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भाकृअनुप
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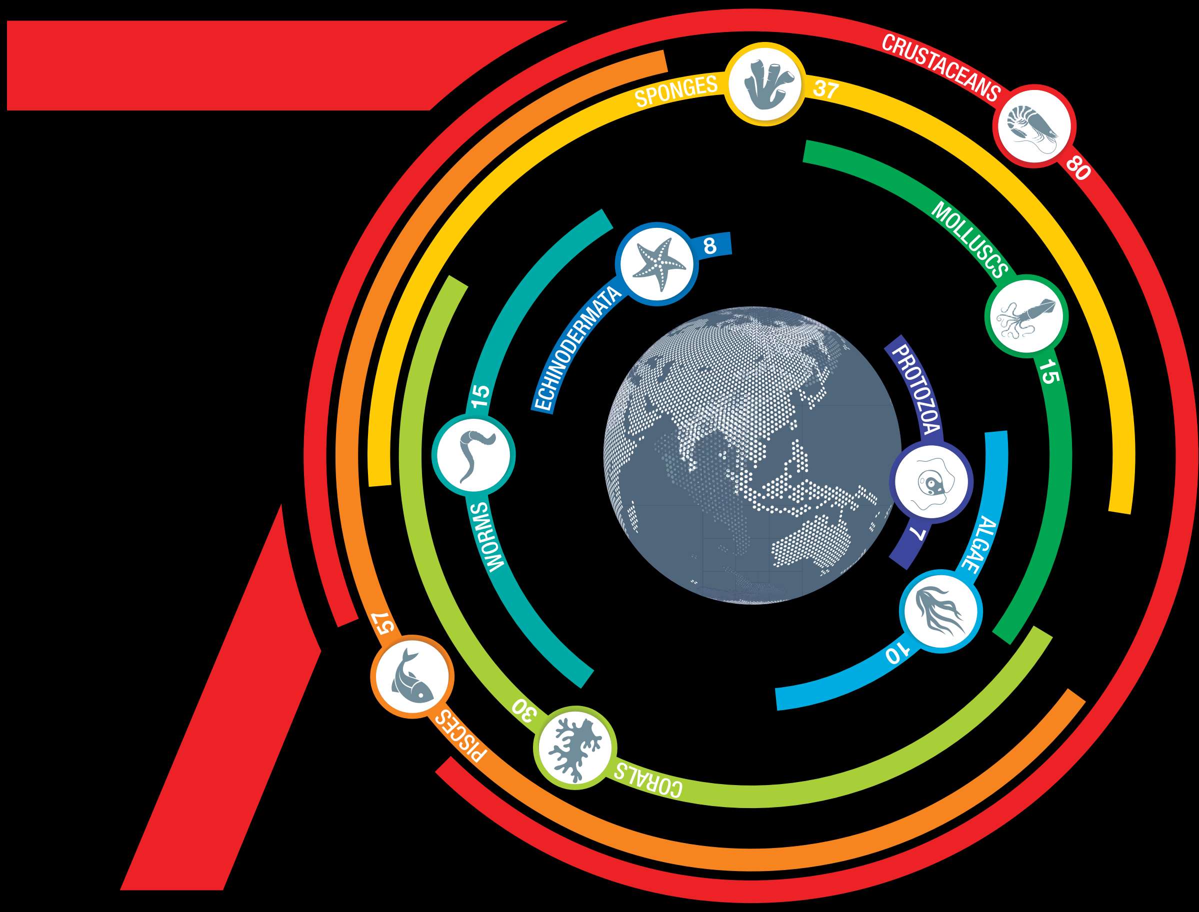
CMFRI

वार्षिक प्रतिवेदन
ANNUAL REPORT 2017 -18

Celebrating



Years of Species Discovery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CMFRI

ANNUAL REPORT 2017-18

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ICAR

Indian Council of Agricultural Research

CENTRAL MARINE FISHERIES RESEARCH INSTITUTE

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CMFRI Annual Report 2017-2018

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Contents

Mandate

1. Monitor and assess the marine fisheries resources of the Indian Exclusive Economic Zone (EEZ) including the impact of climate and anthropogenic activity and develop sustainable marine fishery management plans
2. Basic and strategic research in mariculture to enhance production
3. Act as a repository of geospatial information on marine fishery resources and habitats
4. Consultancy services and human resource development through training, education and extension

सी एम एफ आर आइ
CMFRI

Preface

CMFRI in the year 2017-18 moved forward estimating the marine fish landings in the country as 3.88 million tonnes which is 6.9% more than the preceding year. Resource-wise estimation of potential yield from the depth zone up to 200 m for each maritime state was initiated by the committee constituted by Department of Animal Husbandry, Dairying and Fisheries (DADF) for revalidation of potential yield from the Indian EEZ.

The new initiatives in the marine fisheries management were–data collected during the Marine Fisheries Census 2016 were processed and draft reports are ready for each of the maritime states. Bait fisheries management plan has been prepared for sustainable marine fishery management of Lakshadweep and a Fishery Management Plan (FMP) project of marine fisheries was initiated separately for this union territory which was bracketed with Kerala marine fisheries so far. Policy briefs were prepared for the sustainable exploitation of the marine fisheries of Gujarat and Tamil Nadu. Minimum legal size for exploitation of commercially important marine finfish and shellfish resources of Tamil Nadu was estimated.

`Litter atlas' an interactive map on litter status of Indian beaches available on the CMFRI website vividly presents the conditions prevailing in our beaches. A multivendor e-commerce website and mobile app developed under NICRA project in another information technology initiative ensuring availability of quality seafood.

The parasitologists of the Institute discovered, two new species of fish parasites, *Tenuiproboscis keralensis* sp. nov. an acanthocephalan and *Chloromyxum argusi* sp. nov. a myxosporean this year. Similarly, our crustacean taxonomists reported new records of deep sea shrimp, *Solenocera barunajaya* Crosnier, 1994 and *Solenocera rathbuni* Ramadan, 1938 (Crustacea: Decapoda: Penaeoidea) from the southwest coast of India.

Nutraceutical products for use against hypothyroidism and hyperthyroidism were developed from the bioactive leads isolated from the seaweeds, *Sargassum wightii* and *Turbinaria conoides*.

In the area of fish genetics and genomics characterisation of three complete mitogenomes of *Sardinella longiceps* and *S. gibbosa* and *Etroplus suratensis* from Indian waters was completed.

In mariculture, the number of cages under the technical support and guidance of CMFRI expanded to 1609 pan India. Upscaling of cobia and silver pompano seed production to 1.5 lakh silver pompano fingerlings and 1200 cobia fingerlings respectively resulted in their supply to farmers of Kerala, Tamil Nadu and West Bengal. Culture protocols developed for eight species of copepods suitable for larval feeding of marine finfishes improved the larval survival rates considerably. Up-scaling of mussel seed production and development of micro-nurseries and upwelling systems for spat rearing for commercial scale production of mussel and oysters is on the anvil involving participation of all stakeholders in shell fish farming. Raceway system for mass production of phytoplankton for bivalve seed production is also being implemented.

Under the NFDB funded technology upgradation scheme, CMFRI is establishing broodbanks for supply of larvae to states for production of fish of stockable size.

Cobia has been identified as the species at Mandapam with a financial outlay of 324.11 lakhs and silver pompano at Vizhinjam with a financial outlay of 564.4 lakhs. Thus, attracting external funding to the Institute touched an all-time high. Development of integrated fish market and price information systems (FMPIS) for Indian fisheries sector is another NFDB funded project in the pipeline. We are also working on a Department of Biotechnology (DBT) recommendation in the establishment of a Centre of excellence in marine microbiome and nutrigenomics. A Department of Science and Technology (DST) revival project attracting ₹1.6 Crores for monitoring of *Vibrio* sp. using remote sensing and *in situ* data collected from Vembanad Lake is underway.

CMFRI was recognised for its work in '*Swachh Bharath Abhyan*' and won second prize at national level in recognition of successful implementation of *Swachh Bharat* activities across the country through the research and regional centres. Dr. K. K. Joshi won the best biodiversity Researcher award for the year 2016 instituted by the Kerala State Biodiversity Board (KSBB). CMFRI also received Kochi Town Official Language Implementation Committee (TOLIC) Rolling Trophy for best Official Language performance, continuously from 2003 onwards. We excelled in sports by becoming the overall champions in ICAR South Zone Sports Meet for the 3rd time.

CMFRI hosted the 2nd International Symposium on Societal Applications in Fisheries and Aquaculture using Remote Sensing Imagery (SAFARI-2) from January 15-17, 2017 at CMFRI, Kochi with its exhibition attracting a lot of public. A special stakeholders' workshop on disaster management was also organised as part of this international symposium.

We celebrated the 70th anniversary of CMFRI by taking up 70 different activities in its centres and headquarters. Workshop on Sustainable Development Goal (SDG)14 jointly organised by NITI *Aayog*, WWF India and CMFRI was one of the significant ones among them. An Indo-German training programme on the use of Catch-MSY for the assessment of Indian fish stocks in a data-poor environment organised during 5th and 6th October 2017 was another activity.

CMFRI was recognised as one of the first among ICAR institutions to implement cashless transactions winning an ICAR Award of ₹5 lakhs to CMFRI and ₹50,000/- to another constituent unit of CMFRI, KVK Ernakulam. CMFRI staff contributed ₹6.5 lakhs to OCKHI cyclone relief fund to Chief Ministers of Kerala and Tamil Nadu.

CMFRI organised an international training programme on Fisheries and Aquaculture sponsored by African-Asian Rural Development Organisation, (AARDO), during 14-28 March 2018. Sixteen participants from 13 countries attended the programme. CMFRI and AgriGenome jointly organised a training on Application of Next Generation Sequencing (NGS) in fisheries and aquaculture from 03-04 Nov 2017.

CMFRI was entrusted with the administrative responsibility of KVK Lakshadweep in March 2018. CMFRI staff published 153 peer reviewed articles, 10 technical manuals, 8 books, 15 videos, 148 book chapters/technical articles and presented their research contributions in 112 symposia/seminars.

For all this I thank team CMFRI and gratefully acknowledge the support received from the subject matter division of ICAR.

A. Gopalakrishnan
Director, CMFRI

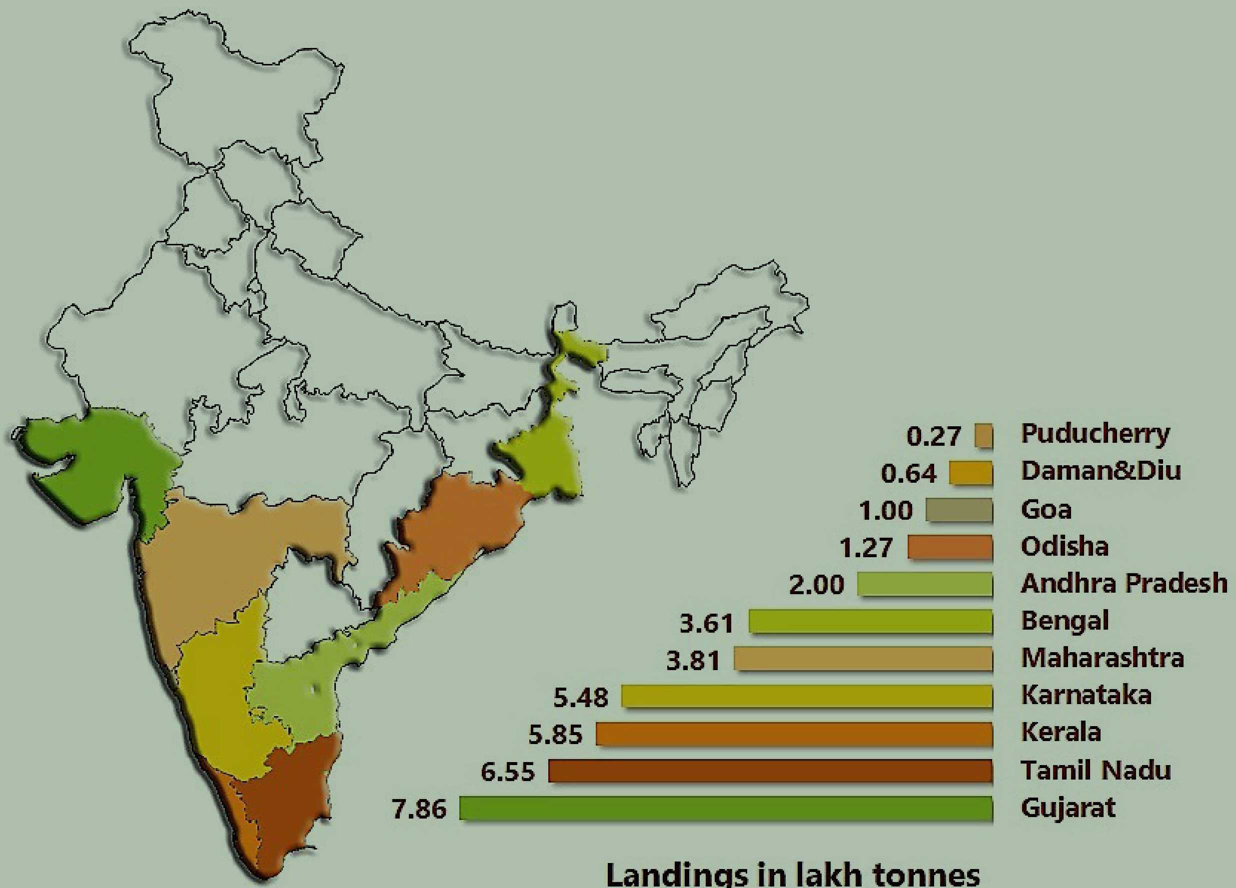
Executive Summary

In the year 2017-18, there were 37 in-house research projects, 27 externally funded projects and 10 consultancy projects was in operation.

The estimated marine fish landings for the peninsular India was 3.83 million tonnes in 2017, which was second highest ever, slightly below 3.92 million tonnes in 2012. The landings witnessed a marginal increase of 5.6% compared to 2016.

The region-wise breakup of the landings indicated that southwest and northwest contributed almost equally to the landings spectrum with 12.33 lakh tonnes and 12.32 lakh tonnes respectively whereas the southeast contributed 8.82 lakh tonnes and only 4.88 lakh tonnes by northeast. In the reporting year, 4 maritime states landed more than 5 lakh tonnes accounting for 67% of country's marine fish landings. Among them, Gujarat continued to be in the topmost position for the fifth consecutive year with 7.86 lakh tonnes. Tamil Nadu stood behind Gujarat with 6.55 lakh tonnes. Kerala has overtaken Karnataka to emerge as the third largest producer in 2017.

State-wise marine fish landings in India 2017



Top three states in marine fish landing 2017

Pelagic finfishes dominated in the marine fish landings 2017 contributing 54% of the landings. Indian oilsardine, mackerel, ribbon fish, lesser sardines and Bombay duck contributed almost 60% of the pelagic fish landings. Of this, oilsardine alone accounted for 16.3%. Demersal finfishes contributed 26.8% to total landings. The major demersal resources landed were threadfin breams, croakers, silver bellies, bullseyes (*Priacanthus* spp.), and catfishes. Crustaceans comprised high value resources like shrimps, crabs and lobsters and the contribution from this group was 12.6%. Molluscs comprising squids, cuttlefish, clams and oysters accounted for the remaining 6.6%.

Marine fisheries census of India 2016 has been processed and digitised and submitted to Department of Animal Husbandry, Dairying and Fisheries (DAHDF) for publication.

Fisheries and ecosystem modelling studies projected rise in sea surface temperature due to climate change on the dynamics of biomass of a few marine fishery resources. A variant of Models of Intermediate Complexity for Ecosystem (MICE), known as Socio-Ecological Adaptations Model of Intermediate Complexity for Ecosystems (SEAMICE) was used for modelling of biomass.

Within the theme, sustainable management of fishery resources, the state-wise findings of all the nine maritime states and union territories are presented. Large pelagic resources, elasmobranch resources, bivalve and ornamental gastropod resources are also included in this section. The section ends with reports of stake-holder consultations held at different locations in the country documenting the concerns raised to be addressed.

In the area of fish genetics and genomics, the complete mitogenome of *Etroplus suratensis* collected from Vembanad Lake has been characterised. This forms the baseline data for further taxonomic investigations and studies on adaptive variations in OXPHOS genes. Mitogenome of fishes belonging to family Clupeidae showed signals of diversifying selection and adaptation in OXPHOS genes specific to freshwater, marine and brackishwater habitats across tropical and temperate latitudes. Molecular identification work included identification of shark fin and gills using CO1 sequences, identification of copepod species *Apocyclops cmfri* a new species and molecular identification of *Prymnesium parvum* and confirmation of *Trichodesmium.* Phylogenetic analysis of pony fish revealed monophyly in the family Leognathidae and population investigations in spiny lobster was continued. Population genetic structure of Indian salmon *(Eleutheronema tetradactylum*) was also delineated. Through an environmental DNA (eDNA) approach to estimate fish biomass, eDNA extraction and analysis from water samples from closed and open systems is progressing.

Studying biomineralisation of mantle tissue in pearl producing molluscs, supplementation of the culture medium with whole tissue extract was attempted to improve mantle epithelial cell culture viability. The biologically active compounds in such an extract were also studied. When expression of genes involved in biomineralisation was compared, amplification products for nacrein (480 bp) and ACCBP (500 bp) genes were obtained in both native mantle tissue and cultured mantle epithelial cells of *Pinctada margaritifera.*

While characterising *in vitro* embryonic stem (ES) cell cultures derived from midblastula stage embryos of the marine ornamental maroon clown fish *Premnas biaculeatus,* presence of stem cell specific surface markers TRA1-60 and SSEA-4 was ascertained by immunoflourescence staining. With derivation of induced pluripotent stem cell (iPSCs) cultures from the humpback grouper *Cromileptes altivelis,* various combinations of transcription factors are being attempted for improving the reprogramming efficiency to derive successful iPSc colonies.

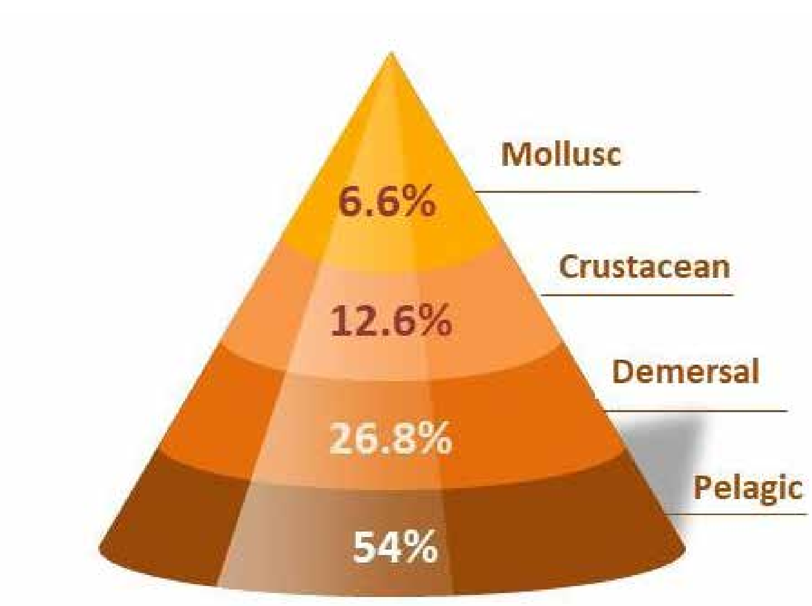
In the field of fish nutrition and feed technology, jamun leaf *(Syzygium cumini)* elicited immune modulated effects in pompano when incorporated in feed at 2%. Similarly, 1% chitosan imparted immunomodulatory effects and growth enhancement in pompano. Beet root meal included in the feeds to the tune of 15% showed beneficial effects in the marine ornamental fish percula clown in terms of colour enhancement. On farm growth of pompano with formulated feeds varied at different locations. When commercially available probiotics were evaluated randomly incorporating it in the feed for pompano, poultry probiotic outperformed, shrimp and fish probiotics.

Silkworm pupae meal evaluated in pompano for replacement of fish meal, indicated 25 – 50% replacement as the practically feasible level. In a pioneering effort, black soldier fly *(Hermetia illucens)* was cultured using food waste and their larvae were analysed for nutrients to use it as an animal protein source in fish feed.

In lobsters, while evaluating the histological changes and enzyme profiles to different feeds, difficulties in absorption of nutrients from formulated feeds was imminent.

In nutritional profiling work, branched murex *(Chicoreus ramosus)* hitherto unreported has been profiled and found to be a good source of fatty acids and amino acids.

Under fish pathological investigations, food fishes, ornamental fish and bivalves were the subjects. In *Scatopahgus argus,* the finding of a new species of myxosporean *Chloromyxum argusi* n. sp. was the highlight. In bivalves, prevalence of *Perkinsus olseni and P. beihaiensis* continued to be a matter of concern. An eDNA based method was developed to detect the pathogen. Several bacterial infections have also been reported and investigated in fish cages and lobster holding systems. Viral Nervous Necrosis (VNN) is the only viral disease reported this year. Development of an algel adjuvanted vaccine for vibriosis and its application in cobia was successful. Microbial profiling of crab haemolymph led to isolation of 33 bacterial species. Immunoprofiling of mangrove red snapper led to identification of contributing factors of its innate immunity. Molecular and functional analysis on the effects of hyper and hypo salinity adaptations in *Etroplus suratensis,* and histological changes were documented. Similarly, bioprospecting for biotic and abiotic stress responsive genes from *Crassostrea madrasensis* and their characterisation led to the complete



Major resource groups landed 2107

characterisation of the ferritin gene C. In the National Surveillance Programme for Aquatic Animal Disease (NSPAAD), screening for OIE (World Organisation of Animal Health) listed pathogens in bivalves and mass awareness programmes continued. In the all India network project on fish health, a plethora of activities from screening of OIE listed pathogens in imported live fish mainly ornamentals, to survey on usage pattern of drugs and chemicals in mariculture progressed. In the consortia project on vaccines and diagnostics, Loop mediated Isothermal Amplification (LAMP) based diagnostic was found to be more sensitive than Rays's Fluid Thiglycollate Media (RFTM) and Polymerase Chain Reaction (PCR) for detection of Viral Nervous Necrosis (VNN) in marine finfish.

Research and development in the area of marine natural products was strengthened further by adding the fifth product to our nutraceutical portfolio, an anti-hypothyroidism extract (CadalminTM ATe) from seaweeds. Active principles in the product, effectively increased level of thyroid stimulating hormone to produce thyroid hormones. An aryl crowned polyketide from *Baccilus amyloliquifaciens was assessed for anti-microbial activity. Some* previously undescribed antioxidant compounds of brown seaweeds *Sargassum ilicifolium* and *Padina gymnospora* have been isolated and studied. Marine microalgae and molluscs as valuable natural sources of bioactive compounds are under investigation. Edible bivalve clams as potential bioactive leads in the functional food formulations are also researched upon.

Mariculture research is strengthened by enhancing the broodstock and seed production capabilities within the country. About a lakh of grouper *(Epinephelus coioides*) seeds were produced at Visakhapatanam. At Mandapam 2.62 lakh pompano seeds and 3230 cobia seeds were produced. Ornamental fish sale touched ₹6.68 lakhs. Mass culture of eight species of copepods was standardised at Vizhinjam and mass production of a super miniscule rotifer, *Colurella adriatica* was successfully standardised at Kochi. Seed production and ranching of green tiger shrimp is an activity continued at Mandapam. A remarkable reduction in the period required for captive maturation of the juveniles of ornamental camel shrimp *Rhynchocinetes durbanensis* was achieved. Improvement in the system design for production of pearl oyster and green mussel spat improved their output. For the first time, the horse conch *Pleuroploca trapezium* was bred by CMFRI at Tuticorin.

Grow-out of *E. coioides* was trialled for nursery growth in ponds, recirculating aquaculture system (RAS) and concrete tanks with uniform feed management and it was found that RAS resulted in the best growth. Further, growth of groupers in cages and stress responses were also monitored and documented. Farming trial with Asian seabass was successful in Karwar in cages, however cobia culture resulted in mortalities due to *Photobaterium damselae*. Lobster grow-out in 6 m dia cages resulted in growth of 130 – 250 g in 130 days at Tuticorin. Culture of pompano and seabass was also successful in coastal villages of Puthukottai District, Tamil Nadu. Adoption of location specific cage designs was successful in Kerala, Andhra Pradesh and Tamil Nadu. Compensatory growth is under investigation in pompano. Blue swimmer crab fattening in individual confinement called `celluloid' is also being propagated.

Samudra oushadhi brand of oysters are produced and marketed by women self-help groups at Moothukunnam and Puthernvelikkara with CMFRI support. A group of 78 farmers ventured into rack and ren method of oyster farming in Udupi District in Karnataka. For Integrated Multi-trophic Aquaculture (IMTA), oyster and green mussels integrated with fish are attempted in Sumana Estuary in Karnataka and Chaliyam in Kozhikode respectively. For replication of such efforts in other states, farmers from Malvan in Maharashtra were also trained in such ventures.

Under All India Network Programme (AINP) in Mariculture, in a consortium mode, seed production and farming activities were strengthened with 12 participating centres under ICAR including the Central Island Agriculture Research Institute (CIARI), Port Blair along with five participating centres from State Agricultural Universities.

In marine biodiversity research, under the research project on developing conservation plan for biologically sensitive areas along the Indian coast, rapid field surveys were conducted in selected maritime states of India. Investigations on the scyphozoan and cubozoan jellyfish diversity and distribution along the Indian coast is another research project in which a preliminary survey along the Indian coast starting from Gujarat to Andhra Pradesh was carried out during the period from April 2017 – March 2018. Underwater survey was performed at nine stations in the Kavaratti atoll to assess the resilience potential of coral reefs. The vulnerability of Lakshadweep reefs in the future Representative Concentration Pathways (RCP) was also estimated and post cyclonic changes that took place in Kavaratti reefs were also recorded after the incidence of the Ockhi cyclone during November 2017. Phenotypic variations in *Conus inscriptus, C. amadis* and *C. malacanus* in different environments are not underpinned by the genome; reveals our research on molecular taxonomy and phylogeny of Cone nails and strombs of the Indian coast. Estimation of marine fish landings in Tamil Nadu with enhanced sampling coverage is another activity taken up with external funding along with popularisation of bivalve farming. Valuation of coastal ecosystem goods and services at Kadalundi-Vallikunnu estuary is another activity CMFRI is involved with funding from Kerala State Biodiversity Board.

While monitoring marine habitats, seaweed production was estimated. From the marine macrophyte habitats, a rare find was bandtail scorpionfish *Scorpaenopsis neglecta* Heckel, 1837. Design of a floating mangrove nursery was another highlight.

Under research project on coastal pollution assessment and bioremediation, the seaweed *Enteromorpha intestinalis* was proved effective for bioremediation. National beach litter map hosted in the CMFRI website based on CMFRI surveys made our work on marine litter visible globally. We studied marine debris on the sea floor and the reasons for massive fish kills at Kovalam. Under the development of microlevel environmental management plans (EMP), EMPs were developed through participatory approach. An assessment of artificial reefs was done to evaluate the state of maturation of artificial reefs deployed at selected sites along north Tamil Nadu coast, and also collected information to assess the impact of artificial reefs on the natural habitat as well as biodiversity.

In the National Innovations on Climate Resilient Agriculture (NICRA) programme, relationship between temperature and abundance of threadfin breams off Mangalore was studied. Studies on larval distribution and recruitment off Vishakhapatnam, confirmed presence of larval croakers, puffer fish, ribbonfish, carangids and polynemids with croaker larvae dominating the samples.
Catch composition and upwelling in Maharashtra coast documented some signature species. Blue carbon potential of mangroves and seagrass and life cycle assessment of fishing operations indicated among other findings that fishing operations for Kerala coast had highest emissions during harvest phase followed by post-harvest and pre-harvest phases. Among the climate resilient products developed, biochar a water hyacinth based soil suppliment; multivendor e-commerce website (www.marinefishsales.com) and a mobile app were prominent. Assessing the alternative livelihood options (ALOs) for climate change vulnerable coastal fishing villages in Kerala, a study was conducted to assess the ALOs among the coastal communities in response to climate change, in

Poonthura and Elamkunnapuzha villages of Thiruvananthapuram and Ernakulum respectively.

In our marine fisheries economics research including sustainability and trade, we found that the estimated value of marine fish landings in the country increased by 8.37% over the past year (2016) followed by consequential increases in unit price at fish landing Centre, unit price at retail market, and in the producers share of the consumers' rupee. Species-wise valuation, state-wise valuation across the value chain, gross valuation of inventories (capital formation) in marine sector and other macroeconomic indicators were also estimated and reported. Economics of the performance of the fishing methods, price behaviour of marine fish varieties, average retail Centre price realisation, and marine fish marketing efficiency were also studied. Location specific studies conducted pertaining to Ernakulam, were assessment of demand drivers augmenting fish consumption and assessment of online fish marketing. Again, in the national scenario, the impact of GST on the fisheries sector was also studied. In the international research project, Global understanding and learning for local solutions (GULLS): In reducing vulnerability of marine-dependent coastal communities; socio-economic vulnerability assessment was carried out in the Ramanathapuram District of Tamil Nadu.

Stake holder responses were key to our work on governance, livelihood and gender welfare. Formal and informal credit transactions among small scale fishers in Kerala were studied in detail to arrive at the measures to rationalize the rules in order to facilitate easy access of credit. In the area of alternate livelihood options and gender mainstreaming for entrepreneurship development in marine fisheries sector of India, coastal states of Bengal, Odihsa and Andhra Pradesh were covered this year. Labour migration was the subject of another investigation. *Theeramythri* and Theeranaipunya programmes, funded by the Society for Assistance to Fisherwomen (SAF) continued. Gender mainstreaming through self-help groups (SHGs) identifying micro enterprises catering to the location specific needs of the SHG members led to imparting 25 Entrepreneurial Capacity Building (ECB) training programmes on the identified micro enterprises by appropriate HRD intervention programmes and organised 40 fisher folk interaction meets. The Institute's Agricultural Technology Information Centre (ATIC) provided advisories to 14130 stake holders, and generated revenue of ₹3,74,128/-. Several exhibitions and training programmes were also organised by ATIC.

कार्यकारी सारांश

वर्ष 2017-18 के दौरान 37 गृहांदर परियोजनाएं, 27 बाहरी वित्त पोषित परियोजनाएं तथा 10 परामर्श परियोजनाएं चालू थीं।

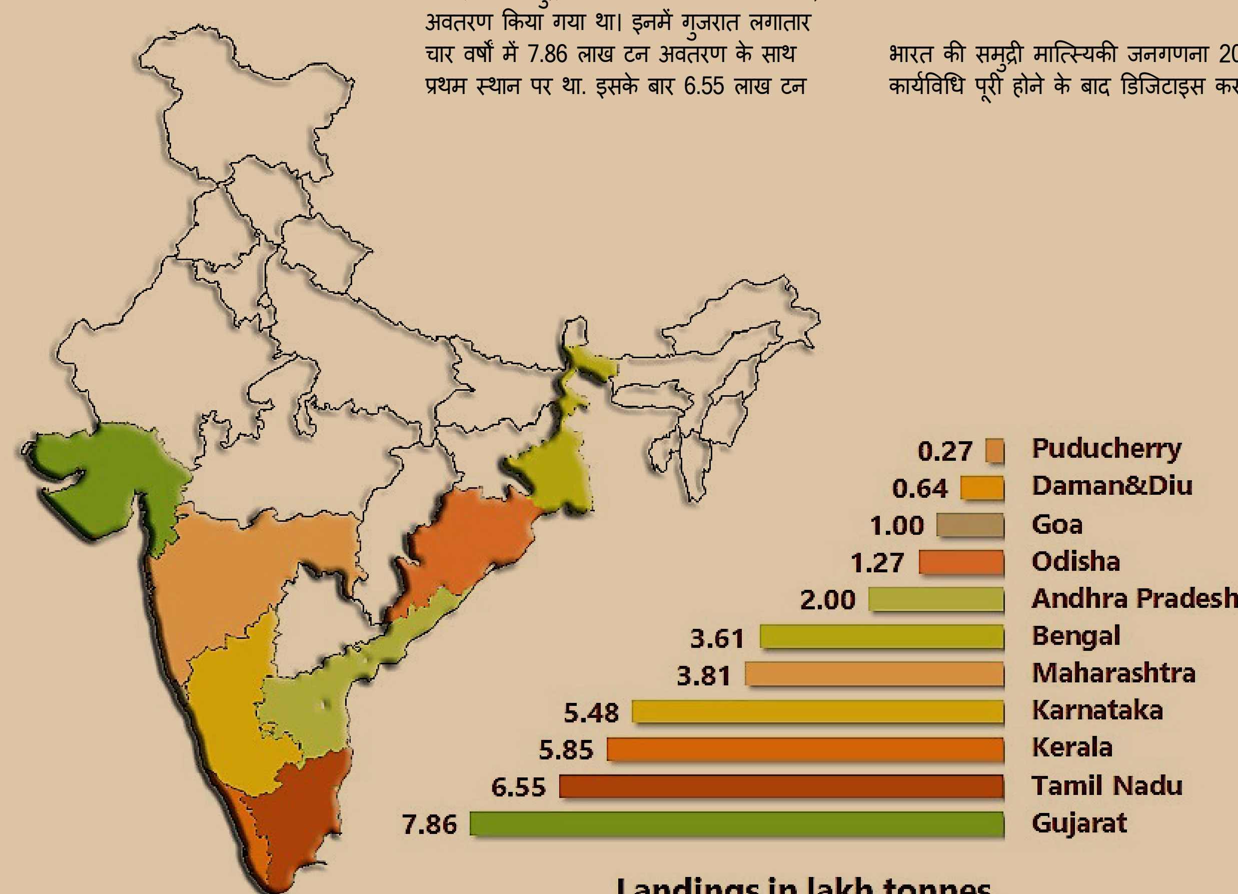
वर्ष 2017 के दौरान प्रायद्वीपीय भारत में 3.83 मिलियन टन समुद्री मछलियों का अवतरण आकलित किया गया, जो वर्ष 2012 के 3.92 मिलियन टन से थोड़ा कम और दूसरा सबसे ज्यादा अवतरण था. वर्ष 2016 की अपेक्षा अवतरण में 5.6 की सीमांत वृद्धि देखी गयी

क्षेत्रवार अवतरण से यह व्यक्त होता है कि अवतरण में दक्षिण-पश्चिम और उत्तर-पश्चिम क्षेत्रों का योगदान समान था, जो क्रमश: 12.33 लाख टन और 12.32 लाख टन था, बल्कि दक्षिण-पूर्व का यागदान 8.82 लाख टन और उत्तर-पूर्व का केवल 4.88 लाख टन था. रिपोर्टाधीन वर्ष में 4 समुद्रवर्ती राज्यों द्वारा 5 लाख टन से अधिक, जो देश के समुद्री मछली अवतरण का 67% था, अवतरण किया गया था। इनमें गुजरात लगातार चार वर्षों में 7.86 लाख टन अवतरण के साथ प्रथम स्थान पर था. इसके बार 6.55 लाख टन अवतरण के साथ तमिल नाडु द्वितीय स्थान पर था. वर्ष 2017 में कर्नाटक के स्थान पर केरल अवतरण के तीसरे स्थान पर आया।

वर्ष 2017 के समुद्री मछली अवतरण में वेलापवर्ती पख मछलियों की प्रमुखता देखी गयी, कुल अवतरण में अनका योगदान 54% था। वेलापवर्ती मछली अवतरण में भारतीय तारली, बांगड़ा, फीतामीन, लेसर सारडीन और बम्बिल का 60% योगदान आकलित किया गया। इनमें केवल तारलियों का योगदान 16.3% था। कुल अवतरण में तलमज्जी मछलियों का यागदान 26.8% था। अवतरण की गयी तलमज्जी संपदाओं में सूत्रपख ब्रीम, क्रॉकेर्स, मुल्लन, बुल्सआइ (प्रियाकांथस प्रजाति) और शिंगटियाँ प्रमुख थीं। क्रस्टेशियनों में चिंगट, केकड़ा और महाचिंगट जैसे उच्च मूल्य वाली संपदाएं सम्मिलित थीं और इनका योगदान 12.6% था. शेष 6.6% अवतरण में स्क्विड, कटिलफिश, सीपी और शुक्तियों सहित मोलस्क सम्मिलित थे।

भारत की समुद्री मात्स्यिकी जनगणना 2016 की कार्यविधि पूरी होने के बाद डिजिटाइस करके पशु

भारत में राज्यवार समुद्री मछली अवतरण - वर्ष 2017



Executive Summary

अवतरण किए गए प्रमुख संपदा ग्रुप - वर्ष 2017

पालन, डयरी एवं मात्स्यिकी विभाग (डी ए एच डी एफ) को प्रकाशनार्थ प्रस्तुत की गयी।

मात्स्यिकी तथा पारिस्थितिक तंत्र प्रतिरूपण पर किए गए अध्ययन से यह अनुमान लगाया जाता है कि जलवायु परिवर्तन से समुद्री सतह के तापमान में वृद्धि होती है जिसकी वजह से कुछ समुद्री मात्स्यिकी संपदाओं के जैवभार गतिकी में परिवर्तन होता है। पारिस्थितिक तंत्र के लिए मध्यवर्ती जटिलता प्रतिरूपण (एम आइ सी ई) के एक प्रकार, जिसे पारिस्थितिक तंत्र के लिए मध्यवर्ती जटिलता प्रतिरूपण का समाज-आर्थिक अनुकूलन (एस ई ए एम आइ सी ई) के रूप में जाना जाता है, को जैवभार के प्रतिरूपण के लिए उपयुक्त किया जाता है।

मात्स्यिकी संपदाओं के टिकाऊ प्रबंधन विषय के अंतर्गत सभी नौ समुद्रवर्ती राज्यों और संघ राज्य क्षेत्रों के राज्यवार जाँच-परिणाम प्रस्तुत किया जाता है। बड़ी वेलापवर्ती संपदाओं, उपास्थिमीन संपदाओं, द्विकपाटियों और अलंकारी जठरपाद संपदाओं को इस खंड में शामिल किया गया है। खंड के अंत में देश के विभिन्न स्थानों में हितधारकों की समस्याओं, जिन पर विचार किया जाना है, को संबोधित करने हेतु आयोजित हितधारक बैठकों की रिपोर्ट जोड़ी गयी है।

मछली आनुवंशिकी एवं जीनोमिक्स विषयक इस क्षेत्र के अंतर्गत वेम्बनाड झील से संग्रहित एट्रोप्लस सुराटेन्सिस के समग्र माइटोजीनोम का विवरण दिया गया है । यह OXPHOS जीन में आगे के वर्गीकरण अनुसंधानों और अध्ययनों के लिए आधारभूत आंकड़ा बन जाएगा । उष्णकटिबंधीय और समशीतोष्ण अक्षांशों में, क्लूपिड़े कुटुम्ब की मछलियों में मीठा पानी, समुद्र जल और खारा पानी के आवास स्थानों के लिए विशिष्ट OXPHOS जीन में विविधता चयन और अनुकूलन देखा गया। आण्विक पहचान कार्य में CO1 अनुक्रम के उपयोग से सुरा मछली के पंख और क्लोम की पहचान, कोपीपोड प्रजातियों पोसाइक्लोप्ससीएमएफआरआइ, जो नई प्रजाति है, की पहचान और पिम्नेसियमपरवम की आण्विक पहचान और ट्राइकोडेस्मियम की पुष्टि सम्मिलित है। पोनी फिश के वंशाववंशावली विश्लेषण से यह व्यक्त हुआ कि लियोग्नाथिडे कुटुम्ब में मोनोफेली है और शूली महाचिंगटों में जीवसंख्या अन्वेषण जारी किए गए। भारतीय सालमन (एल्यूथेरोनेमाटेट्राडक्टाइलम) में जीवसंख्या आनुवंशिक संरचना का चित्रण किया गया। मछली जीव संख्या के आकलन हेतु पर्यावरणीय डी एन ए (eDNA) अभिगम द्वारा बंद और खुली पानी व्यवस्थाओं में से eDNAएक्स्ट्रैक्शन और विश्लेषण के कार्य प्रगति पर हैं।

मोती का उत्पादन करने वाले मोलस्कों में मैन्टिल एपिथीलियल कोशिका संवर्धन में गति लाने हेतु मैन्टिल ऊतक का जैव संश्लेषण, समग्र ऊतक निचोड के साथ संवर्धन माध्यम के पूरक संबंधी अध्ययन जारी रखा गया। इस तरह के निचोड़ में जैव सक्रिय घटकों पर भी अध्ययन किया गया। जैव संश्लेषण में लगे हुए ऊतकों की अभिव्यक्ति की तुलना करने पर पिंक्टाडा मार्गरिटिफेरा के प्राकृतिक मैन्टिल ऊतक एवं संवर्धित मैन्टिल एपिथीलियल कोशिकाओं में नेकरीन के प्रवर्धन उत्पाद (480 bp) और ए सी सी बी पी (500 bp) ऊतकों की उपस्थिति देखी गयी।

समुद्री अलंकारी मरून क्लाउन मछली प्रेम्नास बयाकुलेटस के मिड ब्लास्टुला अवस्था के भ्रूण से व्युत्पन्न इन विट्रो एम्ब्रियोनिक स्टेम(ई एस) कोशिका संवर्धन की विशेषता बताने पर इम्यून फ्लूरसेन्स दाग द्वारा स्टेम सेल विशेष सर्फस मार्केर्स TRA1-60 और SSEA-4 का पता लगाया जा सका। हम्प बैक ग्रूपर क्रोमिलेप्टिसाल्टिवेलिस से प्रेरित प्लूरीपोटन्ट स्टेम सेल (iPSCs) संवर्धन की व्युत्पत्ति से, सफल iPSc कोलनियों के निर्धारण हेतु रीप्रोग्रामिंग क्षमता में सुधार लाने हेतु ट्रान्स्क्रिप्शन घटकों के विभिन्न संयोजनों का प्रयास किया जा रहा है।

मछली पौष्टिकता और खाद्य प्रौद्योगिकी के क्षेत्र में यह पाया गया है कि जामुन के पत्ते (साइज़ीजियम क्युमिनी) को 2% की दर पर खाद्य में मिलाया जाए तो पोम्पानो मछली में प्रतिरक्षा का प्रभाव बढ़ जाता है। इसी प्रकार खाद्य में 1%की दर पर काइटोसन जोड़ने पर पोम्पानो मछली की प्रतिरक्षा का प्रभाव और वृद्धि बढ़ायी जा सकती है। समुद्री अलंकारी मछली पेर्कुला क्लाउन के खाद्य में 15% की दर पर चुकंदर मिलाया गया खाद्य जोड़ने पर रंग बढ़ा

Executive Summary

जा सकता है। तैयार किए गए खाद्य देकर परलन की जाने वाली पोम्पानो मछली की वृद्धि विभिन्न स्थानों में भिन्न होती है। पोम्पानो मछली पालन हेतु वाणिज्यिक तौर पर उपलब्ध प्रोबयोटिकों का मूल्यांकन करने पर, चिंगट एवं मछली प्रोबयोटिकों की अपेक्षा मुर्गी पालन प्रोबयोटिक बेहतर देखा गया।

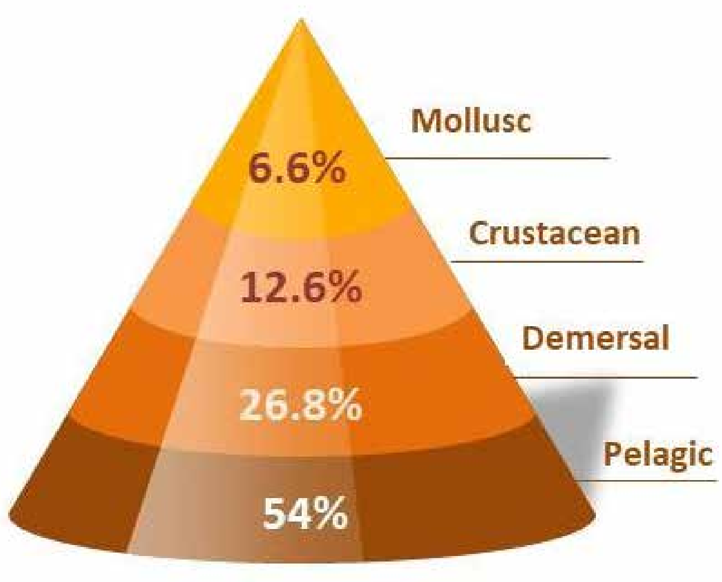
पोम्पानो मछली पालन में मछली खाद्व के स्थान पर सिल्कवर्म प्यूपा दिए जाने पर 25 - 50%तक का प्रतिस्थापन व्यावहारिक तौर पर साध्य देखा गया। इस दिशा में किए गए प्रयास में खाद्य के अपशिष्ट के उपयोग से ब्लैक सोल्जियर फ्लाइ का पालन किया गया और मछली खाद्य में पशु प्रोटीन स्रोत की जांच करने हेतु इसके डिंभकों का विश्लेषण किया गया।

महाचिंगटों में, विभिन्न खाद्यों के प्रति हिस्टोलजिकल बदलाव और एन्ज़ाइम प्रोफाइल का मूल्यांकन करने पर तैयार किए गए खाद्य से पोषक तत्वों के अवशोषण में कठिनाई पायी गयी।

पौष्टिक प्रोफाइलिंग कार्य में, यह देखा गया कि ब्रान्च्ड म्यूरेक्स (चिकोरीयूस्रामोसस), जिनका अब तक रिपोर्टरिपोर्ट नहीं किया गया है, फैटी एसिड और अमिनो एसिड का अच्छा स्रोत है।

मछली रोगविज्ञान अन्वेषणों के अंतर्गत, खाद्य मछलियों, अलंकारी मछलियों और द्विकपाटियों पर अध्ययन किया गया। स्काटोपागुसर्गस के अंतर्गत, माइसोस्पोरीन की नयी प्रजाति क्लोरोमिक्सुमार्गुसिन का अध्ययन प्रमुख था। द्विकपाटियों में पेर्किनसुसोल्सेनी और पी. बीहाएन्सिस के प्रसार पर भी विचार किया जाना है। रोगजनकों पर पता लगाने के लिए eDNA पर आधारित तरीका विकसित किया गया था। मछली पालन के पिंजरों और महाचिंगट पालन स्थानों से कई प्रकार के जीवाणु संक्रमण की रिपोर्ट की गयी थी। इस वर्ष के दौरान रिपोर्ट किया गया विषाणु रोग वाइरल नेर्वस नेक्रोसिस (वी एन एन) था। कोबिया में विब्रियोसिस के प्रति एल्जलाड्जुवान्टड टीका और इसका प्रयोग सफल निकला। केकड़ा हीमोलिम्फ के माइक्रोबिययल प्रोफाइलिंग द्वारा 33 जीवाणु प्रजातियों का विलगन साध्य हो सका। मैंग्रोव रेड स्नापर के प्रतिरक्षा प्रोफाइलिंग द्वारा इसके सहज प्रतिरक्षा के कारक घटकों की पहचान आसान हुई। एट्रोप्लस सुराटेन्सिस में हाइपर और हाइपो लवणता अनुकूलन के प्रभाव के आण्विक तथा प्रकार्यात्मक विश्लेषण और इसके ऊतकविज्ञानीय बदलावों का प्रलेखीकरण किया गया। इसी प्रकार क्रासोस्ट्रिया माड्रासेन्सिस से जैविक और अजैविक स्ट्रेस के लिए उत्तरदायी जीन का जैवपूर्वेक्षण और विशेषीकरण करने से जीन C का समग्र विशेषीकरण साध्य हुआ। जलीय जीव रोगों की राष्ट्रीय निगरानी कार्यक्रम (एन एस पी ए ए डी) के अंतर्गत द्विकपाटियों में ओ आइ ई द्वारा सूचीकृत रोगजकों की जांच और जन जागरूकता कार्यक्रम जारी किए गए। मछली स्वास्थ्य पर अखिल भारतीय नेटवर्क परियोजना के अंतर्गत, समुद्री संवर्धन में दवाओं और रासायनिक पदार्थों के प्रयोग का सर्वेक्षण हेतु अयातित जीवित मछली, विशेषत: अलंकारी मछलियों में ओ आइ ई द्वारा सूचीकृत रोगजनकों की जांच सहित बहुतायत कार्यविधियाँ प्रगति पर हैं। टीका और निदान पर भागीदारी परियोजना के अंतर्गत, समुद्री पख मछलियों में वाइरल नेर्वस नेक्रोसिस (वी एन एन) के निदान के लिए रेयस फ्लूइड थिग्लिकोल्लेट मीडिया (आर एफ टी एम) और पोलिमरेस चेइन रिएक्शन (पी सी आर) की अपेक्षा लूप मीडिएटड आइसोथेर्मल एम्प्लिफिकेशन (एल ए एम पी) पर आधारित निदान अधिक संवेदनशीन दखा गया।

समुद्री शैवालों से एन्टी-हाइपोथाइरोइडिसम एक्स्ट्रैक्ट (CadalminTMATe) नामक पांचवें उत्पाद के साथ अनुसंधान एवं विकास के क्षेत्र में समुद्री प्राकृतिक उत्पादों का विकास प्रबल किया गया। इस उत्पाद में मौजूद सक्रिय घटकों ने थाइरोइड के उत्पादन हेतु थाइरोइड उत्तेजक होर्मोन के स्तर को प्रभावात्मक रूप से बढ़ाया गया। एन्टी-माइक्रोबियल गतिविधि के लिए बासिलस एमिलोलिक्विफेसिएन्स से एक एरिल क्राउन्ड पोलीकीटिडे का निर्धारण किया गया। भुरा शैवाल सरगासम इलिसिफालियम और पाडिना जिम्नोस्पोरा से पहले निर्धारित नहीं किए गए एन्टीओक्सिडन्ट घटकों का विलगन करके अध्ययन किया गया। जैवसक्रिय घटकों के प्राकृतिक स्रोतों के रूप में समुद्री सूक्ष्मशैवालों



समुद्री मछली अवतरण में शीर्ष स्थान पर आए तीन राज्य - वर्ष 2017

Executive Summary

और मोलस्कों की जांच की जा रही है। शक्य जैवसक्रिय के रूप में खाद्ययोग्य द्विकपाटी सीपी को व्यावहारिक खाद्य सूत्रीकरण बनाने हेतु अनुसंधान जारी किए जा रहे हैं।

देश में मछली अंडशावकों और संतति उत्पादन सुविधाओं को बढ़ाए जाने से समुद्री संवर्धन अनुसंधान प्रबल बनाया जा रहा है। विशाखपट्टणम में ग्रूपर (एपिनिफेलस कोइयोइडस) मछली के करीब एक लाख संततियों का उत्पादन किया गया। मंडपम में पोम्पानो मछली के 2.62 लाख और कोबिया मछली के 3230 संततियों का उत्पादन किया गया। लगभग 6.68 लाख रुपए का अलंकारी मछलियों का विपणन किया गया। विषिंजम में कॉपीपोडों की आठ प्रजातियों के भारी उत्पादन और कोच्ची में सुपर मिनिस्यूल रोटिफर कलरेल्लाड्रियाटिका के भारी उत्पादन का मानकीकरण किया गया। मंडपम में हरित चिंगट का संतति उत्पादन और समुद्र रैंचन जारी किया गया। अलंकारी कैमल चिंगट रिंकोसिनेटस डर्बानेन्सिस के किशोरों की प्रग्रहण अवस्था में परिपक्वन के लिए आवश्यक अवधि कम की जा सकी। मुक्ता शुक्ति और हरित शंबु के स्पैटों के उत्पादन की रूपरेखा प्रणाली में सुधार लाने से उत्पादन में वृद्धि हुई। पहली बार सी एम एफ आर आइ टूटिकोरिन में घोड़ा शंख (होर्स कोंच) प्यूरोप्लोका ट्रपीज़ियम का प्रजनन किया जा सका।

समुद्री संवर्धन में, तालाबों, पुन:चक्रण जलजीव पालन व्यवस्थाओं (आर ए एस) और कंक्रीट के टैंकों में समान रूप से खाद्य प्रबंधन के साथ ई. कोइयोइडस के नर्सरी पालन का परीक्षण किया गया और देखा गया कि आर ए एस में पालन करने पर बेहतर वृद्धि होती है। आगे से, पिंजरों में ग्रूपर मछलियों की वृद्धि और स्ट्रेस की प्रतिक्रियाओं की निगरानी करके प्रलेखन किया गया। कारवार में पिंजरों में एशियन समुद्री बास का पालन परीक्षण सफल रूप से किया गया, बल्कि कोबिया के पालन में फोटोबैक्टीरियम डामसले की वजह से मछलियों की मृत्यु हुई। टूटिकोरिन में, 6 मी. के व्यास के पिंजरों में महाचिंगट के पालन के फलस्वरूप 130 दिनों में 130-250 ग्राम की वृद्धि अंकित की गयी। तमिल नाडु के पुतुकोट्टै जिले के तटीय गॉवों में पोम्पानो और समुद्री बास मछलियों के पालन में सफलता पायी गयी। केरल, आंध्रा प्रदेश और तमिल नाडु में स्थान विशेषक पिंजरों की ढ़ांचों की स्वीकार्यता बढ़ गयी। पोम्पानो मछली में प्रतिपूरक वृद्धि जांच के तहत है। 'सेलुलोइड' नामक व्यक्तिगत बंधन द्वारा नीली तैराक केकड़ा (ब्लू स्विम्मर क्रैब) के वज़न बढ़ाने के तरीके को प्रचरित किया जा रहा है।

सी एम एफ आर आइ की सहायता से मूत्तकुन्नम और पुत्तनवेलिक्करा में महिला स्वयं सहायक ग्रुपों द्वारा शुक्तियों के समुद्री औषधी ब्रैंड का विकास किया गया। कर्नाटक के उडुपी जिले में रैक एंड रेन तरीके से शुक्ति पालन में 78 मछुआरों को उद्यम किया गया। एकीकृत बहु पौष्टिक जलजीव पालन (आइ एम टी ए) के अंतर्गत कर्नाटक के सुमना मुहाने और कोषिकोड के चालियम में मछली के साथ क्रमश: शुक्ति और हरित शंबु का संयोजित पालन किया गया। अन्य संस्थानों में भी इस तरह के पालन के प्रचार हेतु महाराष्ट्र के मालवान के मछली पालनकारों को प्रशिक्षण दिया गया।

समुद्री संवर्धन में अखिल भारतीय नेटवर्क परियोजना (ए आइ एन पी) के अंतर्गत सहायता संघों द्वारा भा कृ अनु प के अधीन केन्द्रीय द्वीप कृषि अनुसंधान संस्थान (सी आइ ए आर आइ), पोर्ट ब्लेयर सहित 12 सहभागी केन्द्रों और राज्य कृषि विश्वविद्यालय के पांच सहभागी केन्द्रों में मछली संतति उत्पादन एवं पालन की गतिविधियों का सशक्तीकरण किया गया।

समुद्री जैवविविधता अनुसंधान में, भारतीय तट पर जीवविज्ञानीय तौर पर संवेदनशील क्षेत्रों के लिए परिरक्षण योजना विकास पर अनुसंधान परियोजना के अंतर्गत भारत के समुद्रवर्ती राज्यों में द्रुत क्षेत्रीय सर्वेक्षण आयोजित किए गए। भारतीय तट पर साइफोज़ोअन और क्यूबोज़ोअन जेलीफिश की विविधता एवं वितरण पर अन्वेषण एक और अनुसंधान परियोजना है, जिसके अंतर्गत भारत के गुजरात से आंधा प्रदेश तक के तट पर अप्रैल 2017 से मार्च 2018 के दौरान प्राथमिक सर्वेक्षण आयोजित किया गया। प्रवाल भित्तियों की लचीलापन क्षमता का निर्धारण करने हेतु कवरत्ती द्वीप समूह के नौ स्थानों में जलांदर सर्वेक्षण आयोजित किया गया। भविष्य में लक्षद्वीप की प्रवाल भित्तयों की सुभेद्यता की साध्यताओं और नवंबर 2017 के दौरान हुए ओखी चक्रवात के बाद कवरत्ती की प्रवाल भित्तियों पर हुए परिवर्तनों का भी निर्धारण किया गया। विभिन्न पारिस्थितिक तंत्रों के कोनुसिनस्क्रिप्टस, सी. अमाडिस और सी. मालाकानस की फीनोटिपिक विविधताओं को जीनोम द्वारा निहित नहीं हुआ, जो भारतीय तट पर कोन नेइल्स और स्ट्रोम्ब में आण्विक वर्गीकरण और फाइलोजेनी पर हमारे अनुसंधान को दर्शाता है। द्विकपाटी पालन को लोकप्रिय बनाने के साथ साथ तमिल नाडु में बेहतरीन प्रतिचयन तरीके से समुद्री मछली अवतरण का आकलन बाहरी वित्त पोषण से की जाने वाली एक और प्रमुख कार्यविधि है। कडलुन्डी-वल्लिकुन्नु मुहाने में तटीय पारिस्थितिकी तंत्र की माल और सेवाओं का मूल्यांकन केरल राज्य जैवविविधता बोर्ड के वित्त पोषण से की जाने वाली सी एम एफ आर आइ की प्रमुख कार्यविधि है।

Executive Summary

समुद्री पारिस्थितिकी तंत्रों की निगरानी के अंतर्गत समुद्री शैवालों के उत्पादन का आकलन किया गया। समुद्री माक्रोफाइटों के पारितंत्रों में से विरल रूप से पायी जाने वाली स्कोर्पियोन फिश स्कोर्पीनोप्सिस निग्लेक्टा हेकेल, 1837 को पाया गया। प्लवमान मैंग्रोव नर्सरी की रूपकल्पना एक और महत्वपूर्ण उपलब्धि है। तटीय प्रदूषण के अंतर्गत, जैवउपचार के लिए समुद्री शैवाल एन्टरोमोर्फा इन्टेस्टिनालिस का उपयोग किया गया। सी एम एफ आर आइ के सर्वेक्षणों के आधार पर सी एम एफ आर आइ वेबसाइट में दिया गया राष्ट्रीय समुद्र तट कूड़ा मानचित्र वैश्विक रूप से दृश्यमान है। समुद्र तल पर समुद्री मलबा और कोवलम में व्यापक रूप से हुई मछलियों की मृत्यु पर अध्ययन किया गया। सूक्ष्म स्तरीय पर्यावरणीय प्रबंधन योजना (ई एम पी) के विकास के अंतर्गत, सहभागिता तरीके से ई एम पी का विकास किया गया। तमिल नाडु के उत्तरी तट पर चुने गए स्थानों पर विनियोजित कृत्रिम भित्तियों की स्थिति का निर्धारण करने हेतु कृत्रिम भित्तियों का निर्धारण किया गया और प्राकृतिक आवास तंत्र और जैवविविधता पर कृत्रिम भित्तियों के प्रभाव का भी निर्धारण किया गया।

जलववायु लचीला कृषि पर राष्ट्रीय नवोन्मेष (एन आइ सी आर ए) कार्यकम में, मांगलूर में तापमान और सूत्रपख ब्रीम की प्रचुरता के बीच के संबंध पर अध्ययन किया गया। विशाखपट्टणम में क्रॉकेर्स, पफर मछली, फीता मीन, करंजिडों और पोलीनेमिडों के डिंभक वितरण और रिक्रूटमेन्ट पर किए गए अध्ययन में क्राकर डिंभकों की अधिकता पायी गयी। महाराष्ट्र तट पर पकड़ मिश्रण और उत्स्रवण (अपवेल्लिंग) पर किए गए आकलन से कुछ प्रमुख प्रजातियों की उपस्थिति देखी गयी। मैंग्रोवों और समुद्री घास की नीली कार्बन शक्यता तथा जीवन चक्र और मत्स्यन परिचालन का निर्धारण करने पर यह संकेत मिला कि केरल तट पर मछली संग्रहण के चरण और इसके उपरांत संग्रहणोत्तर तथा संग्रहण पूर्व चरणों के दौरान कार्बन उत्सर्जन सबसे अधिक है। विकसित जलवायु लचीला उत्पादों में, बयोचार नामक मल्टीवेन्डर ई-कोमेर्स वेबसाइट (www.marinefishsales.com) और मोबाइल एप्प महत्वपूर्ण हैं। केरल के जलवायु परिवर्तन लचीला तटीय मत्स्यन गॉवों के लिए बदल आजीविका उपायों (ए एल ओ) के निर्धारण के अंतर्गत तिरुवतंतपुरम के पून्तुरा और एरणाकुलम के एलमकुन्नपुषा गॉवों के तटीय समुदायों के बीच जलवायु परिवर्तन के प्रति बदल आजीविका उपायों पर अध्ययन आयोजित किया गया।

टिकाऊपन और विपणन सहित समुद्री मात्स्यिकी आर्थिकी अनुसंधान के अंतर्गत यह देखा गया कि देश में पिछले वर्ष (2016) की अपेक्षा समुद्री मछली अवतरण के आकलित मूल्य में 8.37% की वृद्धि हुई है, जिसके फलस्वरूप मछली अवतरण केन्द्र के यूनिट मूल्य, खुदरा बाज़ार के यूनिट मूल्य और उपयोक्ता रुपए में उत्पादक के हिस्से में भी वृद्धि हुई । समुद्री सेक्टर और अन्य स्थूल आर्थिक संकेतकों का प्रजातिवार मूल्यांकन, मूल्य श्रृंखला में राज्यवार मूल्यांकन, इन्वेन्टरियों का सकल मूल्यांकन (पूंजी निर्माण) का आकलन और रिपोर्टिंग की गयी। मत्स्यन तरीकों के आर्थिक निष्पादन, समुद्री मछली की किस्मों के मूल्य स्वभाव, औसत खुदरा केन्द्र मूल्य प्राप्ति और समुद्री मछली विपणन क्षमता पर भी अध्ययन किया गया। एरणाकुलम में किए गए स्थान विशेषक अध्ययनों में, मांग उपभोक्ताओं में मछली खपत की वृद्धि और ऑनलाइल मछली विपणन प्रमुख हैं। राष्ट्रीय परिवेश में, मात्स्यिकी सेक्टर में जी एस टी के प्रभाव पर अध्ययन किया गया। अंतर्राष्ट्रीय अनुसंधान परियोजना स्थानीय समाधान के लिए वैश्विक सीख (जी यु एल एल एस): समुद्र पर निर्भर तटीय समुदायों में जोखिम कम करना के अंतर्गत तमिल नाडु के रामनाथपुरम में समाज-आर्थिक सुभेद्यता निर्धारण किया गया।

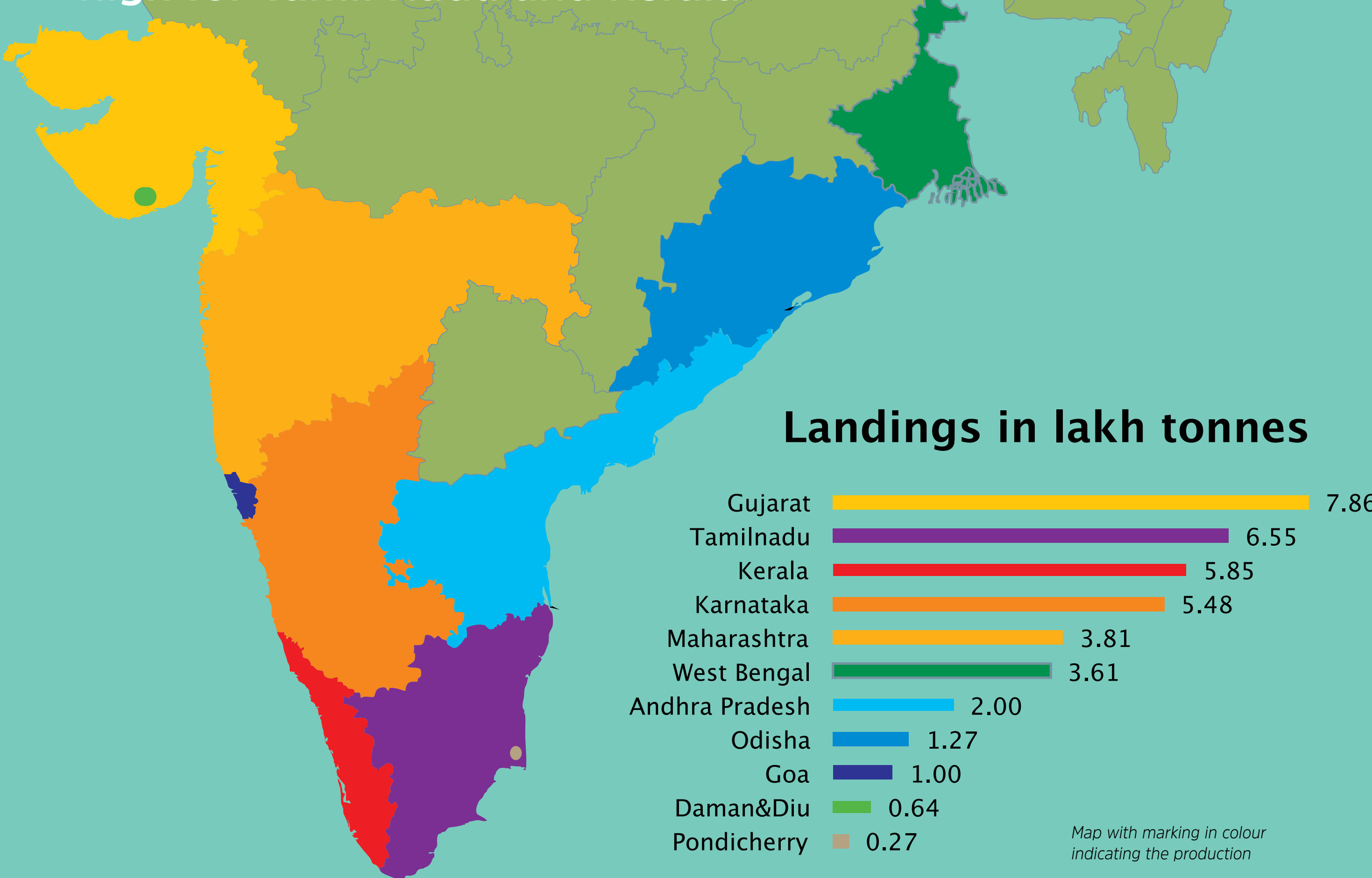
शासन, आजीविका और जेन्डर कल्याण के लिए हितधारकों की प्रतिक्रिया महत्वपूर्ण है। क्रेडिट की आसान पहुँच को सुविधाजनक बनाने के उद्देश्य से नियमों को युक्तिसंगत बनाने के उपायों पर पहुँचने हेतु केरल के लघु पैमाने के मछुआरों के औपचारिक और अनौपचारिक जमा धन के लेन-देन पर विस्तृत रूप से अध्ययन किया गया। बदल आजीविका उपायों और भारत के समुद्री मात्स्यिकी सेक्टर में उद्यमिता विकास में जेन्डर मुख्य धारा के क्षेत्र में, इस वर्ष बंगाल, ओड़ीशा और आंध्रा प्रदेश जैसे तटीय राज्यों में अध्ययन आयोजित किया गया। श्रम प्रवास अनुसंधान का एक और प्रमुख विषय था। मछुआरिनों का सहायता समूह (एस ए एफ) के वित्त पोषण से तीरामैत्री और तीरानैपुण्या कार्यक्रम जारी किए गए। स्वयं सहायता ग्रूपों की स्थान विशेषक आवश्यकताओं की पूर्ति के लिए लघु उद्यमों की पहचान हेतु स्वयं सहायक ग्रूपों (एस एच जी) द्वारा लिंग मुख्य धारा के अंतर्गत उचित एच आर डी हस्तक्षेप कार्यक्रम द्वारा चुने गए लघु उद्यमों को 25 उद्यमिता क्षमता विकास (ई सी बी) कार्यक्रम और 40 मछुआरा आपसी चर्चा बैठकों का आयोजन किया गया। संस्थान के कृषि प्रौद्योगिकी सूचना केन्द्र (ए टी आइ सी) द्वारा लगभग 14130 हितधारकों को आवश्यक सलाह प्रदान किया गया और 374128 लाख रुपए का राजस्व उत्पन्न किया गया। ए टी आइ सी द्वारा कई प्रदर्शनियों और प्रशिक्षण कार्यक्रमों का आयोजन किया गया।

Major Achievements

- Silver pomano seed production touches an all-time high of 2.62 lakhs
- Marine Fisheries Census of India 2016 reports ready for release
- Nutraceutical products for use against hypothyroidism and hyperthyroidism were developed from the bioactive leads isolated from the seaweeds, *Sargassum wightii* and *Turbinaria conoides*
- Characterised complete mitogenomes of *Sardinella longiceps*, *S. gibbosa* and *Etroplus suratensis* from Indian waters
- A new species of copepod *Apocyclops cmfri* sp. nov. was described
- Two new species of fish parasites, *Tenuiproboscis keralensis* sp. nov., an acanthocephalan and *Chloromyxum argusi* sp. nov., a *myxosporean* were reported
- New records of deep sea shrimp *Solenocera barunajaya* Crosnier, 1994 and *Solenocera rathbuni* Ramadan, 1938 reported from the southwest coast of India
- Gross revenue from marine fish at landing centres was estimated at ₹52,807 crores with a market value of ₹80,018 crores
- CMFRI attracts funding to the tune of ₹9 crores from National Fisheries Development Board, for mariculture development in the country
- Championship hat-trick in ICAR south zone sports meet

Fishery Resource Monitoring

Inceased landings in all maritime states except in Tamil Nadu. Cyclone OCKHI affected fishing in Kerala during the last quarter of the year. Diversity in the resources landed high for Tamil Nadu and Kerala



Map with marking in colour indicating the production

5.6%

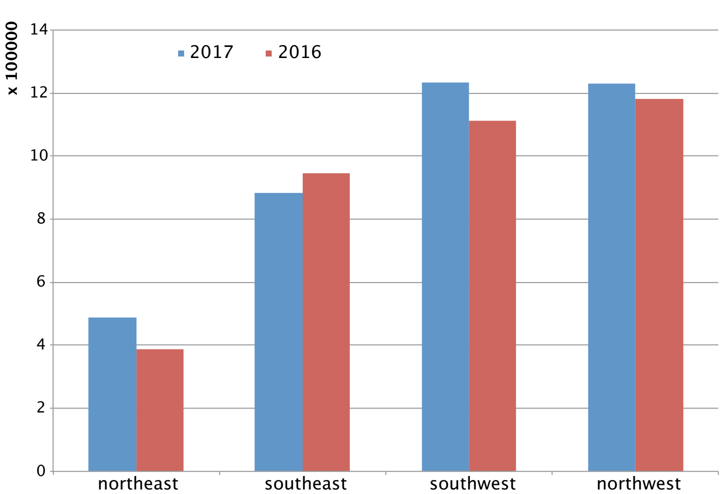
increase compared to the marine fish landings in 2016

Fish harvests

Research Project: FRA/GIS/01

The marine fish landings from the coast of the main land of India in 2017 was estimated as 3.83 million tonnes (t) showing an increase by about 5.6% compared to the landings in 2016. The difference is about 2.05 lakh t which is mainly due to increased landings in West Bengal by nearly 90,000 t, Maharashtra by 89,000 t and Kerala by 62,000 t. Compared to 2016, the landings in all the maritime states except Tamil Nadu increased in 2017. As in the last four years maximum landings took place along the Gujarat coast to the tune of 7.86 lakh t which is 20.5% of the total landings in India. Tamil Nadu, Kerala and Karnataka are the other top three states with respective contributions 6.55 lakh t (17.1%), 5.85 lakh t (15.3%) and 5.48 lakh t (14.3%). Percentage increase was high in Goa (64%), West Bengal (33%), Maharashtra (30%) and Kerala (12%). The union territories of Puducherry and Damen & Diu respectively had 40% and 45% reduction from the landings in 2016. Maximum landings of 12.33 lakh t (32.2%) in 2017 took place along the southwest region comprising Kerala, Karnataka and Goa and almost equal contribution of 12.32 lakh t (32.1%) was from the northwest region (Maharashtra, Gujarat and Damen & Diu). The least landings was 4.88 lakh t (12.7%) from the northeast region and 8.82 lakh t (23.0%) was the contribution from the southeast region.

Rregion wise marine fish production in 2017



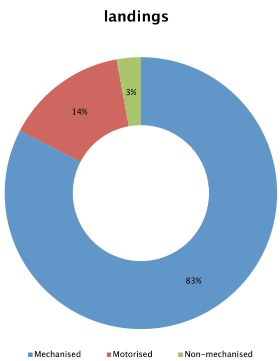
The mechanised sector remained as the highest contributing sector with 3.17 million t (82.6%) being caught by this sector, the motorised sector contributing 5.57 lakh t (14.5%) and the non-motorised sector contributing only 2.9%. The catch rates in terms of per boat catch was high (1568 kg/trip) for the mechanised sector whereas it was only 122 kg/trip for motorised sector and 55 kg/trip for non-motorised sector. In terms of hours of operation also the catch rates were high for mechanised sector (50 kg $^{-1}$) and low for other two sectors (20 kg^{-1} for motorised and 18 kg^{-1} for non-motorised). In the mechanised sector 46.5% of the catch was by Mechanised Multi-day trawlers, 12.5% by Mechanised Single day trawlers, 11.4% by Mechanised Dolnets and 10.2% by Mechanised Purse seines.

Among the different marine fishery resources landed along the Indian coast the oil sardine (*Sardinella longiceps*) fetched back the first position in 2017 with a contribution of 3.37 lakh t at national level from 2.45 lakh t in 2016. The landings of other important resources are Indian mackerel 2.88 lakh t, ribbonfishes 2.39 lakh t, cephalopods 2.31 lakh t, lesser sardines 2.27 lakh t, penaeid shrimps 2.08 lakh t, non-penaeid shrimps 2.02 lakh t, threadfin breams 1.57 lakh t, croakers 1.50 lakh t and Bullseyes 1.43 lakh t. In the assemblage wise classification of pelagic, demersal, crustacean and molluscs of the landed resources the pelagic resources landed 54%, demersal 26.8%, crustaceans 12.6% and molluscs 6.6%.

Species Diversity

In 2017, a total of 788 marine fish species were landed along the Indian coast with maximum numbers landed along the Tamil Nadu coast followed by Kerala and Maharashtra. Along the west coast 618 species were landed whereas the number of species landed along the east coast was 592. The average landings per species was high in Gujarat (3025 t) followed by Karnataka (2513 t) and West Bengal (2493 t). The overall landings per kilometre coast line considering the

Fishery Resource Monitoring



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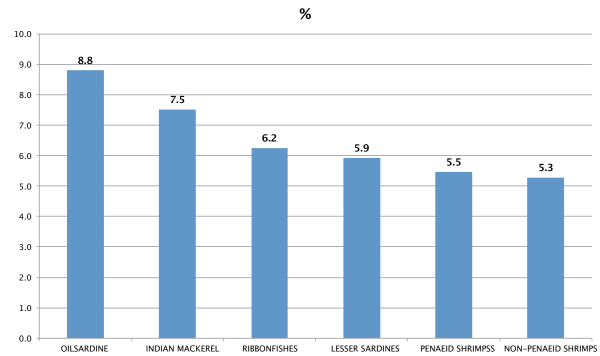

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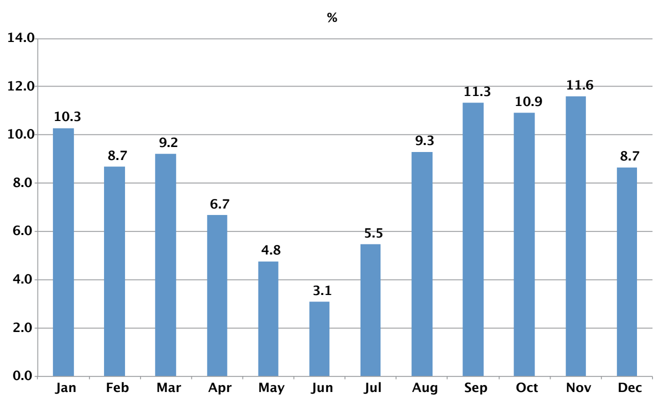

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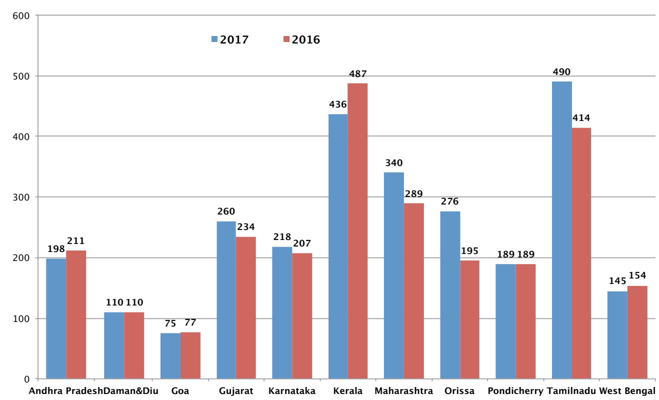


4

1. *Sector wise information*
2. *Major species harvested with percentage production*
3. *Seasonal pattern in catch*
4. *Species diversity*

entire coast line of the main land is 632 t in 2017. This for the west coast is 739 t and for the east coast it is 501 t. The maritime state with maximum landings per kilometre coast line is West Bengal (2288 t) followed by Karnataka (1826 t) and Kerala (991 t). Landings per kilometre is the least for Andhra Pradesh (205 t). The ratio of number of species landed to the length of the line is high for West Bengal, Kerala and Karnataka Goa (0.92, 0.74, 0.73 respectively) and it is low for Gujarat, Andhra Pradesh and Tamil Nadu (0.16, 0.20, 0.46 respectively).

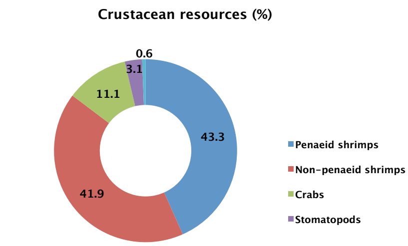
The species wise information on landings during 2007 – 2017 was used to compute different diversity indices especially the average taxonomic distinctness (Delta+) and variation in taxonomic distinctness (Lambda+) for each year and different geographic regions using Primer software. The relation of species diversity in fished taxa with latitude and longitude were also examined.

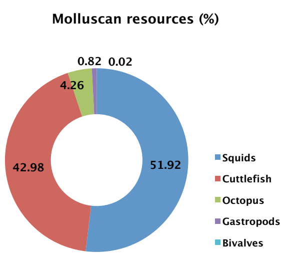
Fishery Modelling

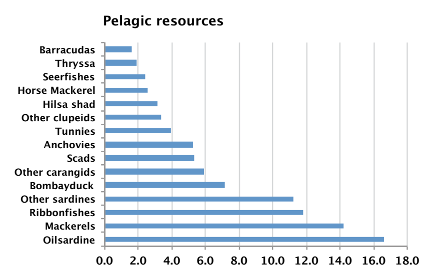
Three different multi-species biomass dynamic models were developed by modifying the MICE model in order to suite the multi-species and multi-gear fishery situation existing in India. The first model has additional parameters for deriving the standardisation of fishing effort corresponding to a resource from the fishing efforts exerted by different categories of fishing vessels that harvest the resource. The second model is with an exponent for the biomass, carrying capacity ratio which forms a parameter in the model. The third model is with an additional term to account for the situation when there is more loss due to natural mortality than the biomass added through reproduction and weight gain. These models have multi-gear fishing effort as an input component.

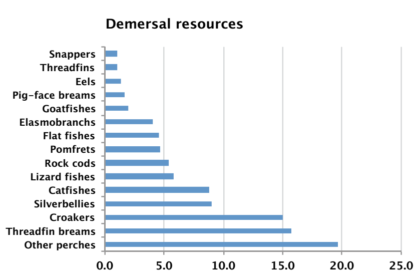
Towards estimation of potential yield from the Indian EEZ for the national

Fishery Resource Monitoring









Estimated marine fish landings (tonnes) in India 2017

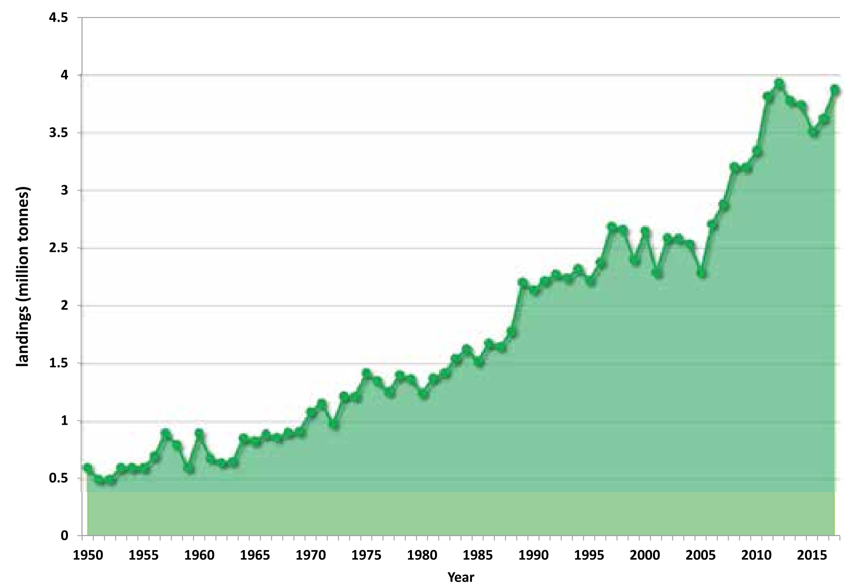
Pelagic finfish	
CLUPEOIDS	
Wolf herring	18566
Oilsardine	337390
Other sardines	226970
Hilsa shad	63437
Other shads	6967
ANCHOVIES	
Coilia	33574
Setipinna	8777
Stolephorus	64859
Thryssa	38003
Other clupeids	67607
Bombayduck	145115
Half Beaks&Full Beaks	7883
Flying Fishes	1345
Ribbon Fishes	239355
CARANGIDS	
Horse Mackerel	51964
Scads	108010
Leather-jackets	16237
Other carangids	120019
MACKERELS	
Indian mackerel	287880
Other mackerels	636
SEER FISHES	
Scomberomorus commerson	30170
Scomberomorus guttatus	18163
Scomberomorus lineolatus	74
Acanthocybium solandri	268
TUNNIES	
Euthynnus affinis	27680
Auxis spp.	16640
Katsuwonus pelamis	10559
Thunnus tonggol	7350
Thunnus albacares	13505
Other tunnies	4656
Bill Fishes	11328
Barracudas	33337
Mullets	7939
Unicorn Cod	325
Miscellaneous	68279

Demersal finfish	
ELASMOBRANCHS	
Sharks	19777
Skates/Guitarfish	2628
Rays	17766
Eels	13174
Catfishes	88177
Lizard Fishes	57803
PERCHES	
Rock cods	53924
Snappers	10518
Pig-face breams	16483
Threadfin breams	157773
Bullseyes	143451
Other perches	53807
Goatfishes	20306
Threadfins	10764
Croakers	150241
Silverbellies	89901
Whitefish	3807
POMFRETS	
Black pomfret	12622
Silver pomfret	28789
Chinese pomfret	5466
FLAT FISHES	
Halibut	2069
Flounders	90
Soles	43173
Shellfish	
CRUSTACEANS	
Penaeid shrimp	209513
Non-penaeid shrimp	202748
Lobsters	2863
Crabs	53476
Stomatopods	14784
MOLLUSCS	
CEPHALOPODS	
Squids	131774
Cuttlefish	109089
Octopus	10816
Miscellaneous	2135
TOTAL	**3834574**

level committee constituted by the Department of Animal Husbandry Dairying and Fisheries, Ministry of Agriculture and Farmers Welfare, New Delhi, estimation of maximum sustainable yield (MSY) based on the new models developed and using time series data on fish catch and fishing effort during 1997 – 2016 for different resources in each maritime state, was completed for most of the important marine fishery resources in each maritime state.

