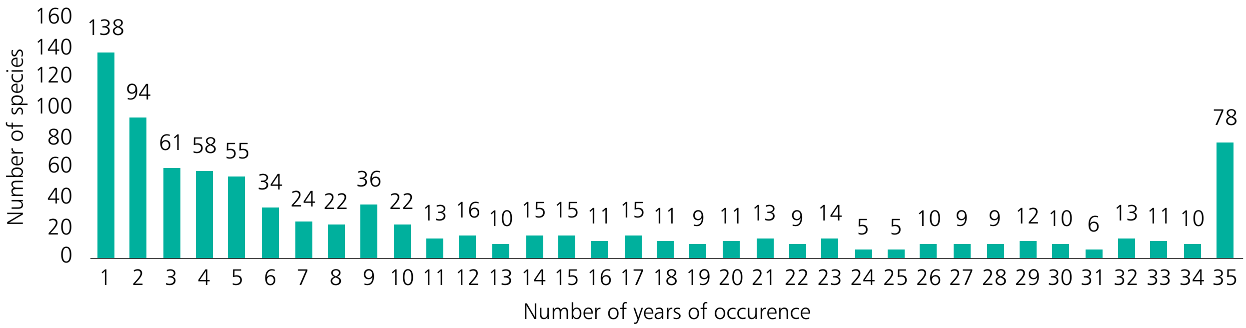

Fig.3. Frequency of occurrence of species during 1985-2019. Numbers over the bars indicate actual values.

number of species in each category and their significance to biodiversity and fisheries monitoring is shown in Table 2. It can be seen that 756 species (86%) are rare or very rare and not common which are also important and needs monitoring from a biodiversity perspective.

The 78 species (8.8%) which occurred in all the 35 years (most common) constitutes 87.33% of the total landings during the period 1985-2019. The contribution to landings of species with frequency of occurrence was 30-34 years is 7.26% and for species with frequency of occurrence 20-29 years was 3.50% (Table 3). The species with frequency of occurrence less than 10 years, the contribution to the total landings is very negligible (0.70%). This indicates that there are 78 most common species which are the mainstay of the marine fisheries of Kerala and have to be tracked consistently on a scientific basis to support fisheries management.

Table 3: Contribution to the total Marine Fish landings of different categories of species (1985-2019)

Frequency of occurrences (in years)	Proportion to total landings
All 35 years	87.33%
30 to 34 years	7.26%
20 to 29 years	3.50%
10 to 19 years	1.21%
<10 years	0.70%

Taxonomic distribution of the most common species

The taxonomical distribution at genus, family, order, class and phyla levels to the most common of 78 species are shown in Figures 4 to 8. This hierarchical classification shows that these species belong to 63 genera comprising 41 families from 13 orders and 4 classes from three phyla (Fig. 4 – Fig. 8). The genus which dominated the distribution is *Sardinella* (5%), the family Scombridae (12%), Order Perciformes (53%), Class Actinopterygii (80%) and Phylum Chordata (85%). The distribution of the most common 78 species in different assemblages (pelagic, demersal, crustacea and mollusca) indicated pelagic finfish formed 50% of the most common species (Fig. 9).

Dynamic change in ranks of species

The top four species with the highest landings over 35 years is depicted through colour gradients (Fig.10). The species which comes in the first position (red colour) is followed by orange, yellow and green for the second, third and fourth positions respectively. *Sardinella longiceps* was the major species landed, which occupied the first position in most of the years (26 out of 35). But, species such as *Cynoglossus bilineatus*, *Priacanthus hamrur*, *Sardinella fimbriata* and *Trichiurus lepturus* were also observed as the highest landed species once in the last 35 years. The sudden jump in landings of red toothed triggerfish (*Odonus niger*) in recent years with record landings in 2019 leading to occupying the first position was never observed earlier in the first four positions during the 35 years monitored.

Gearwise species distribution

The 35-year extended database indicated 15 craft-gear combinations (fleets) that contribute substantially to the marine fish landings in Kerala. The outboard ringseine (OBRS) is the major gear followed by the mechanized trawlnet (MTN) and mechanized multiday trawlnet (MDTN) (Fig. 11). The gearwise average catch and the

Genus

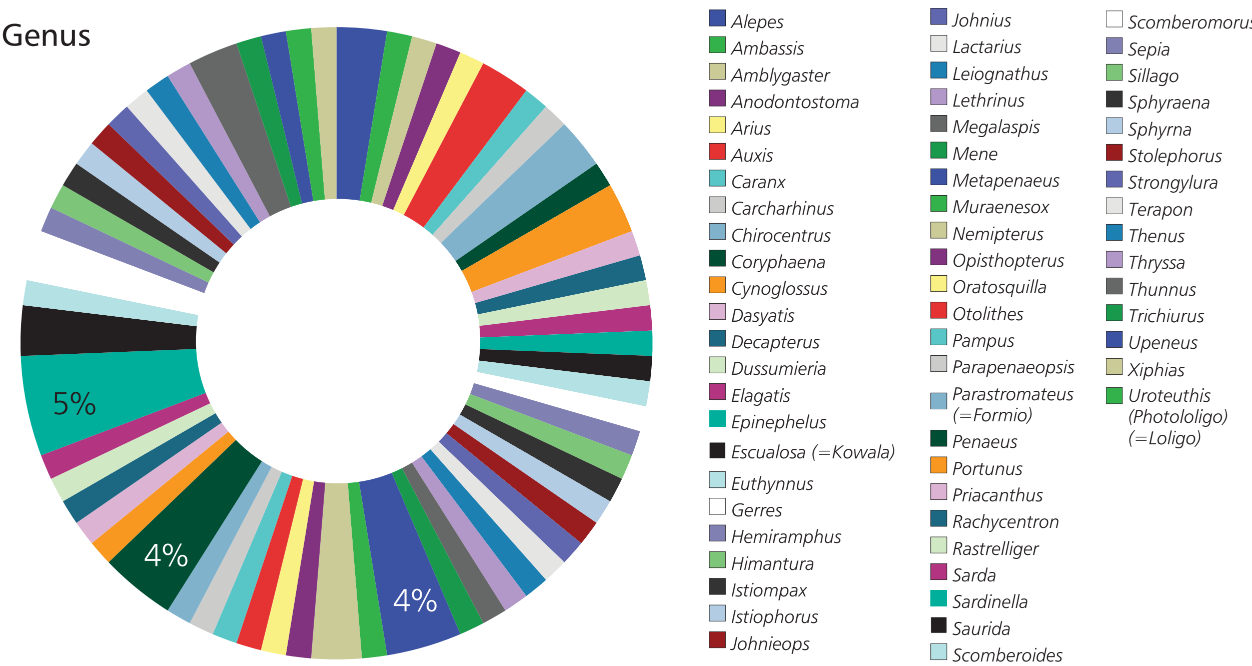

Fig.4. Distribution of 78 species over different genera (total 63 genera)

Family

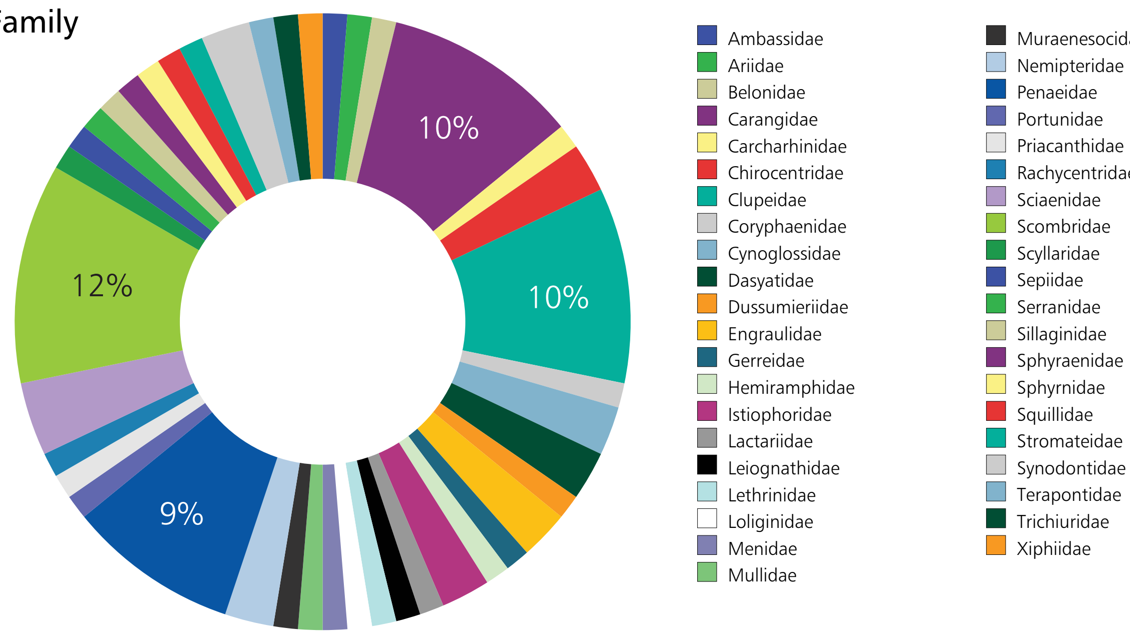

Fig.5. Distribution of 78 species over 41 different Families

number of species exploited by each gear indicated maximum number of species being caught in trawlnet followed by gillnet with the least number of species in shoreseine (Table 4).

Twenty species were reportedly caught in all the 15 gears while 278 species were exclusively caught in a single gear. The number of species exclusively caught in each gear is given in Table 5. Maximum exclusive species