The effect of projected rise in sea surface

Modelling for fishery resources in different maritime states for revalidation of potential yield from the Indian EEZ



temperature due to climate change on the dynamics of biomass of few marine fishery resources was examined by modeling the biomass dynamics through a variant of SEAMICE models for the south Kerala region.

Software and Database

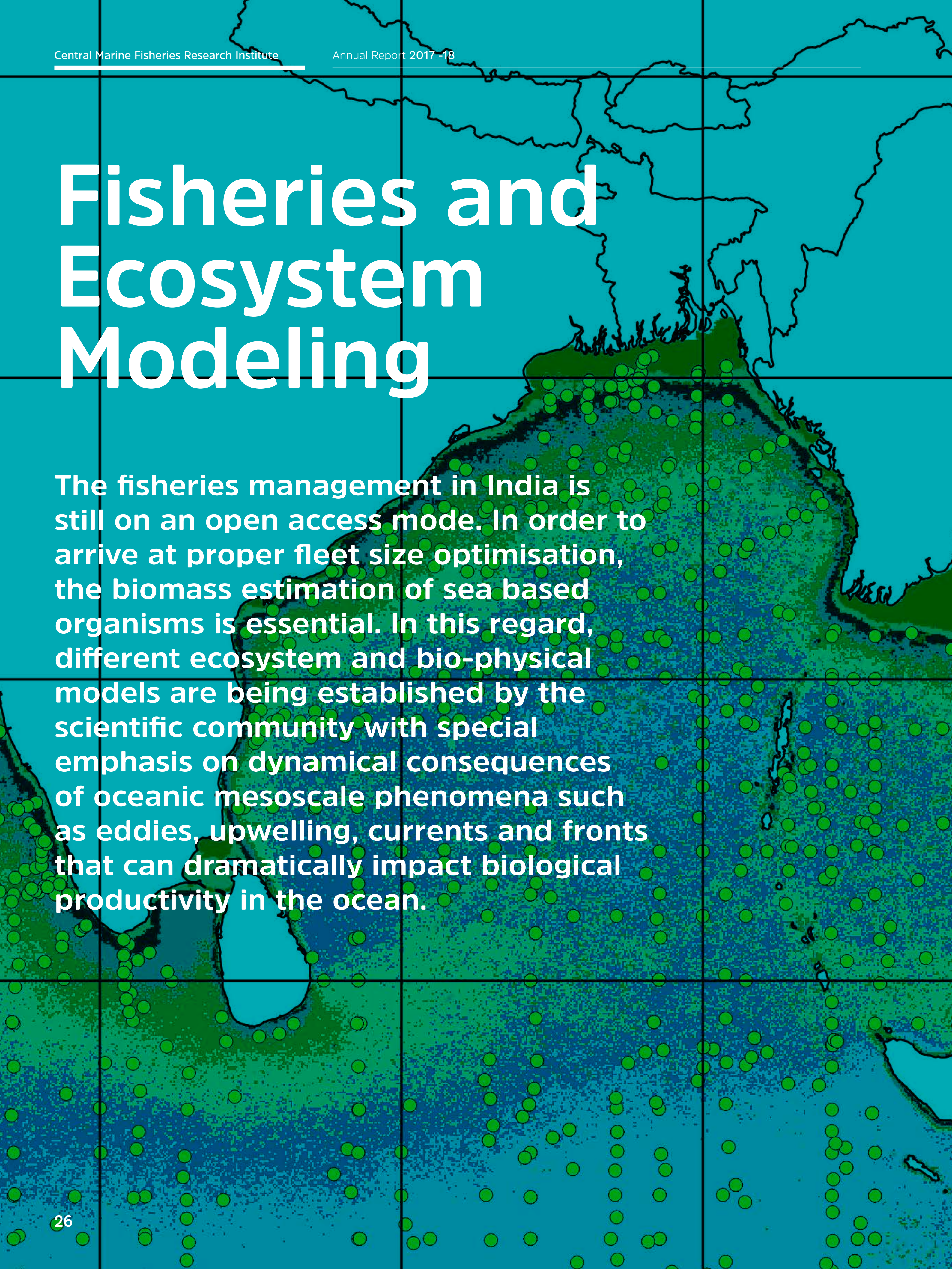
The National Marine Fishery database was updated with information on species wise, gear wise, zone wise and month wise landings in 2017 for all the 75 fishing zones described for the Indian coast. The database was explored to generate all necessary tables of information in different combinations.

The online web application developed in the IBM server with Oracle RDBMS for online data entry from landings centers using electronic tablets was first time used for storing and processing all the information pertaining to marine fisheries collected through the sample survey during the year 2017. The electronic tablets and software for online data entry were tested at selected landing centres of different categories. Developed the database in Oracle and stored all the information collected covering the 1265 marine fish landing centers distributed along 75 fishing zones belonging to the 9 maritime states and two union territories. The data entry, processing for estimation and tabulation in required formats were made using the software recently developed for online data entry.

Developed software in ADMB environment for ML estimation of model parameters and MSY using time series data on fish catch and fishing effort which is being used for estimation of potential yield for the committee constituted for revalidation of potential yield from the Indian EEZ.

Marine Fisheries Census Reports

Marine Fisheries Census 2016 data collected using different schedules digitised, processed and necessary tables for preparation of reports were created from the database for all the 9 maritime states, 2 union territories and all India. Draft reports were prepared for each of the maritime states/UTs and submitted to the Department of Animal Husbandry Dairying and Fisheries for feedback before printing the reports.



Fisheries and Ecosystem Modeling

The fisheries management in India is still on an open access mode. In order to arrive at proper fleet size optimisation, the biomass estimation of sea based organisms is essential. In this regard, different ecosystem and bio-physical models are being established by the scientific community with special emphasis on dynamical consequences of oceanic mesoscale phenomena such as eddies, upwelling, currents and fronts that can dramatically impact biological productivity in the ocean.

Fisheries and Ecosystem Modeling

The study indicates some oceanographic signals which can be inferred as the possible extension of upwelling to the north-west coast of India. This extension probably will have an impact on the biological productivity and biomass in the north-west coast of India.

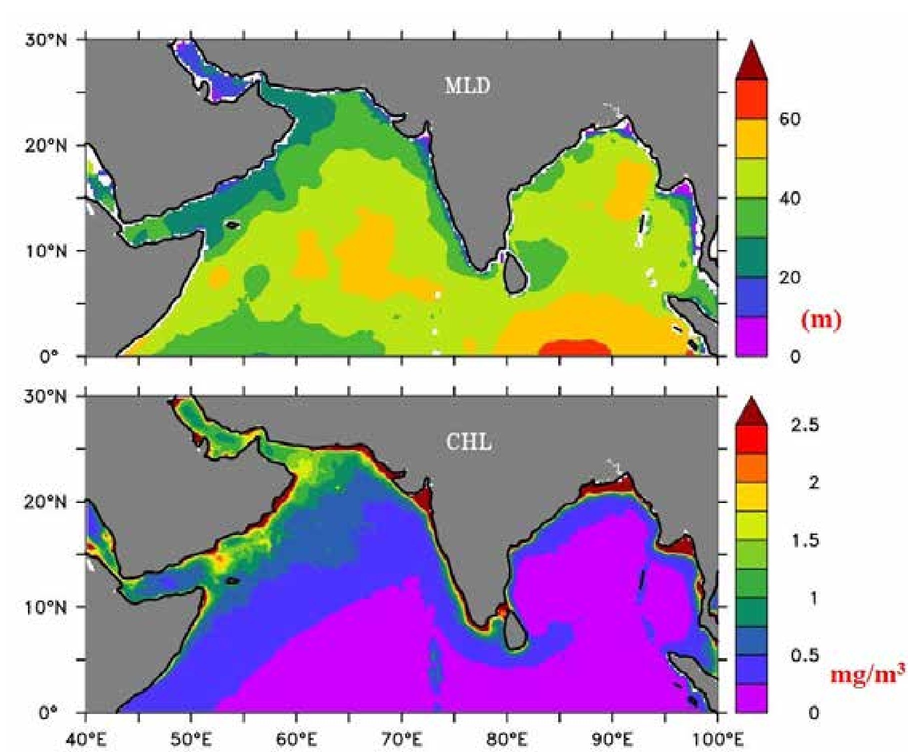
A Model for the Primary Production in Indian Coastal Waters

Research Project: EF/26

Since the mid-20th century, several modelling studies related to primary productivity on global oceans have been carried out. The compartments of the simple first-generation statistical models are expressed by a single differential equation describing the dependence of rate of change of phytoplankton with photosynthesis, respiration and grazing. The functionality of these models is greatly dependent on how efficiently it represents the mixed layer dynamics and its interactions with the euphotic zone. Recently, coupled bio-physical models are extensively used with advanced techniques resulting in better accuracy and resolution of predicted results. The efficiency of these models has significant contribution from mixed layer dynamics and it incorporates causes from horizontal and vertical advection as well. Since the mixed layer variability over the coastal waters of India was greatly dependent on the upwelling and downwelling phenomena, a pilot study was done in the initial months of this project to map the areas of upwelling and downwelling along the coastal waters before the installation of a primary productivity (PP) model.

Primarily, the maps generated as part of the study indicate the areas of upwelling and downwelling along the west coast of India. The upwelling along the south west coast of India starts during April and intensifies during July. Climatology map of chlorophyll–a shows that the concentration along the south-west coast of India also peaks during the same time along with the initiation and progression of upwelling. The present study indicates some oceanographic signals which can be inferred as the possible extension of upwelling to the north-west coast of India. This extension probably will have an impact on the biological productivity and biomass in the north-west coast of India.

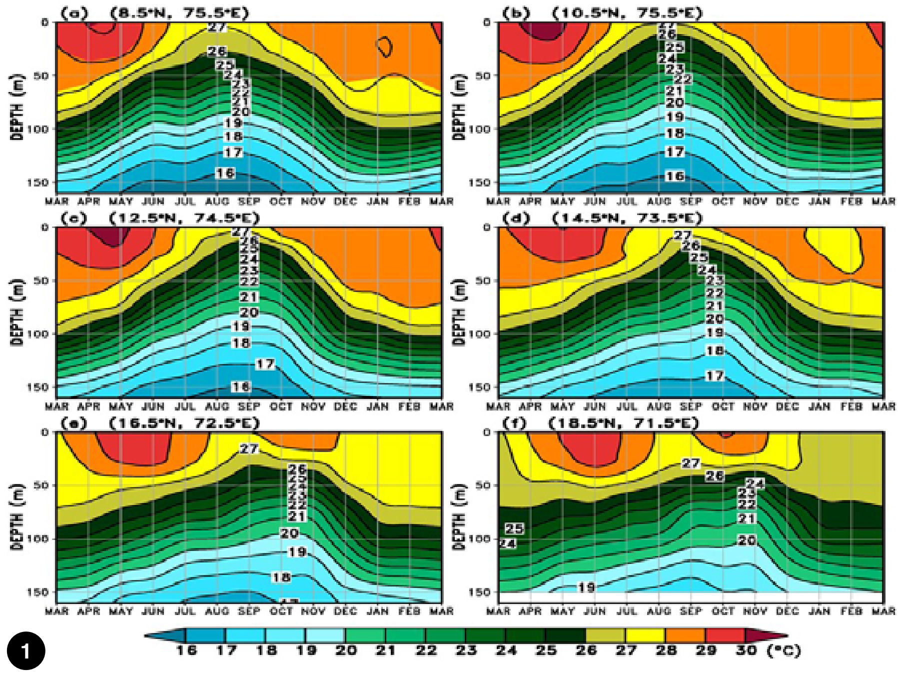
Results from climatology of isotherms revealed that along the west coast of India at southern latitudes (8.5^{O}N to14.5^{O}N) upward movement of isotherms occurred in the subsurface layers sets during February/March and intensified as the summer monsoon progressed. During July and August upwelled water reaches



Climatology of Mixed Layer Depth (MLD) (m) and Chlorophyll –a concentration (mg/m^3) over the north Indian Ocean, oceanic provinces of shallow MLD are characterised by high chlorophyll –a concentration.

Fisheries and Ecosystem Modeling

1. *Climatology map of isotherms at particular latitudes along the west coast of India.*
2. *Climatology map of Chl- a concentration (mg/m^3) along the west coast of India.*



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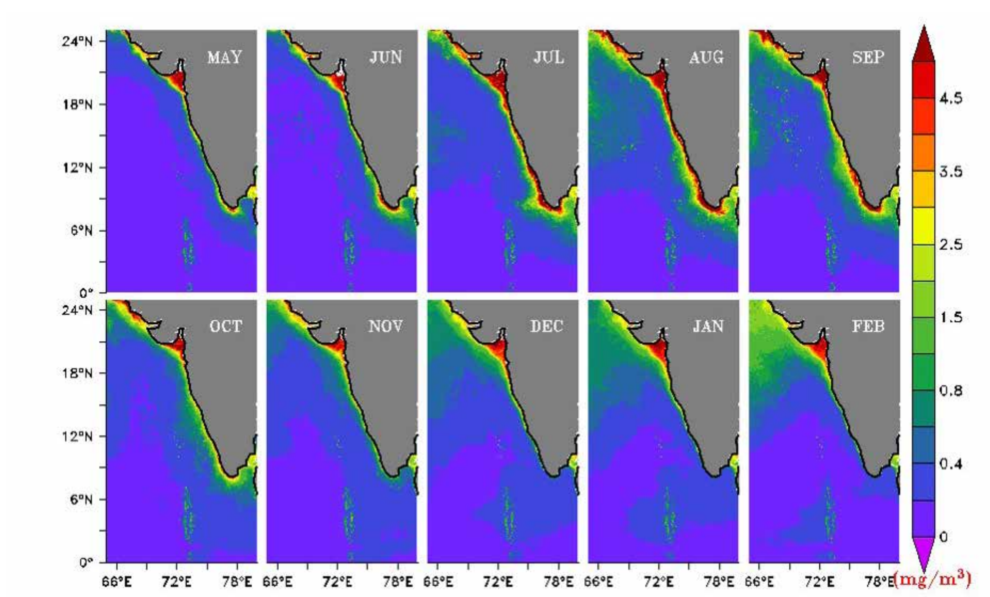


2

and replaces the surface water along the southwest coast of India. The cessation of upwelling starts along the southwest coast during September and the coast was characterised by downwelling during October to February. From the vertical shift of isotherms it was clear that the southwest coast of India experienced most intense downwelling during November to January.

Upwelling was also evident along the northwest coast at the subsurface level during the summer monsoon. Compared with southwest coast, the northwest coast was characterised by the delayed evolution of upwelling in the subsurface level, which extended up to October/ November. Cessation of upwelling and sinking along the northwest coast starts during November. From climatology map of isotherms, it was also clear that along the northern latitude (16.5 ^{O}N and 18.5 ^{O}N), upwelled water does not replace the surface water and the vertical movement

Fisheries and Ecosystem Modeling

Mesoscale eddies are capable of mediating chlorophyll variability through physical-biological coupling. An attempt has been made to relate the evolution and propagation of mesoscale eddies to Chl-a variability, the overall importance of such features and their influence on biological production in the south-west coast of India.

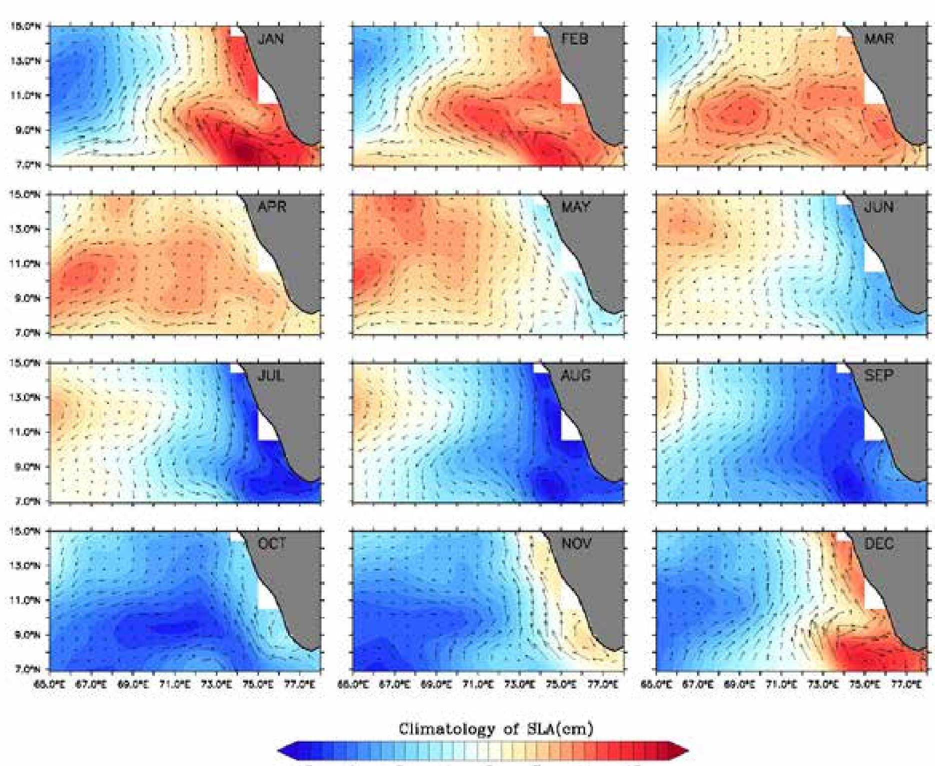
of isotherms was limited to between 30m and 50m depth.

Mesoscale Eddies and Associated Chlorophyll–a Variability in the Arabian Sea

Research Project: FRA/CHL/02

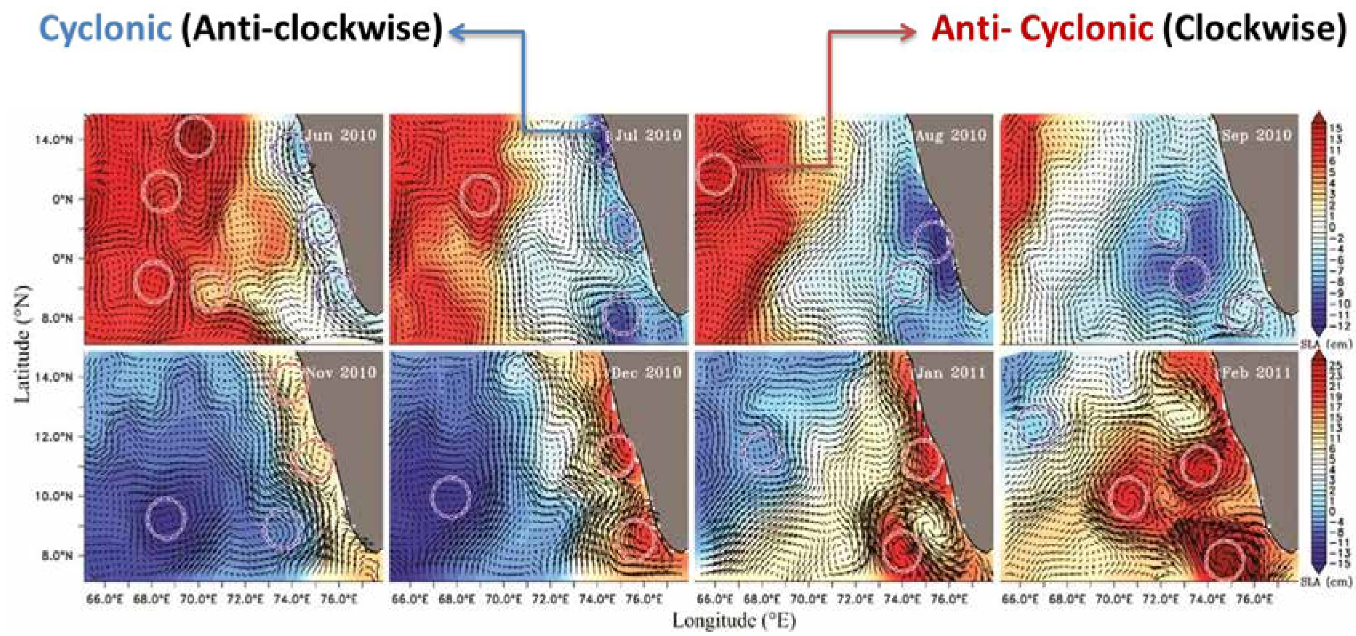
Dynamical consequences of oceanic mesoscale phenomena such as eddies, currents and fronts include perturbation of the chemical and biological environment that can dramatically impact biogeochemical cycling in the ocean. Mesoscale eddies are capable of mediating chlorophyll variability through physical-biological coupling. Satellite derived Sea Level Anomaly (SLA) and Chlorophyll-a (Chl-a) data for the period 2010- 2015 were utilised to pinpoint the occurrence of mesoscale eddies and associated Chl-a variability in the South Eastern Arabian Sea (SEAS). The Okubo-Weiss criterion was used for the identification and tracking of eddies from the said region. The results indicate the presence of cyclonic (cold core) and anti-cyclonic (warm core) eddies during the summer and winter monsoon seasons. The evolution of cyclonic and anti-cyclonic eddies in the SEAS were observed from the climatology map of SLA overlaid by geostrophic currents during the summer and winter monsoon season. Both cyclonic and anti-cyclonic eddies were identified and represented by dotted circles in the SLA map overlaid by geostrophic currents during the summer and winter monsoon season of 2010-2011. The Okubo–Weiss parameter distribution map confirmed the presence cyclonic and anti-cyclonic eddies along the coastal waters of SEAS. The variability of Chl-a was well evidenced in the presence of these eddies during the same period. The Chl-a map shows higher concentration over the cyclonic eddy region and lower concentration over the anti-cyclonic eddy region. We attempted to relate the evolution and propagation of mesoscale eddies to Chl-a variability, the overall importance of such features and their influence on biological production in the SEAS. Since the region is highly dynamic in terms of this study is initiated as a part of our research work

Monthly climatology map of SLA overlaid by geostrophic current.



Fisheries and Ecosystem Modeling

SLA overlaid by geostrophic current during summer (upper panel) and winter monsoon season (lower panel) of 2010-2011. Cyclonic and anti-cyclonic eddies are represented as black dotted circles.



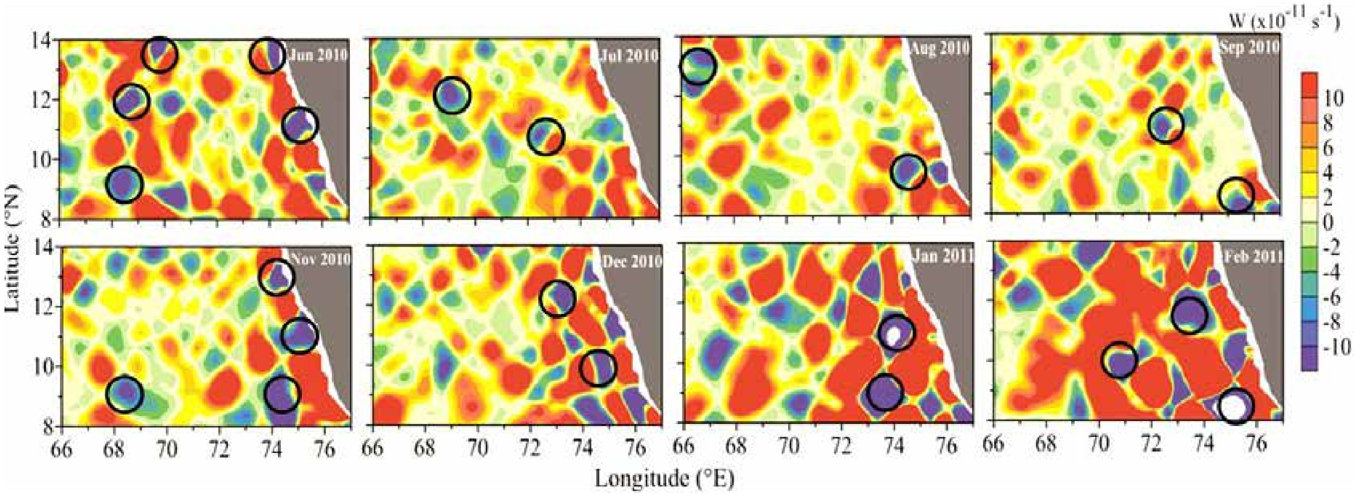
and needs further data analysis for better understanding of eddies and associated Chl-a variability in the SEAS.

Integrating optical classification and biodiversity community composition

The Copepod database from IIOE have been utilised to validate the optical classification of the Indian Ocean with biological information. The available decadal cruise datasets from the years 1962-1990 were compiled for the current study region. Similarly, distribution of dominant phytoplankton and zooplankton taxa such as Diatoms and Copepoda were mapped and sorted using Q-GIS mapping and Point sampling tool. The tool enables to collect raster values at each sampling point among the multiple layers. Using this tool, optical class-wise species abundance and distribution data was organised. In total 84 species of Diatoms and 109 species of Copepoda were sorted. Copepoda was noted to be showing high species diversity in Class 5 (140 species), Class 4 (97 species) and Class 3 (94 species). Diatoms was observed to be showing high species diversity in Class 3 (66 species), Class 2 (50 species) and Class 4 (40 species). On further, the correlation between the biomass of copepods and their distinctness to each class was studied in detail.

In total 109 species belonging to 3 orders, 24 families and 44 genera were present in the selected study region. Class 5 recorded with the highest species richness with 92 species followed by Class 3 (86 species) and Class 4 (78 species). Seven species were commonly distributed in all the eight classes. Eighteen species showed

Fisheries and Ecosystem Modeling



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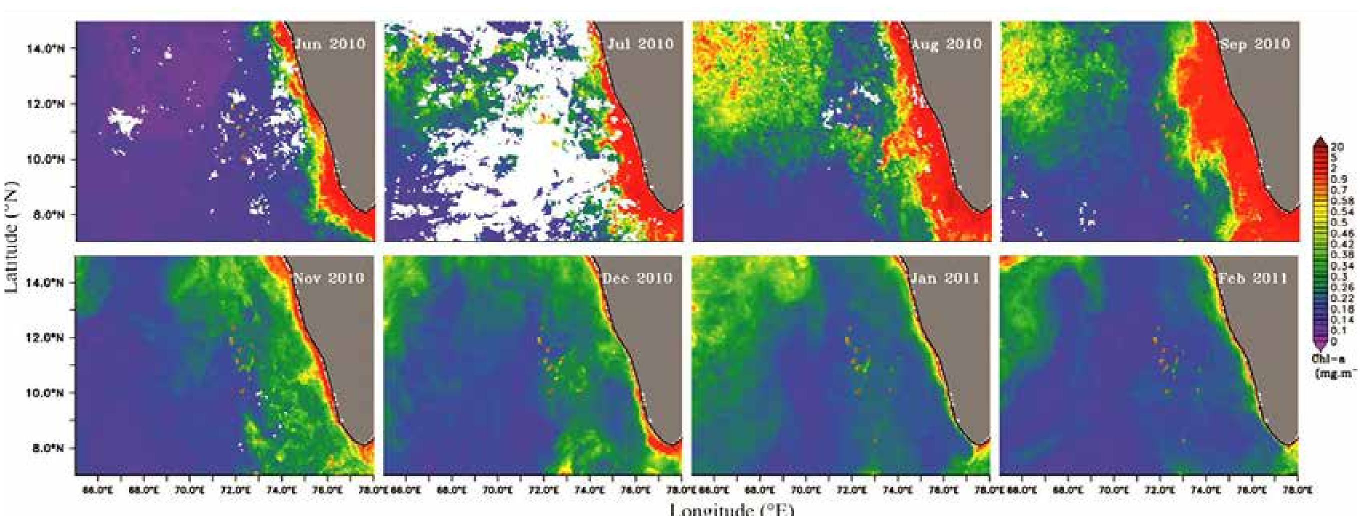


2

1. Okubo–Weiss parameter distribution during the summer (upper panel) and winter (lower panel) monsoon season of 2010-2011

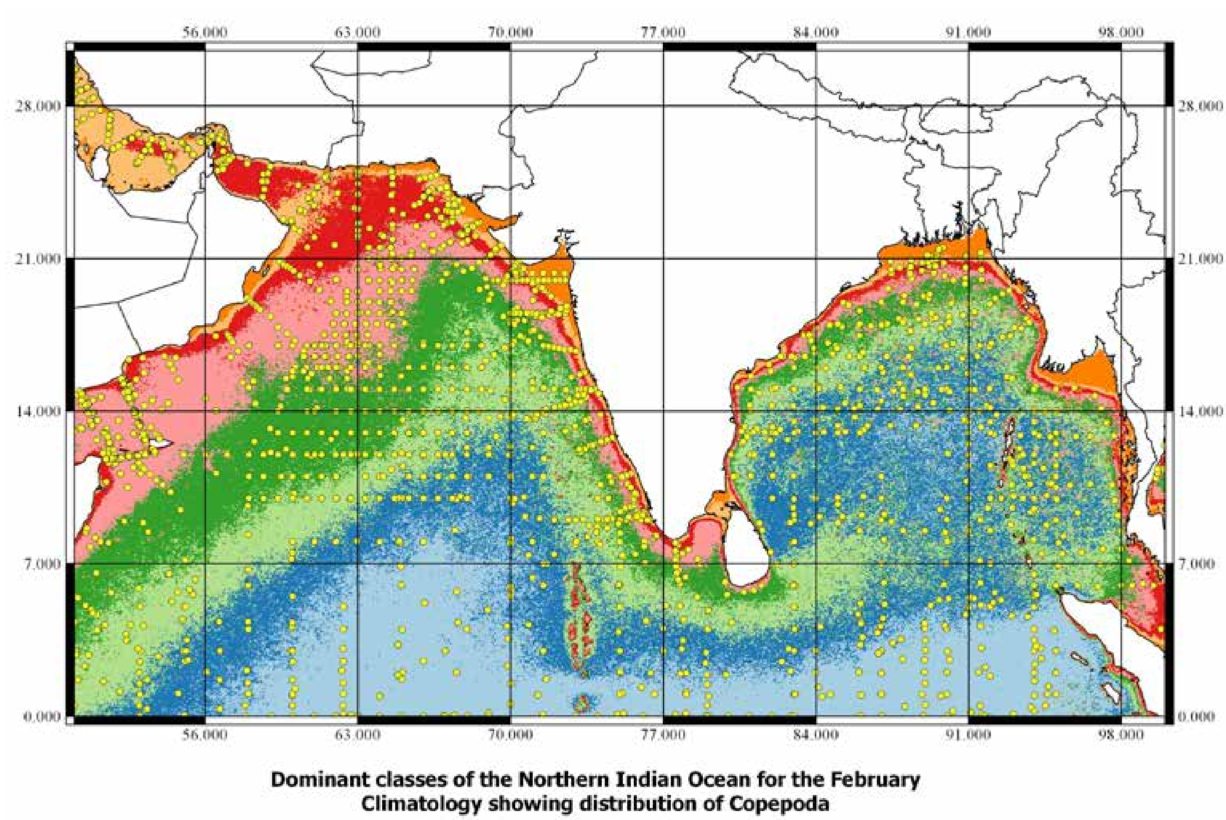
2. Chl-a concentration during summer (upper panel) and winter (lower panel) monsoon season of 2010-2011.

single area occurrence, of which Class 5 constitutes 50% of the species followed by Class 3 and Class 4 (17%). In general, Paracalanidae was the most diverse family representing 16 species followed by Candaciidae and Scolecitrichidae (10 species). Paracalanidae, Calanidae and Acartiidae were the most dominant families found with high species diversity in all the optical classes. Optical Classes 3, 4 and 5 was recorded to have high species richness when compared to other optical classes. The average taxonomic distinctness (Δ+) showed that the values for each optical class fell within the mean 95% confidence level. The values for classes 4 and 5 were below the mean value, indicating that the diversity in terms of taxonomic distinctness was generally lower than the expected. Based on different multivariate analysis such as Kulczynski presence/absence dissimilarity, Non-Metric Dimensional Scaling and Linear Discriminant factor analysis measures on the Copepoda abundance, Cluster 6 was most discriminant with 5 species, shows high distributional abundance and occurrence in all the optical classes. Eucalanus mucronatus, Eucalanus subcrassus, Paracalanus aculeatus, Parvocalanus latus, Undinula vulgaris are the species stands

Fisheries and Ecosystem Modeling

1. *Dominant Optical classes showing distribution of Copepoda.*
2. *The 95% confidence funnel showing the observed Δ+ values; middle line indicates the expected mean value.*
3. *Cluster analysis based on the Kulczynski presence/ absence dissimilarity for the species abundance data*

distinguished in the cluster 6. Cluster 2 appears to be with showing relatively less abundant species, occurrence in either one or one to four optical classes. More of single species occurrence was noted in cluster 2. Moreover, the cluster based on the dissimilarity matrix of the Copepoda abundance, Classes 3 and 5 forms a group at 15% similarity, whereas Class 4 and 7 showed similarity at 13%. Classes 3, 4, 5 and 7 are in turn was linked to the Class 8. In addition, indicator value analysis is yet to be studied to identify the degree to which a species is indicator of (the conditions found in) an optical class/ cluster. This will give us understanding on the spatial distribution of different taxa with respect to the optically distinct classes.



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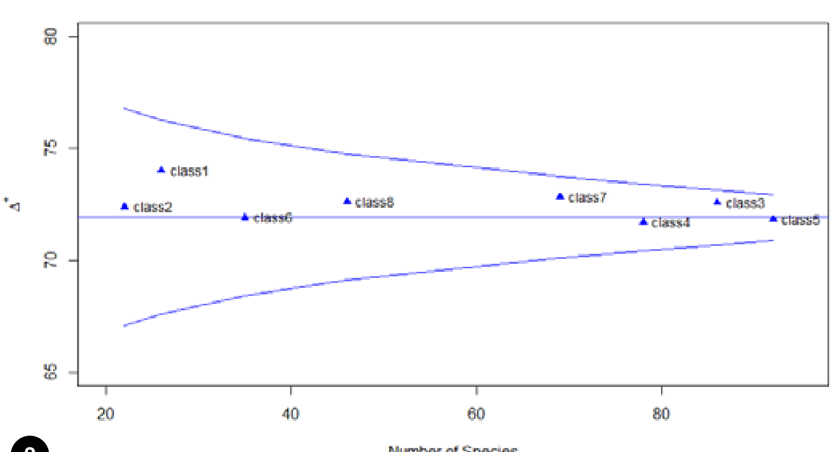

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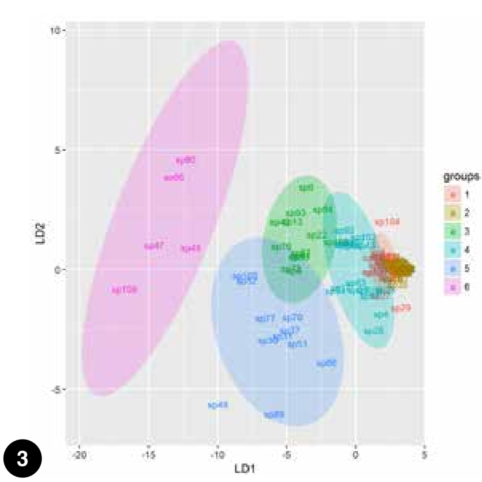


3

Sustainable Management of Fishery Resources

Gujarat is consistently leading in the marine fish production among all the maritime states in the country. With rich marine fish diversity and high productivity, the state produced diverse fishery resources.

Sustainable management of fishery resources: Gujarat

Gujarat

Research Project: DEM/RMS/09

786495t

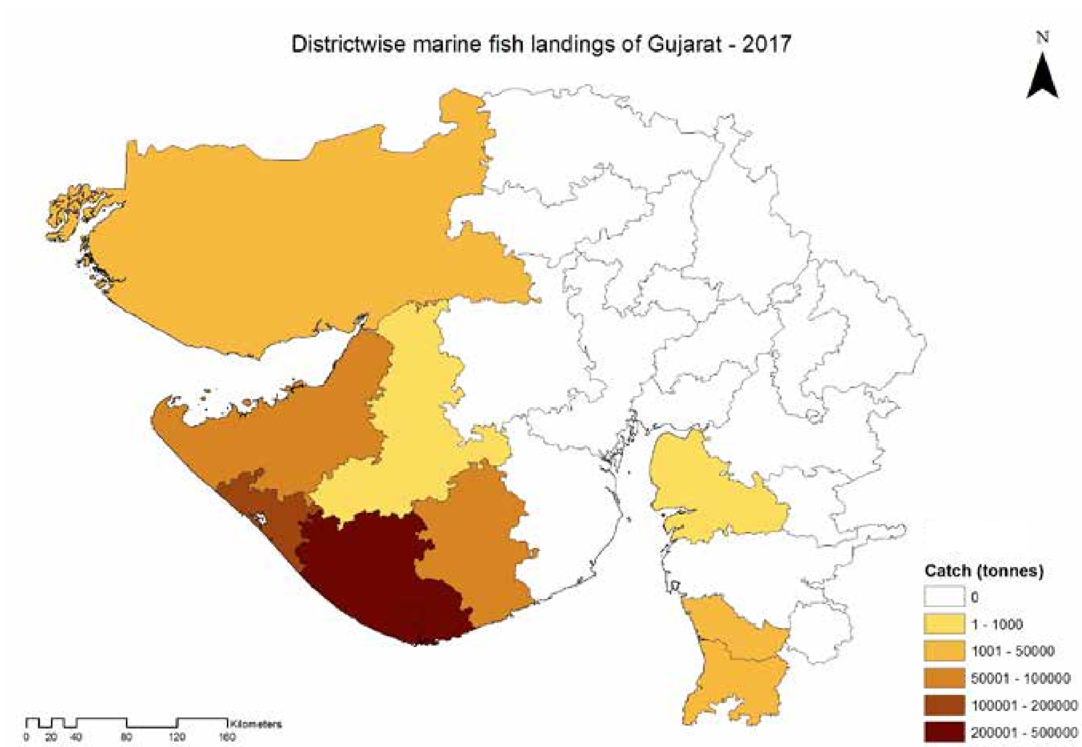
all-time high of annual marine fish landings in Gujarat, during 2017

In Gujarat, the annual marine fish landings during 2017 registered an all-time high of 786495 t. During 2016, the fish landings was 774373 t. Maximum catch and catch per unit effort was noticed during the post-monsoon and winter seasons, which are the peak fishing seasons along the Gujarat coast. Assemblage wise marine fish landings during 2017 showed the predominance of the pelagic finfish resources (36%), followed by demersals (30%), crustaceans (26%) and molluscan resources (8%). The increase in crustacean share was mainly due to the non-penaeid shrimps, followed by penaeid shrimps and crabs. District-wise, Gir-Somnath ranked first with 3.87 lakh t followed by Porbandar (1.25 lakh t), Amreli (0.96 lakh t), Junagadh (0.65 lakh t), Dev Bhoomi Dwaraka (0.62 lakh t), Kutch (0.26 lakh t), Valsad (0.10 lakh t), Navsari (10168 t), Jamnagar (2659 t) and Morbi (270 t).

Sector-wise, Gujarat showed the dominance of mechanised fishing vessels with a catch of 7.38 lakh t, followed by motorised (0.48 lakh t) and non-motorised vessels (87 t). Landings from mechanised sector were mainly contributed by multiday trawlers (MDTN), followed by mechanised gillnetters (MGN) and mechanised dollnetters (MDOL). Highest catch was landed from MDTN (4.04 lakh t), followed by MDOL (2.81 lakh t), OBGN (41345 t), MGN (27923 t) and MTN (18038 t). Catch per unit effort was maximum for MTN (86 kg h^{-1}), followed by MDOL (77 kg h^{-1}), MDTN (46 kg h^{-1}), OBGN (15 kg h^{-1}) and MGN (7kg h^{-1}).

Pelagic resources

Landings of pelagic fishes was 2.82 lakh t in 2017 contributing of 35.85% to the total marine fish landings of Gujarat. Dominant resources were ribbonfishes,



District-wise marine fish landings of Gujarat

Sustainable management of fishery resources: Gujarat

Belonids landed at Veraval fish landing centre

The state is known for production of high value fishery resources like seerfish, billfish, tuna, ribbonfish and dolphinfish

followed by Bombayduck, clupeids, seerfishes, tunas and carangids. The estimated catch of Bombayduck was 76573.87 t, recording a decrease of 18% over the previous year. Bombayduck landings formed 9.74% of the total and 27.16% of the pelagic landings. Mechanised dolnet was the major gear contributing nearly 95% towards Bombayduck landings. Ribbonfish with a landing of 113903.81 t (+19.19% over 2016) accounted for 14.48% of total and 40.4% of pelagic fish landings. Mechanised multi-day trawlers alone contributed 78.7% towards ribbonfish landings. Tunas formed 2.85% of pelagic and 1.02% of the total marine fish landings of Gujarat with a production of 8041.65 t, 24.84% lower than 2016. The dominant species landed was *Thunnus tonggol* (43.68%). Carangids were 27664 t with *Megalaspis cordyla* as major species (30.07%). Clupeids (28424.9 t), Indian mackerel (5628.14 t) and seerfishes (8762.68 t) were other important resources that contributed to the pelagic fish landings of Gujarat.

Biological parameters of selected pelagic resources of Gujarat during 2017

Species	Length range (mm)	L_{mean} (mm)	LC_{50} (mm)	Sex ratio (M:F)	Mature %	Fecundity range
R. kanagurta	289-173	242	244	0.89	64.59	21,930-5,570
H. nehereus	355-111	218	180	1.25	26.86	1,06,360-12,914
C. dussumieri	205-95	161	166	0.68	60	5,570-1,270
M. cordyla	460-207	325	316	1.33	60.64	99,594-9,060
T. lepturus	1182-416	673	668	1.46	62.15	2,47,504-45,296
S. guttatus	725-225	442	380	2.55	25.64	2,36,210-1,10,650
T. tonggol	855-310	554	464	3.07	28.07	5,50,960-1,50,532
E. affinis	790-300	512	454	1.79	77.03	8,04,710-5,95,220
C. hippurus	1390-510	835	601	1.21	100	2,90,302-1,25,630

Population and mortality parameters of selected pelagic resources of Gujarat during 2017.

Species	L_∞ (mm)	K	M	F	Z	E
R. kanagurta	307	0.8	1.52	2.2	3.72	0.59
H. nehereus	382	0.9	0.81	2.58	3.39	0.76
C. dussumieri	238	1.18	2.10	6.38	8.48	0.75
M. cordyla	511	0.75	1.26	3.1	4.36	0.71
T. lepturus	1300	0.3	0.53	1.08	1.61	0.67
S. guttatus	800	1.06	1.40	3.26	4.66	0.7
T. tonggol	952	0.3	0.58	0.75	1.33	0.56
E. affinis	815	0.66	1.02	1.19	2.21	0.54
C. hippurus	1490	0.36	0.3	0.66	0.96	0.69

Sustainable management of fishery resources: Gujarat

Seerfish landed at Bhidia fish landing centre

Demersal resources

Demersal fish landings contributed 227615 t, a decline of 5.18% from the previous year, and accounting for 28.9% of total fish landings of Gujarat. Maximum catch was contributed by trawlers (74.5%) followed by dollnetters (12.7%) and gillnetters (11.4%). Croakers were the most dominant group with a contribution of 19.67% to the demersal landings followed by bull's eye (15.57%), catfishes (13.29%), threadfin breams (12.47%) and rockcods (9.88%). September to March was the most productive period, contributing 88.2% to the landings. The croaker fishery was predominantly supported by *Johnius* spp. (54.4%) and *Otolithes* spp. (31%). Lizardfish landings were 14824 t, 33% lower than the previous year. Pomfrets increased in landings by 5.74% (8446 t) supported by silver pomfret (73.6%), black pomfret (19.5%) and chinese pomfret (6.9%). Total elasmobranchs landing in 2017 was 9468.5 t showing a decline of 46.6% from 2016. Elasmobranchs contribution was 4.16% of total demersal landings compared to 5.67% in 2016. Sharks contributed 65.1% towards total elasmobranchs landings, followed by rays (22.5%) and guitarfishes (13.4%). *Scoliodon laticaudus* is the most dominant shark species with a share of 93.1% (5764.2 t) against 82.3% in 2016. Multiday trawlers contributed maximum towards shark landings (38.8%), followed by multiday gillnetters (27.9%).

75%

catch was contributed by trawlers

Sustainable management of fishery resources: Gujarat

Growth, mortality and exploitation parameters of selected demersal species landed in Gujarat

Species	Length Range (mm)	L∞ (mm)	K (y^{-1})	Z (yr^{-1})	M (yr^{-1})	F (yr^{-1})	L_{c50} (mm)	E
Epinephelus diacanthus	513-86	590	0.61	2.6	1.05	1.55	146	0.59
Nemipterus japonicus	345-102	367.5	0.83	2.48	1.36	1.12	119	0.47
Priacanthus hamrur	415-110	461	0.63	2.98	1.16	1.82	183	0.4
Johnius glaucus	312-104	335.9	0.4	2.09	0.66	1.43	184	0.69
Otolithes cuvieri	354-145	387.5	0.85	3.18	1.48	1.7	215	0.53
Saurida tumbil	610-145	627.9	0.6	1.93	1.03	0.9	253	0.47
Pampus argenteus	239-59	270	0.58	2.42	0.95	1.47	104	0.61
Parastromateus niger	515-97	584	0.58	2.71	1.03	1.68	188	0.62
Scoliodon laticaudus	596-222	702.5	0.48	3.36	0.86	2.5	374	0.74
Rhinobatos annandalei	886-205	980	0.26	1.17	0.53	0.64	519	0.55

Reproductive parameters of selected demersal species landed in Gujarat

Species	L_{min} (mm)	$L_{m\,50}$ (mm)	Peak recruitment	Peak spawning	Av. Fecundity
Epinephelus diacanthus	207	270.7	Mar-Jul	Sep-Nov	78500
Nemipterus japonicus	140	212.1	Feb-Apr, Aug-Oct	Oct-Nov	87403
Priacanthus hamrur	161	215.3	Jul-Oct	Sep-Oct	69173
Johnius glaucus	134	203.1	Mar-Sep	Sep-Nov	35867
Otolithes cuvieri	155	257.9	Jun-Sep	Sep-Dec	81789
Saurida tumbil	220	310.8	Apr-Aug	Nov-Dec	95489
Pampus argenteus	108	180.3	Mar-Jun, Sep-Oct	Nov-Jan	42860
Parastromatus niger	204	339.1	Apr-Sep	Oct-Dec	759826
*Scoliodon laticaudus**	246	400.8	Aug-Nov	Oct-Dec	10
*Rhinobatos annandalai**	505	578	Oct-Dec	Oct-Dec	9

**Average number of pups*

Female guitarfish carrying developing pups with yolk

Sustainable management of fishery resources: Gujarat

Non-penaeid shrimps are unique and key resources along the region, which contributes maximum (19%) to the total Gujarat fish catch and mostly used in fish meal production

19.4%

increase in Crustaceans landings

Crustacean resources

Crustacean resources contributed 1.97 lakh t accounting for 26% of total fish landings of Gujarat during 2017. Crustaceans recorded an increase of 19.4% compared to the previous year. Non-penaeid shrimps were the major component with a contribution of 75.4% to the total crustacean landings followed by penaeid shrimps (17.9%), crabs (4.5%), stromatopods (1.7%) and lobsters (0.5%). The prominent gears contributing to the crustacean landings were dollnets (75.2%) and trawlers (22.3%). Non-peaneids accounted for 3/4th of the crustacean landings with an increase of 25.4% compared to 2016. *Acetus* spp. was the most dominant group with 63% of total crustacean landings. Non-penaeids were mainly exploited by dolnetters (89.2%) followed by trawlers (9.6%). Penaeid shrimps landing was 35287 t which is marginally higher (+6.2%) than 2016. Among penaeid shrimps, *Parapenaeopsis stylifera* was the dominant species forming 7.9% of the total crustacean landings. Crab landings was 8980 t which is slightly lower (-7.5%) than 2016. Among edible crabs, *Charybdis feriatus* dominated (15.9%) followed by *Portunus pelagicus* (11.4%) and *Portunus sanguinolentus* (8.6%). Lobsters with a landing of 1032 t were nearly 0.5% of total crustacean landings, with slight decline of 5.5%. *Panilurus polyphagus* (84.3%) was the dominant lobster species landed followed by *P. homarus* (7.1%). Lobsters were mainly exploited by mechanised gillnetters (43.4%) followed by multiday trawlers (31.8%). Stomatopod landing was 3278 t, 54% higher than 2016.

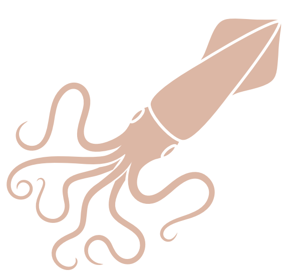
Growth, mortality and exploitation pattern of selected crustaceans landed along Gujarat

Species	Length Range (mm)	Lα (mm)	K (y^{-1})	Z (y^{-1})	M (y^{-1})	F (y^{-1})	E	L_{c50}
P. monodon (F)	133-369	383.3	1.03	4.1	1.69	2.41	0.59	19.4
P. monodon (M)	128-338	360.0	1.11	4.29	1.82	2.47	0.58	18.2
P. semisulcatus (F)	122-249	265.2	1.38	5.85	2.26	3.59	0.61	14.4
P. semisulcatus (M)	121-239	255.7	1.45	5.95	2.38	3.57	0.60	14.2
M. affinis (F)	71-198	212.8	1.51	6.35	2.48	3.87	0.61	10.3
M. affinis (M)	71-179	190.5	1.62	6.66	2.66	4.00	0.60	10.8
M. monoceros (F)	112-259	271.5	1.40	5.33	2.30	3.03	0.57	11.9
M. monoceros (M)	103-239	126.3	1.47	5.87	2.41	3.46	0.59	12.5
S. crassicornis (F)	56-139	147.5	1.28	4.84	2.10	2.74	0.57	76.5
S. crassicornis (M)	51-119	126.3	1.35	4.41	2.21	2.2	0.50	69.4
P. stylifera (F)	64-159	175.4	1.70	6.58	2.79	3.79	0.58	86.7
P. stylifera (M)	62-153	160.0	1.90	6.65	3.12	3.53	0.53	84.0
P. sanguinolentus (F)	55-156 (CW)	167.0	1.48	5.21	2.43	2.78	0.53	81.3
P. sanguinolentus (M)	52-149 (CW)	161.0	1.50	4.99	2.46	2.53	0.51	65.7
P. polyphagus (pooled)	75-329	369.5	0.35	1.48	0.57	0.91	0.61	133.2

Sustainable management of fishery resources: Gujarat

Biological parameters of selected crustacean resources landed in Gujarat

Species	Peak recruitment	L_{min} (mm)	L_{m50} (mm)	Peak spawning	Major prey
P. monodon (F)	Mar-May				
P. monodon (M)	Apr-Jun	11.8	135.5	Dec-Jan	Decapods, gastropods, teleost
P. semisulcatus (F)	Jun-Jul				
P. semisulcatus (M)	Jun-Jul	10.1	119.1	Oct-Dec	Decapods, zooplankton, gastropods
M. affinis (F)	Mar-May				
M. affinis (M)	Jul-Sep	8.1	108.8	Oct-Jan	Decapods, protists, zooplanktons
M. monoceros (F)	Jun-Jul				
M. monoceros (M)	Jun-Jul	10.2	107.9	Nov-Dec	Decapods, teleost, protists
S. crassicornis (F)	Jun-Aug				
S. crassicornis (M)	Apr-Jul	56	77.7	Oct-Jan	Decapods, zooplankton, gastropods
P. stylifera (F)	Jun-Sep				
P. stylifera (M)	Jun-Sep	67	83.6	Sep-Dec	Decapods, zooplankton, protists
P. sanguinolentus (F)	Jun-Jul				
P. sanguinolentus (M)	Mar-Jun	65	90.2	Nov-Feb	decapods, gastropods, teleost
P. polyphagus (pooled)	Jul-Sep	148	170.3	Nov-Dec	decapods, gastropods, teleost



Molluscan resources

Cephalopods wer the major molluscan resource landed in Gujarat with landings of 61688 t in 2017 contributing 7.84% to the total marine landings. Major groups were cuttlefishes (53.86%) followed by squids (45.42%) and octopus with a meagre contribution (0.72%). Cuttlefish fishery was dominated by *Sepia elliptica,* followed by *Sepia pharaonis, Sepiella inermis, Sepia prashadi, Sepia omani* and *Sepia kobiensis. Uroteuthis (Photololigo) duvaucelii* contributed maximum to the squid landings followed by *Uroteuthis (Photololigo) singhalensis*. Species-wise contribution of cephalopods showed the dominance of Indian Squid, *U. (P.) duvaucelii*, followed by *Sepia pharaonis, Sepia elliptica*, *U. (P.) singhalensis* and octopus. Diet components of the major cephalopods showed finfish as preferable food item followed by shrimps, crabs and molluscs. Multiday trawlers contributed maximum towards cephalopod landings followed by mechanised trawlers, mechanised gillnetters, motorised gillnetters and mechanised dollnetters.

Fishery and reproductive parameters of major cephalopods landed in Gujarat

Species	Length range (mm)	Mean Length (mm)	Sex Ratio (M:F)	Mature (%)	L_{c50} (mm)	L_{m50} (mm)
U. (P.) duvaucelii	40-250	107.5	1:0.7	85.96	115.5	113.2
U. (P.) singhalensis	67-268	159.51	1:0.6	91.50	126.4	122.5
Amphioctopus mambranaceus	40-270	78.9	1:0.7	60.30	-	-
Sepia elliptica	50-215	111.31	1:0.5	53.70	106.2	103.0
Sepia inermis	32-143	63.65	1:1.05	42.25	63.2	61.5
Sepia omani	30-111	76.43	1:0.48	24.56	-	-
Sepia pharaonis	128-362	223.92	1:0.82	26.31	178.5	171.0

Sustainable management of fishery resources: Maharashtra

Maharashtra

Research Project: CFD/RMS/13

30%

Increase in the annual marine fish landings during 2017

Estimated marine fish landings of Maharashtra during 2017 was 3.81 lakh t with 30% increase from the previous year (2.92 lakh t). Pelagic resources contributed major share with 39%, followed by demersal fishes (29%), crustaceans (21%) and molluscs (10%). Major gears that supported the fishery were trawlnet (57%), bagnet (20%), purseseines (18%) and gillnet (5%).

Prominent species/groups in the fishery were penaeid shrimps (10.8%), non-penaeid shrimps (9.9%), Indian mackerel (9.8%), croakers (9.6%), squids (7.3%), threadfin breams (7.2%) and Bombayduck (7.1%)

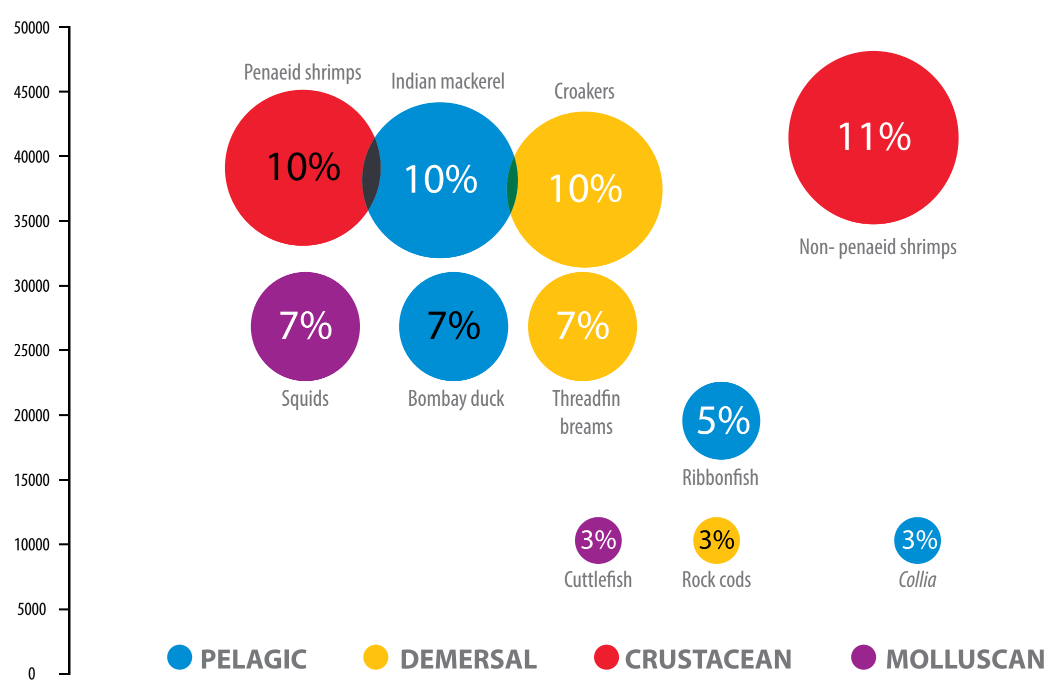
Catch rate in purseseines remained the highest (178.1 kg h^{-1}). In trawls, CPH was 33.7 kg h^{-1} and CPUE for gillnet was 87.8 kg $unit^{-1}$. Landings of hilsa shad, flying fishes, rockcods, snappers, pig-face breams, bull's eye, frigate tuna, unicorn cod and cuttlefish increased significantly in comparison to the previous year.

Pelagic resources

Pelagic fishery contributed 39% to the total marine catch in Maharashtra. Catch increased from 1,19,855 t (2016) to 149535 t due to increase in landings of Indian mackerel, Bombayduck, carangids and ribbonfish. Major gear contributing to the pelagic fishery were purseseine (40%), trawlnet (35%), dolnet (17%), gillnets (8%) and others (1%). Indian mackerel formed 26% of the pelagic fish landings of which 77.26% was from purseseines followed by trawl (12.62%) and gillnets (9.7%). Bombayduck (19%), carangids (14%), ribbonfish (13%), anchovies (7.9%) and oilsardine (6%). Tunas contributed 1.21% of the total catch where 63.94% was contributed by *E. affinis* followed by *T. tonggol* (10.67%), *T. albacares* (8.81%), *Auxis thazard* (10.93) and *Auxis rochei* (5.62%). Seerfish formed 4.7% of the total pelagic catch with *S. commerson* (68.36%) and *S. guttatus* (31.63%) forming the fishery. *Coryphaena hippurus* landings was 568 t and *Coilia dussumieri* contributed 2.9% (11,093 t).

Demersal resources

Demersal fish landings were estimated at 1.09 lakh t (43% increase compared to the previous year 76203.4 t in 2016) which formed 28.7% of total production. Croakers (33.5%) were the most dominant



Top ten species landed during 2017

Sustainable management of fishery resources: Maharashtra

Landing of U. (P) duvaucelii at New Ferry Wharf, Maharashtra

Pelagic fishery resources contributed 39%, demersal 29%, crustaceans 21% and molluscs 10% to the total marine landings

group among demersal fishes which formed 96% of the catch from trawls. Dominant species in trawl fishery was *Johnius borneensis* (=*J. vogleri*) (27.8%), *J. macrorhynus* (25.5%), *Otolithes cuvieri* (23.7%), *Otolithoides biauritus* (11.8%), *J. sina* (3.3%) and *J. glaucus* (3.4%). Threadfin breams contributed 25.2% to demersal fishes followed by rockcods (9.7%), catfishes (8.4%) and soles (3.8%). Pomfret catch was 4133 t, with silver pomfret forming 64.1% (2648 t), Black pomfret 31.7% (1312 t) and chinese pomfret 4.2% (172 t). Catch of rockcods, snappers, pigface breams, threadfin breams, silverbellies and soles increased significantly (>80% from 2016). Trawlers contributed 82.3% to the demersal fish landings, followed by purse seiners (7.3%), gillnetters (5.1%) and bag netters (5.1%).

Crustacean resources

Crustacean resources formed 21.6% (81802.8 t) of the total marine fish landings of Maharashtra, an increase of 22.3% over the estimated crustacean landings of 2016. Major contributors were penaeid shrimps 37,642 t (46%), non-penaeid shrimps 41,296 t (50.5%), crabs 1,439 t (1.8%), stomatopods 1,055 t (1.3%) and lobsters 370 t (0.5%). They were mainly landed by dolnetters (52.1%) and trawlers (47.6%) with a catch rate of 24.10 kg h^{-1} and 6.06 kg h^{-1} respectively.

Molluscan resources

Molluscan resources Cephalopod landing was 38410 t forming 10% of the total fish landing with 48% increase compared to previous year. Trawlers contributed 91% of total cephalopod landing (35061 t) with a catch rate of 5.46 kg h^{-1}. Indian squid, *Uroteuthis (Photololigo) duvaucelii* dominated with landings of 23260 t followed by cuttlefishes *Sepia pharaonis* (3963 t), *Sepiella inermis* (2460 t), *U. (P.) edulis* (2120 t), *Sepia elliptica* (1491 t), *U.(P.) singhalensis* (658 t), *Loliolus (L.) hardwickei* (402 t) *Sepia aculeata* (322 t), *Sepia prashadi* (125 t), *Cistopus indicus* (172 t) and *Amphioctopus neglectus* (83 t). Cephalopod catch by trawlers increased by 37.62% and catch rate by 30.55% from previous year.

Biology of major species

***Sardinella longiceps*:** Size range observed was 100-204 mm. Mature and gravid sardines were observed from November to December. Copepods, tintinnids, foraminifera and plankton

Sustainable management of fishery resources: Maharashtra

43%

catch was contributed by trawlers

like *Coscinodiscus* sp., *Thalassiothrix* sp., *Asterionella* sp., *Skeletonema* sp., *Dinophysis* sp., *Planktoniella* sp., *Biddulphia* sp. and *Eucampia* sp. were the major food items. Juvenile contribution was 54.31% of oilsardine catch.

***Coilia dussumieri*:** Mean size was 154 mm with mode 155-159 mm. Sex ratio was observed to be 1:0.82. Gravid and mature specimens were seen during August to December. Major food items comprised *Acetes*, shrimps, copepods, *Pyrophacus*, tintinnids and crustaceans.

***Rastrelliger kanagurta*:** Size range observed was 120-289 mm. Mean size was 202 mm with mode 200-204 mm. Sex ratio observed was 1:1.17. Females were in mature and gravid condition during May to December. Gut content analysis showed dominance of copepods, *Coscinodiscus*, Foraminifera, *Pleurosigma, Biddulphia*.

***Harpadon nehereus*:** Ranged from 135 to 359 mm in total length and the recorded mode was 255-269 mm. Gravid females were noticed during September to December. Sex ratio was observed to be 1:2.17. Main diet components were *N. tenuipes* (78.5%), *C. dussumieri* (17%.) and *Exhippolysmata ensirostris* (2.3%). Juveniles formed 13% in trawls.

***Trichiurus lepturus*:** Size range observed was 470-969 mm with mean size of 694 mm. Sex ratio was observed to be 1:1.04. Females were in mature and gravid condition during July to August and December to May. Gut content analysis showed presence of *Acetes* spp. (80%), *Loligo* spp. (6.8%) and carangids (8.4%). In trawls 16% juveniles were caught.

***Scomberomorus guttatus*:** Size range observed was 210-649 mm and mean size was 378 mm. Juveniles formed 48% of total catch.

***Sphyraena putnamae*:** Ranged between 240-809 mm Females in mature and gravid stages were noticed in May and September. Gut content analysis showed presence of *Loligo* spp. (91.5%) *M. codyla* (4.6%) and *S. aculeata* (3.8%) as the major food items.

***Chirocentrus nudus*:** Length mode was 401-420 mm. Main food items in their gut were fish (100%). Sex ratio was 1:0.62. In the analysed specimens, 80% were mature.

***Ablennes hians*:** Length mode was 821-840 and 841-860 mm. Sex ratio was 1:0.28. Mature specimens were observed in September.

***Otolithoides biauritus*:** Size ranged between 110-1100 mm with a mean size of 419 mm. Heavy landing of juveniles was observed during October-November.

***Johnius borneensis*:** Fishery had a size range of 70-280 mm, gravid females were dominant during November-January, diet was dominated by crustaceans.

***Nemipterus japonicus*:** Size ranged from 40-300 mm with a mean size of 143 mm. High proportion of mature fishes were observed during September-December.

Uroteuthis (Photololigo) duvaucelii: Size ranged from 20 to 330 mm DML with mean length of 130.9 mm (DML). Mainly fed on fish, crustaceans, squids and *Nemipterus* sp. Sex-ratio was 1:0.65. Maximum number of mature and gravid female were observed in October.

***Sepia pharaonis*:** Size varied from 100 to 400 mm DML with mean length of 318.4 mm (DML). Diet mainly consisted of fish, shrimps and crabs and digested matter. The sex-ratio was 1:0.4. Mature females were observed during November-December.

***Sepia elliptica*:** Size ranged from 40 to 180 mm DML with mean length of 113.1 mm (DML). Mainly fed on fish, shrimps and crabs. Sex-ratio was 1:0.52. Mature females were observed during December.

***Sepiella inermis*:** Size range was from 20 to 80 mm DML with mean length of

Sustainable management of fishery resources: Maharashtra

In experimental dolnet fishing, plastic litter accounted for 10% of the catch

48.9 mm (DML). Gut content was mostly fish and crustacean parts. Sex-ratio was 1:0.7. Mature females were observed during October.

***Cistopus indicus*:** Size range varied from 40 to 220 mm DML with mean length of 99.4 mm (DML). Gut content was mostly fish parts. Sex-ratio was 1:0.7. Mature females were observed during August.

Fishery environmental monitoring

Regular time series oceanographic measurement of selected environmental parameters from PFZ and adjacent grounds off Mumbai coast and Ratnagiri were undertaken. In addition, regular monitoring of selected environmental parameters from 3 creeks and 4 nearshore stations along the Mumbai coast were done. Environmental changes were monitored during pre-monsoon, monsoon and post-monsoon Season. Fifteen synoptic fishing surveys were undertaken off Mumbai up to 30 m depth and off Ratnagiri up to 40 m depth.

Experimental Dolnet fishing: Twenty two single day bagnet fish samples were analysed from two selected stations off Mahul. Net immersion period was 3 h. Pelagics contributed 40% to the annual catch, followed by crustaceans (27%), demersals (23%) and molluscs formed less than 1%. Plastic litter formed 10% in bag net fish catch.

Experimental trawl catch off Ratnagiri

Karnataka and Goa

Research Project: PEL/RMS/03

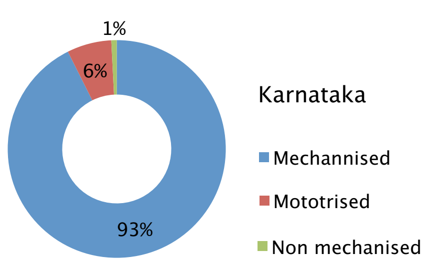
Total marine landings in Karnataka and Goa increased by 3.5% and 63.7% respectively. Mackerel dominated in Karnataka and oil sardine in Goa.

Total estimated marine fish landings in Karnataka (547784 t) and Goa (61219 t) registered 3.5% and 63.7% increase respectively during 2017 as compared to the previous year. The landings during the year in Karnataka was 12.7% higher and in Goa it was 3.7% less as compared to the five year (2013-2017) average landings The landing in Karnataka during the year was valued at ₹5573 crores.

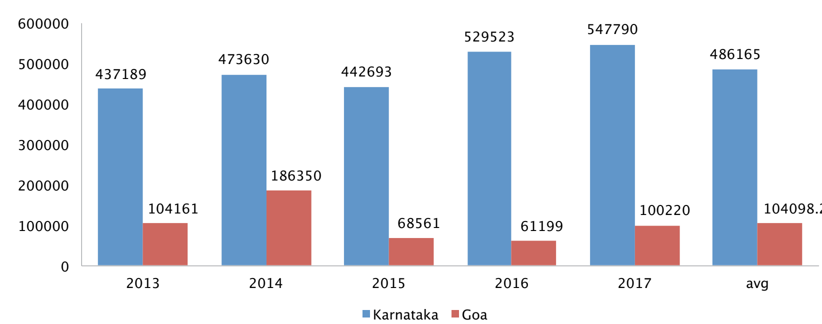
Mechanised sector comprising mainly trawlers and purseseiners was the major contributor to the catch in both the states.

Fishery and biology of 48 species landed were studied in detail. In Karnataka, rapid stock assessment of the major groups/species indicated that 21 were in abundant state, 18 in less abundant state and 16 in declining state. In Goa, none of the species was abundant, 5 species were

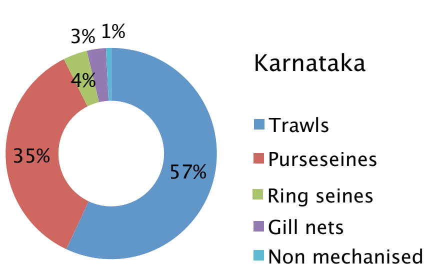
Contribution (%) of different sectors and gears to the total landings in Karnataka



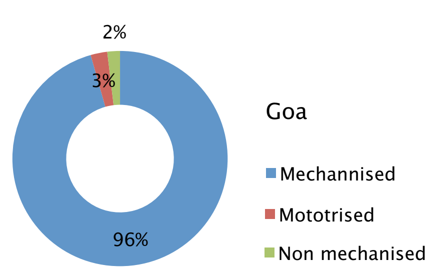
Trends in annual total marine fish landings in Karnataka and Goa



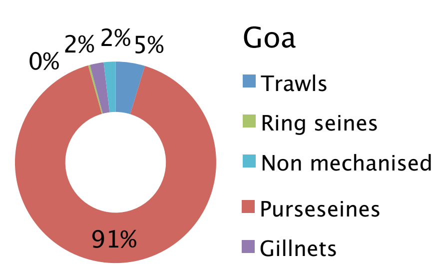
Contribution (%) of different gears to the total landings in Karnataka



Contribution (%) of different sectors and gears to the total landings in Goa



Contribution (%) of different gears to the total landings in Goa



Sustainable management of fishery resources: Karnataka and Goa

Length range, mean lenght and sex ratio of important resources studied

Species	Length range (cm)	Mean length (cm)	Sex ratio (Male:Fenale)
Pelagic fishes			
*S. longiceps**	9.0-21.0	15.4	1:0.98
*S. fimbriata**	11.5-20.9	18.6	1:1.93
*S. gibbosa**	12.5-19.4	15.6	1:0.95
*S. albella**	18.0-18.7	18.5	1:0.33
*S. brachysoma**	14.1-19.5	16.6	1:1.50
*R. kanagurta**	3.4-33.8	18.2	1:0.83
*T. lepturus****	2.2-59.0	23.0	1:0.88
*E. devisi**	4.0-11.5	8.2	1:0.82
*E. thoracata**	7.2-12.7	9.2	1:0.90
*M. cordyla**	8.0-48.5	20.0	1:0.69
*D. russelli**	3.5-28.7	15.3	1:0.62
*S. nigrofasciata***	12.2-57.5	28.0	1:1.29
*R. canadum***	24.0-84.0	42.0	1:0.98
*S. commerson***	34.0-90.0	51.0	1: 1.5
*S. guttatus***	32.0-54.0	38.0	1:1.7
*E. affinis***	28.0-70.0	41.0	1:1.16
*A. thazard***	32.0-46.0	37.0	1:1.2
*A. rochei***	22.0-38.0	45.0	1:0.7
*T. tonggol***	38.0-67.0	41.0	1:0.5
*T. albacares***	66.0-80.0	42.0	1:0.9
*S. orientalis***	40.0-48.0	45.0	1:1.4
*S. obtusata***	14.0-34.0	24.0	1:0.9
*S. putnamae***	24.0-58.0	42.0	1:0.7
*S. jello***	20.0-130	38.0	1:0.5
*S. commersonianus***	26.0-94.0	45.0	1:1.2
*S. tol***	22.0-58.0	28.0	1:1.3
*S. tala***	22.0-44.0	32.0	1:0.7
*S. lysan***	30.0-48.0	39.0	1:2.6
*C. hippurus***	28.0-96.0	59.0	1:1.27
*A. hains***	64.0-110.0	81.0	1:0.7
*T. crocodilus***	68.0-118.0	73.0	1:2.0
*E. bipinnulata***	45.0-54.0	47.0	1:3.0
Demersal fishes			
*N. japonicus**	3.0-28	16.8	1:0.7
*N. randalli**	4.0-36.0	12.2	1:0.7
*L. lactarius**	5.0-28.0	14.6	1:0.8
*P. argenteus**	8.0-41.0	21.1	1:0.4
*P. niger**	10.0-57.0	25.4	1:0.6
*L. inermis**	13.0-43.0	28.0	1:0.9
*O. cuvieri**	10.2-41.7	20.1	1:2.3
*O. ruber**	6.0-39.0	23.0	1:2.2
*S. tumbil**	8.0-52.0	25.0	1:1.9
*S. undosquamis**	10.0-34.0	17.9	1:1.5

Sustainable management of fishery resources Karnataka and Goa

Species	Length range (cm)	Mean length (cm)	Sex ratio (Male:Fenale)
*P. hamrur**	7.0-33.0	22.7	1:1.4
Crustaceans			
Shrimp			
*M. dobsoni**	4.1-12.5	8.5	1:1.4
*P. stylifera**	5.1-11.5	9.1	1:0.9
*M. monoceros**	9.1-18.5	13.3	1:1.3
*S. choprai**	5.1-11.5	7.6	1:1.4
Crabs			
*P. sanguinolentus**	4.1-15.0	10.0	1:1.1
*P. pelagicus**	4.6-15.0	10.4	1:0.6
*C. feriatus**	4.1-12.0	7.7	1:1.9
Cephalopods			
Squids			
U. (P.) duvaucelii	3.5-35.0	12.9	
U. (P.) singalensis	5.0-29.5	13.8	
U. (P.) edulis	3.0-37.5	11.8	
Cuttlefish			
S. pharaonis	8.0-39.0	21.4	
S. elliptica	4.5-15.5	9.2	
S. vecchioni	5.0-18.0	13.0	
S. inermis	3.0-11.5	6.5	
S. trygonina	3.0-11.5	7.3	
Octopus			
A. neglectus	2.0-10.0	5.4	

*Total length, **Fork length, ***Anal length, for Cepahalopods-Mantle length

Yield, standing stock and spawning stock biomass of important species studied

Speceis	Yield(t)	Standing stock biomass (t)	Spawning stock biomass (t)	Recruitment (Nos.)	% SSB
S. longiceps	98082	7072	14209	10824400	30.19
R. kanagurta	119527	53198	34037	6156412000	63.98
E. devisi	3848	4359	1723	14262597000	39.53
D. russelli	29724	28962	8162	3834740000	28.18
M. cordyla	5349	2202	752	131889000	33.20
T. lepturus	24055	22715	15668	593277000	68.90
S. commerson	7059	1074	236	1276000	21.84
E. affinis	8379	5400	2941	19692000	54.48
A. thazard	936	435	311	3806000	71.49
S. obtusata		707	142	22556000	20.13
S. putnamae	3057	1057	199	15241000	18.74
S. commersonianus	1111	6716	3701	7936000	55.16
S. tol	959	914	621	16164000	67.97
R. canadum	635	206	64	849993	30.80
C. hippurus	733	345	264	13280000	76.52
N. japonicus	10136	10077	6264	1435927	62.16

Sustainable management of fishery resources: Karnataka and Goa

Speceis	Yield(t)	Standing stock biomass (t)	Spawning stock biomass (t)	Recruitment (Nos.)	% SSB
N. randalli	17967	8044	1660	1091426	20.64
L. lactarius	970	762	462	101475	60.63
P. argenteus	2467	4894	2065	36201	42.19
P. niger	987	34994	20404	75568	58.31
O. cuvieri	735	1955	1507	55762	77.08
O. ruber	1034	2661	1538	61122	57.80
S. tumbil	5927	11600	8040	126516	69.38
S. undosquamis	6459	13688	10240	205081	74.81
P. hamrur	60279	73923	42198	1698288	57.08
M. dobsoni	1452	2311	1572	2626690	68.05
P. stylifera	1694	1088	455	1357051	41.73
M. monoceros	1472	1453	967	360935	66.55
S. choprai	1086	417	319	451951	76.50
C. feriatus	1672	261	111	178477	42.53
P. pelagicus	2338	1525	887	145365	58.16
P. sanguinolentus	2591	1424	935	128004	65.70

less abundant state and the rest of the species studied were in declining state.

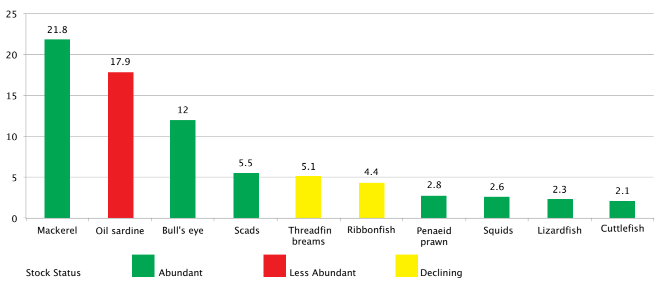
Pelagic resources continued to be the dominant group in both states followed by the demersal fishes, crustaceans and molluscs.

Pelagic resources

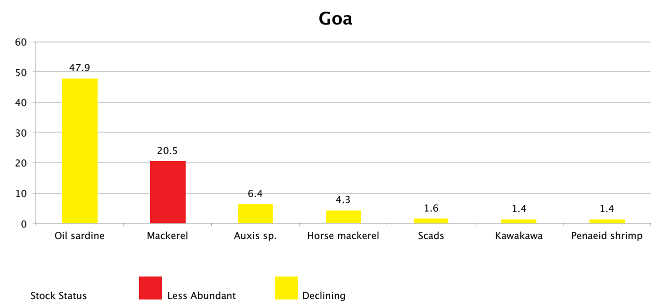
Pelagic fishes contributed 350037 t forming 63.9% of the total landings in Karnataka registering 24.5% increase than 2016.

Sustainable management of fishery resources Karnataka and Goa

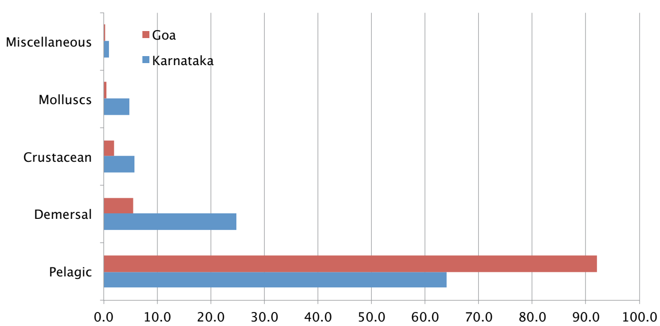
Contribution (%) and stock status of dominant resources in Karnataka



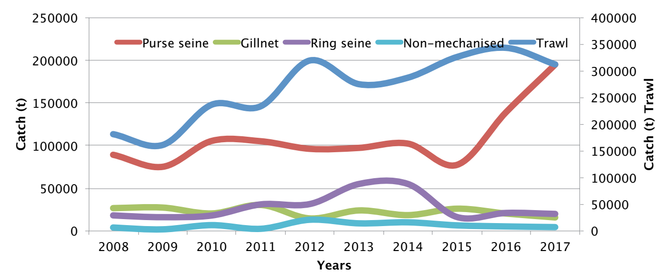
Contribution (%) and stock status of dominant resources in Goa



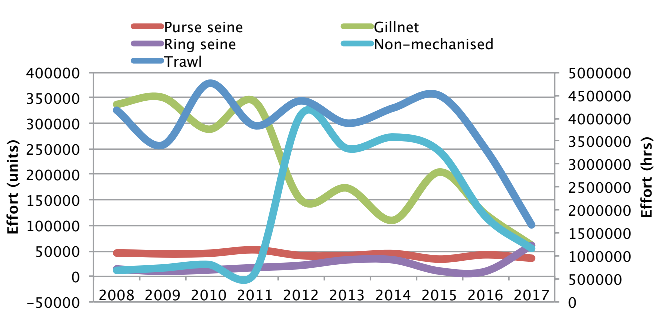
Contribution (%) of pelagic, demersal, crustacean and molluscs in Karnataka and Goa



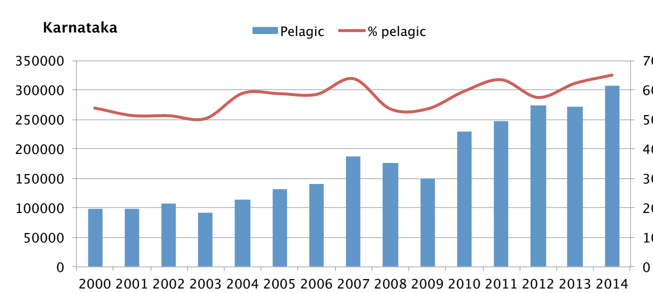
Decadal trends in marine fish landings by different gears in Karnataka



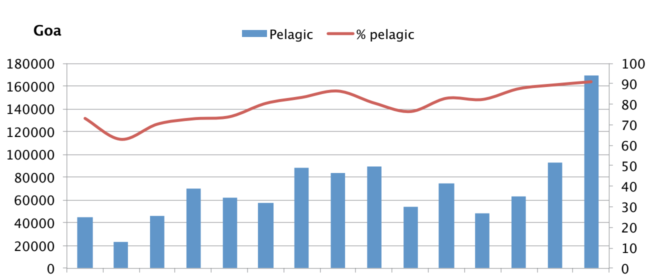
Trends in effort expended by different gears in Karnataka



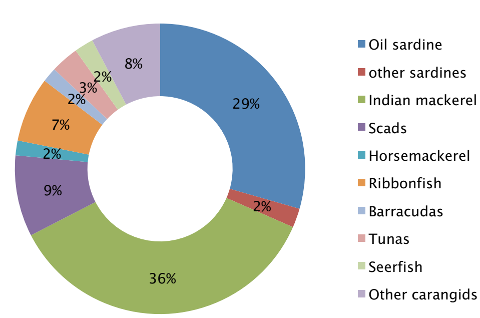
Annual trends and % contribution of pelagic fishes to total landngs in Karnataka



Annual trends and % contribution of pelagic fishes to total landngs in Goa



Major pelagic fishes (%) landed in Karnataka



Sustainable management of fishery resources: Karnataka and Goa

In Goa, pelagic fishes with an estimated landing of 92145 t formed 91.9% of the total catch.

Major groups that constituted the pelagic resources were the clupeids (sardines, shads and anchovies), scombroids (mackerel, tuna and seerfish), carangids (scads, horsemackerel, black pomfret and other carangids), ribbonfish, barracudas and fullbeaks.

Demersal resources

Demersal fishes with an estimated catch of 135136 t formed 24.7% of the total catch in Karnataka and 5.6% (5572 t) in Goa. Catch declined by 28.5% as compared to the previous year.

In the demersal catch, perches including *Nemipterus* spp. contributed 71 % of the catch followed by lizard fishes (10%), croakers (5%) and soles (3%).

Composition (percentage) of juveniles and adults of dominant demersal species landed in Karnataka was estimated using the Minimum Legal Size (MLS).

Crustacean resources

Crustaceans formed 5.6% (30798 t) of the total marine landings of Karnataka and was 11% more than that recorded in the previous year. Shrimps (15489 t), crabs (6916 t), stomatopods (8390 t) and lobsters (3 t) contributed to the catch.

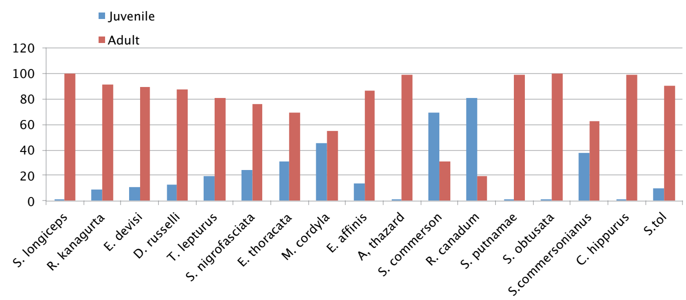
Cephalopod resources

Cephalopod production from Karnataka was estimated at 26,129 t during the year 2017. The resource constituted 4.8% of the total marine fish production of the State. Total cephalopod production by all gears in Karnataka registered 1.8% decrease as compared to previous year's production of 26,604 t.

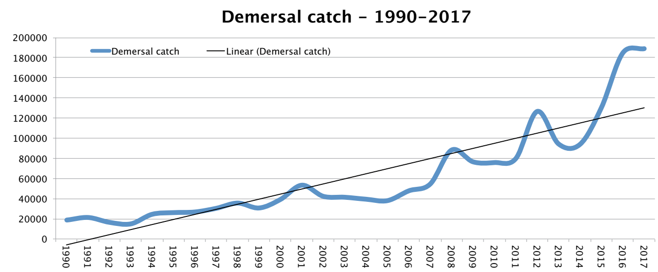
Squids dominated the cephalopod fishery. Proportion of squids in the total

Sustainable management of fishery resources Karnataka and Goa

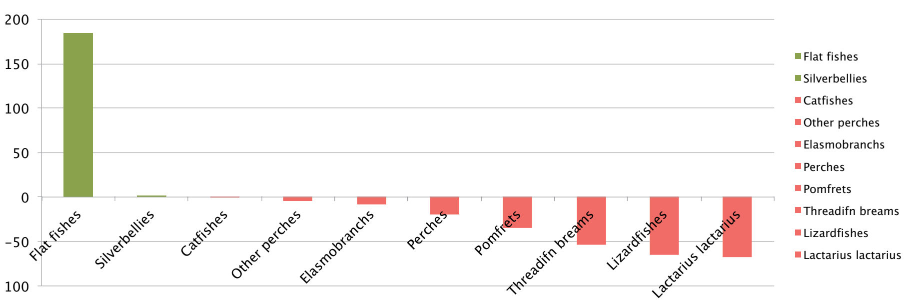
Composition (%) of juveniles and adults of pelagic fishes landed in Karnataka



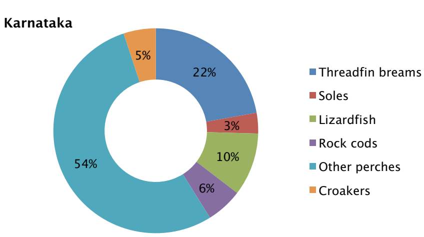
Trends in landing of demersal fishes along Karnataka



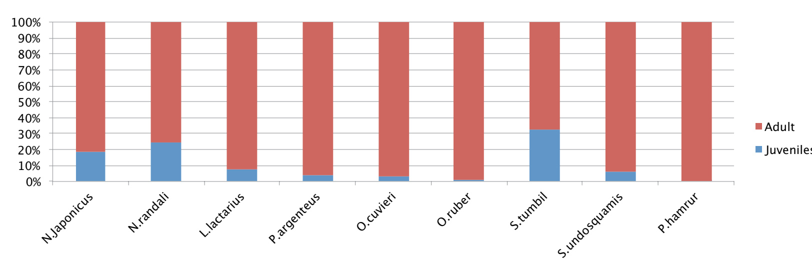
Increase/decrease (%) in landings of major demersal groups in Karnataka during 2017 as compared to 2016



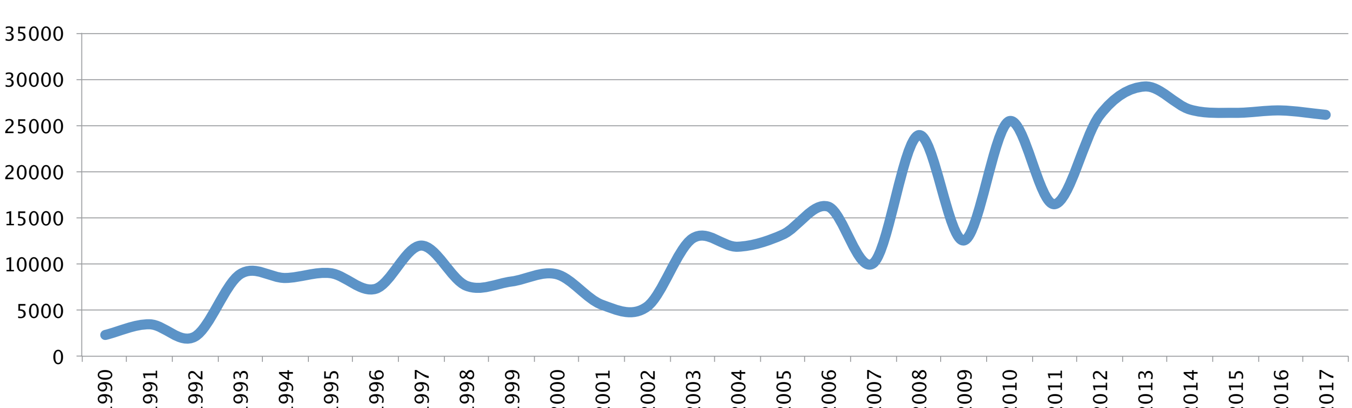
Dominant demersal species landed in Karnataka



Composition (%) of juveniles and adults of important demersal fishes landed in Karnataka



Trends in cepahalopod landings of Karnataka



Sustainable management of fishery resources: Karnataka and Goa




cephalopod production increased from 48% in 2016 to 55.1% in 2017, while, the cuttlefish fraction remained at 43% in 2016 and 2017. Octopus proportion decreased from 8% in 2016 to 1.4% in 2017.

Cephalopod production from Goa was estimated at 470 t during 2017. Cephalopods constituted 0.5% of the total marine production from Goa. Total cephalopod production by all gears, except purse-seines, registered decreasing trend compared to 2016 (740.6 t). Squids dominated the cephalopod fishery (91%) followed by cuttlefish.

Coastal water health monitoring

In-situ water quality of selected purseseine fishing grounds was analysed. Significant difference in nitrate level was recorded between the types of fishing (purse seine during day, during full moon, nights and fishing with artificial lights. Levels of pH, salinity, nutrients (phosphate, silicate, nitrite, nitrate), Chlorophyll (a, b, c)-TSS and ammonia were 8.2, 32.4 ppt, 2.6 μg at l^{-1}, 1.819 μg at l^{-1}, 0.187 μg at l^{-1}, 0.771 μg at l^{-1}, 43.11 mg l^{-1}, 1.14 mg m^{-3}, 0.143 mg m^{-3}, 0.82 mg m^{-3} and 0.166 μg at l^{-1} respectively.

Sustainable management of fishery resources: Kerala

Kerala

Research Project: DEM/RMS/07 & DEM/RMS/SUB/07

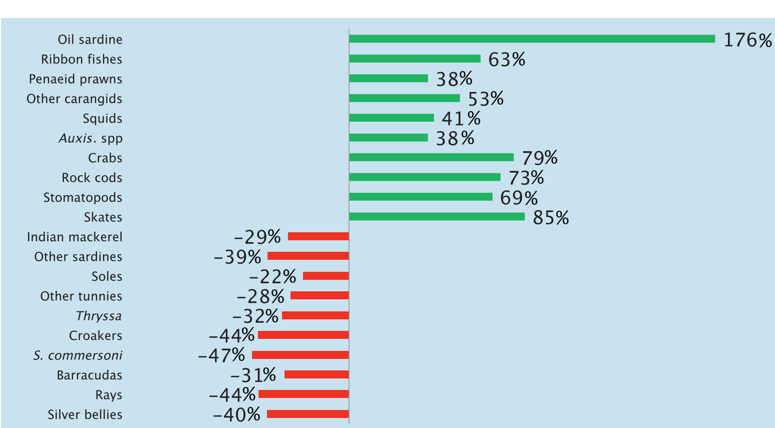
10.4%

Increase in Marine fish landings compared to previous year.

Total marine fish landings in Kerala during 2017 was 5.85 lakh tonnes, which was 10.4% higher than that of 2016. Estimated landings of pelagic finfishes in Kerala during 2017 was 360148 t which formed 62% of the total catch. Demersal finfishes constituted 21.1% with an estimated landing of 123462 t. Crustacean resources contributed 9.2%, followed by cephalopods (7.4%).

Oilsardine: Oilsardine fishery in Kerala showed revival with an estimated landing of 127000 t in 2017 compared to that of 43492 t in 2016, which showed three- fold increase. Mechanised ring seine accounted for 71% of the landings followed by outboard ring seines (22%). Size range of 95 -220 mm occurred in the catches with bulk of the catches in the 140–180 mm size groups. Monthly mean size ranged from 130 -167 mm indicating sustainable exploitation with fishes above the size at first maturity. Fishes below MLS formed <0.1% of the numbers caught. Peak spawning season was during April-June indicating an early spawning and recruitment process. Stock assessment of oil sardine along the Kerala coast indicated that the stock had fallen below MSY levels due to a combination of adverse environmental factors in 2013 and intense fishing pressure during 2009-2012.

Variation in the landings of some of the major resources of Kerala during 2016 and 2017 period.



Mackerel: Mackerel landings showed a decline of nearly 30% (33336 t) compared to the previous year. Multiday trawls and ring seines contributed 28% and 32% respectively. Size range of 135–295 mm occurred in trawls with 180–240 mm forming the major fishery sizes exploited. In ringseines, the size range was 95 -265 mm with 145–240 mm forming the major fishery size group. Peak spawning was during March to April. Catches below MLS were negligible.

Carangids: Carangids represented 13.1% of the total marine fish landings of the state with an estimated landing of 77161 t. Fishery was supported by 23 species,

Sustainable management of fishery resources: Kerala

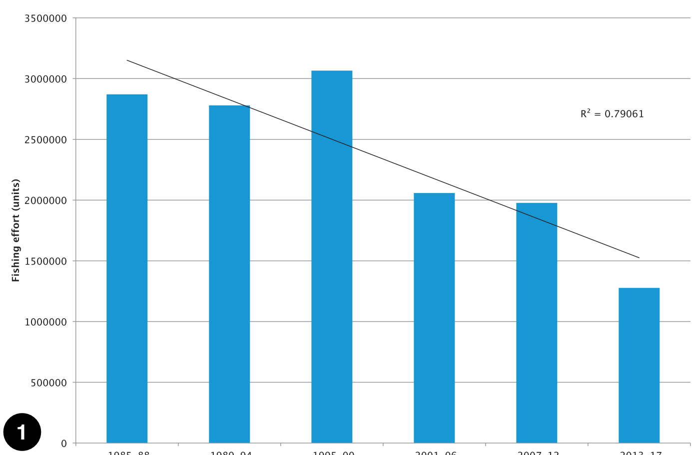
Elasmobranchs formed 0.9% of total marine fish landings and 4.2% of demersal landings of Kerala

of which 11 are commercially important. Major component of carangid catch was scads (63.6%). *Decapterus* sp. dominated in the landings with a share of 81.3%. Size range of *Alepes djedaba* landed in trawl nets was 104-267 mm with a mean size of 204 mm.

Seerfish: Seerfish landings during 2017 was 3741 t, Fishery was supported by four species with king seer, *Scomberomores commerson* (90%), followed by *S. guttatus, Acanthocybium solandri* and *S. lineolatus*. Length of *S. commerson* landed in trawls and ringseines ranged from 194-640 mm and that landed in gillnets and hooks and line comprised of large fishes in the range of 600-1720 mm.

Tuna: Tuna landings declined during the year with an estimated catch of 22587 t. They were caught mainly by drift gillnets and hooks and line. Nine species (five neritic and four oceanic) supported the fishery. Coastal species constituted 53.5% of the tuna catch and was dominated by yellowfin tuna (29.3%) and kawakawa (29.2%). Stock assessment indicated that neritic species were exploited fully or beyond the optimum level.

Elasmobranchs: A total of 5184 t of elasmobranchs were landed in all gears during 2017, which formed 0.9% of the total marine fish landings and 4.2% of demersal landings of the state. Sharks contributed 56.6% of total elasmobranchs (2936 t), followed by rays (40.4%) and



1. *Changes in fishing effort (units) expended along the coast of Kerala during 1985-2017.*
2. *Landings of billfishes at Cochin Fisheries Harbour*
3. *Sharks landed at Cochin Fisheries Harbour*

Sustainable management of fishery resources: Kerala

44%

decrease in landings of croakers as compared to previous year

guitar fishes (3%). More than 25 species of sharks were observed in the landings, of which *Carcharhinus falsciformis* (46%) was the dominant one with a mean length of 153 cm., followed by *C. longimanus* (12%), *Sphyrna lewini* (9%), *C. leucas* (5%), *Galeocerda cuvier* (5%), *C. limbatus* (3%), *Isurus oxyrhynchus* (3%) and *Alopias pelagicus* (3%). The catch rate of sharks landed in multiday hooks and line and multiday gillnet units ranged from 41 (September) to 1399 kg unit^{-1} (June) with average annual catch rate of 267 kg unit^{-1}.

Threadfin breams: With annual landings of 41,841 t, they formed 34% of the total demersal finfish landings of the state. The dominant species was *Nemipterus randalli* (73%) followed by *N. japonicus* (24%) and *N. bipunctatus* (3%). Mean length of *N. randalli* was 149 mm and that of *N. japonicus* was 179 mm.

Groupers: An estimated 4319 t of groupers were landed in 2017. Trawlers contributed 66%, gillnet 21% and hooks and line 6%. April to June is the spawning period for both *Epinephelus diacanthus* and *E. longispinis* and new recruits entered the fishery in October. About 80% of the *E. areolatus* in the fishery in the size range 201-400 mm and were immature. Size range of *E. diacanthus* in the catch was 120-530 mm.

Croakers: Landings of croakers was 4886 t, 44% lower than that of the previous year. In *Otolithes ruber*, the breeding period coincided with the post- monsoon period and the young recruits were seen in the fishery during pre-monsoon period. Spawning period also coincided with the presence of large sized fishes in the commercial catch (181-290 mm).

Lizardfishes: Estimated landing was 16371 t which formed 3.1% of the total marine fish landings of Kerala. Fishery occurred throughout the year with peak landings during August (17.7%). *Saurida tumbil* dominated with 60% followed by *S. undosquamis* (38%) and *Trachinocephalus myops* (2%). Annual mean length of *S. tumbil* was 355 mm and that of *S. undosquamis* was 213 mm.

Silver pomfret: Estimated catch was 689 t, which was 39% lower than that of the previous year. Peak landing was observed in post-monsoon season with highest contribution by multiday trawl units. Size range of *Pampus argenteus* landed ranged from 65-325 mm with a mean size of 160 mm.

Exploitation status of major fishery resources of Kerala

Resource	Stock Status
Oilsardine	Declining
Indian mackerel	Declining
Ribbonfishes	Declining
Indian scad	Less abundant
.*Stolephorus* sp	Declining
Threadfin breams	Declining
Rockcods	Declining
Whitefish	Declining
Silver pomfret	Declining
Lizardfishes	Abundant
Croakers	Declining
Soles	Declining
Penaeid shrimps	Less abundant
Crabs	Less abundant
Squids	Less abundant
Cuttlefishes	Less abundant

Sustainable management of fishery resources: Kerala

1. *Juvenile octopus landed at Cochin Fisheries Harbour*
2. *Shrimp harvest by OB-ring seine units in the mudbank fishery at Chettuva Fisheries Harbour*

1

2

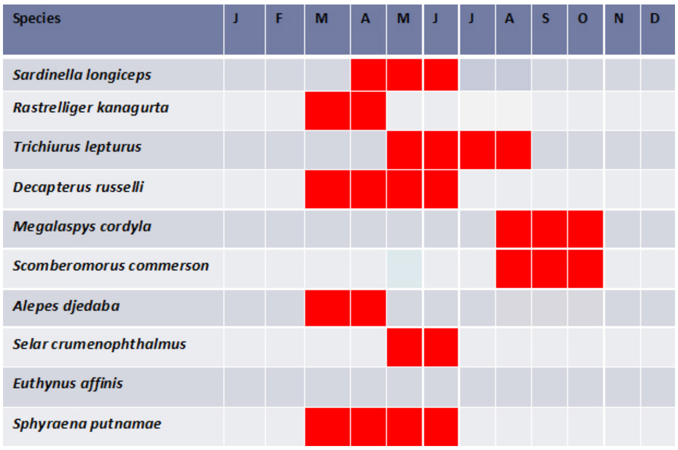
Inceased landings in all maritime states except in Tamil Nadu. Cyclone Ockhi affected fishing in Kerala during the last quarter of the year. Diversity in the resources landed high for Tamil Nadu and Kerala

Crustaceans: Estimated landings of crustaceans was 53,913 t which was 94% higher than the previous year. About 81% of the catch was contributed by penaeid shrimps, followed by crabs (9.5%) and non-penaeid shrimps (6.9%). *Metapenaeus dobsoni* formed 57.7%, followed by *Parapenaeopsis stylifera* 7.2%. Mean Length of *M. dobsoni* females ranged from 70-78 mm and that of males were 72-98 mm. Among *P. stylifera* females, the mean length ranged from 67.7 to 98.8 mm and that of males from 63.7 to 85.3 mm. Species composition in deep sea shrimps showed dominance of *P. quasigrandis* (31.7%) followed by *H. chani* (27.8%). Crabs recorded an annual landing of 4183 t by trawlers, showing an increase of 93% compared to 2016. Multiday trawlers contributed 79% of the crab landings and single day trawlers 21%. *Portunus sanguinolentus* dominated the total landings with 2119 t.

Cephalopods: Estimated landings of cephalopods was 42,313 t , which showed an increase by 20.2% compared to the previous year. Peak landings was observed during August-September. Squids (51.80%) were dominant followed by cuttlefishes (36.3%) and octopuses (11.9%). The mean length of the squid *U. (P.) duvaucelii*, was marginally below the optimum length of capture. Cuttlefish *S. pharaonis* was exploited at 16.2% below the optimum length of capture (Lopt) during 2016-2017. In the case of major species of octopus, *A. neglectus*, the mean lengths was close to the L_{opt}.

Karikkadi fishery: Investigation on the spatial distribution and seasonal migration of Karikkadi (*Parapenaeopsis stylifera*) along the Kerala coast was carried out by undertaking five experimental cruises. *P. stylifera* was observed in the catch during the months of March, July, October,

Sustainable management of fishery resources: Kerala



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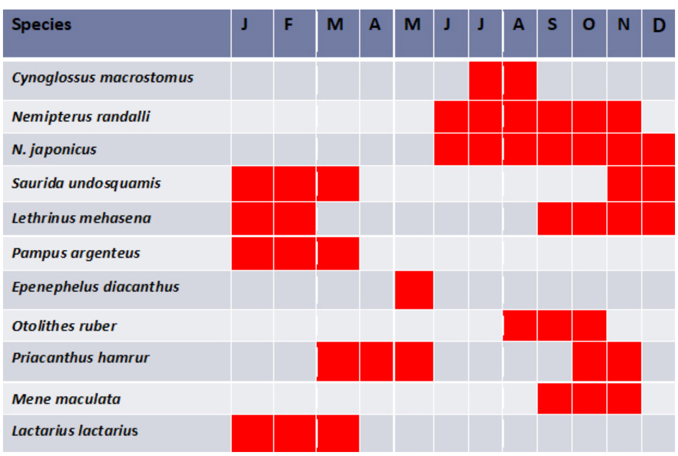

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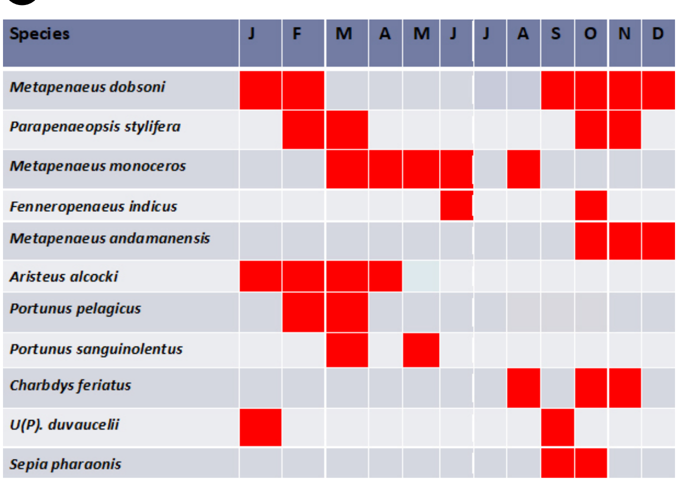


3

1. *Spawning period of major pelagic finfish resources along Kerala coast*
2. *Spawning period of major demersal finfish resources along Kerala coast*
3. *Spawning period of major crustacean and molluscan resources along Kerala coast*

January and February with females dominating in the catch. Dominance of mature specimens was observed at 13-25 m depth.

Environmental parameters: Selected environmental parameters and chlorophyll, were studied. Seawater temperature off Kochi varied from 25-30°C in the surface and 23.6-31.2°C in the bottom with a mean of 27.94°C and 27.33°C respectively. Delta T, varied from 2.6°C to 2.0°C, with a mean of 0.47°C. This was in concordance with the LTA plot off Kochi (with a positive value of 1), indicating peak upwelling in August 2017. Mean phytoplankton biomass was also maximum in January 2017 (162250 cells l^{-1}), the dominant species present being *Pleurosigma* spp.

Impact of Ockhi cyclone: Direct impact of *Ockhi* cyclone in the fishery was reflected in the seasonal marine fish landings of Kerala. Marine fish landings during the cyclone period was 35465 t lower than that of the previous year, i.e., 31% decrease in landings compared to the previous year. Due to the loss of fishing days during the cyclone by 46% compared to the last year, the landings share during the above period was decreased. Economic loss due to the cyclone was estimated at ₹585 crores at landing centre level and ₹821 crores at retail level.

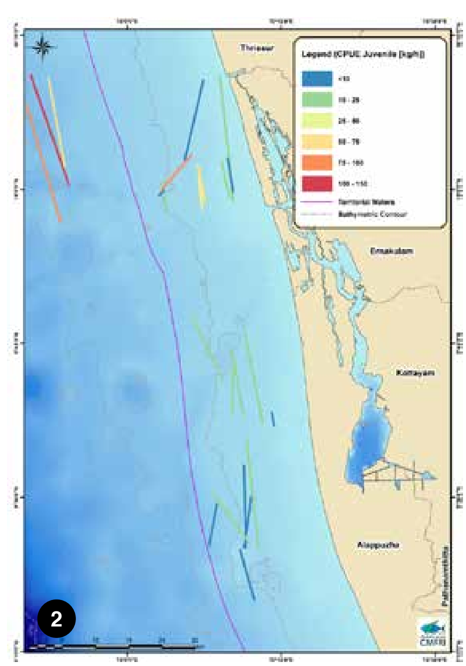
Price behaviour and economic valuation: Gross value realised at landing centre level increased to ₹9,652 crores in 2017 from ₹9,149 crores in 2016. At retail level, the gross value realised was ₹1,3536 crores in 2017. Among mechanised fishing units, the highest gross income and net operating income were recorded for multiday trawlnets with Chinese engine. But low capital productivity and high input-output ratio indicates high input cost in this sector. At landing centre level, the lowest prices were recorded for oilsardine (₹55 /kg) and highest for black pomfrets (₹420/kg). Fishermen's share in the consumer rupee varied from 55% for oilsardine to 84% for snappers and jumbo tiger shrimps.

Sustainable management of fishery resources: Kerala

Direct impact of Ockhi cyclone in the fishery was reflected in the seasonal marine fish landings of Kerala

Impact of Juvenile fishing: Even after the implementation of MLS regulations in the state, considerable landings of juveniles (60-80%) of certain commercially important species (*Nemipterus randalli, Epinephelus diacanthus, Saurida undosquamis*) by mechanised trawlers, were observed during the post ban period of 2017. Incidence of juvenile harvest was more for the species with lower differential ratio for juvenile and adult fish prices. Economic loss due to juvenile fishing of important resources was estimated using the bio-economic model and that for *N. randalli* was estimated at ₹221 crores during 2017.

Spatiotemporal mapping of juvenile grounds off Kerala was carried out using experimental trawling using CMFRI research vessel *FV Silver Pompano* as well as using the data collected by fishermen participatory mode. The highest average juvenile occurrence (67%) was observed during January to March and the lowest (38%) was during October to December. The species-wise data were plotted in GIS platform to enable identification of the juvenile grounds along the coast.



1. *Landings of juvenile threadfin breams and lizardfishes at Munambam Fisheries Harbour*
2. *Spatio-temporal map of juvenile fishing grounds along the coast of Kerala*

Tamil Nadu & Puducherry

Research Project: DEM/RMS/08

655090 t

Total marine fish landings in Tamil Nadu during 2017

Tamil Nadu: Total marine production in Tamil Nadu during 2017 was 6.55 lakh t, registering a decrease of 7% compared to previous year. Maximum contribution was from Ramanathapuram (29.3%) followed by Kanyakumari (22.5%) and Cuddalore (14.4%). Single day mechanised trawlers contributed 56.5% of the total landings, followed by multiday trawlers (17.5%) and together formed 74% of the total landings. Other major contribution was from motorised gillnets (15.8%). Pelagic finfishes formed 51.9%, demersal finfishes 32%, crustaceans 6.5% and cephalopods 9.6%. The effort expended by trawlers showed a drastic reduction in nine districts compared to previous year. The percentage varied from 1.6 to 65.2% in single day trawlers (MTN) whereas in multiday trawlers (MDTN), it

Sustainable management of fishery resources: Tamil Nadu & Puducherry


Fishery resources that formed ≥1% in the landings

Tamil Nadu	
Pelagics	**% in Total catch**
Other sardines	16.9
Oilsardine	7.9
Carangids	7.3
Barracudas	2.6
Indian mackerel	3.4
Tunas	2.8
Stolephorus	2.1
Thryssa	1.4
S. commerson	1.2
Ribbonfishes	1.1
Demersals	**≥**
Silverbellies	11.7
Other perches	4.2
Threadfin breams	3.2
Pig-face breams	2.3
Croakers	2
Goatfishes	1.7
Crustaceans	
Penaeid shrimps	3.5
Crabs	2.6
Molluscs	
cephalopod	9.6

Sustainable management of fishery resources: Tamil Nadu & Puducherry

District-wise landings, dominant gear and percentage contribution

Resource	Catch(t)	Major District	% contribution	Major gear	% contribution
Other sardines	110193	Ramanathapuram	54.8	Trawl	93.0
Oilsardine	51716	Ramanathapuram	46.5	Trawl	100
Barracuda	16730	Kanyakumari	53	Trawl	93.5
Indian mackerel	21928	Kanyakumari	25.5	Trawl	82.3
		Cuddalore	22.4	OBGN	71.6
Tuna	18098	Kanyakumari	38.6	MDTN	50.6
		Chennai	327	MGN	95.4
S. commerson	7886	Cuddalore	39.1	OBGN	92.9
Stolephorus	13789	Cuddalore	54.9	Trawl	99.5
Ribbonfishes	7075	Cuddalore	35	Trawl	81.5
		Chennai	31.3	Trawl	96.7
Thryssa	7381	Cuddalore	46.1	OBGN	58.8
Carangids	48173	Kanyakumari	37.3	Trawl	81.6
Croakers	13164	Ramanathapuram	47.1	Trawl	96.8
Goatfishes	11223	Kanyakumari	39.7	Trawl	97.3
Other perches	27121	Kanyakumari	41.4	Trawl	91.1
Pig-face breams	15137	Kanyakumari	46.3	OBHL	61.8
Silverbellies	76221	Ramanathapuram	64.6	Trawl	99.2
Threadfin breams	20705	Kanyakumari	59.9	Trawl	93.0
Penaeid shrimps	23159	Nagapattinam	28.9	Trawl	97.0
		Cuddalore	22.2	Trawl	97.6
Crabs	17276	Cuddalore	20.6	Trawl	83.9
		Nagapattinam	19.5	Trawl	75.2
		Ramanathapuram	16.5	OBGN	61.4
		Tuticorin	15.8	OBGN	82.8
Cuttlefish	24265	Kanyakumari	53.6	Trawl	96.2
Squids	32642	Kanyakumari	76.5	Trawl	99.0

30%

Landings of oilsardine was lower than that of the previous year.

Sustainable management of fishery resources: Tamil Nadu & Puducherry

Trawlers contributed 74% of the total landings in Tamil Nadu

varied from 31.1 to 42.3%. However in Kanyakumari, MDTN showed an increase of 96.2% and in Thanjavur, MTN showed an increase of 3.5%. Motorised and non-motorised gears in almost all the districts showed an increase over the corresponding period last year.

Puducherry: Total landing was 27040 t a decrease of 40% when compared to previous year. MDTN contributed 74% and MTN 14% of the total landing which together formed 88%. Pelagic resources formed 38.2%, demersals 29.9%, crustaceans 15.1% and cephalopods 16.7%. Karaikal District contributed 74.4% of the total landings.

Fishery resources in TN: Landings were constituted by 10 pelagic, 6 demersal, 2 crustacean and 1 cephalopod resources. Pelagic resources compraised lesser sardines (16.9%), oilsardine (7.9%), carangids (7.3%), Indian mackerel (3.4%), tunas (2.88%) barracudas (2.6%), whitebaits (2.1%), *Thryssa* spp. (1.4%), *Scomberomorous commerson* (1.2%) and ribbonfishes (1.1%). Demersal resources were silver bellies (11.7%), other perches (4.2%), threadfin breams (3.2%), pig-face breams (2.3%), croakers (2%) and goatfishes (1.7%). Crustacean resources were penaeid shrimps (3.5%) and crabs (2.6%). Cephalopods formed 9.6%. Trawl nets were found to be the major gear even for pelagic resources. Other important gear was outboard motor operated gillnets. For tuna, multiday gillnet was the most important gear followed by trawl. Six districts accounted for the landing of 19 resources/resource groups which formed ≥1% of the total

Sustainable management of fishery resources: Tamil Nadu & Puducherry

Length range and mean size of pelagic resources from different regions

Chennai	Min (cm)	Max	Mean
Sardinella longiceps	12	19	14.7
S. gibbosa	8	19	12
Ilisha megaloptera	17.5	20.5	19.3
T. ilisha	15	17	15.7
Stolephorus indicus	7	14	10
S. commersonni	7.5	12.5	11
Rastrelliger kanagurta	11.6	26.5	20.9
R. faughni	10.3	27.2	20.5
Trichiurus lepturus	29	91	56.9
Alectis indica	13	28.5	19.5
Seleroides leptolepis	12.5	14	13.5
Atule mate	15	20.5	18.2
Carangoides armatus	14	24	20.1
Caranx ignobilis	21	32.5	24.4
Selar crumenophthalmus	17.5	28.5	21.2
Decapterus russelli	9	15	11.7
Sphyraena putnamae	36	116	55.3
S. forsteri	19	31.5	24.4
S. obtusata	18	25.5	21
Scomberomorus commerson	10	130	67.2
S. guttatus	29	43	36.3
Rachycentron canadum	30	98	54.4
Euthynnus affinis	26	64	43.9
Katsuwonus pelamis	32	76	54.9
Thunnus albacares	38	144	77
Auxis thazard	30	46	39.3
Sarda orientalis	30	36	33.3
Istiophorus platypterus	80	250	164
Istiompax indica	140	270	211.2

Mandapam			
S. longiceps	12	19	16.4
S. gibbosa	9	15	11.8
S. albella	8	14	11.3
Amblygaster sirm	12	20	17
A. clupeoides	14	30	20.4
Chirocentrus dorab	10	53	35
Lepturacanthus savala	22	104	52.6
S. leptolepis	7	20	12.5
Scomberoides commersonianus	13	103	27
Caranx heberi	10	43	17.7
S. putnamae	31	78	60.2
S. obtusata	16	40	25
S. commerson	19	121	55

catch, Among these districts, Kanyakumari and Cuddalore accounted for the landing of maximum number of resource/ resource groups.

Mean size of majority of the finfishes and shellfishes are above the mean legal size though the minimum size of exploitation is found to be below the MLS in majority of the cases However, of the sampled fishes, 41% were found to spawn in the first and second quarter, 49% in the third and fourth quarter and 10% throughout.

Length range and mean length of dominant species of demersal fishes from different regions

Chennai	Min(cm)	Max	Mean
Nemipterus japonicus	4	25.9	12.6
Nemipterus randalli	8	19.9	12.2
Upeneus guttatus	9	16.9	12.3
Upeneus sulphureus	9	16.9	10.2
Arius arius	20	29.9	23.9
Plicofollis tenuispinis	11	40.9	31
Epinephelus aerolatus	10	37.9	22.3
Cephalopholis sonnerati	14	40.9	31
Lutjanus lutjanus	10	25.9	15.2
Pristipomoides filamentosus	13	66.9	17.7
Parastromateus niger	9	35.9	20.8
Psettodes erumei	14	44.9	22.9
Saurida micropectoralis	11	37.9	24.7
Otolithes ruber	14	30.9	19.5
Nibea maculata	11	22.9	14.4
Mandapam			
Cynoglossus arel	17	35	25.6
Dendrophyssa russelii	10	19	14.3
Eubleekeria jonesi	8	16	11.7
Gazza minuta	7	16	11.6
Karalla daura	7	15	11.4
Karalla daura	9	15	11.7
Leognathus brevirostris	8	14	11.2
Lutjanus quinquelineatus	11	199	15.4
Nibea maculata	11	23	15.8
Otolithes ruber	9	30	18.6
Pennahia anea	10	20	13.9
Siganus canaliculatus	11	26	17
Upeneus sundaicus	14	25	20
Upeneus tragula	11	22	14.9
Parupeneus indicus	12	31	22.6
Scolopsis bimaculata	11	21	16.3
Tuticorin			
Gazza minuta	6.5	13.5	9.4
Equulites lineolatus	8	14	10.6
Parupeneus indicus	12.6	32.6	20.4
Lethrinus lentjan	12.5	40	22.6
Nemipterus bipunctatus	12.5	30	22.2
Epinephelus malabaricus	20	95	47.4

Sustainable management of fishery resources: Andhra Pradesh

Andhra Pradesh

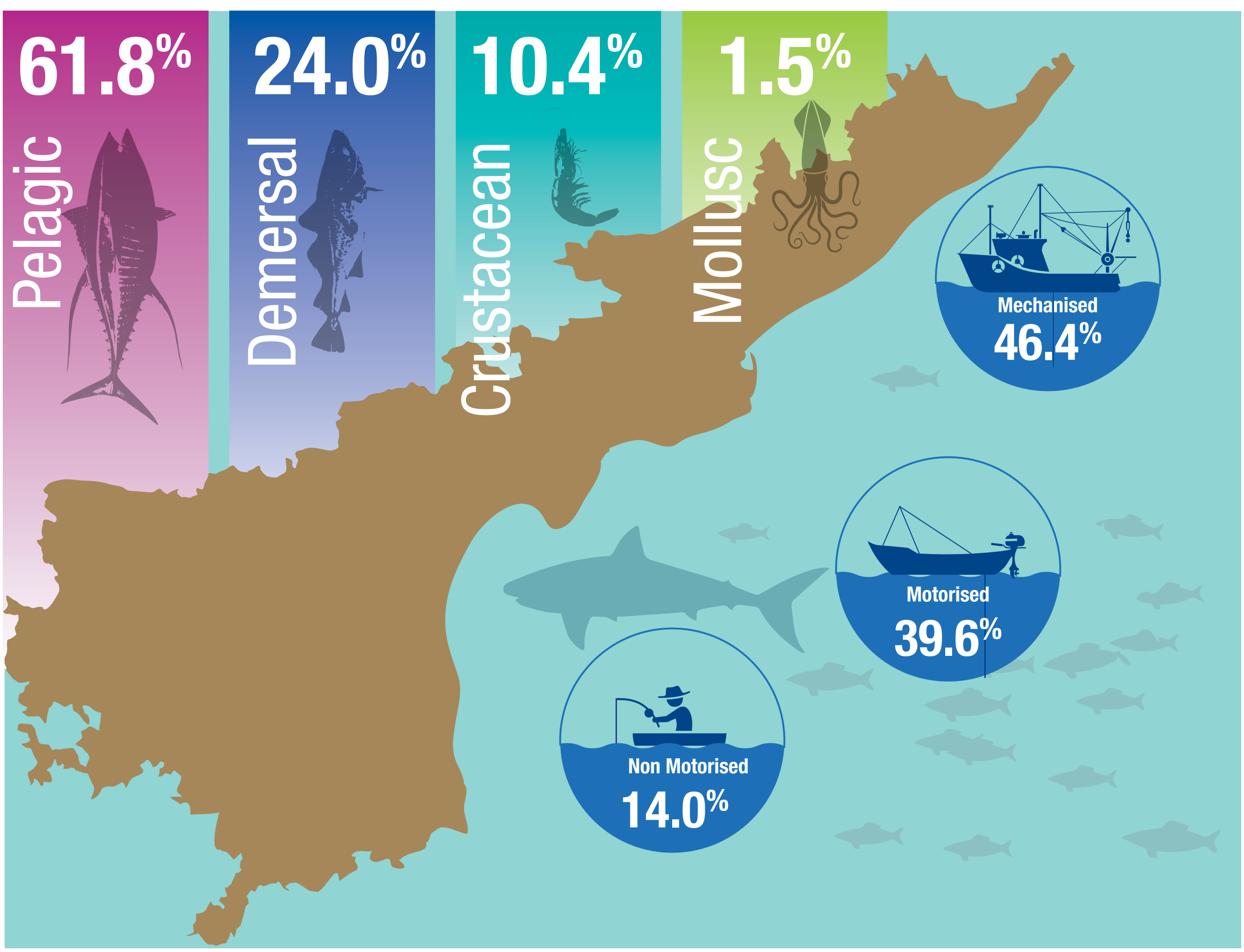
Research Project: DEM/RMS/10

Marine landings of Andhra Pradesh in 2017 were estimated at 1.99 lakh t, a 41.7% decline from the peak landings obtained in 2014. Trawl was the major gear contributing 46.78% with catch rates of 22.06 kg h^{-1} for multiday trawlers and 8.34 kg h^{-1} for motorised outboard trawlers. Gillnets accounted for 20.63% of the landings with catch rates of 116.84 kg $unit^{-1}$. Seines contributed 14.54% with catch rates of 174 kg $unit^{-1}$ for boat seines and 482.34 kg $unit^{-1}$ for ring seines. Hooks and lines accounted for 4.03% at a catch rate of 148.63 kg $unit^{-1}$. Contribution of non-mechanised sector to the catch was 14.02%.

Pelagic resources

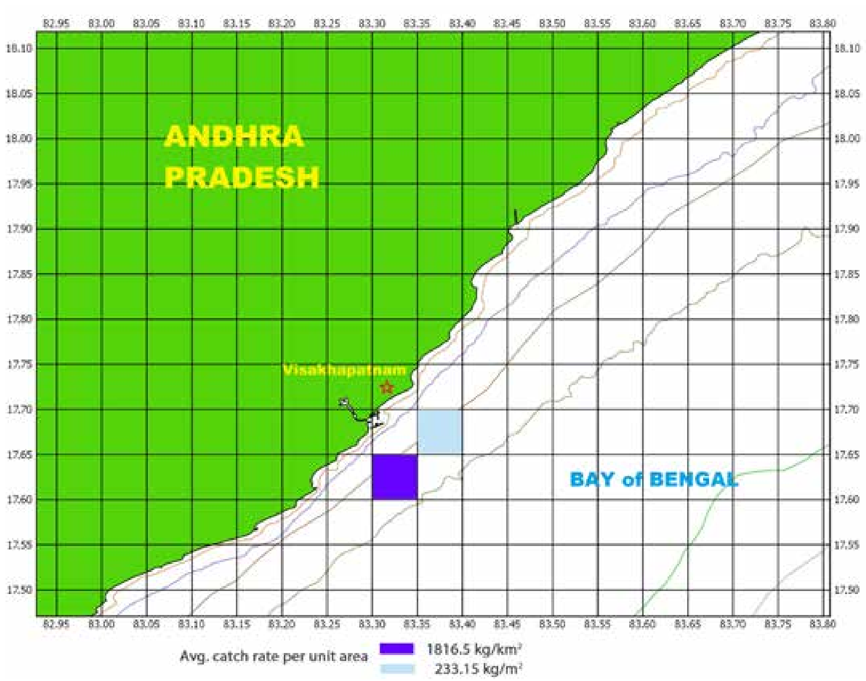
Among pelagics, the major contributors were clupeids contributing 0.63 lakh t

Marine fish landings of Andhra Pradesh in 2017: 1.99 lakh t

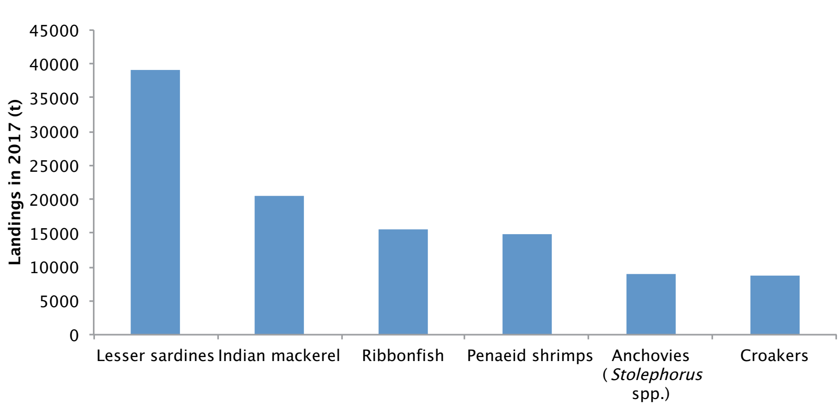


Sustainable management of fishery resources: Andhra Pradesh

(50.99%), followed by mackerel (16.73%), ribbonfish (12.55%), carangids (10.91%), tunas (3.2%), seerfishes (2.6%) and barracudas (1.82%). Among clupeids, lesser sardines contributed 62.06%, followed by *Stolephorus* 14.17% and *Thryssa* 6.63%. Carangids landings were dominated by horse mackerel 35.99%, followed by scads 15.22% and leatherjackets 5.44%. Indian mackerel accounted for more than 99.5% of the mackerel landings. Three-fifth of the seerfish landings were contributed by spotted seer and the rest by king seer. In the tuna landings, little tuna dominated with 38.73%, followed by yellowfin tuna 27.18%, frigate tuna 17.33% and skipjack tuna 16.76%. *Sphyraena barracuda* and *Sphyraena jello* contributed mostly to the barracuda landings. The other large pelagics landed were billfishes (903 t), dolphinfishes (173 t), needlefishes (69 t) and cobia (10 t). Around 62% of the billfishes landed were represented by *Makaira indica* and 24% by *Istiophorus platypterus*. Dolphinfishes were represented by a single species *Coryphaena hippurus*. More than 99% of the needlefish landings were contributed by *Strongylura*.



Estimates of biomass per unit area from experimental trawling off Visakhapatnam during 2017; each grid measures 0.05 degree by 0.05 degree



Major marine resource groups/species landed in Andhra Pradesh in 2017

Demersal resources

Among the demersals, croakers dominated the landings forming 18.07% (8650 t), followed by silverbellies (11.77%), pomfrets (10.4%), catfish (49.47%) and goatfish (9.46%). Major croaker species landed were *Otolithes ruber*, *Pennahia anea*, *Nibea maculata* and *Johnius carutta*. Major silverbellies landed were dominated by *Photopectoralis bindus*, *Leiognathus equulus*, *Gazza minuta* and *Secutor insidiator*. Among pomfrets, *Parastromateus niger* contributed 57.77%, followed by *Pampus argenteus* (28.27%) and *Pampus chinensis* (13.95%). Elasmobranchs contributed 5.5% of total demersal landings, with rays contributing 65.39%, followed by sharks (27.7%) and guitarfish (6.9%). Major ray species landed in Andhra Pradesh were *Maculabatis gerrardi*, *Gymnura poecilura* and *Neotrygon indica*.

Crustacean resources

Crustacean landings in the state comprised of penaeid shrimp (71.59%), crabs (21.96%), non-penaeid shrimp (5.09%), stomatopods (1.03%) and lobsters (0.32%). The major shrimp species landed in the state were *Metapenaeus monoceros* (26.14%), followed by *Solenocera crassicornis* (15.78%), *Metapenaeus affinis* (9.14%)

Sustainable management of fishery resources: Andhra Pradesh

Optimum fleet size of 1300 mechanised trawlers is recommended to reduce overcapacity in the marine fisheries sector of Andhra Pradesh

and *Metapenaeus dobsoni* (8.68%). Major crab species landed were *Portunus sanguinolentus* (38%), *Portunus pelagicus* (17.0%), *Charybdis feriatus* (16.78%) and *Charybdis lucifera* (8.1%).

Molluscan resources

Among cephalopods, cuttlefishes contributed 65.13% and squids 34.87%. Cuttlefishes comprised mainly of *Sepia pharaonis* (29%), *S. aculeata* (26%), *S. brevimana* (13%), *S. prashadi* (6%) *and Sepiella inermis* (26%). Squids comprised mainly of *U. (P.) duvaucelli* (49%), *Sepioteuthis lessoniana (9%) Uroteuthis (Photololigo) edulis* (4%), *Loliolus (Loliolus) hardwickei* (13%) and *Loliolus (Nipponololigo) uyii* (25%). The contribution of octopus was almost negligible with about (0.2%); which comprised mainly of *Amphioctopus aegina* (90%), *Cistopus sp.* (5%), *Amphioctopus neglectus* (3%) and other octopus (2%).

Biology of major species

Mackerel: Mean length encountered at Visakhapatnam was 197.7 cm fork length. Annual sex ratio was 0.36. Length at first maturity varied between 18.32 and 18.86 cm. Peak spawning season was between July and October and February and April. Relative fecundity was 567.51 ova per gram body weight. Feeding

Fisherwoman carrying dolphinfish landed at Pudimadala

Mechanised trawler-gillnetter at Nizampatnam

Sustainable management of fishery resources: Andhra Pradesh

Fishermen pulling a motorised Theppa onshore

intensity was high with two-third of the fishes encountering quarter to half filled stomachs and the rest one-third having empty to trace amounts of food in the stomach.

Skipjack tuna: Length range varied from 20 to 79.9 cm with mean length of 45.8 cm. Annual sex ratio was 1.84 with females dominating in most months of the year. Peak spawning period was from December to March. Feeding intensity was less with prey contents being dominated by cephalopods, shrimps, frigate tuna and carangids.

Yellowfin tuna: Length range varied from 24 to 165.9 cm. Mean length was 73.6 cm. Annual sex ratio was 2.16 with females dominating in most months of the year. Peak spawning period was from November to February. Feeding intensity was less with prey contents dominated by cephalopods, crabs, mackerel and carangids.

King seerfish: Highest mean length of 80.85 cm was recorded during December and the lowest mean length of 57.13 cm was recorded in July. Annual sex ratio was 1.33 with females dominating in most months of the year. Peak spawning period was from September to March. Sardine was the most preferred food item, followed by *Stolephorus*. Feeding intensity was very less, with high proportion of fishes exhibiting empty or trace amounts of food in the stomach.

Spotted seerfish: Length ranged from 18 to 71.9 cm and mean length was 43.0 cm. Annual sex ratio was 1.87 with females dominating in most months of the year. Peak spawning period was from November to April. Sardine and *Stolephorus* were the preferred food items. Feeding intensity was less, with high proportion of fishes exhibiting empty or trace amounts of food in stomach.

Barracuda (*Sphyraena jello*): Length

Sustainable management of fishery resources: Andhra Pradesh

range varied from 24 to 73.9 cm. Mean length was 38.1 cm. Annual sex ratio was 1.67 with females dominating in most months of the year except October. Peak spawning period was from October to November. Carangids, sardines, *Stolephorus* and cephalopods were the preferred food items. Feeding intensity was less, with high proportion of fishes exhibiting empty or trace amounts of food in stomach.

Dolphinfish (*Coryphaena hippurus*): Length range recorded was from 30 to 127.9 cm. Mean length was 59.6 cm. Annual sex ratio was 2.02 with females dominating in most months of the year. Peak spawning period was from June to December. Carangids, sardines, *Stolephorus,* shrimps and cephalopods were the preferred food items. Feeding intensity was moderate with less than half of the fishes exhibiting empty or trace amounts of food in stomach.

Unicorn leatherjacket (*Aluterus monoceros*): Length range varied from 20 to 63.9 cm. Mean length was 47.6 cm. Annual sex ratio was 1.05 with females dominating in most months of the year except for August, October and November. Peak spawning period was from August to December. *Apogon, Stolephorus, Acetes* and juveniles of finfishes and cephalopods were the preferred food items. Feeding intensity was less, with high proportion of fishes exhibiting empty or trace amounts of food in stomach.

Cobia: Length ranged from 20 to 131.9 cm. Mean length was 62.9 cm. Mean length varied from a maximum of 87.7 cm in June to a minimum of 49.2 cm in August.

Giant trevally (*Caranx ignobilis*): Length range of *C ignobilis* was 74.2-92.8 cm TL and weight ranged from 4.5-10.2 kg total weight. Sex ratio was 4:1 with dominance of female fish. Predominant diet was fish and crab.

Indian pompano: Average length was 71.1 cm TL with lengths ranging from 50 to 80 cm. Average body weight was 4055 g with weights ranging from 1569 to 6950 g. Sex ratio was 0.69 favouring males. Diet was dominated by gastropods, followed by fish.

Snapper (*Lutjanus johnii*): Length range of *L johnii* was 30.3-83.0 cm TL with weights ranging from 0.474-7.15 kg. Mean length was 55.7 cm and mean weight was 2.54 kg. Sex ratio was 1.4:1. Predominant diet component was fish followed by crabs, shrimps and stomatopods.

Flathead (*Platycephalus indicus*): Mean length was 41.1 cm TL with average body weight being 511 g. Total length ranged from 28 to 58 cm. Body weights ranged from 143 to 1565 g. Sex ratio was 0.6 favouring males. Diet consisted mainly of fish with small contributions from shrimp, crabs and cephalopods.

Penaeid shrimps: Mean size of *Metapenaeus dobsoni* was 8.7 cm with lengths ranging from 4.8 to 11.6 cm in commercial landings. Sex ratio was 1.15 in the samples. Mean size of *Metapenaeus monoceros* was 12.6 cm with lengths ranging from 8 to 20 cm. Sex ratio was 1.86.

Crabs: Mean size of *Portunus sanguinolentus* was 12.1 cm with sizes ranging from 5.8 to 21.3 cm. Sex ratio was 1.42 for the species.

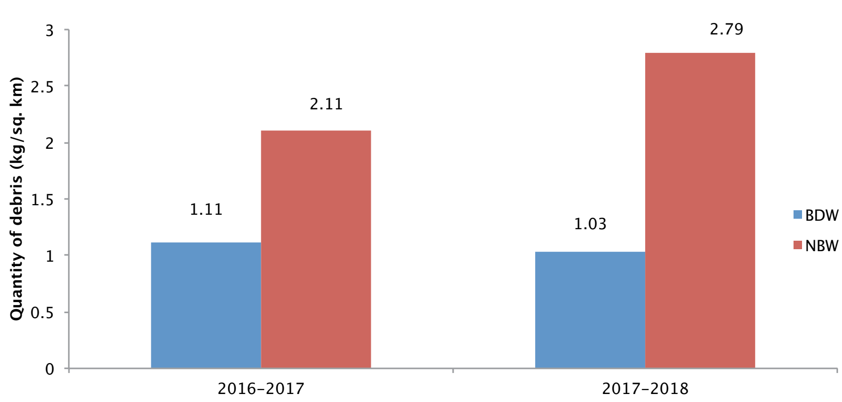
Cuttlefish: Dorsal Mantle Length (DML) of *Sepia aculeata* ranged from 7.9 to 21.4 cm with an average of 13.8 cm. Total weight recorded was 54 g to 901 g with an average weight of 292.58 g. Number of females exceeded males in the landings with sex ratio of 1.62. They fed mostly on crustaceans (squilla, crabs and shrimps) and fishes. DML of *Sepia prashadi* ranged from 4.4 to 10.8 cm with an average of 8.2 cm. Total weight ranged from 11 to 106 g with an average weight of 52.11 g. Males exceeded females in landings of this species with sex ratio of 0.81.

Experimental trawling off Visakhapatnam

Twenty experimental trawling trips were

Sustainable management of fishery resources: Andhra Pradesh

Debris caught during experimental trawling off Visakhapatnam



Estimates of biodegradable (BDW) and non-biodegradable (NBW) wastes collected off Visakhapatnam coast during experimental trawling

conducted off Visakhapatnam during 2017-2018 mainly in the 30-40 m depth zone off Visakhapatnam. Catch rate ranged from 0.32-107.3 kg h^{-1} with an average of 36.9 kg h^{-1} over the entire study period. Highest catch rate was seen in May and lowest in August. Catch per unit area ranged from 13.4-6660.7 kg m^{-2} with an average of 1615.2 kg m^{-2} over the entire study area. Major resources caught during experimental trawling were threadfin breams, ribbonfish, crabs, cephalopods and stomatopods with ribbonfish dominating the resources. Estimated average ribbonfish catch was 696.5 kg m^{-2} indicating that areas off Visakhapatnam were good fishing grounds for ribbonfish.

Debris along seafloor off Visakhapatnam

During experimental trawling off Visakhapatnam, both biodegradable and non-biodegradable debris were collected along with fish and shellfish. Results indicated that on one hand biodegradable wastes decreased from 2016-17 to 2017-18 but on the other hand non-biodegradable wastes increased off Visakhapatnam. This increasing trend is of concern since accumulation of non-biodegradable wastes in fishing grounds in addition to affecting the economic returns to fishermen also affects the habitats of marine fish.

Socio-economic survey

A socio-economic survey of fishermen of the motorised and mechanised sector of Visakhapatnam District indicated several key points. Most notable was that illiteracy was high among marine fishermen of the area. Nearly 75% of the respondents were illiterate. Use and ownership of life saving equipment was very low (only 11% had life jackets). The capital productivity was worked out to be 0.59 for the motorised sector and 0.72 for the mechanised sector.

Sustainable management of fishery resources: Large pelagic resources

Large Pelagic Resources

Research Projects: PEL/LPR/04

13.8%

decline in LP landings due to the disruption in fishery following OCKHI cyclone

Fishery of tunas, billfishes, seerfishes, dolphinfishes, cobia, barracudas, queenfieshes, fullbeaks and related species were monitored along the Indian coast. Total large pelagic (LP) landings along the mainland coast declined by 13.8% to 205,784 t and it contributed 5.4% of the total marine landings in 2017.

Mechanised sector contributed the maximum to the landing followed by motorised sector. Major share of the catch was by gillnets which contributed 38.5% of the total LP landing in 2017. Longlining contributed 8.8% which comprise larger size groups of all species. Purse/ring-seines targeted mostly shoaling resources especially tunas and contributed 16.3 % of the landings. Trawls contributed nearly 29.8 % of the total resource catch. Other gears like bagsienes/bagnets and dolnets also contributed to LP landing in small quantities during the year. About 205784 t of large pelagics were landed during 2017 registering a decline of 13.8%.

Landing exhibited increasing trend over the years with minor annual fluctuation. All resources showed uptrend during the period except seerfish and needlefishes which exhibited steady level of landing with annual ups and downs.

Major share of the catch was from the southern coast of India, southwest coast contributed 37.8% followed by southeast coast contributing 29.7%. Northwest cost contributed 26.1% and the rest by northeast. Considerable variation was observed in the spatial pattern in landings of individual resources. Tamil Nadu, Kerala, Karnataka and Gujarat are the major maritime states that contributed to the LP fishery.

Tuna, seerfish and barracuda were the major contributors; which together represented about 77.3%. Other resources in the fishery were billfishes, queenfishes, mahimahi and cobia. Over the years, LP landing steadily increased. It was 62000 t in 1985, 198991 t in 2012, and 234143 t in 2016. However during 2017, marginal down trend to 205784 t was recorded due to the disruption in fishing activity following cyclonic havoc. Landings of all groups except dolphinfish and fullbeaks registered a downtrend.

Sustainable management of fishery resources: Large pelagic resources

Resource	2017	2016	% Change
Barracudas	33337	37948	-13.8
Billfishes	11328	16812	-32.6
Cobia	2870	3380	-17.8
Mahimahi	10754	9025	16.1
Fullbeaks	5142	3621	29.6
Queenfishes & Rainbow runner	16817	17591	-4.6
Seerfishes	48674	55148	-13.3
Tunas	76862	90618	-17.9
Total LP	205784	234143	-13.8

Tuna stock assessment indicates tremendous potential for enhanced production of principle oceanic species from seas around Indian Peninsula.

LP were landed throughout the year with no specific pattern at the national level. However, LP's together and individual resources showed specific seasonality along different regions.

Tunas: Contributed 37.4% of the LP landings forming 76862 t. Landing was supported by eight species, four each of neritic (56.7%) and oceanic species (43.3%). Major share of the landing was by *E. affinis* (36.0%) among neritic and *T. albacares* (17.6%) among oceanic groups. Fishery occurred all along the coast with major share of the landing from southern coasts. Southern states contributed 72.4% of the tuna landings. Kerala and Tamil Nadu were the major contributors.

Seerfishes: Constituted 23.7% of the LP landing. Landings declined to 48,674 t during the period. *Scomberomorus commerson* (62%), *Scomberomorus guttatus* (37%) and small quantities of *Scomberomorus lineolatus* and *Acanthocybium solandri* supported the landing. Fishery occurred all along the coast. Tamil Nadu, Gujarat, Karnataka and Maharashtra were the major contributors. Southwest coast (34.7%) was the major contributor to the landing. followed by northwest (29.5%), southeast (26.9%) and northeast coast. *S. commerson* formed fishery along the entire coast, whereas *S. guttatus* was abundant towards northern coasts. Wahoo formed a fishery only along the southern most coast.

Barracudas: Contributed 16.2% of LP landings with a production of 33337 t. Landing declined during the year. They were landed along the entire coast with major contribution (57.8%) from southeast coast followed by southwest coast and northwest coast. Tamil Nadu alone contributed 49% of the bararcuda landing. Eleven species were landed, dominated by *Sphyraena jello* and *Sphyraena obtusata*.

Billfishes: With a landing of 11328 t billfishes contributed 5.5% to the LP landing. Fishery was supported by three species of marlins and one species each of sailfish and swordfishes. Billfishes were landed all along the coast with major share of 81.4% of the landing from southeast coast followed by southwest coast.

Dolphinfishes: Contributed 5.2% of the LP landings with a catch of 10754 t. Fishery was supported by two species; dominated by *Coryphaena hippurus.* Landing exhibited uptrend during the year and were landed all along the coast, but major (93.6%) contribution was from the west coast. Contribution from northwest coast alone accounted for 57.5% of the total landing.

Cobia: Represented 1.4% of LP landing with a production of 2870 t. Fishery was by a lone species; *Rachycentron canadum*. Landing showed steady increase over the period, but declined marginally during the year. Cobia was landed along the entire coast with major share (82.3 %) from west coast. Contribution by northwest coast was 41.7 and south westcoast was 40.6%.

Queenfishes: Formed 7.9% of the total

Sustainable management of fishery resources: Large pelagic resources

LP landing with a production of 16817 t. Landings were reported from the entire coast with the major share from northern coast. Landing along Kerala and Tamil Nadu coast was only nominal. Fishery was supported by four species. Major share of the catch was by *S. lysan* (40.3%) and *S. commersonianus* (27.7%). Landing registered marginal downtrend.

Rainbow runner: Though formed only a minor proportion of the LP landing, has high commercial value. Annual landing was 580 t with major part of the landing from Maharashtra, Kerala and Tamil Nadu. Fishery was supported by single species, *Elagatis bipinnulata*.

Fullbeaks: Contributed 2.5% to LP catch with a production of 5142 t. Landings are highly fluctuating over the years and maintained a downtrend during the decade, but registered improvement during 2017. Landed along the entire

Spawning biology of major large pelagics exploited

Resource	Species	Spawning season	Peak spawning	Rel. fecundity (per kg body wt.)
Tunas	*E. affinis*	Round the year	June-October	274,286
	K. pelamis	Round the year	December – March	187,688
	G. unicolor	Round the year	August-March	347,-558
Seerfish	*S. commerson*	Round the year	September-December	248,768
	S. guttatus	Round the year		
Mahimahi	*C. hippurus*	Round the year	June-September	189,430
	C. equisilis	Round the year		404,061

Sustainable management of fishery resources: Large pelagic resources

Table Biological reference points of tunas

Species	Lr	L_{max}	Mean	Lmat	SSB%
T. albacares	38	172	108.6	57.6 /94.6	39.8
K. pelamis	28	96	48.2	40.9	30.2
G. unicolor	38	136	84.6	69.0	42.7
T. tonggol	37	102	50.9	49.8	36.3
E. affinis	27	82	43.3	37.7	30.6
A. thazard	22	48	36.7	29.7	30.2
A. rochei	14	37	24.4	23.6	23.1
S. orientalis	28	68	40.4	42.0	29.8

Species	Stock status
T. albacares	Not subjected to overfishing
K. pelamis	Not subjected to overfishing
G. unicolor	Not subjected to overfishing
T. tonggol	Not subjected to overfishing
E. affinis	Subjected to overfishing
A. thazard	Subjected to overfishing
A. rochei	Subjected to overfishing
S. orientalis	Not subjected to overfishing

coast, but major share, (76%) was from southern coast. Six species supported the fishery, dominated by *Ablennes hians*, *Tylosurus crocodilus* and *Strongylura incisa*

Biology

Landing of most of the species was supported by adult population except that of kingseer and swordfish. Trawls and gillnets landed young ones of kingseer and sword fishes in large numbers. All species were highly predatory and carnivorous in feeding habit. Most of the LP species found to spawn almost round the year with very specific peak spawning activity pertaining to certain period of the year.

Stock status

Stock assessment of tunas indicated that spawning stock biomass of all species except, bullet tuna (*A. rochei*) is above 30% and sufficient for maintaining sustainable production. Fishing rate is also at lower level than required to maintain MSY. The situation suggests considerable scope for increasing the production by extending fishing operations to areas like Andaman and Lakshadweep seas.

Rapid stock assessment indicated that resources except needlefish are at healthy, abundant state along the Indian coast and show scope for enhanced production.

Bivalve fisheries and management

Research Projects: MFD/BIV/15

23%

increase in bivalve production compared to previous year

National bivalve production

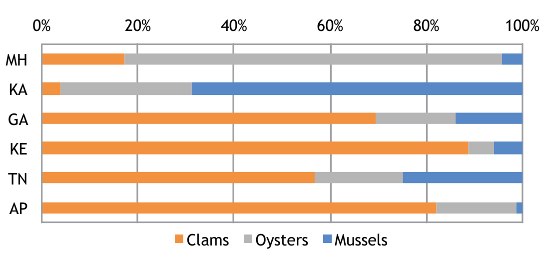
Bivalve production from Kerala (KE), Karnataka (KA), Goa (GA), Maharashtra (MH), Tamil Nadu (TN) and Andhra Pradesh (AP) was estimated at 1,03,639 t. Bivalve production registered an increase by 23% when compared to the fishery in 2016 (84,483 t).

Kerala (68.1%) and Karnataka (24.5%) were the important bivalve producing states followed by Tamil Nadu (4.4%), Maharashtra (1.2%) Goa (1.0%) and Andhra Pradesh (0.8%).

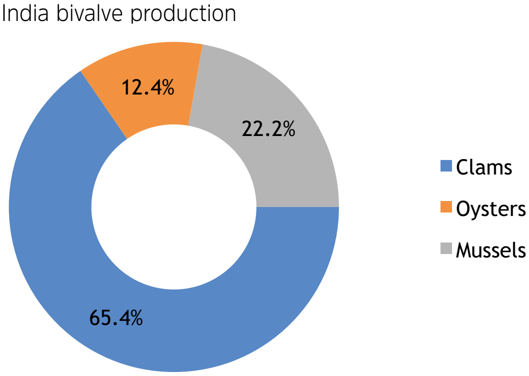
Clams dominated the fishery contributing 65.4% to the annual bivalve production followed by mussels (22.2%) and oysters (12.4%). Mussel catch increased by 3-folds, clams by 10%, while oysters decreased by 26% compared to 2016 production.

Kerala: Clams formed 88.7% of bivalve production in the State followed by mussels (5.9%) and edible oysters (5.4%). Black clam,

Contribution of clams, oysters and mussels by State



Contribution of clams, oysters and mussels to all India bivalve production



Mussel fishery in Vizhinjam, Kerala

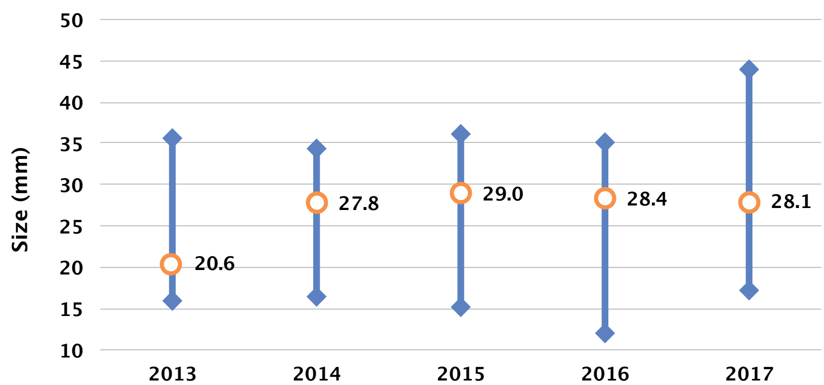
Sustainable management of fishery resources: Bivalve fisheries and management

Estimated bivalve fishery production (t) in India by States (2017)

	MH	GA	KA	KE	TN	AP	OD	WB	Total (t)
2017	1237	1035	25427	70592	4565	784	-	-	103639
2016	1418	132	9936	64015	3609	2124	2050	1200	84483

Bivalve collection in Azhoor, Kerala

Mean size and size range of *Villorita cyprinoides* in Vembanad fishery



Villorita cyprinoides was the most important clam species exploited in India (71.7%), with Vembanad Lake contributing 88.2% to the fishery. *V. cyprinoides* catch and catch rate in Vembanad increased by 15.5% and 10.5% respectively in 2017. Mean size of *V. cyprinoides* in the fishery decreased from 28.4 mm in 2016 to 28.1 mm in 2017.

Clam biomass survey during 2017 in lease area of "Vaikom lime shell co-operative society" of Vembanad, recorded reduction in clam biomass from 2,082 t in 2016 to 530 t in 2017.

Paphia malabarica fishery in Ashtamudi Estuary 2017 registered an increasing trend by 24%. The dominant size ranges in the fishery was 27.3 to 35.4 mm. Fishing ban continued during December 2016-February 2017. Clam biomass in Ashtamudi Lake during February was estimated at 7,753 t. The fishable biomass was estimated at 13,199 t.

Adaptive management measures for prudent exploitation of *P. malabarica* adopted in 2015 in Ashtamudi was extended during 2017. The input for 3rd Surveillance Audit Process for the MSC certified *P. malabarica* fishery of Ashtamudi Lake was provided by ICAR-CMFRI.

Contribution of bivalve catches from the Malabar Coast to the State production reduced from 40% in 2015 to 25% in 2016 and to 21% in 2017. Clams, oysters and mussel fishery recorded a decrease by 60.3% in Malabar region. *V. cyprinoides* dominated the clam fishery.

Estimated catch of brown mussel *Perna indica* from Vizhinjam- Kovalam bed was 619 t. Compared to 2016 (302 t) there was an increase in catch. Increase in the landing was due to heavy spatfall of brown mussel reported during 2016. Size range was 34-102 mm. Peak fishing season extended from August to December. Due to impact of OCKHI cyclone catch declined considerably during the month of November. Maximum number of maturing and ripe females were found during March and April. Spatfall began by June. Average size of the spat was 4.23 mm. Due to the *Ockhi Cyclone*, mussels spats (<4 cm size) were destroyed/ smothered and washed away in Vizhinjam-Kovalam and Perumathura Coast.

Clam fishery in Azhoor-Perunguzhi landing Centres of Muthazhapoli Estuary was

Sustainable management of fishery resources: Bivalve fisheries and management

dominated by *P. malabarica.*

Maharashtra: Estimated bivalve landing of Maharashtra was 1,237 t. Oysters dominated the fishery (79%) followed by clams (17%) and mussel (4%). The Indian rock oyster, *Saccostrea cucullata* locally known as '*Kalva*' contributed 90% to the oyster catch. The fishery was observed mainly in Sindhudurg and Ratnagiri Districts. Clam landing comprised of *Meretrix meretrix* (44%), *M. casta* (30%), *P. malabarica* (18%), *Katelysia opima* (7%) and *Polymedosa erosa* (1%). Green mussels (*Perna viridis*) were harvested along the coastal waters off Ratnagiri. There was good demand for bivalves in local markets during the mechanised fishing ban period, hence peak clam fishing was observed during June-July. Mostly women were handpicking the clams during low tide. Inter-state transportation of *Paphia malabarica* from Kerala to Ratnagiri and Mumbai market continued during the period.

1. *Bivalve collection in Palghar, Maharashtra*
2. *Bivalve collection in Ratnagiri, Maharshtra*

1

2

Sustainable management of fishery resources: Bivalve fisheries and management

Scientific input for third Surveillance Audit Process for the Marine Stewardship Council certified *P. malabarica* fishery of Ashtamudi Lake was provided by ICAR-CMFRI

Karnataka: Bivalve production in Karnataka during 2017 was estimated at 25,427 t. Green mussel, *Perna viridis* formed the dominant bivalve species in the fishery registering a five-fold increase compared to 2016. This was consequent to the heavy spatfall of *P. viridis* during September-December 2016 and increase in fishing effort. Mussel fishery was observed along Someshwara, Surathkal, Kaup Malpe, Gangoli, Byndoor, Nagoor, Kirimanjeshwara, Tadri, Manki, Murudeshwar, Belekeri, Ankola Keni, Belambar and Karwar. Mussel spat fishery was also observed near bar mouths and estuaries along Karnataka. Mortality in mussel beds was observed during February-April 2017 with increase in seawater temperature. Mussel spat settlement was poor during the post-monsoon period of 2017. Clam production recorded an increasing trend by 67%. *M. casta* and *P. malabarica* contributed 88% to the fishery. Clams were transported in bulk quantities by road and by rail from estuaries of Kerala prior to retailing in local markets of Karnataka, Goa and Maharashtra. Edible oysters, *C. madrasensis* and *S. cucullata* formed a good fishery in Karnataka. Production from the estuaries was estimated at 6,908 t.

Goa: Clams dominated the bivalve fishery in Goa contributing 70% to the landings (1,035 t), followed by oysters (16%) and mussels (14%). Fishery was observed in Pernem, Terekhol-Keri Canacona, Sal and Mandovi-Zuari Estuaries.

Tamil Nadu: Bivalve production from Tamil Nadu and Puducherry was estimated at 4,565 t. Clams dominated the fishery (57%) followed by mussels (25%) and oysters (18%). Bivalve fishery was reported in Chennai (Pulicat Lake, Ennore), Kanchipuram,

Mussel exploitation at Kanyakumari, Tamil Nadu

Sustainable management of fishery resources: Bivalve fisheries and management

Oyster exploitation at Bheemli, Andhra Pradesh

Tuticorin (Karapad Bay, Korampallam Creek, Punnakayal and Pazhayakayal); Ramanathapuram (Athankarai and Chinnapalam) and Kanyakumari Districts (Colachel, Kadapattinam, Kodimunai, Kurumpanai and Enayam). Estimated bivalve production at Karapad Bay was 26 t, comprising of *P. malabarica* (36%), *M. meretrix* (34%), *Marcia opima* (21%) and *M. casta* (9%). Biomass surveys in Karapad Bay indicated a clam density of 16-60 clams m^{-2}.

Andhra Pradesh: Bivalve landings from Kakinada Bay and Bheemli Estuary was estimated at 874 t. Landings decreased by 63% compared to previous year. *Tegillarca* (*Anadara*) sp. (36.8%) and *M. meretrix* (34.7%) dominated the clam fishery and *Crassostrea madrasensis* dominated the oyster fishery. Spat settlement studies identified nursery settlement zones in Bheemli. Spatfall of *M. meretrix* (90%), *Donax* sp. and other clam sp. were observed during July–September.

Bivalve Potential Yield: MSY of clams, mussels and oysters was re-estimated based on cMSY model following Bayesian approach. State-wise, region-wise MSY was estimated and compiled for arriving at national marine bivalve potential yields.

Ornamental Gastropods

Research Projects: MF/GAST/13

9%

increase in landings of ornamental gastropods at Tuticorin over the previous year.

Gastropod landings

Tamil Nadu

Totally seven gastropod landing centres from south east coast of Tamil Nadu comprising Ramnad and Tuticorin districts and one centre at Chennai were covered. At Tuticorin gastropod landing in 2017 was 351 t, which showed 9% increase compared to the previous year. The highest catch recorded was in the month of December and lowest catch recorded during March and April. Among the different landing centre 72 % of the catch is from Kalavasal and 28 % of the catch is from Kayalpattinam. Tuticorin Fishing Harbour contributed very meagre amount to the total landing of gastropods from Tuticorin District.

Ramanathapuram total gastropod landing in 2017 was 2,348 t, which showed an 18 % decrease compared to previous year. The highest and lowest catch was observed in April and June respectively.

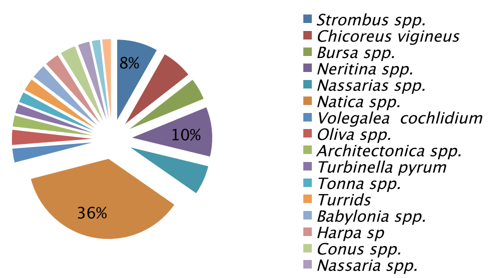
At Kayalpattinam, gastropods especially

Sustainable management of fishery resources: Ornamental Gastropods

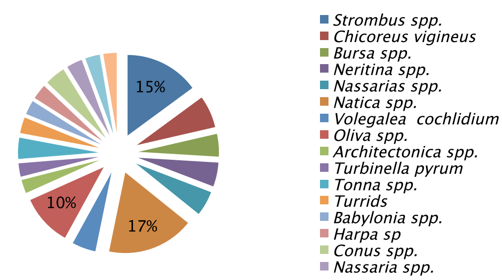
Annual estimated gastropod landing by trawlers

Centre	Craft	Gear	Catch(t)	CPUE (Kg/unit)	CPUE (Kg/hr)	Fishing month
Rameswaram	Trawler	Trawl	1092	18	2	All months
Mandapam	Trawler	Trawl	978	18	1.5	All months
TF Harbour	Trawler	Trawl	35	25	-	Oct,Nov, Dec

Gastropod species composition at Mandapam



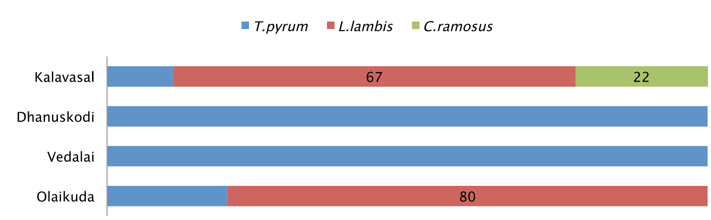
Gastropod species composition at Rameswaram



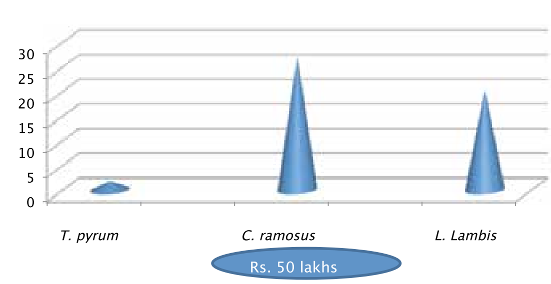
Annual estimated gastropod landing by diving

Centre	Craft	Catch(t)	CPUE (Kg/unit)	CPUE Kg/person	Species composition (%) T.pyrum	C.ramosus	L. lambis	Fishing month
Vedalai	Vallam	34	38	7.5	100	-		Jan, Feb, Nov, Dec
Olaikuda	Vallam	158	96	24	12		89	Mar-Oct
	Catamaran	29	7.8	7.8	27		73	Mar-Oct
Dhanuskodi	Catamaran	57	63	12.6	100	-		Jan, Feb
Kalavasal	Vallam	227	37	7	11	22	67	All months

Percentage composition of gastropod species exploited by diving



Gastropod Opercula trade at Tuticorin (in lakhs)



Sustainable management of fishery resources: Ornamental Gastropods

Annual estimated catch at Kayalpattinam by bottom set gill net

Centre	Gear	Catch(t)	*T. pyrum*	*C. ramosus*	CPUE (Kg/unit)
Kayalpattinam	Bottom set gill net	89	44	45	11.8

Exploitation of fossilised chank at Kalavasal

Centre	Craft	Gear	Catch (t)	CPUE (Kg/unit)	CPUE (Kg/person)	Fishing Month
Kalavasal	Vallam	Diving	269	19	3	All months

Turbinella pyrum and *Chicoreus ramosus* are caught as by catch in the bottom set gill nets primarily set for lobsters.

Gastropod opercula are collected and traded for forming the base ingredients for fragrance industry, especially to Taiwan through middle men. The operculum of the three species *T. pyrum, C. ramosus* and *L. lambis* are collected and exported as per the market demand. From the estimated number of such gastropod landings, the estimated quantity of the operculum is calculated and the total value involved in the trade is estimated. The market value of operculm of the following species are *T. pyrum*: ₹2,200/kg; *C. ramosus:* ₹3,700/kg and *L.lambis*; was ₹14,000/kg.

As in the previous years, the fossilised chanks *T. pyrum* estimated at Kalavasal showed 6.3 % increase compared to 2016. The highest catch observed in the month of June (39690 kg) and lowest catch observed during the month of March (13778 kg).

Total estimated landing of gastropods at Chennai Fisheries harbour was 11t supported by about 30 species.

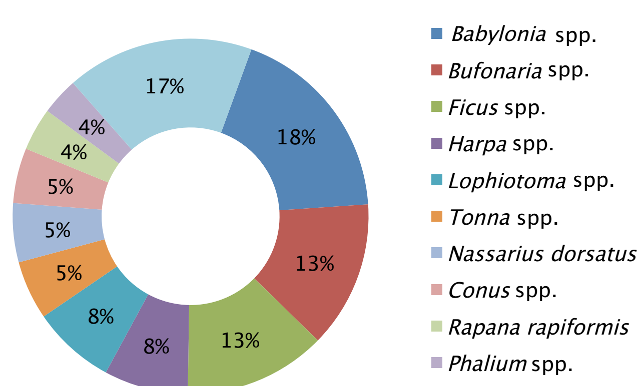
Andhra Pradesh (Kakinada & Kancheru)

Total gastropod production from the Kakinada regions was about 355.5 t. The average effort was about 755 units with an average CPUE of 38.04 kg

Total gastropod production from the Kancheru regions was about 746.4 Kg. The average effort was about 11 units with an average CPUE of 5.53 kg

5

Million worth gastropod opercula trade estimated .



Gastropod species composition at Chennai

Sustainable management of fishery resources: Ornamental Gastropods

L. lambis operculum **sells at Rs.14000/- per kg.**

Kerala (Kollam)

Total estimated gastropod landings were 590 t. Contribution by various gears: Single day trawl net [91.3%], Multiday trawl net [4.3%], Gill net [4.2%] and Non-mechanised [0.1%].

Babylonia spirata (78.63 %) and *B. zeylanica* (7.52 %) were the dominant species in the catch forming 86.15%.

Biology of *Babylonia spirata* and *Bursa spinosa* studied in detail:

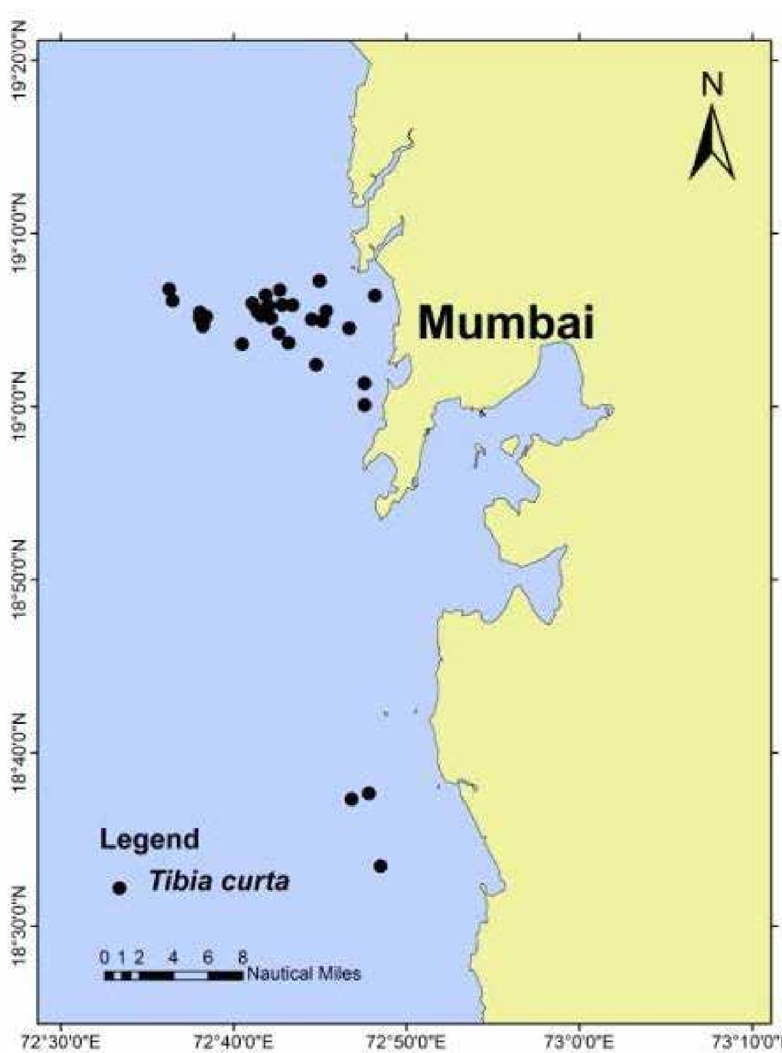
Size range in the fishery of *Babylonia spirata* was 20.0 to 51.5 mm. Smallest size appeared in June and the largest obtained in April. The total weight (shell-on) 2.52 – 27.42 g meat weight–1.76 g – 13.89 g. Sex ratio (Male to Female) was 1: 1.4.

Size range in the fishery of *Bursa spinosa* ranged from 31.4 to 83.9 mm. Smallest size in May and the largest size was recorded in August. Total weight shell-on 4.96 – 40.8 g, meat weight 1.63 – 16.75 g.

Maharashtra (Mumbai)

Field surveys conducted at Mumbai, Palghar, Alibaghand Ratnagiri revealed the gastropod resources as by catch in trawl and gillnet fishery. Dominant gastropod caught in trawl and gill net is *Tibia curta*. In single day trawl, gastropod catch at Versova ranges from 1-5kg/ haul. Fishermen discard it in the fishing ground as there is no market. *Tibia curta* bed was mapped with geolocations.