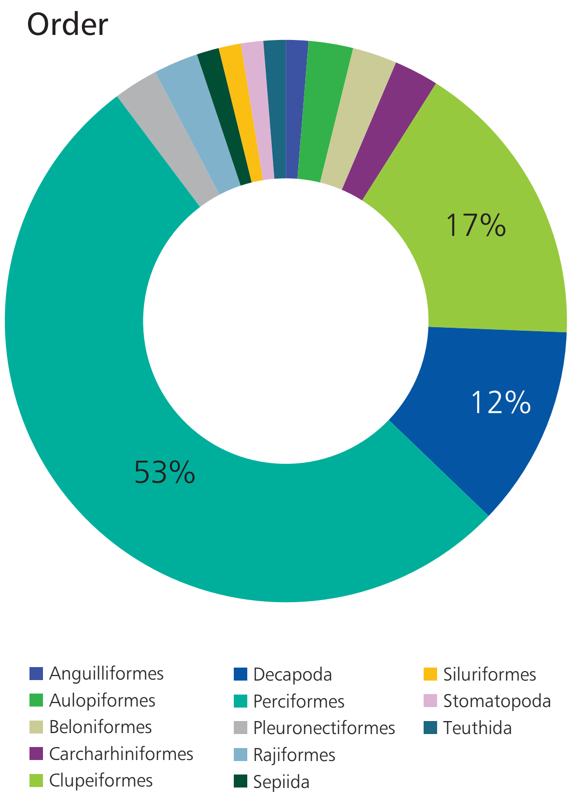

Fig.6. Distribution of 78 species over 13 different orders

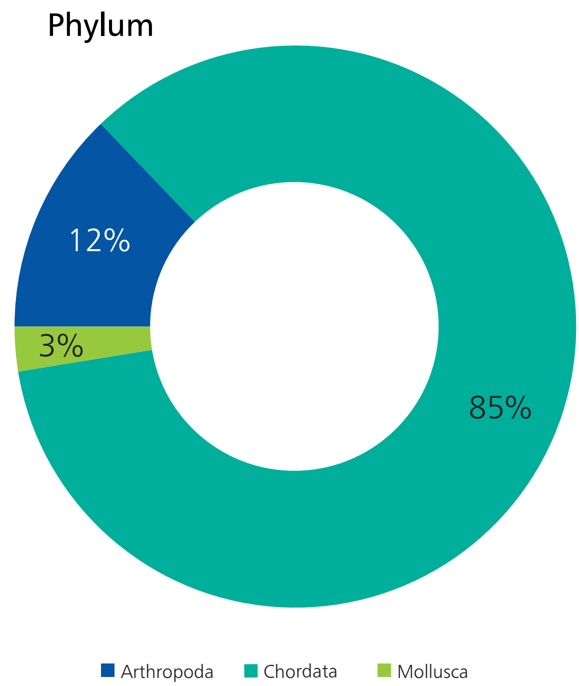

Fig.8. Distribution of 78 species over 3 different Phyla

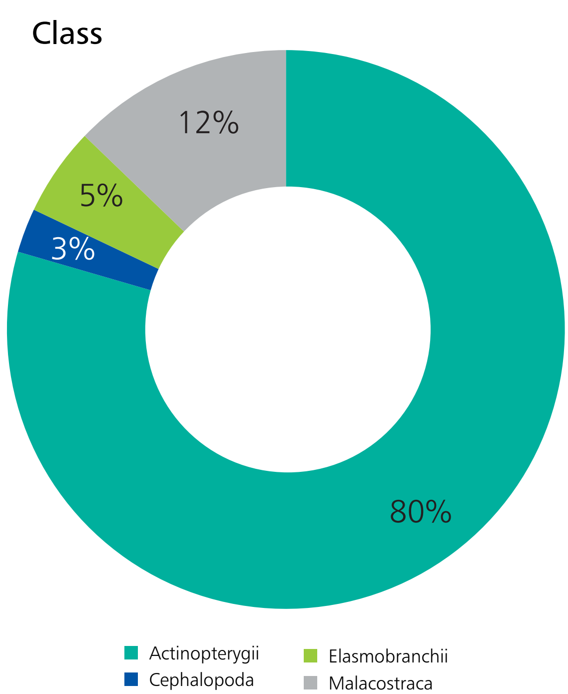

Fig.7. Distribution of 78 species over 4 different Classes

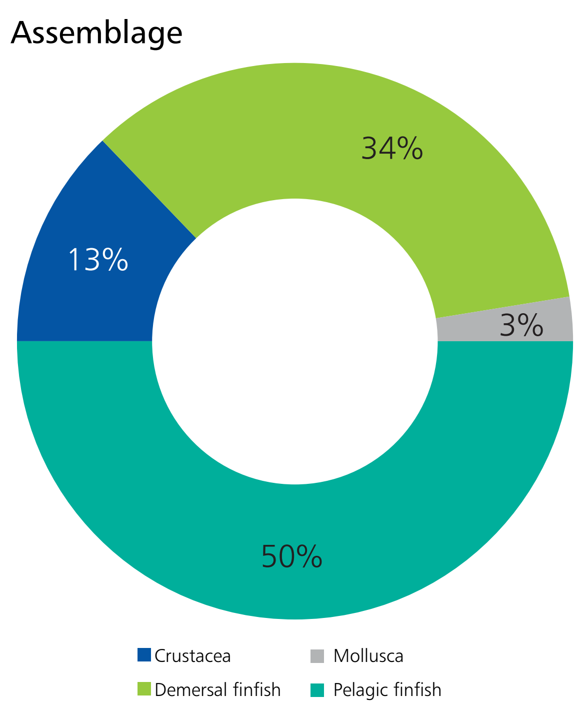

Fig.9. Distribution of 78 species by species assemblages

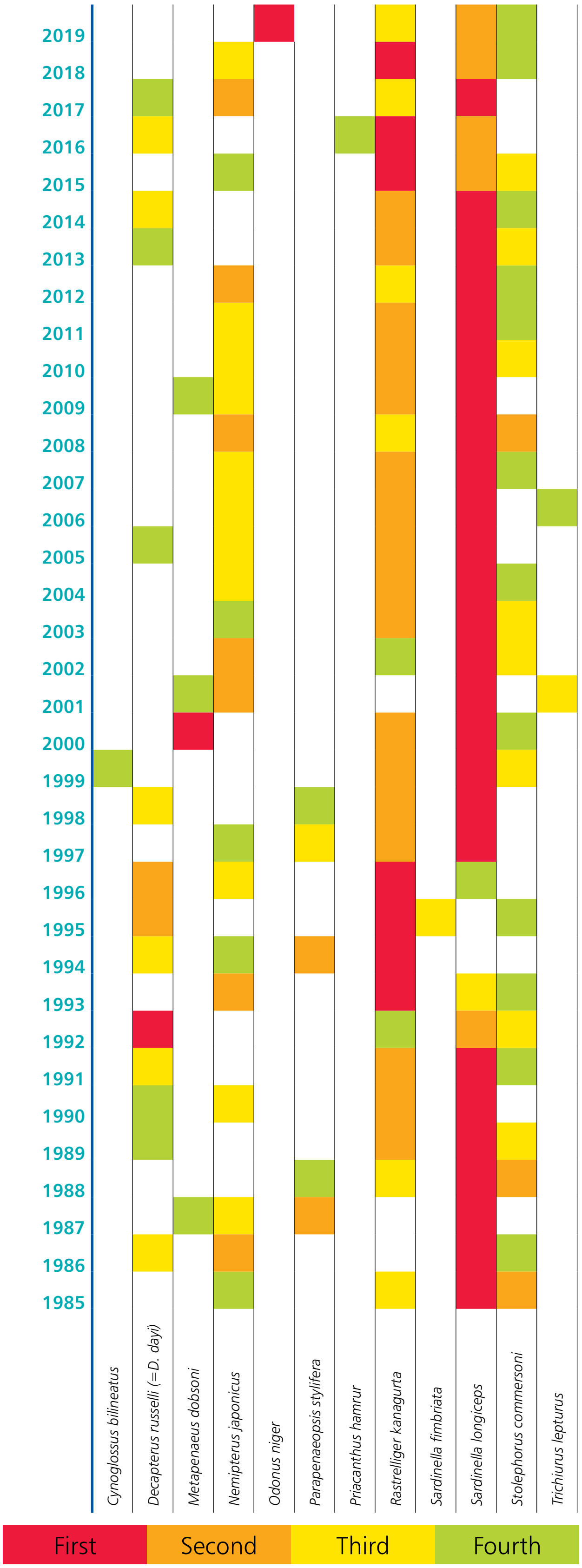

Fig.10. Top four ranked species with the highest landings during 1985-2019

Table 4. Gear-wise ranking based on number of species caught.

Gear Name	Gear Code	Number of species
Mechanised Trawlnet (Single day)	MTN	764
Mechanised Trawlnet (Multi day)	MDTN	750
Outboard Gillnet	OBGN	585
Non-Mechanised (Artisanal)	NM	549
Mechanised Combination Gears	MCGR	424
Outboard Hook & Line	OBHL	400
Mechanised Gillnet	MGN	345
Outboard Ringseine	OBRS	329
Mechanised Hook & Line	MHL	291
Outboard Boatseine	OBBS	282
Outboard Combination Gears	OBCGR	279
Outboard Trawlnet	OBTN	211
Mechanised Ringseine	MRS	210
Mechanised Purseseine	MPS	120
Outboard Shoreseine	OBSS	89

were observed in MTN and MDTN followed by NM and OBGN. The MTN which is operated very close to the shore have the highest number of species caught and also the maximum species which are exclusively caught by the gear. The seine nets (MPS, MRS, OBSS, OBBS and OBRS) have minimum exclusive species. This information indicates that biodiversity is concentrated in the nearshore benthic region of the ecosystem.

Twenty species were caught in all the 15 gears, and these include *Alepes* spp., *Ambassis* spp., *Arius* spp., *Caranx* spp., *Cynoglossus* spp., *Decapterus* spp., *Euthynnus affinis, Megalaspis cordyla, Mene maculata, Parastromateus niger, Penaeus indicus, Rastrelliger kanagurta, Scomberoides tol, Scomberomorus commerson, Scomberomorus guttatus, Sphyraena* spp., *Uroteuthis* spp. There are also 278 species which are exclusively caught only in one of the fishing gears in operation (Table 5 & 6) which indicates the multigear and multispecies nature of the marine fisheries in Kerala.

Determining gear interactions with ETP species

A major conservation concern is the interaction of different gears with ETP (Endangered, Threatened and Protected) species and the expanded database allows us to examine this in the long term. The maximum interaction was observed with MGN followed by MDTN, MTN and OBHL. In terms of the percentage of the catch of all the ETP species by the gears it is less than 0.05% of the total. Many gears such as MPS and MRS did not record any interaction with ETP species (Fig.12).

Table 5. Number of species caught exclusively by a gear

Gear	MDTN	MGN	MHL	MCGR	MPS	MRS	MTN	NM	OBBS	OBGN	OBHL	OBCGR	OBRS	OBSS	OBTN
Number of species	68	11	15	9	0	1	93	32	0	25	15	2	5	0	2

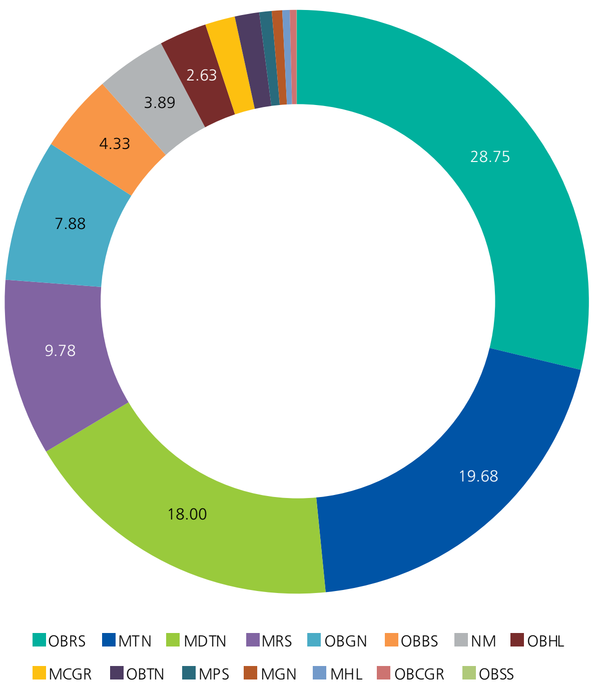

Fig.11. Percentage contribution of gear-wise landings to the total landings from 1985 to 2019. [MDTN- Multiday Trawlnet, MGN-Mechanised Gillnet, MHL- mechanised Hook& Line, MCGR-Mechanised Combination Gears, MPS-Mechanised Purseseine, MRS- Mechanised Ringseine, MTN-Mechanised Trawlnet, NM- Non-Mechanised (Artisanal), OBBS-Outboard Boatseine, OBGN- Outboard Gillnet, OBHL-Outboard Hook & Line, OBCGR- Outboard Combination Gears, OBRS- Outboard Ringseine, OBSS- Outboard Shoreseine, OBTN- Outboard Trawlnet]

Table 6. Number of species that occurred in multiple gears

No. of gears	No. of species caught
15	20
14	39
13	32
12	33
11	35
10	36
9	38
8	58
7	50
6	53
5	72
4	85
3	131
2	190
1	278

Determining species that are to be assessed

In the multispecies and multigear fisheries as in Kerala, it is important to develop an objective methodology to determine which are the species to be assessed, for determining their stock status. In an ecosystem perspective, it is not feasible to assess many of them due to several reasons and stock assessments cannot be practically done for all the 78 most common species every year. Species

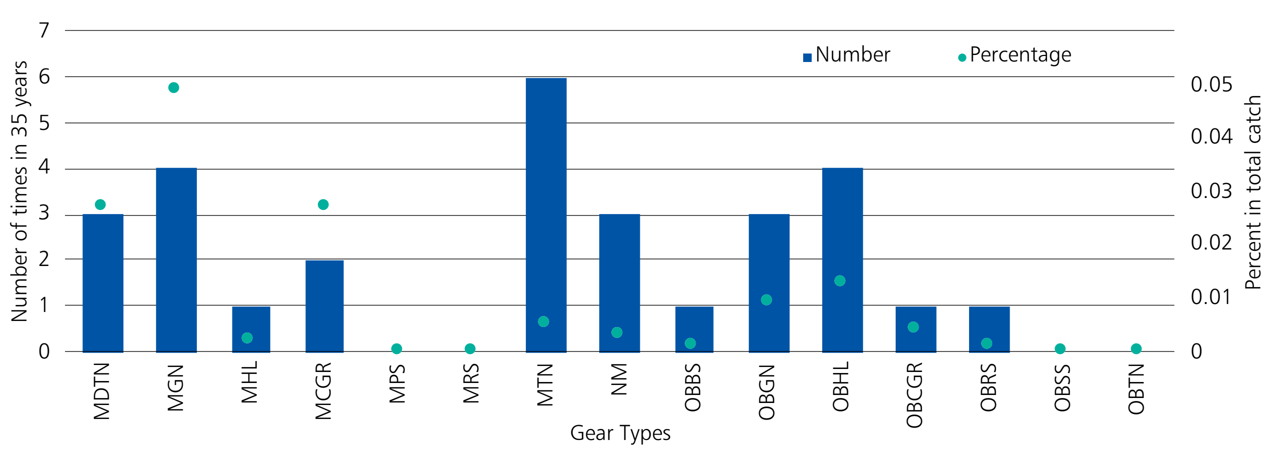

Fig.12. Record of incidental capture of ETP species in Kerala during the 35 years.

that form a substantial portion of the catch (and thence a major component of the ecosystem) and those having high economic value are usually the targets of fishers. The remaining catch is usually considered a bycatch or incidental catch. Many authors have classified bycatch as low-value bycatch (LVB), trash etc (Dineshbabu *et al*., 2014; Mahesh *et al*., 2019).

The number of species to be assessed was determined based on the cumulative distribution of both catch percentage & value and the gear-wise distribution of the 78 species is provided (Fig. 13 & 14). The lines on the top show the gears in which a few species are dominant, while those at the bottom show a more diverse species distribution. This indicates that outboard gears such as OBTN, OBRS and OBSS and the mechanised gears such as MRS and MPS are exploiting only a few species and attained the maximum for cumulative percentage with the species ranked within ten species. For other gears, the species diversity is more.

Of the 78 species, the list of species selected as per the criteria are shown in Table 7. Among these, the genera indicated with spp. are those in which the species have to be identified based on their dominance among the genera. Evidently, several species require multigear assessments (Fig.15)

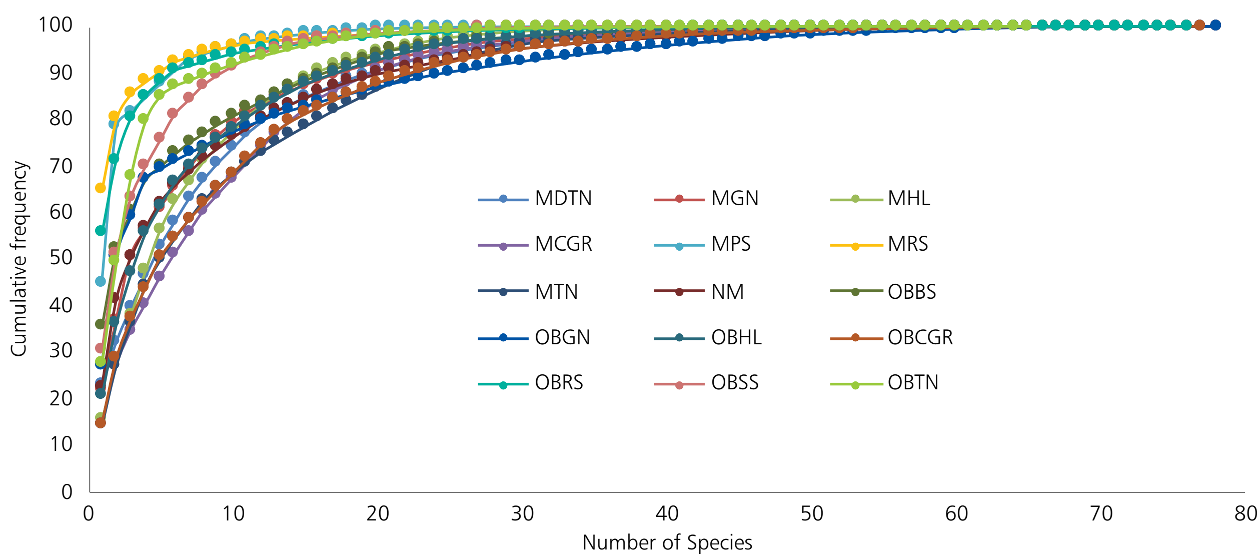

Fig.13. Cumulative frequency distribution (Based on landings) of the selected 78 species in each gear.

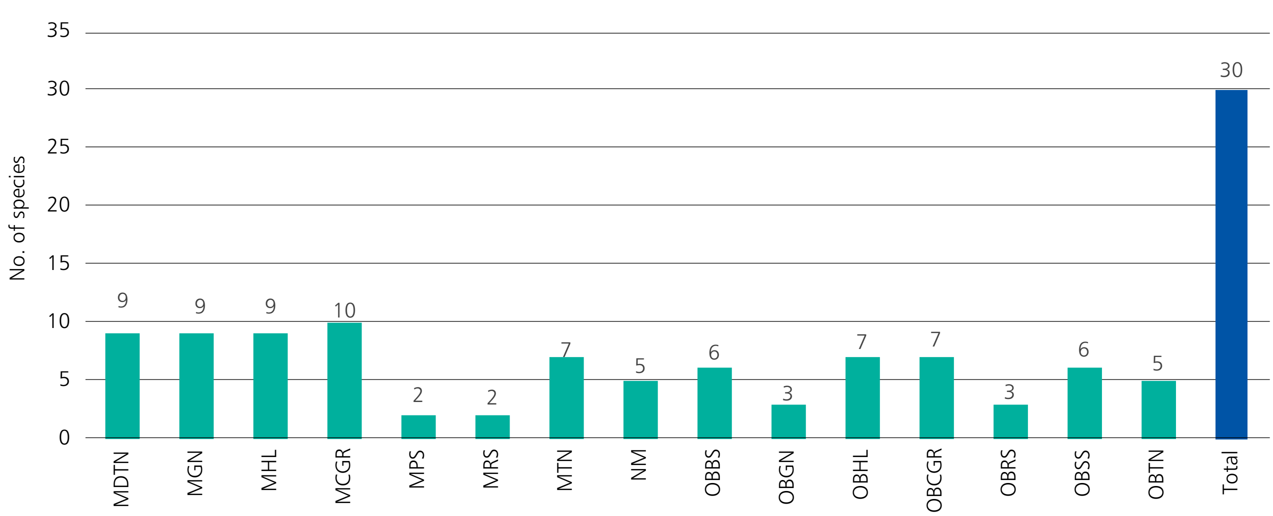

Fig.14. Gear-wise distribution of the number of species to be assessed

Table 7. Gear-wise list of species to be assessed.