Tibia curta bed



Elasmobranch resources

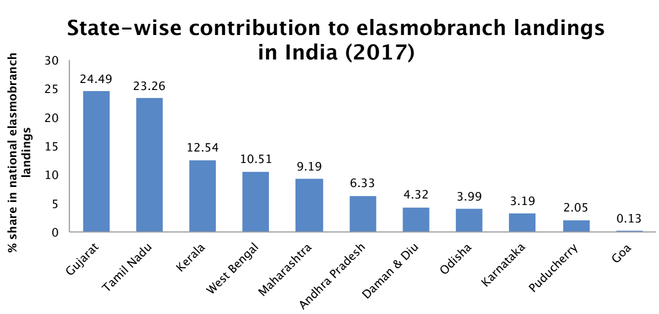
Research Projects: DEM/ELS/11 & DEM/ELS/SUB/11

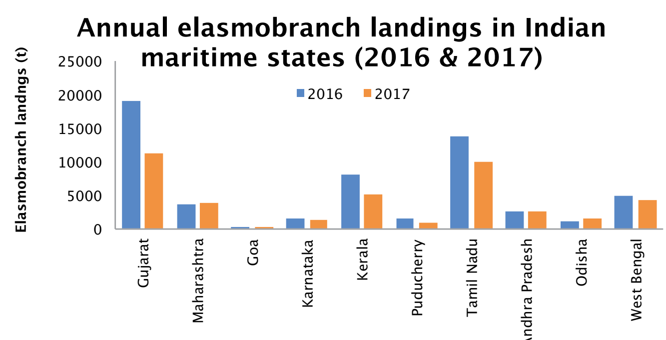
21%

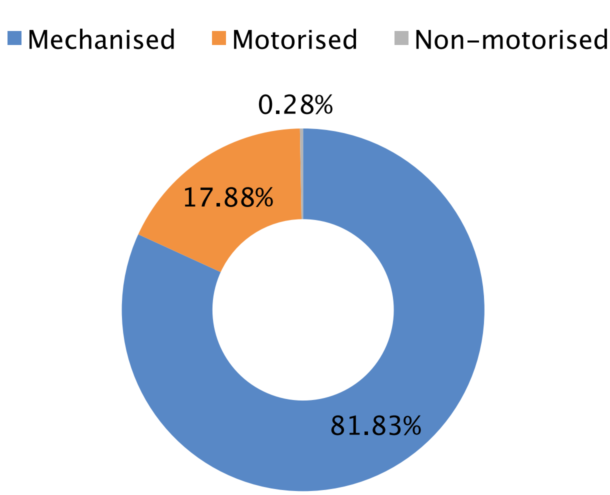
decrease on Elasmobranch landings in India during 2017 from the previous year.

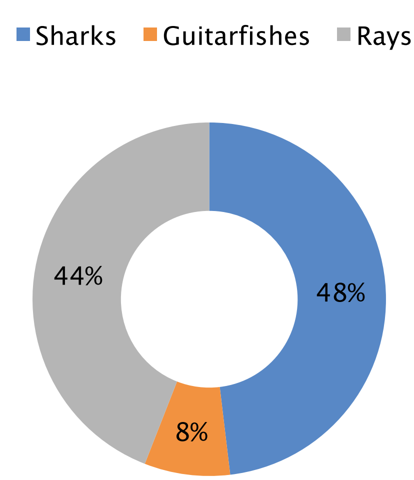
Fishery

Elasmobranch landings in India during 2017 was 41,345 t, registering a decrease of 21.8% from the previous year. Gujarat and Tamil Nadu were the major contributors. The west coast accounted for 53.8% of the landings and the east coast, 46.1%. Compared to the previous year, the landings decreased in all the states except Odisha and Maharashtra. The mechanised sector contributed to more than 80% of the elasmobranch landings. Contribution of non-motorised sector was negligible. Trawl nets contributed 65.2% of the









Sustainable management of fishery resources: Elasmobranch resources

Elasmobranch landings in India fluctuated between 41,000 and 75,000 t during the period 1985-2017, showing a declining trend

landings by the mechanised sector and gill nets 23.1%.

Sharks and rays together formed 92% and guitarfishes formed 8% of the elasmobranch landings. Sharks registered a fall by 15%, guitarfishes by 12% and rays by 43% from 2016. Shark landings were highest in Gujarat, Maharashtra, Kerala and West Bengal while rays were landed more in Tamil Nadu, Gujarat, Kerala and Andhra Pradesh. Guitarfishes were landed mainly in Gujarat and Tamil Nadu.

Elasmobranch landings in India fluctuated between 41,000 and 75,000 t during the period 1985-2017, with a declining trend. The average increase in the last five years is 2.6%.

Changes in elasmobranch landing patterns have been documented along the south Tamil Nadu coast, particularly in Thengapattanam and Colachel, where landings by Thoothoor fishermen have increased considerably over the last two years. Changes in elasmobranch fishery have also been observed following the Ockhi cyclone. Targeted shark fishery along north Kerala coast has almost stopped following the relocation of fishermen from Tamil Nadu who were engaged in this fishing.

Biology

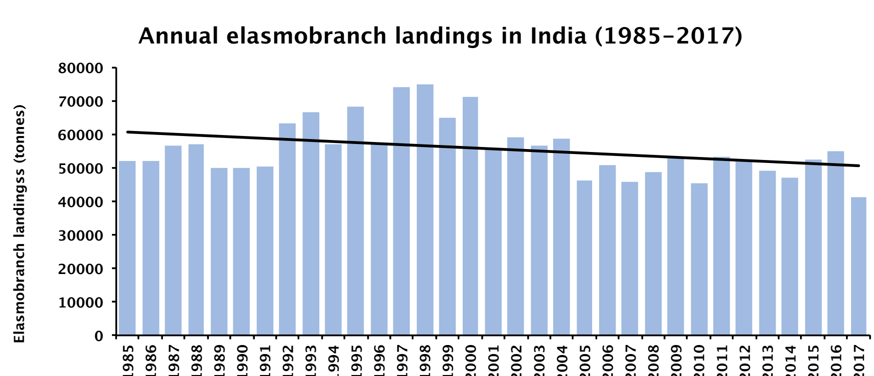
Size range of female *Neotrygon indica* in the fishery along Andhra Pradesh coast was 23-40 cm DW with a mean size of 30 cm, while that of males was 10-38 cm DW with a mean size of 29 cm. Sex ratio was 0.48. Mature females were seen in all months. Only a single pup at a time was seen in gravid females. Most of the stomachs were empty. The non-empty stomachs mainly had *Acetes* spp. and *Stolephorus* spp.

Stock assessment of *Gymnura poecilura* for the Andhra Pradesh coast revealed that the spawning biomass of male was only 11.8% of virgin biomass indicating a severely stressed stock. Spawning biomass of female was 20.8% of virgin biomass. Considering the critical need for conservation, a higher size of 50 cm DW has been proposed as Minimum Legal Size for Indian waters.

Size range of *Pateobatis bleekeri* in the fishery along Mandapam coast of Tamil Nadu was 30-180 cm DW, with mean length ranging between 59 and 170 cm DW. Sex ratio was 1:1.6. The litter size was 1. Major diet components were fishes, (silverbellies, *Sardinella* spp., *Selaroides* sp., eels and *Lethrinus* spp.), shrimp and crab.

Size range of *Himantura uarnak* in the fishery along Mandapam coast was 50-190 cm DW, with mean length ranging between 65 and 157 cm DW. Sex ratio was 1:1. The litter size was 1. Major diet components were fishes (silverbellies, *Lutjanus*, *Sillago*, *Stolephorus* spp. and goatfishes), stomatopods, octopus, shrimp and crab.

Size range of *Neotrygon indica* from



Sustainable management of fishery resources: Elasmobranch resources

Landing of juvenile sharks at different centres along the Indian coast

1. *Carcharhinus amblyrhyncoides pups - Cochin*
2. *Requiem sharks - Mumbai*
3. *Hammerhead sharks - Calicut*
4. *Tiger sharks - Mumbai*

Mandapam coast was 10-31 cm DW; mean length ranged between 26.5 and 38.8 cm DW. Sex ratio was 1:0.9. Litter size was 1-3. Major diet components were fishes, shrimp and crab.

Studies on the smoothback guitarfish *Rhinobatos lionotus* from north Tamil Nadu coast indicated size range of 10-81 cm TL in the fishery, with a sex ratio of 1:2. The litter size ranged from 2 to 7. Diet studies revealed a preference for fishes and shrimps.

Length range of *Carcharhinus falciformis* landed at Cochin was 95-255 cm with lowest annual mean length of 153 cm. The mean length (117 cm) was reported in November and the highest (186 cm) was in January.

Size range of *Mobula japanica* in the landings at Cochin was 45-135 cm DW, with annual mean size of 98.7 cm DW. The gill plates of this ray are smaller in size than that of manta rays and *Mobula tarapacana*, and are categorised as 'Third Grade' for trade purposes.

Size range of the scalloped hammerhead shark *Sphyrna lewini* in the fishery along Karnataka coast was 41-212 cm TL, with mean length of 47 cm, indicating fishing of juveniles. Sex ratio was 1:1.05. Juveniles of *S. lewini* measuring 40-80 cm TL were also recorded along the north Kerala coast and the Maharashtra coast. Landing of juveniles of other sharks were also quite high at Mumbai. Juvenile fishing and exploitation of undersised sharks remains a major concern all along the Indian coast.

The size range of the spadenose shark *Scoliodon laticaudus* in the fishery along Karnataka coast was 30-82 cm TL. The mean length of males was 36 cm and that of females was 42 cm. Growth parameters of *S. laticaudus* were estimated from Gujarat coast as L_∞ = 70.25 cm and K= 0.48 year^{-1}. Mortality parameters were Z = 3.36 year^{-1}, M = 0.86 year^{-1} and F = 2.50 year^{-1}. The current exploitation ratio (E) of 0.74 is much higher than E0.1 (0.704) and E0.5 (0.374) and is almost approaching E_{max}.

Growth parameters estimated for the guitarfish *Rhinobatos annandalei* from

Sustainable management of fishery resources: Elasmobranch resources

Rare/unusual landings of sharks recorded at different centres

1. *Crocodile sharks landed in Chennai*
2. *Bull shark landed in Vizhinjam*

Protected elasmobranchs stranded/accidentally caught

3. *Whale shark - Odisha*
4. *Sawfish - Maharashtra*
5. *Sawfish - West Bengal*

Gujarat coast were L_∞ = 98 cm and K = 0.26 year^{-1}. Mortality parameters were Z = 1.17 year^{-1}, M = 0.53 year^{-1} and F = 0.64 year^{-1}. The current exploitation ratio (E) of 0.64 is higher than $E_{0.5}$ (0.374) and almost approaching $E_{0.1}$.

Rare/unusual landings

The quagga catshark, *Halaelurus quagga* one of the rarest sharks in the family Scyliorhinidae (Order Carcharhiniformes) which is known only from < 20 specimens in the world was observed at Muttom landing centre, Tamil Nadu. It was landed as bycatch of a demersal trawl operation off Muttom at 150-200 m depths. Unusual landings of the crocodile shark *Pseudocarcharias kamoharai* was observed at Chennai in March 2018, as a part of the catch landed by trawlers that operated in offshore waters. Unusual landing of the bull shark, *Carcharhinus leucas* was observed all along the south Kerala coast in February and March 2018.

Training Workshop

Training Workshop on "Taxonomy and Identification of Elasmobranchs" was conducted at CMFRI, Kochi during 23-25 January 2018. Scientists associated with the project and technical staff of the Divisions of Demersal Fisheries and Fishery Resource Assessment at CMFRI, Kochi attended the workshop.

Value chain study

A value chain study has been initiated in collaboration with WWF and Traffic-India. Questionnaires for assessing socio-economics of shark fishers, economics of shark fisheries, market trends and

Sustainable management of fishery resources: Elasmobranch resources

1. *Participants of the training workshop on Taxonomy of Elasmobranchs*
2. *Fishermen awareness programme*

A pamphlet titled "Save Our Sharks" developed by CMFRI was translated and prepared in all the vernacular languages for distribution among stakeholders in all the maritime states.

consumer statistics were developed. The survey is being carried out in all the coastal states, across more than 70 centres.

Database on landings of protected elasmobranchs

Historic information on landings, accidental catches and sightings of the protected elasmobranchs in India was documented from published literature, news articles and data available at CMFRI centres and other organisations. Sawfish records were collated from sawfish rostrums preserved in museums across the country. Data were collected on such landings/occurrences in 2017 also.

On 26 September 2017, a dead male whale shark *Rhincodon typus Smith*, 1828 measuring 525 cm TL was stranded at Puri beach, Odisha. The specimen was identified as a young male without any physical injuries. One juvenile whale shark was accidentally caught and landed in Mangalore Fisheries Harbour on 28 Nov 2017. Accidental catches of sawfishes were recorded from Maharashtra and West Bengal.

Awareness generation

The First International Sawfish Day was observed on 17 October 2017. Wide media coverage on the work being carried out by CMFRI and awareness generation regarding the protected species was given. A pamphlet titled "Save Our Sharks" developed by CMFRI was translated and prepared in all the vernacular languages for distribution among stakeholders in all the maritime states.

Stakeholder Consultations

The annual stakeholder consultations held at CMFRI headquarters and different regional and research centres of the Institute were attended by fishermen/farmers, representatives of cooperative societies, fishermen associations, officials from state and central government organisations, scientific and technical personnel working in the field.

Veraval

The major discussions held in the meeting were on the increase in fleet size, decreased value realisation, scientific validation of monsoon fishing ban, harvest of undersised fishes etc. The fishermen suggested extension of fishing ban period instead of implementation of MLS. A SWOT analysis was also carried out with the fishermen to analyse strengths, weaknesses, opportunities and threats in the sector.

Mumbai

The major issues discussed were coastal pollution, harvest of live broodstock from sea, juvenile harvest of pomfrets by dolnets, MLS implementation, alternative incentives for the fishermen during closed season, pair trawling and regulation of cod end mesh size. One of the major concerns was the impact of coastal pollution on the survival of larvae

1. Stakeholder Meeting at Tuticorin RC of CMFRI

2. Stakeholder Meeting at CMFRI, Kochi

Sustainable management of fishery resources: Stakeholder Consultations

1. *Stakeholder Meeting at Visakhapatnam RC of CMFRI*
2. *Stakeholder Meeting at Vizhinjam RC of CMFRI*
3. *Stakeholder Meeting at Karwar RC of CMFRI*
4. *Stakeholder Meeting at Mangalore RC of CMFRI*

and juveniles of commercially important marine species. Suggestion also came up to implement fuel quota to reduce fishing effort. Capacity building among fishermen for cage culture also was suggested in the context of dwindling catches.

Karwar

The discussions were mainly focused on the experiences in cage farming by the farming community. They shared their concerns and issues came up during cage culture and appreciated the institute's efforts in demonstration programmes. Many farmers have shown interest to take up farming, for which the Institute offers technical assistance.

Mangalore

The key issues that came up for elaborate discussion in the meeting was on bull trawling, lack of uniform ban period, juvenile fishing, proliferation of fishing vessels with higher HP, destruction of submerged mussel beds, FAD based fishery and encroachment of mechanised vessels into traditional vessel zones. The suggestions included introduction of square mesh of 35 mm and make it mandatory at manufacturing level, HP regulations, and extension of trawl ban for 3 months and restriction of juvenile fish at procurement level of processing plants and ban on night fishing. Minister Fisheries, Govt. of Karnataka, Shri. Pramod Madhwaraj attended the consultation meeting.

Kochi

Elaborate discussions took place on the implementation of MLS regulation and impacts on juvenile fishery and on the revival of sardine fishery of the state. The major recommendations emanated were the implementation of MLS regulations to the neighbouring states to curtail growth overfishing, protection of spawners during their peak breeding season, detailed study on depleted near shore resources and migration pattern in demersal resources, changes in feeding and feed availability of oil sardine and to address the role of fishermen in coastal security. The

Sustainable management of fishery resources: Stakeholder Consultations

1. *Stakeholder Meeting at Veraval RC of CMFRI*
2. *Stakeholder Meeting at Mumbai RC of CMFRI*

fishermen also urged to consider scientific facts rather than political decisions while formulating policy frameworks.

Vizhinjam

The suggestions raised were to enforce strict regulatory measures to curb light fishing in territorial waters, community based conflict management system, impart training on marine ornamental fish culture to women, assistance to establish cages by fishermen at certain locations in light of the depletion of catches. Traditional fishermen also demanded to impose mechanised fishing ban for period of 90 days to curtail the huge harvest by the mechanised fishermen immediately after the ban period.

Tuticorin

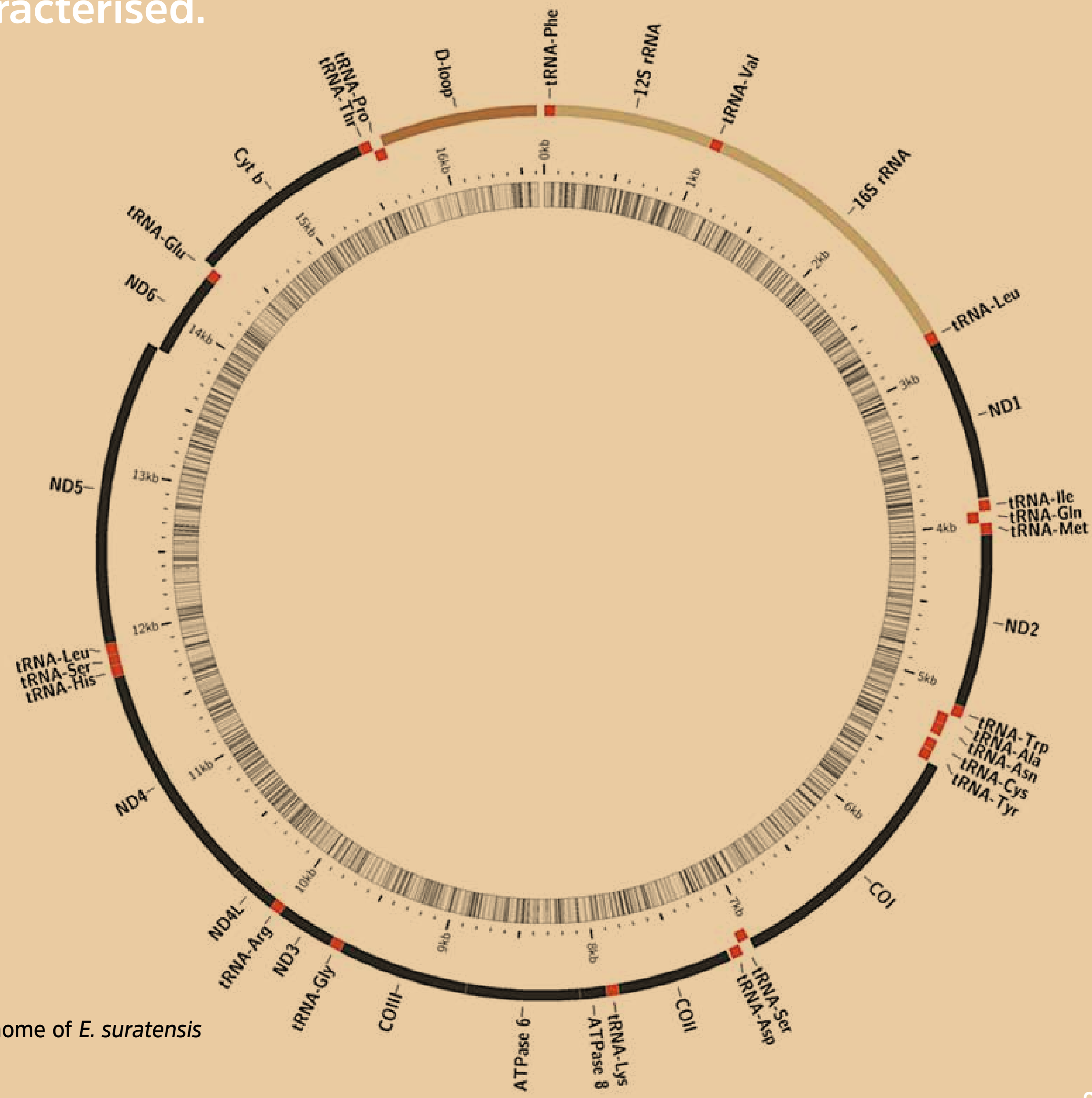
The major viewpoints raised in the meeting were the concern over the depletion of nearshore resources, provision for subsidised procurement of high power engines to reach the fishing grounds, impact of industrial effluents on the benthic fauna of nearshore waters, juvenile fishing of rays by skin diving, There was a demand from fisherwomen to get training on production of value added products.

Visakhapatnam

The points that emerged in the discussions were, concern on lack of formal sources of finance in marine fisheries sector, proliferation of high power engines in trawlers, lack of assistance from authorities during outbreak of disasters and lack of sufficient berthing facilities at Nizamapatinam and Machilipatinam areas of Andhra coast. The MLS suggested by CMFRI were agreeable to all stakeholders who attended the meeting.

Genetics and Genomics

The complete mitogenome of *Etroplus suratensis* collected from Vembanad Lake has been characterised.



Mitogenome of *E. suratensis*

Genetics and Genomics

16456bp

The mitogenome of *Etroplus suratensis* is 16456 bp circle with 37 mitochondrial structural genes

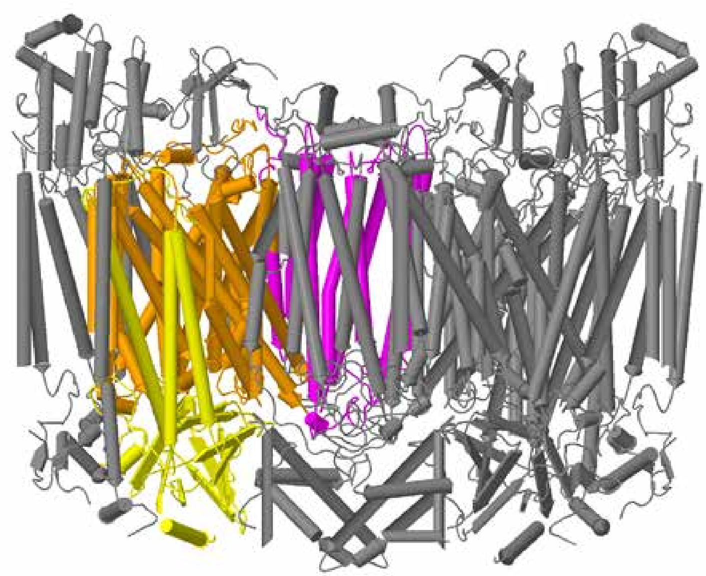
Characterisation of the complete mitogenome *Etroplus suratensis*

Research Project: MBT/GEN/25

The complete mitogenome of the green chromide, *Etroplus suratensis* has been characterised. The entire mitogenome was PCR amplified as contiguous, overlapping segments and sequenced. The assembled mitogenome of *E. suratensis* is 16456 bp circle, contained the 37 mitochondrial structural genes; two ribosomal RNA genes (12S rRNA and 16S rRNA), 22 transfer RNA (tRNA) genes, and 13 protein-coding genes and 1 non coding control region/D-loop with the gene order identical to typical vertebrates

Evidence for positive selection and adaptation in the mitogenome of Clupeids

Climatic vulnerability and adaptive potential of Clupeids of the world oceans was studied by analysing signals of diversifying selection on mitogenomes of 70 clupeid species belonging to 5 families. Clupeids adapted to fresh, brackish and marine waters spanning temperate and tropical regions were analysed to understand signals of diversifying selection if any. Habitat specific signals of positive and diversifying selection were discovered on mitochondrial protein



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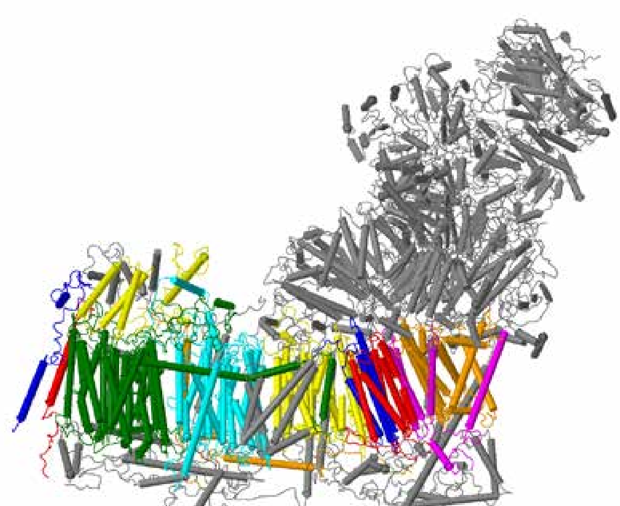


2

1. *Cytochrome C Oxidase protein*
2. *Respiratory Complex I*

Genetics and Genomics

Mitogenome of selected clupeid fishes showed signals of diversifying selection and adaptation in OXPHOS genes specific to freshwater, marine and brackishwater habitats across tropical and temperate latitudes

coding genes indicating the role of mitochondrial OXPHOS machinery as a critical adaptation mechanism.

Forensic identification of shark fin and gill samples

Forensic identification of shark fin and gill samples seised by the wildlife department was carried out using mitochondrial CO_1 sequences. The samples were identified as *Isurus oxyrinchus* -Short fin mako shark; *Rhina ancylostoma*- Bowmouth Guitar fish; *Manta birostris*- Giant manta ray; *Carcharhinus limbatus*- Black tip shark; *Carcharhinus longimanus*- Oceanic white tip shark and *Carcharhinus falciformis*- Silky shark.

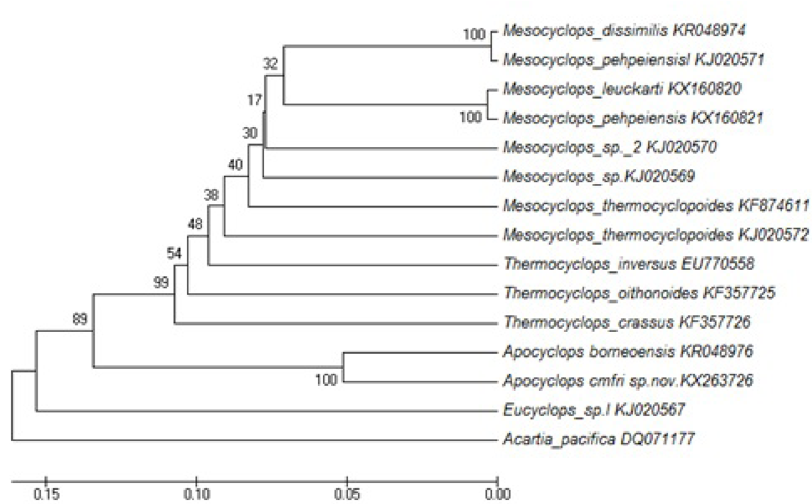
Molecular identification of a new species of copepod *Apocyclops cmfri* sp. nov.

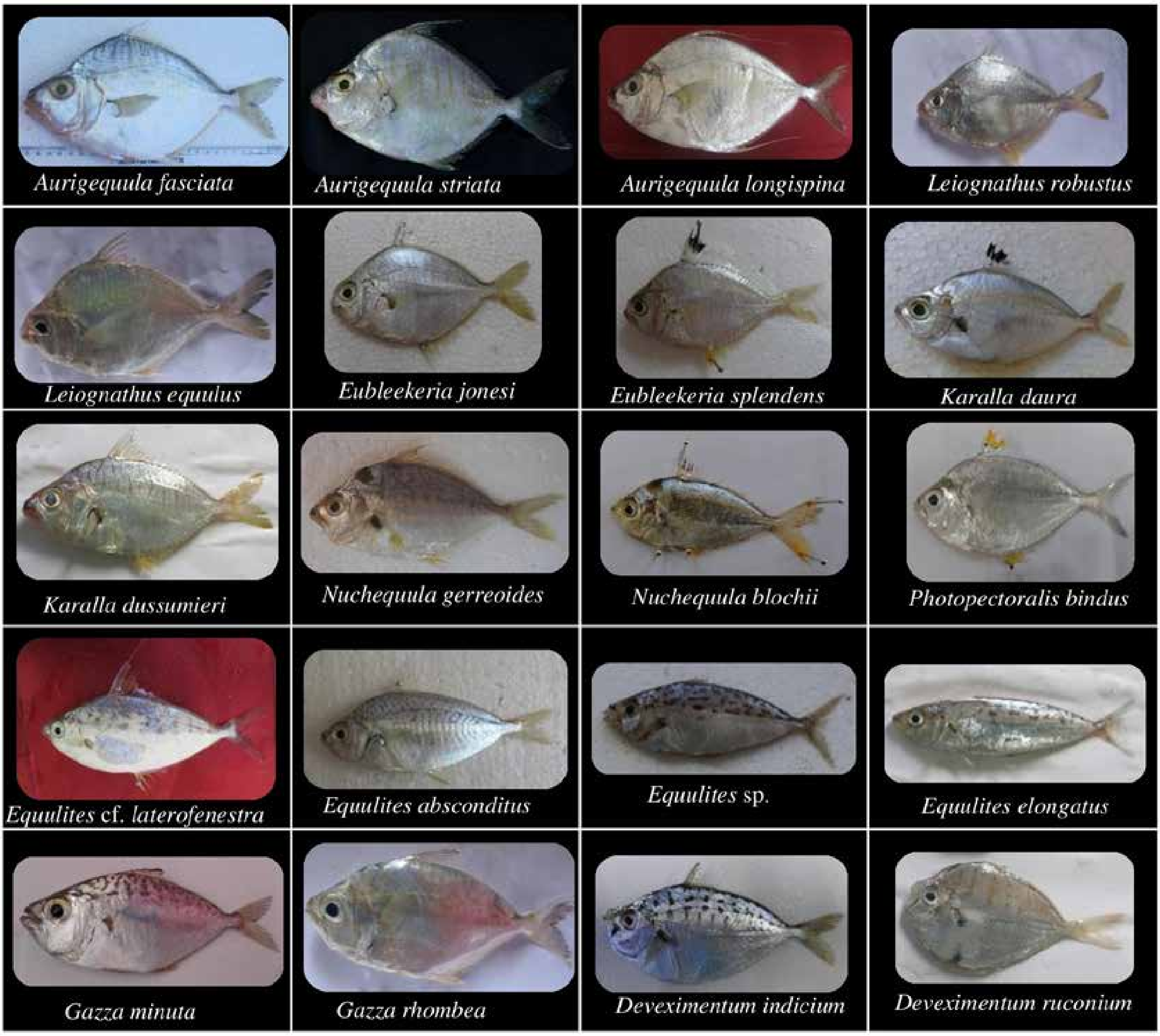
Molecular identification of a new species of copepod *Apocyclops cmfri* sp.nov. was carried out by mitochondrial cytochrome c oxidase 1 (CO_1) gene sequencing and the sequence was submitted to NCBI, GenBank. The CO_1 sequence of *Apocyclops* sp. was aligned with sequences (Gen Bank) of other valid species belonging to *Apocyclops* genus *viz*., *A. borneoensis* and species belonging to other closely related genera *Mesocyclops, Thermocyclops* and *Eucyclops* using Clustal W in MEGA 6.

The phylogenetic tree constructed using 13 sequences of the four closely related genera with *Apocyclops cmfri* sp.nov. showed distinct clustering among genera with significant bootstrap values. Kimura 2 p distance values between species showed 10.2% divergence between *A. cmfri* sp. nov. and *A. borneoensis* and 26.6, 27.5 and 34.9% divergence between *Apocyclops* genus and the genera *Mesocyclops*, *Thermocyclops* and *Eucyclops* respectively.

Phylogenetics of leiognathids

Phylogenetic analysis with Mr. Bayes was conducted for 20 fish species of family Leiognathidae using 3523 characters derived from four mitochondrial and one nuclear markers. Monophyly of Leiognathidae was strongly supported with a high posterior probability value of 1. The phylogram was divided into two main clades with high Bayesian clade support values. Clade-I represented non-sexually dimorphic genera of subfamily Leiognathinae and Clade II included representatives of all sexually dimorphic ponyfish genera of subfamily Gazzinae available along Indian coast. The evolutionary divergence between the two clades was 17.4%. In Gazzinae, tribe Nuchequulini recovered as a sister clade to tribe Equulitini and tribe Eubleekerini formed one sister clade to Gazzini.





Microalgal species identification

Molecular identification of *Prymnesium parvum* from Kovalam Field Lab, Chennai was carried out using 18S rRNA marker. Genetic characterisation of *Trichodesmium erythraeum* bloom from the Gulf of Mannar was done with heterocyst differentiation protein (*hetR*) gene. Phylogenetic analysis, carried out with partial sequences of *hetR* gene in 8 reported species of *Trichodesmium*, resulted in 3 clusters with high bootstrap support.

Characterisation of IGF-Insulin like Growth Factor gene of *Trachinotus blochii*

IGF-Insulin like Growth Factor gene of Pompano, *Trachinotus blochii* was partially characterised by cross amplification method employing primers reported from gilthead sea bream *Sparus aurata*. The sequences obtained were found to be covering the promoter (861 bp) region through first exon (25bp) and the full first intron (1466bp).

Growth related hormone gene identification in marine fin fish

Partial gene of growth related hormones such as growth hormone (GH) and Insulin like Growth Factor (IGF) genes were identified from Indian pompano. Primers for respective genes were designed based on the GH & IGF gene sequences of fish species from *Trachinotus* genus. Added to this, partial sequence of β-actin gene was also amplified from the species. The nucleotide sequence of 272 bp of GH gene, 350 bp of IGF gene & 264 bp of β actin genes deduced through Sanger sequencing. The blast search of the *Trachinotus mookalee* GH sequence showed 91% similarity with GH gene sequence of *Seriola lalandi* & *S. quinqueradiata* growth hormone (GH) mRNA, at 100 % coverage. Blast search for IGF gene showed 91% & 90% similarity with *Seriola lalandi, S. dumerili* & *L. calcarifer* IGF gene sequence at 99% sequence coverage. The β actin gene blast search showed that the gene sequence of *T. mookalee* has a similarity of 97 and 95% with *T. ovatus* & *Oryzias dancena* beta actin gene at 100% coverage.

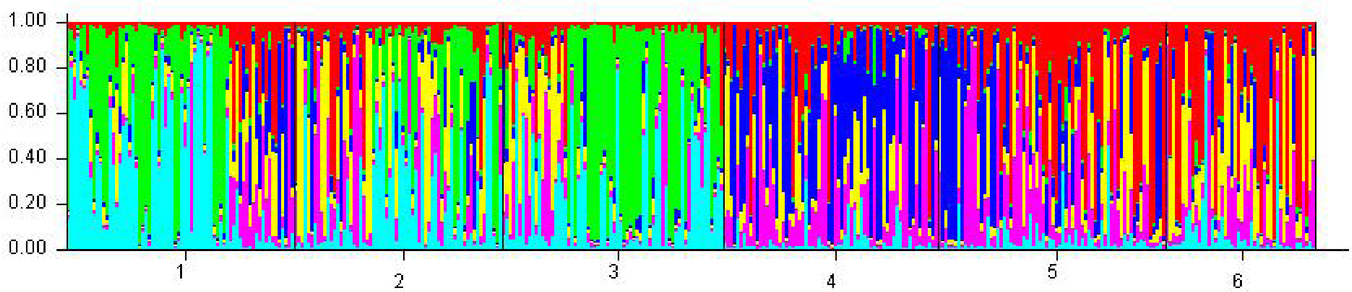
Growth related hormone gene expression in orange spotted grouper

Growth hormone related gene expression was studied in orange spotted grouper fed with different protein feeds. The objective of the study was to find out the level of gene expression in fish fingerlings that showed different growth with different feeds. Orange spotted grouper fingerlings of 2 g size were stocked and fed with 8 different feeds including 32%, 40%, 45% and 50% crude protein (CP) in one experiment and in another experiment the fingerlings were fed with 32%, 40%, 45% and 50% of crude protein with *Acetes indicus* at 1:1 ratio. Fingerlings were fed

Characteristics of twelve microsatellite loci amplified in *L. argentimaculatus*

Si. No	Locus	Repeat motif	Primer sequence(5' to 3')	T (°C)	No alleles	Size range (bp)
1	Lru001	$(CA)_{15}$	F= TCCCTCTGTTGTTGAAAG R= CCTGATCTCGATAGTGCC	59	31	110-350
2	Lru010	$(CA)_{28}$	F= GCAAACGGAGGAAACAAA R= CTGAAGCTCGGATGAGGA	61	48	114-298
3	LCA20	$(CA)_{12}$	F= CAACCCTCTGGCTAGTGTCA R= ATCCTGAAGCCCTGGTTTAC	64	27	134-250
4	LCA22	$(GT)_{29}$	F= TCCACAGGCTTTCACTCTTTCAG R= TGCTCTTTTCTTTCCGTCATTCC	66	74	112-348
5	Lca27	$(TG)_{15}$	F= TGAGTGGCTGTGTTTTGCTG R= GTGCGTTGTGTTTGTTGGTC	61	21	102-188
6	BST2.33	$(TG)_{35}$ $(CG)_{12}$	F= TAATGCCCACAAACCTGCTGG R= ATGTTCCACAACGCCTGACAAACC	57	23	114-200
7	BTS6.39TG	$(CA)_{17}$	F= GCAGCATTAAGTGAGAGAGGC R= GGATAATGTAGGGCCAGAGCG	60	38	102-196
8	BTS6.56	$(TG)_{8}$	F= ACGTGAGCATTCAGGGTAA R= ATCTCCATCATCTGCTGCCTTGG	52	21	100-234
9	90RTE	$(CA)_{4}$CTCATA $(CA)_{17}$	F=ATGCTGTCCACTTCCTCCAGC R=TTTCTCAAACTCCTGCCCTTCC	55	19	122-204
10	Lk-31	$(AGAT)_{13}$	F= AAGCAGACGATGACTGAAGACT R= GCACCATCGACACGTGATAC	56	14	104-168
11	PRS-275	$(CA)_{12}$	F = CACAGATACAAACCCAGACA R= AGTAGGTCTTTGGTCATCA	58	17	102-172
12	Lru013	$(CA)_{12}$	F= CATCGGGTATTTAGACAA R= AGTGCCAACTACTGCTTT	55	22	144-244

Genetics and Genomics



Bar plot of structure analysis for microsatellite data.

for two months with respective feeds and after two months, brain samples were collected, RNA isolated using Trizol solution and then converted to cDNA using the PrimeScript™ 1st strand cDNA Synthesis kit (Takara, Japan). The, GH gene expression level was quantified using qRT-PCR with the primers designed from Orange spotted grouper GH sequences available in NCBI Genbank database.

Genetic stock structure analysis of *Lutjanus argentimaculatus*

Genetic stock structure of *L. argentimaculatus* from Indian waters was studied using 12 polymorphic microsatellite markers. A total of 384 individuals from six different geographic locations (Mumbai, Mangalore, Kochi, Mandapam, Vizag and Port Blair) were used for the study. Data generated from all the 12 loci was considered. The total number of alleles per locus ranged from 14 (Lk-31) to 74 (LCA 22). Allele size ranged from 100 to 350 bp. The mean of observed number of alleles was found to be 29.5. The observed and expected heterozygosities were found to be 0.734 and 0.791 respectively. Pairwise F_{ST} values

Details of microsatellite primers selected for genetic stock structure analysis in *E. tetradactylum*

No	Primer name	Sequence	Size range
1	Pse8	F: AGTGCCCGTGCAACCATACC R: GACTTGGGGTTCAATGTCGT	194
2	Pse27	F: TGACATATTGCGTGGGATTG R: AATGGTCACCTGCTGGGAAG	229
3	Pse52	F: GAGTTGCTCAGGTGGGGTTA R: TGAGGAGTGGCTGAAGTGAA	181
4	Etet1	F –CCCAGAAGGCAGCGTGAG R-TCCCATGAGTGATAGCTTTTGC	128-264
5	Etet2	F-TTGGGCATGGTGGCTTTTG R-GTCAGATGGACCAGATTAACTTCC	206-241
6	Etet3	F-GTGCAACGAGGTCATCAGC R-TGCACACCTTCTCCAGCTC	194-215
7	Etet4	F-GCACAGCTCGGTTTTCTGG R-TACAACCTC CCTGCTGGAC	155-191
8	Ptd11	F: AAGATCCTCGTGCCACCTCA R: GTTATTTAGAGTTGTCACCG	239
9	Ptd15	F: GCACCCACAAACATGCTCAAAT R:TGTGACGGTTTCTCCATTG	206
10	Ptd16	F: CGCAATGGAGAAACCGTCA R: GATGTTCACCTTGGCTCTC	189
11	Ptd20	F: AAAGTCTCCCAACAGATGAT R: ATGCCAATTACAAGAGTCGA	267
12	Ptd57	F: AAAAGGCTGTGAGTGAATGA R: GACCTGGTGCTTTATTACTT	179

Genetic stock structure investigations in *Lutjanus argentimaculatus* revealed lack of significant genetic differentiation between geographical locations along the Indian coast

and AMOVA results indicated lack of stock structuring in *L. argentimaculatus.* Bar plot of structure analysis for microsatellite data also support this finding. Bottle neck analysis using Wilcoxon test and Mode shift test hints a stable population In Indian waters.

Population genetic structure of *Eleutheronema tetradactylum* using microsatellite markers

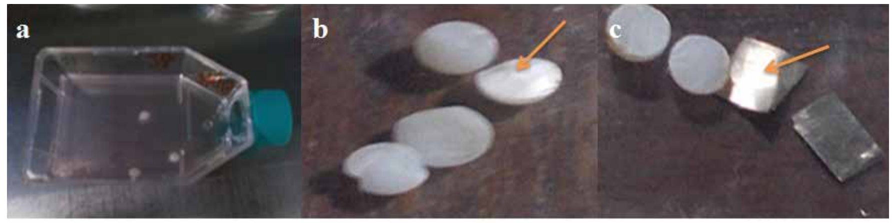
Research Project EF/3

Genetic stock structure of *E. tetradactylum* was studied using microsatellite markers by collecting samples from Veraval, Mumbai, Goa, Kochi, Mandapam, Vizag, Chilka and Digha. Twelve polymorphic microsatellite markers were identified through cross species amplification and NGS technology. Microsatellite genotyping was carried using 6FAM labelled primers. A total of 510 samples were collected for the study. Microsatellite genotyping using 7 microsatellite primers has been completed and the remaining is in progress.

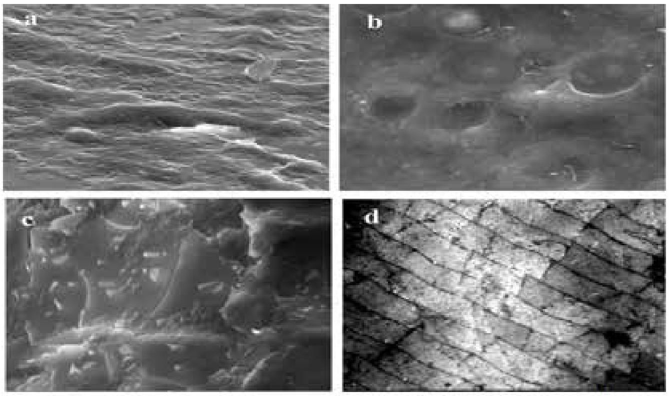
Biomineralisation of mantle tissue from pearl producing molluscs

Research Project: MBT/TSU/26

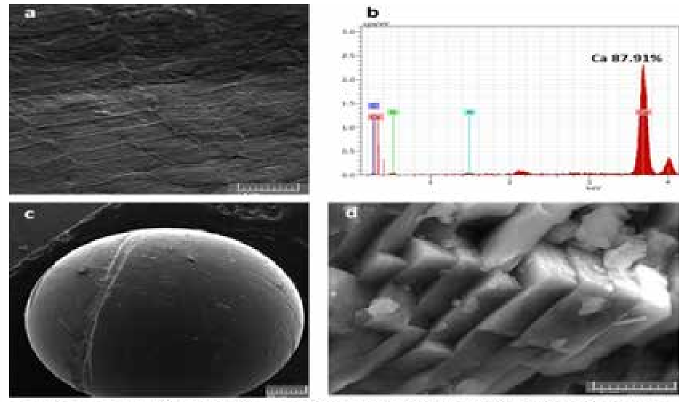
Mantle tissue extract, whole body extract and body fluid of *Pinctada fucata* were prepared for supplementing the medium, studying their effect on cell proliferation and also for profiling of compounds. Effect of supplements bovine insulin, epidermal growth factor, catalase and calcium chloride on improving mantle epithelial cell culture viability in *Pinctada margaritifera* was studied. The biological active compounds of *P. fucata* were screened for the first time. 4-flourohistamine, 2,4,6,8,10-tetradecapentaenoic acid and hexesterol were the major compounds extracted from mantle tissue of *P. fucata* and hexesterol, 1,2,4-benzenetricarboxylic acid, 1,2-dimethyl ester and 3-phenyl-2H-chromene from the whole body of *P. fucata.* Increased cell proliferation and crystal formation were noticed in explant cultures and iridescent crystals were seen in groups in organ cultures. Nacreous layer formation by cultured mantle epithelial cells of *P. margaritifera* on nuclei made of smooth plastic, rough plastic, glass and shell analysed using Scanning Electron Microscopy and Energy Dispersive X-ray Analysis revealed a typical brick and mortar formation, characteristic of nacre only on the nucleus made of shell. When a semi-solid agar substrate was used to study nacre formation on nuclear shell beads, a good brick and mortar formation of nacre, with a high concentration of calcium was observed by SEM. A cross section of the coated bead revealed a pattern of arrangement of aragonite tablets similar to that seen in cross sections of nacre layer of molluscan shell. Amplification products for nacrein (480 bp) and ACCBP (500 bp) genes were obtained in both native mantle tissue and cultured mantle epithelial cells from *P. margaritifera* when expression of genes involved in biomineralisation was compared. The amplicons of these genes were sequenced. Cryoprotective effects of 5-10% glycerol, dimethyl sulfoxide, ethylene glycol and a mixture of the three



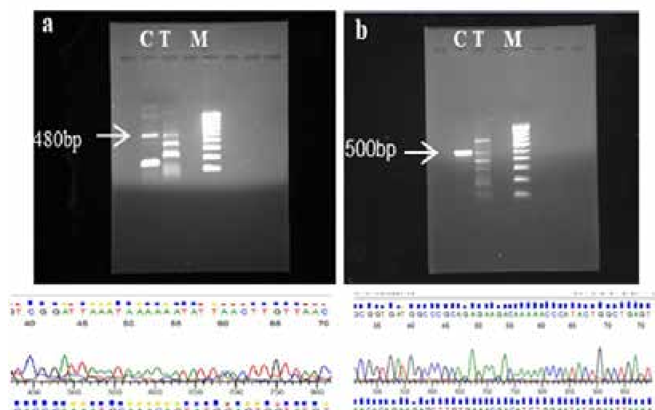
a) Culture plate with half beads; b)Shining over a half bead;; c) Titanium piece with shining



Scanning electron microscope images of nuclei made from different materials with cultured mantle epithelial cells of the black-lip pearl oyster, *Pinctada margaritifera*. a) smooth surface plastic; b) glass; c) rough surface plastic; d) shell.

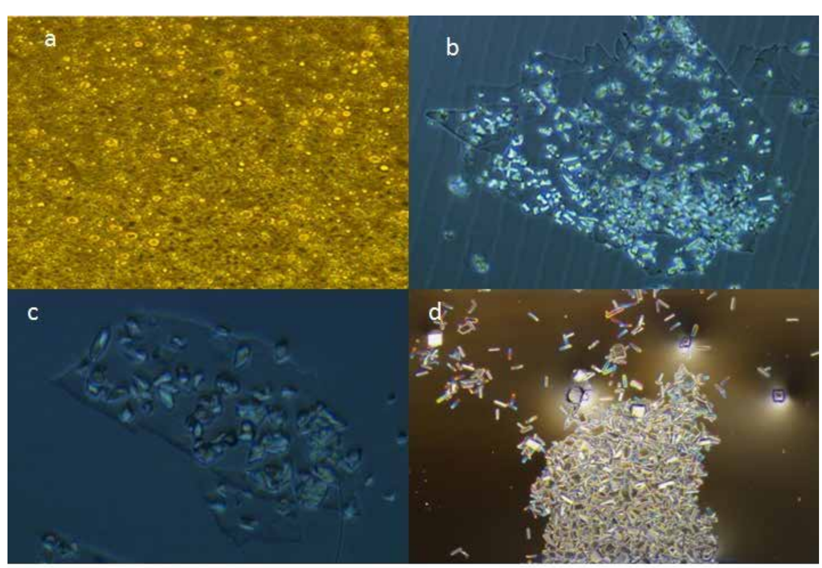


Scanning electron microscope images of nuclear bead incubated in semi-solid substrate with cultured granulated mantle epithelial cells of the black-lip pearl oyster, *Pinctada margaritifera* a) surface view; b) X-ray spectrum of bead surface; c) bead with cut made on surface; d) cross-section of cut region of bead. Scale bar-5 µm.



Top: Expression of (a) nacrein and (b) amorphous calcium carbonate binding protein (ACCBP) genes involved in biomineralization in *in-vitro* cultured mantle epithelial cells (C) and mantle tissue (T) from *P. margaritifera;* M-100 bp DNA ladder.Bottom: Partial sequences of these gene amplicons

Screening of *Pinctada fucata* revealed 4-flourohistamine, 2,4,6,8,10 -tetradecapentaenoic acid & hexesterol as the major biologically active compounds in mantle tissue and hexesterol, 1,2,4-benzene tricarboxylic acid, 1,2-dimethyl ester & 3-phenyl-2H-chromene in the whole body



a)Cell proliferation in explant cultures; b & c) crystal initiation in explant cultures; d) Iridescent crystals in groups in culture plate.

cryoprotectants were compared. Viability and metabolic activity were better in glycerol and DMSO-treated cells.

In vitro culture of embryonic stem cells and induced pluripotent stem cells

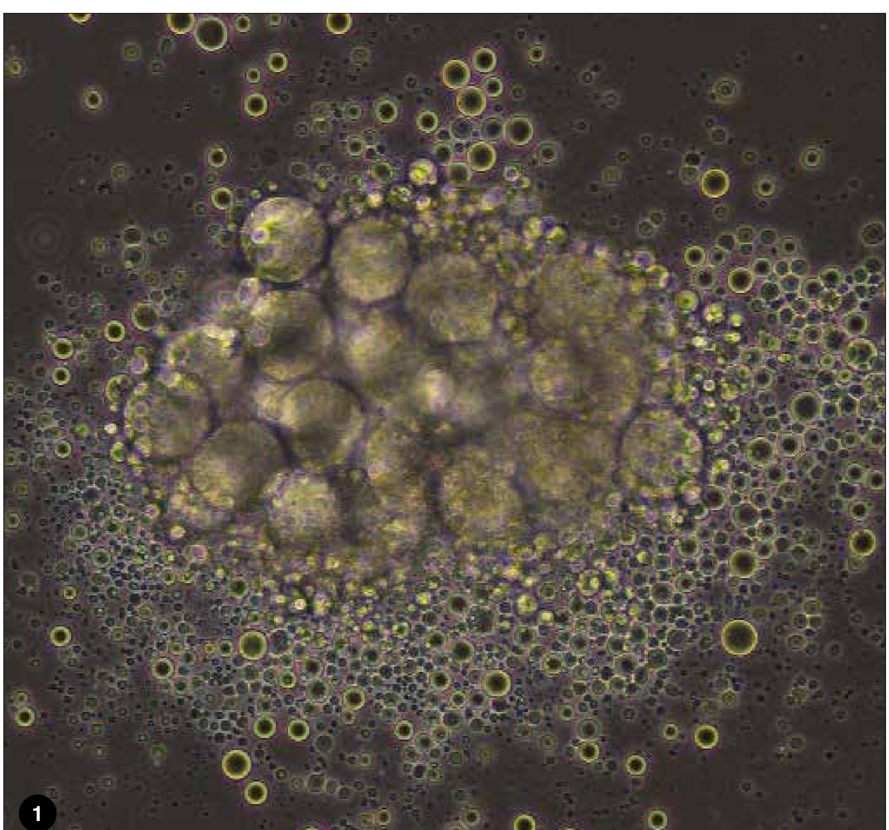
Research project: EF/10

Embryonic stem cells

Embryonic stem (ES) cell cultures derived from midblastula stage embryos were characterised for the presence of stem cell specific surface markers TRA1-60 and SSEA-4 by immunoflourescence staining. To ascertain the efficiency of *in vitro* gene transfection, ES cells were transfected with pMAX GFP by nucleofection. ES cells were found to be positive for TRA1-60 and SSEA4. ES cell cultures exhibited efficient transgene expression when transfected with pMAX GFP by nucleofection.

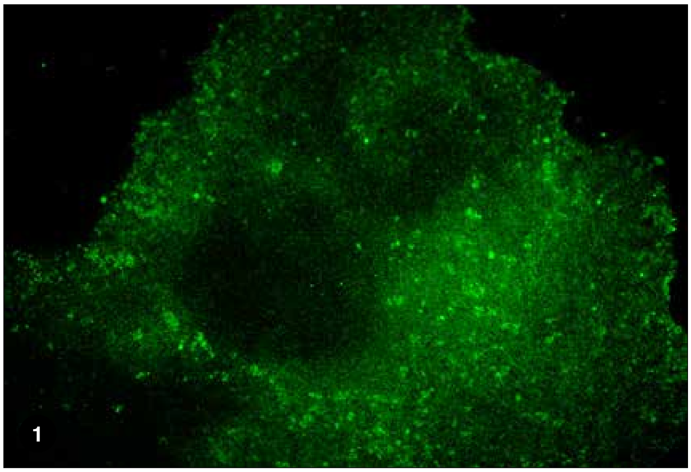
Derivation of induced pluripotent stem cells (iPSCs)

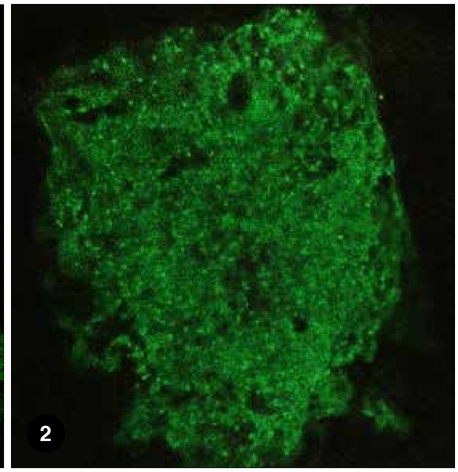
Attempts were made to passage the putative iPS colonies derived from fibroblast cultures of CA1F4Tr (initiated from fin tissue of *Cromileptes altivelis* at passage level 3) by transfection with the oriP/EBNA1 episomal vector pEP4 E02S CK2M EN2L having 6 pluripotentcy transcription factors *viz*., Oct4, Sox2, Nanog, Klf4, Lin28 and C-Myc. Putative iPS colonies showing strong signals of the reporter gene (GFP gene) expressions were obtained. However, after subculture successful iPS colonies could not be established and therefore different vectors having various combinations of transcription factors are being attempted for improving reprogramming efficiency and to derive successful iPS colonies.

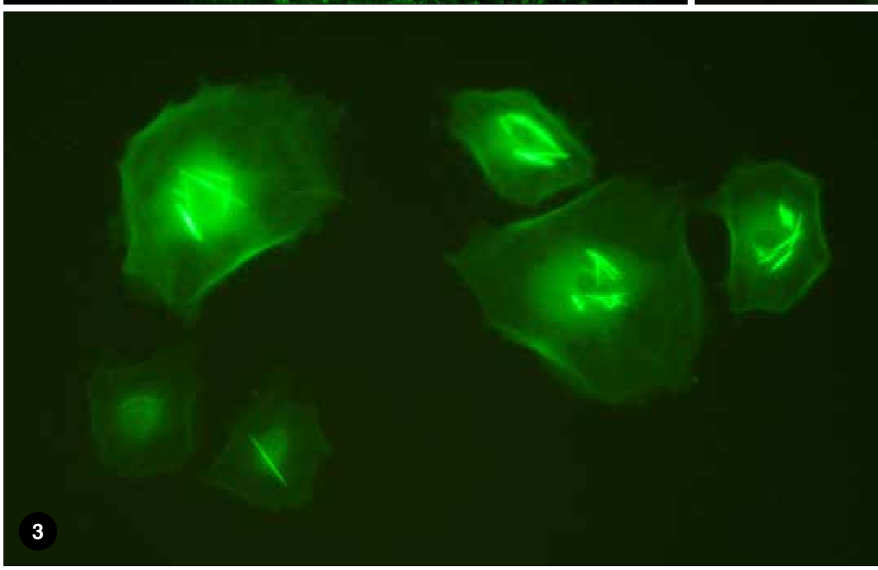


1. *ES cell primary cultures*
2. *ES cell colony*

Genetics and Genomics







1. *TRA1-60 positive cells*
2. *SSEA-4 positive cells*
3. *Expression of GFP gene*

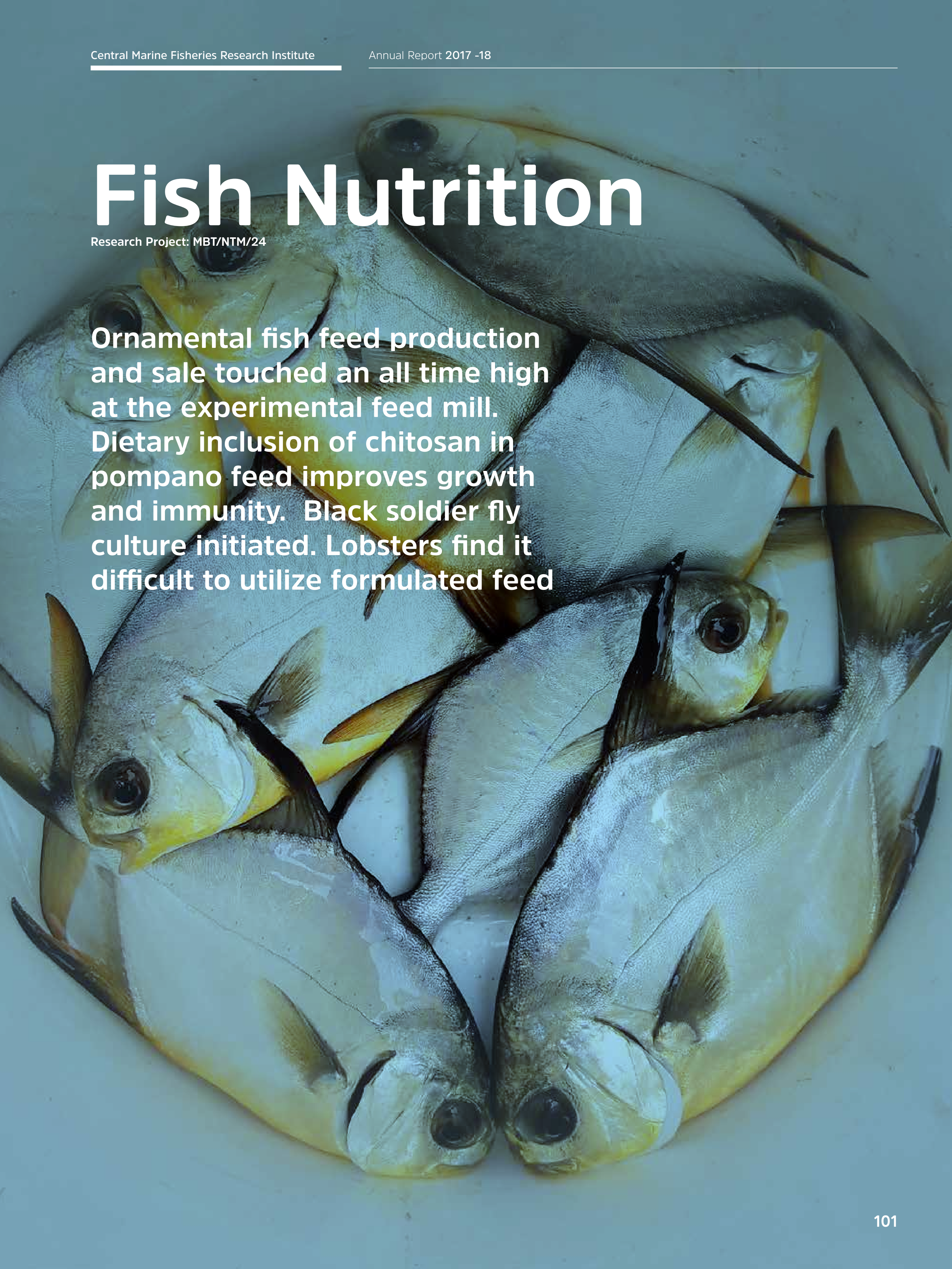
eDNA metabarcoding based estimation of marine stocks

Research project: MBT/DNA/37

Initiated eDNA (environmental DNA) barcoding from known fish samples in CMFRI marine aquarium tanks. Five hundred millilitres of water (salinity 35 ppt; temperature 26.2ºC) collected from each of 4 different tanks and pooled. Water was filtered through 0.45 µ filter, DNA extracted and PCR-amplified. DNA was purified, cloned and 5 positive clones were sequenced. Of the five clones sequenced, as per BLAST (NCBI) search four of them belonged to Silver moony (*Monodactylus argenteus*) and one to Orange skunk clownfish (*Amphiprion perideriaon*). The observed results were in agreement with the dominance of species in the samples, thereby confirming efficacy of the present methodology used.

Particulars of marine aquarium tanks from which water samples were collected for eDNA study

Tank #	Fish species	Number	Total length (mm)
1	*Rhinecanthus aculeatus*	1	70
	Dascyllus trimaculatus	1	90
2	*Apolemicthys xanthurus*	1	120
	Labroides dimidiatus	1	80
	Halichoeres leucoxanthus	1	90
3	*Amphiprion perideraion*	10	70-80
	Pomacentrus caeruleus	1	70
	Threespot Dascyllus (Dascyllus trimaculatus)	1	90
4	*Silver moony (Monodactylus argenteus)*	20	90-100



Fish Nutrition

Research Project: MBT/NTM/24

Ornamental fish feed production and sale touched an all time high at the experimental feed mill. Dietary inclusion of chitosan in pompano feed improves growth and immunity. Black soldier fly culture initiated. Lobsters find it difficult to utilize formulated feed

Fish Nutrition

239 kg

ornamental fish feed was produced and sold

Feed production at the experimental feed mill in CMFRI Kochi

Fish feed production in the experimental feed mill at CMFRI reached an all-time high of 239 kg generating ₹88,100/- during the financial year. The month-wise production data indicated, *Varna* the marine ornamental fish feed as the most sought after product

Dietary chitosan improves growth and immunity of the snub nose pompano, *Trachinotus blochii*

Effect of dietary chitosan on the growth, haematological parameters and immune response of snub nose pompano, *Trachinotus blochii* was evaluated with four isonitrogenous and isoenergetic practical diets (40% crude protein, 6% crude lipid) formulated by incorporating chitosan (Himedia, degree of deacetylation ≥75%) at four concentrations as 0 (T_1), 1.0 (T_2), 2.0 (T_3) and 4.0 (T_4) percent.

Sub-adults of pompano with an average size of 560.67±7.08 g were used for the experiment with six fish kept in each tank of 1 t capacity. Biological filter assembly was provided in all the tanks with aeration. The fishes were maintained in filtered seawater of 20 ppt salinity. Feeding was done up to satiation twice daily at 10:00 and 16:00 h and the feeding trial was conducted for a period of 30 days.

Growth

Growth parameters such as percentage weight gain (WG%), specific growth rate (SGR), feed efficiency ratio (FER) and average daily growth (ADG) was highest

Growth of snubnose pompano fed different levels of chitosan

Parameters	T1	T2	T3	T4
WG%	4.42 ± 0.36[bc]	4.68 ± 0.24[c]	3.67 ± 0.22[ab]	3.57 ± 0.10[a]
SGR%	0.14 ± 0.011[bc]	0.15 ± 0.008[c]	0.12 ± 0.007[ab]	0.12 ± 0.003[a]
ADG (g)	0.82 ± 0.06[ab]	0.88 ± 0.05[b]	0.69 ± 0.04[a]	0.67 ± 0.019[a]
FCR	3.73	3.21	3.42	3.32
FER	0.27	0.31	0.29	0.30

WG%-weight gain%; SGR (%)- specific growth rate (%); FCR- feed conversion ratio; PER- protein efficiency ratio; FER-Feed Efficiency Ratio; ADG (g)- average daily growth in grams;

in fishes fed with 1% chitosan in feed (T2 group). Lowest values of WG%, SGR% and ADG were observed in T4 group fed with highest level of chitosan (4%). FCR was highest in T1 and lowest in T2.

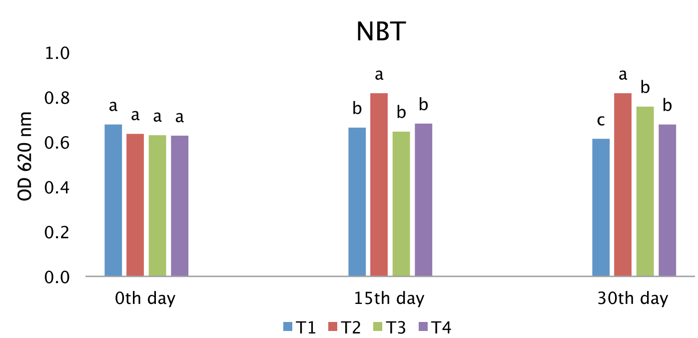
Haemato-biochemical parameters

A better respiratory burst activity was observed in the blood of fishes fed with 1% chitosan in the diet in the 15th and 30th days of experiment, which indicates an enhanced immune response. A faster rate of blood clotting was observed in T4 group fed with 4% dietary chitosan, which supports the hemostatic effect of chitosan. Other hemato-biochemical parameters were found to be within the normal limits. There was no significant difference in the levels of serum uric acid and creatinine between the treatments during the experimental period, which indicates lack of any adverse effects to the kidneys due to dietary chitosan.

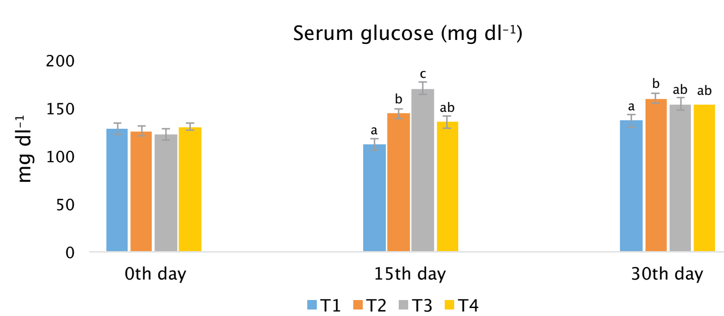
Serum glucose levels were significantly different ($P<0.05$) among the treatments. The highest level of glucose was observed in T3 group, in the 15th day of sampling and in T2 group on the 30th day.

There was a significant difference ($P<0.05$) in the levels of serum cholesterol and triglycerides between the treatments on the 15th and 30th days of trial. On the 15th day, the highest level of cholesterol and triglycerides was observed in the T4 and T3 groups while on the 30th day, the

Respiratory burst activity of pompano in different treatments



Serum glucose levels (mg dl^{-1}) in pompano fed with different levels of chitosan



In a pioneering attempt, black soldier fly (BSF) were cultured by utilising food waste

highest levels were observed in T2 and T1 groups respectively.

Based on the analysis of various parameters, it can be concluded that 1% of dietary chitosan acts as an immunostimulant in snubnose pompano and results in better growth and immunity.

Growth of *Trachinotus blochii* at farm level using the feed developed by CMFRI

In collaboration with the ICAR-KVK, Ernakulam at Njarakkal and ICAR-CIBA, Chennai, growth of pompano on farm, using a cost effective, slow sinking formulated feed (with crude protein and lipid content of 40% and 6% respectively) developed by ICAR-CMFRI through laboratory trials was evaluated. The feed was manufactured in the feed mill of ICAR-CIBA, Chennai. Fishes with an average size of 3.2 cm and 0.7 g were obtained from the marine fish hatchery at ICAR-CMFRI, Mandapam and stocked in floating cages (2x2x1.5 m^3) owned and operated by farmers at four different locations namely, Pizhala, Kadamakkudy, Kottapuram and Anapuzha identified by KVK at the rate of 300 fish per cage, in December, 2017. The fishes were fed to apparent satiation twice daily. The feed was observed to be palatable and readily acceptable by the fishes. The feeding trial was planned for a period of six months (12th December, 2017 to 12th June, 2018).

Sampling was done monthly and data pertaining to the growth of fish and quality parameters of water were collected from December, 2017 onwards. Among the four sites, Kadamakkudy registered maximum weight gain percentage, specific growth rate and average daily growth, while the least values were observed at Kottapuram.

Feed supplied by CIBA, Chennai for the trial

Nutritional composition of black soldier fly pupae (BSF), *Hermetia illucens* using food waste as substrate

In a pioneering attempt, BSF were cultured by utilising food waste from the departmental canteen of ICAR-CMFRI (HQ). As an excellent means for the bioconversion of organic wastes into high value sustainable protein for aquaculture, an indigenous small scale system was designed using low cost components. Food waste was filled up to a quarter in the unit and kept in an open area. The eggs of BSF were observed after two weeks. Metamorphosis of egg to larva is within four days and larva to pre-pupa is within 10-14 days normally, which may extend up to three weeks depending upon the nutrition. Pupa formation is within another seven days. The samples were analysed for nutritional composition. An average of 20g wet weight of BSF pupae was collected on alternate days for a period of one month from food waste of about 2 kg.

Effect of stocking density on growth, feed utilisation and biochemical composition in snubnose pompano

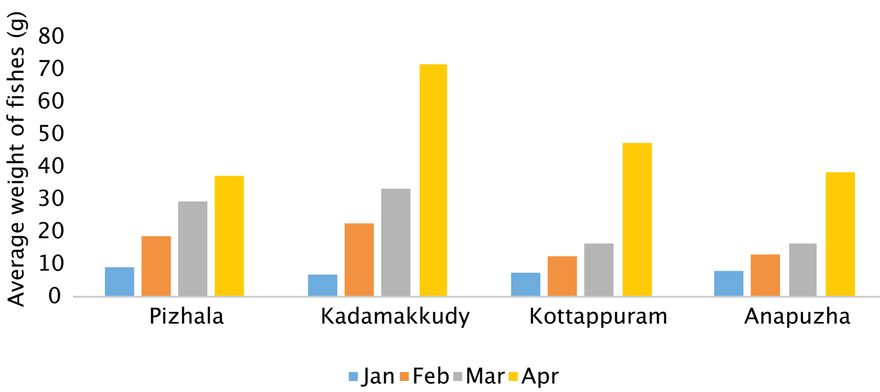
Snubnose pompano with an average weight of 220±10 g were distributed

Fish Nutrition

Water quality parameters

Locations	Salinity (ppt)	DO (ppm)	Water temp. (°C)	pH	NH_3	NO_3	NO_2
Pizhala	27.67 ± 3.38	6.61 ± 0.26	27.32 ± 0.52	7.62 ± 0.37	ND	ND	ND
Kadamakkudy	24.40 ± 0.89	7.82 ± 0.35	27.42 ± 0.56	7.82 ± 0.29	ND	ND	ND
Kottapuram	23.18 ± 1.34	6.21± 0.21	27.64 ± 0.79	8.10 ± 0.71	ND	ND	ND
Anapuzha	22.16 ± 1.32	6.92 ± 0.36	26.89 ± 0.85	7.80 ± 0.82	ND	ND	ND

Data expressed as Mean±SE, n=3.



Monthly growth of snubnose pompano in different sites in and around Ernakulam






Farm sites: *Pizhala, Kadamakkudy, Kottapuram, Anapuzha*

Fish sampling on site

Water sampling

Fish Nutrition

Differential growth was found in pompano when formulated feed was evaluated on farm

1. *Black soldier fly culture system*
2. *Black soldier fly pupae*
3. *Dried black soldier fly pupae*

in 2 treatments in triplicate and the effect of stocking density on growth, feed utilisation and body biochemical composition was determined. The fish were stocked in two stocking densities such as high (4.4 kg m^{-3}) and low stocking density (1.1 kg m^{-3}) in the experiment. The fish fed to apparent satiation with the diet containing crude protein and fat content of 40% and 6% respectively.

Growth

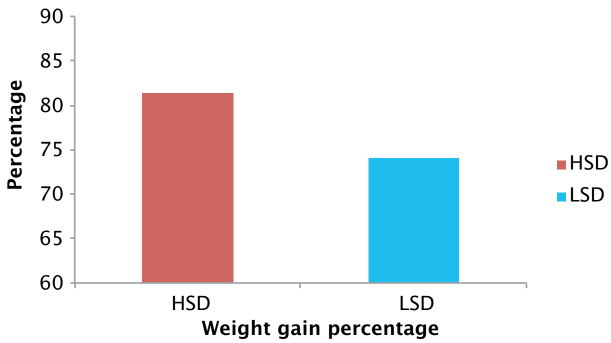
There was no significant difference in weight gain percentage, SGR%, ADG, FCR and PER among the two treatments ($P>0.05$). Highest weight gain percentage, SGR% and ADG were recorded in high stocking density (HSD) group.

The body indices such as hepatosomatic index (HSI) and viscerosomatic index (VSI) were significantly different in the two stocking densities ($P<0.05$). Highest HSI and VSI were noticed in HSD group which clearly indicates that HSD restrict the fast movement of the fish and thereby reduce the energy expenditure for motion which allows more visceral and hepatic fat deposition than the LSD group.

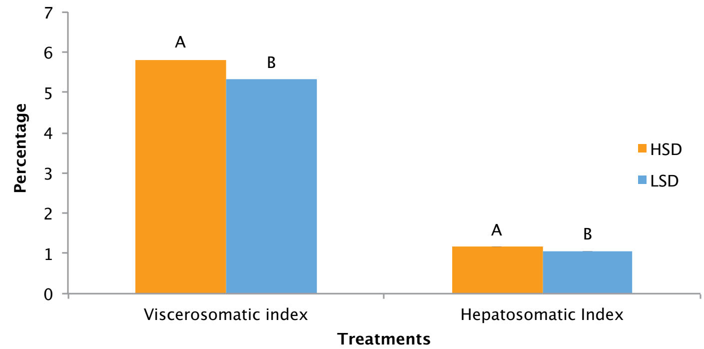
Nutritional composition of BSF pupae (% dry matter basis)

Proximate principles	
Crude protein (%)	40.42 ± 0.89
Crude lipid (%)	39.89 ± 1.74
Crude fibre (%)	8.16 ± 1.64
Total ash (%)	10.71 ± 2.04
NFE (%)	0.82 ± 0.04.

Fish Nutrition



Relative growth rate of snubnose pompano



Variations in body indices of snubnose pompano

Proximate composition

The whole body crude protein and crude fat showed significant difference in HSD and LSD groups (P<0.05). Crude protein and crude fat content of whole body samples were higher in HSD group.

Digestive enzyme activity

There was no significant difference in amylase and lipase activities of HSD and LSD treatment groups (P>0.05). Higher amylase and lipase activities were observed in LSD and HSD treatment groups respectively. Protease activity showed significant difference among HSD and LSD treatment groups (P<0.05).

The results revealed that higher stocking density yielded growth and feed utilisation similar to lower stocking density in snubnose pompano sub-adults.

Effect of commercial probiotics on growth and innate immunity of *Trachinotus blochii*

Three commercially available probiotics meant for poultry (PB1), shrimp (PB2) and fish (PB3) were evaluated in an experimental matrix along with a control feed devoid of probiotics. Fingerlings of *T. blochii* with an average size of 7.35 g were randomly distributed in triplicates. The fish were stocked in an indigenous recirculatory aquaculture system of 200 L capacity each filled with low saline seawater (7 ppt). Feeding was done to apparent satiation level for a period of 30 days. Sampling for growth was done at the end of the experiment to assess the body weight of the fishes. After 30 days of feeding experiment fishes were challenged intraperitoneally with 0.1 ml of a combination of *Aeromonas hydrophila, Enterobacter cloacae* and *Acinetobacter* sp. bacterial suspension at a concentration of 10^7 CFU ml^{-1}. Mortality was observed for 5 days. The percentage of survival in different treatment groups was calculated.

Growth

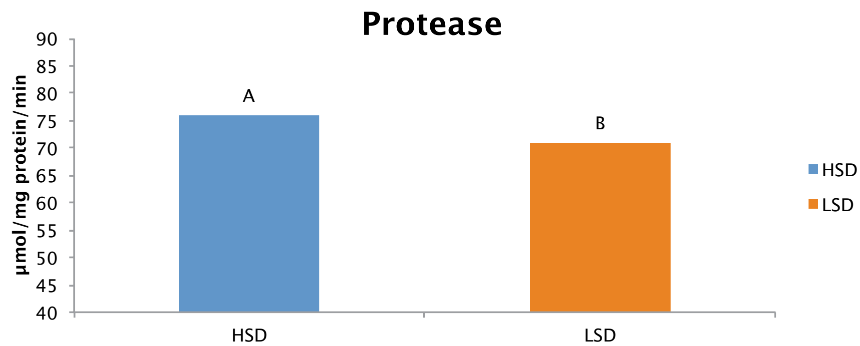
There was significant difference in weight gain percentage, SGR%, average daily growth (ADG) among the different treatments (P<0.05). Highest weight gain, SGR% and ADG were recorded in PB1 group and the lowest was found in PB2 group.

Whole body proximate composition (%)

Treatment	Moisture	CP	CF	Total ash	Fibre	NFE
HSD	67.37^{A}±0.19	20.19^{B} ±0.08	7.61^{A} ±0.24	4.41±0.16	0.09±0.01	0.44±0.06
LSD	68.38^{B} ±0.04	19.43^{A} ±0.05	6.88^{A} ±0.06	4.77±0.12	0.14±0.02	0.53±0.08
P value	0.005	0.001	0.043	0.148	0.131	0.620

Mean values in the same column with different superscript (A, B) differ significantly (P < 0.05).

Fish Nutrition



Protease activity in micromoles of tyrosine released/min/ mg protein in snubnose pompano

Digestive enzyme activities

All the three digestive enzymes, alpha amylase, protease and lipase from liver and intestine tissues showed significant difference (P<0.05) among the different treatments except liver lipase. Among the treatment groups better digestive enzyme activity was found in PB1 group followed by control and PB3 group.

Haemato-immunological parameters

In case of respiratory burst activity, significant difference found among the treatments (P<0.05). The best activity was observed in PB1 group.

There was no significant difference in the total erythrocyte count (TEC) and total leucocyte count (TLC) among the different treatments (P>0.05). The maximum TEC and TLC count was noticed in PB1 group.

The serum biochemical profile such as total protein, globulin and A:G ratio showed significant difference among the different treatments (P<0.05). Higher serum total protein was found in PB3 group and highest total albumin level was in PB2 group. The best globulin level was in PB3 group.

Survival

The percentage of survival of fish challenged with a combination of bacterial suspension in different treatment groups indicated highest survival in poultry probiotic (PB1) group and least survival was in control and PB2 group.

All commercially available probiotics used in the study were found equally effective in promoting growth and immunity in *Trachinotus blochii*. Out of the 3 probiotics tested, except the poultry probiotic (PB1), remaining two probiotics were on par or lower than the control diet without probiotics.

Dietary supplementation of beetroot meal on growth, pigmentation and disease resistance in percula clownfish *Amphiprion percula*

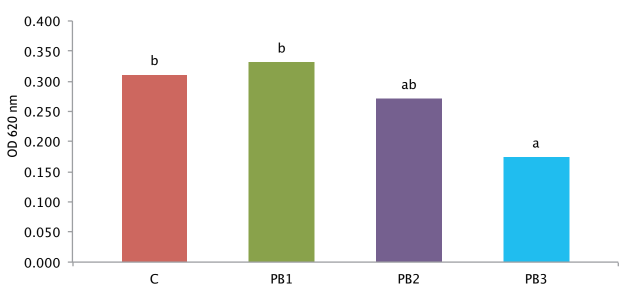
Whole beetroot meal was supplemented

Parameters	C	PB1	PB2	PB2	P value
WG%	202.01^{bc} ± 5.41	219.85^{c} ± 8.42	175.25^{a} ± 3.7	186.69^{ab} ± 9.08	0.010
SGR%	3.68^{bc} ± 0.08	3.873^{c} ± 0.08	3.37^{a} ± 0.044	3.50^{ab} ± 0.10	0.010
FCR	1.62 ± 0.03	1.55 ± 0.03	1.64 ± 0.048	1.64 ± 0.04	0.290
PER	1.46 ± 0.03	1.53 ± 0.03	1.44 ± 0.043	1.44 ± 0.04	0.287
ADG (g)	0.50^{ab} ± 0.02	0.54^{b} ± 0.02	0.43^{a} ± 0.01	0.46^{a} ± 0.02	0.015

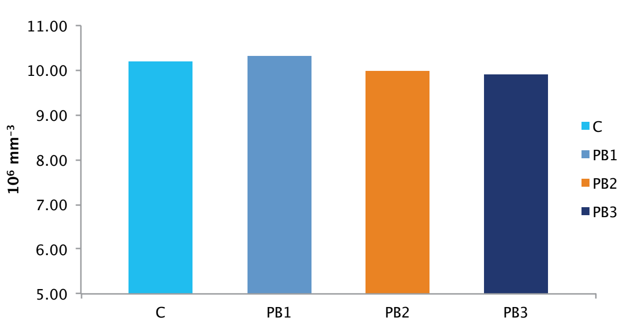
Mean values in the same row with different superscript (a,b,c) differ significantly (P<0.05).

in feeds at 5, 10 and 15% for evaluation of its effect on growth, pigmentation and disease resistance on percula clown fish, *Amphiprion percula*.

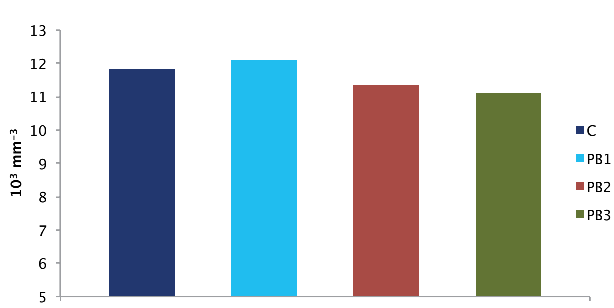
The nutritional experimental trial was conducted in the percula clown fish of 1.0±0.20 g for a period of 60 days. The parameters monitored were growth (weight gain%, specific growth rate%) pigmentation (skin colouration and tissue carotenoid). The animals were challenged with pathogenic bacteria, *Vibrio alginolyticus.*



Respiratory burst in snubnose pompano on probiotic treatments



Total leucocyte count in snubnose pompano on probiotic treatments



Total erythrocyte count in snubnose pompano on probiotic treatments

The *in-vitro* antibacterial test showed that beetroot extract possesses potentially antibacterial compounds and it could be used as natural source of immunostimulants in fish feeds. Protease activity and amylase activity were not significantly different among treatments indicating that higher inclusion of beetroot (15%) does not affect the digestive system of the animal. There was significant difference ($p < 0.05$) in cumulative mortality (%) and relative percentage of survival (%) between control and treatment groups when challenged with *Vibrio alginolyticus*. The least survival was recorded in control group and highest survival was recorded in 10% and 15% inclusion levels. The weight gain percentage (WG%) and specific growth rate percentage (SGR;% day $^{-1}$) were not significantly different among different treatments. The total muscle carotenoid deposition and body surface colour was significantly higher in fish fed with 10% and 15% dietary inclusion level of beetroot compared to other treatments. The present study suggests that dietary supplementation of beetroot meal has the potential to enhance skin pigmentation and can also promote disease resistance capability in clown fish.

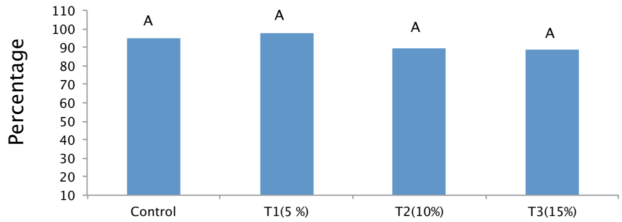
Evaluation of silkworm pupae meal as a fish meal substitute

Nutritional profile of silkworm pupae meal (SPM) was analysed and the percentage of total protein and lipid on dry weight were 49% and 29% respectively.

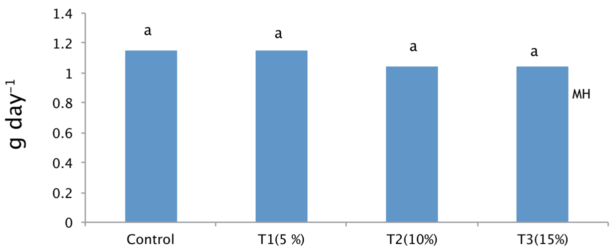
A nutritional evaluation of 45 days duration was conducted in silver pompano substituting fish meal with SPM at 25, 50, 70 and 100% levels as shown in the ingredient composition table of the experimental diets. Weight gain, specific growth rate, protein efficiency ratio and digestive enzyme profiles were analysed along with the proximate composition of the experimental feeds.

Statistically there was no significant difference between the different

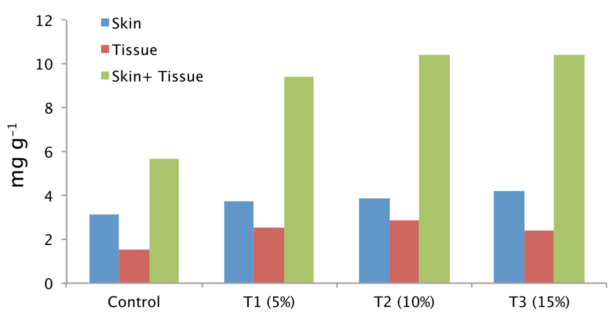
Fish Nutrition



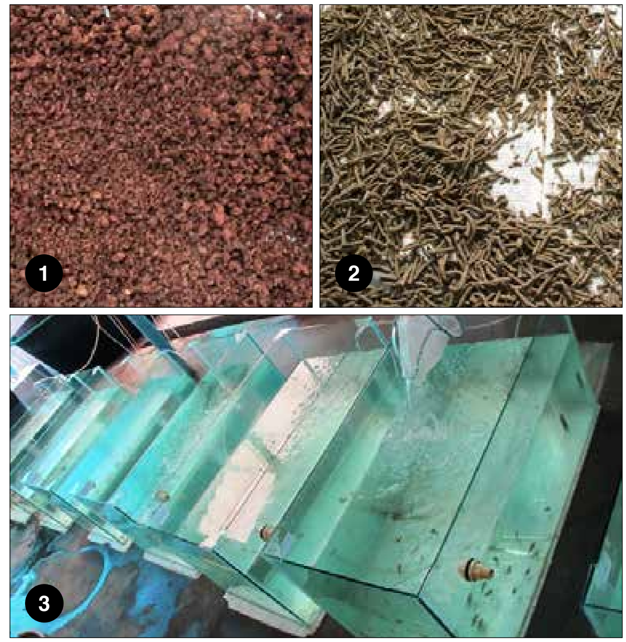
Weight gain variations in clown fish fed beetroot incorporated feeds



Specific growth rate (SGR) variations in clown fish fed beetroot incorporated feeds



Total carotenoids in clown fish fed beetroot incorporated feeds in tissue and skin



1. *Whole beetroot meal*
2. *Beetroot meal incorporated feed*
3. *Experimental set-up*

treatments. However, 100% replacement of marine ingredients with silkworm pupae meal showed inferior growth than control group. Best growth was observed in control group, 25% and 50% replacement (T1 and T2) groups indicating the propensity of silkworm pupae meal as an alternate animal protein source in marine fish feeds.

Lobster nutrition

Biochemical and digestive enzyme activities in juvenile spiny lobster, *Panulirus homarus* subjected to different feeding regimes

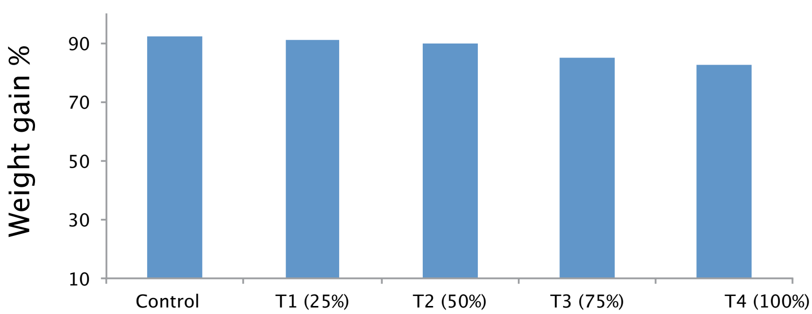
A twenty day feeding trial was conducted to evaluate the biochemical responses and digestive enzyme activities of juvenile *Panulirus homarus* under 3 different feeding regimes, namely starvation, feeding with live prey and feeding with formulated feeds. The formulated feed used for the experiment was a soybean and shrimp head extract based diet. Starvation severely affected the hepatopancreas and caused a reduction in the hepatosomatic index, compared to clam and formulated feed fed groups. During starvation hepatopancreas forms the primary organ for mobilisation of energy reserves as compared to the muscle in *P. homarus*. Both lipids and proteins from hepatopancreas were utilised simultaneously during starvation.

Significant differences were also observed in the digestive enzyme activities in different treatment groups. Proteolytic enzyme activity (total protease, trypsin, chymotrypsin) in the starved group was significantly higher compared to the other two groups. Lipase activity showed no

Fish Nutrition

Proximate analysis of silkworm pupae meal

Nutrient	% As such	% on dry matter basis
Protein	48.83	53.16
Crude fiber	7.38	8.02
Lipid	28.96	31.4
Total ash	5.68	6.17
Soluble carbohydrates	1.15	1.25
Moisture	8.00	-



Weight gain variations in pompano fed different level of SPM

Percent ingredient composition of the experimental diets

Ingredients	Control Diet I	Diet II	Diet III	Diet IV	Diet V
Wheat gluten	3	3	3	3	3
Soya flour	24	24	24.5	23.45	22.5
Squid meal	2	2	2	2	2
Silkworm pupae meal	0	8.2	16.4	24.6	32.8
MBM	10	9	8	8	8
GNOC	10	9	8	8	8
Shrimp meal	8	6	4	2	0
Fish meal	16	12	8	4	0
wheat powder	18.35	19.15	19.55	19	17.75
Fish oil	2.5	1.5	0.4	0	0
Vitamin	2	2	2	2	2
Mineral	2	2	2	2	2
SMB+BHT	0.2	0.2	0.2	0.2	0.2
Methionine	0.2	0.2	0.2	0	0
Vitamin C	0.25	0.25	0.25	0.25	0.25
Lecithin	1	1	1	1	1
DCP	0.5	0.5	0.5	0.5	0.5

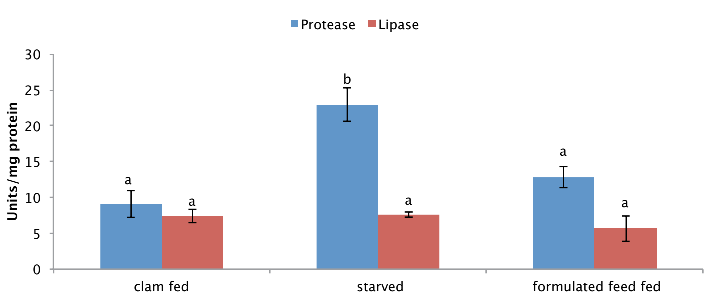
Proximate composition of experimental feed (% on dry matter basis)

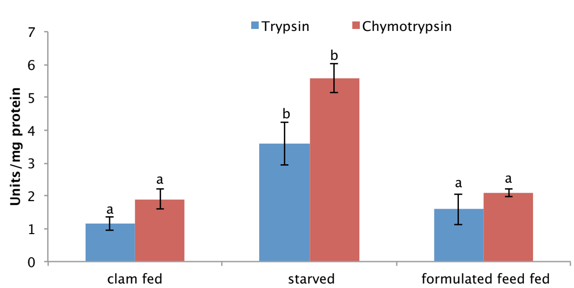
Proximate composition	Control Diet I	Diet II	Diet III	Diet IV	Diet V
Crude Protein	44.14	44.44	44.81	44.04	44.36
Crude Fibre	2.75	3.53	4.13	4.3	5.20
Ether Extract	7.39	7.34	7.50	7.40	7.35
Total Ash	14.23	14.05	12.84	12.75	12.28
NFE	31.49	30.64	30.72	31.51	30.81
Gross Energy (kcal kg^{-1})	4391	4398	4401	4440	4485

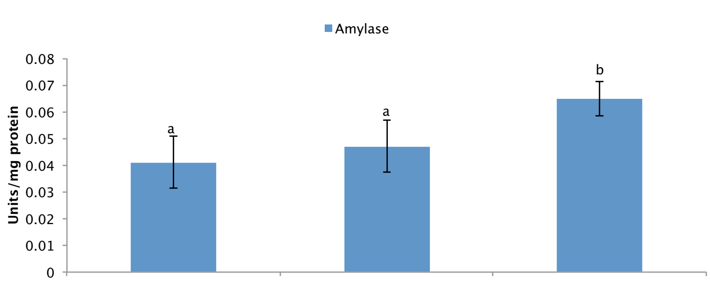
Vacuolation in lobster hepatopancreas points toward poor digestibility of formulated feeds

significant difference among treatment groups. Amylase activity was higher in the group fed with formulated diet compared to the other two groups, probably due to the carbohydrate-rich nature of the feed.

Histological studies showed increased vacuolation in the hepatopancreas of the group fed on formulated feed. Vacuolation may indicate increased effort to eliminate waste products in response to poor digestibility of feeds, or difficulty in mobilising the nutrients absorbed from formulated feeds to the different body tissues for energy and growth.







Hepatopancreatic digestive enzyme profiles under different feeding regimes

Microalgae as replacement of fish meal in fish feeds

The marine microalgae, *Coelastrella* sp. was grown in nutrient medium and harvested during the exponential phase from batch cultures. Cell counts were taken by a haemocytometer and biomass estimations were made and noticed an average of 19x10^{6} cells ml^{-1}. The biomass collected by filtration was homogenised by grinding in a mortar and pestle. The ground algal mass was dried at 37^{0} C in hot air oven to make a paste. When it becomes a paste, it is squeesed through a syringe and further dried in room temperature to make into pellets. The dry weight of the sample was found as an average of 0.08g l^{-1} of algal suspension. These pellets are under initial trial as fish feed. It was found that the fishes are consuming the pellets.

Biochemical properties of marine macroalgae-associated heterotrophic bacteria

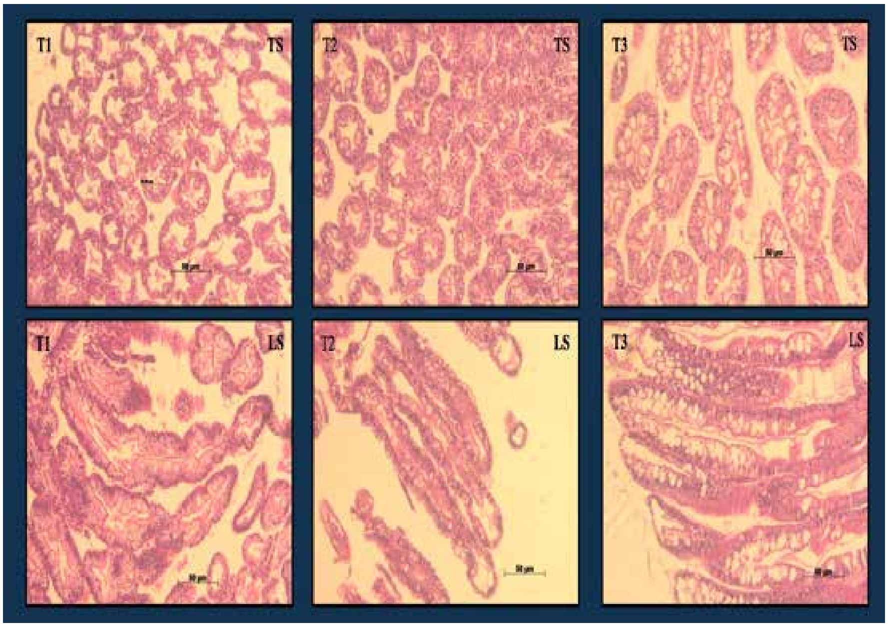
An extracellular lipase was partially purified from heterotrophic *Shewanella algae* associated with macroalgae *Padina gymnospora*. The enzyme possessed a molecular mass of 20 kD, and was purified 60-fold with a specific activity of 36.33 U mg^{-1}. The enzyme exhibited V_{max} and K_m of 1000 mM mg^{-1} min^{-1} and 157 mM, respectively, with an optimum activity at 55°C and pH 10

The purified lipase hydrolysed the refined liver oil from *Centrophorus squamosus*, yielding a total C_{20-22}*n*-3PUFA concentration of 34.99% with EPA+DHA accounting the major share (34% TFA), after 3 h of hydrolysis.

Isolation and characterisation of antioxidative pigments from seaweeds and deep sea shrimp

This study was aimed to evaluate the antioxidant properties of different seaweeds and deep sea shrimp species. *Sargassum wightii* exhibited significantly higher DPPH (IC_{50}6.0 µg ml^{-1}) and ABTS scavenging activities (IC_{50} 7.0 µg ml^{-1}) compared to other seaweed extracts ($p<0.05$).

Fish Nutrition



Transverse (TS) and longitudinal (LS) sections of digestive gland tubules of Panulirus homarus juveniles reared under different feeding regimes: fresh clam (T1), starvation (T2) and pelletised feed (T3)

The shrimp, *Aristeus alcocki* exhibited significantly greater DPPH (IC$_{50}$ 9 μg ml^{-1}) and ABTS (IC$_{50}$ 7 μg ml^{-1}) scavenging potentials when compared to other deep sea shrimp extracts ($p<0.05$).

Based upon the proton integral abundance and antioxidant properties, *S. wightii* and *A. alcocki* were selected for further purification and characterisation of pigments. The chromatographic purification of *S. wightii* yielded fucoxanthin pigment as major compound, whereas the extract of deep sea shrimp, *A. alcocki* yielded astaxanthin pigment as a major compound.

Nutritional properties of common edible molluscs

The current study determined the nutritional parameters of edible molluscs from Arabian Sea and estuarine systems of southwest coast of India. The selected species included *U. (P.) duvaucelii, Amphioctopus marginatus, Sepiella inermis* and *Crassostrea madrasensis.*

U. (P.) duvaucelii was found to contain greater quantities of sulfur containing amino acids (0.102 g 100 g^{-1} wet weight) and lysine (1.566 g 100 g^{-1} wet weight) than other molluscs.

A. marginatus exhibited significantly greater (~ 7, $P<0.05$) *n*-3/*n*-6 PUFA than other molluscs. Lower atherogenicity and thrombogenicity indices (<0.85 and <0.45, respectively) makes the molluscs desirable for cardioprotection and anti-platelet aggregation.

It can be inferred from the study that the marine molluscs is a valuable food, due to its high quality protein and well-balanced amino acid and fatty acid profiles.

Nutritional qualities of branched murex *Chicoreus ramosus* (family Muricidae)

Chicoreus ramosus, the branched murex, a species of marine gastropod mollusc collected off the Gulf of Mannar on

Essential amino acid composition of common edible molluscs

	U. (P.) duvaucelii	*C. madrasensis*	*A. marginatus*	*S. inermis*
Essential amino acids (g 100 g^{-1} wet weight)				
His	0.095±0.003	0.003±0.002	0.013±0.003	0.043±0.002
Arg	0.425±0.003	0.338±0.003	0.352±0.002	0.427±0.002
Thr	0.139±0.001	0.123±0.003	0.066±0.003	0.108±0.002
Val	0.171±0.002	0.147±0.007	0.012±0.006	0.114±0.002
Met	0.099±0.001	0.093±0.002	0.051±0.003	0.068±0.004
Ileu	0.177±0.002	0.143±0.001	0.062±0.002	0.115±0.003
Leu	0.301±0.005	0.221±0.003	0.096±0.003	0.176±0.002
Phe	0.156±0.003	0.114±0.005	0.085±0.003	0.116±0.002
Lys	0.287±0.002	0.157±0.002	0.136±0.00	0.172±0.008

Fish Nutrition

Fatty acid composition (% total fatty acids) of common edible molluscs

Fatty acids	*A. marginatus*	*C. madrasensis*	*U. (P.) duvaucelii*	*S. inermis*
∑ Saturated fatty acids	38.32±0.37	43.01±0.45	35.85±0.24	41.98±0.48
∑ Monounsaturated fatty acids	25.92±0.36	26.79±0.41	29.18±0.30	27.83±0.12
Polyunsaturated fatty acids (PUFA)				
18:2n-6	1.35±0.05	1.26±0.03	2.42±0.06	1.63±0.02
18:3n-6	0.32±0.06	0.59±0.04	0.35±0.02	0.69±0.02
18:3n-3	1.19±0.07	3.34±0.10	0.96±0.03	1.21±0.02
20:2n-6	2.14±0.04	1.92±0.05	1.96±0.04	1.85±0.04
20:3n-6	0.41±0.05	1.12±0.08	1.16±0.01	0.63±0.03
20:4n-6	0.29±0.02	1.05±0.05	0.72±0.03	0.98±0.03
20:5n-3	10.27±0.03	7.57±0.07	8.29±0.045	7.63±0.06
22:5n-3	0.89±0.05	0.62±0.02	0.74±0.01	0.58±0.02
22:6n-3	17.43±0.03	8.68±0.20	14.7±0.05	12.33±0.29
∑PUFA	34.37±0.36	26.35±0.47	31.44±0.20	27.7±0.45

Marine molluscs are valuable source of food, owing to high quality protein and well-balanced amino acids and fatty acids

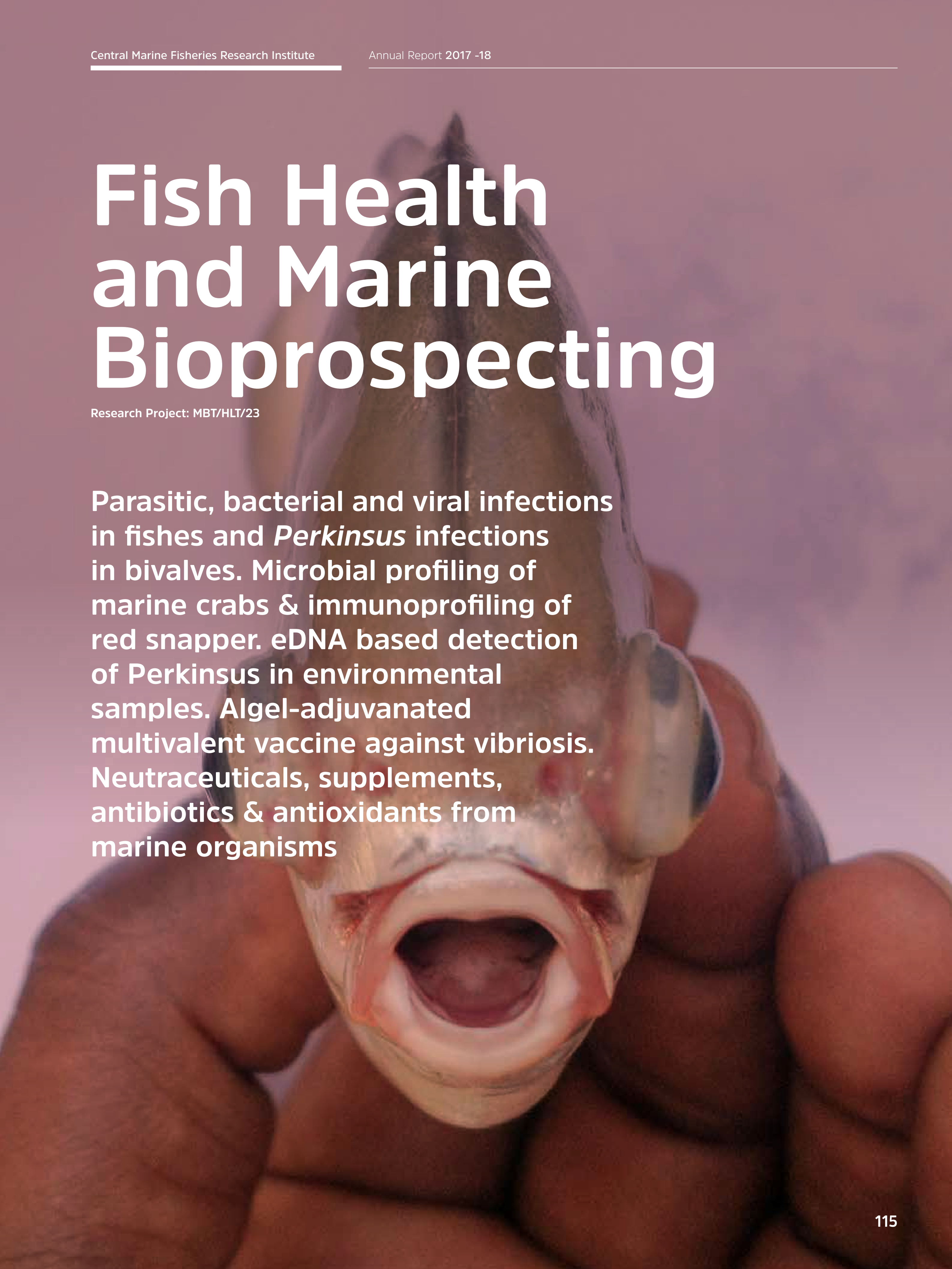
the southeastern coast of India was studied for their nutritional composition. The edible portion of *C. ramosus* demonstrated protein content with balanced ratio of essential to non-essential amino acids (~0.94).

The C_{20}-C_{22} *n*-3 fatty acids, eicosapentaenoic acid and docosahexaenoic acid, were predominant in the edible part (15.8 and 17.2% total fatty acids, respectively).

The previously undescribed report with regard to nutritional composition of *C. ramosus* demonstrated this low-value gastropod species as a valuable depot of essential nutritional elements, and as a health food favoured for human consumption.

Fatty acids composition (%) of *C. ramosus*

Saturated fatty acids (SFA)		Polyunsaturated fatty acids (PUFA)	
12:0	0.15±0.01	16:2n-4	0.86±0.03
14:0	0.22±0.01	16:3n-4	0.18±0.02
15:0	3.11±0.10	18:2n-6	3.56±0.01
16:0	6.21±0.50	18:3n-6	3.26±0.01
∑SFA	29.14	20:5n-3	15.83±0.03
		22:6n-3	17.17±0.05
Monounsaturated fatty acids (MUFA)		∑PUFA	49.77
14:1n-7	0.11±0.01		
15:1n-7	1.49±0.05	∑n-3	33.93
16:1n-7	7.01±0.20	∑n-6	14.52
18:1n-7	0.91±0.01	∑n-3/∑n-6	2.33
18:1n-9	2.35±0.01	∑ C18 fatty acids	7.12
20:1n-9	3.06±0.20	DHA + EPA	33.00
22:1n-9	6.00±0.02	EPA/AA	21.11
24:1n-9	0.02±0.00	DHA/EPA	1.12
∑MUFA	20.94	∑PUFA/∑SFA	1.67



Fish Health and Marine Bioprospecting

Research Project: MBT/HLT/23

Parasitic, bacterial and viral infections in fishes and *Perkinsus* infections in bivalves. Microbial profiling of marine crabs & immunoprofiling of red snapper. eDNA based detection of Perkinsus in environmental samples. Algel-adjuvanated multivalent vaccine against vibriosis. Neutraceuticals, supplements, antibiotics & antioxidants from marine organisms

438

fishes were screened for the presence of parasitic infections, of which 222 were positive for myxosporean parasites.

Disease investigations in finfishes

Parasitic infections

Protozoan infections were reported from various food fishes. Infections with myxosporean parasites were common, with 148 of 319 fishes harbouring infections. Myxosporeans belonging to eight genera namely, *Auerbachia, Ceratomyxa, Ellipsomyxa, Zschokkella, Ortholinea, Chloromyxum, Myxobolus* and *Sphaerospora* were recovered. Prevalence of infection ranged from 4.26% to 75% while the overall prevalence stood at 46.39%. One hundred and nineteen marine ornamental fishes belonging to 15 species were screened for parasitic infections, of which 74 were positive for myxoxporeans. Parasites of the genus *Ceratomyxa, Sphaeromyxa* and *Zschokkella* were recovered. Prevalence of infection varied form 20% to 100% with an overall prevalence of 62.18%.


Ceratomyxa sp. – E. suratensis


Zschokkella sp. – T. lepturus


Ceratomyxa sp. – L. parzia


Chloromyxum sp. - S. argus


Ellipsomyxa sp. - A. arius


Ceratomyxa sp. – S. undosquamis


Ortholinea sp. – S. argus


Ceratomyxa sp. – M. cephalus


Myxobolus sp. – M. cephalus


Myxobolus sp. – M. cephalus


Myxobolus sp. – M. cephalus


Myxobolus sp. – M. cephalus

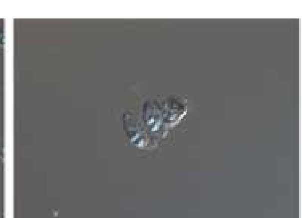

Myxobolus sp. – M. cephalus


Myxobolus sp. – M. cephalus


Sphaerospora sp. - M. cephalus

1


Sphaerospora sp. – A. ocellaris

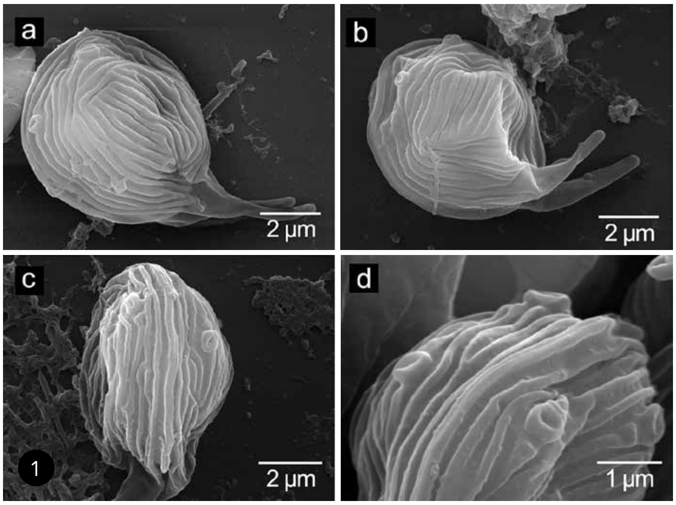

Ceratomyxa sp.- A. ocellaris

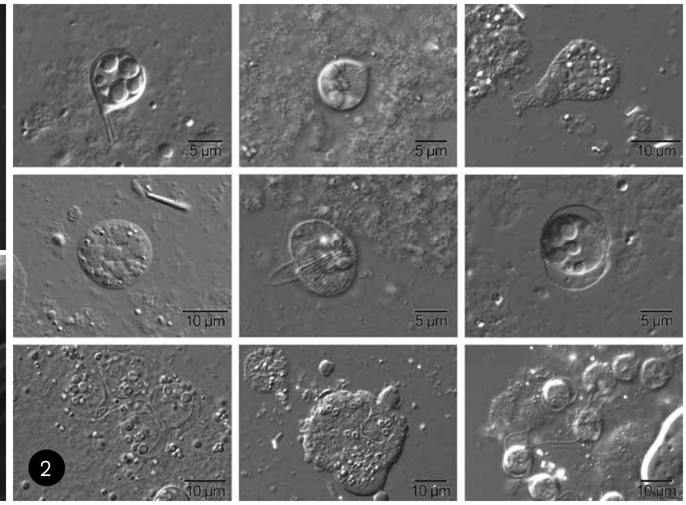

Ceratomyxa sp. – Z. velli

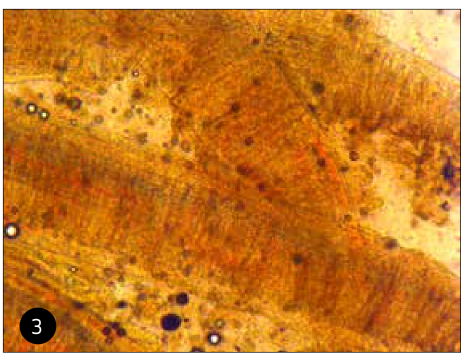
2

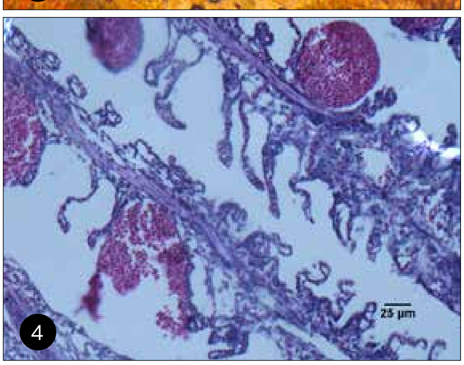
1. *Myxosporean parasites reported from foodfishes.*
2. *Myxosporean parasites reported from marine ornamentals.*

Fish Health and Marine Bioprospecting









1. *Scanning electron micrograph of Chloromyxum argusi n. sp.*
2. *Developmental stages of Chloromyxum argusi n. sp.*
3. *Amyloodinium ocellatum*
4. *A. ocellatum on gill tissues – histopathology*

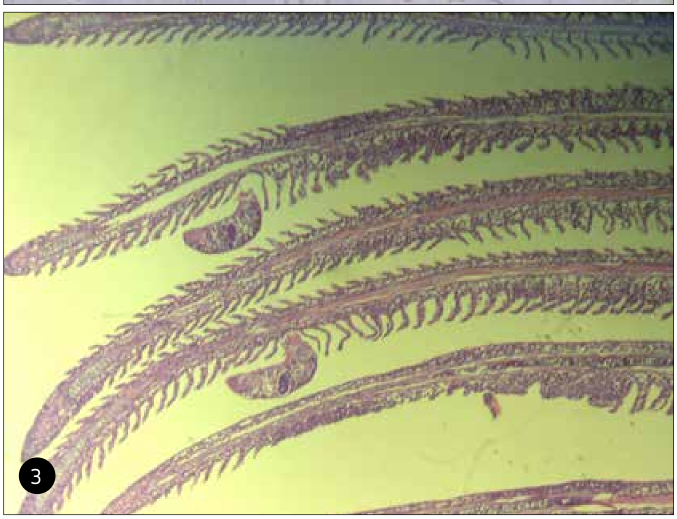
One of the myxosporeans recovered from *Scatophagus argus* was significantly different from all previously described species. Spores and vegetative stages were studied in detail. Morphology, morphometry, scanning electron microscopy, principal component analysis and molecular and phylogenetic analysis were carried out. Morphologic, morphometric and molecular analysis revealed it to be a new species under the genus *Chloromyxum* and has been reported as a new species, *Chloromyxum argusi* n. sp.

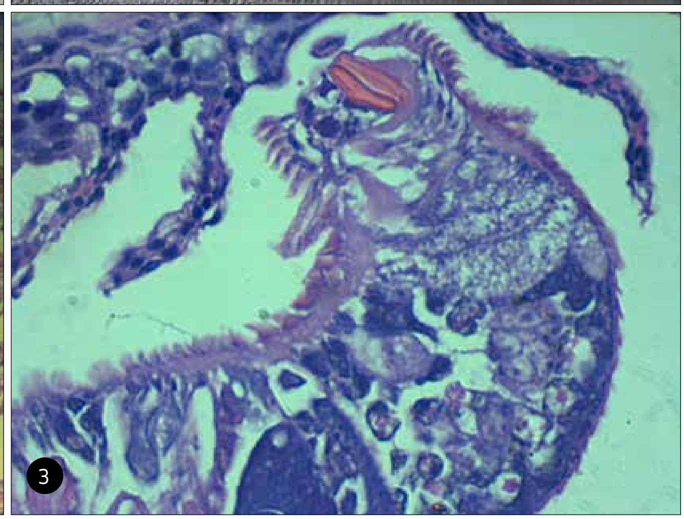
Infection with *Amyloodinium ocellatum* was reported from *Trachinotus bailloni* and *Lethrinus lentnjan* larvae at Vizhinjam. *A. ocellatum* was also reported from cobia, pompano and marine ornamentals at Mandapam.

Oodinium sp. infestation was recorded in tank reared pompano juveniles with 80% mortality. Excess mucus secretion in the gills was a consistent feature. Microscopically, trophonts of the parasite were observed in gill tissues along with pathological changes.

Other protozoan parasite infections reported are *Chilodonella* sp. from the larvae of *Anthias* sp. and pompano at

Fish Health and Marine Bioprospecting





1. *Chilodonella sp. infecting Anthias larvae*
2. *Cymathoa infestation*
3. *Dactylogyrus sp. attached to gills*

Vizhinjam and *Trichodina* spp. from seabass at Karwar.

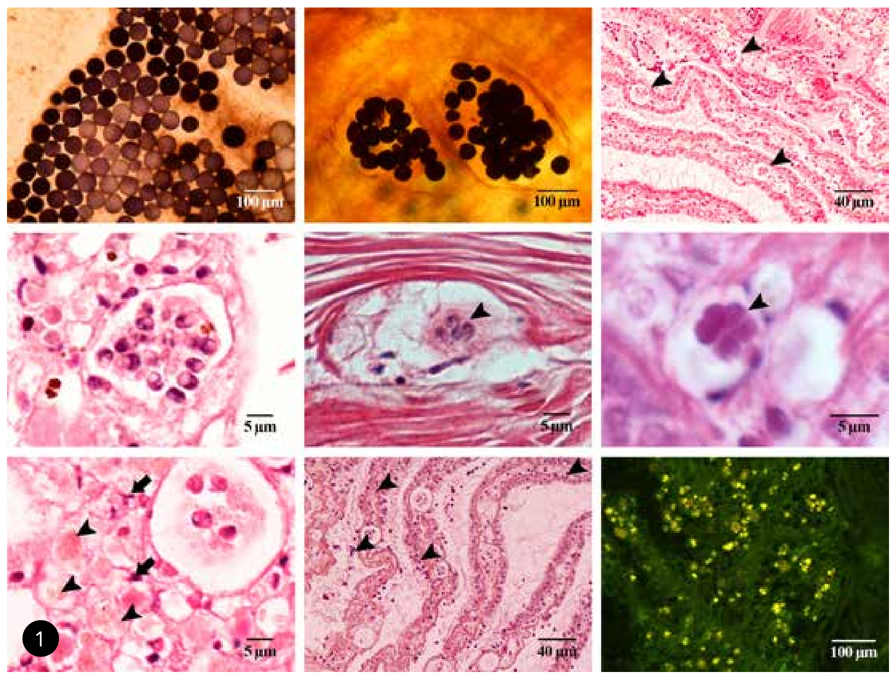
Infestation with the gill fluke, *Dactylogyrus* sp. was reported from *Lates calcarifer* and *Epinephelus coioides* at Karwar. Histopathology studies showed pathological changes including loss of secondary lamellae due to attachment. Infestation with *Cymathoa* was recorded from *Rastrelliger kanagurta* and *Siganus canaliculatus* at Karwar.

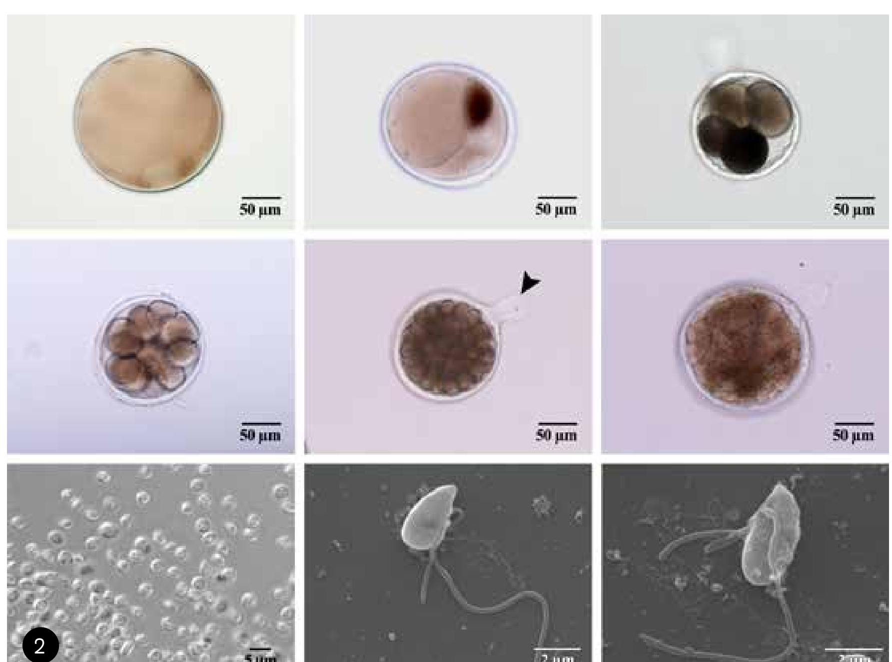
Infestation with the capsalid monogenean was found in the *L. calcarifer* grown in cages in Pulicat, Chennai. Infections with the acanthocephalan, *Tenuiproboscis keralensis* was reported from various food fishes from Kerala.

Disease investigations in bivalves

Infections with the OIE listed pathogen, *Perkinsus olseni* was observed in the short-necked yellow clam, *Paphia malabarica* along the southwest coast of India. Diagnosis was carried out using Ray's Fluid Thioglycollate Medium (RFTM) culture, histology, fluorescent *in-situ* hybridisation, molecular taxonomy and phylogeny. Intensity of infection was heavy with pathological changes including histological lesions, host cell disintegration, pyknosis of nuclei, hemocytic infiltration and ceroid bodies in infected tissues. Development of spores was not simultaneous and took 5-6 days for the complete sporulation of all mature spores. Scanning electron microscopy revealed that the zoospores were elongate-oval in shape with a smooth surface, pointed anterior end, round posterior region and possessed a pair of unequal, uniformly thick flagellae. Molecular and phylogenetic analysis confirmed the taxonomic status of the parasite as *P. olseni*. Prevalence of infection ranged from 75% to 100% with an overall prevalence of 88.90% in RFTM assay.

Molecular studies using species specific primers revealed the wide spread prevalence of another species of *Perkinsus*, *P. beihaiensis* in *P. malabarica* from the southwest coast of India. Heavy infections were observed and





1. *Perkinsus olseni infection in Paphia malabarica*
2. *Development of P. olseni – hypnospores to dinospores*

Bacterial infections are responsible for most of the mortalities reported from cultured fishes

histopathology indicated tissue level damages, but gross external signs/ symptoms were absent. Concomitant infections with *P. olseni* and *P. beihaiensis* in *P. malabarica* were also observed. The study shows that *P. malabarica* can harbor *P. olseni* as well as *P. beihaiensis* and appears to be quite tolerant for *Perkinsus* infections. High prevalence and intensity of *Perkinsus* infection in clams raises concerns, as clam reserve in this geographical area sustains fishery and livelihood of local fisher folks.

Bacterial infections

Photobacterium damselae ssp. *damselae* was isolated from cage reared cobia showing clinical signs of bacterial infection and mortalities at Karwar. Two strains–a sucrose fermenting and another non-sucrose fermenting were isolated from the infected fish. Infections with *Vibrio, Pseudomonas, Streptococci* and *Alcaligenes* were reported from grouper at Karwar.

Four strains of genus *Vibrio*, *V. harveyi, V. alginolyticus, V. parahaemolyticus* and *V. brasiliensis* were isolated from infected and moribund Indian pompano at Visakhapatnam. Infections with *Pseudomonas aeruginosa, Streptococci* spp-2 and *Bacillus* spp. were reported from Pompano while *V. parahaemolyticus and P. aeruginosa* were reported from cobia at Mandapam.

Heavy mortalities in the Asian seabass (*L. calcarifer*) grow-out cages were observed at Tuticorin. Infected fishes displayed a disoriented whirling movement, hemorrhages on operculum, skin, base of fins and around anus. Abdomen was distended with sanguineous fluid and exophthalmia was observed. The liver was pale and the spleen appeared deep red. *Enterobacteriaceae* sp. was isolated from heart blood samples and *Streptococci* sp. from kidney tissues.

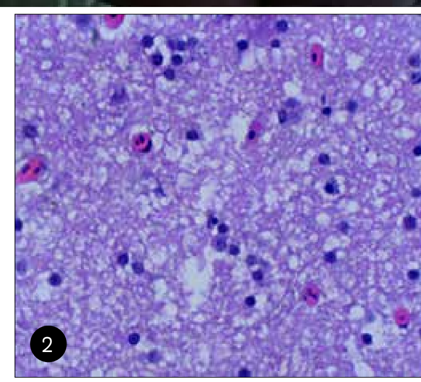
Vibrio alginolyticus isolated from diseased red snappers was characterised using biochemical and molecular tools. The enzymatic profiling of the extracellular products of *V. alginolyticus* revealed that the pathogen was positive to Trypsin, Alkaline phosphatase, Esterase, Leucine acrylamide, Esterase lipase and Casinase.

Studies on the pathogenicity and infection cycle of *Vibrio* species in the sand lobster (*Thenus unimaculatus*) larvae was carried out. Healthy larval haemocoel was filled with haemocytes while the infected ones showed bacterial colonies in the haemocoel. Heavy fouling was also observed on larval setae in infected phyllosoma.

Culture-based microbial community analysis carried out in sand lobster rearing system revealed luminescent bacterial species, *V. campbelii* and *V. harveyi* as the dominant strains. These pathogens were repeatedly isolated and were dominant at different points of time in larval-rearing systems.

Other bacterial pathogens reported from various fishes at Kochi included *V. harveyi, V. vulnificus, Aeromonas* sp., *P. damselae* and *Schewanella* in pompano (*T. blochii*), *P. damselae, V. alginolyticus, Schewanella* sp. and *A. jandaei* in seabass (*L. calcarifer*), *Vibrio* sp. and *Psuedoalteromonas*

Bacterial infection in pompano - exopthalmia and bulged anus.



1. *Bacterial infection in seabass*
2. *VNN – vacuolation in brain tissues*

sp. in tomato clown fish (*Amphiprion frenatus*), *Pseudoalteromonas piscicida* and *Alteromonas macleodii* in common clown fish (*A. ocellaris*), *A. veroni* in oscar fish (*Astronotus ocellatus*), *Streptococcus agalactiae, V. vulnificus, A. hydrophila* and *P. shigelloides* in cage farmed tilapia (*Oreochromis niloticus*).

Unusual, intense bloom of *Noctiluca scintillans* was observed along the coastal waters of Karwar during August 2017. The bloom was associated with the following bacterial assemblages: *Staphylococcus pasteuri*, *Photobacterium leiognathi* ssp. *mandapamensis, Chryscomicrobium imtenchense*, *V. sinaloensis*, *Marinobacter* spp., *Psychrobacter* spp., *Pseudomonas pachastrella* and *Schewanella coraltii.*

Viral infections

Mortality associated with VNN was reported from Karwar. Symptoms included exophthalmia with corneal opacity, fin rot, pale gills with excessive mucus and focal hemorrhages on skin. Histologically inflammation was observed in brain.

Neoplasia

Incidence of tumours was reported in *Sardinella longiceps* from Palk Bay. Tumour masses were observed near the mouth and opercular regions. Histologically these neoplasmic conditions

Fish Health and Marine Bioprospecting

were identified as fibroma, fibrosarcoma, and adenocarcinoma.

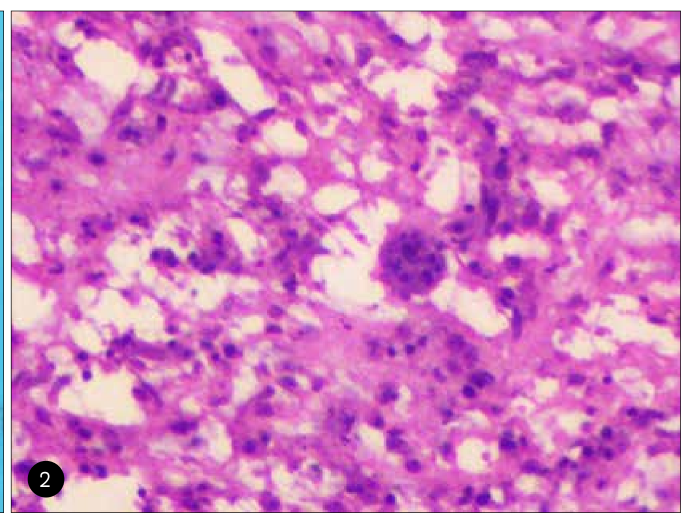
Health management

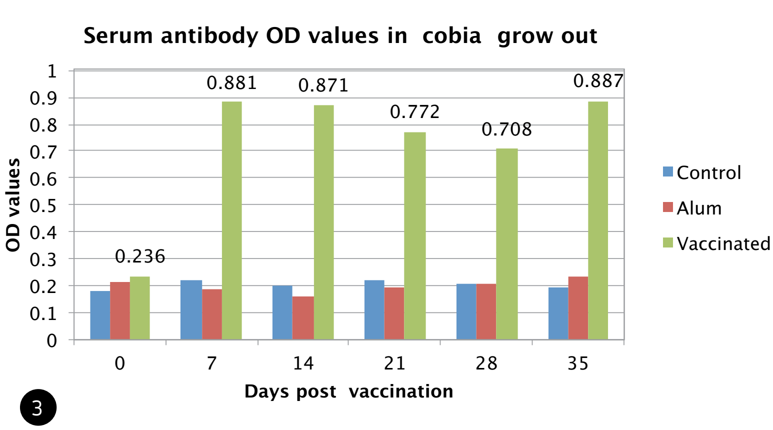
An Algel-adjuvanated multivalent vaccine against vibriosis was standardised *in vitro.* Field trials were carried out in cobia grow-out system. Serum antibody levels were estimated which showed an increasing trend from 7th day post vaccination (DPV) and continued up to 21 DPV. A decreasing trend of serum antibodies was noticed after 21 DPV. A booster dose (on 28 DPV) was able to further increase the antibody levels and further studies are being continued. Regular epizootics in cage cultured cobia during the July to September (pre-monsoon season) were successfully prevented by immunisation and efficient cage farming management.

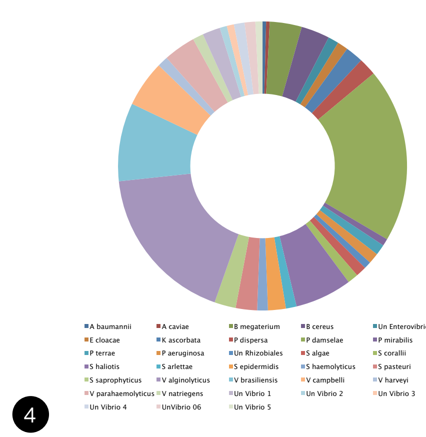
Microbiological profiling of haemolymph from four commercially significant marine crab species (*Portunus pelagicus, Charybdis feriatus, P. sanguinolentus* and *C. lucifera*) in apparently healthy conditions was carried out and the possible role of haemolymph microbes in crab defence strategy was investigated. Thirty-three distinct bacterial species belonging to 14 different genera were isolated.

Immuno-profiling of live, apparently healthy Mangrove red Snapper *(Lutjanus argentimaculatus*) was carried out to identify the major contributing factors in relation to the overall innate immunity. Contribution of gut microbes towards disease resistance of *L. argentimaculatus* was also evaluated through direct antagonism and co-aggregation studies.

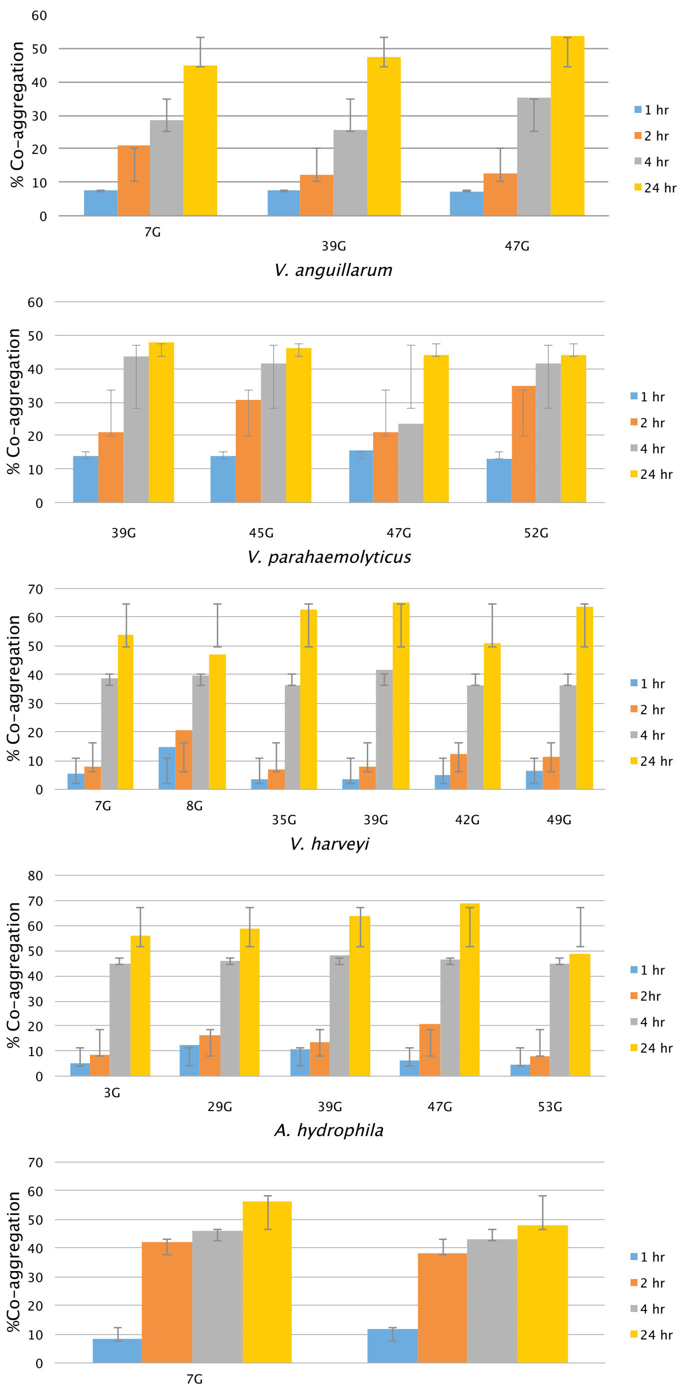
1. *Neoplasia in Sardinella longiceps*
2. *Fibrosarcoma*
3. *Hyper-immune serum analysis by ELISA*
4. *Composition of haemolymph microbes in four commercially significant apparently healthy marine crabs namely, P. pelagicus, C. feriatus, P. sanguinolentus and C. lucifera*







Fish Health and Marine Bioprospecting



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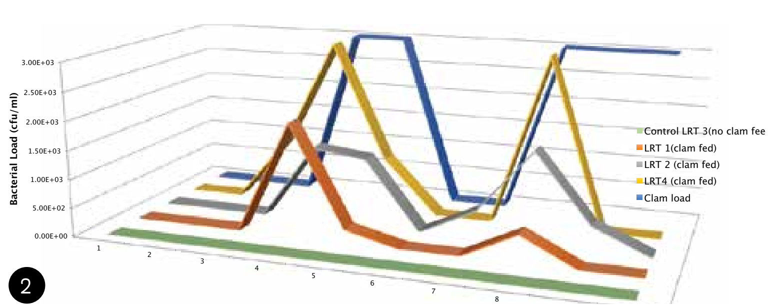

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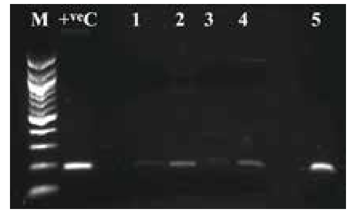

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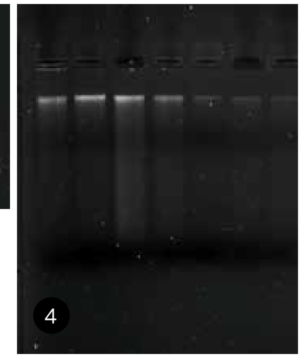

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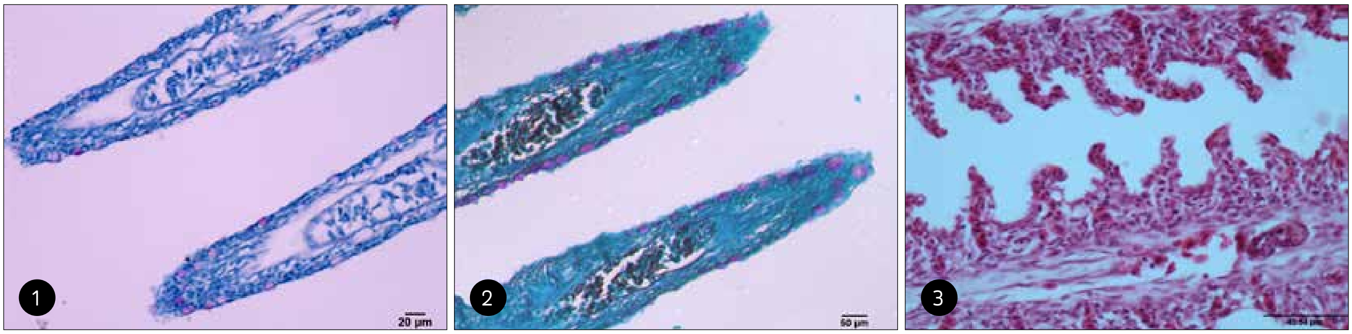
1. *Contribution of gut microbes of L. Argentimaculatus towards disease resistance*
2. *Evaluation of bacterial load in lobster larval rearing tanks due to clam*
3. *eDNA from various water bodies for screening Perkinsus*
4. *e DNA based PCR screening for presence of Perkinsus*

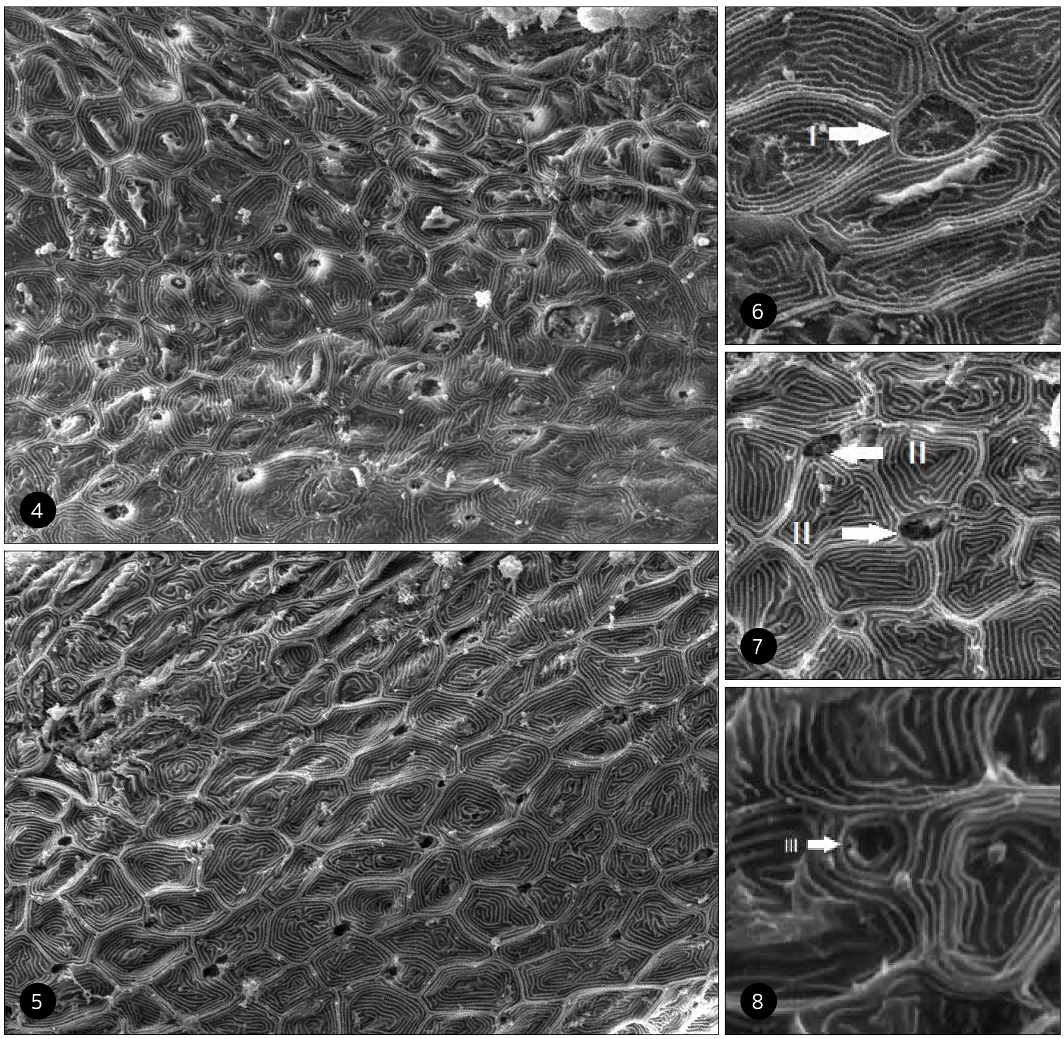
Immuno-biochemical attributes of the Asian green mussel (*Perna viridis*) in natural ecosystem was studied to develop baseline data in apparently healthy conditions. Partial characterisation of ferritin gene was carried out.

eDNA based detection of the bivalve protozoan parasite, *Perkinsus* sp. from environmental samples was attempted. Specific primers were designed and eDNA was detected using Nested PCR. The method was able to detect the presence of the parasite in culture systems and can be used as an easier, faster and cost-effective method for the surveillance of the parasite. Further studies are in progress.

Season-wise screening for *Vibrio* in lobster rearing tanks was carried out to monitor the progression of *Vibrio* loads associated with changes in environmental parameters. Clam hepatopancreas given as feed acts as the major source of bacterial contamination in sand lobster larval rearing tanks.

Molecular and functional analysis on





1. *Reduced mucous production in E. suratensis at 0 ppt*
2. *Enhanced mucous production in E. suratensis at 36 ppt*
3. *Histopathological changes in gills at 36 ppt*
4. *Gill – 0 ppt*
5. *Gill – 36 ppt*
6. *Subtype 1 – wavy convex*
7. *Subtype 2 – shallow basin*
8. *Subtype 3 – deep hole*

the effect of hyper and hypo salinity adaptations in *Etroplus suratensis*

Experiments were conducted to study the effect of variations in salinities in *E. suratensis.* Histopathological changes observed in the gills of the fish exposed to higher salinities included hyperplasia of the epithelium, fusion of secondary lamellae, excess mucous production etc. SEM studies revealed the presence of different subtypes of mitochondrion-rich (MR) cells (Subtype I–Wavy convex, Subtype II–Shallow basin, Subtype III – Deep hole and Pavement cells) on gill surface in response to variations in salinities. Wavy convex MR cells (subtype I) and deep-hole type cells (subtype III) are responsible for Cl^- uptake and Cl^- secretion respectively. While shallow

Fish Health and Marine Bioprospecting

Mass awareness programme for mussel farmers at Kadalundi

basin MR cells (subtype II) are responsible for Ca^{2+} uptake. Most branchial MR cells of sea water adapted *E. suratensis* were deep-hole MR cells.

Bioprospecting for biotic and abiotic stress responsive genes from *Crassostrea madrasensis* and their characterisation: Complete sequence of the Ferritin gene of *C. madrasensis* was using RACE PCR. Both 5' and 3' RACE was carried out to obtain the complete sequence.

Validation of expression of Stress responsive genes obtained through SSH: Ten genes differentially expressed in *C. madrasensis* reared in the wild as compared to the laboratory maintained ones were selected for validation by real time PCR. Two genes – 18S and E-alpha were found to have stable expression in both the conditions and were chosen as the reference genes. The selected genes showed an upregulation in wild *C. madrasensis* as compared to the laboratory-maintained ones, thus validating the SSH results.

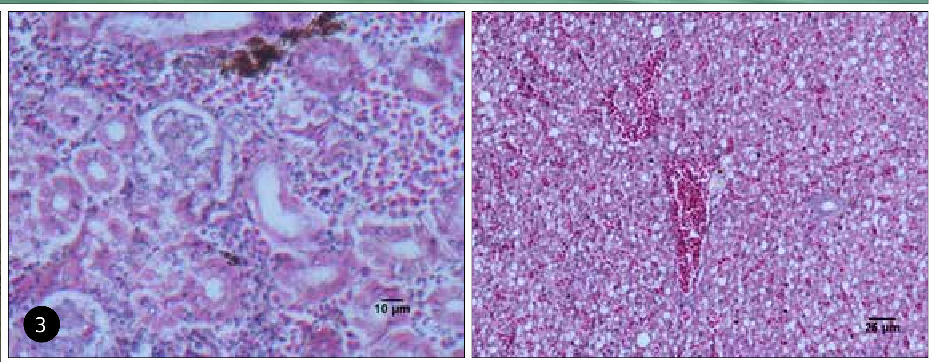
Pancreatic triacyl glycerol lipase like protein was recombinantly expressed using prokaryotic expression system.

National Surveillance Programme for Aquatic Animal Disease (NSPAAD)

External Funded Project: 7

Under the National Surveillance Programme for Aquatic Animal Diseases, regular screening of wild and farmed bivalves for OIE listed pathogens were carried out along the east and west coasts of India including Lakshadweep Islands. A mass awareness programme was conducted for mussel farmers at Kadalundi. A total of 1110 bivalve samples belonging to 20 species were collected and screened. *P. olseni* was observed in *Perna viridis, P. indica, Anadara granosa, P. malabarica, Pinctada fucata, Pinna bicolor, Donax cuneatus, Circe scripta, Gefrarium tumidum* and *Placuna placenta. P. beihaiensis* was observed in *P. viridis, P. indica, A. granosa, P. malabarica, Saccostrea cucullata, Arca* sp., *C. madrasensis and P. placenta.* The prevalence of infection for *Perkinsus* sp. infections in wild bivalves was 37.8%. Mixed infections were observed in *A. granosa, P. malabarica, P. viridis* and *P. indica.* Bivalves from Lakshadweep Islands were free from *Perkinsus* infections.

Fish Health and Marine Bioprospecting



1. *Mussel farms at Kasaragode*
2. *Mussel mortalities*
3. *OTC associated Histopathological changes in liver and kidney*

Under the surveillance of cultured bivalves, base line data/information along with the GPS locations of farms was collected. A total of 384 samples of farmed *P. viridis* and *P. indica* were screened and *P. olseni* and *P. beihaiensis* infections were detected. The prevalence of *Perkinsus* sp. infections in farmed bivalves was 92.2%. *Perkinsus* infections coupled with altered environmental conditions led to mortalities in farmed green mussels.

All India Network Project on Fish Health

External Funded Project: 24

Information regarding the usage pattern of drugs and chemicals in aquaculture (fish and shrimp farms) was collected through a questionnaire based survey carried out in eight districts of Kerala, covering 58 fish and 18 shrimp farms. The results indicate that drugs/chemicals are not generally used in farms in Kerala.

Estimation of dose and drug withdrawal period for Oxytetracycline (OTC) was carried out in pompano (*T. blochii*). Treatment levels ranged from 240 mg to 800 mg per Kg biomass with experiment lasting for 10, 20 and 30 days. Tissue morphological changes were studied using histopathology. OTC at lower dosages produced mild changes in liver including cloudy swelling and nuclear degenerative changes. At higher dosages it induced severe changes in liver and kidney parenchyma including extensive fatty change, hemorrhage and congestion. No significant difference in growth rate was observed between fish fed with different dosages of OTC and control fish. Safety study for Emamectin benzoate was also carried out in pompano (*T. blochii*) with treatment doses ranging from 25 to 500µg/kg.

Economic loss assessment based on loss/mortalities in mussel farming in Kasaragode was carried out. The study was based on primary data collected from farmers through a structured questionnaire The losses due to mortalities ranged from 77-81% on an average while the economic losses range between 2.70-2.85 crores. Screening of imported marine ornamental fish for OIE listed pathogens was carried out.

ICAR-Consortia Research Platform on Vaccines & Diagnostics

External Funded Project: 4

Sensitivity of the LAMP based diagnostic for detecting *Perkinsus* sp. infections in bivalves was improved and was capable of detecting single copy of the DNA template. The developed LAMP was able to detect both *P. olseni* and *P. behaiensis* which are the two *Perkinsus* sp. infecting bivalves in Indian waters. Validation of the LAMP using field collected samples of infected mussels was carried out and was found to be more sensitive than RFTM and PCR. *In-vitro* culture of *Perkinsus* sp. using gills and/or mantle of infected mussels was scaled up for antigen production.

Marine Bioprospecting

Research Project: MBT/ HLT/SUB/23

Nutraceutical against hypothyroidism: Developed an anti-hypothyroidism extract (Cadalmin™ ATe) from seaweed. The bioactive leads concentrated in Cadalmin™ ATe were found to stimulate thyroid releasing hormone and increase the activity of selenodeiodinase to produce metabolically active thyroid hormones, tetraiodothyronine (T4) and 3, 5, 3'-triiodothyronine (T3).

In vivo studies showed that the active principles effectively increased thyroid stimulating hormone to produce thyroid hormones (T_3 and T_4) in experimental groups with healthy control and hypothyroidism induced by administering methimazole (MTZ) @100-150 mg/kg body weight (@one-time dose for 15 days). Serum T_3, T_4 and TSH levels were significantly decreased in hypothyroid group.

The results demonstrated a significant elevation in serum TSH level upto 5 μIU/mL at 100 mg/kg body weight for the Cadalmin™ ATe-treated group. Serum triiodothyronine (T_3) level for the Cadalmin™ ATe treated group (1.4 ng/dL at 150 mg/kg body weight) was greater than the active ingredient alone treated group (0.7 ng/dL at 150 mg/kg body weight) and positive control group (~1 ng/dL). Notably thyroxine (T_4) level for the active ingredient with Cadalmin™ ATe treated group (9 μg/dL at 150 mg/kg body weight) was greater than the active ingredient alone treated group (5 μg/dL at 150 mg/kg body weight) and positive control group (6 μg/dL). Cadalmin™ ATe has no side effects (LD_{50} > 5000 mg/kg

Cadalmin™ ATe is a nutraceutical product, which provides a unique blend of 100% natural marine bioactive ingredients with anti-thypothyroidism principles extracted from seaweed, with an ecofriendly "green" technology.

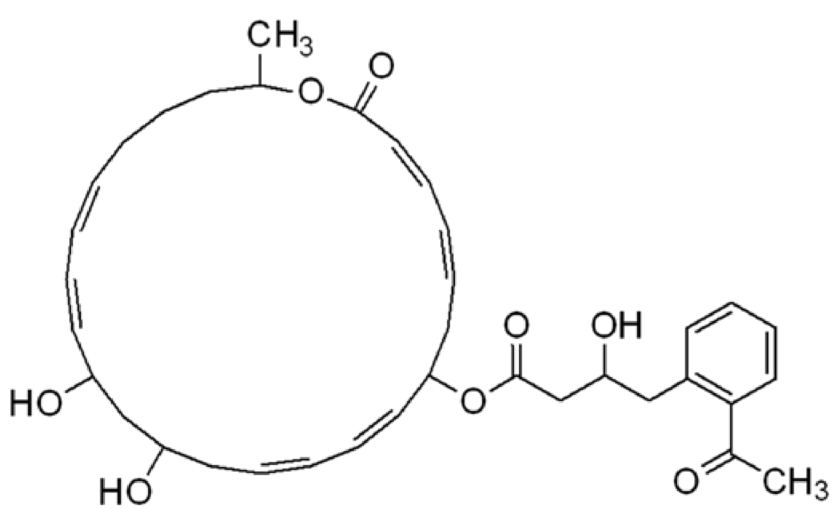
Fish Health and Marine Bioprospecting

Seaweeds are a good source of bioactive molecules. Cadalmin™ ATe developed from seaweeds is effective in combating hypothyroidism. An aryl-crowned polyketide isolated from seaweed associated bacterium shows excellent antibacterial properties

BW) as proved from the preclinical and acute/long term chronic toxicity studies on experimental subjects. The product is ready for commercial out-licensing.

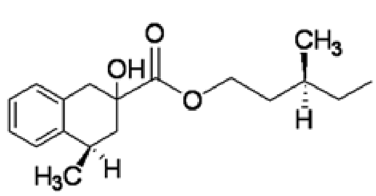
Antibacterial aryl-crowned polyketide from bacterium associated with seaweed

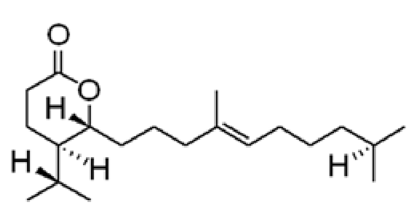
A culture-dependent method was used to isolate heterotrophic *Bacillus subtilis* MTCC 10403 associated with brown seaweed *Anthophycus longifolius*, and was assessed for its antimicrobial properties. It was found to be antagonistic against Gram-negative food-borne pathogenic *Pseudomonas aeruginosa, Escherichia coli*, *Klebsiella pneumoniae***,** *Salmonella enterica* serotype *Typhi*, *Aeromonas hydrophilla*, and *Vibrio* spp. (diameter of zone of growth inhibition 13-22 mm). *B. subtilis* was assessed for the presence of secondary metabolite aryl-crowned polyketide designated as 7-*O*-6'-(2''-acetyl-phenyl)-5'-hydroxyhexanoate-macrolactin. The minimum inhibitory concentration (MIC) assay showed that the reference antibiotics tetracycline and ampicillin were active at 25 µg/mL against the test pathogens, whereas the newly isolated polyketide displayed antagonistic properties against *E. coli*, *A. hydrophilla*, *P. aeruginosa* and *Vibrio* spp. at a lower concentration (MIC < 13 µg/mL). Putative biosynthetic pathway of the *pks* gene product further validated its molecular attributions. This study recognised a new variant of antimicrobial aryl-crowned polyketide bearing methyl 6'-(2''-acetylphenyl)-5'-hydroxyhexanoate moiety at the C-7 position of the macrolactin system from *A. longifolius*-associated bacterium *B. subtilis*.

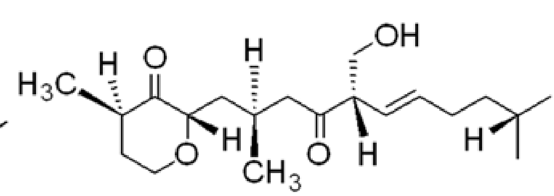


Previously undescribed antioxidant compounds of brown seaweeds *Sargassum ilicifolium* and *Padina gymnospora*

Bioassay-guided chromatographic separation of the crude extracts of these seaweeds, yielded four bioactive compounds namely 14-methyl pentyl tetrahydro-8-hydroxy-10 methylnaphthalene–8-carboxylate (1) and tetrahydro-4-isopropyl-9-(9, 14-dimethyldec-9-enyl)-pyran-1-one (2) from *S. ilicifolium*, whereas *P. gymnospora* afforded dihydro-2-(10-(hydroxymethyl)-7,15-dimethyl-9-oxoundec-11-enyl)-2-methyl-2*H*-pyran-1(4*H*)-one (3) and 1-(decahydro-1-hydroxy-7-methyl-







8-vinylnaphthalen-2-yl)ethanone (4) as major constituents.

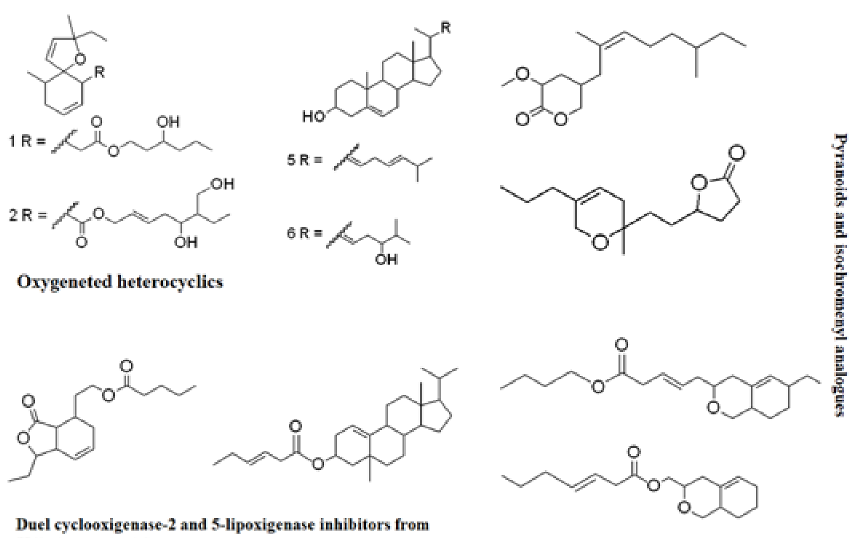
Development of small molecular weight angiotensin-II converting enzyme inhibitor from marine organisms

External Funded Project: 27

The study demonstrated marine microalgae and molluscs as valuable natural sources of bioactive compounds with antihypertensive activities. Optimised culture techniques were developed for the mass culture of microalgae *Dunaliella salina*, *Chlorella salina*, *Tetraselmis tetrathele*, *Isochrysis galbana*, *Chaetoceros calcitrans*, *Pavalova lutheri*, and *Nannochropsis oculata*.

The solvent extract of *C. salina* and *C. calcitrans* showed potential 1,1-diphenyl-2-picryl-hydrazil (DPPH) and 2,2'-azinobis-3-ethylbenzothiozoline-6-sulfonic acid (ABTS$^+$) radical scavenging activities (IC_{50} < 1 mg/ml).

The extract of *Sepiella inermis* displayed greater antihypertensive properties as showed by higher ACE inhibitory activity (IC_{90} 0.87 mg/mL) followed by *Uroteuthis duvaucelii* (IC_{90} 1.35 mg/mL). The serum Angiotensin-II levels were significantly increased in $CdCl_2$ induced hypertension rats, whereas these levels were recovered upon treating with extracts of the mollusc considered in this study.



ICAR-CRP on Health Foods–Development of nutraceuticals supplements from marine molluscs, macroalgae and shrimps

External Funded Project: 16

The edible bivalve clams, *Paphia malabarica* and *Villorita cyprinoides* were subjected to bioassay guided chemical investigations. *V. cyprinoides* was found to possess bio-potent metabolites classified under different classes of chemistries, such as irregular spirocyclic ether (1-2) and meroterpenoid derivatives (3-5), hexahydro isochromenyl analogous (6-7) and cholestenol derivatives (8-10).

Chemical investigations of *P. malabarica* led to the isolation of different metabolites classified under aryl polyketides (1-3), chromenyl analogues (4-5), isopimarane norditerpenoid (6), meroterpeno 2*H*-pyranoids (7-8) and cholestenol derivatives (9-10).

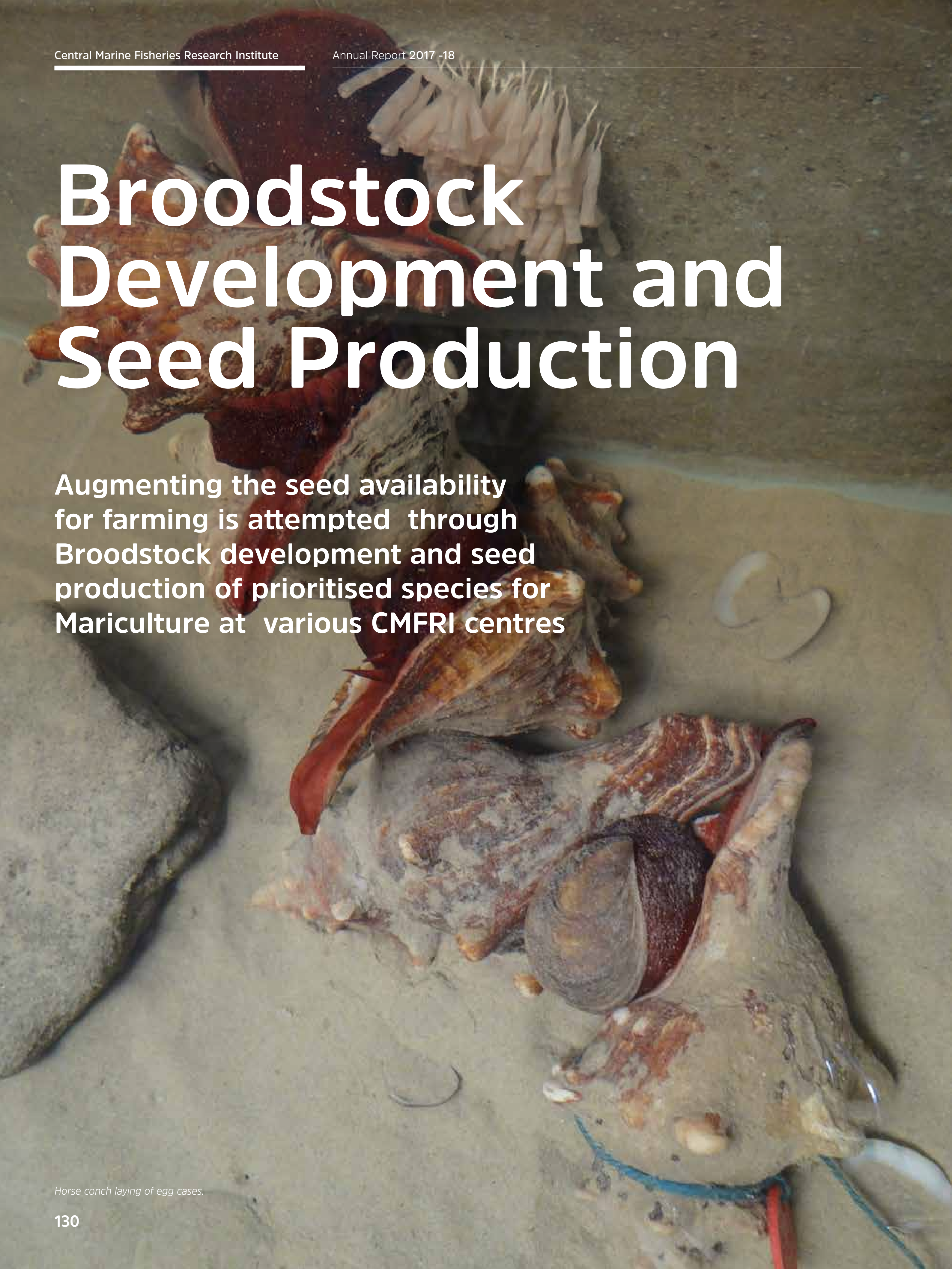
The prenylated spirocyclic ether derivatives, 1 and 2 isolated from *V. cyprinoides* displayed significantly greater (p < 0.05) antioxidant activities against DPPH radical (IC_{50} 0.59 and 0.54 mg/mL, respectively) when compared to other compounds and standard, α-tocopherol (IC_{50} > 0.60 mg/mL.

The spirocyclic ether derivative, 2 exhibited significantly greater (p < 0.05) inhibitory activity against COX-1 and COX-2 (IC_{50} 0.86 and 0.65 mg/mL, respectively) when compared to other studied compounds (IC_{50} >0.90 and >0.70 mg/mL, respectively) isolated from *V. cyprinoides*.

The current findings recommended the utilities of edible bivalve clams as potential bioactive leads in the functional food formulations and templates for medicinal applications.

Broodstock Development and Seed Production

Augmenting the seed availability for farming is attempted through Broodstock development and seed production of prioritised species for Mariculture at various CMFRI centres



Horse conch laying of egg cases.

Broodstock development and seed production

Seeds of grouper, cobia, silver pompano produced from finfish hatcheries of CMFRI at Mandapam and Visakhapatnam were distributed to farmers for grow-out operations

Seed production of food fishes

Research Project: MDN/HCY/18

Orange spotted grouper *Epinephelus coioides*

A total of 1.0 lakh advanced larvae were produced at Visakhapatnam and distributed to other centres of CMFRI and various State departments.

Cobia *Rachycentron canadum*

A total of 3230 cobia fingerlings were produced at Mandapam and supplied to farmers and research institutions for farming, field demonstrations and broodstock development.

Silver Pompano, *Trachinotus blochii*

A total of 2.62 lakhs silver pompano fingerlings were produced at Mandapam and supplied to farmers, fishermen and research institutions of Kerala, Tamil Nadu and West Bengal for farming and field demonstrations.

Broodstock development and spawning of other species of food fishes

Brood stock development and larval rearing of various species are progressing at various centres. At Mandapam, the golden travelly, *Gnathanodon speciosus* and the rabbit fish, *Siganus* spp. are being developed in sea cages as broodstocks. The broodstock development of the mangrove red snapper, *Lutjanus argentimaculatus* is being carried out at Kochi and Karwar and the goldsilk seabream, *Acanthopagrus berda* is progressing at Calicut. At Chennai, a total of 25 viable spawnings from wild collected broodstock of the shovel-nosed lobster, *Thenus unimaculatus* were obtained and larvae were reared up to late P3 and P4 stages. The broodstock development of the Indian halibut, *Psettodes erumei* and the goldlined

Details of the beneficiaries under demonstration of the technology		Quantity of Seed (nos.)
State Fisheries Development Corporation, Govt. of West Bengal	:	800
Mr. Regan, Muttom, Kanyakumari, Tamil Nadu	:	100
Project Director, RGCA, Thiruvananthapuram, Kerala	:	30
CMFRI, Mandapam RC for Research & Broodstock development	:	2300
TOTAL	:	3230

Details of the beneficiaries received the fingerlings		Quantity of fingerlings
supplied (nos.)		
Fisheries Research Station, Kakinada, Andhra Pradesh	:	250
Travancore Aqua Farms, Kerala	:	3500
SFDC, Kolkata, West Bengal	:	21000
Fisheries College and Research Institute, Thoothukudi, Tamil Nadu	:	300
Ayiram Thengu Fish Farm, ADAK, Kollam, Kerala	:	39780
Haja Oli Aqua Farm, Karapidagi, Nagapattinam, Tamil Nadu	:	6000
KVK, Ernakulam, Kerala	:	3000
Mr. N.C. Manoj, Kannur, Kerala	:	4250
Eranholi Fish Farm, ADAK, Kannur, Kerala	:	15000
Annamalai University, Parangipettai, Tamil Nadu	:	50
Mr. K.B. Sasitharan, Kerala	:	2000
Mandapam RC of CMFRI	:	2500
MBT Division, CMFRI, Kochi	:	400

Broodstock development and seed production

1. *Seacages for cobia brooders*
2. *Photothermally controlled indoor system for silver pompano brooders*
3. *Handing over cobia seed*
4. *Handing over Silver pompano seed*

seabream, *Rhabdosargus sarba* is being carried out at Chennai. At Visakhapatnam, the broodstock development of John's snapper, *Lutjanus johnii* is in progress.

Ornamental fishes

At Mandapam, seed production of following ornamental fishes were carried out and the fingerlings were supplied to farmers, fishermen, entrepreneurs and research institutions. Generated a total of ₹6.68 lakhs as revenue through sale of ornamental fishes.