MDTN	MGN	MHL
1. *Decapterus russelli*	1. *Auxis thazard**	1. *Carcharhinus* spp.
2. *Metapenaeus dobsoni*	2. *Carcharhinus* spp.*	2. *Epinephelus* spp.*
3. *Nemipterus* spp.	3. *Euthynnus affinis*	3. *Euthynnus affinis*
4. *Priacanthus* spp.*	4. *Rastrelliger kanagurta*	4. *Istiophorus platypterus*
5. *Rastrelliger kanagurta*	5. *Scomberomorus commerson*	5. *Sepia* spp.
6. *Saurida tumbil**	6. *Scomberomorus guttatus**	6. *Thunnus albacares*
7. *Sepia* spp.	7. *Thunnus albacares*	7. *Trichiurus* spp.
8. *Trichiurus* spp.	8. *Parastromateus (=Formio) niger(=F. niger)*	8. *Himantura* spp.
9. *Uroteuthis duvaucelii*	9. *Himantura* spp.	9. *Uroteuthis duvaucelii*

MCGR	MPS	MRS
1. *Carcharhinus* spp.	1. *Rastrelliger kanagurta*	1. *Rastrelliger kanagurta*
2. *Decapterus russelli*	2. *Parastromateus (=Formio) niger(=F. niger)*	2. *Sardinella longiceps*
3. *Euthynnus affinis*		
4. *Istiophorus platypterus*		
5. *Nemipterus* spp.		
6. *Rastrelliger kanagurta*		
7. *Scomberomorus commerson*		
8. *Thunnus albacares*		
9. *Trichiurus* spp.		
10. *Uroteuthis duvaucelii*		

MTN	NM	OBBS
1. *Cynoglossus* spp.	1. *Decapterus russelli*	1. *Amblygaster sirm**
2. *Decapterus russelli*	2. *Rastrelliger kanagurta*	2. *Rastrelliger kanagurta*
3. *Metapenaeus dobsoni*	3. *Sardinella gibbosa*	3. *Sardinella longiceps*
4. *Nemipterus* spp.	4. *Sardinella longiceps*	4. *Sardinella fimbriata*
5. *Parapenaeopsis stylifera*	5. *Stolephorus* spp.	5. *Stolephorus* spp.
6. *Stolephorus* spp.		6. *Uroteuthis duvaucelii*
7. *Uroteuthis duvaucelii*		

OBGN	OBHL	OBCGR
1. *Euthynnus affinis*	1. *Auxis rochei**	1. *Cynoglossus* spp.
2. *Rastrelliger kanagurta*	2. *Caranx* spp.*	2. *Euthynnus affinis*
3. *Sardinella longiceps*	3. *Euthynnus affinis*	3. *Parapenaeopsis stylifera*
	4. *Rastrelliger kanagurta*	4. *Penaeus indicus*
	5. *Scomberomorus commerson*	5. *Rastrelliger kanagurta*
	6. *Sepia* spp.	6. *Sardinella longiceps*
	7. *Uroteuthis duvaucelii*	7. *Stolephorus* spp.

OBRS	OBSS	OBTN
1. *Rastrelliger kanagurta*	1. *Amblygaster sirm*	1. *Cynoglossus* spp.
2. *Sardinella longiceps*	2. *Leiognathus* spp.	2. *Metapenaeus dobsoni*
3. *Stolephorus* spp.	3. *Rastrelliger kanagurta*	3. *Oratosquilla nepa*
	4. *Sardinella fimbriata*	4. *Parapenaeopsis stylifera*
	5. *Sardinella gibbosa*	5. *Sardinella longiceps*
	6. *Stolephorus* spp.	

Appropriate species may be chosen for assessment as per expert opinion for Genus name with spp. ; *species exclusively caught in one gear

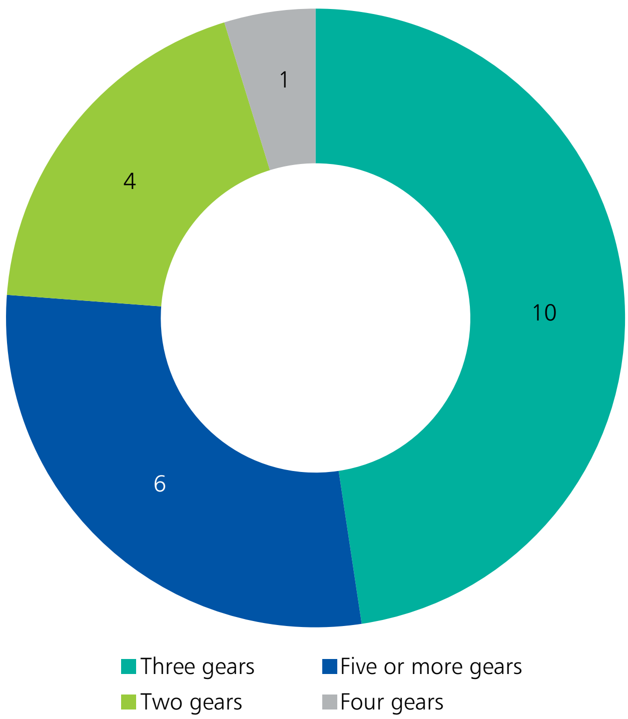

Fig.15. Number of species that require multigear assessments

Conclusion

Expanding the NMFDC database has helped to explore the full range of species information in the catch and effort database. Assessing the status of fish stock is of utmost importance to develop management strategies for the sustainable harvest of marine fishery resources. To make it possible regularly in the case of tropical regions where species diversity is high, two components are very essential viz., the data about the status of marine fish stocks over periods and the number of stocks to be assessed. The periodicity of assessment of important species has been already reported by Kuriakose *et al*. (2020) based on longevity and life-history parameters. We believe that this analysis would be helpful to the researchers to objectively identify species that are to be assessed and for policymakers to set up guidelines for the management of the marine fishery resources in tropical regions.

Acknowledgement

The work is based on the estimated marine fish landings data collected by ICAR-CMFRI from various landing centres along Kerala coast during 1985-2019

Financial assistance received for the data digitization under the international collaborative research project titled "Benchmarks for Ecosystem Assessment: Indicators and guidelines for Practical Ecosystem- Based Fishery Management (EBFM)", completed jointly by ICAR-CMFRI-CSIRO-LENFEST ocean programme, is duly acknowledged. We also acknowledge the facilities provided by Director, ICAR-CMFRI, Kochi, for conducting the research.

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Research Communications

Status of billfish fishery along the Indian coast

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Abstract

The landings of billfishes along the Indian coast showing an increasing trend since the 1990s and the estimated landings during 2019 was reported to be 14759 tonnes. In India, five species *Istiophorus platypterus*, *Kajikia audax*, *Istiompax indica*, *Makaira nigricans* and *Xiphias gladius* are reported regularly while rare landings of *Tetrapturus angustirostris* are also recorded. The average annual billfish landings during 2012-2019 in different maritime states indicates that Kerala (4942.9 t) leads followed by Tamil Nadu 3386.8 t, Andhra Pradesh 2215.3 t, Gujarat 944.5 t, Maharashtra 277.8 t and so on. Mechanised gillnetter forms the chief craft and gear operated for billfish resources. *I.platypterus* dominated among the billfish species landed during all the years followed by *I.indica, X.gladius, M.nigricans* and *K.audax*. The fishes commanded rate of ₹100 per kg for *I. platypterus,* 120-140 for *X. gladius* and 160-200 for Marlins.

Keywords*: Billfish, fishery trends, India.*

Billfishes contributing substantially to the total large pelagics landings in India although it does not constitute a targeted fishery and occurs as the bycatch in longlines, troll and oceanic drift gillnet fisheries. Billfishes reported commonly along the Indian coast are *Istiophorus platypterus* (Indo-Pacific Sail fish), *Kajikia audax* (Striped marlin), *Istiompax indica* (Black marlin), *Makaira nigricans* (Blue marlin) and *Xiphias gladius* (Sword fish). Rare landings of *T. angustirostris* was also reported. The landings of billfishes along the Indian coast are showing an increasing trend (Fig.1).

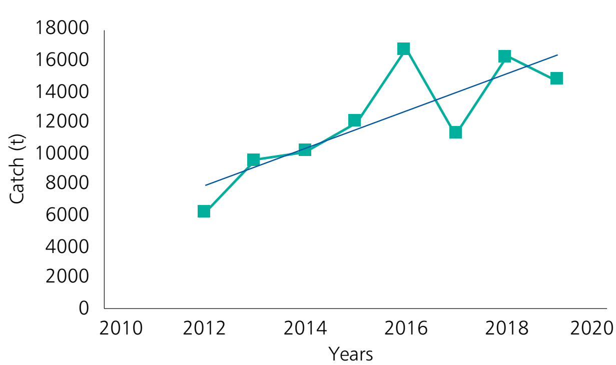

Fig.1. Trend of billfish landings in India (2012-2019)

Total billfish landings in different maritime states during 2012-2019 indicates contribution of Kerala (41%), Tamil Nadu (28%), Andhra Pradesh (18%), Gujarat (8%) and Maharashtra (2%), with only meagre landings in other maritime states and union territories (Fig.2). The annual state-wise billfish landings of India from 2012-2019 indicated Kerala topped during most of the years followed by Tamil Nadu, Andhra Pradesh, Gujarat and Maharashtra (Fig.3).

The major crafts and gears chiefly employed in billfish harvest during the 2012- 2019 period was Mechanised Gillnetter (MGN-29238 t), Mechanised others (MOTHS-

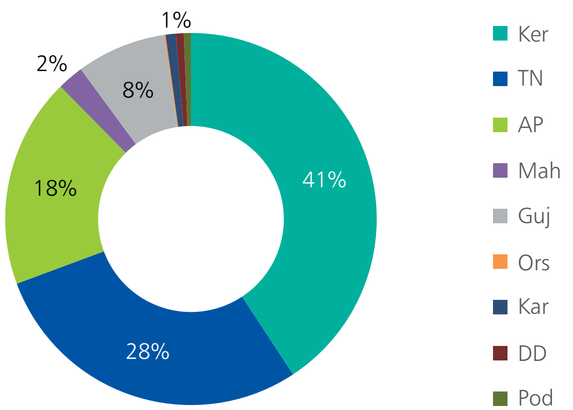

Fig.2. Percentage contribution of different maritime states and Union territories in annual total billfish landings from 2012-2019

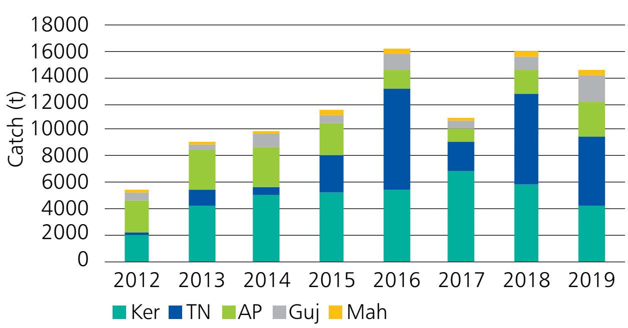

Fig.3. Annual contribution of various maritime states to billfish landings (t) along Indian coast (2012-2019)

23239 t), Out board Gillnetter (OBGN- 14947t), Out board Hook and Line (15928 t), Multiday Trawlnet (MDTN- 5659 t), Mechanised Hook and line (MHL- 3287 t), Out board others (OBOTHS- 2379 t), Mechanised Gillnetter cum Hook and line (MGNHL- 1992 t), Mechanised trawl (MTN- 1650 t), Non-motorised crafts (NM- 1271 t), Multiday trawler cum hook and line (MDTNHL- 329 t), Mechanised Purseseine (MPS- 307 t), Mechanised Ringseine (MRS- 0.8 t) and Mechanised Dolnetter (MDOL- 12.16t). Fishermen opine operating gillnets for billfishes is more profitable than line fishing. The species composition in the catch was *I.platypterus, M.nigricans, I.indica, Xiphias gladius, Thunnus albacares* and *Katsuwonus pelamis*. Bigger sized billfishes were caught in gillnets and a blue marlin weighing 400 kg landed in September 2020 was auctioned at the rate of ₹49500. They can operate lines only when the water is clear and billfishes and shark are landed with the chances of getting tunas being rare. The gillnet catch fetches more profit due to the different species that are commonly caught in this gear.

The billfish landings by different gears in different maritime states and union territories during 2012-19 indicate MGN, OBGN, MGNHL, MHL, MDTN, OBHL and MOTHS are the major gears (Table 1). *I.platypterus* formed the major species landed by all the gears during the reporting period.

The major species landed along the Indian coast during 2012-2019 were *Istiophorus platypterus, Istiompax indica, Makaira nigricans, Xiphias gladius* and *Kajikia audax*. *I.platypterus* dominated in all the years followed by *I.indica, X.gladius, M.nigricans* and *K.audax* (Fig.4).The maximum landing of *I.platypterus* was reported in Kerala in most of the years followed by Tamil Nadu, Andhra Pradesh, Gujarat and Maharashtra. The maximum annual landings of *I.indica* was from Andhra Pradesh followed by Kerala, Tamil Nadu, Karnataka and Maharashtra. Maximum landings of *M.nigricans* were observed in Tamil Nadu followed by Kerala, Andhra Pradesh, Gujarat, Maharashtra and West Bengal. For *X.gladius* maximum

Table 1. Average annual billfish landings by different gears in different states and union territories during 2012-2019.