- Percula clown *Amphiprion percula*
- False percula clown *Amphiprion ocellaris*
- Tomato clown *Amphiprion frenatus*
- Maroon clown *Premnas biaculeatus*
- Pinkskunk clown *Amphiprion perideraion*
- Designer percula clowns (Platinum, Snow flake and Picasso)
- Yellow tail blue damsel *Chrysoptera cyanea*
- Camel shrimp *Rhyncocinetes durbanensis*

At Kochi, hybridisation between *A. percula* (female) and *A. ocellaris* (male) was successfully carried out and 25 fertile spawnings were obtained. The hybrid has been named as *Amphiprion percularis*. The broodstock development of the following ornamental fish species were initiated at Kochi.

- Fire goby *Nemateleotris magnifica*
- Scissortail dartfish *Ptereleotris evides*
- Designer ocellaris clown (Domino)
- Skunk clown fish *Amphiprion akallopisos*

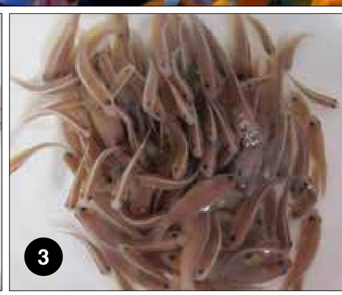
At Vizhinjam, breeding of the cloudy damsel *Dascyllus carneus* was successfully carried out and the larviculture is in progress.

Live feed

Mass culture of following eight species of copepods is being carried out at Vizhinjam:

- *Temora turbinata*

Broodstock development and seed production



1. *Designer clowns*
2. *Hybrid clown*
3. *Skunk clown*
4. *Maroon clown*

- *Pseudodiaptomus serricaudatus*
- *Acartia spinicauda*
- *Acartia southwelli*
- *Parvocalanus crassirostris cochinensis*
- *Bestiolina similis*
- *Dioithona* sp.
- *Euterpina acutifrons*

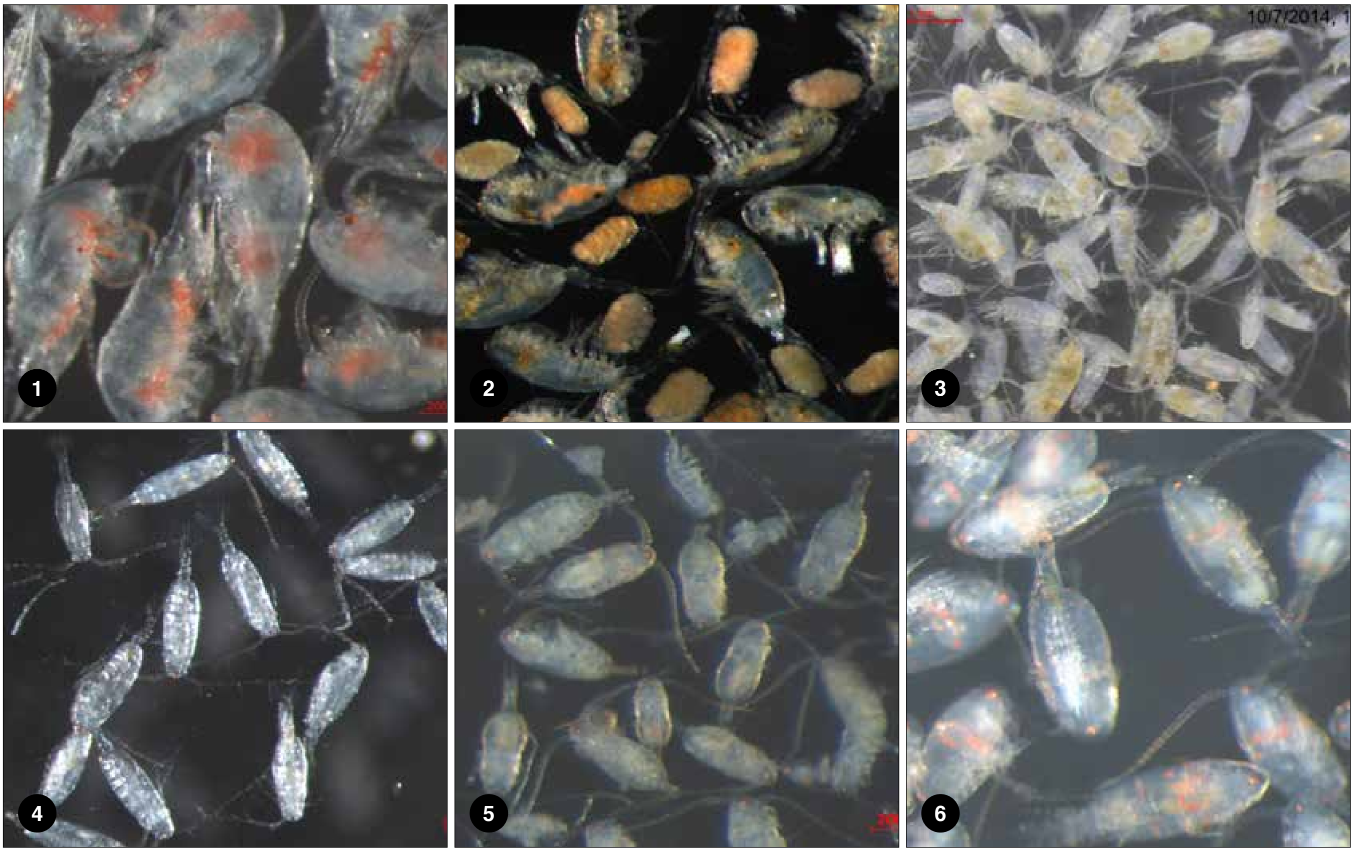
Among these copepods, *Acartia southwelli*, *Parvocalanus crassirostris cochinensis, Bestiolina similis* and *Dioithona* sp. have naupliar size (N1) with length 62-75 µ and width 39-60 µ, suitable for feeding smallest fish larvae.

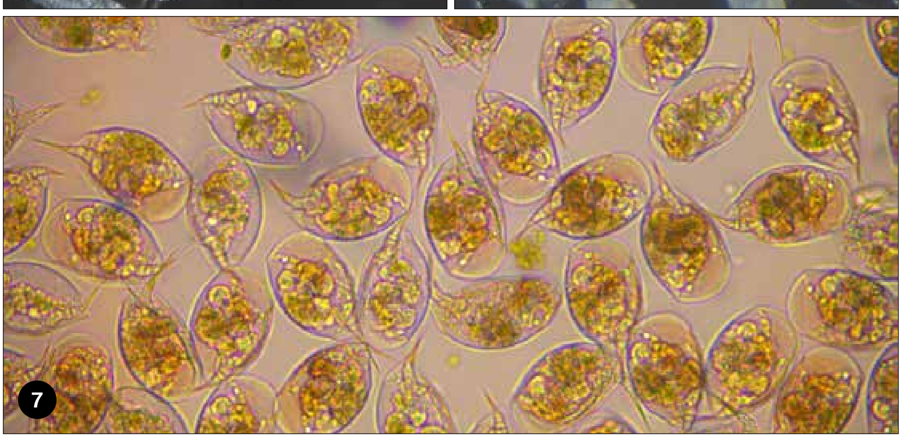
At Kochi, mass production of a super miniscule rotifer, *Colurella adriatica* was successfully standardised. Additionally, four species of marine rotifers, one species of marine cladoceran and two species of marine copepods were isolated and the purestocks are being maintained.

At Mandapam and Visakhapatnam, mass production of phytoplankton (*Nannochloropsis salina, Chaetoceros calcitrans*, *Isochrysis galbana)*, marine copepods (*Acartia spinicauda, Parvocalanus crassirastris cochinensis* and *Oithona* species) and marine rotifer (*Brachionus* species) are being carried out. A new technique for harvesting the nauplii of copepods was developed at Visakhapatnam.

At Karwar, stock cultures of marine microalgae *viz., Nannochloropsis salina, Chaetoceros calcitrans*, *Isochrysis galbana*, *Chlorella salina, Dunaliella salina, Pavlova lutheri* and *Tetraselmis* species and marine copepods *viz., Oithona spp., Acartia spinicauda* and *Parvocalanus crassirastris cochinensis* are being maintained in the laboratory.

Broodstock development and seed production





1. *Temora turbinata*
2. *Pseudodiaptomus serricaudatus*
3. *Acartia spinicauda*
4. *Acartia southwelli*
5. *Parvocalanus crassirostris cochinensis*
6. *Bestiolina similis*
7. *Colurella adriatica*

Augmentation of seed production through research

Mandapam

Preparation of pellet of 17-α-Methyl testosterone for implantation in cobia: Cylindrical semisolid 17-α-Methyl testosterone hormone pellets containing 0.75 mg of the hormone were prepared using the hormone, punctilious ethanol and coco butter by dicing through specially designed brass dice having pore diameters ranging from 1-2 mm. The diameter of the pellets was selected so as to fit into the hormone applicator *i.e.* PIT tag applicator. The prepared pellets were implanted in male cobia to enhance their spawning ability.

Seed production and sea ranching of green tiger shrimp (*Penaeus semisulcatus*) The green tiger shrimp *Penaeus semisulcatus* seeds were produced

Broodstock development and seed production

at Mandapam RC of CMFRI from wild collected brooders from the shrimp trawlers operated in Gulf of Mannar and Palk Bay. After spawning, nauplii were transferred to 5 t capacity larval rearing tanks. Larvae from protozoea I to mysis III were fed with *Chaetoceros* spp. Post-larvae (PL) 1 to 20 were fed with combination of rotifer, artemia nauplii and encapsulated larval feeds. All the larval stages were observed under microscope for analysing health and feeding status. Water quality parameters were maintained within the optimum range. Water exchange was carried out from 20–40% on daily basis.

Larvae were reared up to PL 10-30 stages for sea ranching programme to enhance the shrimp productivity and replenishment of natural stocks in Gulf of Mannar and Palk Bay. Initially 2 lakhs PL-35 of *P. semisulcatus* were released at Thonithurai in the Palk Bay region in the presence of trawl fishermen along with their association leaders, fishermen SHGs and officials of the state fisheries department. On another occasion, about 10 lakhs PL-10 were sea ranched at Pamban (Palk Bay) in the presence of traditional country-craft fishermen along with their association leaders, fishermen SHGs and the officials of State fisheries Department. About 5 lakhs PL-30 were sea ranched at Mandapam in the Gulf of Mannar by the Chief Executive, NFDB, Hyderabad and the Vice-Chancellor, TNJFU, Nagapattinam in the presence of both trawl as well as traditional fishermen along with their association leaders, fishermen SHGs and the officials of State Fisheries Department.

Growth, development and survival of green tiger shrimp larvae under different algal feeding regimes

An experiment was conducted to assess the growth, development and survival of larvae of green tiger shrimp, *Penaeus semisulcatus* under different regimes of microalgae/diatoms *viz., Chaetoceros calcitrans, Skeletonema costatum, Isochrysis galbana, Nanochloropis salina* and *Thalassiosira* sp. Protozoea I of *P. semisulcatus* were stocked in 5 l containers @100 nos. per litre and


1


2


3


4

1. *Sea ranching of green tiger shrimp in Pamban*
2. *Sea ranching of green tiger shrimp in Thonithurai*
3. *Handing ove of shrimp seed to fishermen by Smt. Rani Kumudini, Chief-Executive, NFDB*
4. *Handing over of shrimp seed to fishermen by Dr. S. Felix, Vice Chancellor, TNFU*

Broodstock development and seed production

feeding of algae was carried in the concentration of 50000 cells per ml @ 4 times per day. The water quality parameters such as salinity, temperature and pH were maintained at 34-36 ppt, 27-29°C and 8.2-8.4 respectively. The growth and development were assessed by random sampling of larvae and observed under microscope for the larval developmental stages from protozoea I to mysis III and the survival was recorded in each larval stage under different algal regimes. Results showed that the growth and survival were better under *Thalassiosira* species followed by *Chaetoceros calcitrans.* Hence, these two algal species can be suitable for larval rearing of *P. semisulcatus* up to PL stage.

Improvements in the seed production techniques of camel shrimp

Efforts to standardise the protocols for larval and juvenile rearing of marine ornamental shrimp, the camel shrimp, *Rhyncocinetes durbanensis* species were done. The major improvements includes the speedy metamorphosis of the larvae to juveniles, captive maturation and spawning of the F1 progeny, and a remarkable reduction in the period required for captive maturation of the juveniles. The total number of days to complete metamorphosis was 60 days in the initial trials, which was same as reported elsewhere. However, among the larvae from subsequent batches, the time taken for larval metamorphosis was remarkably reduced; *viz.,* on 45th day the first juvenile was obtained. Later on in another batch, the first juvenile shrimp was obtained on 35th day and more than 50 % of the larvae completed metamorphosis within 50 days period. The larval rearing was carried out in 200 l circular FRP tanks. Live feeds such as copepod nauplii @3-5 nos. ml^{-1} and rotifers @10-15 nos. ml^{-1} along with micro algae, *Nannochloropsis occulata* and diatom *Chaetoceros* spp. were used for larval rearing. Juveniles were weaned to commercial shrimp feed (sinking pellets) of appropriate size range. Water quality parameters include: Dissolved Oxygen above 5 ppm; salinity

Growth of larvae in terms of length (mm) under different algal regimes

Larval stage	*Thalassiosira* sp.	*Chaetoceros calcitrans*	*Skeletonema costatum*	*Isochrysis galbana*	*Nanochloropis salina*
Protozoea I	0.98	0.96	0.94.	0.94	0.94
Protozoea II	1.79	1.76	1.72	1.73	1.68
Protozoea III	2.50	2.45	2.30	2.28	2.20
Mysis I	3.30	3.20	3.10	3.10	3.07
Mysis II	3.68	3.52	3.25	3.22	3.20
Mysis III	4.70	4.60	4.45	4.20	4.10
Post-larvae I	5.20	4.85	4.60	4.50	4.30

Survival (%) of larvae in different algal regimes

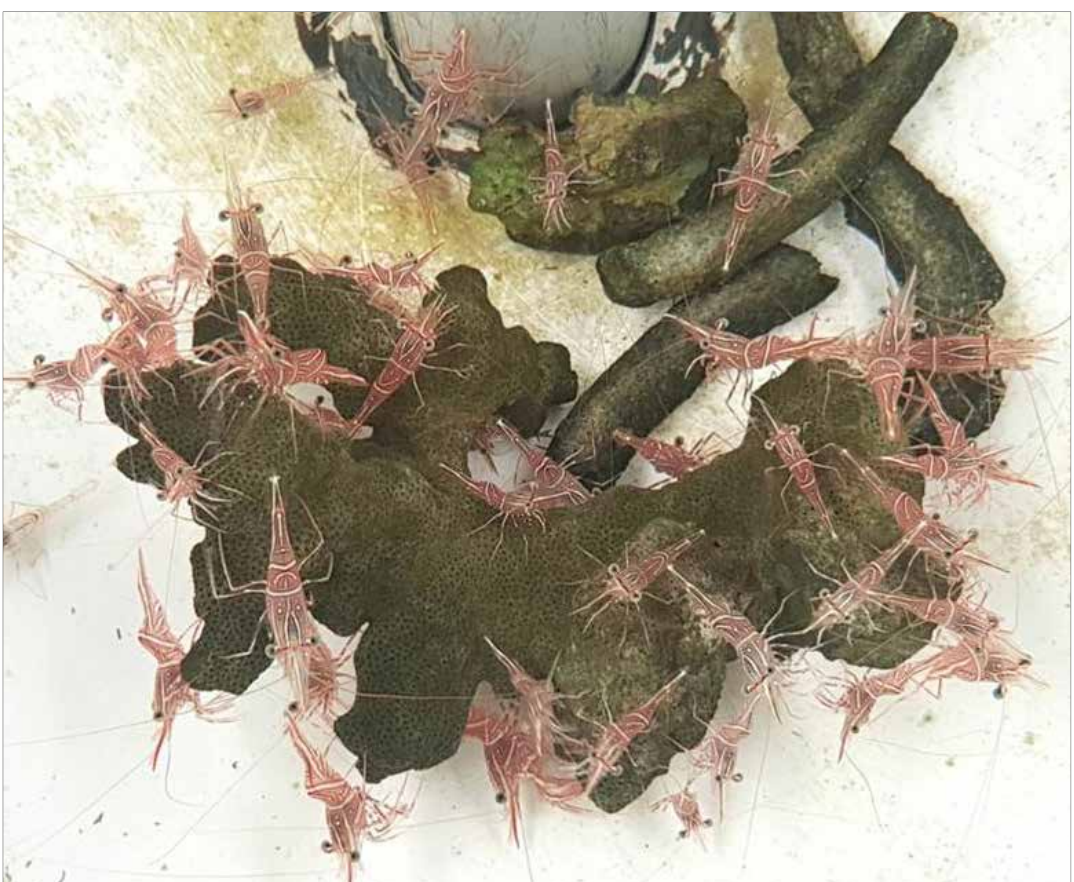
Larval stage	*Thalassiosira* sp.	*Chaetoceros calcitrans*	*Skeletonema costatum*	*Isochrysis galbana*	*Nanochloropis salina*
Zoea I	100	100	100	100	100
Zoea II	92	94	85	82	74
Zoea III	87	84	78	71	64
Mysis II	75	72	62	56	45
Mysis II	72	69	58	51	32
Mysis III	68	64	52	39	18
Post-larvae I	65	58	47	32	10

Reduction in duration for metamorphosis of larvae to juveniles, captive maturation and spawning of F1 progeny of camel shrimp *Rhyncocinetes durbanensis* were achieved with proper feed and environment management

at 35 ppt; pH 7.5 -8.2; Temperature 27-29°C. Another important achievement was the successful captive maturation and spawning of F1 progeny of this shrimp. The initial batch of larvae took 180 days for maturation and spawning. On successive rearing trials, maturation and spawning could be obtained after 135 days. The improvements could be attributed to the modifications in the feeding regimes and maintenance of optimum water quality parameters. Presently mass scale seed production of the species is underway at Mandapam.

Comparative assessment of copepods and rotifer for larviculture of silver pompano

A study was undertaken to assess the usefulness of copepods in larviculture of silver pompano. Newly hatched larvae of silver pompano were reared in three groups such that, one group received rotifer (*Brachionus plicatilis* and *B. rotundiformis*) as live feed, the second group were fed only on copepod nauplii (*Parvocalanus crassirostris*) and the third group were fed with both rotifer and copepod. The stocking density of larvae was 10 nos. l^{-1}. Water quality parameters include: salinity: 33-35 ppt, temperature: 28-30, pH: 7.8 -8.2, DO: 4-6 ppm. Routine management protocols established for pompano larviculture was followed for all the tanks. Growth, survival and metamorpohosis rate of the larvae were recorded to assess the impact of different live feeds used in the experiment. It was observed that, a combination of rotifer and copepod could yield better survival and growth; whereas the larvae fed with copepods exhibited a faster rate of metamorphosis.



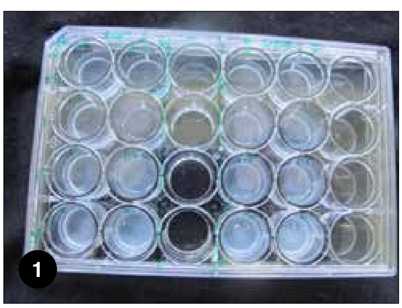
Juveniles of camel shrimp produced at Mandapam RC of CMFRI

Effect of taurine enriched live feeds on survivability, growth and development of silver pompano larvae

Feeding taurine enriched rotifers (@2 g l^{-1}) to silver pompano *Trachinotus blochii* was not effective in improving larval survival and growth. Survivability of the taurine fed larvae was significantly ($P < 0.05$) less than the control fed larvae at all point of sampling. The commencement and completion of metamorphosis process of the taurine fed larvae were also found to be delayed by at least 3 days in comparison to the control fed larvae. Further experiments involving taurine enrichment of the rotifers at lesser concentrations (<2 g l^{-1}) would be helpful to reveal beneficial effects of taurine if any at lesser concentration on pompano larvae.

Health management in of cobia and pompano broodstocks

Immunisation of broodstock and grow-out fishes in sea cages: After the standardisation of multivalent vibriosis vaccine *in vitro* and experimental studies, the field application trials were carried out in the cage farmed cobia grow-out fishes. Sub-adults (90 nos.) and broodstock (35 nos.) of cobia were vaccinated with multivalent (*Vibrio alginolyticus, V. parahaemolyticus* and *V. harveyi*) Algel adjuvanted vaccine during July and September 2017 followed by a booster dose after 21 days interval of the first dose. The serum antibodies were estimated and observed an increasing trend from 7th day post-vaccination (DPV) and continued up to 21 DPV. A decreasing trend of serum antibodies was noticed



1. *Cobia monoclonal antibodies Anti- cobia IgM*
2. *Adjuvant and antigen adsorption estimation*
3. *Immunisation of cobia sub-adults by intra-peritoneal administration of multivalent vaccine*

Broodstock development and seed production

1. *Blood collection from caudal vein for serum separation*
2. *Hyper-immune serum collected after 35day post vaccination (DPV)*

after 21 DPV and again an increasing trend from 35th DPV was observed.

The OD values of antibody to multivalent vaccine differed significantly ($P<0.05$) in the laboratory and in the field trial. There was a significant ($P<0.05$) increase in the OD values of antibodies from 7th to 21st day and dropped significantly ($P<0.05$) at 28 DPV. Hence, it was decided to administer one booster on 28 DPV. The 35th day OD value was higher than 21st and 28th day which indicated serum antibody OD levels were in increasing trend after the booster dose of the vaccine and the immunity was extended up to further 28 days. Thus, the regular epizootics observed in cage cultured cobia every year during the months of July to September (pre-monsoon season) was successfully prevented by immunisation and efficient cage farming management.

Bivalves: Spat production and rearing

Research Project: MFD/MOL/17

Pearl oysters

Adult pearl oysters were brought to the laboratory and fertilisation was done by stripping method and produced one lakh pearl oyster spat. Pearl implantation trials were conducted and best quality pearls produced were in the range of 20-22%.

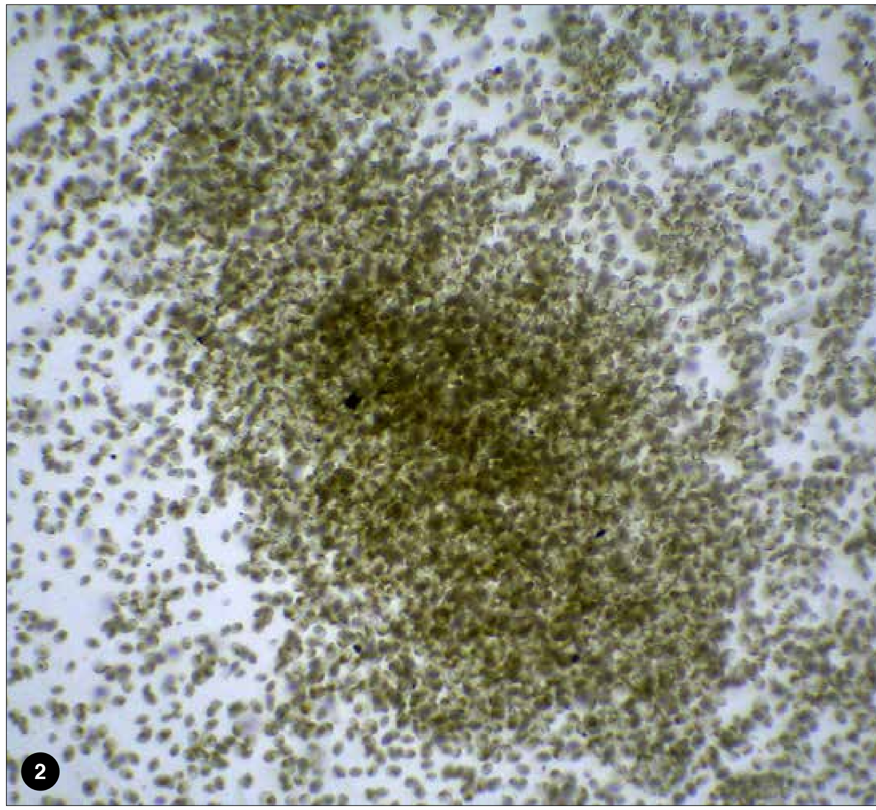
Mussels

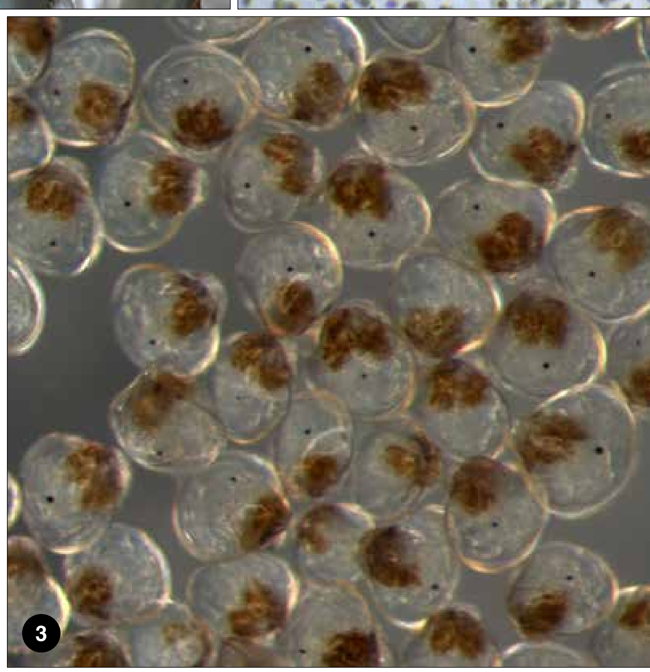
Flow-through system was used for larval

Upwelling and downwelling systems were designed for rearing bivalve larvae for eyed stage and spats

Broodstock development and seed production

1. Pearl production trials
2. Oyster larvae- Umbo stage
3. Larvae of mussel
4. Upwelling system for rearing of mussel larvae





rearing of mussels and stocking density could be improved from 10 to 15 nos. ml^{-1}. Downwelling and upwelling systems were designed for rearing the bivalve larvae for eyed stage and spats. Downwelling systems were also designed and developed to rear about-to-settle larvae (eyed stage)

Gastropods

For the first time, captive breeding of Horse conch *Pleuroploca trapezium* is reported from Indian waters. The brood stock of horse conches (106-208 mm and weighing 118-843 g) were collected

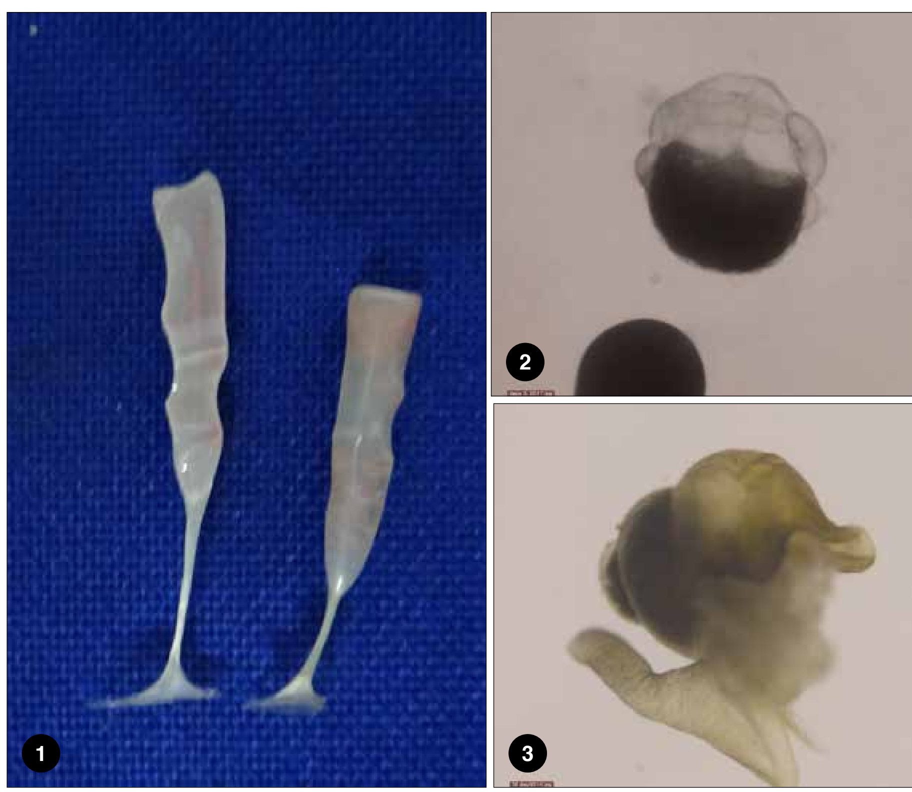
Broodstock development and seed production

and maintained in the hatchery. After 10 months of rearing, three female brooders spawned by laying 340 to 458 vase-shaped capsules as a cluster. The average length of the capsule was 25 mm. The number of egg per case varied from 320 and 460. On an average, nearly 300±50 numbers of larvae hatched out from the egg cases after an incubation period of 23 to 30 days. The newly hatched larvae measured 760 to 825 µm. The early larvae had a bi-lobed velum with very active cilia in the periphery of the velar lobe. The larvae were fed with *Isochrysis galbana* from the day one at a rate of 40,000 cells per ml. The larvae reached 1500 to 1800 µm in size after 40 days post-hatch. Further, attempts are being made to settle the presetting larvae by different cues in the rearing tanks.

Feeding protocol and environmental conditions for the gastropod broodstock

Parameter	*Lambis lambis*	*Chicoreus ramosus*	*Cypraea tigris*	*Pleuroploca trapezium*
Feed	*Ulva* spp.	Clam meat	*Ulva* spp.	Live clam
Feeding rate (g/ brooder/day)	15	2	15	2

Parameter	Temperature (ºC)	Salinity (ppt)	pH	DO (mg l^{-1})	Ammonia (µm l^{-1})
Value	27.21–31.97 (av. 29.3)	28.56–37.13 (av. 33.2)	7.98–8.49 (av. 8.26)	4.59–6.05 (av. 5.46)	0.171–1.539 (av. 0.95)



1. *Vase-shaped egg capsule of horse conch*
2. *Intracapsular development (post- spawn: day 9)*
3. *Larval development (post-hatch :Day 40)*

Growout Technologies

Cage farming technology developed by CMFRI for Cobia, Pompano, Grouper, Seabass, Snappers and lobsters was widely adopted by farmers at various locations in the country

Combined feeding with pellet feed (40% protein) and fish meat at 1:1 ratio showed better growth with highest % weight gain in *Epinephelus coioides*

Nursery and grow-out farming

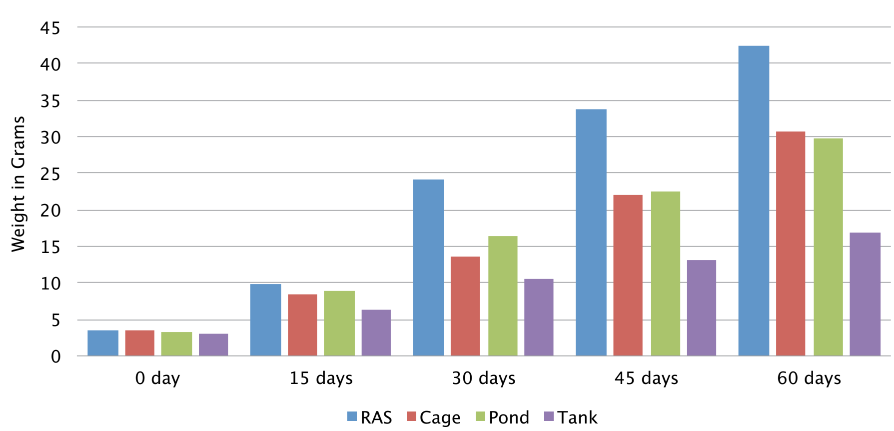
Research project: MDN/CGE/19

Nursery rearing of orange spotted grouper (***Epinephelus coioides***) in different culture systems and feeds

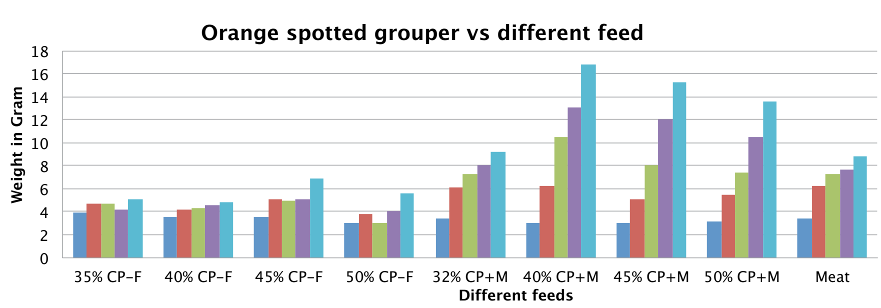
Nursery rearing of *E. coioides* was carried out in earthen pond, cage, Recirculating Aquaculture System (RAS) and concrete tanks to find out the impact of environment on the growth performance. Fingerlings were stocked and fed at 10% of body weight with feed (containing 45% protein and 10% fat) thrice a day for 60 days. Growth was measured on every fortnight and it was observed that the fishes reared in RAS had better growth 38.78 g and those reared in concrete tank had lowest growth 13.72 g in 60 days.

In another experiment nursery rearing of *E. coioides* was carried out using different feeds to find out the effect of feed on growth. In the experiment, 4 diets with varying protein content (35, 40, 45 and 50% protein) were used. In the second experiment, commercial feed with different protein content (35, 40, 45 and 50% protein were mixed with fish (low value fish) meat at 1:1 ratio and used, added to this the growth performance in nursery was also tested with meat (low value fish meat) alone. In all the experiments, advanced fry were used and fed @10% body weight thrice a day for 60 days. Among the formulated feed, the fish fed with 45% protein showed high % weight gain and in the experiment with combined feeding showed that feed with 40% protein and fish meat at 1:1 ratio showed better growth with the highest % weight gain (446%).

Growth of *E. coioides* grown in different culture systems



Growth performance of *E. coioides* fed on different diets



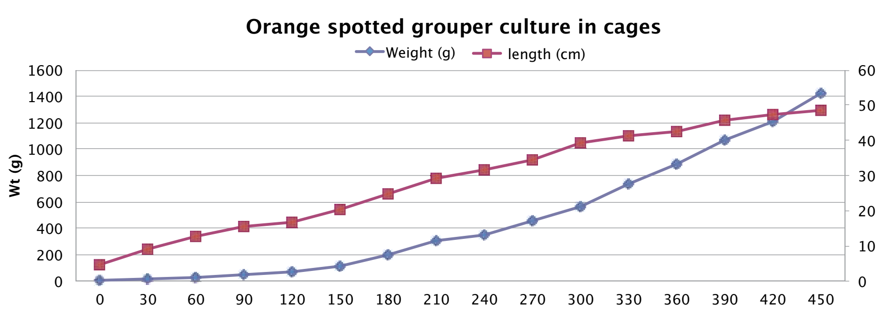
Grow-out culture of orange spotted grouper in cages and ponds

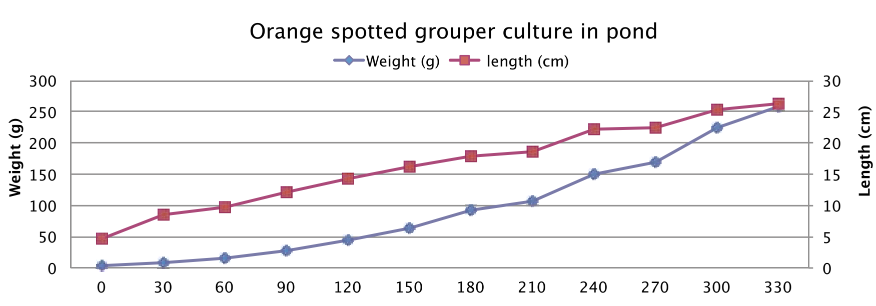
Culture of *E. coioides* has been carried out in sea cages in Visakhapatnam and ponds in Nagayalanka, Krishna District, AP. In cages, fish stocked at stocking densities 5 and 10 per cubic metre and fed with artificial feed until 150 g and later with low value fishes. Fingerlings stocked at 3.47 g size attained an average weight of 1420 g in 15 months.

In case of pond culture, nursery rearing was carried out in hapas erected in the


E. coioides cultured in pond and cage

Growth performance of *E. coioides* in cages





Growout Technologies

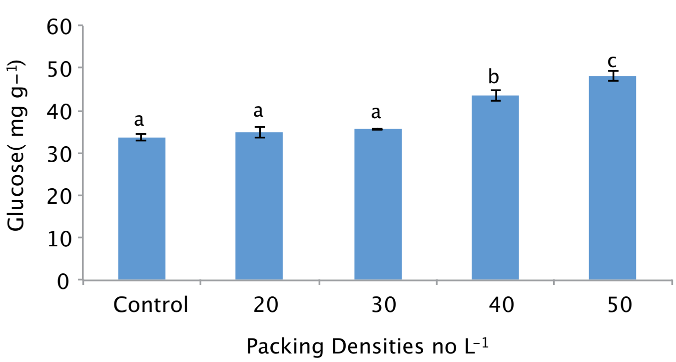
***Epinephelus coioides* fingerlings stocked in cages attained an average weight of 1,420 g in 15 months compared to 257 g in ponds in 12 months**

pond and were fed with pellet feeds containing 45% protein until they reached 15-20 g. During initial period, fishes were fed with 45% protein feed and after reaching 100-150 g, they were fed with 40% protein feed. Fishes fed with protein feed in pond attained size of 257 g and 26.38 cm in length after 12 months of culture.

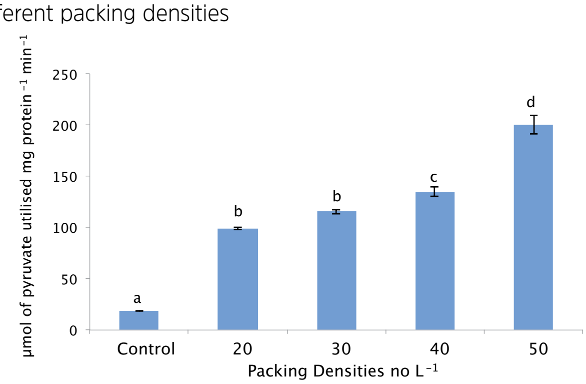
Stress response to different packing densities during transportation of *E. coioides* fingerlings

Stress response of *E. coioides* fingerlings (3.0 ± 0.2 g & 6.0 ± 0.2 cm) packed in sealed double layer polythene bags (ratio H_2O: O2 = 1:3) at densities such as 20, 30, 40 and 50 nos. l^{-1} was studied. The tissue and water sample were analysed after 6 h of transportation by road for various stress parameters. The whole body glucose level and the activities of key metabolic enzymes (Lactate dehydrogenase–LDH, Aspartate Aminotransferase- AST and Alanine Aminotransferase-ALT) was significantly ($p<0.05$) higher at the highest packing density (50 nos. l^{-1}). On transportation water quality parameters *viz*., pH, DO, CO_2 and TAN had significantly ($P<0.05$) varied at different packing densities. However, it was observed that none of the measured stress parameters led to mortality of the fingerlings in any of the packing densities during transportation. Based on survival and different stress parameters, it has been concluded that the optimum density for transporting grouper fingerlings weighing 3.0 g is 50 nos. l^{-1} .

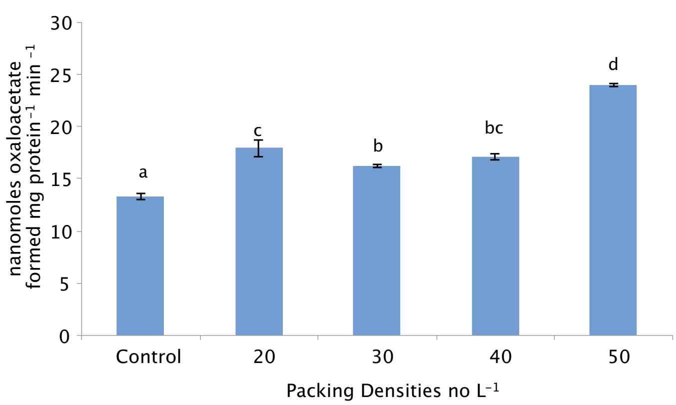
Muscle glucose content of grouper fingerlings during transportation



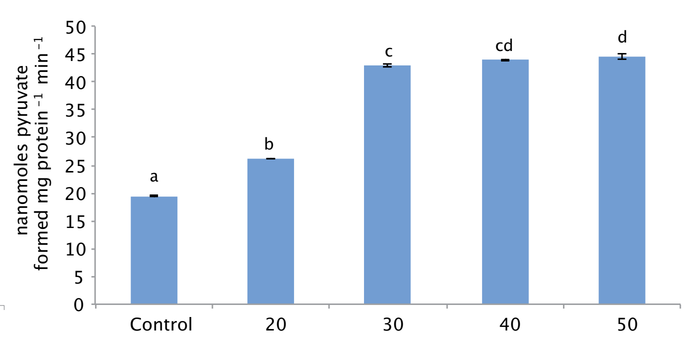
LDH activity of grouper fingerlings during transportation at different packing densities



AST activity of grouper fingerlings during transportation at different packing densities



ALT acitvity of grouper fingerlings during transportation at different packing densities



Evaluation of fouling of the net treated with anti-fouling paint "Boumou"

In this study, the effect of an antifouling paint on fouling of cage net in the sea was evaluated. Two pieces of nets (cross-section of HDPE net used by CMFRI and net used in cages in Japan) were tested for a period of six months for attachment of fouling organisms in the sea. Half portion of both the nets was coated with antifouling paint "Boumou". The nets were hanged and positioned parallel to the outer cage net. After six months, nets were examined and it was observed that there was a dense attachment of fouling organisms in the half portion of both the nets where antifouling paint was not coated. In the remaining half, where antifouling paint was coated there was no attachment in both the nets.

Farming Demonstrations in 10 m dia sea cages

For farming trial in 10 m dia HDPE cage 1510 nos. of 100 g size *L. calcarifer* were stocked during January 2017 at Karwar bay. By feeding with oil sardine @8% body weight, the fish attained an average weight of 1.2 kg in seven months showing a growth rate of 5.2 g day^{-1} with survival rate of 80%. After harvesting the production was observed as1.4 t with a revenue gain of ₹5,27,460/-.

In another cage, 1,200 cobia *R. canadum* juveniles with an average weight of 50 g were stocked during October 2017 and fed with oilsardines @6% biomass. Bacterial infections were observed and heavy mortality recorded. The survival rate was only 10% for a period of 150 days and the average weight of fish obtained was 350 g at the final day. *Photobacterium damselae* sub sp. *damselae* was the causative agent of the disease, detailed in the fish health section.

Farming of lobster ***Panulirus homarus*** in cages at Tuticorin

Five GI sea cages of 6 m dia deployed at Sippikulam Sea was stocked with juvenile lobsters were stocked at a density 1000 nos. per cage. After the culture period of 130 days, 794 kg lobsters were harvested and ₹2,09,373/- was realised. Size ranges of harvested lobsters were observed to be 130 to 246 g.

1. *Farming in 10 m dia cages*
2. *Seabass harvested from cage*
3. *Sampling of fish*

Growout Technologies

Culture of *Trachinotus blochii* and *Lates calcarifer* in sea cages at Tuticorin

CMFRI had selected 20 sea cage farm sites in 10 coastal villages of Puthukottai District, Tamil Nadu and had deployed 5 nos. of 6 m dia GI cages having net depth of 2.0 m with pompano seeds at a stocking density of 1000 nos. per cage and 5 cages of 6 m dia were stocked with seabass fingerlings @700 nos. per cage. Pompano attained a mean weight of 460±38 g in 180 days of farming.

Seabass farming in Palk Bay and Gulf of Mannar

L. calcarifer seeds with a mean weight of 23 g was stocked in 3 cages in Palk Bay and 3 cages in Gulf of Mannar at a stocking density of 8 nos. m^{-3}. (900 nos. per cage) Feeding during initial days was 8-10% of biomass and later shifted to 5-8% of biomass of fishes. After 9 months of culture experiment, harvested fishes weighed 3.7 and 3.2 t from cages deployed at Palk Bay and Gulf of Mannar respectively. Survival rate of fishes during the culture period was observed to be 77.3% from Palk Bay and 72.5% from Gulf of Mannar.

Sea cage farming of grouper in Muttom, Kanyakumari

Epinephelus coioides (1.5 to 2.0 g) brought from Visakhapatnam Regional Centre of CMFRI were nursery reared at Mandapam Regional Centre. It was stocked in a 6 m diameter; 4 m depth HDPE cage of a farmer at Muttom,

1. *Harvesting of cage farmed lobsters at Tuticorin*
2. *Harvesting of cage farmed lobsters at Tuticorin*
3. *Sea farming in Palk Bay and Gulf of Mannar*


1


2


3

Growout Technologies

Cage farming of seabass in Palk Bay and Gulf of Mannar yielded 3.7 and 3.2 t after 9 months of culture in 6 m dia sea cages

Kanyakumari District, Tamil Nadu. The cage was stocked with 1000 nos. of 15-20 g fish for a period of 5 months and attained an average body weight of 500 g.

Sea cage farming trials at Kutchh, Gujarat

Sea cage farming trials for finfishes and lobster at Kutchh were initiated to rehabilitate the displaced fishermen in the area due to the construction of Adani Ports. The lobsters attained an average weight range of 220 -250 g from 80 to 100 g sizes.

The fishermen of Kutchh were also trained in fabricating indigenous low cost bamboo cages for farming lobsters and fishes with the technical guidance of CMFRI. Cage farming of finfishes (*Acanthopagrus latus* and *Rhabdosargus sarba*) is progressing. The seeds were collected from wild through cast netting by the fisher folk. The fishes were fed with trash fish about 8% of fish biomass and the average growth rate recorded was 1.82 g per day.

Open water cage farming in different types of water resources

Open water cage farming has been widely adopted by farmers in Kerala especially in Ernakulam, Thrissur, Alappuzha, and Kottayam districts in backwaters and rivers. Farmers at Malappuram, Kozhikode and Kannur also have initiated cage farming in open waters. The widely adopted dimensions of cages were 8 m x 4 m; 4 mx 4 m and 6 m x 6 m. However, 4 m x 4 m was found to be ideal in terms of ease of operation in open water system. Farmers were provided with guidance for site selection, cage design and fabrication, cage farming, nursery rearing of seeds and net exchange. GPS marking was done for about 400 cage farms in Kerala, operated by 200 farmers from Ernakulam, Alappuzha and Thrissur districts.

1. *Low cost cage in Kutchh region*
2. *Cage gown lobsters with natural fish*
3. *Handing over of standing stock to Junabundar fisherfolk*
4. *Cage farm established at Mundra*

1. *Cages installed in the sea at Perinjanam, Thrissur District*
2. *Instillation of cages at MUttom, Kanyakumari*
3. *Harvested groupers from cages at Muttom*

Cage farming in open water at Moothakunnam and Kottappuram, Kerala

The stocking density studies in seabass revealed survival was more in cages with stocking density of 20 m^{-3} to 30 m^{-3} (60 – 70%) and less in 40 m^{-3} (45 to 55%). The feed and feeding rates studied in different stocking densities showed that excess feeding will result in increased weight gain, with less economic profit.

Economic viability of open water cage farming in Kerala

The profitability of cage farming varied with locations, cage dimensions and types of fish cultured. The average investment varied from ₹20,000 for 2 m x 2 m x 1.5 m cages to ₹70,000 for 8 m x 4 m x 4 m cages including cage structure, nets and floats. The other items of fixed cost were freezer for keeping fish feed, plastic crates for storage and transportation of fish/ feed. Seed and feed costs were the major operational cost components. The cost of seed varied from ₹35–43 for seabass, ₹10 for pearl spot and ₹5 for tilapia. The average survival rate varied from 80-90% in different locations for seabass, red snappers and carangids and 90% for pearl spot and tilapia. Comparative economic performance in different locations indicated that cage farming of red snappers and carangids in 2 m x 2 m

Growout Technologies

Different designs and dimensions of cages in Kerala

x 1.5 m cages yielded a net profit of ₹1.35 lakhs and ₹58,133 respectively through capture based aquaculture. For seabass in cages of dimension 2 m x 2 m x 1.5 m, the net profit varied from ₹28,833 in Gothuruthu to ₹69,473 in Palathuruthu. In Pizhala the gross revenue realised was ₹4 lakhs for seabass and ₹4.32 lakhs for tilapia in 8 m x 4 m x 4 m cages.

The financial performance of cage farming was analysed using NPV, IRR and BCR at 15% discount rate. The Internal rate of return varied from 21% for seabass culture (2 m x 2 m x 1.5 m) to 101% for red snappers (2 m x 2 m x 1.5 m). The depreciation for cage structure was calculated for an expected life of 7 years for cages of dimensions of 8 m x 4 m x 4 m in Pizhala and 4 years for cages of dimensions 2 m x 2 m x 1.5 m in Gothuruthu and Palathuruthu villages. The expected life of accessories was assumed as 5 years.

Cage culture demonstration of seabass in creeks at Kuruthuvenu and Etipagaru in Krishna District

In this site, two GI cages of 6 x 6 m size were installed. The cages were stocked with 500 nos. of wild caught seabass seeds of size range 100-250 g. Fishes

1. *Fishes on harvest at Moothakunnam and Kottappuram*
2. *Demonstration of seabass cage farming, Krishna Dist.*

were fed with trash fishes available in the creek. After eight months of rearing, the fishes reached a size range of 500-1500 g. In another demonstration, 250 wild caught grouper juveniles (250 – 500 g) were stocked and fed with trash fishes and the culture is progressing.

Celluloid type indoor unit for crab grow-out culture

Soft shell crabs and young crabs obtained from crab farms in Thoothukudi District were stocked in single boxes. Crabs were kept individually for a period of 7 to 8 weeks until they got hardened. Crabs were fed with semi-moist feed/trimmed squid waste/live clam/ fresh fish at 10% body weight two times a day. In two culture cycles, 130 nos. of mud crab (600-1000 g) and 50 nos. of blue swimmer crab (300 to 460 g) were harvested.

Rearing of seabass (*Lates calcarifer*) in RAS

About 700 nos. of *L. calcarifer* shooters with an average weight of 80 g from nursery rearing tanks were stocked in the 100 t RAS at Karwar RC of CMFRI. Average growth and growth rate was 370 g and 3.16 g respectively after 120 days of culture.

Harvest of cage farm by State Agriculture Minister, Kerala

The harvest of pearl spot and tilapia cages installed in Periyar River, Alwaye, Kochi for the first time with design and technology support from Mariculture Division, CMFRI, Kochi was inaugurated by Shri. V. S. Sunil Kumar, State Agriculture Minister, Kerala on 16 October 2017. The culture duration was seven months and farmer could harvest 4.5 t of tilapia from 4 cages and nearly one tonne of pearl spot.

Farming of lobsters by CBA (Capture Based Aquaculture) method

Lobster farming was conducted in participatory mode, managed by a farmers' group at Thirumullavarum, Kerala. Undersized lobsters (*Panulirus homarus*) collected by fishermen were stocked in a cage of 3 m x 3 m x 3 m size. The cage was partially damaged due to unexpected rough sea during the culture period. Harvest was done on 5 May 2017 and farmers got 15.3 kg of lobsters after the rearing period.

Compensatory growth pattern in stunted fingerlings of silver pompano *Trachinotus blochii*

Research project: MDN/GRO/22

In order to find out the compensatory growth pattern in stunted fingerlings of silver pompano, 30 and 60 days

Growout Technologies

1. Celluloid crab holding trays
2. Harvest of a cage farm by State Agriculture minister, Kerala1

stunting experiments were conducted in marine condition and low saline condition. Stunting experiment in marine condition was conducted at Mandapam RC of CMFRI and in low saline conditions at Calicut RC of CMFRI (one month stunting) and Karwar RC of CMFRI (two month stunting) with similar procedure. The fishes were stunted for 30/60days at a stocking rate of 100 m^{-3} providing commercial feed at 3% of body weight and were further reared (post-stunting) for 30/60 days at a stocking rate of 20 m^{-3} providing feed at 15% of body weight. Control was maintained at a stocking rate of 20 m^{-3} providing feed at 10% of body weight and the fishes were reared for 60 days. The experiment was conducted in three replicates. Fishes were fed with an artificial diet 45% crude protein 0.8 to 1.2 mm size). Silver pompano was exhibiting a compensatory growth pattern in both marine and low saline condition after one month and two month stunting. Preliminary on farm trial is going on in low saline conditions at Nagnathwada, Karwar.

Bivalve farming

Research project: MFD/MOL/17

Farmed edible oyster, *Crassostrea madrasensis* and mussel, *Perna viridis* were harvested from Moothakunnam and Puthenvelikkara (Ernakulam District).The harvested oysters and mussels were jet washed thoroughly and depurated in the Moothakunnam Value Added Production (VAP) unit. Total harvest was about 15 t shell-on. The depurated steamed oyster and mussel meat were sold through the ATIC of CMFRI. 113 kg of oyster meat and 15 kg of mussel meat were sold at the rate of ₹ 660 per kg. The brand name “Samudra Oushadhi” was given to the depurated quality oysters produced from the farms. New oyster farms were set up in Moothakunnam and Puthenvelikkara. Ten oyster farms with 350-400 strings per farm and 3 mussel farms were put in Moothakunnam and Puthenvelikkara.

Oyster farm at Udupi District, Karnataka

Farms constructed in April 2016 in Sita Swarna Estuary harvested oysters during May-June 2017. Nearly 78 farmers ventured into oyster farming by rack and ren method in Udupi District for the first time with technical guidance from the MRC of CMFRI. The number of ren per rack varied between 120 and 200. The total harvest of 124 t of shell-on oyster was marketed locally.

Harvest of oyster from commercial farms in Dakshina Kannada

The oyster farms were fabricated by the Fisher women groups in Dakshina Kannada District in shallow estuarine waters of (Kolachikambala) Sambhavi River and (Padubailu, Karnad) Pavanje River. Spat collectors suspended during October-November 2016 were harvested during June-July 2017. Total farm production was 36 t of shell-on oysters.

The oyster harvest was carried out in batches and the shucked meat was supplied to local markets, restaurants, bars, households and as well marketed

1. *Harvested lobsters*
2. *Mussel meat shucking at Moothakunnam*
3. *Mussel farm at Moothakunnam*

through the outlets of Karnataka Fisheries Development Corporation, Mangalore.

Integrated multi-trophic aquaculture (IMTA)

Integrated multi-trophic aquaculture (IMTA) of mussel and finfish was initiated in estuarine areas of Sumana Estuary of Karnataka. The green mussel *Perna viridis* was farmed as the organic extractive component in IMTA by rack & rope method near fish cages. The cages were stocked with wild-caught fingerlings of red snapper. In the IMTA system, 1800 culture ropes were suspended from floating bamboo racks. About 7 t of farm grown mussels were harvested in June 2017 and marketed at a farm-gate value of ₹2.5 to 3 per kg of shell-on mussel. By exploiting the extractive capacities of co-cultured lower trophic level taxa, the IMTA farm obtained added products and thereby increased the profits through diversification. Eighty finfish cages were operated in Sumana Estuary during the period.

IMTA was demonstrated in the Chaliyam area in Kozhikode District along with the cage farming activity. The cage-fish aquaculture was initiated in two 4 m x 4 m cages by stocking seabass, (*Lates calcarifer*). Green mussel was cultured by suspending mussel ropes from the cage frames. After four months of growth, 400 kg of mussels were harvested and were sold at ₹150 per kg of shell-on.

Farmers from Malvan area (Maharashtra) who participated in the Bivalve farming training at Padanna (Kasaragod District, Kerala)

Malvan farmers given hands-on training in seeding operation at Padanna

All India Network Project on Mariculture

AINP-Mariculture is coordinating the research in mariculture at 12 participating centres under two major themes (1) Grow out technologies and (2) seed production

Indian pompano fingerlings

All India Network Project on Mariculture

Identification of site with required depth, current and water quality parameters is a primary requirement for successful sea cage farming

AINP -Mariculture is coordinating the research in mariculture at 12 participating centres under two major themes (1) Grow out technologies and (2) seed production with CMFRI as the lead Institute. Central Island Agriculture Research Institute (ICAR-CIARI) Port Blair was included as a participating centre from 2017-18 onwards along with 5 other participating centres from State Agricultural Universities.

Major programmes undertaken under AINP mariculture were

- Identification and demarcation of suitable sites for mariculture
- Development of cost effective sea farming technologies
- Standardisation of larval rearing technologies to augment seed supply
- Estimation of natural seed resources

Mariculture Site identification/ demarcation

The primary requirement for development of sea cage farming is the selection of suitable sites with required depth, current and water quality parameters. Under this project, it is envisaged to identify suitable locations all along the East and West Coast of India for sea cage farming of high value marine finfishes. As a part of this study, sites along the Ramanathpuram District, Tamilnadu were identified and a digital database was developed using the GIS platform to earmark the suitable locations for sea cage farming. Initially, a list of coastal villages or coastal areas along with their GPS coordinates were collected. Then, the Naval Hydrographic Charts along with bathymetric contours of the respective locations were obtained from the State departments. Later, the data on water quality parameters in the respective sites were recorded and used for the development of database. The spatial criteria followed in the selection of coastal villages were:

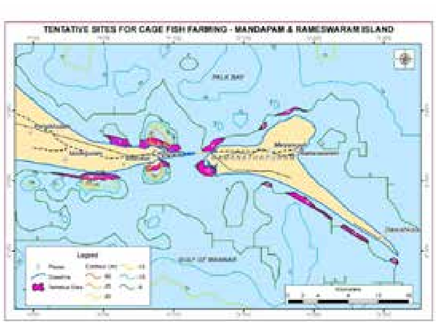
- Depth: 5 to 15 m
- Distance from shore: Up to 1.0 km, preferably within 0.5 km
- Access to arterial roads and markets

Cage culture site selection survey was carried out in Krishna, Prakasm and Guntur district of Andhra Pradesh. Based on different physical, chemical, biological and other social parameters a total of 10 sites have been selected as suitable for cage culture operation. Therefore, a total 29 sites have been selected from 8 district of Andhra Pradesh (other than Nellore district) as a suitable site for cage culture.

Four suitable sites for inshore cage farming in three different villages near Karwar viz., Nandangadda

The total area identified for cage farming in the Palk Bay and Gulf of Mannar are given below:

Area in the Gulf of Mannar	:	26.114 Km^2
Area in the Palk Bay	:	19.929 Km^2
Total area	:	46.043 Km^2



All India Network Project on Mariculture

(Naganathwada, N 14o 50' 304" E 74 o 08', 631"), Small Masjid, N 14 o 50' 528" E 74 o 09', 028"), Sunkeri (Jakatkatta, 14 o 84' 244" E 74 o 15', 612") and near Honnavar were identified. Demostration of cage farming at identified sites are in progress with 6m diameter circular cages.

Coastal surveys were conducted along Gujarat coast for identifying suitable mariculture sites. During the survey sea water samples were collected for Physico-chemical parameter analyses. Parameters such as temperature, salinity, pH, TSS, turbidity, DO, nutrients i.e., Ammonia, Phosphate, Silicate and phytoplankton, zooplankton diversity were analysed. Bottom sediment samples were also collected through grab and bottom profile were analysed through hand held SONAR. The identified sites along Gujarat coast were mapped in GIS. Validation of the mapped potential farming sites were also performed. Based on the optimal ranges of physico-chemical variables, sea cage farming sites were categorised into most suitable, suitable, less suitable, relatively unsuitable and unsuitable.

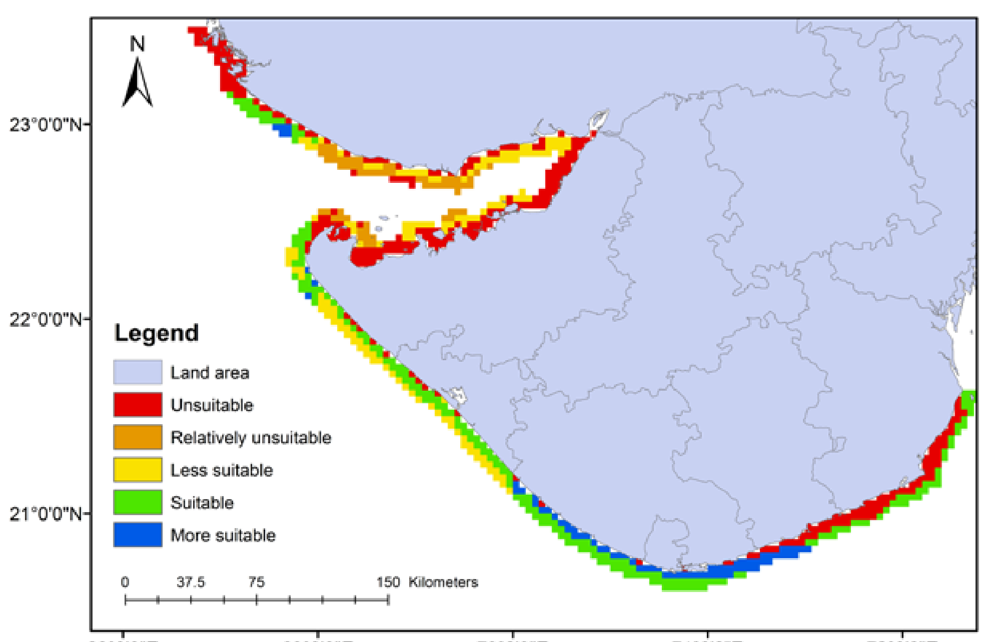
Development of cost effective sea farming technologies

Grow out culture of Indian pompano (*Trachinotus mookalee*)

Culture of Indian pompano was experimented in three different environments such as cage, earthern pond and in FRP tanks. Nursery rearing carried out from 1.27 g to 15 g for 45 days in hapa and after attaining 15g size fishes shifted to ponds and FRP tanks and 2

Table : The percentage area available under each category in relation with the area surveyed along the Gujarat coast

Sl. No.	Category	Area (Km2)	(%)
1	More suitable	256.90	9.23
2	Suitable	737.67	26.52
3	Less suitable	495.45	17.81
4	Relatively unsuitable	220.20	7.92
5	Unsuitable	1071.64	38.52



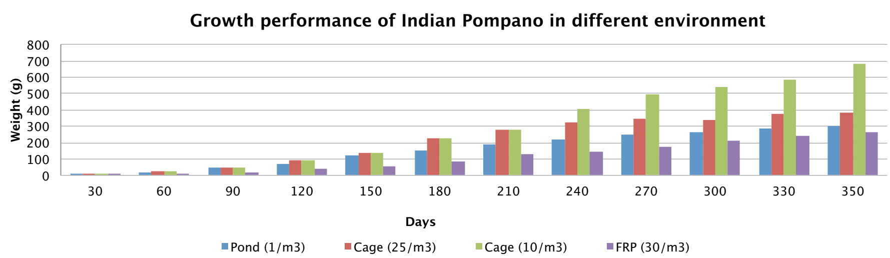
All India Network Project on Mariculture

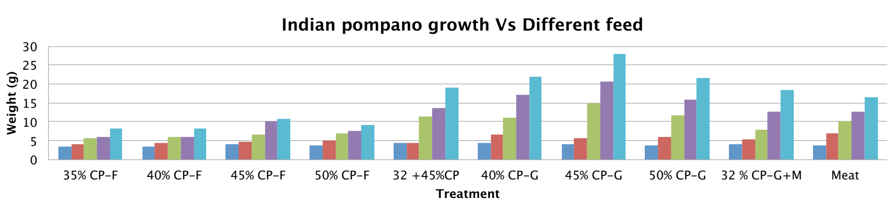
cm mesh sized net cages. During nursery period fishes fed with 45% protein diet and then in grow out culture fishes fed with 40% protein diet with different size. The growth of the fishes recorded from hatching to 350 days of culture period. During the study period, fishes reached to the size of 382 g, 301 g & 261 g in cages, ponds & FRP tank, respectively.

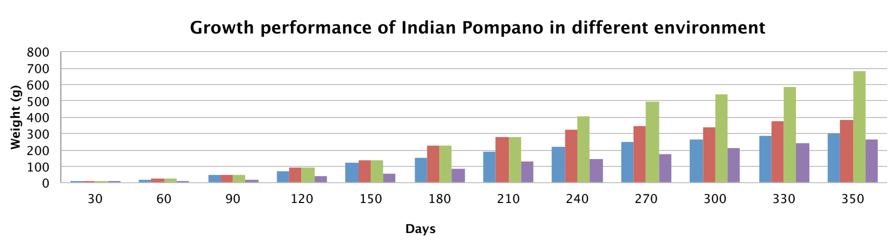
An experiment on stocking density in cages showed that fishes stocked at a density of 10/ m^3 attained a weight of 679 gms whereas stocking density of 25/ m3 gave a growth of 382 g during the study period.

Nursery rearing of Indian pompano (Trachinotus mookalee) with different feed.

Growth performance of *Trachinotus mookalee* in Nursery rearing was assessed with total of 10 different feeds like prepared feeds, commercial feeds and combination of formulated feed and fresh feeds. Four different treatments of formulated feeds with different protein content (35, 40, 45 & 50% CP) , three different treatments of commercial feed with different protein content (40, 45 & 50% CP) and alternate feeding of 32% CP & 45% CP, 32% CP commercial feed & fish meat at 1:1 ratio and fish meat







alone were experimented. In all the experiments, juveniles were reared for two months with respective treatments with a feeding frequency of three times in a day. During the period of study, the fish fingerlings were weighed at every 15 days intervals and their percentage weight gain also calculated. Among the formulated feed, the fish fed with 45% protein (commercial feed) showed high growth (3.95 g to 28.08 g with 610 % weight gain and the fish fed with 35% of formulated feed showed least growth (3.42 g to 8.1 g with 135% of weight gain)

Effect of Salinity on growth performance of hatchery produced Indian pompano (*T. mookalee*) fingerlings

An experiment was conducted for 30days with hatchery produced Indian pompano fingerlings at various salinities like 5, 10, 15, 20, 25, 30 & 35ppt. Fingerlings of average weight 20gm was reared with commercial feed of 45% CP (Growel aqua feed Pvt Ltd). Fingerlings reared in 20ppt salinity performed better with Weight gain % (135.23), SGR (0.92) and FCR (1.14). There was no significant difference in growth performance of fingerlings reared in 35ppt and 5ppt salinity.

Cage farming demonstrations

Cage farming demonstrations to popularise cage farming of marine finfishes were conducted at every participating centres at various locations with farmer's participation. Cages of various sizes and shapes suited to the local conditions were demonstrated among fish farmers with identified finfish species.

Estimation of natural seed resources

Sea cage farming and coastal mariculture requires the continuous availability of fingerlings (seeds) of commercially important fishes. Apart from the hatchery seed production of marine finfishes, seed resources available in the estuaries, lagoons and near shore waters can be effectively utilised under capture based aquaculture. However, comprehensive information on the availability of the seeds of these fishes during different seasons is not available. Hence, seed survey studies were carried out to assess the availability, season, size range

Farming demonstrations by various centres

Species	Type and size of cages	Culture specifics	Location
Epinephelus coioides	Square GI cages 4x4m; HDPE nets	Stocking with hatchery produced seeds of size 15g. Feeding with trash fish given two times daily to satiation, 10 months culture period, harvested size 1.5 kg. Demonstration in 6 cages at two locations. Isopod infestations observed	Kollam
Lates calcarifer	Squarecages 4x4m, Galvanised Iron cages,	Stocking density is 10/m ^{3} with nursery reared seeds of size 25.6 g. Farming duration was 12 months. Feeding upto satiation with trash fishes, 2 times a day. Harvested size ranged from 1-1.7 kg.	Kollam
Indian Pompano *Trachinotus mookalee*	Circular 6m dia Square GI cages 4x4m	Hatchery produced seeds ofsize 10.2 g stocked at a density of 20/m^3. Feeding with commercial pellets or crumbles. Feeding two times a day *ad libitum.* Average production of 421 g per fish in 8 months of culture period.	Kollam
Epinephelus coioides	Circular cages of 6 m diameter	1550 numbers of nursery reared groupers with an initial average weight of 20 g were stocked. Initial feeding with commercial pellets (Growel feeds) @ 6% biomass in two rations. Later shifted to feeding with trash fishes.	Karwar
Lates calcarifer	Rectangular GI cages 4x4x3m	Nursery reared seeds of size 40g were stocked @ 22/m^3. Feeding with trash fish two times day to satiation. Initial biomass in the cages were 0.9kg/m^3 and final biomass was 9.2kg/m^3 after 120 days of culture. Prodcution was 575g per fish.	Karwar
Lates calcarifer	Rectangular GI cages 2.5x2.5x2m^3	Stocking density was 32/m^3 with nursery reared seeds of size 40g. Initial biomass stocked was 1.28km/m^3 and harvested biomass was 18kg/m^3. Duration of culture was 120 days. Feeding with trash fishes 2 times a day @ 6% bodyweight. Average salinity was 28ppt and DO 5.4 mg/L.	Karwar

All India Network Project on Mariculture

Lates calcarifer	6m diameter marineGIcages	Stocking density 9/m^3. Culture duration was 10 months. Feeding with low value trash fishes two times a day. Survial ranged from 56.5 -65.8%. Average weight of fishes in the cages at the time of harvest was 2.10 kg.	Mandapam – 6 cages in two locations
Lates calcarifer	Rectangular cage (3m x 2m x 2.5 m) Total volume : 15.0 m^3	300 numbers of seeds of*Latescalcarifer* (Sea bass) ranging from 40mm to 80 mm size were stocked at a stocking density of 20 pieces/m^2. Fish were fed with pellet feeds @ 6% of body weight initially, and then reduced to 5%, 4%, 3% and 2% in successive months. Added, Trash fish were fed to the fish during 5th, 6th and 7th month of culture period @ 10% of body weight. Growth up to 240 gm was achieved within 7 months. Length- weight relationship suggested a growth coefficient of 2.456 indicating nearly isometric growth.	Gopalpur creek, Odisha
Trachinotus mookalee	4m diameter circular cages	Stocked with 2000 numbers of nursery reared fingelings of size 10-15g. Feeding with commercial pellet feeds two times a day. Feeding ring is installed in the cages to minimise wastage of feeds. Production of 700g per fish during culture period 7 month	Veraval
Indian pompano *Trachinotus mookalee*	4x4m cages	Hatchery produced juveniles of size 2.5g were stocked @15/m^3. Feeding with minced trash fish two times a day. Growth recored was 60gs from the initial size of 2g in a culture period of 3 months.	Visakhapatnam
Epinephelus coioides	6m diameter circular cages	Stocked with 10g sized hatchery seeds @ 10/m^3. Co- feeding of commercial pellet feeds (40% protein) and low valued fishes. Feed was given two times a day. Production of 1.4kg/fish was obtained after a culture duration of 450 days.	Visakhapatnam
Silver pompano	Circular 4.0 diameter	Hatchery produced seed of size 11.3g @ 10/m^3. Feeding with floating commercial pellets (35% crude protein). Production of 125g per fish was obtained after 5 months of farming.	Kakinada
Milkfish	6m diameter circular cages 8m diameter circular cages	Wild collected seeds were stocked after nursery rearing @ 10/m^3. Stocking size of fishes were 124g and size at harvest was 715g after a culture period of 12 months. The average salinity at the culture site wass 29ppt and average dissolved oxygen content was 5.9ppm.	Kakinada
Lutjanus argentimaculatus	Circular cages of 6m diameter	Wild collected seeds, stocked at density of 2000numbers per cage. Feeding with trash fishes, two times a day. Culture duration was 7 months and size at harvest was 800g.	Kochi
Caranx ignobilis	Circular cages of 3m diameter	Seeds having a weight of 20g collected from wild are stocked @ 10/m^3. Feeding with trash fishes two times a day. Average size at harvest was 1.2 kg with survival of 80% and culture duration was 8 months.	Kochi

Cage at Kundukal, Mandapam

1. *Cage culture demonstration at Kollam*
2. *Demonstration cages at Kollam*

and abundance of fingerlings and juveniles of commercially important marine finfish species. Cast net and shore seine operation were conducted to collect the fishes on site. Survey was conducted in 12 villages in the Palk Bay region.

Seed survey trials conducted at Varkala, Paravoor Thankassery and Ashtamudi area revealed rich resources of snappers, groupers, carangids and sillaginid fishes.

Availability of natural seed resources along Kali estuary was carried out during the period 2017-18. Under prioritised species, *Caranx ignobilis* was found be the most dominant species followed by *L. argentimaculatus* and *L. johnii* were found recorded throughout the year. However, the dominance varied between stations and also seasons. In Goa, a survey was also carried out in two marine waters areas of Karwar and found carangids and pomfrets as the most dominant species.

A total of nine species were collected at varied composition. Crab juveniles recorded maximum composition (19%) followed by *P. monodon* (13%). *Eleutheronema tetradoctylum*, *Mugil sp*., *P. indicus, Etroplus suratensis, Elops machnata* recorded a composition between 9% and 10% while *Lates sp*., and *Chanos sp*. recorded minimum composition between 3% and 4%. Higher abundance of fish seeds were recorded during July to December while lesser abundance was recorded during summer months.

A total of 10 fish seed resources survey were conducted during the period under report to assess the prioritised fish species along the coast of Udupi and a few places in Daksina Kannada District during the pre and post-monsoon periods along Shirur, Byndur, Uppunda, Hangarakatte, Malpe, Udyavar estuarine stretches in Udupi District and Mulki, Pavanje, Gurupur and Nethravathi estuarine stretches in

Successful cative spawning and larval rearing of Pink Ear Emperor *Lethrinus lentjan* was accomplished at Vizhinajm centre of CMFRI.

Dakshina Kannada District. At all the selected stations, a specially fabricated fine meshed dragnet (6m) was operated for three times for a known duration and the numbers thus collected were grouped species wise to calculate % abundance (numbers) and to compute CPUE per hour. The Shirur estuarine stretch was composed of prioritised fish species like mullets with a CPUE of 50 and the highest CPUE was contributed by white shrimp (160) followed by mud crab. The Byndur estuarine stretch did not show any occurrence of prioritised fish seed resources but however highest CPUE was contributed by *Ambassis commersoni* followed by white shrimp and *Gerres sp.*

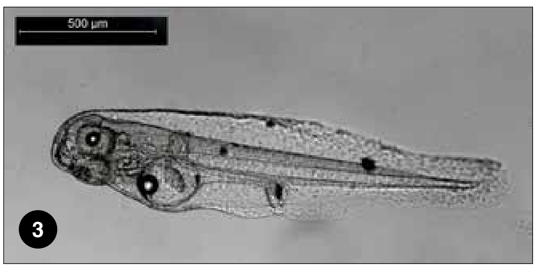
In Uppunda estuarine stretch the highest CPUE was contributed by white shrimp (64) followed by *Ambassis commersoni* and *Lutjanus sp* was the only prioritised fish species with CPUE of 40. The pearl spot showed a CPUE of 36 indicating its potential resources. In Hangarakatte stretch also sand whitings and mullets were the only two prioritised fish species with CPUE of 73 and 206 respectively occupying 4th and 2nd position respectively. The highest CPUE (580) was contributed by white bait.

In Malpe, the beach sample was composed of prioritised fish species like sand whitings and mullets occupying 3rd position with CPUE of 280. The highest CPUE of 2900 was contributed by *Ambasis sp.* The Udyavara estuary was composed of prioritised fish species like sand whitings and mullets occupying 3rd and 4th position with CPUE of 160 and 106.

Standardisation of larval rearing technologies to augment seed supply

Broodstock development and breeding of pink ear emperor *Lethrinus lentjan*, in recirculation aquaculture system.

Pink Ear Emperor *Lethrinus lentjan* (Lacepede, 1802) is a potential species for mariculture because to its high market value due to its superior flesh qualities, hardy nature and ability accept trash fish and compounded feed. Sixteen numbers of *L. lentjan* of the family Lethrinidae in the size range of 19 to 48 cm (750-1200g) were collected and stocked in 10 t RAS system and reared for a period of three months. The first successful spawning with fertilised eggs was obtained after three months rearing in RAS without any hormonal induction. The second spawning with more than 95% fertilisation of eggs was obtained after a week and regular spawning was observed thereafter. The eggs hatched after about 16-18 hours after spawning at a water temperature range of 27-29° C. The newly hatched (pro larvae) larva measured 1100-1150µ. At hatching, there was no mouth opening. The mouth opening was formed after about 30 hours



L. Lentjan indoor broodstock rearing system

Hatchery produced Lethrinus lentjan

One day old larvae of Pseudanthias marcia

post hatch. The mouth gape was around 110µ. Larval rearing is done in green water feeding larvae with copepod nauplii, rotifer, artemia nauplii and micro diet. Juvenile stage with squamation is reached in 35-40 days.

Long distance transportation and sea ranching of Pink ear emperor, *Lethinus lentjan* egg and larvae

Year-round spawning was obtained in the indigenously developed recirculating aquaculture system developed at Vizhinjam Research Centre.. A total of more than 1 million fertilised Egg/spawn of Pink ear emperor, *Lethinus lentjan* was transported successfully in oxygen filled bags from Vizhinam RC to Narackal hatchery of CMFRI and Karwar Research Centre of CMFRI.

Development of satellite hatchery technology for *Lethrinus lentjan*

Fertlised eggs of The pink face emperor fish *Lethrinus lentjan* procured from Vizhinjam Centre of CMFRI were transported to Njaarakkal facility in oxygen filled bags. Transportation of eggs was successful with insignificant mortality rates. The transported larvae were stocked in 1 ton tanks for hatching and out of 3 trials successful hatching (>80%) was observed at two occasions. Hatched out larvae were reared in 1 on FRP tanks. The water quality parameters were maintained as salinity 30 ppt, temperature 28-30ºC and pH 7.5-8.5. The water is well aerated for maximum survival in the initial stage. The eggs were stocked in a tank which is pre-stocked with copepods to ensure a steady supply of different size copepods for young ones, once it starts exogenous feeding. Copepods were regularly added to the tank as feed. Green water technique using microalgae *Nanochloropsis* was employed in larval rearing. Algae not only act as feed for copepods but also a water conditioner in the tank. Copepods of different sizes were given to larvae as feed . On 25th day, larvae were fed with formulated feed of size 250-300 micron in addition to copepods. The fishes were healthy until 37th day. Mass mortality occurred on 37th day in the tank and a complete mortality of larvae occurred after 60 days of rearing

All India Network Project on Mariculture

Pseudanthias marcia juveniles

Indian pompano fingerlings

in captive condition. There are mainly two reasons for the mortality; one may be due to poor water filtration system or due to the metamorphosis of the larvae to juvenile at a specific period of time. Another set of experiments were also initiated to correct the failure. The study will help in the development of satellite hatcheries of breams.

Mass scale seed production of Indian Pompano (*Trachinotus mookalee*)

Broodstock of Indian pompano were collected from seas stocked in land based–Recirculating Aquaculture System (RAS) for development and maturation. With manipulation of water quality and feeding protocols the fishes achieved maturity in RAS at 2-2.5 kg size. Fishes were induced to spawn in the RAS through hormonal (hCG of 350IU/Kg body weight of fish) stimulation. The mass scale seed production was achieved in May, 2017. Metamorphosis from larvae to fry started on the 17th day post-hatch and was completed by the 22nd day. After 30 days of rearing, the survival rate was around 17.2% and the fry reached an average size of 2.9 cm in length and 1.27 g in weight. Since May, 2017 around 35,000 seeds have been produced. The seed produced has been given for state governments and research centers of CMFRI.

An experiment was initiated for larval rearing of *Lethrinus lentjan* with *Apocyclops cmfri sp.nov as initial live feed diet.* Eggs of *Lethrinus lentjan* were brought from Vijhinjam Research Centre during February 2018 and the hatched larvae were fed with the nauplii of Copepod, *Apocyclops cmfri* @ 200 numbers / 100 ml density. But the larvae could be maintained up to 5th day. Further trials are being carried out to standardize the protocol for larval rearing of this species at Karwar Centre.

Broodstock development and hatchery technology of sand whiting (*Sillago sihama*).

The broodstock development of *Sillago sihama* is in progress in three different environments like pond system, hatchery system and cage system. Four distinct stages in male maturity have been delineated under different size ranges as depicted below. However, stage I is yet to be ascertained that fall under the size range < 14 cm. The unequal length of

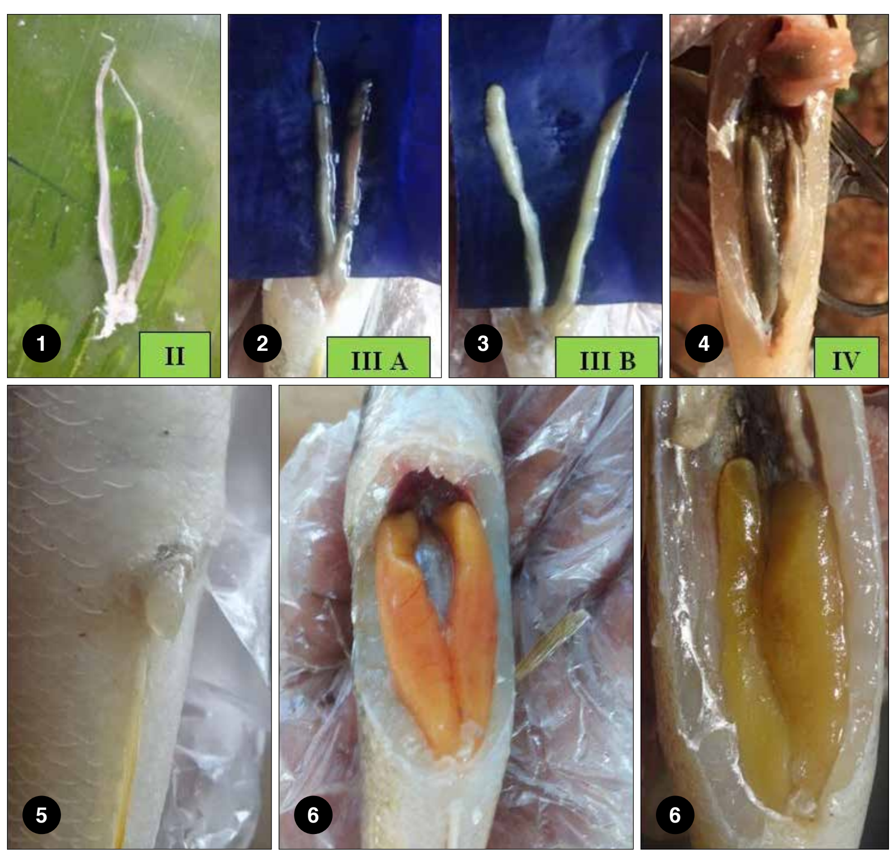
Large scale hatchery production of Indian Pompano (*Trachinotus mookalee*) with average survival rate of 17.2% was achieved at Visakahaptnam centre of CMFRI.

ovarian lobe was evident in I and II stage of maturity.

Fully matured female fish showed bulged vent. Only III A and III B stages were encountered with distinct colour difference of orange and yellow in the size range of 16-20 cm: 38 g and 21-25 cm: 72 g respectively.

Captive broodstock development and breeding of serranid marcia's anthias pseudanthias marcia using recirculation aquaculture system.

Marcia's anthias *Pseudanthias marcia* Randall an Hoover, 1993 with vibrant pink shade belonging to subfamily Anthiinae (family: Serranidae) is a highly sought after marine ornamental fish. Successful captive brood stock development, spawning, and larval rearing of this species were achieved. Brood stock was developed in a 5-ton recirculation aquaculture system (RAS) using 12 wild caught juveniles. Fishes were fed ad libitum using compounded feed and mussel meat. After 6 months rearing fishes (8-9.5 cm size) started courtship behaviour such as vertical and slanting swimming and chasing. Spawning occurs at 1930 hrs. and fertilised eggs were collected using 250 μ mesh egg collector kept at the overflow conduit of the RAS. Fertilised Eggs of *Pseudanthias marcia* were pelagic, non-adhesive, transparent and measured 617.891±14.9 μ (mean±SD). Each egg had a single oil globule which measured in 125.866 ± 14.06μ (mean±SD). Cell division or two cell stage started forming after 14 min of collection of the fertilised eggs from the brood stock tank. Larval motility began after 14 hours: 30 minutes and completion of hatching of larvae took 14 hour 50 minutes at 29° C. The larva broke out of the capsule by extensive wriggling movements. Average total length of the newly hatched larvae was



Male maturity stages in Sillago sihama

1. *14-16 cm: 20 g*
2. *16-20 cm: 38 g*
3. *21-25 cm: 72 g*
4. **25 cm:** *80 g*

Female maturity stages in Sillago sihama

5. *Matured fish with bulged vent*
6. *Ripe gonads in Stage IIIA*
7. *Ripe gonads in stage IIIB*

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1206.55±100.02 μ and the yolk sac length was 826.00±46.00 μ. On 3rd dph larvae measured 1906.26± 32.3μ. Pigmentations began with hatching. Hatched larva developed eight pigmented areas on the dorsal surface of the larva and one spot on the posterior tip of the yolk sac after 4 hours of hatching. Spinous dorsal fin, opercular spines and teeth formation began after 14 to 15 days post hatch and larva measured 4.44 mm in total length. Second dorsal fin spine and pelvic fin elongation occurred between 14 -16 days post hatch and it became short and smaller and acquired normal shape after 20 days post hatch and caudal fin was round shaped. During 32-34 dph larvae metamorphosed to adult shape. Adult coloration and forked caudal fin shape was observed only after 50 days of post hatch and the total body length of the larvae was 42-43 mm.

Newly hatched larvae were stocked in 1-ton larval rearing tanks at the rate of 2 larvae per liter filled with green water at a density of 1X106 cells per ml using *Nannochloropsis oculata* and *Isochrysis galbana* at 1:1 ratio. Mouth opened at 40-50 hours post hatch and measured 50-70 μ and the total length of larvae was 1786 μ. Larvae were fed with copepod nauplii (40-60 μ) at the rate of 10 nauplii per 50 ml, from 3 DPH and co-feeding with enriched artemia from 17 DPH at the rate of 0.2/ml. By 40th day they reached the juvenile stage with a survival rate of 4% and at which they were transferred to nursery

Trainings

National level training programme on *Live feed culture with special emphasis on copepod culture* sponsored by AINP and HRD of CMFRI from 13th -16th December 2017 at Vizhinjam Research Centre of CMFRI, Vizhinjam. Trainees were scientists, technical officers and scholars working in mariculture sector.

Skill development training programme of 3 days duration on sea cage fish farming was conducted at FRIC (Marine), Ankola from 26.03.2018 to 28.03.2018 during the period under report. 40 fishermen were benefited from the programme.

Six training programmes organised at Karwar centre on cage culture of the programme for state officials, fishermen and students of Kerala and Karnataka under AINP during the period 2017-18. 171 participants were trained on the cage culture technology during April 2017-March 2018.

Two training programmes on Cage culture were conducted at Katrenikona Mandal in East Godavari Dist.

1. *Training on live feed culture*
2. *Cage culture training programme at Kakinada*
3. *Cage culture traiing at Ankola*

Marine Biodiversity

Biologically Sensitive Areas (BSAs) along the coast face major threats due to anthropogenic pressures, plastic pollution and destructive fishing practices

Dense mangrove cover of Chettuva Estuary

1. Bird congregation at Yanam
2. Mangrove forest at Hamsaladeevi

Developing conservation plan for biologically sensitive areas along the Indian coast

All India Network Project on Mariculture MBD/CNS/30

A Project Inception Workshop was organised in June 2017 to identify the criteria and indicators that can be used for identifying the sensitive areas. A total of twelve criteria and 34 indicators have been identified. The criteria and indicators were identified taking into account the EBSA criteria adopted by the CBD, and modified to suit the coastal and marine ecosystems along the Indian waters. A total of 5 criteria *viz*., (i) Ecosystem resilience potential, (ii) ecosystem functions, (iii) aggregations, (iv) cultural and aesthetic values and (v) socio-economic values, were added to the existing CBD criteria.

Rapid field surveys were conducted in different maritime states of the country to identify the sensitive areas. Along the Tamil Nadu coast. A total of 29 sites were studied from Vembar to Thengapattinam, covering important ecosystems like the mangroves, estuaries and backwaters, sea turtle nesting grounds, coral reefs and seaweeds. A detailed survey was also carried out in Muthupettai lagoon which has an area of 16.27 km^2, encompassing 1855 ha of healthy mangrove forest and 7180 ha of degraded mangrove area. The lagoon is known to be a home for about 160 species of birds including 80 migratory ones.

A total of 22 sites were surveyed along the Andhra Pradesh coast covering some of the important habitat types in Srikakulam District (6 sites), Vizianagaram (1 site), Visakapatnam (7 sites), East Godavari (4 sites) and Krishna District (4 sites).

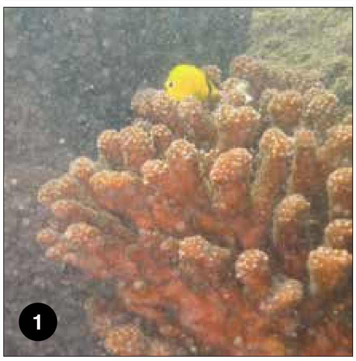
Dense mangrove forest and bird congregation was observed at Yanam.

Along the Kerala coast, scoping surveys were carried out from Thirumullavaram to Poovar covering different ecosystems. Intertidal rocky stretches, patchy coral reef areas and seaweed diversity were

160

species of birds including 80 migratory ones. The Muthupettai lagoon is known to be a home for them.

Marine Biodiversity



1. *Patchy corals between Thirumullavaram and Thankassery*
2. *Pollution in Veli backwater*

Chettuva Estuary has 4.9 acres of mangrove area, rich in floral and faunal density. The sandy beaches along Azhikode to Periyambalam are important turtle nesting grounds

some of the significant features between Thirumullavaram and Thankassery. Sea erosion between Kollam and Lakshmipuram beach, flourishing tourism between Paravoor and Kappil and pollution at Veli were also observed.

A total of 12 sites were covered between Alappuzha District and northern Kollam District. The human population pressure, plastic pollution and destructive fishing practices appeared to be the major threats in all the sites. Thottapally which was the most biologically diverse, is the staging grounds for migratory birds and nesting grounds for sea turtles also had the highest score in terms of threats to biological diversity.

A total of 8 sites were surveyed between Chellanam and Munambam of which Puthuvype and Chellanam were studied in detail. Field surveys were also conducted in Chettuva estuary and in 9 beaches along the coast of Azhikode-Periyambalam stretch of Trichur district. Chettuva estuary has 4.86 acres of mangrove area rich in floral and faunal diversity. The sandy beaches along Azhikode to Periyambalam has been found to be important turtle nesting grounds.Along the North Kerala areas from Chaliyam to Valapattanam were studied .

In Karnataka, a total of 11 sites were studied to identify the sensitive areas. Along the Maharashtra coast, a total of 7 sites were surveyed which included coral reef areas, seagrass beds, and areas known for marine mammals and avian fauna. Along the Gujarat coast, scoping surveys were carried out and a total of 40 sites were studied covering coral reef areas, mud flats, mangroves, turtle nesting beaches and areas of whale shark congregation.

Scyphozoan and Cubozoan jellyfish diversity and distribution along the Indian coast

Research Project: MBD/JLY/32

Preliminary survey along the Indian coast starting from Gujarat to Andhra Pradesh

Marine Biodiversity

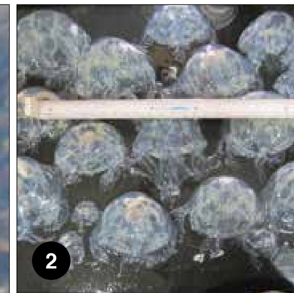
1. *Turtle conservation along Azhikode to Periyambalam*
2. *Thikkodi intertidal rocky stretch*

was carried during the period from April 2017 – March 2018 and the swarming of different jellyfishes were recorded. *Catostylus* sp., *Rhopilema* sp.,*Chrysaora* sp., *Chriopsoides* sp., *Lychnorhiza malayensis*, *Acromitus flagellatus*, *Crambionella* sp., *Cephea* sp., *Lobonema* sp., were found to be swarming in varied intensity along the East and West coast of India during the observation. These jellyfishes belonged to 9 families and 14 genera. *Chrysaora* sp., is the most dominant jellyfish found along both the coast of India. In general, on both the coast the peak swarm was observed to occur in pre-monsoon period (March-May) on the west coast and March-June on the east coast. There is a post-monsoon swarming during September to October along both the coasts.

There is active jellyfish fisheries along Kerala, Gujarat and Visakhapatnam coast

Study locales and the associated criteria for each location along North Kerala

Sl No	Criteria	Survey sites							
		Chaliyam	Korapuzha	Thikodi	Kolavipalam	Payyoli beach	Thalassery	Dharmadom estuary	Valapattanam
1	Naturalness	√		√	√	√	√	√	√
2	Ecosystem resilience potential	√		√	√		√	√	√
3	Threatened, endangered/ declining species and/ habitats			√	√	√	√	√	√
4	Ecosystem functions				√		√	√	√
5	Vulnerability, fragility, sensitivity			√	√	√	√	√	√
6	Uniqueness or rarity								
7	Importance for life history stages of species	√		√	√		√	√	√
8	Biological diversity	√	√	√	√		√	√	√
9	Biological productivity	√		√	√		√	√	√
10	Aggregations								
11	Cultural/ aesthetic value	√		√	√	√	√	√	√
12	Socio-economic value	√	√	√	√	√	√	√	√



1. *Zooanthid colonies in rocky areas of Thikkodi*
2. *Chiropsoides sp.*
3. *Crambionella orsini*
4. *Jelly fish trade*

of Andhra Pradesh and four species are viz., *Crambionella stuhlmanni, C. orsini, Catostylus perezi, Rhopilema hispidum* are traded.

Assessment of resilience potential of coral reefs

Research Project: MBD/CRL/18

Climate resilience study has been initiated in the Lakshadweep Atolls. Underwater survey has been performed in nine stations in the Kavaratti atoll and data on the coral diversity, coral recruitment, average herbivore biomass, coral diseases and percentage composition of bleach resistant coral species has been collected. Three transects each were done at these nine stations. Coverage of macroalgae was nil in most of the stations except a few which had an algal domination with 70% coverage. *Rhodophyta* were found to be dominant with the species *Hypnea pannosa* being widespread. Estimates of anthropogenic stressors like pollution, sedimentation, physical impacts and fishing pressure were also made from the island. A trend analysis of the SST from the past 100 years were performed to compare the rate of increase in SST over the four major reefs of India viz., Lakshadweep atoll, Gulf of Kutch, Gulf of Mannar and Andaman and Nicobar Islands.

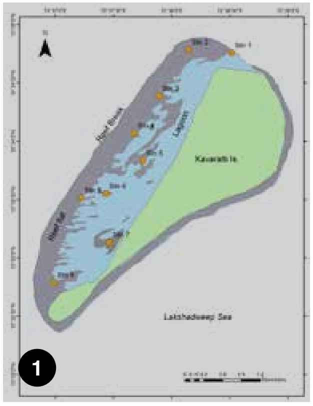
The vulnerability of Lakshadweep reefs in the future Representative Concentration Pathways (RCP) also was estimated. Post cyclonic changes in the Kavaratti reefs were also recorded after the incidence of the OCKHI cyclone during November 2017. *Pyrosomes, Pyrosoma* a colonial tunicate was recorded for the first time in India from the lagoon of Kavaratti Island. Connectivity simulation study of different reefs using remotely sensed data are also being carried out to identify the sources and sinks of coral larvae

Marine Biodiversity

Swarming of different species of jellyfishes along the Indian coast during 2017-18.

State	Surveyed Areas	Jellyfish collected/reported
Gujarat	Jakhau, Veraval	*Catostylus* sp.
		Rhopilema hispidum
		Chrysaora chinensis
		Chiropsoides quadrigatus
Maharashtra	Malvan to Dahanu	*Chiropsoides buitendijki*
		Aequorea sp.
		Lychnorhiza malayensis
		Salpa sp.
		Chrysaora sp.
		Rhopilema sp.
Karnataka & Goa	Netravathi/ Gurupura	*Chrysaora* sp.
		Acromitus flagellatus
		Lychnorhiza malayensis
Kerala	Kazhakootam to Calicut	*Lychnorhiza malayensis*
		Chrysaora sp.
		Cephea sp.
		Crambionella orsini
		Marivagia stellata
		Acromitus flagellatus
Tamil Nadu	Vembar to Kanyakumari	*Acromitus flagellatus*
		Mastigias papua
		Chiropsoides buitendijki
		Cassiopea andromeda
		Rhopilema hispidum
		Lobonema sp.
		Cyanea sp.
		Chrysaora sp.
		Crambionella stuhlmanni
		Porpita porpita
Andhra Pradesh	Krishna estuary to Srikakulam	*Acromitus flagellatus*
		Mastigias papua
		Chiropsoides buitendijki
		Carybdea sp.
		Cassiopea andromeda
		Rhopilema hispidum
		Lobonema sp.
		Cyanea sp.
		Chrysaora sp.
		Crambionella stuhlmanni
		C.helmbiru
		Porpita porpita
Odisha	Puri	*Crambionella* sp.

Marine Biodiversity



1. *GIS Map of Kavaratti atoll indicating the sampling stations*
2. *Pyrosoma sp recorded from Kavaratti Lagoon*
3. *Congregation of Sooty Terns and Brown Noddies in the northern side of the island*

among different reefs. A visit has been made to the waters around Pitti Bird Sanctuary during February 2018 and about 1000 Sooty Terns and about 400 Brown Noddies were recorded from this island. The population of terns has significantly declined during this season. Earlier records also corroborate a gradual decline of pelagic bird population in the island from 20,000 in 1963 to 8000 in 1991. The drastic reduction in the number of birds over the decades calls for the need for in-depth study on their ecology and dedicated conservation measures for preserving this important breeding site. Sensitising the local human population to the need and benefits of conserving Pakshipitti and its breeding bird population would go a long way to achieving these goals.

A new cryptic species of cone snail *Conus* sp. nov., from Lakshadweep has been recorded.

Molecular taxonomy and phylogeny of Cone snails and strombs

Research Project: EF 11

PCR amplification of 50 individuals from 20 species of the families Conidae and Strombidae from six sites along the Lakshadweep Islands for four genes have been completed. A new cryptic species of cone snail, *Conus sp. nov*., from the Lakshadweep Islands, which closely resembles the tropical species *C. distans*. Maximum likelihood clustering approaches revealed separate genetic cluster hence the phylogenetic methods converged to reveal new species. Drastically varying phenotypes were observed among the targeted *Conus* species of different environments which were confirmed using mitochondrial and nuclear markers. Morphological parameters were recorded for the phenotypes of the species. Specific differences were observed for shell coloration. The analysis revealed that the phenotypic variations in *C. inscriptus, C. amadis and C. malacanus* in different environments are not underpinned by the genome.

Estimation of marine fish landings in Tamil Nadu with enhanced sampling coverage

Research Project: EF 22

The detailed training calendar, was prepared and communicated to Tamil Nadu Fisheries Department. The first activity, fish resource identification at species level, was conducted at ICAR-CMFRI headquarters, Kochi in which 25 officials from the Department were trained on the scientific ways of taxonomic identification of various fin fish and shell fish resources. The second training was held at Tamil Nadu at Chennai, Mandapam and Tuticorin with focus on identification of region specific fishery resources at species level. The third training was conducted at field level during which the trainees were assigned the landing centres covered by ICAR-CMFRI field staff at various coastal districts of Tamil Nadu based on the stratified random sampling methodology adopted by the Institute. The data thus collected was collated at the three Research Centres. The fourth training conducted at Chennai centre wherein the handling, coding and correction issues of field data collected is being explained alongside data entry and estimation using software. A specially prepared software "FSDatafeed" is being utilised for demonstration and training purposes which has an easy to use spreadsheet front end and an entry level DBMS software at backend. This gear-centred data entry-cum- estimation software has options for entering the fish resource codes using the names and the various types of stratum and monthly raising factors for each landing centre day. The fifth level of training conducted at all three ICAR-CMFRI Research Centres wherein the data validation, data entry app hands on training were conducted for Data Collection Assistants and TNFD officials.

Bivalve farming

Market survey for estimation of demand and supply of mussels/clam/oysters was carried out in Tamil Nadu and Puducherry indicated that there is very limited number of fishers only go for clam fishing. Most of the respondents revealed that, the mussel production has decreased over the years. Regarding the method of sales, only clam meat selling is popular compared to depurated meat. About 50 per cent of the fishers sell clams with shell only. Among the clam buyers, 25 per cent buy clam and 16 per cent green mussel. Evaluation of consumers' perception about consumption of mussels /oysters /clams revealed that most of the consumers were aware that clam meat, mussels and Oysters can be consumed and also aware of the medicinal values of these bivalves. Most of them preferred to buy depurated meat to whole clam. However, most of the consumers eat clam occasionally and all of them buy clams from fishers directly.

1. *Construction of Bivalve farm*
2. *Sea gulls in Kadalundi-Vallikunnu Community Reserve*

Three sites were selected for setting up bivalve farms (Oyster and Mussel) in three fishing villages Viz; Cuddalore Chinnakuppam, Kottaikadu and Palavercadu in Tamil Nadu. Beneficiaries were selected from the respective villages. Rafts were installed by the beneficiaries with technical guidance from CMFRI and oyster rens were suspended in the farms. The beneficiaries were trained to prepare oyster rens and installation of rafts.

Valuation of marine and coastal ecosystem in Kadalundi Community Reserve of Kerala

(Project funded by the Kerala State Biodiversity Board)

The project is envisaged to assess the present value of ecosystem goods and services in the Kadalundi-Vallikunnu Community Reserve (KVCR), which is the first Community Reserve of Kerala, which lies partly in the Kozhikode and Malappuram districts, with a total area of 153.84 ha. The Community Reserve is characterised by Islands *viz*., Cheru Thuruthu, Company Thuruthu, C P Thuruthu, Bala Thuruthu and Mannan Thuruthu. Besides, along the boundaries within 200 m area, there are 1000 families who are also part of the Community Reserve. The Reserve is also characterised by rich mangrove vegetations, edible oyster beds, diverse fishery resources, mud flats and bird sanctuary offering livelihood to scores of people who are inhabitants of the Community Reserve.

Preliminary studies have revealed that the inhabitants of the Community Reserve are mostly engaged in labour activities and about 52% of the people's annual income is below ₹20,000/-.The villagers depend on the KVCR for fishing activities

Ecosystem services rendered by the Kadalundi-Vallikunnu Community Reserve

Provisional services	Regulating services	Supporting services	Cultural services
Fishing (50 fishers–gill net, cast net, hook & line, traps, 20 oyster pickers), Aquaculture (fish seed production -1 farmer, mussel farming– 30 farmers)	Nutrient cycling, biological production, control of erosion by mangroves, waste regulation by mangroves, carbon sequestration by mangroves	Nursery and feeding ground of fishes, mangroves as habitat for birds, Mud flats as foraging area of birds	Tourism, rich species diversity of mangroves (recreational and educational), visit of birds (recreational and educational)

Marine Biodiversity

1. *Striated heron.*
2. *Black-headed Ibis, Threskiornis melanocephalus*
3. *Grey heron, Ardea cinerea*
4. *Cormorant*

and tourism. About 50 fishermen are regularly involved in fishing and operate various gears like the cast net, gill net and hook & line. Eight groups of fishermen operate specially designed bamboo fence locally called *thada*. About 30 farmers are involved in on-bottom mussel farming. However, there are few threats to the Kadalundi-Vallikunnu Community Reserve which are of serious concern. The accretion of sand has affected the flow of water due to constriction of bar mouth. The accretion of sand is also affecting the foraging area of birds. Sand accretion has also covered the root system of mangroves, particularly those near the estuarine bar mouth, resulting in the death of some mangrove trees. Besides these, dumping of slaughter house wastes into the estuary is a cause of concern.

Marine Habitats

Beach litter along the Indian coast assessed and interactive map showing the status is hosted in CMFRI website

Marine Habitats

4120 t

The total quantity harvested was 4,120 t (dry weight)

Marine macrophytes

Research Project: FEM/ MPH/29

Seaweed production

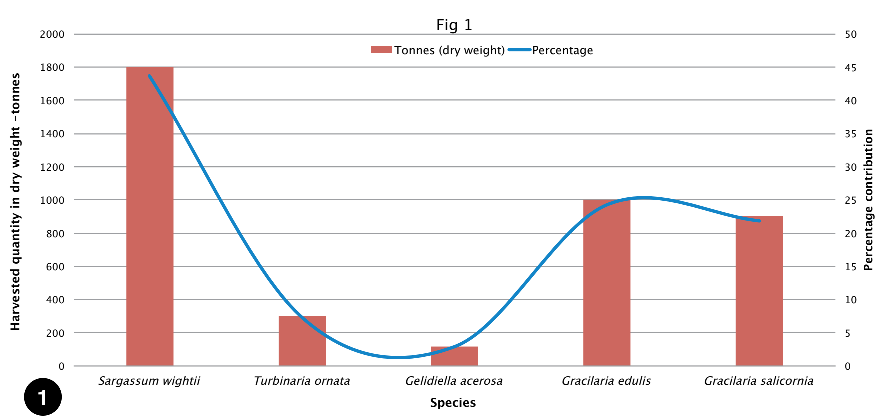
Two alginophytes, *Sargassum wightii* and *Turbinaria ornata* and three agarophytes *Gelidiella acerosa, Gracilaria edulis* and *Gracilaria salicornia* were harvested from Gulf of Mannar and Palk Bay region of Tamil Nadu coast. The total quantity harvested was estimated as 4,120 t (dry weight) where the alginaphytes contributed 51% and the agarophytes 49%. *S. wightii* (44%) was the dominant species followed by *G. edulis* (24%) and *G. salicornia* (22%). Contribution by *T. ornata* was 7% and by *G. acerosa* was 3%. Quantity of *Kappaphycus alvarezii* cultivated in Tamil Nadu coast during 2017 was only 70 t dry weight.

Seagrass ecology

Organic carbon content in sediments of seagrass meadows of different regions were found to vary: Mandapam 0.57 – 0.69%, Lakshadweep atolls 0.11-0.21% and Pulikat lake 0.24–0.82%. The unutilised stranded mass of leaves and shoots from seagrass meadows of Palk Bay contribute organic matter such as humus to the coastal waters to a tune of 2.5 to 3.2 %.

Bandtail scorpionfish spotted after 42 years

A live rare Bandtail Scorpionfish *Scorpaenopsis neglecta* Heckel, 1837 was observed in the seagrass beds at Sethukarai in Gulf of Mannar. Initially, the physical appearance of the fish was similar to corals and then changed to brown, a clear indication of the camouflaging behavior of the fish. This fish was last observed by Prof. John E Randall, the famous American Ichthyologist from Krusadai Island of Gulf of Mannar in 1975. The specimen which was collected has been deposited in CMFRI museum. This is the only specimen available in the country.



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2

3

1. *Quantity and percentage contribution of seaweeds harvested from Gulf of Mannar and Palk Bay during 2017*
2. *Underwater live photograph of the rare Bandtail Scorpionfish Scorpaenopsis neglecta Heckel, 1837 observed in the seagrass beds at Sethukarai in Gulf of Mannar*
3. *View of the floating nursery with propagule*

Seaweeds are efficient bioremediators and could bring down the BOD of treated waters considerably.

Floating mangrove nursery

A floating raft to rear mangrove saplings was designed and fabricated and planted with propagules in disposable bags. The propagules showed good growth. The advantage of this is that no additional agronomic care like irrigation with salt water is required.

Coastal and marine Pollution: Assessment and Bioremediation

FEM/PLN/28 and FEM/PLN/ SUB/28

Preliminary experiments using seaweed *Enteromorpha intestinalis* for bioremediation reduced the BOD level to 5 ml l^{-1} from 25 ml l^{-1}. The turbidity of the water is reduced drastically. Bioremediation experiments on sewarage were conducted with *Nannochloropsis* and other species. Reduction in turbidity and nutrient load were observed: nitrite 99.69%, ammonia 97.2% and silicate 38.89% at Tuticorin. The BOD reduced from 43.6 mg l^{-1} to 1.89±0.8 mg l^{-1}.

Preliminary experiments using macro alga, *Ulva flexuosa* was tried as one of the bio-remediators to contain lead pollution in coastal waters. Further studies are required before confirmation.

Acanthus ilicifolius had the highest level of Cu (6.14 ppm) while the levels of Cd was least in this species. *Avicennia officinalis* had the highest level of Cd (5.51 ppm).

Eicchornia crassipes, an aquatic weed was used to treat effluent water. There was reduction in phosphate, ammonia, cyanide and sulphide level initially. An increase of 40% and 55% in Cu and Cd uptake was observed.

Mapping of oil spills along Indian coast

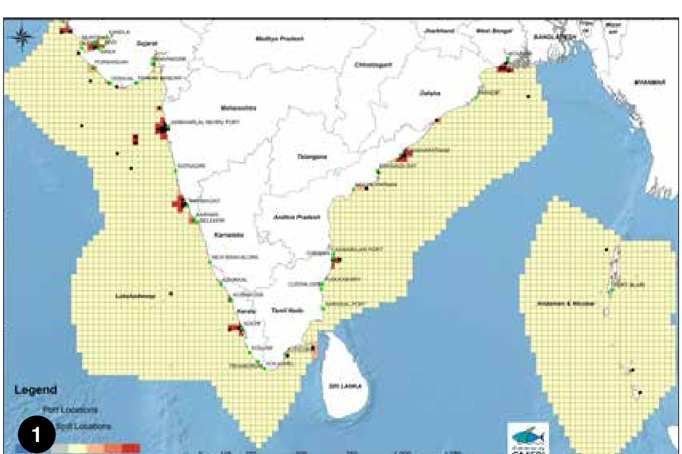
The data of oil spill accidents between 1970 and 2017 in the EEZ was sourced from "Blue water" publication of Indian coast guards and the information was plotted in GIS format. The hot spots of oil spillage were identified. This information will also be helpful for policy makers for conservation of critical habitats like corals and mangrove ecosystem. It was observed that the maximum number of oil spill happened near Mumbai, while other major oil spill areas are Kolkata, Sikka, Murmagao, Vishakhapatnam and Chennai.

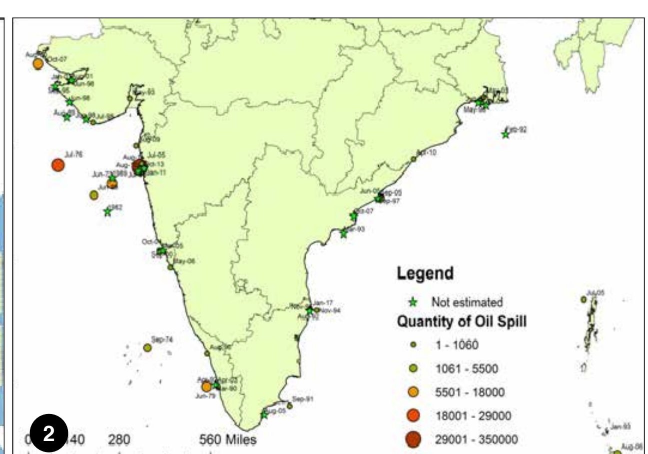
National Beach Litter Interactive Map

Beach litter status of Indian coast which was assessed through surveys earlier was mapped. In order to make the information easily available, an interactive web map was developed and hosted in the CMFRI website. Upon clicking each location, the map will open a pop-up window with the

1. *Map showing the Oil Spill locations in Indian Exclusive Economic Zone*

2. *Map showing the quantity of oil spill along the Indian EEZ*





Marine Habitats

Interactive map of beach litter status along the Indian coast

following information *viz*. name of the beach, coordinates, state/UT, litter status, category and category-wise photograph. This interactive map can be of use to the policy makers, researchers and public who are interested in waste management and conservation of marine ecosystems. Moreover, it represents an efficient way to ensure last mile connectivity between the information and its end user.

Marine debris estimates

Studies were conducted in Visakhapatnam to estimate the debris along the seafloor, by experimental bottom trawling surveys at depths ranging from 30-40 m during the period from April 2017 to March 2018. The mean quantity of biodegradable waste and non-biodegradable waste were found to be 1.03 ± 0.37 kg km^{-2} and 2.79 ± 0.36 kg km^{-2} respectively. Considerable increase in the quantity of non-biodegradable waste on the sea bottom were noticed when compared to 2016.

Studies conducted on the litter contamination of the sea floor of Veraval coast, by estimating the litter trapped in dol net fishing indicated a range of 0.49-5.36 kg during hauls and are represented by thematic maps.

Plastics in fish gut

Two pieces of macro plastic material, like a transparent plastic piece of 250 mm with the weight of 3.71 g and a blue colour plastic bottle cap of 6 mm diameter, were observed in the gut of dolphin fish *Coryphaena hippurus* of Veraval coast.

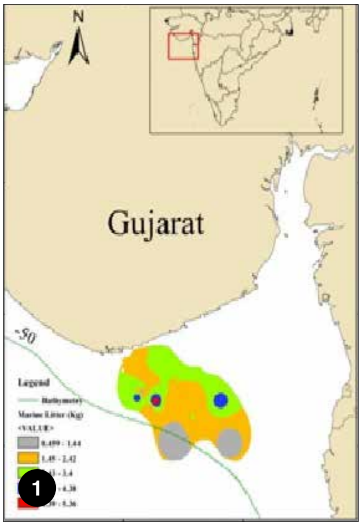
Other anthropogenic impacts

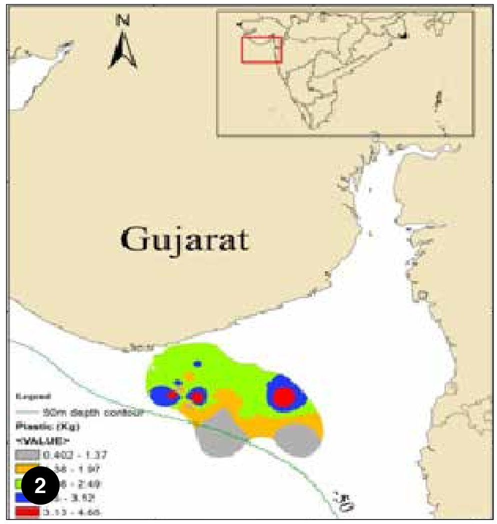
Three sites along Vishakapatnam coast *viz* Fishing harbour (Surface and Bottom), Lawsons Bay and Mangamaripeta were monitored for environmental degradation. They were graded as per USEPA, 2004 as Good, Fair and Poor. Fishing harbor surface and Bottom waters were graded as 'Fair' and Lawson's bay as 'poor' and Mangamaripeta 'good'.

Organic pollution in Vembanad Lake

Studies on the organic pollution levels regarding BOD and most probable

Marine Habitats





1. *Map of litter in fishing ground off Gujarat*
2. *Map indicating various quantity of plastic found in dolnetters of Nawabandar.*
3. *Debris in the sediment sample in backwater canals of Vembanad Lake.*

Marine debris on the sea floor off Vishakapatnam showed an increasing trend compared to 2016

numbers (MPN) of *E. coli* per 100 ml at 17 locations of Vembanadu lake indicated that 70% of the stations were of fair BOD (2 to 4 mg l^{-1}) followed by 24% good BOD and 6% poor BOD. In the case of *E. Coli*, 59% of the stations showed fair quality (10000 to 25000 MPN per 100 ml), followed by 35% poor quality (>25000 MPN per 100 ml) and 6 % with good quality (<10000 MPN per 100 ml).

Fish mortality

Studies conducted on the causative agents of fish mortality happened near Kovalam beach, Mullakadu, south of Tuticorin on 12 February 2018, at the incident spot and the surrounding areas around 5 km indicated normal values of all water quality parameters except for the slightly higher value of ammonia (0.146 mg l^{-1}) higher than the toxic limit of 0.1 mg l^{-1} indicated the possibility of ammonia entry as the reason for the fish mortality.

Coastal pollution

The coastal pollution sites were selected along the Gurupur River to assess the impact of sewage and industrial discharge. Analysis of the earlier data of the river shows an increasing trend of fair water quality as per US EPA 2004 and most of the poor water quality rating was from February to May when the freshwater inflow was the least. An increasing DIP trend and higher chlorophyll *a* value was also noticed in the river which could be attributed to land use changes.

Development of Micro-level environmental management plans (EMP)

Research Project: FEM/HBT/27

Protocol Development for Micro level EMP

Mulavukad Gram Panchayat in Ernakulam District, Kerala was selected for developing the protocol for Micro-EMP for model coastal village. Through Google maps 52 stations were selected for assessing the environmental health status. Five different categories of sampling locations were identified 1) open estuary 2) mangrove 3) interlinking canals 4) active shrimp ponds and 5) inactive ponds. Twenty seven ecological parameters related to water and sediment were studied. Marine litter was found to clog the interlinking canals in most wards. The van veen Grab sampling was also difficult due to macro-litter over the sediment. Benthic biomass was studied to assess the ecosystem health. Household survey was also conducted to assess the

Marine Habitats

quantity of litter per house per day.

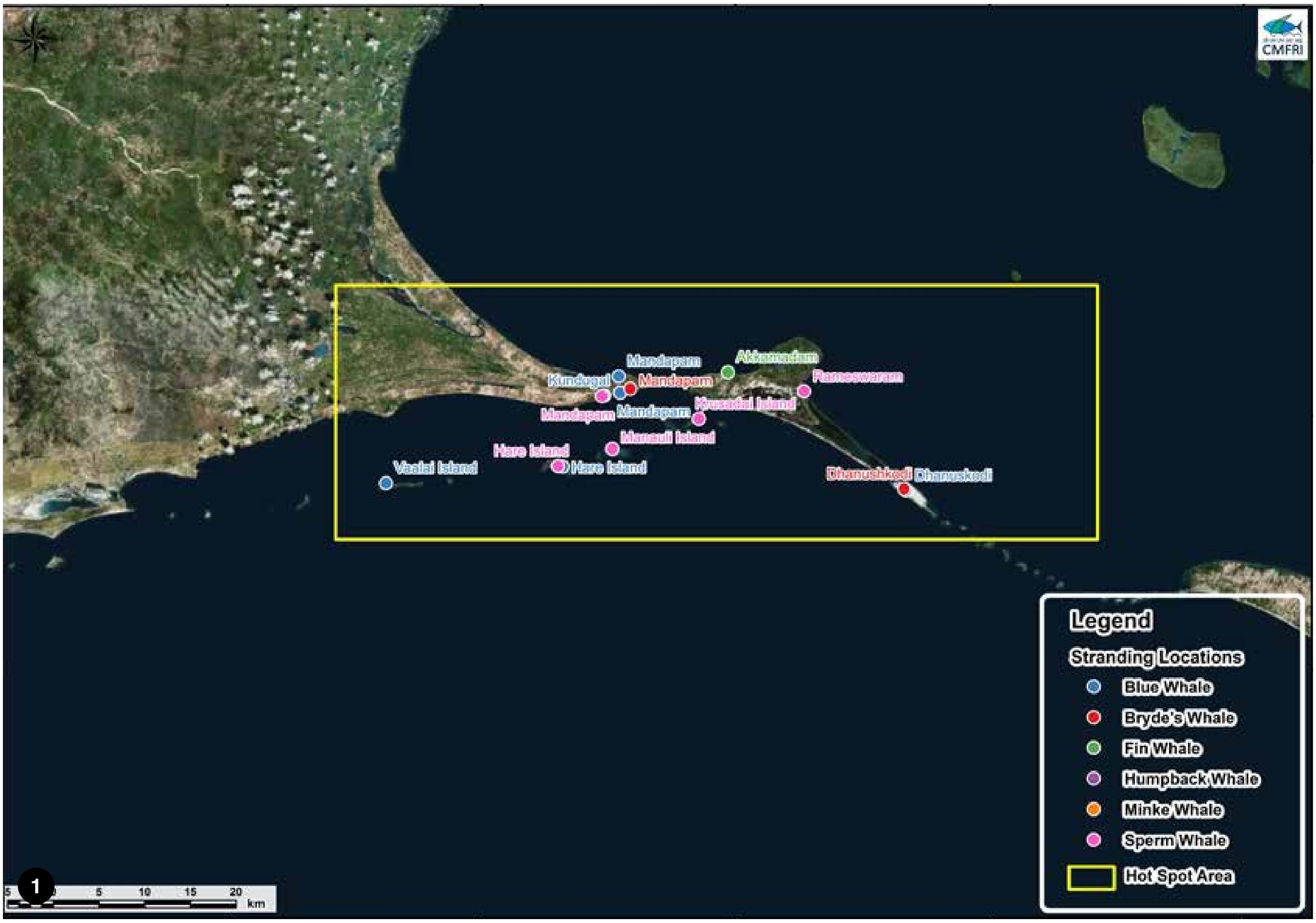
Participatory approach for EMP

Draft Micro EMPs were developed for the village and presented them in a workshop conducted at Mulavukadu Grama Panchayath with all the stake holders and line departments. Group decision was taken for nano level implementation of the location specific EMPs.

Tamil Nadu: Munaikadu and Chinnapalam in Ramnad District were selected for Micro- EMP. This region has mangrove and efforts were made to restore the mangrove through planting propagules. Similarly efforts were made to restore sea grass and species like *Cymodocea serrulata*, *Enhalus*

1. *CMFRI staff along with Kudumbashree workers collecting plastic waste for assessment in Mulavukad, Kerala*
2. *Mrs Viji Shajan, Panchayat President commenting on the EMP studies conducted by CMFRI in the village*
3. *Planting of Mangrove sapling in Munaikadu, Ramnad District*
4. *Seagrass restoration program at Chinnapalam, Ramnad District*
5. *Analysis of benthos in CMFRI Environmental Biology laboratory at Kochi*

Marine Habitats



1. *A hot spot of marine mammal stranding along the Tamil Nadu coast*

2. *Interactive map of major stranding location of marine mammals along the Indian coast.*

acoroides and *Halodule* sp. were planted in small rafts for restoration.

Geospatial Technology for Marine Mammal Conservation

A marine mammal stranding interactive map was prepared which will give the scientific information of the animal like genus, species, habitat, reference articles and standard operating procedure in case of standing. Upon clicking each stranding location, the map will open a pop-up window with the following information *viz*. common name, scientific name, stranding location, coordinates, state/UT, year, reference and standard operating procedure. The web map comes handy with information required for field level conservationists and policy makers alike.

Marine Habitats

Artificial reef modules ready for deployment

a. Grouper module

b. Well ring module

c. Reef fish module

d. Modified grouper module

e. Modified well ring module

Assessing the performance of artificial reefs

Research Project: MCD/FAD/21

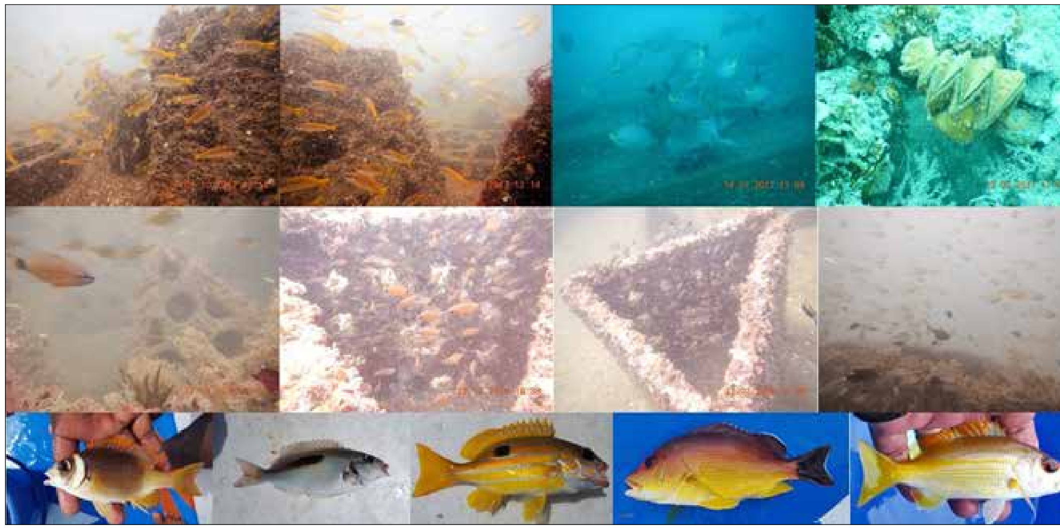
Artificial reefs are modified FADs set on the sea bed to promote habitat recovery or development and enhance the growth of marine floral and faunal benthic communities.

Artificial reef technology has been used widely across the globe for both habitat and ecosystem enhancement and commercial fishery enhancement. The materials used for artificial reef construction are variable like concrete, steel and glass-reinforced plastic. In India, Tamil Nadu has, in recent years, become a major player in the practice of artificial reef deployment in coastal waters, under technical guidance from CMFRI. Artificial reefs modules made of concrete have been deployed in about 50 sites along the Tamil Nadu coast, under different schemes during the period 2009-2016. Different models have been deployed at selected sites, usually as a combination of Grouper, Reef fish and Well ring modules. Slightly modified modules have also been deployed. The dimensions and efficient surface area created through the deployment of 200 numbers of modules at a particular site.

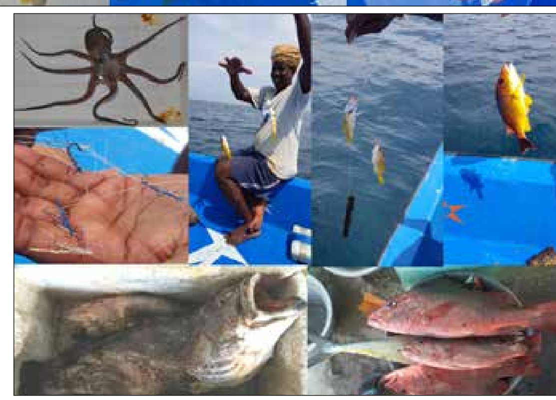
Studies were conducted to assess the state of maturation of artificial reefs deployed at some selected sites along north Tamil Nadu coast and to collect information to assess the impact of artificial reefs on the natural habitat and its biodiversity. Underwater survey and transect sampling of artificial reef habitats with photo and video documentation was carried out at 3 sites in Kancheepuram

Dimensions of artificial reef modules and surface area available for habitat build-up

Name of module	Area of each module (m^2)	No. deployed	Effective surface area
Grouper	258	70	
Reef fish	410	70	
Well ring	244	60	0.1 ha
Modified Grouper	325	75	
Modified Reef fish	925	100	
Modified Well ring	340	50	0.15 ha



Glimpses of the reefs under water and fishes caught from the reefs



Experimental fishing over reef site at Kovalam

District – Kovalam, Chemmencherry and Kanathur and one site in Villupuram D istrict–Anichankuppam. Historic fish landing data available with CMFRI (pertaining to the reef sites and nearby villages) is being used for baseline comparison. Experimental hook & line fishing at reef sites were carried out on the days of underwater survey. Reef fishery data collection was done through fishermen participation using specially developed daily log sheets.

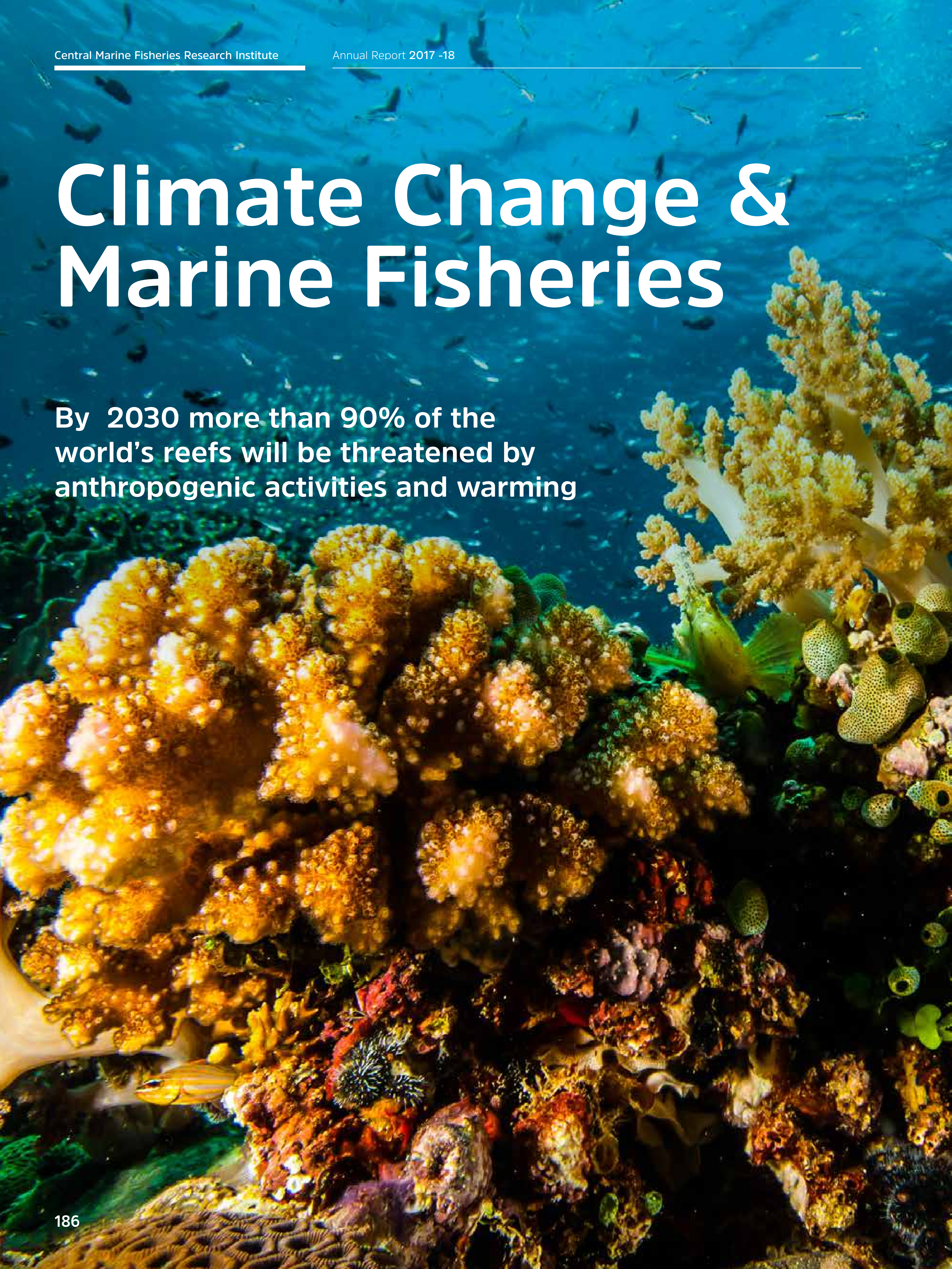
Comparison of fish landings before and after reef deployment indicate improved catches of certain groups of fishes like perches and carangids. The direct beneficiaries are the artisanal hook & line fishermen. Aggregation of breeding fishes and juvenile recruitment in the reef area is immense. The reefs also aggregate bait fishes which help the fishermen to carry out live bait fishing of economically valuable pelagic fishes slightly offshore.

Underwater observations indicate aggregation of fish groups like groupers, pig-face breams, snappers, carangids, cardinal fishes, damsel fishes, angel fishes, scorpion fishes, rabbit fishes and fusiliers. The reefs are also major settlement sites for benthic fauna including crinoids, urchins, starfishes, soft corals, acorn barnacles, mussels, giant clam and oysters. On the economic front, while reef fishing has considerably reduced scouting and fishing time, as well as diesel consumption, the quality of the fishes caught from the reefs has induced higher demand and better price in local markets. Experimental fishing also indicated good resources in reef area.

Comparison of fish catch by hook & line and gillnet at artificial reef site in Kovalam before deployment (2011) and post deployment (2014 & 2017) indicate an increase in certain groups of fishes like rock cods, fusiliers, snappers, emperor breams, crabs and cuttlefish.

Climate Change & Marine Fisheries

By 2030 more than 90% of the world's reefs will be threatened by anthropogenic activities and warming



National Innovations in Climate Resilient Agriculture (NICRA)

Research Project: EF/1

Phenology and distribution

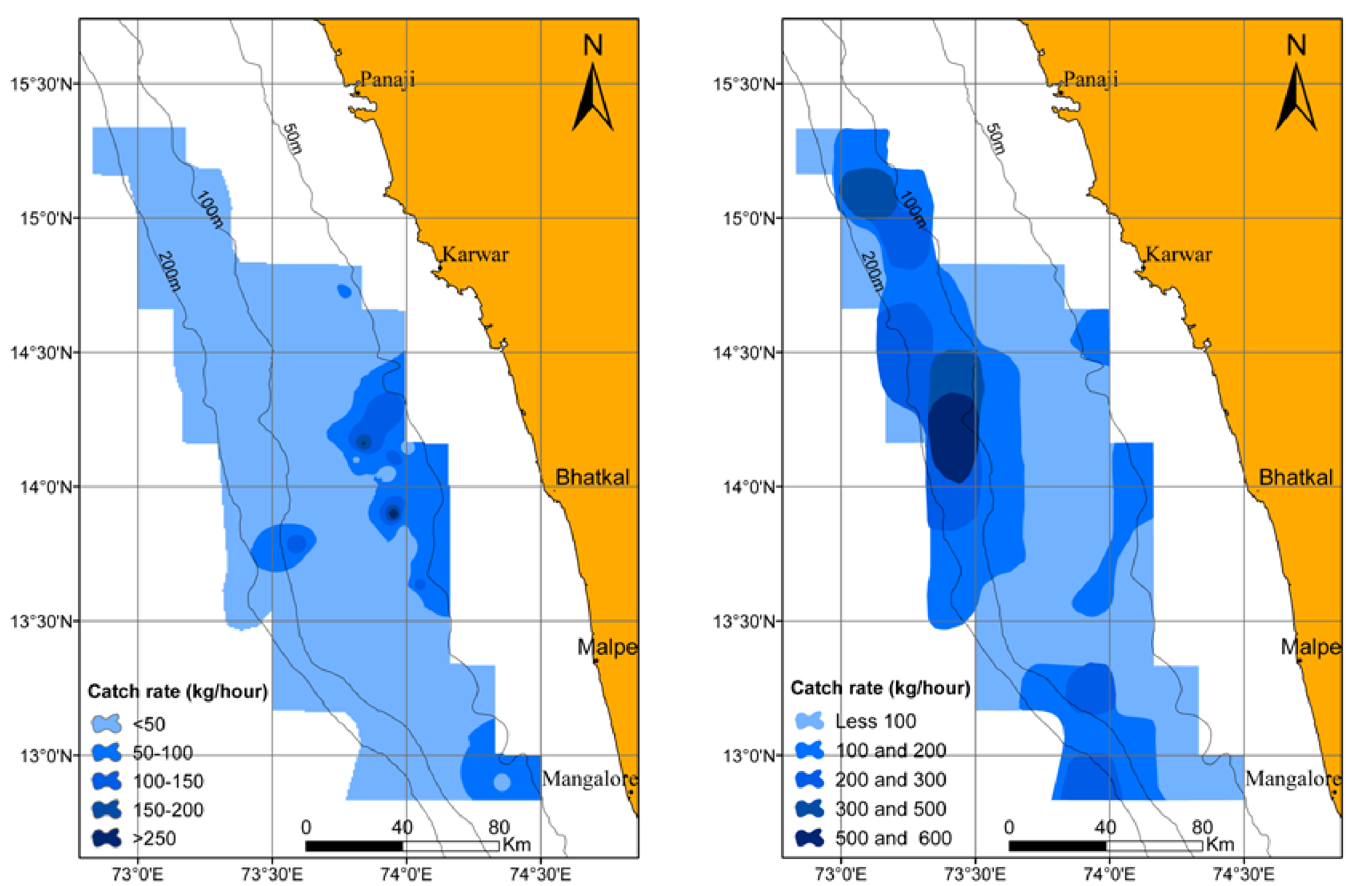
Relationship between temperature and abundance of threadfin breams off Mangalore

To see the relationship between temperature and abundance of threadfin breams, comparison of catch rate of two different periods were made. Comparison of the catch rate data in the same location shows slight reduction in the catch rate. Experimental fishing done during 1993-95 covered depth range from 50- 200 m and maximum abundance of threadfin breams was 500-600 kg h^{-1} while that during 2013-15 was 250 kg h^{-1}. The temperature maximum during 1993-95 was 28.65°C and minimum was 28.41°C while during 2013-15 it was 29.85°C and minimum was 29.54°C. A relation between threadfin bream distribution and SST was observed.

Larval distribution and recruitment off Vishakhapatnam

A preliminary analysis of presence of fish larvae collected within 20-50 m depths with oceanographic variables indicated that the presence of crustacean larvae had positive correlation (0.35) with Sea Surface Temperature and Chlorophyll a (0.17) and negative correlation with sea current (-0.26). The main type of larvae seen were mysis and post-larval stages of shrimps, Alima stages of stomatopods and crab zoea and megalopa stages. Main type of fish larvae seen were that of croakers, puffer fish, ribbonfish, carangids and polynemids with croaker larvae dominating the samples.

Distribution map of threadfin breams off Mangalore



Climate Change & Marine Fisheries

Catch composition of various commercially important species landed in Maharashtra

Pre-monsoon (May)		Post-monsoon (Sept & Oct)	
Coilia dussumieri	51	*Parapenaeopsis stylifera*	145
Johnius vogleri	51	*Ostorhinchus fasciatus*	87
Parapenaeopsis stylifera	51	*Cynoglossus macrostomus*	69
Johnius glaucus	50	*Odontamblyopus roseus*	63
Arius caelatus	50	*Otolithes cuvieri*	53
Metapenaeus affinis	47	*Harpadon nehereus*	50
Penaeus merguiensis	35	*Portunus hastatus*	50
Oratosquilla nepa	34	*Harpiosquilla harpex*	43
Johnius belangerii	31	*Epinephelus diacanthus*	41
Metapenaeus brevicornis	20		

Catch composition and upwelling off Maharasthra coastal waters

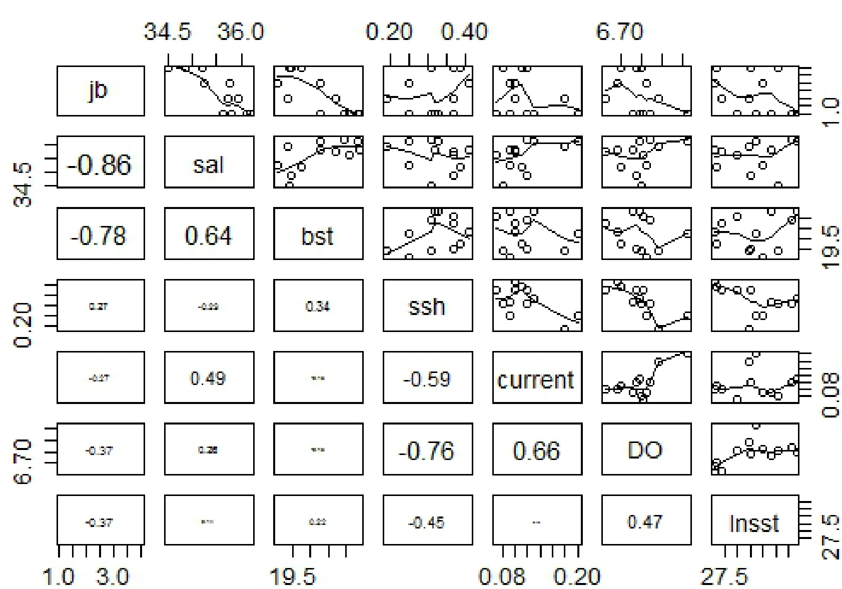
The catch composition in relation to upwelling clearly shows difference in species during post-monsoon and pre-monsoon season. Most of the species (37 nos.) found during post-monsoon were the signature species of upwelling reported at southern part of India.

Six species of jelly fishes (*Chiropsoides* sp., *Aequorea* sp., *Lychonorhiza* sp., *Chrysoara* sp., *Rhopilema* sp. and *Rhizostoma* sp.) were identified from Maharashtra coastal waters and their bloom in certain seasons affect the commercial fishing activities and livelihoods. Jelly fish abundance was high during October, November and December. Pair plot of jelly fish abundance and selected explanatory variable shows maximum correlation with salinity (-0.86) followed by bottom surface temperature (-0.78).

Carbon foot print and blue carbon

Blue carbon potential of mangroves and seagrass; Life Cycle Assessment of fishing operations

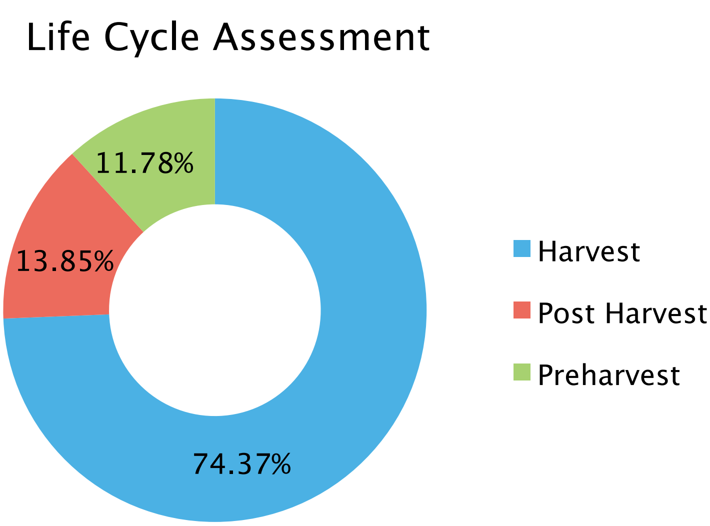
The mean combined carbon stock (above ground, root and sediment) of mangrove ecosystem was found to be 240.58 t C ha^{-1} and 137.45 t C ha^{-1} for the study areas in Kerala at Dharmadom and Thalassery



Pair plot of jelly fish intensity and environmental variables

Climate Change & Marine Fisheries

Carbon emission contributions of various phases of fishing operations in Kerala



respectively. The highest C stock was recorded for above ground followed by sediment carbon stock and root biomass.

Analysis of carbon assimilation potential of important seaweed biomass along Gulf of Mannar revealed highest potential for *Sargassum* sp. (6736 t of standing biomass) with CO_2 absorption of 379.9 t per day.

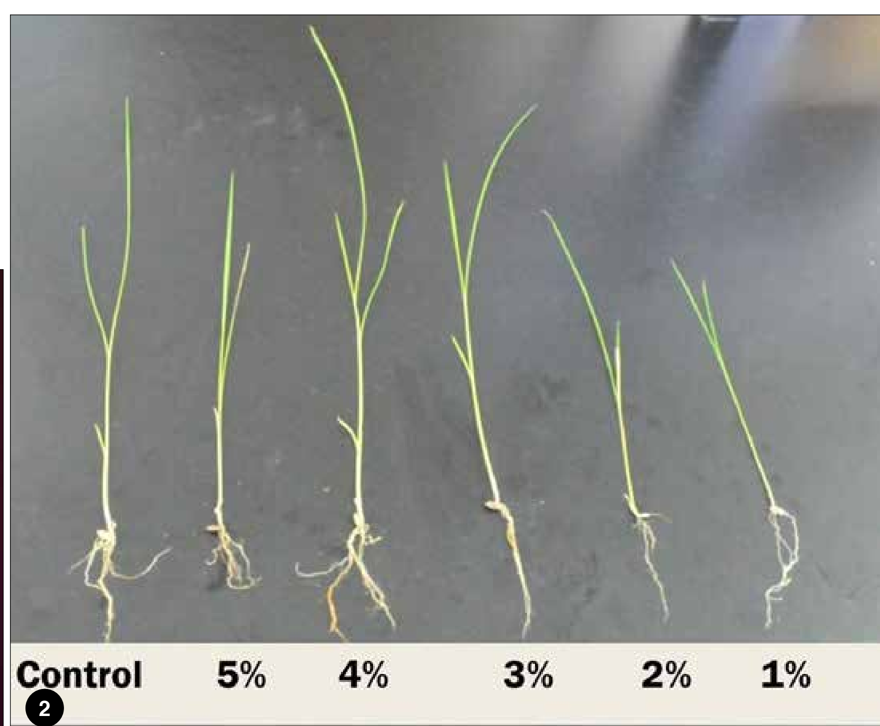
Life cycle analysis of fishing operations for Kerala coast showed highest emissions during harvest phase followed by post-harvest and pre-harvest phases.

Climate resilient technologies and products

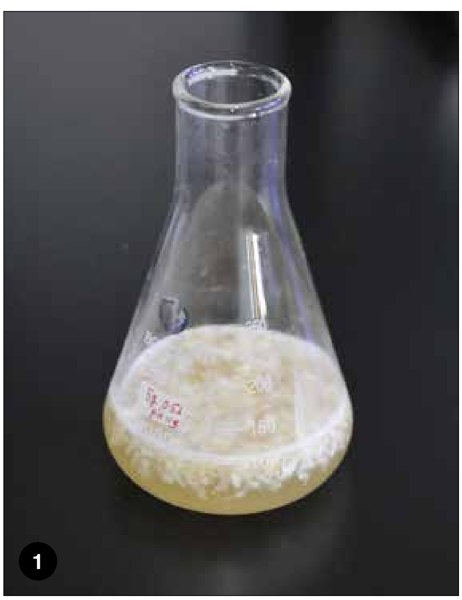
Water hyacinth based biochar as feed and soil mixture to representative paddy-fish system

Experimentation of water hyacinth based biochar incorporation on a representative pokkali-tilapia system yielded positive results. Weight and length of tilapia were found to be enhanced with biochar mixed feed. Biochar mixed soil

1. *Biochar produced from water hyacinth*
2. *Pokkali growth in biochar amended soils*



Coverage about the multivendor e-commerce portal mobile App developed by CMFRI, in print media (The Hindu | The New Indian Express | Times of India | The Financial Express | Deepika Hindu Business Line | India Today | Deepika | Kerala Kaumudi | Madhyamam | Mangalam | Mathrubhumi | Metro Vartha | Outlook)



1. *Seaweed pretreatment*
2. *Seaweed hydrolysis*

resulted in enhanced Pokkali growth and improvement in water quality profile was also observed in biochar amended system. Slight positive changes were observed for pH, dissolved oxygen and total alkalinity.

Multivendor e-commerce portal and Mobile App

A multivendor e-commerce website hosted as www.marinefishsales.com and associated android mobile application '*marinefishsales*' has been developed. Fishermen or farmers can register as vendors and avail login credentials based on their fish products and update their stock availability under pre-approved categories. Customers visiting the website or app can place order with cash on delivery option. Customers and vendors are notified through email and SMS, upon which the quality products within the pre-assigned time frame will be delivered. The innovation incorporated is that, in contrary to typical e-commerce ventures where single firm or company as major profit beneficiary, the developed e-platform envisions multiple fishermen self-help groups (SHGs) as beneficiaries. The Portal and App got wide coverage in national and regional print as well as in visual media.

Low cost feeds for Integrated Multi-trophic Aquaculture (IMTA) species

Performance of blue swimmer crab, *Portunus pelagicus* to formulated low cost feeds showed significant difference in growth parameters such as weight gain percentage (WG%), specific growth rate (SGR), average daily growth (ADG) and feed conversion ratio (FCR) among the different treatments in both male and female sex ($P<0.05$). Male crabs showed higher ADG, WG% and SGR than female crabs.

Bioprocessing of seaweeds

Pretreatment and hydrolysis of seaweeds as precursors for biofuel production was attempted. Seaweeds (*Gracilaria*,

1. *Field demonstrations of Integrated Multi-trophic Aquaculture*
2. *Training programme on 'marinefishsales' App*

Kappaphycus and *Sargassum*) were subjected to hydrogen peroxide pretreatment and bleaching of substrate was observed. Seaweeds after pretreatment were subjected to acid hydrolysis and fermented using yeast *Saccharomyces cerevisiae.*

Climate smart villages

Trainings and technology demonstrations

At Sippikulam farms in Tuticorin, Tamil Nadu coastal fishermen were empowered to harness positive impact of climate change by capture based aquaculture technologies of sea cage farming of high-value fishes (cobia, seabass and pompano), lobsters and low-cost cage construction as well as mooring of cages in the Sea. Field demonstrations were carried out in Sippikulam farms by Integrated Multi Trophic Aquaculture (IMTA). Awareness programmes and field demonstrations of cage culture potential for high value fishes and Integrated Multi Trophic Aquaculture were also conducted.

Multivendor e-commerce trainings, farmer meets, fish processing and packaging for e-marketing and trial sales were organised to familiarise the developed e-commerce website and mobile app among fishermen communities. Thirtyfive fishermen/farmers registered as vendors through the e-venture and separate distribution network was also enabled.

Participatory mode of coastal vulnerable resource mapping meant to indicate the status of different resources such as mangroves, sea grasses, coral reefs, fish farming, natural calamities, environmental changes, anthropogenic activities and industrial development occurred over the years to the present time in the respective villages were conducted at Tuticorin, Tamil Nadu. Fishermen expressed that the program was an innovative and useful one for them in understanding the scope of adaptability to climate change.

Climate Smart Village development through technology dissemination/ demonstration to ensure income improvement and mitigate climate change impacts on coastal communities

Climate Change & Marine Fisheries

stakeholder meeting held at the Alvaekodi climate smart village at Udupi, Karnataka.

Wetland restoration for aquaculture

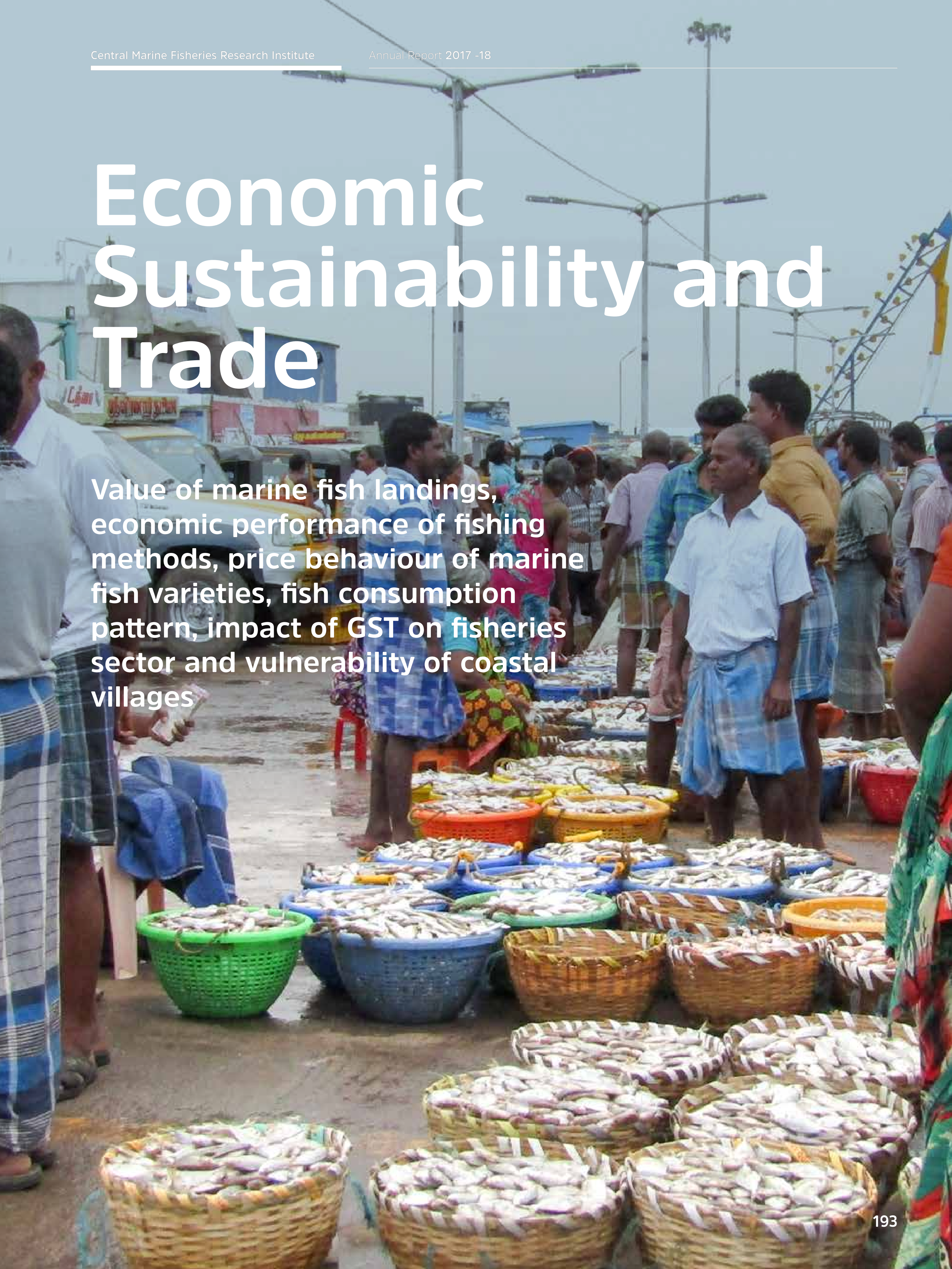
A degraded wetland of around 5 acre was restored and made suitable for aquaculture practice at Edakochi, Kerala. Restoration works includes side bund construction and fortification of sluice gates so as to enable aquaculture practices on a large scale.

Village adoption

Two villages namely Vadakadu (Rameswaram) and Chinnapalam (Pamban) of highly vulnerable Ramanathapuram district, Tamil Nadu (identified through PARS) were adopted to develop as "Climate Smart Village (CSV)". Village level meetings were conducted and technologies on small-scale entrepreneurship for production of marine ornamental fishes were disseminated to the selected fishers.

Hands-on training was given to 40 fisherwomen from Chinnapalam Village, on broodstock development, breeding, larval and juvenile rearing of clown fishes, grow-out techniques, livefeed culture, water quality and disease management. Thematic Apperception Test (TAT) and Training Effectiveness Index (TEI) revealed that majority of the participants attained medium to high level of achievement.

Alvaekodi in Paduvari Grama Panchayat, Udupi District of Karnataka was adopted to upgrade as CSV through interventions that can facilitate sustainable increase in agricultural productivity and income. Interactive stakeholders meeting on climate smart technologies was conducted. Hands-on training to alternate vocations (seaweed farming) to 40 fishermen participants was provided. Seaweed farming was introduced to the small scale cage farmers of Alvaekodi.



Economic Sustainability and Trade

Value of marine fish landings, economic performance of fishing methods, price behaviour of marine fish varieties, fish consumption pattern, impact of GST on fisheries sector and vulnerability of coastal villages

Economic Sustainability and Trade

Valuation of marine fish landings showed upward trend in 2017 from 2016 by 8.37% at landing centre and 6.98% at retail market levels

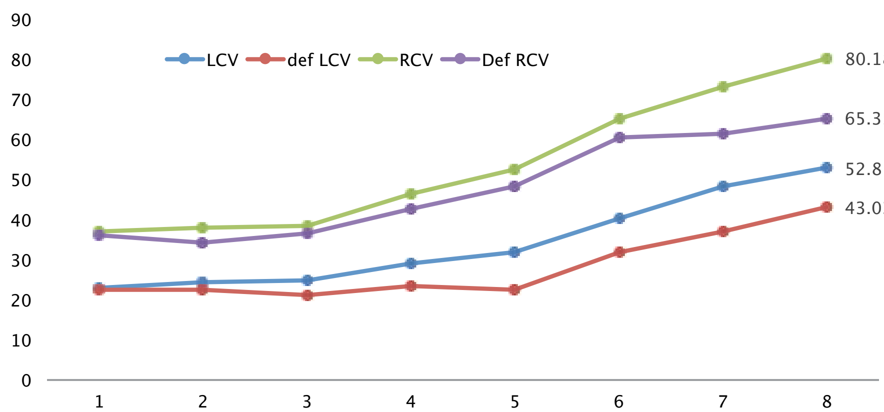
Valuation of marine fish landings, economic performance and supply chain management

Research Projects: SEE/SOC/33 and SEE/DCD/35

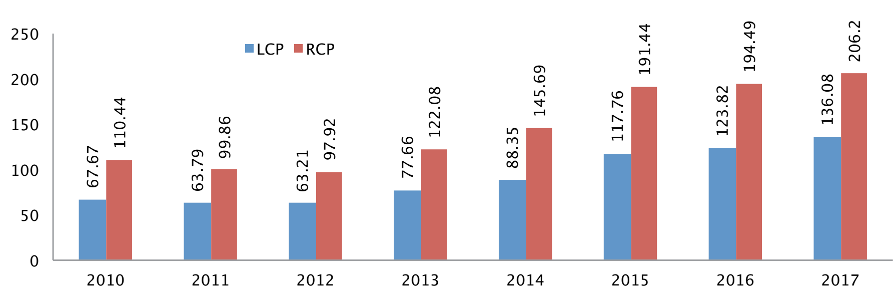
Valuation of marine fish landings and inventories

The estimated value of marine fish landings during 2017 at landing centre level was ₹ 52,431 crores (8.37% increase over 2016). The unit price per kg of fish at landing centre was ₹136.73

The value of marine fish landings (base year 2010)



Unit price realisation at the points of first and last sales (2010 base year)



Species-wise share in landings (%)

Species	Landings	Valuation (₹ crores)	% to total
Penaeid shrimps	2,09,513	8,827	11.16
Indian mackerel	2,87,880	6,131	7.75
Non-penaeid shrimps	2,02,748	5,453	6.90
Ribbonfishes	2,39,355	4,555	5.76
Oilsardine	3,37,390	3,476	4.40
Squids	1,31,774	3,372	4.26
Other sardines	2,26,970	3,183	4.02
Other perches	1,92,758	3,148	3.98

Economic Sustainability and Trade

Valuation of fish landings across states (₹ crores)

	Landing Centre Valuation			Retail Centre Valuation		
State	2016	2017	% change over 2016	2016	2017	% change over 2016
Gujarat	8,427	9,931	17.8	13,130	14,729	12.2
Maharashtra	5,369	6,397	19.1	8,313	9,488	14.1
Goa	997	1,245	24.9	1,451	1,796	23.8
Karnataka	6,247	6,639	6.3	9,108	10,196	11.9
Kerala	9,149	9,699	6.0	12,398	13,501	8.9
Tamil Nadu	6,492	6,807	4.9	10,728	11,088	3.4
Puducherry	605	432	-28.6	868	618	-28.8
Andhra Pradesh	2,516	2,679	6.5	3,916	4,043	3.2
Odisha	1,645	1,729	5.1	2,836	2,901	2.3
West Bengal	5,501	5,783	5.1	8,190	8,490	3.7
Daman & Diu	1,433	1,089	-24.0	2,351	1,557	-33.8
Total	**48,381**	**52,431**	**8.4**	**73,289**	**78,408**	**7.0**

Valuation of marine fish landings in India, 2011-2017

Details	2011	2012	2013	2014	2015	2016	2017	% change per annum
Landing centre level (₹ crores)	24,369	24,890	27,577	31,754	37,317	48,381	52,431	14.5%
Retail market level (₹ crores)	38,147	38,562	44,054	52,363	64,593	70,600	78,408	15.08%
Index of Landing centre value	107.60	109.90	121.76	140.21	184.98	196.41	233.16	
Index of retail market value	103.21	104.33	119.19	141.68	174.77	189.91	212.11	

(5.55% increase). At the retail level, the estimated value was ₹ 78,408 crores (6.98% increase). The unit price at the retail market level was ₹204.48 (4.20% increase over 2016). The marketing efficiency determining the producers' share of the consumers' rupee was found to be 66.87 (1.3% increase).

Species-wise valuation of marine fisheries in India

Valuation of Indian fisheries landings vis-a-vis major species is given. Although oilsardine registered the highest landings (8.87% of total landings), they contributed only 4.4% of the value of the landings.

State-wise valuation across the value chains

Gujarat recorded the highest realisation of prices at the landing centre and retail centres registering a growth 17.8% and 12.2% respectively over 2016. Besides, ranking second in the fish landings in the country the state of Kerala has the highest realisation of prices at the landing centre and retail centres registering a growth of 6 and 8.9% respectively over 2016.

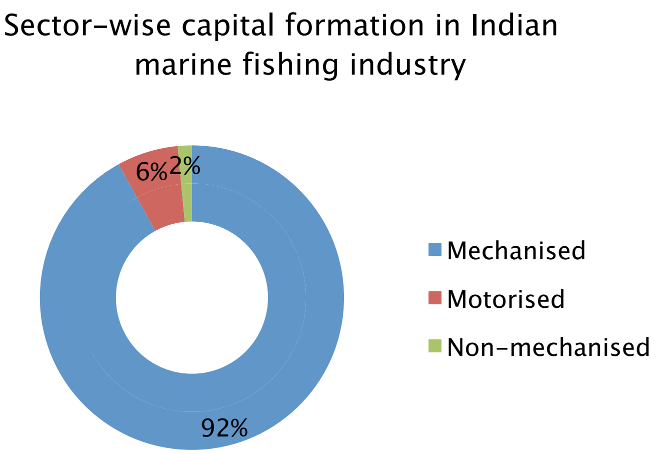
Value of marine fish landings in India, 2011-2017

During 2011-2017, the estimated value of marine fish landings at landing centre level increased from ₹24,369 crores in 2011 to ₹52,431 crores in 2017, at an annual increase of 14.5%, while at retail centre level, increased from ₹38,147 crores to ₹78,404 crores at an annual increase of 15.08%. The increase in the value can be attributed primarily to the increase in landings followed by the increase in prices of fish.

The index number of value of marine fish landings at landing centre level has increased to 233.16% in 2017 (base year 2010) while at the retail centre level, it increased to 212.1%.

Economic Sustainability and Trade

Unit price realisation at the points of first and last sales (2010 base year)



Estimation of private capital formation (gross valuation of inventories) in marine fisheries sector

The capital formation is grouped into private capital formation and public capital formation. Private capital formation refers to the investments in the crafts and gears owned by the fishermen in the country.

Macroeconomic indicators in marine fisheries sector

The macroeconomic indicators emphasise the role of marine fisheries sector in the Indian economy at a glance.

The gross value added to the economy by the marine fisheries sectors was estimated at ₹30,714 crores. The rate of return (gross ratio) worked out to 2.08, which indicated that an investment of one rupee in the sector will give double the return in the sector. The average capital productivity was 0.56, which indicated that 56% of the gross revenue is absorbed by the fishing operations and the balance is available to meet the secondary and fixed cost commitments like taxes, depreciation and repairs & maintenance.

Economic performance of marine fishing methods

Mechanised crafts

Economic performance of various marine fishing methods practiced in the country was assessed by working out economic

Macroeconomic indicators of marine fisheries sector in India, 2017-18 (₹ crores)

Macroeconomic Indicators	Value
Value at landing centre	52,431
Total operating cost	28,607
Net operating income	23,824
Total valuation of inventories	25,180
Gross ratio at landing centre valuation	2.08
Capital Productivity	0.56
Gross value added	30,714

Economic performance of single day trawl fishing, 2017-18

Indicators	Maharashtra	Kerala	Tamil Nadu
Net operating income =(Gross revenue-total operating cost) (₹)	1,24,331	1,584	1,12,812
Capital productivity =(Total operating cost/Gross revenue)	0.19	0.85	0.60
Labour productivity	149	13	140
Input-output ratio =(Total input cost/Gross revenue)	0.13	0.58	0.01
Gross value added= (Net operating income + crew share) (₹)	1,32,801	4,484	1,80,658

Economic Sustainability and Trade

Economic performance of multi-day (2-5 days) trawl fishing 2017-18

Indicators	Maharashtra	Kerala	Tamil Nadu
Net operating income (₹)	3,84,417	79,165	66,603
Capital productivity	0.23	0.70	0.69
Labour productivity	236	75	248
Input-output ratio	0.17	0.54	0.68
Gross value added (₹)	4,12,536	1,46,708	1,24,022

indicators like net operating income, capital productivity (operating ratio), labour productivity, input-output ratio and gross value added. The significant findings across the states are given below.

Capital productivity was most efficient in Maharashtra with a lowest operating ratio of 0.19 followed by Tamil Nadu (0.60). The comparatively high revenue in Maharashtra due to higher prices for fish during last year is the reason for the efficient use of capital in the fishing method. However the gross value added was highest in Tamil Nadu at ₹1,80,658 followed by Maharashtra (₹1,32,801) and Kerala (₹4,484).

Capital productivity was most efficient in Maharashtra with a lowest operating ratio of 0.23 followed by Tamil Nadu (0.69) and Kerala (0.70). The comparatively high revenue in Maharashtra due to higher prices for fish during last year is the reason for the efficient use of capital in the fishing method. Labour productivity was highest in Tamil Nadu (248 kg per crew per trip) followed by Maharashtra (236 kg) and Kerala (75 kg). However the gross value added was highest in Maharashtra (₹4,12,536), followed by Kerala (₹1,46,708) and Tamil Nadu (₹1,24,022).

Analysis of economic performance of the multi-day voyage fishing of our sample units in Gujarat and Maharashtra indicated that the economic performance varied only marginally in terms of capital productivity between Maharashtra (0.37) and Gujarat (0.36) and also in terms of labour productivity, which worked out to 380 kg in Maharashtra and 400 kg in Gujarat. The gross value added per trip was higher at Gujarat (₹4, 67,740) than that of Maharashtra (₹4, 61,335), which can be attributed to the higher gross revenue per trip in Gujarat than in Maharashtra.

Analysis of economic performance of gillnet and purse seine fishing indicated

Economic performances of motorised crafts, 2017-18

Indicators	Tamil Nadu	Andhra Pradesh	Kerala	Odisha	Gujarat
Total operating cost (₹)	8,538	7,547	23,613	5,946	3,520
Gross revenue (₹)	9,987	15,603	31,173	9,640	6,058
Net operating income (₹)	1,449	8,056	7,561	5,946	3,520
Capital productivity)	0.85	0.54	0.76	0.62	0.58
Catch (kg)	83	140	286	89	85
Crew size	4	6	22	7	2
Labour productivity	19	22	13	13	43
Input-output ratio =(Total input cost/Gross revenue)	0.25	0.26	0.43	0.16	0.29
Gross value added (₹)	7,495	11,876	17,821	8,085	4,298

Economic Sustainability and Trade

Economic performance of motorisation and non-mechanisation fishing units in Kerala

Components	OBRS Paravoor	OBRS Punnapra	OBRS Chellanam	OB Gillnet Neendakara	NM Ring seine Paravoor
Total operating cost (₹)	13446	19331	11007	22892	1172
Catch (kg)	200	229	157	475	16
Gross revenue (₹)	16719	23690	14134	31510	1337
Net operating income (₹)	3273	4359	3127	8619	165
Capital productivity	0.80	0.82	0.78	0.73	0.88
Labour productivity	17.65	9.96	16.28	118.85	15.75
Input-output ratio	0.37	0.39	0.29	0.40	0.10
Gross value added (₹)	10495	14529	10099	18859	1209

that the single day gillnet is better than that of the multi-day gillnet in Tamil Nadu with a lower operating ratio of 0.53 and a higher gross value added of ₹2, 19,551. In case of purse seine operation in Maharashtra, the multi-day purse seining of 2-5 days is performing better economically with a lower operating ratio of 0.19 and the high gross value added.