State/Gears	Average annual landing of Billfishes (t) by different gears in different States and Union territories during 2012-2019												
	MDTN	MGN	MGNHL	MHL	MOTHS	MRS	MTN	NM	OBGN	OBHL	OBOTHS	MDTNHL	MPS
West Bengal	210												
Odisha	7	2							47	82			
Andhra Pradesh	188	695			2		1	93	5473	2124	152.7		
Tamil Nadu	2832	16727	119	263	3208		1635	36	1059	1567		320	
Puducherry	237	344					11					1.5	
Kerala	64	5578	1835	2928	20016				4994	1935	2184	6.6	
Karnataka	292	140	36	1	11	0.800			296	3.7	43		35.4
Maharashtra	295	1911		58			1	0.46	257				271.6
Gujarat	1482	3433		35					2603	1.5			
Daman and Diu	45	404							215				

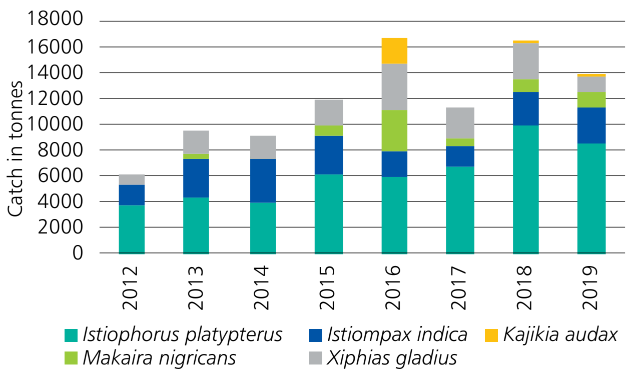

Fig.4. Annual species wise landings of billfishes along Indian coast

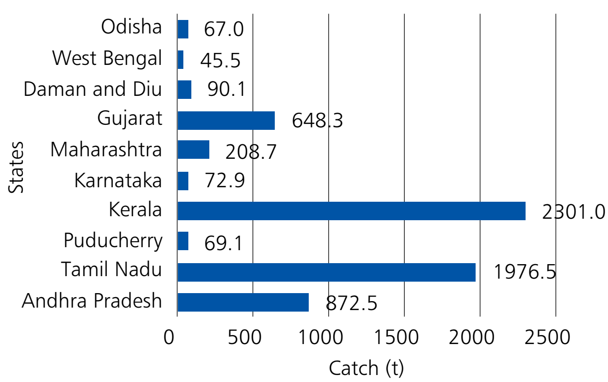

Fig.5. Annual average landings (t) of *I.platypterus* along maritime states of India (2012-19)

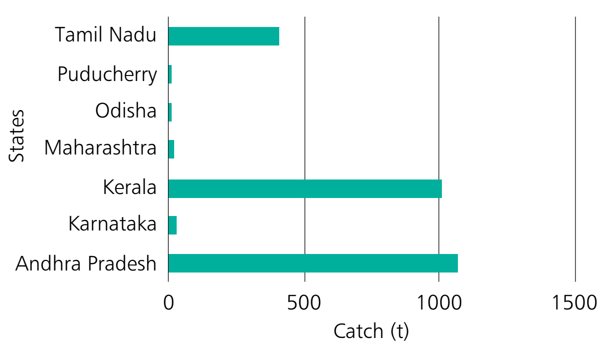

Fig.6. State-wise annual average landings of *I.indica* (2012-19)

annual landings were reported in Kerala followed by Tamil Nadu, Gujarat, Maharashtra and Andhra Pradesh. *K.audax* was reported from Tamil Nadu and Maharashtra in some years (Figs. 5-8).

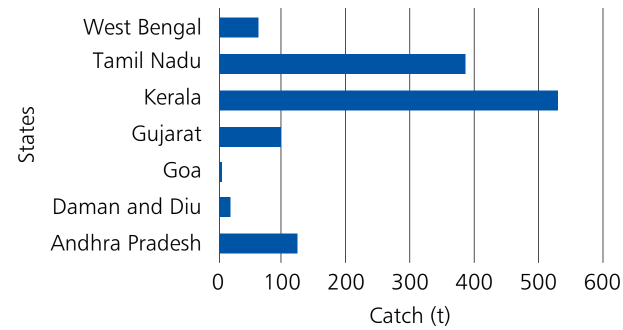

Fig.7. State-wise annual average landings (t) of *M.nigricans* (2012-2019)

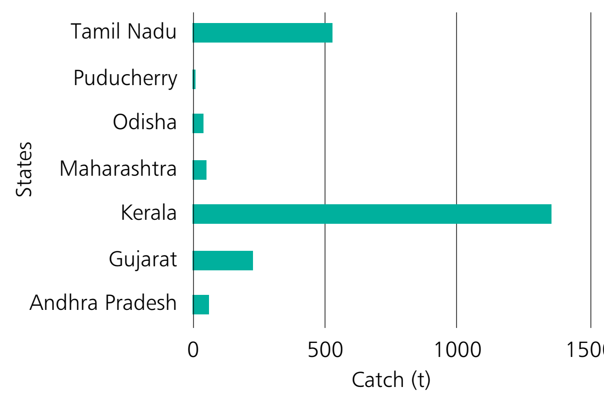

Fig.8. State-wise annual average landings (t) of *X.gladius* (2012-19)

The billfishes landed in Thoothoor – Kanyakumari region of Tamil Nadu, were processed at the fisheries harbour itself for easy transportation. The fishes were often auctioned at the rate of ₹100 per kg for *I. platypterus,* ₹120-140 per kg for *X. gladius* and ₹160-200 for marlins. With little demand in local markets, most of these processed fishes packed in plastic and thermocol containers with ice are transported to neighboring states, mainly Kerala. In fish markets of Kerala like in Thalassery, Aluva, Kottayam, Idukki, Changanassery these are sold at the rate of ₹200-350 per kg. The processing plants located at Kanyakumari send the fresh ice packed fishes to Kerala and the salt dried fishes to Tuticorin and Chennai, which is often exported to countries like Sri Lanka, Malaysia and Singapore.

Assessment of changes in the cephalopod species composition in landings off Visakhapatnam coast, Andhra Pradesh

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Cephalopods are landed by the large trawlers (12-14 OAL (Overall Length), 98/110 hp), known as sona boats and the smaller trawlers (9.5-10 OAL, 68/90 hp). Time series data with respect to catch, catch rate and species composition of cephalopods (cuttlefish and squids) off Visakhapatnam coast for the period 1998-2010 were analysed. The Markov chain model was used to assess the species dominance to understand the changes and predict the dominance order of different species of cephalopods.Monthly and annual data on the effort and total cephalopod landings by the trawlers based at Visakhapatnam Fisheries Harbour collected by ICAR -CMFRI through a stratified multi-stage random sampling method was used. For estimation of species composition, weekly samples collected during the period were analyzed and appropriately weighted to arrive at monthly and annual landings. The three dominant species/groups *Uroteuthis (Photololigo) duvaucelii* (A), *Sepia aculeata* (B) and *S. pharaonis* (C) were employed to assess the resource dominance pattern over the period. The basis of the simple Markov model applied to fish dynamics is that at any particular period, the fishery can be classified into discrete number of states, and that the probability of change from one state to another over a particular time interval depends on the present state. The sequence of states occurring at a particular point is called a Markov chain and is essentially stochastic or random in nature with transitions occurring with given probabilities. The controlling factor in a Markov chain is the transition probability; which is the probability for the system to go to a new state, given the current state of the system. Transitions are then recognized as occurring when dominance at a point changes from one species or species group to another.The process of dynamic change in the fishery with respect to most abundant species in the fishery can be studied over long periods of change through higher order transition probabilities Limiting probabilities are used to find whether the fishery will ever reach a stable state or equilibrium if the conditions affecting the fishery remain the same over time.

During the period 1998-2010 estimated landings of cephalopod in Visakhapatnam Fisheries Harbour was 12113.6 t with an average annual production of 931.8 t. The cephalopod landing during 1998-2003 was less than 1000 t; which increased subsequently and recorded a steep increase to 2193 t (in 2010). The effort also increased over the period from a 139462 in 1998 to 2461167 in 2010. The average catch per unit effort was 1.03 Kg. The CPUE was very low during the 2002 to 2006 although effort was high. Cephalopods were landed by the large trawlers (sona boats) and small mechanized boats (SMBs). While the SMBs mainly contributed to the cephalopod landings during 1998 -2003, the contribution of the larger trawlers increased tremendously. The small mechanized trawlers had contributed 58.3 % during 1998 to 2001 while sona boats contributed 63.4 % of the cephalopod landings during 2002-2010. Fishery for cephalopods begins by June and peak landings occur during June to September.

During the period squids contributed 20.5% and cuttlefish 79.8% to the total cephalopod landings. Octopus landings were negligible. Among cuttlefish, *Sepia pharaonis*, *S. aculeata*, *Sepiella inermis* and occasionally *S. elliptica, S. brevimana* and *S. prashadi* were landed. *S. aculeata* contributed 34.22% followed by *S. pharaonis* (29.6 %), *S. inermis* (9.6%), *U. duvaucelii* (20.54 %) and the

Table 1. Dominance of major species/species groups

Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1998	C	C	C	A	A	A	A	A	A	A	A	A
1999	A	A	A	A	-	A	A	A	B	B	C	C
2000	A	A	A	A	-	A	A	A	A	A	A	B
2001	A	A	A	B	-	B	A	B	A	B	B	B
2002	B	B	B	B	-	B	C	B	B	C	B	B
2003	B	B	C	B	-	B	B	B	B	B	B	B
2004	B	B	B	B	-	B	B	B	B	B	B	B
2005	B	B	B	B	-	B	B	B	B	B	B	B
2006	C	C	B	B	-	C	C	B	B	B	B	B
2007	B	B	B	C	-	B	B	B	B	B	C	C
2008	A	A	A	A	-	C	C	C	A	C	A	B

A –. *Uroteuthis (Photololigo) duvaucelii* B – *Sepia aculeata* C – *Sepia pharaonis*

Table 2. Transition probabilities of major cephalopod species landed

Species	*U. duvaucelii*	*S. aculeata*	*S. pharaonis*
U. duvaucelii	0.750000	0.166667	0.083333
S. aculeata	0.075758	0.818182	0.106061
S. pharaonis	0.192308	0.307692	0.500000

Table 3. Higher order transition probabilities

Species	*U. duvaucelii*	*S. aculeata*	*S. pharaonis*
U. duvaucelii	0.591152	0.287005	0.121843
S. aculeata	0.139199	0.714682	0.146121
S. pharaonis	0.263695	0.437645	0.29866

rest (6.23%) to the total cephalopod landings. Among squids, *Uroteuthis (Photololigo) duvaucelii* contributed entirely to the squid landings. Stray numbers of *L. uyii* and *Sepioteuthis lessoniana* were observed. During 1998-2010 periods, *U. duvaucelii* was the dominant species. During 2002 to 2007, *S. aculeata* was the dominant species contributing to the fishery while 2008 to 2010 *S. pharaonis* landings were the highest.Over the decade, price per kilogram for *S. pharaonis* was ₹220 to ₹230, *S. aculeata* ₹220, *S. inermis* ₹80-100 and *U. duvaucelii* at ₹50-60.

The higher order transition probabilities can be used to predict the fishery at various time periods (Table 3). The limiting probabilities of the various states indicated for *U. duvaucelii, S.pharaonis* was 0.291286 and 0.164078 respectively and highest in *S.aculeata* (0.544647). The transition probabilities of the dominant species estimated using the maximum likelihood estimator are given in Table 2.

The Markov chain model a probabilistic model to produce estimates of unobservable, yet meaningful parameters indicated that the probability that *U. duvaucelii* is dominating the fishery in a month, given that the same was dominating in the fishery in the previous month (p_{00}) is 0.75. From the higher order transition probabilities it is clear that, if *U. duvaucelii* is dominant in the fishery now, the probability that it continues to be the dominant group in the next year ($p_{00}^{(1)}$) is 0.5911. In case of *S. aculeata*, p_{22}, which gives the probability of dominance in two successive months, is 0.7147. The limiting probability that *S.aculeata* will dominate in the cephalopod fishery of Vishakhapatnam is 0.5446 while it is only 0.29 and 0.16 for *U.duvaucelii* and *S.pharaonis* respectively. The analysis indicates that in the long run the cephalopod fishery of Vishakhapatnam coast is more likely to be dominated by *S.aculeata*

Extreme weather events in northern Indian Ocean region–An appraisal with respect to cyclones and marine heatwaves

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The abnormal and accelerated warming of the atmosphere since 1950s has contributed to a significant increase in the occurrence of extreme weather events like cyclones, snow storms and droughts globally. This has caused loss of human life and property as well as adversely impacted the local biodiversity. The Northern Indian Ocean region has also experienced this phenomenon in terms of increased occurrence of cyclones and marine heatwaves. Cyclones are strong winds that spiral inward to a central low pressure core and the impacts of cyclones on marine ecosystem are manifold. The super cyclone of 1999 that crossed Odisha coast increased the nutrient concentrations of surface waters causing an increase in the primary production in the south western Bay of Bengal (Madhu *et al.*, 2002, Nayak *et al.,* 2001) and the post-cyclone blooms have implications for pelagic communities and ecosystem dynamics. The extreme hydrodynamic force exerted by tropical cyclones also exerts significant impact on coral reefs and seagrass ecosystems which are important breeding, nursery and feeding grounds of various marine organisms and fishes in particular. Marine heatwaves are prolonged, extreme warm water events with disruptive consequences for marine ecosystems. The intensity (the temperature anomaly exceeding a climatology) and duration (the sustained period of extreme temperatures) are the main parameters which affects the marine flora and fauna including planktons, corals, seagrass, seaweeds and fishes (Benthuysen *et al.*, 2020). It has been observed that, in general, marine heatwaves negatively affect canopy-forming seaweeds while promoting turf-forming seaweeds (Straub *et al.*, 2019). Temperatures changes to the tune of 0.5 ºC can change the recruitment pattern in fish and shellfishes with larval fishes more sensitive to the temperature fluctuation than the adults (Vivekanandan, 2013).

The northern Indian Ocean region which includes the Bay of Bengal and the Arabian Sea, is following the global patterns in terms of the occurrence of extreme weather events especially the cyclones and marine heatwaves. As the pace of global warming is not equal throughout, the trends in sea surface temperature (SST), marine heatwaves and the cyclones are also different for the Bay of Bengal and the Arabian Sea. The global average SST warming during the period 1951– 2015 is approximately 0.7 °C (0.11 °C/decade) while the tropical Indian Ocean reported a rapid basin-wide sea surface temperature (SST) warming of 1.0 °C (0.15 °C/decade) during the same period. The warming trend of northern Arabian Sea is reported to be the maximum and is to the tune of 0.18 °C per decade during the period 1976–2005 (Roxy *et al*., 2020; Krishnan *et al.*, 2020).

Compared to the Arabian Sea, the Bay of Bengal produced maximum number of cyclonic disturbances during the period 1982-2020 (Fig.1). The northwest Bay of Bengal

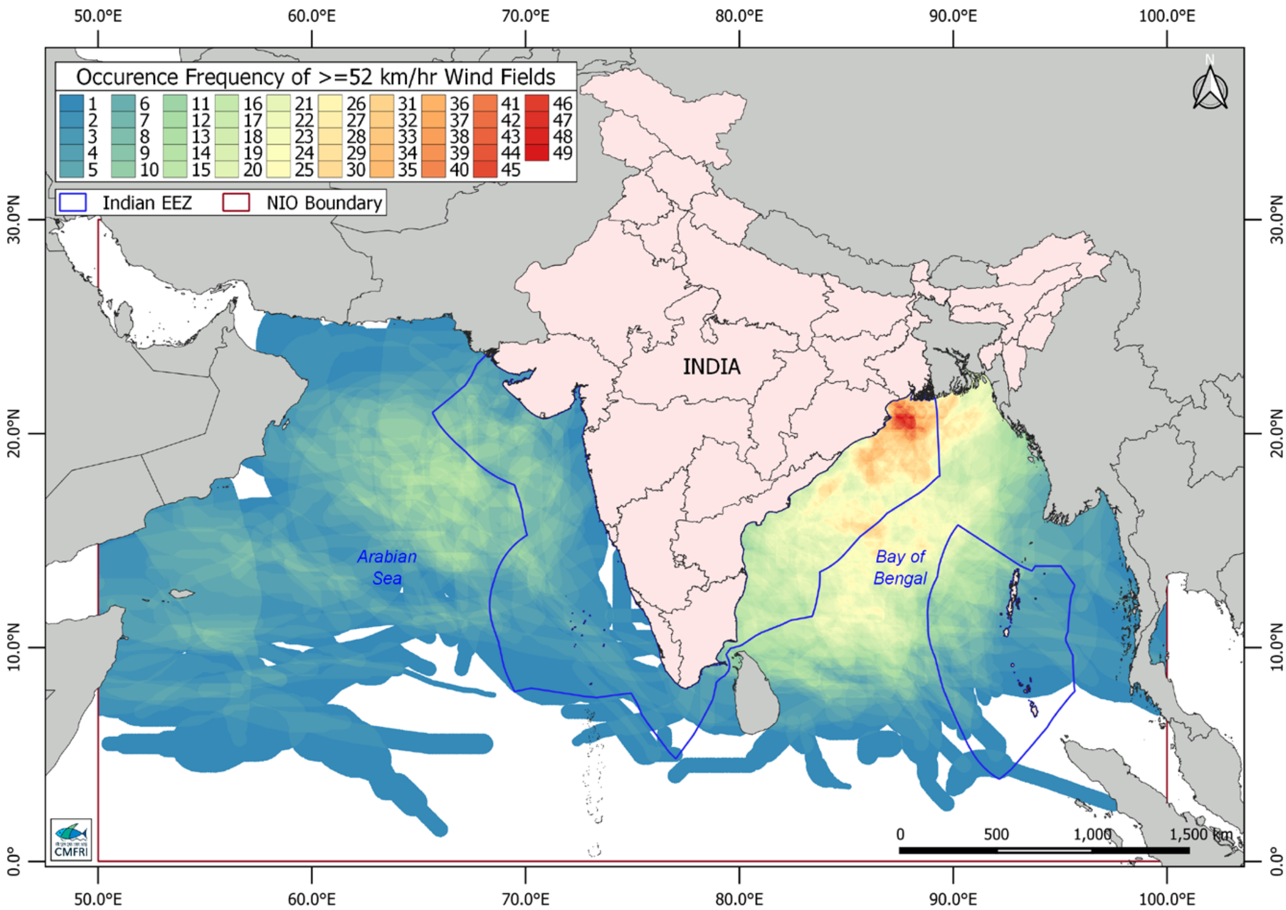

Fig.1 Occurrence frequency of >=52 km/hr wind fields associated with the cyclonic storms over NIO region during 1982-2020

experienced most of the storms followed by northeast, west central and east central Bay of Bengal. The east and west central Arabian Sea experienced the highest number of storms. There is definitely a noticeable distinction between Bay of Bengal and Arabian Sea with respect to the number of occurrences of storms with Bay of Bengal witnessing most of the storms. But, if you analyse the basin-wise trend, we can observe a shift in the trend. Arabian Sea is now producing more cyclonic disturbances compared to the Bay of Bengal (Fig. 2 and 3). Especially, the number of high energy storms is on the rise in Arabian Sea area. Climate change induced rapid pace

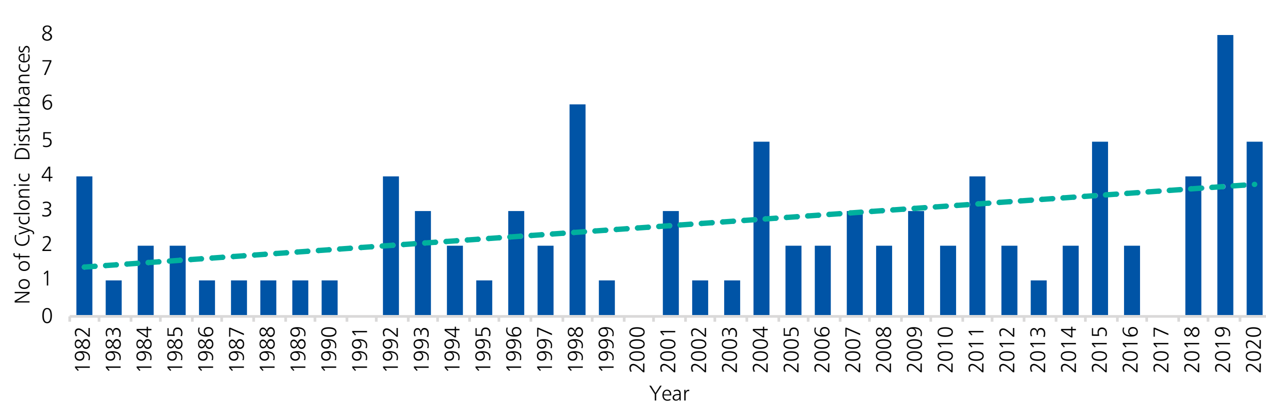

Fig.2 Number of cyclonic disturbances formed over the Arabian Sea during the period 1982-2020

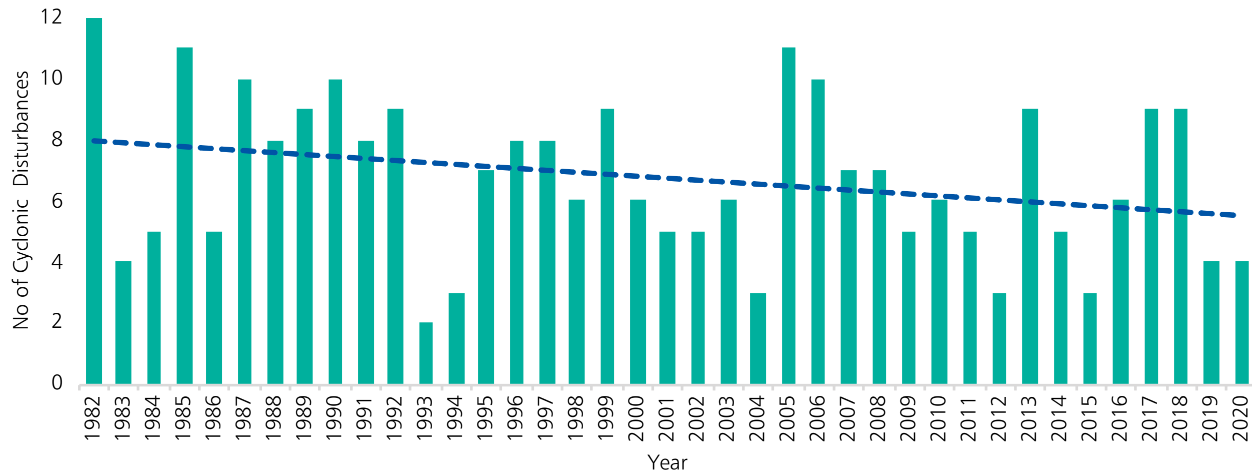

Fig.3 Number of cyclonic disturbances formed over the Bay of Bengal during the period 1982-2020

of warming of the Arabian Sea and increased presence of aerosols may be the factors influencing increased occurrence of cyclonic disturbances in the Arabian Sea (Krishnan *et al.*, 2020).

The occurrence of marine heatwaves in the NIO region also shows a similar trend where the Arabian Sea shows an upward trend and the Bay of Bengal shows a downward trend (Fig 4.). The coastal areas of Tamil Nadu and Andhra Pradesh are very clearly showing negative trends while the

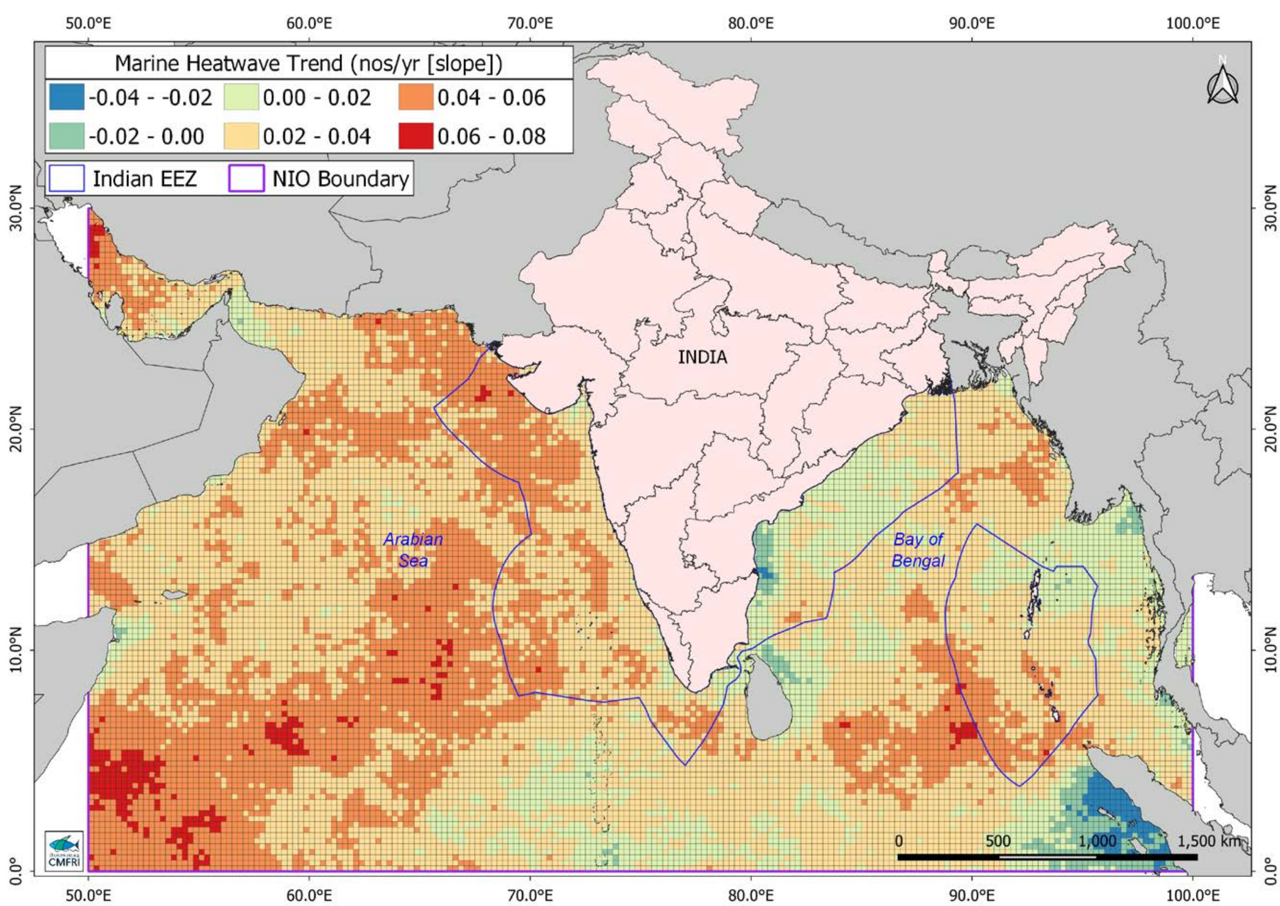

Fig.4 The trend of marine heatwaves in NIO region for the period 1982-2019

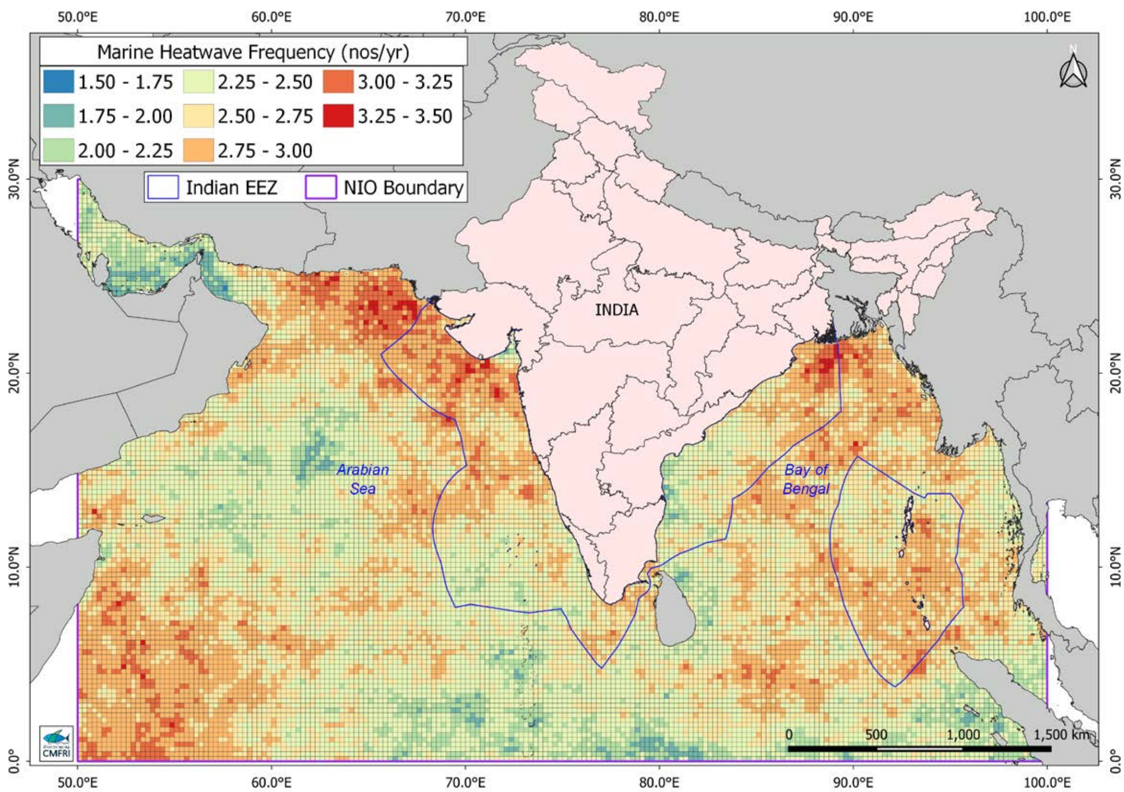

Fig.5 The average frequency of marine heatwaves in NIO region during the period 1982-2019

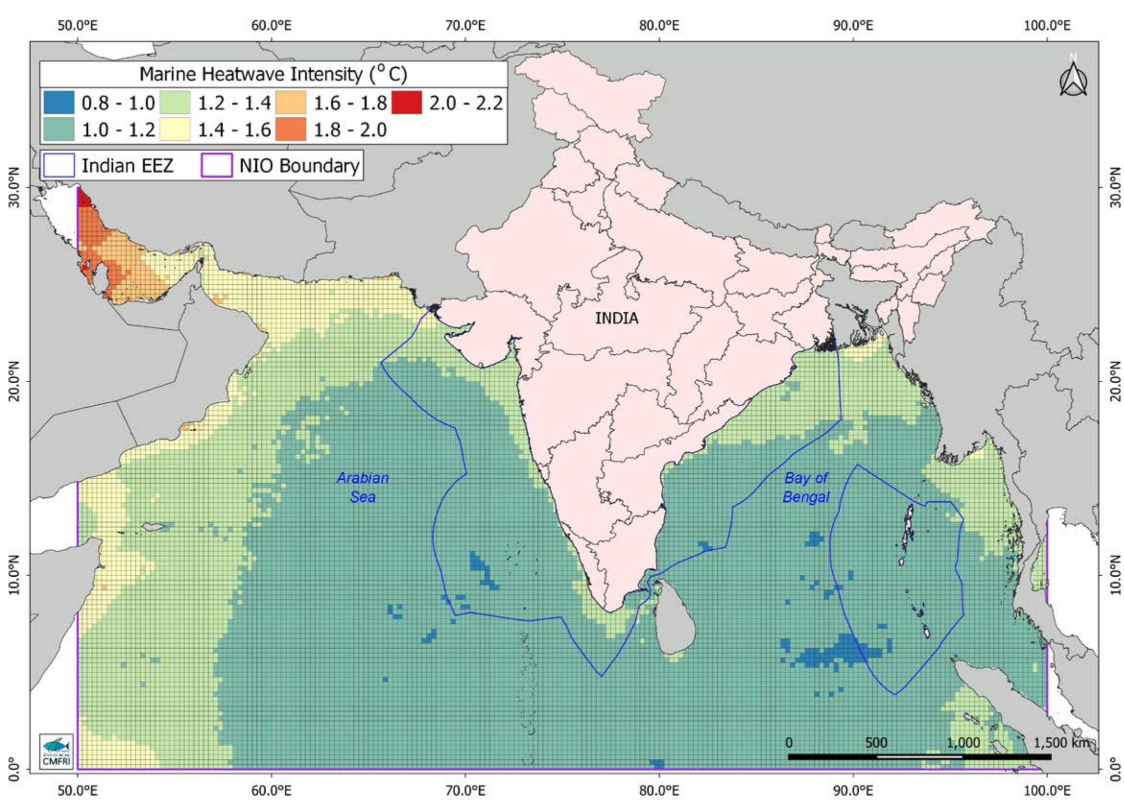

Fig.6 The average intensity of marine heatwaves in NIO region during the period 1982-2019

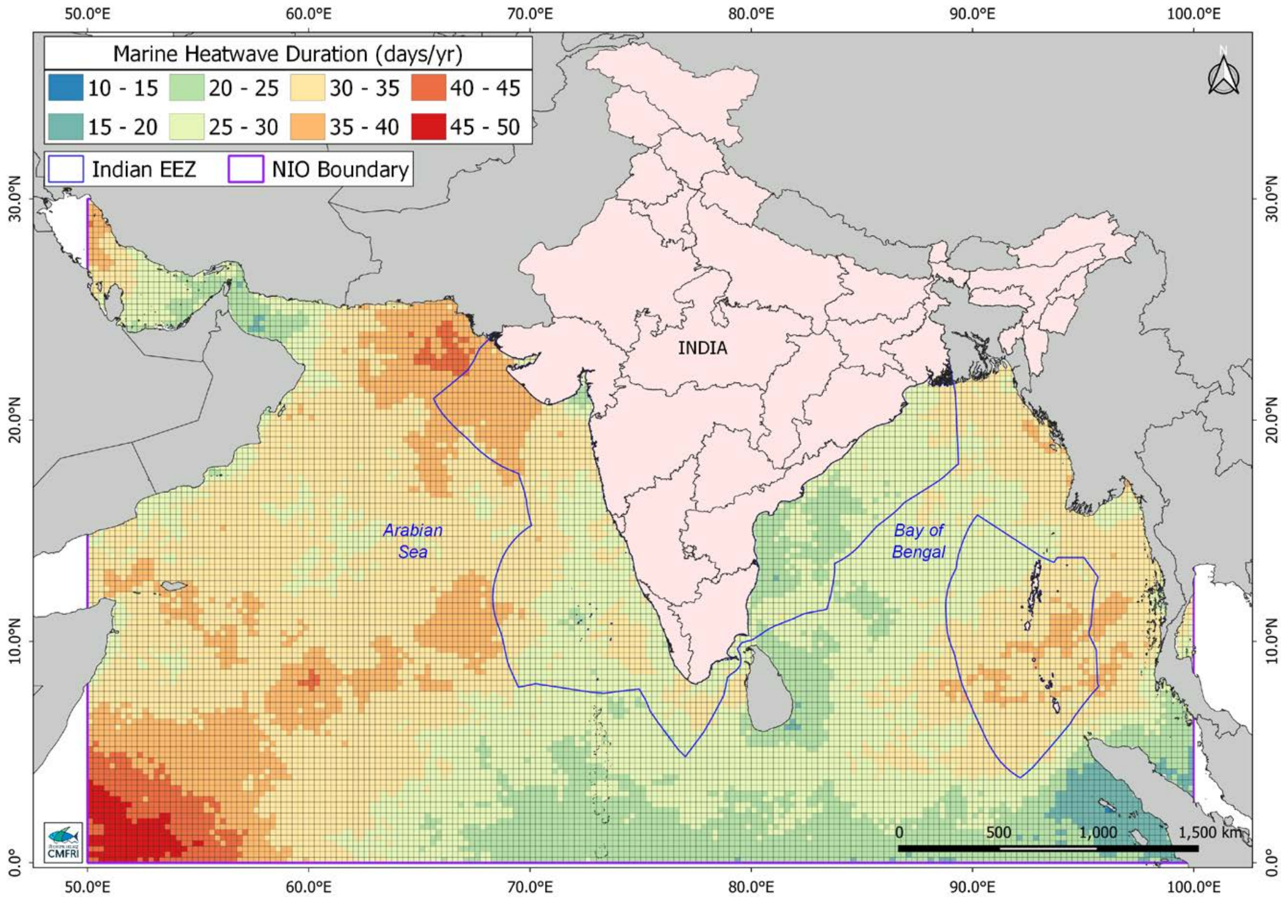

Fig.7 The average number of days in a year affected by marine heatwaves in NIO region during the period 1982-2019

coastal areas of Gujarat and Maharashtra are showing positive trends. The mean frequency (number per year) of the marine heatwave occurrence ranges from 1.5 to 3.5 in the NIO region and the northeast Arabian Sea and the northwest Bay of Bengal report the highest values (Fig. 5). But the mean intensity of the heatwaves in the NIO region indicate that the coastal areas experience more intense marine heatwaves (1.2 – 1.4 °C) while the open ocean experience less intense ones (0.8 – 1.2 °C) and the Persian Gulf experience the most intense (2.0 – 2.2 °C) marine heatwaves (Fig. 6). The mean number of days in a year affected by the marine heatwaves is more in the southwest Arabian Sea (45-50 days) followed by the northeast Arabian Sea (40-45 days). On an average, the east coast of India experiences marine heat waves for 20-30 days in a year while the west coast of India experiences 25-35 days of marine heatwaves in a year (Fig. 7).

More frequent weather and oceanographic extremes could destabilise existing trophic links and favour the shorter-lived, high-turnover fish species at higher trophic levels. It could also lead to increased spatial and temporal variability of plankton productivity. The impact of changes in plankton communities on the pelagic larvae of important target fish species demands additional attention. A misalignment between fish reproduction and periods of high plankton productivity could have a significant impact on fish population replenishment. The fish larvae spend days to months in the planktonic form, whereas important fishery invertebrates like crustaceans spend months in the planktonic form before settling (Hobday *et al*., 2008). Larval starvation is major contributor to mortality and the impact is felt more when the larval duration is more. Hence, a shift between low-nutrient and high-nutrient plankton communities, which might result from extreme weather events, would exert significant influence on fish larvae survival (McKinnon *et al.*, 2003; Johnson *et al.*, 2011).

The above discussions points to the fact that there has been a shift in the pattern of the extreme weather events that occur in the NIO region, especially the cyclones and the marine heatwaves. Moreover, these events have intricate interactions with the marine ecosystems and its ramifications can be felt in the marine fish resources. Even though some sporadic studies are available, a more systematic and comprehensive study on the impact of these extreme weather events on marine fish resources are needed, especially in the NIO region.

Acknowledgement

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Brief Communications

Cage farming of fish- A success story of SHGs

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Cage fish farming technology facilitates utilization of public water bodies for the livelihood enhancement of coastal fisherfolk. The open water resources of our country have been widely utilized for fish production by establishing location-specific cage culture systems and ICAR-Central Marine Fisheries Research Institute (CMFRI), has played a vital role in disseminating the cage fish culture technology throughout the coastal belt of the country. The present work was carried out as a part of the project entitled "Empowerment of Scheduled Caste fisherfolk through Entrepreneurial Capacity Building of Self Help Groups in marine sector" funded by Department of Science & Technology, New Delhi.

Under Scheduled Caste Sub Plan (SCSP) programme, successful cage culture ventures were undertaken in Edavanakkad and Manjanakkad villages of Ernakulam district of Kerala state by mobilizing 3 SHGs. Cage fish culture was done in Veerampuzha backwater at Edavanakkad, Vypin Island, Ernakulam (10.0929° N, 76.2045° E) and Manjanakkad (10.0467° N, 76.2321° E). The technical assistance was provided through Krishi Vigyan Kendra (KVK) of ICAR–CMFRI and several training programmes including the theoretical aspects and practical demonstration on cage fabrication and management were arranged. A ready reckoner cage culture pamphlet in vernacular was distributed to the SHG members. A floating cage made using Galvanized Iron (GI) frame of 4m x 4 mx 2m was stocked with 800 Asian seabass fingerlings of 10 cm size in Edavanakkad. Similarly in Manjanakkad, two floating cages were fabricated and 400 seeds of Asian Seabass (10 cm size) and 500 Pearl

Seabass cage culture seeding in Edavanakkad

Fish harvested from the cages

Seeding in Manjanakkad cage

Harvest of seabass in Manjanakkad

spot seeds of (7 cm size) were stocked in each of these cages. The grading process as per the size was done systematically after 1-2 weeks and until fish reached marketable size. The linkage established gave the benefits of the provision of a deep freezer from ICAR–CMFRI under the National Innovations in Climatic Resilient Agriculture (NICRA) project along with seed and solar spot lights in the cages to the identified beneficiaries.

The gender analysis, performance level of SHG, Empowerment Index and economic feasibility analysis were assessed with socio-economic surveys undertaken in the selected localities. The male and female counterparts of the families were separately interviewed regarding the gender mainstreaming aspects in terms of equity and equality to access to resources, participation profile, decision making aspects, gender need analysis etc. Though males were favoured in most of the activities, the female counterparts of the households also had a definite role in decision making, feed preparation, management, harvesting, sales and marketing etc.

The fish harvest on 22nd December, 2020 in Edavanakkad yielded a bumper output of 600 kg sea-bass having an approximate weight of 1 to 1.5 kg each. The harvest was undertaken as per the demand from consumers and Support through social media like Facebook, Whatsapp etc. played an important role in achieving good sales for the farmers.The social and economic empowerment dimensions and capacity building aspects achieved highest score in Empowerment Index. The economic feasibility analysis gave an average Benefit Cost ratio for cage culture as 2.5: 1 in the first year.

Brief Communications

Gender mainstreaming through coastal cage farming- a success story from Andhra Pradesh

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The results of gender researches reveal that despite the important role women play in agricultural production, they remain disadvantaged in numerous aspects. Women mostly have limited access to agricultural inputs including seeds and fertilizers, technological resources, equipment, land often also lack the capacity needed to deploy these resources. Today, cage culture of marine fish is receiving more attention as increasing consumption of fish coupled with declining stocks of wild fishes has increased interest in fish production in cages. Suitable locations along the long coastline including brackish water areas available in coastal states and other underutilized water bodies can be better utilized by adopting cage culture which can play a significant role in increasing the overall fish production and household incomes of fishermen.

In this context, a case study was taken up at Lakshmipuram village in Kruthivennu mandal of Krishna district in Andhra Pradesh, to assess the gender roles in cage farming, and their contribution to family income. The respondents consist of the joint family of Shri Gandham Nagaraju, Shri. G. Nagamalleswara Rao, Smt. G. Kanthamma and Smt. G. Peddhintiamma belonging to the *Enathi* community, which is recognized as scheduled tribe. Their primary occupation was artisanal fishing in coastal backwaters, from which they were earning an annual gross income of about ₹1.20 lakh but faced problems like declining catches and non-consistent income.

Role performance of women in artisanal fishing

Later on, with technological interventions by ICAR-Central Marine Fisheries Research Institute (ICAR-CMFRI), they ventured into coastal cage farming of Asian Seabass. Gender mainstreaming initiatives such as, involving both men and women in training and demonstrations, equitable distribution of resources and inputs, and gender sensitization of the communities were done in every stage of the livelihood and income generating activities, women were involved *viz.,* in fishing in backwaters, seeding and feeding the cages and also played a major role in marketing the catches. The women of this joint family spend about 8 hours in a day, from 6 to 9 am and 5 to 10 pm, fishing with their husbands in the backwaters using cast nets. On an average, the women were also spending about 4 hours per day in cage culture activities, mainly in feeding and marketing. The major species caught were *Mugil cephalus, Lates calcarifer* and *Scylla serrata*. The daily income realized from the catches of *Mugil cephalus* and *Scylla serrata* was ranging from the minimum of about ₹200 to the occasional maximum of about ₹1500, which were mostly utilized for the day-to-day household expenses, especially food. The catches of small size *Lates calcarifer* were used for feeding the fishes grown in the cages.

Women feeding fish cultured in the cages

Fish harvested from the cages

Marketing the fish harvested from the cages

When the coastal cage farming of Asian Seabass started with two cages in November 2020, they were getting a fish production of 10 quintals, fetching a price of ₹300/- per kg, which generated a gross income of ₹3 lakhs. After deducting the operational expenses of ₹2.00 lakhs, the net income realized was about ₹1.00 lakh. From the income analysis from the base line period of 2016-17 till 2020-21, the net income of the family has doubled through coastal cage farming, in addition to their artisanal fishing activities. The cash in hand among women increased by 40 per cent.

Earlier, the daily earnings from artisanal fishing in backwaters supported only daily food requirements and there were hardly any savings. But the cash-savings through cage culture improved their standard of living, and help in purchasing household articles including a two-wheeler for self and bi-cycle for daughter. With the goals to double the income of every Indian farm household by 2022 being set, this success story of beneficiaries doubling their income through cage culture can motivate others also.

The two-wheeler purchased out of the income from cages

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Dissemination of cage culture technology among Scheduled tribes in Coastal Andhra Pradesh – A successful model for livelihood improvement

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The central government of India introduced the Tribal Sub-Plan (TSP) with an aim to bridge the gap between the schedule tribes (STs) and the general population with respect to socio-economic development indicators in a time-bound holistic manner. This plan has been effectively implemented by the Government of India through different state and central government agencies with research institutions functioning under Government of India also actively involved in working for welfare of the tribal communities including skill development programmes with recent viable technologies. Cage farming technology has emerged as one of the most important farming methods in mariculture for enhancing fish production. The cage culture methods for marine fin fishes such as Asian sea bass, Indian pompano, silver pompano, orange spotted grouper and mangrove red snapper has been demonstrated by ICAR-CMFRI in different places of the country. Cage farming can be efficiently utilised by the tribal population living in the vicinities of the water bodies, who are generally considered as landless or having mere land areas.

In Andhra Pradesh, culture of marine finfishes such as Indian pompano and Asian seabass has been demonstrated in cages in Krishna and Godavari backwaters by Visakhapatnam Regional Centre of ICAR-CMFRI under different programmes by involving fishermen and marginal landless aqua farmers. Among the tribes, Yenadis are numerically the third largest scheduled tribe in the state of Andhra Pradesh and are mostly distributed in the coastal districts of Nellore, Prakasam, Guntur, and Krishna. The TSP programme was first initiated during 2018-19, with a group of 30 people under Yenadis tribal community from Maripalem village, Nagayalanka Mandal, Krishna District and was demonstrated using three square shaped cages prepared from Galvanised iron. In the subsequent years, under the same plan, 13 cages were installed in different places of Krishna districts including Peddapalem village (Nagayalanka Mandal), Eduromundi village (Nagayalanka Mandal), and Laxmipuram village (Kruthivennu Mandal) and are presented as case studies.

Case study -1: Cage culture of Indian pompano at Maripalem, Nagayalanka, Krishna District, Andhra Pradesh

Harvest of Indian pompano reared in high saline estuarine cages by the Yanadi Tribal community was carried out on 24th May, 2020 in the presence of tribal beneficiaries, farmers and fishermen at Nagyalanka, Krishna district, Andhra Pradesh. The programme initiated in April, 2019, with three Galvanized Iron (GI) cages measuring 5 x 5 x 2.5 m in size which were installed in the high saline estuaries of the Krishna river at Nagayalanka with the active involvement of the Yenadis tribal community attached with the Antyodaya Women Mutually Aided

Harvest of Indian pompano at Maripalem, Nagayalanka, Krishna District

Co-operative Society under the supervision of ALERT/ ATMA, a non-governmental organization. Thirty tribal beneficiaries belonging to Maripalem village, a coastal village in Krishna district, were selected. Hatchery produced seeds of Indian pompano at Visakhapatnam RC of ICAR-CMFRI were nursery reared for three months, and then stocked in cages. In July, 2019, grow-out culture was initiated at a stocking weight of 80 g with density of 15 nos/m^3 (N = 950 numbers/cage) in all cages. The stocked fishes were reared for 10 months, and were fed four times daily with pelleted feed containing 40% crude protein (CP) and 10% crude fat (CF). The cultured fishes were harvested on 25th May, 2020 at an average weight of 745g; with a survival of 97.3%, FCR of 1:1.62 and a biomass of 10.86 kg/m^3. The harvested fishes were sold to Maxwell Sea Foods, Cochin at the rate of ₹330/ kg. A part of the revenue generated was shared among the tribal beneficiaries and the remaining amount was kept as common corpus fund to meet the operational expenditure for the next culture.

Case study -2: Cage culture of Indian pompano at Peddapalem Village, Nagayalanka Mandal, Krishna District, Andhra Pradesh

Hatchery reared Indian pompano were stocked in 4 estuarine cages at Peddapalem, Nagayalanka Mandal, Krishna District, Andhra Pradesh which were managed by 40 beneficiaries from Yenadis community from five different villages. The cages made of Galvanised Iron pipes of 5x5 m size with a 3 m net depth were stocked during November 2020, with nursery reared Indian pompano of 25.0 ± 5.0g in weight @13 numbers/m^3. Pelleted diet with 40% crude protein and 10% crude fat was given four times daily at 6 to 2 % of body weight. The fishes reached to an average size of 675.0 ± 25.0 g after

Harvest of Indian pompano at Peddapalem, Nagayalanka, Krishna District

Harvest of cage cultured Asian Seabass under Tribal Sub Plan Component at Laximipuram, Nagayalanka, Krishna District

seven months and were harvested during June, 2021. About 575 to 600 kg were harvested from individual cages which were sold at ₹295 per kg to wholesale fish traders in Chennai, Tamil Nadu. The income from was shared among the beneficiaries.

Case study -3: Cage culture of Asian Seabass at Laxmipuram Krishna District, Andhra Pradesh

Asian seabass was stocked in two estuarine cages at Laxmipuram village, Kruthivenu Mandal, Krishna District, Andhra Pradesh with 30 beneficiaries belonging to Yenadis community. The cages made using Galvanised Iron pipes of 5x5 m size with a 2.5 m net depth were stocked during October, 2020 with nursery reared Asian Seabass of 80.0 $\pm$ 5.0g in weight at 15 numbers/m^3. Stocked fishes were fed with chopped low value fish (Tilapia), thrice a day at 3 – 10% of body weight, depending on the fish growth during different periods of culture. The fish reared for 8 months was harvested on 17th June, 2021 and each fish had attained an average weight of 725g ranging from 650 to 1150 g. A total of 865 kg of fishes were harvested from the two cages at approximately 430 kg per cage. Harvested fishes were sold at the rate of ₹300/kg and the income of ₹ 2.6 lakhs was shared among the beneficiaries.

Cage culture of Asian Seabass under Tribal Sub Plan Component at Laxmipuram, Nagayalanka, Krishna District

Skill development programme organised at Maripalem, Nagayalanka Mandal, Krishna District

Skill development programme organised under Tribal sub plan at Peddapalem, Nagayalanka Mandal, Krishna District

Skill development programme on cage culture of finfishes

Different training and awareness programmes were organised since 2018 under Tribal Sub Plan component, to bring awareness and inculcate technical knowhow on cage culture of marine finfishes among tribal beneficiaries. During the financial year 2018-19 to 2020-21, five training programmes and 13 awareness programme were organised and around 300 persons benefitted. Different aspects of cage culture including cage fabrication, installation and maintenance; feeding and disease management, harvest and sources of financial support available for cage culture were apprised to trainees. The beneficiaries trained by the Visakhapatnam ICAR-CMFRI Regional Centre have gained skill and will now act as trainers for the new comers who wants to initiate cage farming.

Way Forward

Most of the tribal families are landless and without any permanent source of income. They meet their daily expense working as daily workers in different sectors including agriculture, shrimp farming, artisanal fishing in small scale, and other small scale works. Due to urbanisation, many youths and elderly males working in daily wages or monthly salary in small shops/malls/ workshops and offices. Most of the male population are willing to work as daily labours for meeting family expenses. Many had initially hesitated to venture into cage culture of finfishes, since it is a new area of work for them that would take atleast 10 – 12 months to reap the benefit. On involvement in cage culture, they would have to spend their time in cages, and might not be able to earn money till the fish is harvested. In spite of providing 100% monetary support under Tribal Sub-plan component, therefore, many were reluctant. However, after attending the several awareness and training programmes organised by Visakhapatnam Regional Centre of ICAR-CMFRI, several showed willingness to venture in the cage culture of marine finfishes.

The concept of cluster cage culture approach and two-tier culture system was appraised to them which was well accepted as sustainable source of income from the coastal backwaters. In a cluster based approach, a set of 5 or 10 cages would be installed in a single place and can be managed by an individual from the group in rotation basis either on alternative days or week basis on their convenience. By this way, all can equally participate in routine cage culture activities and at the same time, can manage their daily livelihood by performing other works. In two-tier based culture system, the culture period could be reduced by performing separate nurseries in parallel to grow-out. Both the concepts have convinced many from Krishna district of Andhra Pradesh, and several exhibited interest to venture in cage based marine finfish culture. Also, some of the beneficiaries are continuing the cage culture activities without seeking further financial support under the plan and a few groups have initiated their own culture using the concept of capture based aquaculture. The marine fish cage culture model established for marine fish by Yenadis tribal communities in Krishna backwaters is seen as a role-model for landless tribes, who do not have any reliable source of income. This model could be emulated among different groups of landless population living in various coastal districts of Andhra Pradesh, for their livelihood improvement.

An account of bivalve fishery of Tamil Nadu and Puducherry

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Bivalve resources comprising of clams, cockles, oysters and mussels are distributed throughout the Indian coast including the estuaries and backwaters and are commercially exploited by the local fishers for their sustenance. Of the 652 species of marine bivalves reported from India, 88 species are endemic and are mainly exploited for their meat and shells. They are also used in the ornamental shell craft, pharmaceutical, lime and dye industries. The total average bivalve fishery of Tamil Nadu and Puducherry during 2016-2020 was estimated at 3713 tonnes (Fig. 1). The commercial fishery for clams, mussels and oysters (2016-2020) occured mainly in the

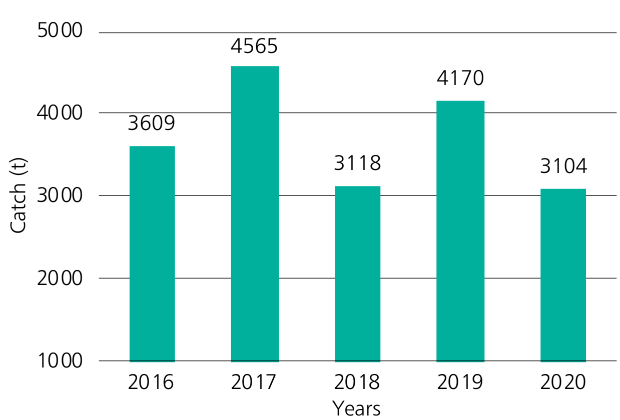


Fig.1. The production of bivalve resources of Tamil Nadu and Puducherry

Tuticorin, Ramanathapuram, Kanyakumari, Chennai, Thiruvallur and Kancheepuram districts of Tamil Nadu and Puduchery. The maximum catch (51 %) was from Athankarai estuary in Ramanathapuram district (Fig. 2). The species exploited from the various estuaries and backwaters are diverse (Fig. 3)

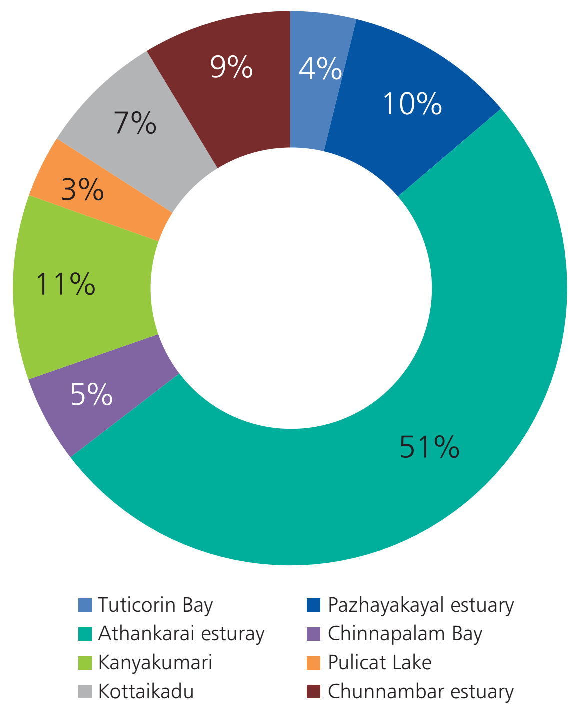
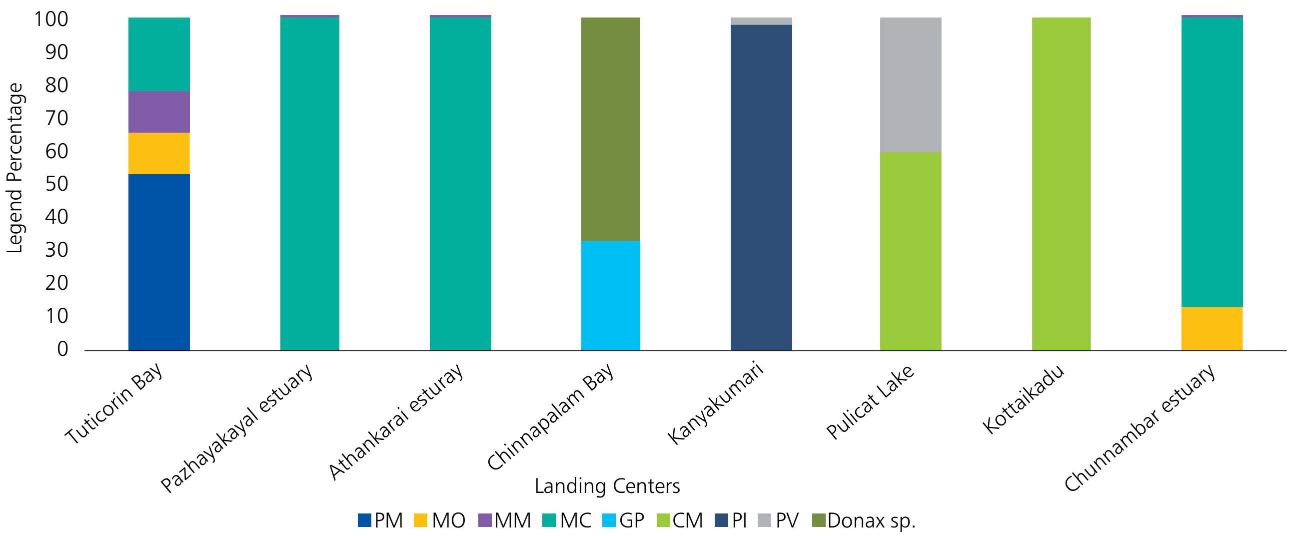


Fig.2. Catch composition of bivalves from different locations of Tamil Nadu and Puducherry

The Tuticorin Bay supports bivalve resources predominantly consisting of 6 species (*Paphia malabarica, Marcia opima, Meretrix casta, Meretrix meretrix, Gafrarium pectinatum* and *Crassostrea madrasensis*) of which *M. meretrix* population has considerabily declined. Clams are exploited during the low tide period from shallow areas of the soft muddy substratum by digging the substratum using a sharp metallic plate and hand-picking. The annual average clam exploitation is 135 tonnes with a CPUE of 40 kg/person/day. The local clam catch shows a sharp increase since 2019, because of selective demand from



PM–*Paphia malabarica,* MO–*Marcia opima,* MM–*Meretrix meretrix,* MC–*Meretrix casta,* GP–*Gafrarium pectinatum*, CM–*Crassostrea madrasensis*, PI–*Perna indica,* PV- *Perna viridis.*

Fig.3. The catch composition of bivalve resources from different locations of Tamil Nadu and Puducherry

Kerala market fishers due to its higher market value after regular hand-picking. Among the several species of clams, they retain *P. malabarica* and *M. casta* species and release the rest of the live clams in the Bay.

Pazhaykayal Estuary

Pazhayakayal Estuary located 15 km away from Tuticorin receives the freshwater influx during southwest and northeast monsoon from Thamirabharani River. The estuary having a muddy substratum has bivalve resource mainly consisting of edible oyster *Crassostrea madrasensis* and the clam, *M. casta*. Fishers using motorized FRP boats conduct clam collection by hand-picking in shallow areas during the low tide period. Fishers are target *M. casta* for trade due to lack of market demand for *C. madrasensis*. The estimated annual average clam catch in this estuary is 367 tonnes with an average CPUE of 100 kg/person/day. In both Tuticorin Bay and Pazhayakayal Estuary, the clam exploitation is carried out throughout the year except during unfavourable environmental conditions. In Tuticorin District, until 2016, the exploited clam species of *P. malabarica, M. opima, M. casta, M. meretrix* and *G. pectinatum* were sold at the rate of ₹5/kg to lime industry, poultry feed industry and as live feed for lobsters reared under cage farming. Since 2019, this trend has changed with fishers exploiting only *M. casta* and *P. malabarica* which is sold in Kerala markets and fetches ₹5 and ₹25 per Kg respectively for fishers. In Tuticorin District, the income of the fishers from clam exploitation ranged from ₹300-1000/person/day with an average income of ₹500/person.

The Athankarai Estuary is sandy and muddy with depth ranging from <1 m in the upper stretches to 2 m or more in the lower part. The bivalve resource consists of a single clam species, *M. casta* and edible oyster beds. The fishers are exploiting *M. casta* on a seasonal basis from March to September. After September, when northeast monsoon commences, influx of Vaigai river water prevents clam exploitation from October to February. Nearly 150 people are engaged in the seasonal clam exploitation and during the northeast monsoon, goes for other artisanal fishing activities. Clam exploitation is done by handpicking and also by using a small hand net locally known as Kacha at depth of around 1.8m. In The annual average clam exploitation is 1,880 tonnes with the CPUE of 100 kg/person/day. The end collected shells are mainly used in the lime and poultry industry with meagre quantity used for edible purposes. Fishers are getting ₹5/kg of clam and each can earn ₹300-500/day.

The Chinnapalam Creek is located at Pamban in the Rameswaram Island has bivalve resources such as *Gafrarium pectinatum* and *Donax* sp. which is exploited by the local fisherwomen. The clam collection by handpicking is done during the low tide. The estimated annual average clam production in Chinnapalam Creek is 188 tonnes with the CPUE of 20 kg/person/day and are mainly used in shell craft industries.

In Kanyakumari District, bivalve exploitation is carried out in Colachel, Kadapattinam, Kodimunai, Kurumpanai, Thengapattinam and Enayam. Mussels are the major resource the fishery is seasonal. Motorized FRP boats and non-motorized catamarans are employed from October to Marchto reach rocky areas one to two kilometres away from shore. Two fishermen are involved in the operation which includes a diver and a helper and actual fishing is done only for 2 hours a day. On reaching the spot, dives are made to collect the mussels with the aid of a chisel or knife which are stored in a bag net. The annual average catch from this region is around 400 tonnes with CPUE of 39 kg/person/day. Among the species Brown mussel, *Perna indica* dominated the fishery (98 %)followed by Green mussel *Perna viridis*. Each shell-on mussel fetches ₹3/- and a major portion of the catch is marketed in Kerala.

Pulicat Lake, second largest brackish water lake, lying partly in Tamil Nadu and Andhra Pradesh. In Tamil Nadu, this lake is located in Pulicat village of Thiruvallur District and it is connected with the Bay of Bengal. Pulicat Lake has a rich biodiversity of about 17 bivalve species. The most abundant species are *C. madrasensis* and *P. viridis*. Fishers in motorised FRP boat tap mussels and oysters by skin-diving which are transported to Kasimedu Fisheries Harbour, Chennai for retail sale. The fishery is demand driven and hence is not observed regularly. About 5-10 fishers are engaged in bivalve fishery and the estimated annual average catch of green mussel is 54 tonnes while edible oyster accounts for 80 tonnes.

Kottaikadu Buckingham Canal runs from Kakinada in the East Godavari of Andhra Pradesh via Tiruvallur, Chennai, Kancheepuram and finally to Viluppuram districts in Tamil Nadu which connects several natural backwaters. Around 25 fisherwomen in Kottaikadu are engaged hand picking of edible oyster based on demand. The annual average catch of *C. madrasensis* was estimated as 269 tonnes. The fisherwomen shuck the meat and discard the oyster shells in the water itself. Each fisherwomen can collect 2 to 3 kg oyster meat in a day which is sold to the local traders for ₹160-175/kg.

In Chunnambar Estuary, Puducherry clam species such as *M. casta* and *M. opima* are tapped by fisher folks from Nonankuppam, Ariyankuppam, Pooranankuppam and Pudhukuppam villages. Nearly 40-50 fisher folks are engaged in traditional hand-picking method. Using a scoop or bag net attached to a pole ia also done to harvest the bivalves by fishermen operating from a canoe. The net is pushed into the mud to rake up the clams and lifted up. The female fishers harvest clams in the shallow area whereas, male fishers exploit clam from 2-3 feet depth and is carried out throughout the year. Harvested clams are sold in the local market at the rate of ₹20/kg. Total estimated annual average clam catch in Chunnambar Estuary is 320tonnes with the CPUE of 25 kg/person/day. On an average the male fisher can earn around ₹450 and female fishers ₹300/day. There is a good demand for clam meat among locals as well as tourists.

Brief Communications

Fossilised chank fishery in Thoothukudi

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The Gulf of Mannar and Palk Bay region are the primary areas for the Sacred Chank (*Turbinella pyrum)* resource along the south-east coast of India. Skin divers sell the live chanks to merchants who sort them based on size and quality. The fossilised gastropod fishery of *T. pyrum* exploited off the Tuticorin was commenced in 2009. The existence of fossilised chank resources was accidentally identified by fishers during the deepening of Tuticorin New harbour of V. O. Chidambaranar Port Trust (VOCPT) in Thoothukudi. Until 2013, exploitation of fossilized chanks was carried out by skin diving using sharp metal to find out the presence of chank which was time consuming. From 2014 onwards, the fishermen started using air compressor for locating and exploiting this resource mmore easily saving time.

Fossilised Chank shells harvested

Generally, fossilised chank beds are situated along with the live chank beds and any resourceful chank bed identified during random collections, are geo-tagged by GPS. The fishers continue the exploitation in the same area until sufficient fossilised chank are available for collection and thereafter move on in search of new beds. Tuticorin major harbour area, Vann tivu, Kaswari island, Lighthouse tivu, Nallathanni tivu, Pulipoondu, Patharai Kilathi Atompathu, Melaonpathu, Siluvai, Pullaveli, Mullukambi and Thollayirampaar areas have good white chank resources. Mechanised country boat, vallam (10–14 m length built with 15 -20 HP engine) are employed to tap the chank resources. Each craft is fitted with 15 hp locally designed air compressor, air storage tank, 2 filters and air hose arrangements generally used to inflate vehicle tires. The air stored in the storage tank passes through two filters and is supplied through the hose to aid diving. In each compressor unit nearly 6-10 numbers of 100 m lengthy hoses are connected which are used to extend the diving duration. 130 boats are involved in exploitation of white chank at Tuticorin coast. The fishing operation start at 6.00-6.30 hrs and generally, 6 divers and 4 helpers are involved as crew per trip. After reaching the ground, operations are carried out during 09.00 –15.00 hrs. During the first 2 hours of operation, the divers carried out exploitation of dead sacred chanks by digging the ground up to 2 m using a pair of scrappers attached to their legs. The divers onboard the boat and take rest for 2 hour prior to dive again for the period of 1.5 to 2 hours. The least depth of exploitation site may be 4 fathom and the average depth of operation is between 8 and 12 fathom. The operation between the depth of 10 and 15 fathom are considered very risky. Younger divers are able to stay in the water for up to 4 hours and have started night fishing during 7 pm to 5 am to avoid competition.The average cost per trip varies from ₹3000 to ₹5000 which includes fuel and food. The trip expense is based on the craft engine power and number of persons onboard. The income is mainly based on age, as lower age group divers are able to exploit more numbers of chank compared to the elders. The average daily income is ₹5000 for the 18-35 age group fishers, ₹3500 for 35-45 age group and ₹1500 for 35-45 age group. The emoluments of ₹1-5 lakhs to divers and ₹10,000-20,000 for helpers is being paid by the boat owners based on their skills to retain the crew members for regular chank fishing.

A fluctuating trend of the chank caught ranged from 200–329 t during 2013 -2020 with the estimated average annual catch of 251 t. The exploitation is dominated by 80-100 mm size group (50%) followed by 100-130 mm size group accounts (25%), 65–80 mm size group represents (20%) and rest to above 130 mm sized chanks.Price of the chank is fixed based on its quality and size. Nearly 50 middle men are involved in the white chank trading from Tuticorin District. Emoluments as an advance are being paid by middleman to the vallam owners or daily share to the buyers (₹5-10 /chank of middle and large size). At present, majority of the collected chanks are transported to Kolkata directly by local chank trader.

Fishers of the age group of 16–55 are involved in fossilized chank exploitation. 24 divers (20-25 age group: 20 persons & 50+ age group: 4 persons) have reportedly succumbed due to the pressure in lungs and heart through compressor aided diving for fossilized chank exploitation. Although experienced skin divers are not facing much problem inexperienced divers are facing problems. In 2014, a modified equipment for SCUBA diving was introduced to chank collectors, but still the divers prefer locally customised compressors due to less operational timings and cost, even though this apparatus is available at 75% subsidised price. Although the State fisheries department has provided 2 numbers of scuba diving equipment to every chank fishers' society, the divers are demanding 3 numbers of free scuba diving equipment per diver with subsidy for filling of oxygen.

Kaleidoscope

Beaching of pneumatophores of Blue button jellyfish

Blue jelly, *Porpita porpita*

Pneumatophores of blue jelly observed in beaches of Surathkal

Jellyfish are zooplanktonic organisms commonly found in coastal and offshore water of all oceans in the world. The true jellyfish are the planktonic stages of three cnidarian classes: the Hydrozoa, the Scyphozoa, and the Cubozoa. The occurrence of jellyfish blooms, beach stranding as well as interference with fisheries is reported from various parts of the world. Spatiotemporal dynamics of jellyfish are highly variable, and irregular blooms or stranding of jellyfish make it difficult to predict. Mass beaching of pneumatophore of blue button jelly was observed in the beaches of Dakshina Kannada during the second week of September 2020. The occasional beaching of blue button in stray numbers was observed earlier, but mass beaching is rare, especially of pneumatophores alone. Previous studies had mentioned sea surface temperature (SST), shoreward wind, currents and tides as main drivers in coastal waters, allowing the huge accumulations and beach stranding of medusae. Hence the hydrographical parameters like wave direction, wave height, wind direction, wind speed and SST of the coastal and offshore water of Dakshina Kannada was collected from INCOIS for 6 days (9-14 September, 2020; Table 1) to understand the influence of these parameters on the mass beaching of blue button pneumatophores. The 15x15 cm quadrants were used to collect pneumatophore samples from beaches from 5 sampling points in the beach. Since pneumatophores were mainly seen in the wrack lines, quadrants were placed in 3 sites in each sampling points ie; one on the wrack line and one above and below the wrack line at almost equal distance.Mass beaching of disc-like chitinous floats (pneumatophore) were observed in the wrack line of Panambur, Surathkal, and Sasihithlu beaches on 13th and 14th September, 2020. *Porpita porpita* (Linnaeus, 1758) commonly known as the blue button or blue button jelly belongs to the family Porpitidae (Phylum: Cnidaria, Class: Hydrozoa) and in live condition is made of pneumatophores and hydroid colony. The golden-brown round and flat chitinous pneumatophore are 2-3cm wide while the hydroid colony is usually bright turquoise blue and looks similar to the tentacles of a jelly fish. The branchlets of the colony end in knots of nematocysts. The size of pneumatophores stranded in the beaches of Dakshina Kannada ranged from 10.2 to 30.8mm weighing 0.009 to 0.27mg. The size of the pneumatophores suggest that the dead and decomposed organisms includes both juveniles and adults. Blue buttons are frequently observed in the off-shore waters of Karnataka and Goa during pre-monsoon seasons. The decrease in salinity and temperature of the coastal water due to the prevalent south west monsoon might have resulted in the death of blue button jelly. The hydroid colony of these dead specimens might have disintegrated leaving behind the pneumatophores which drifted with the current and wind. During the second week of September 2020, a cyclonic circulation was lying over east-central Arabian Sea, off coastal Karnataka and throughout the event, the direction of the current and wind was towards the shore which might have resulted in the mass beach stranding of pneumatophores in the beaches of Dakshina Kannada.

Table 1. Hydrographical parameters of Dakshina Kannada Coast (0-50m from coast) during second week of September 2020.

Date	Landing centre	Wave Direction	Wave Height (m)	Wind Direction	Wind Speed (m/s)	SST (oC)
14.09.2020	Mangalore	NE	6-7	SE-E	14-40	28
	Mulki	NE	6-7	SE-E	14-40	28
	New Mangalore	NE	6-7	SE-E	14-40	28
	Suratakal Pt	NE	6-7	SE-E	14-40	28
13.09.2020	Mangalore	NE	6-7	E	18-36	28
	Mulki	NE	6-7	E	18-36	28
	New Mangalore	NE	6-7	E	18-36	28
	Suratakal Pt	NE	6-7	E	18-36	28
12.09.2020	Mangalore	NE	6-7	E	18-29	28
	Mulki	NE	6-7	E	18-29	28
	New Mangalore	NE	6-7	E	18-29	28
	Suratakal Pt	NE	6-7	E	18-29	28
11.09.2020	Mangalore	NE	7-8	E-NE	22-36	28
	Mulki	NE	7-8	E-NE	22-36	28
	New Mangalore	NE	7-8	E-NE	22-36	28
	Suratakal Pt	NE	7-8	E-NE	22-36	28
10.09.2020	Mangalore	NE	6-7	NE-NW	4-29	28
	Mulki	NE	6-7	NE-NW	4-29	28
	New Mangalore	NE	6-7	NE-NW	4-29	28
	Suratakal Pt	NE	6-7	NE-NW	4-29	28
09.09.2020	Mangalore	NE	6-7	NE-NW	4-29	28
	Mulki	NE	6-7	NE-NW	4-29	28
	New Mangalore	NE	6-7	NE-NW	4-29	28
	Suratakal Pt	NE	6-7	NE-NW	4-29	28

(Reported by Divya Viswambharan*, K. M. Rajesh, Prathibha Rohit, Raju Saravanan, K. K. Joshi and S. Srinath | Mangalore Regional Centre of ICAR-Central Marine Fisheries Research Institute)

Report of *Thyrsitoides marleyi* from south eastern Arabian Sea, India

A single specimen of Blacksail snake mackerel *Thyrsitoides marleyi* having 121 cm total length (TL) was found in the landings of a multiday trawler on 10/09/2021 at Munambam Fisheries Harbour, Kochi, Kerala. The trawl had reportedly fished at a depth of 80-100 metres in area 90-100 nautical mile north -west of Munambam Fisheries Harbour. The family Gempylidae which includes the Blacksail snake mackerel comprises of 16 genera and 26 species widely distributed in tropical and subtropical waters. Also known as the Black snoek, it is found in the Indo-Pacific from Red Sea to Australia, preferring slopes on sea mounts and ridges.

(Reported by M.A. Jishnudev*, Sijo Paul, Paulose Jacob Peter and T.G. Kishor | ICAR-Central Marine Fisheries Research Institute, Kochi-682 018)

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