Analysis of the comparative costs and revenues of different fishing units in Kerala indicated that among the mechanisation units, the highest gross income and net operating income were recorded for Multiday trawl nets operated with high speed Chinese engine. But the high input-output ratio (0.47) indicates the cost of fuel and ice are critical inputs in this sector.

Motorised crafts

Analysis of economic performance of motorisation crafts indicated that capital productivity of the motorisation crafts was most efficient in the state of Odisha with the lowest operating ratio of 0.16 followed by Tamil Nadu (0.25), Andhra Pradesh (0.26) and Gujarat (0.29). Due to high labour wages, the operating ratio in Kerala was very high at 0.43. The gross value added was the highest in Kerala (₹17, 821) followed by Andhra Pradesh (₹11, 876), Odisha (₹8,085) and Tamil Nadu (₹7,495).

Among the motorisation fishing units in Kerala, the highest capital productivity was shown by motorisation gillnets operating in Neendakara.

Economic performance of non-mechanisation fishing method, Tamil Nadu 2017-18

Indicators	Bottomset gillnet (BSGN) Ramnathapuram	SD Other BSGN Ramnathapuram	Gillnet Colachel	Gillnet Thuthoor	Gillnet Thengapatnam
Total operating cost (₹)	207	199	719	1288	1039
Gross revenue (₹)	498	448	1249	1624	1584
Net operating income (₹)	295	247	530	335	544
Capital productivity	0.41	0.45	0.57	0.79	0.66
Catch	3	8	30	29	28
Crew size	2	2	3	2	2
Labour productivity	1	4	10	16	15
Input-output ratio	0.11	0.13	0.12	0.15	0.13
Gross value added (₹)	439	396	1101	1373	1379

Economic Sustainability and Trade

Non-mechanised crafts

In case of non-mechanisation crafts, the bottom set gillnets in Ramanathapuram District is performing comparatively better than the other gears in other centres. However, the gross value added was the highest in gillnet operating from Thengapatnam landing centre (₹1, 379) followed by Thuthoor (₹1, 373) and Colachel (₹1, 101).

Price behaviour of marine fish varieties

Average landing centre price realisation

The analysis of the price behaviour for major species at landing centres indicated that there is a wide variation in prices across species. The landing centre price ranged from ₹56.47 kg^{-1} for oilsardines to ₹332.95 kg^{-1} for Penaeid shrimps, closely followed by black pomfret at ₹216.14 kg^{-1}.

Average retail centre price realisation

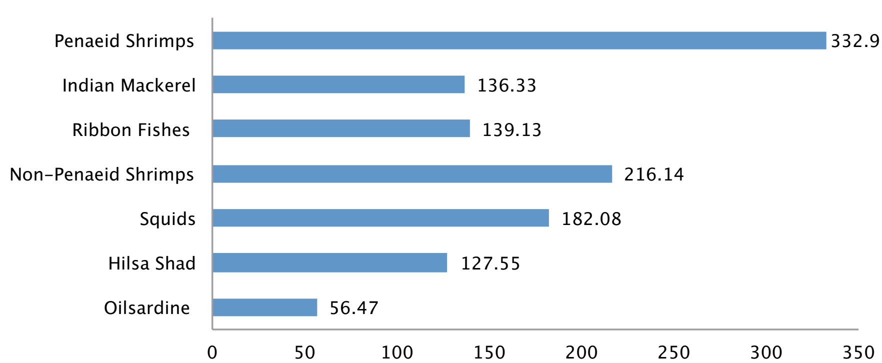
Average retail centre price for major species in India indicates that penaeid shrimps realisation the highest retail at ₹416.31 followed by non-penaeid shrimps (₹319.34), while oilsardines realisation prices at ₹99.84 per kg which is the lowest.

Marine fish marketing efficiency

The marketing efficiency of the major species varied across the maritime states based on the percentage share of fishermen in the consumer rupee.

In general, the high value species like Penaeid shrimps (79%), Seerfishes (76.65) Squids (73%) and Hilsa shad (73%) registered higher marketing efficiencies compared to non-penaeid shrimps, Threadfins, Lizard fishes, Snappers, Scads and oilsardines.

Average Landing Centre Price realisation – All India (₹ per kg)



Landing Centre Price behaviour across states (₹)

Species	KER	KNK	WB	OR	AP	TN	PO	GO	MH	GJ	DD
Penaeid shrimps	360	365	345	214	440	312	327	340	312	285	360
Indian mackerel	162	152	92	122	122	136	205	148	123	102	135
Ribbon Fishes	180	160	95	119	125	129	180	130	135	111	165
Non-penaeid shrimps	290		220	171	225	197	194	285	213	120	245
Squids	195	207	128	155	165	165	180	245	172	160	230
Hilsa shad	0	0	360	95	92	75	75	260	102	212	132
Oilsardine	54	52	63	63	65	44	85	85	73	35	0

High value fish registered greater marketing efficiency than low value fishes indicating a consistent demand-supply pattern (or) relationship

Assessing demand drivers in augmenting fish consumption in Ernakulam

A study was conducted to analyse the trends and pattern of fish consumption as well as the factors that drive people to consume fish of Ernakulam District of Kerala. About 360 respondents were contacted and the analysis reveals that socio-economic variables affect consumption of fish to a great extent. About 44% respondents were of middle age group (35 to 55 years) from urban, rural and semi urban areas. The average monthly income of the respondents have a very good role on the fish consumption as about 38% of the income is used for purchasing fish. Fifty-four per cent of the respondents were purchasing fish on a daily basis and about 72% of the respondents depend on the retail centres for purchasing fish.

Conjoint analysis results indicated that the optimum fish quality set, which provides the consumers with optimum benefit is the variety of fish from the retail fish markets which are highly fresh and good quality. Mackerel remains the most preferred fish with a high score of 0.577 followed by sardine 0.561 in the preference index analysis and it has been found that the highest preference index is given for the availability of the fish species. Despite of any income group there exist high uniformity among the respondents in buying mackerel as well as sardine. Lack of fresh fish, high price and irregular supply were ranked as the major constraints for fish consumption by the consumers

Assessment of online fish marketing in Ernakulam District, Kerala

Fish marketing strategies developed and evolved along with the changing time and has now reached the digital era where the possibilities of incorporating technology in the marketing system is being explored and resulted in online fish marketing. A study was conducted to assess the online fish trade existing in Ernakulam District of Kerala. Seventeen firms/outlets were selected to analyse various aspects related to the online firms including species traded, mode of sales, customer profile, storage facilities, constraints faced and related parameters. Results revealed that all the online fish trading firms were of recent origin and their average monthly turnover was about ₹10 lakhs. Firms with wider outreach or strong backward and forward linkages were found to realize comparatively much higher returns. Around 31% of the online fish trading firms opined that customers opt their service due to the time saving process. Twenty four per cent of them reported that readiness of the product traded online attracted their customers to choose their services. Many of the firms were found to have closed their outlets due to many constraints, the most important being huge overheads/advertisement costs. When considering fish marketing in the Ernakulam District, only 0.52% of the total fish marketed is being delivered by the online firms.

Indian financial reforms: Implementing GST in fisheries sector

A study was done to assess the level of awareness and perception of impact of GST on fisheries and to estimate the additional cost per annum in marine capture fisheries sector of Kerala due to GST implementation and also to highlight the possible positive effects of inclusion of diesel price under GST. The study was undertaken in the fish landing centers/ harbours of Alappuzha and Ernakulam aimed at measuring the extent of uncertainty generated by introduction of GST. Primary data from 90 fishermen respondents were collected for the study.

The analysis revealed that the implementation came as a complete bolt from the blue with majority of the fishers in disagreement with the process of implementation of GST without taking all stakeholders into confidence. Compared to VAT, the GST and post Guwahati council

Economic Sustainability and Trade

Possible positive effects of GST on fuels

Price of Diesel with GST		Cost of diesel/trip	Cost reduction (%)
At 18%	42.77	20572	32.66
At 28%	46.39	22314	26.95
Subsidisation diesel price with GST for fishers			
At 18%	39.35	18927	32.66
At 28%	42.68	20529	26.95

Implementation of GST in fisheries sector faces mixed short term impacts. Smoothening of the negative impact is anticipated over time

GST rates are found to be high, affecting the fishing community at multidimensional levels. The fishing equipments including fishing rods and fishing twines are taxable at 12% under GST while that on fishing ropes and hooks has been fixed at 5%. All these fishing gears were exempted from tax under the VAT regime. Floats used for nets will now attract 28% GST. Outboard motors and ice boxes that had a VAT rate of 14.5% now attract a GST of 28% and 18% respectively. Even the price of ice is expected to rise as it to attract an additional 5% GST.

The results also indicated that the marine capture fishing operations across all sector in Kerala will be incurring an additional cost of`₹171.25 million per year due to GST introduction. However introducing GST on fuels will lead to a reduction of diesel price by 30-40% and 25-30% at 18 and 28% GST slabs respectively, which would reduce the ever increasing cost of fishing. The study also advocates that the implementation of GST in fuel prices shouldn't add to exploitation of the already dwindling fisheries resources.

Global understanding and learning for local solutions: Reducing vulnerability of marine-dependent coastal communities (GULLS)

Socio-economic vulnerability assessment

Socio-economic vulnerability assessment was carried out for the coastal villages in the southeast hotspots covering 600 samples from the coastal villages of Ramanathapuram District across four taluks/ sixteen villages to assess the extent of exposure, sensitivity and adaptive capacity. A training workshop for the enumerators was conducted during September 2017 and the data collection has been completed and the analysis is in progress.

Trans-disciplinary tools were used through participatory frameworks for assessing the opportunities and threats in the coastal community wherein the economic impact on environmental vulnerability was assessed. The changes in environment which impacts the coastal community were the direct components considered for exposure whereas financial necessity and social dependence are the components for sensitivity. The components of adaptive capacity are mainly the approach, insight, acclimatising ability and resources. In addition, the sub components associated in the framework gives priority for nurturing the fishing culture; environmental awareness and communal resilience are part of the sensitivity side.

Assessing the alternative livelihood options for climate change vulnerable coastal fishing villages in Kerala

A study was conducted to assess the Alternative livelihood options (ALOs) of climate change, among the coastal communities in Poonthura and Elamkunnapuzha villages of Thiruvananthapuram and Ernakulum respectively. About 1,259 samples have been taken from Poonthura and Elamkunnapuzha for the study. The results showed about 70% of them needed alternative livelihood options supports. Around 76% of the respondents are

Economic Sustainability and Trade

ClimEd series in Hindi, Tamil and Malayalam

willing to participate in adaptation and mitigation programmes against climate change. Most of the respondents (61%) liked to take part in individual climate change adaptation activities followed by household and social roles.

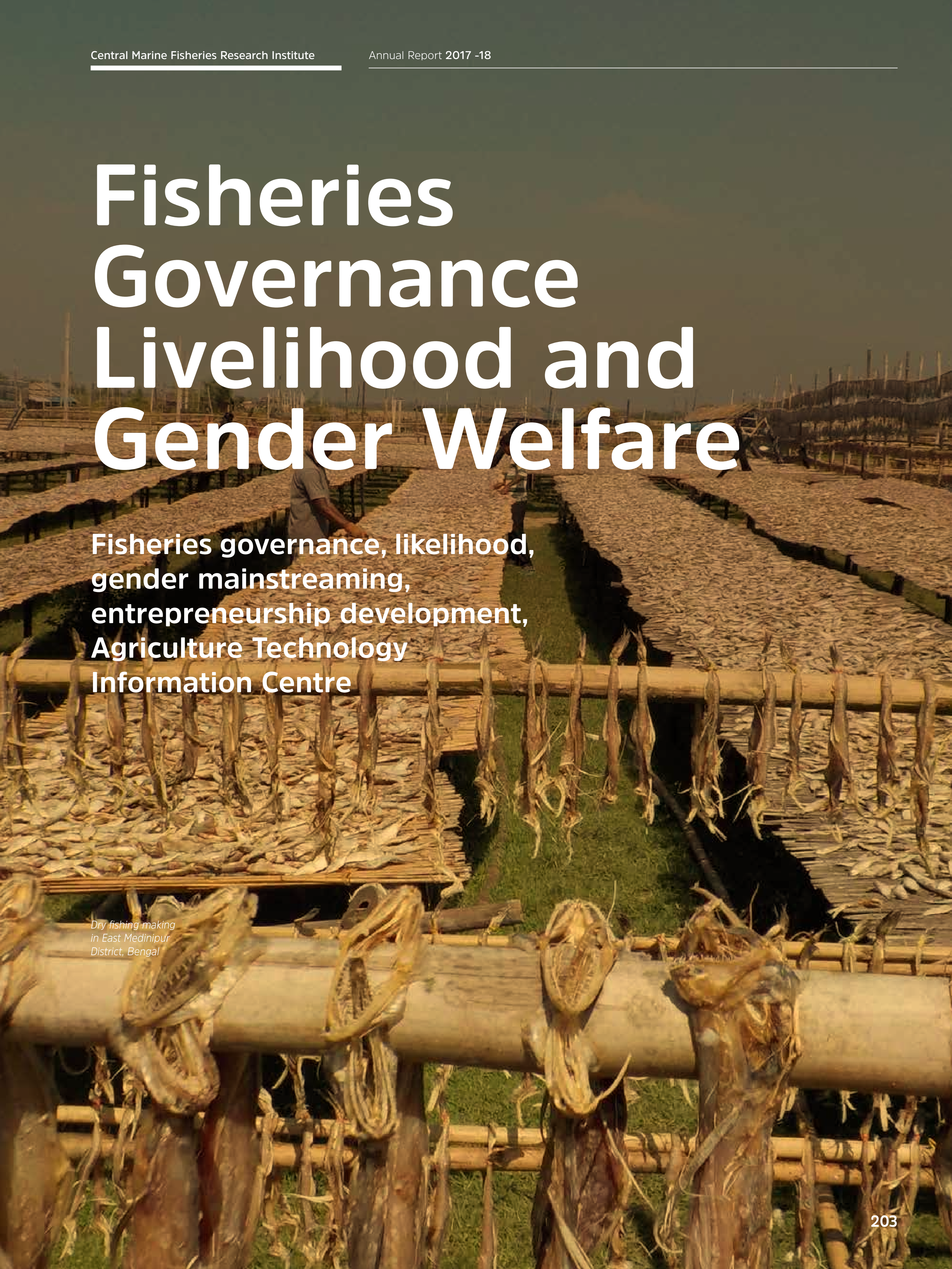
Communication: The following ClimEd series were developed in Hindi, Tamil and Malayalam

Human resource development: The climate change awareness workshop and stakeholders interaction meet was held in Beemapally on 11 May 2017 to sensitise the fishers including women and children on the impact of climate change. Three hundred and fifteen fishers including women participated from the Thiruvananthapuram corporation wards of Beemapally, Beemapally East, Poonthura and Manikavilakam.

Climate change training workshop at Bheemapally

Fisheries Governance Livelihood and Gender Welfare

Fisheries governance, likelihood, gender mainstreaming, entrepreneurship development, Agriculture Technology Information Centre



Dry fishing making in East Medinipur District, Bengal

Various capacity development tools for responsible fisheries developed and validated

Fisheries governance and livelihood (including ATIC)

Responsible marine fisheries governance: Compliance analysis and peripatetic capacity development

Research project: SEE/GOV/34

A new multi – media tool titled "Fishing or Finishing" in Malayalam was developed as a supplementary sequel to the animation film on the tragedy of the commons theme. The tool was subjected to validation during the peripatetic capacity development interventions which were conducted in the State of Kerala in collaboration with the State Department of Fisheries in 12 locations. This included the mega events (*Matsya adalath and Matsyotsavam*) organised by the Department of Fisheries and Matsyafed in Ernakulam, Kollam and Trivandrum which were attended by not less than 3,000 stakeholders each.

The tool was validated in a one day seminar on "Sustainable fisheries and participatory governance" was organised on World Fisheries Day (21 November) in collaboration with the Kerala State Fish Workers Federation. The seminar held in Town Hall, Kochi was inaugurated by Smt. Mercykutty Amma , the Minister for Fisheries, Cashew and Ports, the Government of Kerala. About 200 fisher leaders from across the State participated. The lecture delivered during the occasion was published as cover story by "*Janapadham*", the Government of Kerala PRD magazineissued magazine issued in March 2018.

A four step communication protocol was validated through the interventions. In the first step the stakeholders were exposed to the animation film "*Ottakku Keman koottathil Mandan", which* was followed by a short probing session where the reasons for the tragedy were elicited. Then the new tool was used to continue the discourse. The new tool dealt with the various issues like need for scientific temper, role of CMFRI , , fishery collapse cases-Canadian cod and Californian sardine, Lessons, introduction to FAOto FAO Code of Conduct on Responsible Fisheries (CCRF) & Small Scale Fisheries (SSF), the three fundamental questions in fisheries management (How to fish (technological),Why (the science)and who (political) questions), the necessity for compliance and co-governance, outlining participatory governance Model of USA as example and unique governance requirements of Kerala state. In the third step the animation film on juvenile fishing was shown highlighting the need to adopt MLS regulations. The last step was arranged as a question and answer session culminating with a pledge to follow responsible fisheries.

The protocol was validated through in house interfaces provided by two Winter schools conducted by the Fisheries Resource Assessment Divisionand the International training programme coordinated by the Maricultre Division.

1. *One day seminar held at Town Hall, Kochi*
2. *International participants of the AARDO Workshop held at CMFRI with the CD tools*

Interpretation of typical stakeholder responses

	response	interpretation
1	“hey if we bring more , they won’t eat them all, and price goes down, Fish meal plants give at least 30’	Subliminal indicative Change of mind-set among ring-seiners–Fish meal plants viewed as buffer during glut
2	“Go for quota not MLS, look what Europe does, You know better”	Need to go beyond MLS (seasonal based on SSB?) mooted by the Mechanised sector
3	“Council? Good for doles, not for hauls”	Concerns over the fisheries council based management (Bottom up or down, Party politics, jurisdiction issues beyond TW)
4	“Impractical if you say 50% and you measure the length”	Officers finding the modified measure impractical especially after the agitation by the trawl fishers against MLS.
5	“they say catch (violators), they say release them”	Concern over upright officers becoming demoralised
6	“You say It is climate change , jelly fish and pollution, why we are blamed” “Can You demonstrate the benefit of MLS”? “Don’t you see, we bring plastics and save fish” Didn’t we tell pollution and plastic and factory vessels cause fish decline”	Opportunistic use of scientific claims

Some of the typical stakeholder typical responses recorded during the peripateticinterventions held in Kerala are interpreted in the table given below.

Formal and Informal credit transactions of small-scale fishermen in Kerala- Insights

Research Project: SEE/GOV/SUB/34

The intricacy of multifarious credit transactions of small-scale ring-seine fishers in Kerala, India was investigated. The diverse finance options available, quasi-credit contracts/interlinked deals therein, and the complex inter-linkages between the formal and informal stakeholders in the arena were explored in detail. It was found that strong presence of informal financing, catered significantly to the credit requirements of fishermen. Though the *Matsyafed* model of financing found success through disbursing affordable credit with a flexible approach of accepting interest payments as share of harvests, other institutional agencies have limited presence in the region, mainly due to operational rigidities as conveyed by the fishers.. Informal agencies offer solutions to these rigidities thereby meeting the unmet demand for credit, although at a higher cost. Auctioneers have a considerable footprint in the dominion primarily because of their clear understanding of the market demands, familiarity with the target group and that, they offer the much needed flexibility in credit contracts. However, the widespread demand for loans from private money lenders at exorbitant charges suggests that even those offered by auctioneers and third-party share-holders are not sufficient enough to meet the market demand for credit. This calls for urgent measures to boost the supply of credit and to rationalize the rules to help the fishers to get easy credit. The findings also point to a direct competitive relationship between the informal and formal credit regimes. Measures such as linking insurance with formal credit, further strengthening of fishery co-operatives and tightening state control to curb exploitative lending practices are suggested to enhance financial inclusion in the study area.

Alternate livelihood options and gender mainstreaming for entrepreneurship development in marine fisheries sector of India

Research Project: SEE/GEN/36

The Coastal States of Bengal, Odisha and Andhra Pradesh were surveyed for documenting the fishery related and fishery non-related ALOs (Alternate Livelihood Options) among the marine

Fisheries governance livelihood and gender welfare

Dry fishing making in East Medinipurdistict ,Bengal

fisher folk of these States. Besides, the extent to which ALOs supplement the income, from the main occupation i.e. marine fisheries sector was also studied. East Medinipur district of Bengal, Jagatsinghpur, Kendrapada, Balasore and Puri districts of Odisha and Visakhapatnam district of Andhra Pradesh formed the study areas.

It could be observed from table that, among the various ALOs studied the percentage increase in annual income ranged from 19.12 per cent in the case of agriculture labour to as high as 93.75 per cent in the case of dry fish making. The man-days ranged from 75 to 108 for the ALOs practiced by them.

It is observed from the table that in Odisha sale of fresh water pearls (imported from China) and income from marine eateries fetched the highest percentage increase in Annual income (91.83 %). These avocations are practiced during the fishing ban season (15 th of April to 15 th of June every year)

Studies among marine fishers in Paradeep indicated that dry fish making was practiced on board the trawlers during the fishing trips by labourers alone and it contributed to 34percentage increase in Annual income. (Table 3) However

Bengal-East Medinipur district, Main Occupation: Marine Fisheries,Mean Annual Income per fisherman= ₹80,000 (Mechanised Gill Netter)

ALOs	Enterprise	No. of fishers involved	Man-days	Income from ALO (₹)	Percentage Increase in Annual income
Fishery related	Dry Fish making	700	100	75,000	93.75
	Net Repair	500	105	31,500	40.00
Non Fishery Related	Paddy and vegetable cultivation	550	108	30,000	37.50
	Agricultural labourer	700	75	15,300	19.12

Odisha-Chilka, Mirjapur, Bhagawanpur (Puri district) Gadakunja Nuliasari (Jagat Singhpur district) Main Occupation: Marine Fisheries, Mean Annual Income per fisherman = ₹24,500 (Out Board Motorised Fiber boats)

ALOs	Enterprise	No of fishers involved	Man-days	Income from ALO (₹)	Percentage Increase in Annual income
Fishery related	Eco-tourism	700	50	15,000	61.22
	Sale of Fresh Water Pearls	500	135	22,500	91.83
	Marine Fish Eateries	40	94	22,500	91.83
	Lime making for betel leaf	70	113	7,500	30.61
	Fresh water Carp Farming	12	120	107,000	437

Fisheries governance livelihood and gender welfare

1. Boat building at Kendrapada, Odisha
2. Marine Fish Eateries,Mirjapur, Puri, Odisha

Odisha–Paradeep (Jagatsinghpur District) Main Occupation: Marine Fisheries, Mean Annual Income per fisherman = ₹81,000 (Multi Day Trawlers) Kharnashi, (Kendrapada District) Main Occupation: Main Occupation: Marine Fisheries, Mean Annual Income per fisherman = Labourer ₹63,000, Owner 1,04,000

ALOs	Enterprise	No of fishers involved	Man-days	Income from ALO (₹)	Percentage Increase in Annual income
Fishery related	Dry Fish making	5950	135	27,500	34
	Boat building	7	60	Owner -95,000 Labourer 24,000,	91.34, 38

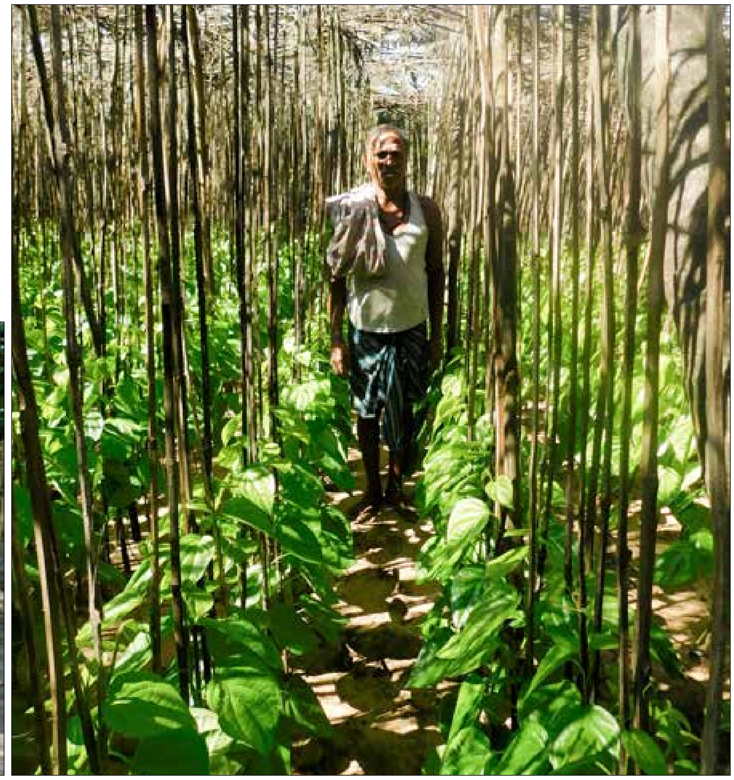
Odisha–Dagara (Balasore district) Main Occupation: Marine Fisheries, Mean Annual Income per fisherman = ₹60,000 (Non-mechanised traditional Canoe) Bichitrapur (Balasore district) Main Occupation: Marine Fisheries, Mean Annual Income per fisherman = ₹1,20,000 (Mechanised Inboard Gill Netter)

	Enterprise	No of fishers involved	Man-days	Income from ALO	Percentage Increase in Annual income
ALOs	Betel leaf cultivation	300	90	60,000	100
Non-Fishery related	Paddy cultivation	2000	56	18,000	30
	Cashew cultivation	35	23	14,000	23
	Eco tourism	18	75	30,000	25
	Masonry	50	36	10,800	18
	Integrated farming	20	1125	1,62,766	271

Fisheries governance livelihood and gender welfare

Betel leaf cultivation, Dagara, Odisha

Integrated Farming, Dagara,Odisha



Andhra Pradesh–Muthialammapalem, Mangamaripettah (Visakhapatnam district) Main Occupation: Marine Fisheries, Mean Annual Income per fisherman = ₹32,000 (Traditional Motorised Boats)

ALOs	Enterprise	No of fishers involved	Man-days	Income from ALO	Percentage increase in Annual income
Fishery related	Dry Fish making	2900	300	50,000	156
Non-Fishery related	Cashew picking	1300	23	1,00,000	312
	Labourer in Power plants (NTPC)	1500	75	18,750	58

boat building an ALO practiced by only 7 fishermen in the region fetched 91.34 per cent and 38 per cent increase in annual income for the owner and labourer respectively

The study in Dagara in Balasore district of Odisha revealed that betel leaf cultivation was an important ALO practiced, contributing to 100 percentage increase in Annual income. (Table 4). It could be further discerned that, Integrated farming

The results highlights that among the non-fishery related ALOs in Visakhapatnam district, cashew picking by fishermen from leased cashew plantations fetched as high as 312 per cent increase in annual income with only 75 man–days since only a single harvest was taken in a year with no after cultivation practices followed in the crop.

Labour Mobility in Marine Fisheries Sector: Kerala and Odisha

A study was conducted in Kerala and Odisha as an insight an insight to the mobility of the marine fishers. The migration of labour has become an important feature of the globalizing world, accompanied with many economic, social and political concerns. Income inequalities, climate change, demographic

Dry Fish making at Muthialammappalem, Visakhapatnam, Andhra Pradesh

shift, conflicts had significantly contributed for the migration of labour in search of employment and security.

The pros and cons of labour migration in the marine fisheries sector were assessed by analysing the cases of fisher folks from various part of the country who migrated to Kerala coast and to Odisha. The analysis of the socio-economic profile of the migrant fishers revealed that 64 per cent of migrant populations are in the age group 31-50 years. The prime reasons for migration included low income, debts and financial commitments and disguised unemployment. The analysis indicated that consequent to migration the fishers augmented their income besides increased savings, construction of house and possession of personal assets along with an elevation to their social status. The major problems confronted during migration are the language barrier, cultural lag and the competition with established migrant labour. However, they did not face any problem with the skill and income discrimination in their profession. Both seasonal and long-term migration has been observed. The migration is found out to be influenced by the historical patterns of resource availability, skill empowerment and economic as well as political factors. Hence, proper management is needed by considering the migratory pattern as well as the native fishers of the region

Theeranaipunya – Scaling up Fisher Youth Domains in Cognitive Development

In Theeranaipunya – Training projects for capacity building for fisherwomen youth, a short term training project for imparting capacity building training for the educated unemployed fisherwomen youth in Ernakulum district was funded by Society for Assistance Fisherwomen (SAF) was perceived as a part of the social commitment to the fisher community. Theeranaipunya III – scaling up fisher youth domains in cognitive development was held during 5th July to 5th August 2017 for 32 educated, young unemployed fisherwomen.

Self-appraisal and need assessment were done prior to the training programme to identify the skill set and future prospects of the trainees. The training programme involves two phases each lasting for a month. Inferential learning through classroom training for a period of 25 days, 100 sessions of one and a half hour duration were covered. Experiential learning (job training) of the training program was arranged with reputed organisations to create resourceful short term career and to develop trainee's entrepreneurial skills.

Fisheries governance livelihood and gender welfare

Consultations were made with different organisations for the placement of the trainees and this was continued even after the training. Educational tools like a training manual and DVD encompassing all the training materials were developed. Many of the trainees got placements and the efforts are still on.

Assessing the financial viability/ sustainability of Theeramythri enterprises

The objectives include developing a vibrant benefit monitoring and evaluation system and also in evolving appropriate marketing interventions and policy support/ advisories for the effective functioning of the Theeramythri groups. Stakeholder's conclaves were conducted in Kozhikode, Kannur and Kasaragod with a view to highlight the constraints faced in the effective functioning of the Theeramythri enterprises. In addition training on Theeramythri Information Monitoring and Evaluation (TIME) was also conducted for the proper documenting of the expenditures. CMFRI continues to provide institutional support in the effective implementation of the SAF plans and programs.

Mainstreaming the Gender Perspective of SHGs in Indian Fisheries sector (SEE/GEN/ SUB/36)

Assessment of the level of performance and extent of empowerment of 250 'Self Help Groups' (SHGs) in gender mainstreaming in marine fisheries sector, through appropriate indices of measurement from Kerala, Tamil Nadu and Andhra Pradesh was conducted. Relevant

1. *Trainees of a SHG from Thevara*
2. *Interaction with fisher folk at Bendarvanipetta, Vijayanagaram, AP*
3. *Women SHG members in a seafood kitchen at Poyya*

Assessed empowerment index of SHG in 3 maritime states, Organized 25 ECB training programmes and 40 interaction meetings for SHG's, Done economic feasibility analysis and Developed business plans for 18 micro enterprises

fishery based micro enterprises catering to the location specific needs of the SHG members was identified and imparted 25 Entrepreneurial Capacity Building (ECB) training programmes on the identified micro enterprises by appropriate HRD intervention programmes and organised 40 fisher folk interaction meets.

The Economic Feasibility analysis of 18 micro enterprises accomplished by SHGs was worked out and video documented. Developed business plans of the microenterprises such as clam processing SHGs in Pookaitha of Alappuzha, dry fish SHG units in Sakthikulangara of Kollam and Ramanathapuram in Tamil Nadu, Sauparnika and Vandanam SHGs of Narakkal and Malippuram engaged in Aqua tourism, Nithyaharitha Karshakasangham, Karshakasree Vanitha Karshaka Sangham SHG units on fish amino acid production in Elamkunnappuzha, Theeramythri sea food kitchen SHGs in Poyya and Wayanad under SAF, Muthuchippy and Sagara Rani SHGs on Mussel Farming in Malappuram, Srayidthode groups of 6 SHGs in pearl spot and tilapia cage farming in Vembanadu lake, Prakruthisree and Jaivasree SHGs of Fertifish in Engandiyoor in Thrissur, hygeinic fish marketing SHGs in Thevara, seaweed farming SHGs in Ramanathapuram in Tamil Nadu.

In Andhra Pradesh, farmer interaction meetings and video documentation were conducted for women SHGs engaged in fish marketing in Bandarvanipetta of Sreekakulam district, Chinthappaly of Vijayanagaram district and Pudimadakka, Lawson's bay and Jalaripetta of Visakhapatnam District and developed respective business plans. Documentation of 18 success stories on ECB of SHGs with special reference to gender perspective was completed. Five movies were brought out as gender mainstreaming series focusing on success stories of impact of SHGs.

Agricultural Technology Information Centre (ATIC)

The Agricultural Technology Information Centre of CMFRI is involved in the activities of providing technology advisory services to various stakeholders, linking stakeholders with various research divisions, collection and transfer of feedback and training needs assessment to research system of the institute and sale of institute technology products and services. The centre also contributes to the economic empowerment of fisherwomen SHG members through marketing of their value added products, organizing training programmes and exhibitions.

Technology advisory services

Technology advisory services were provided to 14, 130 stakeholders consisting of students, fishermen, farmers and

Revenue generation through ATIC

Details of products/ services	Revenue generated (₹)
VARNA Feed	88,100
Posters	30,250
ICAR Publications	2,325
CDs	1,700
Ornamental Fish seed	14,600
Rotifer/Algae/Zoo plankton	10,020
PCR / analytical tests	68,920
Others	20,513
Visitors fee	1,37,700
Total	3,74,128

ATIC functions as single window system to provide all support - products and services - to the stake holders

entrepreneurs during 2017-18. Advisory services were also provided to 1610 stakeholders through telephonic and email contacts. The revenue generated through visitor's fee collection was ₹1, 37,700.

Number of stakeholders availing technology advisory services and revenue generated in 2017-18

The revenue generation through sale of technology products, services and visitors fee was ₹3.74 lakhs and 2,259 people befitted through the technology products and publications.

Training Programmes

1. On-the-job training programme on Advances in Fisheries and Aquaculture from 25.10.17 to 2.11.17 was organised through ATIC for 50 vocational higher secondary students from Kaippamangalam, and Thevara VHS schools. More than 80% of the students from fishermen communities from the coastal areas benefitted through the programme.
2. Two days training programme for the vocational higher secondary students from VHSS, Kadamakkudy was organised through ATIC from 18.9.17 to 19.9.17.
3. Motivational visit and Student-Scientist interactive session under the Walk with the scholar programme was organised for the students of CMS College, Kottayam on 5th July, 2017.

Exhibitions organised through ATIC

1. Matsyotsav held at Kollam from 27-29 May, 2017. The Matsya Adalath held in connection with the programme was inaugurated by Shri. Pinarayi Vijayan, Honourable Chief Minister of Kerala in the presence of State Fisheries Minister Smt.J.Mercykuttiamma.
2. Matsyotsav held at Alappuzha from 13-15th August, 2017
3. Matsyotsav at Kochi from 25-27th July organised by the Department of Fisheries, Kerala.
4. World Food India exhibition, New Delhi from 3.11.17 to 5.11.17. The exhibition was inaugurated by Honourable Prime Minister Narendra Modi on 3.11.17.
5. World fisheries day exhibition from 21-23 November at NASC, Pusa, New Delhi. The exhibition was inaugurated by Shri Radha Mohan Singh, Union Minister of Agriculture and Farmers Welfare.
6. Science exhibition at Jama-ath Residential Public School, Padamugal, Kochi from 1.11.17 to 2.11.17.
7. Exhibition in connection with 11th

VHSE student receiving certificates during after on-the-job training programme

Fisheries governance livelihood and gender welfare

1. DG, ICAR, DDG, Fisheries and Director, CMFRI at CMFRI exhibition stall during the 11th IFAF conference
2. Fisheries Minister Smt. J. Mercykutty Amma along with Director, CMFRI visiting the exhibition organised in connection with SAFARI-II International Conference.

IFAF at Le-Meridien, Kochi from 21-24 November, 2017.

8. Exhibition at MES College Aluva from 28.02.18 to 1.03.18.
9. Exhibition in connection with the SAFARI -2 international conferences was organised at CMFRI, Kochi from 15th to 17th January, 2018(3days). Dr.N.Aswathy, Senior Scientist and Manager, ATIC served as the chairperson of exhibition committee. Various Government institutions, farmers/ entrepreneurs and food stalls of women self-help groups participated in the exhibition. The exhibition provided opportunities for fishers and farmers to get wide publicity to their products and promote the sale of live fish products and various farm products. The exhibition sales generated revenue of around ₹15 lakhs during the three days for the fisher's/ fish farmers.

Intellectual Property Management

Cadalmin™ Antihypercholesterolemic extract developed from seaweeds showed potential to combat obesity/dyslipidemia/ non-alcoholic fatty liver diseases.

Institute Technology Management Unit (ITMU)

Patents ensure property rights (legal title) for the invention for which patent have been granted, which may be extremely valuable to an individual or an institution. The patents are being filed through ITMU (Intellectual Property Management and Technology Transfer/ Commercialisation Unit). All action pertains to the filing of IPR applications and their follow up under the law including maintenance of IPR, and further management of IP, is being undertaken by ITMU of Central Marine Fisheries Research Institute.

Functions of ITMU in the Institute

- IP protection, maintenance and management.
- To carry out internal examination before filing patents.
- Patent filing; invite expert opinion from patent attorney/ IPR expert.
- ITMC duly records the reasons for acceptance/rejection of each patent proposal.
- Correction/ rectification/ updation of primary information.
- Technology transfer/ commercialisation.

Commercialisation of Technologies during 2017-18

CadalminTM Antihypercholesterolemic extract developed from seaweeds showed potential to combat obesity/dyslipidemia/ non-alcoholic fatty liver diseases was commercialised to VLCC (Vandana Luthra Curles and Curves) Health care Ltd @ ₹10,00,000/- (@5% royalty) on May 2017. The active ingredients in the product were packed in plant-based capsules to meet the dietary needs of vegetarians. This product showed potential to inhibit hydroxymethyl glutaryl reductase, an established statin target, and reduce obesity and hypercholesterolemic disordersas determined by the *in vivo* mammalian model.

Name of Technology/ Know-how	IP Protection (Yes/ No)*	Name of Contracting Party	Mode of Patnership **	Date of Licensing	Revenue Earned (₹)
CadalminTM Antihypercholesterolemic extract (CadalminTM ACe) to combat dyslipidemia and obesity from seaweeds	Patent Appl. No. (201711018741)	Vandana Luthra Curles and Curves (VLCC) Health Care Limited, a leading Indian MNC in wellness and obesity management	MoU (Licensing and royalty)	24/5/2017	₹10 lakhs as license fee and 5% royalty

Intellectual Property Management

Management of IP portfolio

Patent Filed and Application number obtained during 2017-18

A process to prepare anti-dyslipidemic concentrate from seaweed and a product therof (Appl. no. 201711018741)

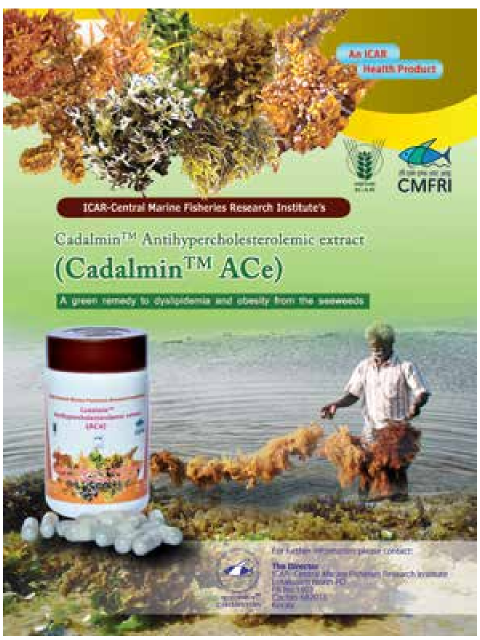
(Current status: FER awaited)

FER Filed during 2017-18

Response towards the FER has been filed for 5198/CHE/2012 in respect of "A process to isolate anti-inflammatory principles from green mussel" (with prior intimation of NBA, Chennai (The technology has been commercialised with Accelerated Freeze Drying Company Pvt. Ltd, Kochi)

Patents Granted during 2017-18

- A process to prepare naturalised *Artemia francesciana* from Indian subcontinent with high docosahexaenoic acid and



CadalminTM Antihypercholesterolemic extract (CadalminTMACe) goes commercial: MoU with VLCC during May 2017 with a license fee of ₹10, 00, 000/- and 5% royalty on annual revenue

trehalose. 2063/CHE/2010 (Indian patent application).

- A process to prepare antioxidant and anti-inflammatory concentrates from brown and red seaweeds and a product thereof. 2064/CHE/2010 (Indian patent application).

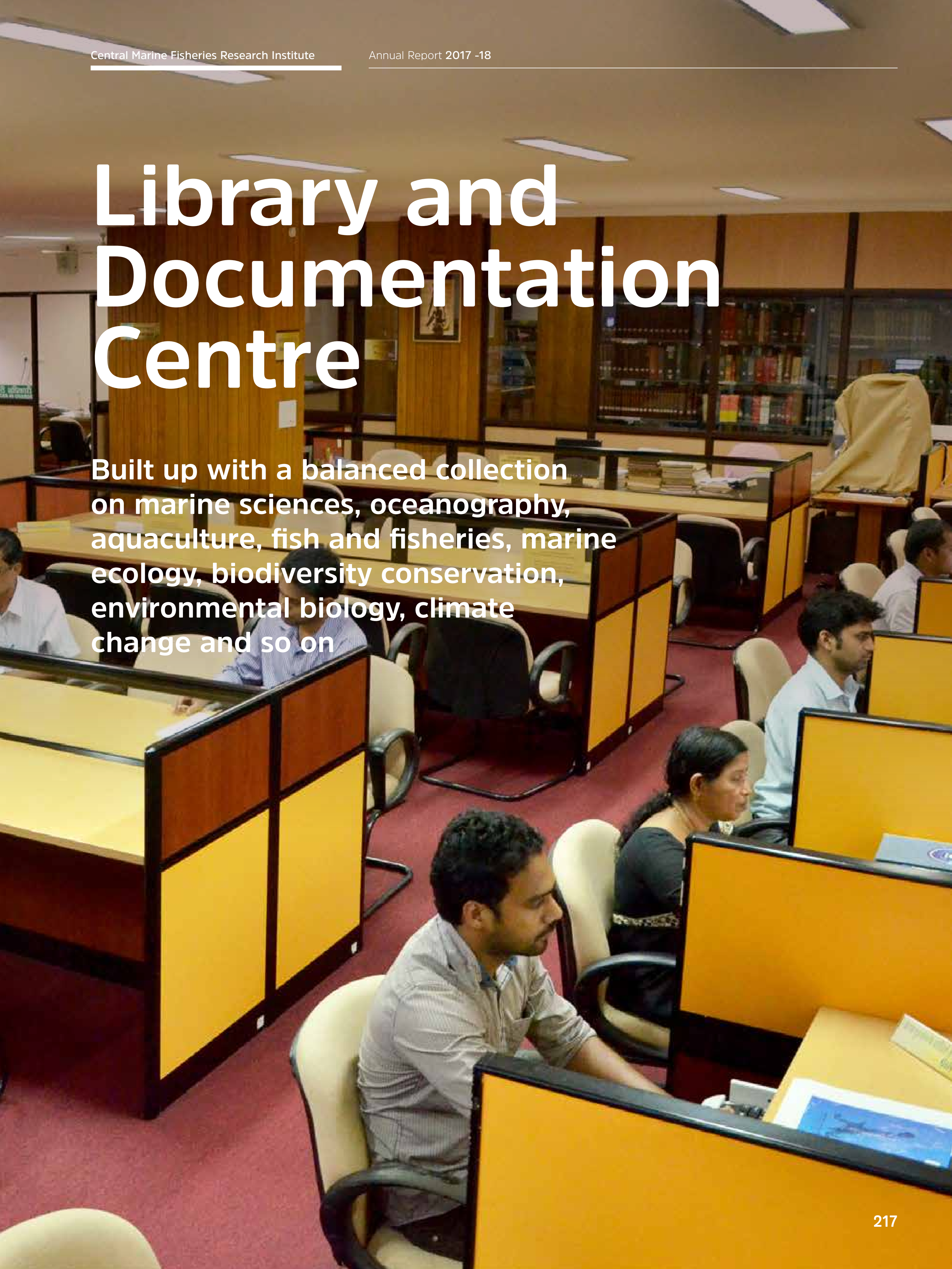
- A process to concentrate anti-inflammatory principles from green mussel *Perna viridis* and a product incorporating these ingredients. 2065/CHE/2010 (Indian patent application).

- A product containing anti-inflammatory principles from green mussel *Perna viridis* and a process thereof. 2066/CHE/2010 (Indian patent application).

Prominent MoUs signed with

- Vandana Luthra Curles and Curves Health care Ltd for commercial production and marketing of CadalminTM Antihypercholesterolemic extract
- National Fisheries Development Board for e-marketing intervention in Indian Fisheries sector
- Indian National Centre for Ocean Information Service, Govt. of India
- Indian Fish Meal and Fish Oil Exporters' Association
- Mangrove and Marine Biodiversity Conservation Foundation of Maharashtra
- MS Swaminathan Research Foundation
- National Biodiversity Authority
- Goa University

India is a member of the World Trade Organisation, and therefore, must comply with the TRIPS Agreement since 1st January 1995. IPRs are primarily important because they offer mechanisms to stimulate R & D keeping in mind the practical applications, and therefore, ultimately benefit the end users. Patents ensure property rights (legal title) for the invention for which patent have been granted, which may be extremely valuable to an institution. Commercialisation of IPR enabled technologies and other expertise, through public-private partnership, would lead to their accelerated and efficient transfer. The adoption of IP protected technologies by producers will lead to increase in productivity, production, farmers' income and employment.



Library and Documentation Centre

Built up with a balanced collection on marine sciences, oceanography, aquaculture, fish and fisheries, marine ecology, biodiversity conservation, environmental biology, climate change and so on

Library and Documentation Centre

1004

new publications added to 'eprints@cmfri' during 2017-2018

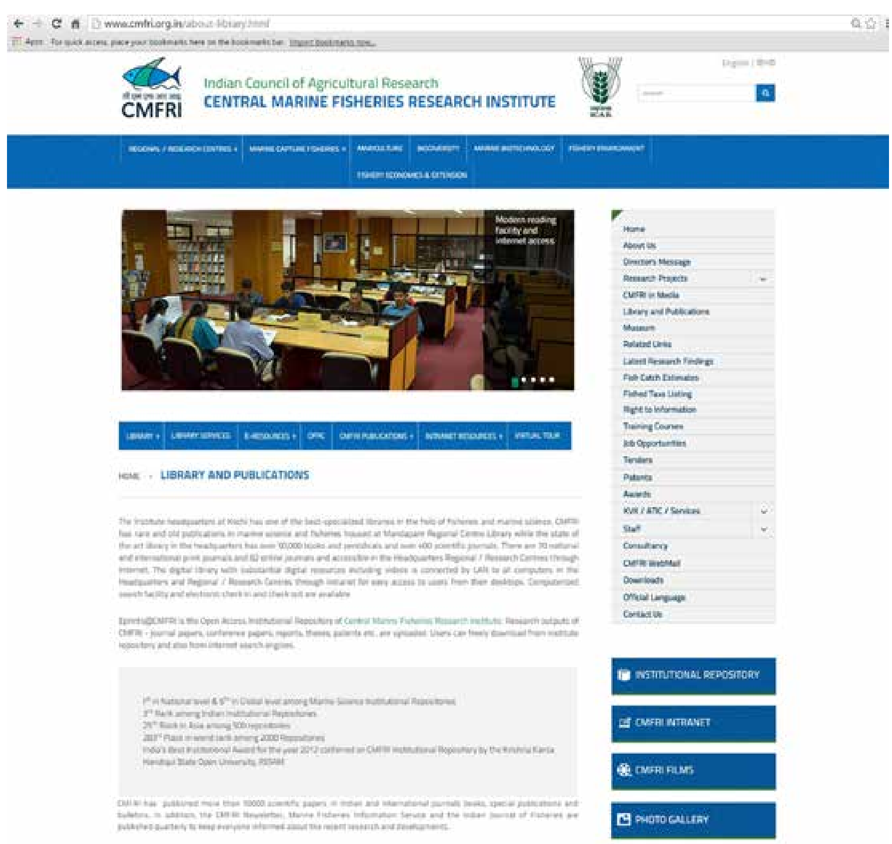
Library and Documentation Centre of CMFRI is one among the best-specialised state of the art libraries in the field of fisheries, aquaculture and marine sciences. Library plays an important role in the research activities of the Institute by providing literatures and services to the staff at HQ as well as RCs. Students and researchers from Universities, Colleges, State Fisheries Departments, and other Institutions utilise CMFRI library for their academic and research purposes. Library purchased 63 new books, subscribed 27 journals and MarinLit- online Database on Marine Natural Products and 750 issues of current periodicals were added to library stock .

Digital Library

The digital library of CMFRI named "Library and Publication" is hosted in the Institute website to extend the digital services. All digital services are accessible at HQ as well as RCs. The Library Catalogue, OPAC can be accessed globally for searching the documents available in the library. 78 online journals, 2 online databases (MarinLit and IndiaAgristat.com) and 252 open access journals on fisheries and allied subjects are accessible. CeRA subscribed e-journals are made available through J-Gate platform. Access to 1174 e-books on agriculture and allied subjects and more than 3,500 ejournals are available through CeRA. 80 e-books on fish and fisheries, 17 e-book series and e-journals on fish and fisheries published by Elsevier, Wiley, Springer, Taylor & Francis are accessible at HQ and RCs.

Institutional Repository 'eprints@cmfri'

'eprints@cmfri' is the open access Institutional repository developed and hosted in the Institute website for archiving the Intellectual products created by CMFRI. Institutional Repository has a total collection of 12,396 publications now. During the period 1,004 new publications were added.



Library and Documentation Centre

The digital archive of CMFRI “DSpace@CMFRI” hosts rare volumes and old literatures since 1800s

DSpace@CMFRI

“DSpace@CMFRI” is the digital archive of CMFRI developed for archiving Rare and old publications from the year 1800s available in CMFRI. Six thousand old and rare documents like Memoirs, Catalogues, Reports and Expedition Reports are archived in “DSpace@CMFRI”. The documents can be searched by Author, Subject, Keyword and Year of publication. Full text of the documents can be accessed at HQ and RCs of CMFRI.

Current Awareness Service

Library compiles the digital magazine “Current Awareness Service” with content pages of new journals received in library and accessible at HQ and Regional/ Research Centres through intranet.

Online Library Information Service

Online Informations on release of new Institute publications, activation of online databases and journals, new books purchased etc. were sent regularly to scientists & researchers in HQ and RCs by email.

Online Document Delivery Service

Online requests are received from users of Institutional Repository and users of ICAR-CeRA for full text articles published by CMFRI scientists. Library delivered 392 articles online during the period.

Newspaper clippings

News clippings on fisheries, aquaculture and related subjects published in various newspaper were collected and compiled on monthly basis as News Clippings magazine for reference. Links to online news clippings were provided in the digital library.

Scanning and digitisation

Library has a high quality digital scanner for in house scanning and digitisation of damaged old documents. Old

Library and Documentation Centre

dissertations and books were scanned, digitised and added to Repositories during the period.

Plagiarism checking

Library made arrangements for checking plagiarism for scientific articles of the institute staff for publishing in various journals.

Institute Publications

Library is entrusted with arrangements for printing, stock maintenance, distribution and sale of Institute publications. Printing arrangements made for 26 Institute publications during the period and ISBN, ISSN and Series Nos were allotted. The digital versions of Institute publications were uploaded in the Institute website. The Revenue generated by Library from sale of publications during the period is ₹1,09,234.

Indian Journal of Fisheries

During the year, 4 issues of IJF Vol. 64 were published and taken to stock. Worldwide usage statistics of IJF for the year shows a total of 35,745 users and 21,260 users were from India. Indian Journal of Fisheries got NAAS rating 6.24.

Library Training Programme

Library co-ordinated One Day Training-cum-Awareness Workshop on "Journal Discovery through J-Gate@CeRA for Southern Region" on 15th December 2017 jointly organised by ICAR DKMA, CMFRI and Informatics, Bangalore for Library Professionals. 50 professionals from various Universities and Institutes participated. The workshop was held to create awareness in better utilisation of digital knowledge resources through CeRA J-Gate platform.

Exchange of Publications

Library maintains exchange relationship with various National and International Research Institutes, Universities and other organisations. Mailing lists are maintained for free distribution of Institute publications.

Binding of back volumes

657 back volumes of print journals were bound during the period and added to Bound Volumes stock.

User Orientation Service

Orientation classes provided to new users and visitors from various research

Library hosted One Day Training-cum-Awareness Workshop on "Journal Discovery through J-Gate@CeRA for Southern Region"

Library and Documentation Centre

institutions, universities and colleges for better utilisation of library services.

Visitors

1,742 visitors comprising students and researchers from various research organisations, universities and colleges availed the library services.

CMFRI Publications released during 2017-18

CMFRI Annual Report 2016-2017

CMFRI Annual Report 2015-2016 (Hindi)

Cadalmin–CMFRI Newsletter No. 151, 152,153,154 (English)

Cadalmin–CMFRI Newsletter No. 151, 152 (Hindi)

Marine Fisheries Information Service No. 230, 231, 232

Indian Journal of Fisheries Vol. 64

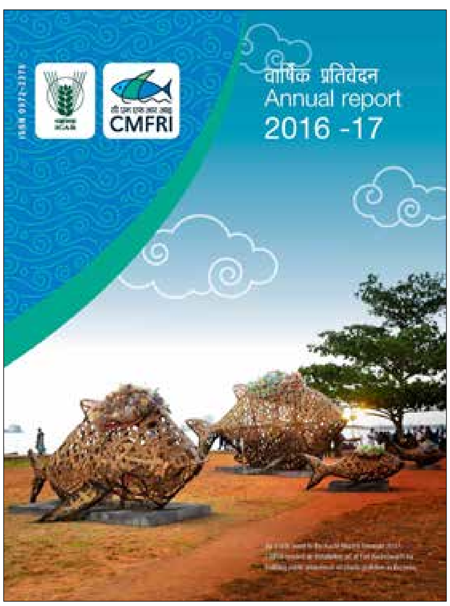
Marine Fish Landings in India – 2016

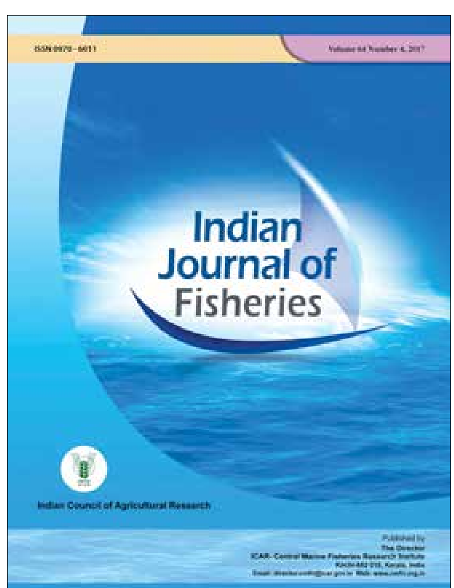
Matsyagandha

Prioritised Species for Mariculture in India

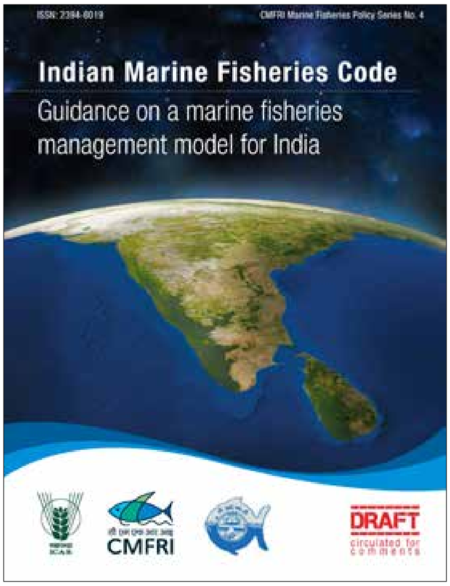
An Illustrated Guide to the Carangid fishes of Indian Seas

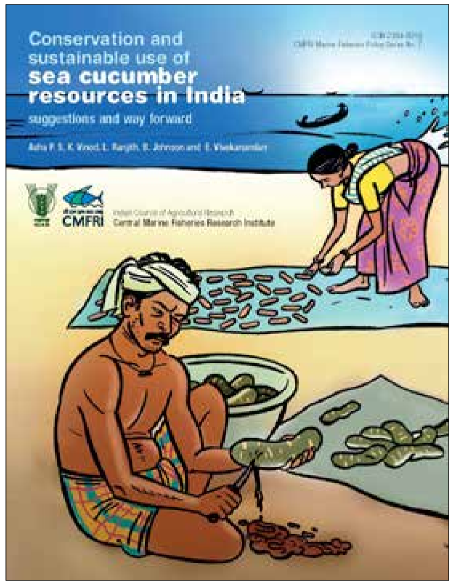
CMFRI Special Publication No. 127- Methodological Tools for Socioeconomic and Policy Analysis in Marine Fisheries

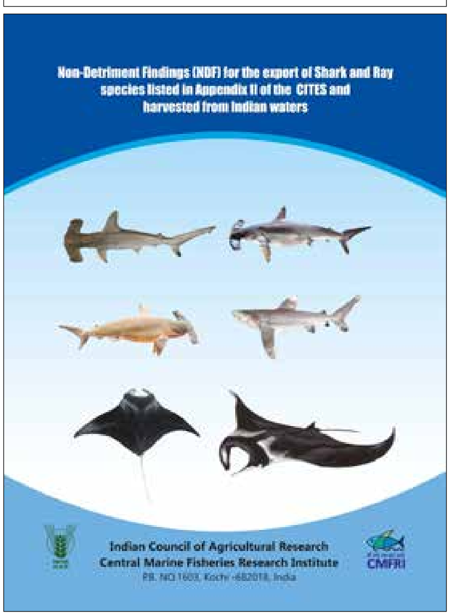




Library and Documentation Centre







Marine Fisheries Policy Series no. 4, Indian Marine Fisheries Code: Guidance on a Marine Fisheries Management Model for India

Marine Fisheries Policy Series no. 5, Management Plans for the Marine Fisheries of Karnataka.

Marine Fisheries Policy Series no. 6, Non-Detriment Findings (NDF) for the export of Shark and Ray species listed in Appendix II of the CITES and harvested from Indian waters

Marine Fisheries Policy Series no. 7, Conservation and sustainable use of sea cucumber resources in India suggestions and way forward

Marine Fisheries Policy Series no. 8, Seahorse resources in India: need for paradigm shift in approach for sustainable fisheries and conservation

Book of Abstracts & Lead Articles of the Second International Symposium SAFARI-2

Budget & Expenditure

up to 31-03-2018 (` in lacs)

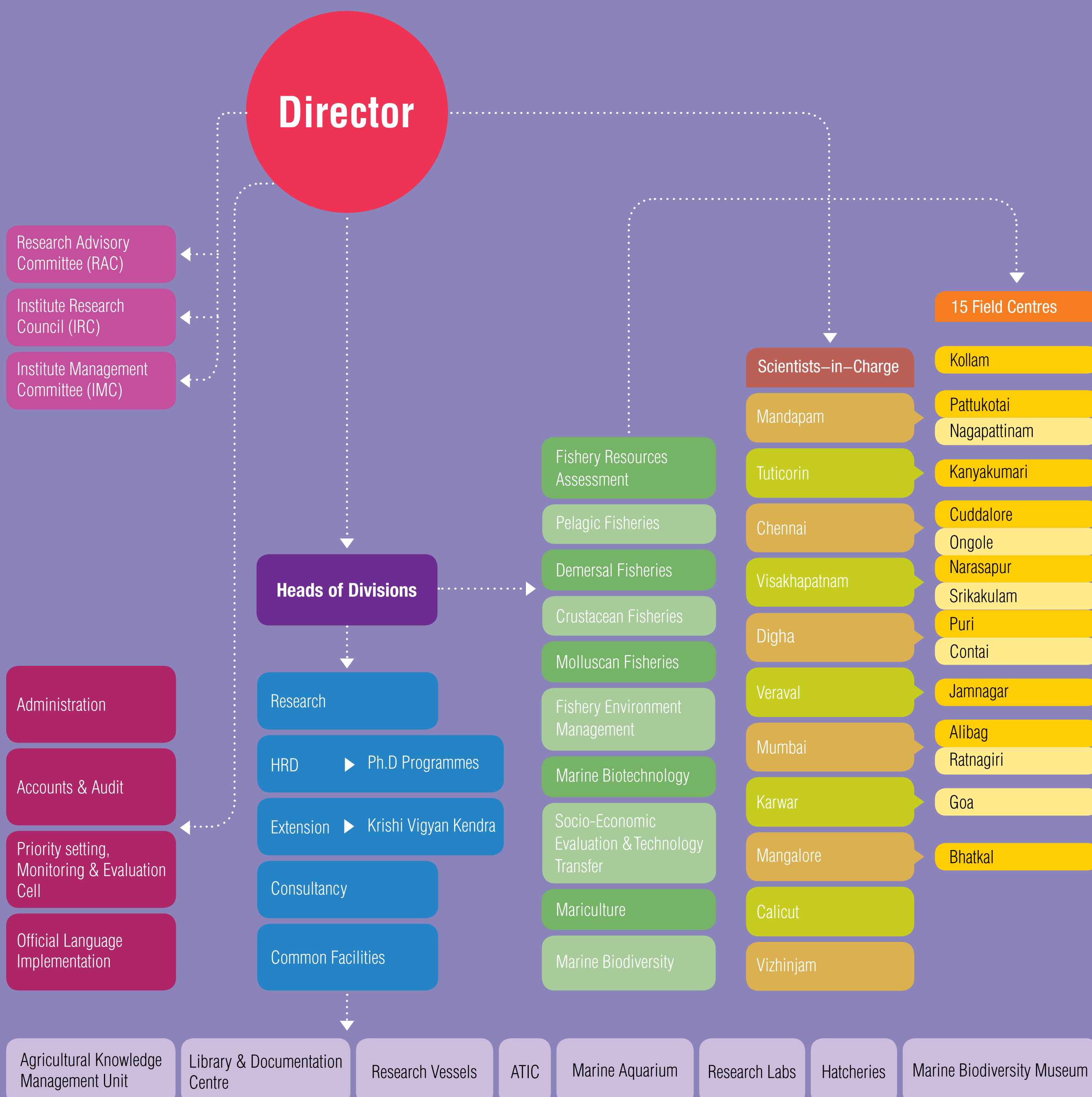
Sl. No.	Name of the Head	R.E. 2017-18	Progressive Expenditure up to 31-03-18	% of utilisation
	Grants for creation of Capital Assets (Capital)			
1	Works			
	(A) Land	0.00	0.00	0.00
	(B) Building	0.00	0.00	0.00
	i Office Building	184.00	184.00	100.00
	ii Residential Building	33.00	32.27	97.78
	iii Minor Works	8.00	7.86	98.25
2	Equipments	75.00	76.38	101.84
3	Information Technology	40.00	39.66	99.14
4	Library Books and Journals	15.00	14.92	99.44
5	Vehicle & Vessels	0.00	0.00	0.00
6	Livestock	0.00	0.00	0.00
7	Furniture & Fixtures	10.00	9.92	99.18
8	Others	0.00	0.00	0.00
	Total Capital (Grants for creation of Capital Assets)	365.00	365.00	100.00
	Grant -in- Aid - Salaries			
1	Establishment Expenses			
	(A) Salaries			
	I Establishment charges	6200.00	6200.00	100.00
	ii Wages	0.00	0.00	0.00
2	iii Over time Allowances	1.00	0.00	0.00
	Grants In Aid - General (Revenue)			
1	Pension & Other Retirement Benefits	6737.00	6681.00	99.17
2	Travelling Allowance			
	(A) Domestic TA/Transfer TA	175.00	175.00	100.00
	(B) Foreign TA	5.00	5.52	100.00
3	Research & Operational Expenses			
	(A) Research Expenses	270.00	270.52	100.19
	(B) Operational Expenses	150.00	149.48	99.65
4	Administrative Expenses			
	(A) Infrastructure	500.00	500.00	100.00
	(B) Communication	65.00	65.07	100.11
	(C) Repairs & Maintenance			
	i Equipments, Vehicles & Others	120.00	113.45	94.54
	ii Office Building	68.00	67.86	99.79
	iii Residential Building	12.00	12.00	100.00
	iv Minor Works	12.00	11.95	99.58
	(D) Others (excluding TA)	220.00	226.66	103.03
	Sub-Total	997.00	997.00	100.00
5	Miscellaneous Expenses			
	A HRD	22.00	22.00	100.00
	B Other items (Fellowships, Scholorship etc.)	25.00	24.49	97.98
	C Publicity & Exhibition	8.00	7.97	99.61
	D Guest House - Maintenance	4.00	5.45	136.18
	E Other Miscellaneous	23.00	22.09	96.04
	Sub-Total	82.00	82.00	100.00
	Sub-Total	82.00	82.00	100.00
	Tribal Sub Plan Expenditure	13.00	13.00	100.00
	Total	14630.00	14573.00	99.61
	Grand Total	14995.00	14938.00	99.62
	Loans & Advances	30.00	24.20	80.67

Revenue Receipt

Revenue Receipts 2017-18	Achieved
Income from Sales/services	40.22
Fee/Subscription	26.39
Income from Royalty, publication etc.	10.91
Other Income	108.93
STD Interest	50.66
Recoveries on Loans & Advances	18.28
CPWD/Grants Refund	35.92
TOTAL	291.31

	Receipts (Including Opening Balance)	Expenditure	Refund	Closing Balance
Winter/Summer School	16.29	14.77	0.00	1.52
Emeritus	1.68	0.00	0.00	1.68
AINP M	295.00	295.00	0.00	0.00
NICRA	129.83	121.67	0.83	7.33
National Fund Schemes	13.42	7.08	4.88	1.46
Other Schemes	84.86	51.03	17.64	16.19
Deposit Schemes (Externally funded)	1121.25	717.81	16.21	387.23
KVK, Narakkal	151.96	150.23	0.00	1.73
Consultancies	726.56	104.40	0.00	622.16

Organogram


Director
Research Advisory Committee (RAC)
Institute Research Council (IRC)
Institute Management Committee (IMC)
Heads of Divisions
Research
HRD
Ph.D Programmes
Extension
Krishi Vigyan Kendra
Consultancy
Common Facilities
Administration
Accounts & Audit
Priority setting, Monitoring & Evaluation Cell
Official Language Implementation
Fishery Resources Assessment
Pelagic Fisheries
Demersal Fisheries
Crustacean Fisheries
Molluscan Fisheries
Fishery Environment Management
Marine Biotechnology
Socio-Economic Evaluation & Technology Transfer
Mariculture
Marine Biodiversity
Scientists–in–Charge
Mandapam
Tuticorin
Chennai
Visakhapatnam
Digha
Veraval
Mumbai
Karwar
Mangalore
Calicut
Vizhinjam
15 Field Centres
Kollam
Pattukotai
Nagapattinam
Kanyakumari
Cuddalore
Ongole
Narasapur
Srikakulam
Puri
Contai
Jamnagar
Alibag
Ratnagiri
Goa
Bhatkal
Agricultural Knowledge Management Unit
Library & Documentation Centre
Research Vessels
ATIC
Marine Aquarium
Research Labs
Hatcheries
Marine Biodiversity Museum

Personnel

Scientific

No.	Name of Employee	Designation
1	Dr. A. Gopalakrishnan	Director & Principal Scientist
2	Dr. K. Sunilkumar Mohammed	Principal Scientist & Head I/c, MFD
3	Dr. (Smt.) V. Kripa	Principal Scientist & Head I/c, FEMD
4	Dr. P.U. Zachariah	Principal Scientist & Head I/c, DFD
5	Dr. G. Maheswarudu	Principal Scientist & Head I/c, CFD
6	Dr. R. Narayanakumar	Principal Scientist & Head I/c, SEETTD
7	Dr. T.V. Sathianandan	Principal Scientist & Head, FRAD
8	Dr. K.K. Joshi	Principal Scientist & Head, MBD
9	Dr. P. Vijayagopal	Principal Scientist & Head I/c, MBTD
10	Dr. Prathibha Rohit	Principal Scientist & SIC and Head I/c, PFD
11	Dr. (Smt.) Imelda Joseph	Principal Scientist &Head I/c,Mariculture
12	Dr. Boby Ignatius	Principal Scientist & SIC, HRD/PME
13	Dr. J. Jayasankar	Principal Scientist/SIC, AKMU
14	Dr. Veerendra Veer Singh	Principal Scientist & SIC, Mumbai
15	Dr. A.K. Abdul Nazar	Principal Scientist & SIC, Mandapam
16	Dr. P.P. Manoj Kumar	Principal Scientist & SIC, Thoothukudi
17	Dr. Jayasree Loka	Principal Scientist & SIC, Karwar
18	Dr. P.K. Asokan	Principal Scientist & SIC, Kozhikode
19	Dr. Shubhadeep Ghosh	Principal Scientist & SIC, Visakhapatnam
20	Dr. P. Laxmilatha	Principal Scientist & SIC, Chennai
21	Dr. M.K. Anil	Principal Scientist & SIC, Vizhinjam
22	Dr. Divu Damodaran	Scientist & SIC, Veraval
23	Shri. Subal Kumar Roul	Scientist & SIC, Puri
24	Shri. Gyanranjan Dash	Scientist & SIC, Digha
25	Dr. Shinoj Subramannian	Sr. Scientist & PC, KVK, Narakkal
26	Dr. P. Kaladharan	Principal Scientist
27	Dr. P. Jayasankar	Principal Scientist
28	Dr. (Mrs.) Reeta Jayasankar	Principal Scientist
29	Dr. (Smt.) Molly Varghese	Principal Scientist
30	Dr. N.K. Sanil	Senior Scientist
31	Dr. S.R. Krupesha Sharma	Principal Scientist
32	Dr. E.M. Abdusamad	Principal Scientist
33	Dr. C. Ramachandran	Principal Scientist
34	Dr. (Smt.) Josileen Jose	Principal Scientist
35	Dr. K. Madhu	Principal Scientist
36	Dr. (Smt.) Rema Madhu	Principal Scientist
37	Dr. (Smt.) K.S. Sobhana	Principal Scientist
38	Dr. (Smt.) Shoji Joseph	Principal Scientist
39	Dr. (Smt.) D. Prema	Principal Scientist
40	Dr. (Smt.) Somy Kuriakose	Principal Scientist
41	Dr. V.P. Vipin Kumar	Principal Scientist
42	Dr. Shyam S. Salim	Principal Scientist
43	Dr. (Smt.) Ganga U.	Principal Scientist
44	Dr. (Smt.) Rekha J. Nair	Principal Scientist
45	Dr. (Smt.) S.Lakshmi Pillai	Principal Scientist
46	Dr. (Smt.) Mini. K.G.	Principal Scientist
47	Dr. T.M. Najmudeen	Principal Scientist
48	Dr. R. Jeyabaskaran	Senior Scientist
49	Dr. Kajal Chakraborty	Senior Scientist
50	Dr. (Smt.) N. Aswathy	Senior Scientist
51	Dr. Grinson George	Senior Scientist
52	Dr. (Smt.) Rekhadevi Chakraborty	Senior Scientist
53	Dr. V. Venkatesan	Senior Scientist
54	Dr. (Smt.) Sandhya Sukumaran	Senior Scietist
55	Dr. (Smt.) Miriam Paul Sreeram	Senior Scientist
56	Shri. K. Mohammed Koya	Scientist
57	Shri. Wilson T. Mathew	Scientist
58	Dr. Pradeep M.A.	Scientist
59	Smt. Reshma K.J.	Scientist
60	Dr. (Smt.) Vidya R.	Scientist
61	Shri. Sanal Ebenezeer	Scientist
62	Shri. Vivekanand Bharti	Scientist
63	Dr. Shinoj P.	Scientist
64	Dr. Rajesh N.	Scientist
65	Dr. (Smt.) Sumithra T.G.	Scientist
66	Dr. Shelton Padua	Scientist
67	Smt. Livi Wilson	Scientist
68	Dr. (Smt.) Jeena N.S.	Scientist

Personel: Scientific

No.	Name of Employee	Designation
69	Dr. Eldho Varghese	Scientist
70	Shri. Sreenath K.R.	Scientist
71	Dr. Gulshad Mohamed	Principal Scientist
72	Dr. Vinod K.	Principal Scientist
73	Shri. K.P. Said Koya	Scientist
74	Smt. Ramya Abhijith	Scientist
75	Dr. Mahesh V.	Scientist
76	Smt. Shilta M.T.	Scientist
77	Dr. Joe K. Kizhakudan	Principal Scientist
78	Dr. (Smt.) Sobha Joe Kizhakudan	Principal Scientist
79	Dr. M. Sivadas	Principal Scientist
80	Dr. (Smt.) P.T. Sarada	Principal Scientist
81	Dr. K. Vijayakumaran	Principal Scientist
82	Dr. (Smt) A. Margaret Muthu Rathinam	Principal Scientist
83	Dr. Vidya Jayasankar	Senior Scientist
84	Ms. Saima Rehman	Scientist
85	Shri. Adnan Hussain Gora	Scientist
86	Dr. Srinivasa Raghavan V.	Scientist
87	Smt. E.M. Chhandaprajnadarsini	Scientist
88	Dr. Rengarajan Jayakumar	Senior Scientist
89	Shri. S. Thirumalaiselvan	Scientist
90	Shri. Vinothkumar R.	Scientist
91	Shri. Sankar M.	Scientist
92	Dr. G. Tamilmani	Scientist
93	Dr. M. Sakthivel	Scientist
94	Dr. Johnson B.	Scientist
95	Dr. P. Rameshkumar	Scientist
96	Shri. Saravanan R.	Scientist
97	Dr. Anikuttan K.K	Scientist
98	Shri. S. Chandrasekar	Scientist
99	Ms. Remya. L	Scientist
100	Shri. Rajkumar. M.	Scientist
101	Dr. Amir Kumar Samal	Scientist
102	Dr. A.P. Dinesh Babu	Principal Scientist
103	Dr. Sujitha Thomas	Principal Scientist
104	Dr. (Smt.) Geetha Sasikumar	Principal Scientist
105	Dr. (Smt.) Bindu Sulochanan	Senior Scientist
106	Dr. K.M. Rajesh	Senior Scientist
107	Smt. Divya Viswambharan	Scientist
108	Shri. Purushottama G.B.	Scientist
109	Shri. Bhendekar Santosh Nagnath	Scientist

No.	Name of Employee	Designation
110	Dr. (Smt.) Anulekshmi Chellappan	Scientist
111	Dr. S. Ramkumar	Scientist
112	Shri. Ratheesh Kumar R.	Scientist
113	Shri. Akhilesh K.V	Scientist
114	Shri. Nakhawa Ajay Dayaram	Scientist
115	Shri. Rajesh Kumar Pradhan	Scientist
116	Dr. I. Jagadis	Principal Scientist
117	Dr. (Smt.) Asha. P.S.	Principal Scientist
118	Dr. (Smt.) C.P. Suja	Principal Scientist
119	Shri. C Kalidas	Scientist
120	Dr. Renjith. L.	Scientist
121	Smt. Kavitha M.	Scientist
122	Shri. Linga Prabhu D.	Scientist
123	Shri. Abdul Azeez P.	Scientist
124	Shri. Tarachand Kumawat	Scientist
125	Shri. Sukhdhane Kapil Sukhadeo	Scientist
126	Shri. Vinaya Kumar Vase	Scientist
127	Shri. Rajan Kumar	Scientist
128	Smt. Shikha Rahandgale	Scientist
129	Dr. S.Sathyanarayana Raju	Principal Scientist
130	Smt. Indira Divipala	Scientist
131	Dr. Ritesh Ranjan	Scientist
132	Dr. (Smt.) Biji Xavier	Scientist
133	Smt. Muktha M.	Scientist
134	Shri. Loveson Edward L.	Scientist
135	Shri. Pralaya Ranjan Behera	Scientist
136	Dr. Sekar Megarajan	Scientist
137	Smt. Jasmin F.	Scientist
138	Dr. Manas. H.M	Scientist
139	Dr. P.S. Swathilekshmi	Principal Scientist
140	Dr. B. Santhosh	Principal Scientist
141	Smt. S. Jasmine	Principal Scientist
142	Dr. (Smt.) K.N. Saleela	Senior Scientist
143	Smt. Surya S.	Scientist
144	Shri. Ambarish P. Gop	Scientist
145	Smt. P. Gomathi	Scientist
146	Smt. Swathipriyanka Sen Dash	Scientist
147	Dr. T. Senthil Murugan	Senior Scientist
148	Ms. Saloni Shivam	Scientist
149	Shri. Kurva Raghu Ramudu	Scientist
150	Dr. Suresh Babu. P. P.	Scientist
151	Shri. Anuraj. A	Scientist

Personel: Technical

Technical

No.	Name of Employee	Designation
KOCHI		
1	Shri. P. S. Anilkumar	Assistant Chief Technical Officer
2	Smt. G. Shylaja	Assistant Chief Technical Officer
3	Smt. P. Geetha	Assistant Chief Technical Officer (Library)
4	Shri. N. Viswanathan	Assistant Chief Technical Officer (Civil)
5	Smt. K. Ramani	Assistant Chief Technical Officer
6	Smt. E. K. Uma	Assistant Chief Technical Officer (Hindi Translator)
7	Smt. Jenni. B.	Senior Technical Officer
8	Shri. Sijo Paul	Senior Technical Officer
9	Smt. K. P. Salini	Senior Technical Officer
10	Dr. M. P. Paulton	Senior Technical Officer (Training)
11	Shri. K. M. Venugopalan	Senior Technical Officer
12	Smt. P. K. Seetha	Senior Technical Officer
13	Shri. K. N. Pushkaran	Technical Officer
14	Shri. V. K. Manu	Technical Officer (Programme Assistant - Computer)
15	Shri. P. K. Baby	Technical Officer
16	Shri. K. G. Baby	Technical Officer
17	Smt. Sindhu K. Augustine	Technical Officer
18	Shri. A. Padmanabha	Technical Officer (Electrical)
19	Shri. K. G. Radhakrishnan Nair	Technical officer (Motor Driver)
20	Smt. P. M. Geetha	Technical Officer (Museum)
21	Smt. Dipti N. V.	Technical Officer (Programme Assistant - Laboratory Technician)
22	Shri. N. K. Harshan	Senior Technical Assistant
23	Shri. P. S. Alloycious	Senior Technical Assistant
24	Shri. K. C. Hezhakiel	Senior Technical Assistant
25	Shri. D. Prakasan	Senior Technical Assistant
26	Shri. Arun Surendran P. S.	Senior Technical Assistant
27	Shri. K. Solaman	Senior Technical Assistant
28	Shri. Retheesh. T.	Senior Technical Assistant
29	Smt. Lavanya S.	Senior Technical Assistant
30	Shri. Manjeesh R.	Technical Assistant (Computer Application)
31	Smt. Sajeela. K. A.	Technical Assistant
32	Shri. M. N. Sathyan	Technial Assistant (Motor Driver)
33	Shri. Sajikumar K. K.	Technical Assistant
34	Shri. Retheesh T. B.	Technical Assistant
35	Smt. Anusree V. Nair	Technical Assistant
36	Shri. Binoy Bhaskaran	Technical Assistant
37	Shri. Ragesh N.	Technical Assistant
38	Shri. Sayooj P.	Technical Assistant
39	Shri. Aju. K. Raju	Technical Assistant
40	Shri. K. M. David	Technical Assistant (Artist)
41	Shri. C. V. Jayakumar	Technical Assistant (Press & Editorial)
42	Smt. Vandana V.	Technical Assistant(Hindi Translator)
43	Shri. David Babu	Senior Technician
44	Shri. P. R. Abhilash	Senior Technician (Exhibition Assistant)
45	Shri. M. Radhakrishnan	Senior Technician
46	Smt. Dhanya G.	Senior Technician
47	Shri. M. P. Mohandas	Senior Technician
48	Shri. V. H. Venu	Technician
49	Smt. J. Sudhadevi	Technician
50	Smt. Shyamala M. P.	Technician
51	Shri. P. V. Sunil	Technician
52	Shri. Shaji A. K.	Technician
53	Smt. Sheela P. P.	Technician
54	Shri. Jestin Joy K. M.	Technician
55	Shri. Sreekumar K. M.	Technician
56	Shri. Vijayan M. T.	Technician
57	Shri. Kishor T. G.	Technician
58	Shri. Sreesanth. L.	Technician
59	Shri. Sunil K. T. S	Technician
60	Smt. S. Prasannakumari	Technician
KVK		
61	Smt. P. Sreelatha	Chief Technical Officer
62	Shri. F. Pushparaj Anjelo	ACTO (SMS- Agricultural Extension)
63	Dr. (Smt.) Karikkathil Smitha Sivadasan	ACTO (SMS- Animal Husbandry)
64	Shri. Shoji Joy Edison	ACTO (SMS- Horticulture)
65	Dr. Vikas P. A.	Senior Technical Officer (SMS- Fisheries)
CHENNAI		
66	Shri. D. Pugazhendi	Assistant Chief Technical Officer
67	Shri. S. Mohan	Assistant Chief Technical Officer
68	Smt. S. Gomathy	Senior Technical Officer
69	Shri. N. Rudhramurthy	Senior Technical Officer
70	Shri. K. S. Shiak Mohamed Yousuf	Senior Technical Assistant
71	Shri. P. Jaiganesh	Senior Technical Assistant
72	Shri. S. Selvanidhi	Senior Technical Assistant
73	Shri. M. Ravindran	Senior Technician
74	Shri. R. Vasu	Senior Technician
75	Shri. R. Sunder	Senior Technician
76	Shri. V. Joseph Xavier	Senior Technician
77	Shri. M. Bareen Mohamed	Technician
78	Shri. V. Sitaramacharyulu	Technician
79	Shri. S. Chandrasekharan	Technician
80	Shri. J. Balaji	Technician
MANDAPAM		
81	Shri. Chidambaram P.	Assistant Chief Technical Officer (Library)
82	Dr. V. Mohan	Assistant Chief Technical Officer (Library)

Personel: Technical

No.	Name of Employee	Designation
83	Shri. I. Mendonza Xavier	Senior Technical Officer (Draughtsman)
84	Shri. S. Sekar V. Rayer	Technical Officer (Skin Diver)
85	Shri. A. Vairamani	Technical Officer
86	Shri. A. Gandhi	Technical Officer
87	Shri. N. Bhoominathan	Senior Technical Assistantt
88	Shri. M. Anbarasu	Senior Technical Assistant
89	Shri. Ashok Maharshi	Senior Technical Assistant
90	Shri. G. Hanumantha Rao	Senior Technical Assistant
91	Shri. M. Asokan	Senior Technical Assistant (Painter-cum-Polisher)
92	Smt. Priya K. M.	Technical Assistant (Hindi Translator)
93	Shri. Vijaya Karthikeyan	Senior Technician (Electrician)
94	Shri. M. Palanichamy	Senior Technician (Electrician)
95	Shri. K. Shanmughanathan	Senior Technician
96	Shri. S. Murugaboopathy	Senior Technician
97	Shri. N. Ramakrishnan	Senior Technician
98	Shri. I. Syed Sadiq	Technician
99	Shri. V. Muniasamy	Technician
100	Shri. B. Kathiresan	Technician
101	Shri. K. Muniyasamy	Technician
102	Shri. M. Ganesan	Technician
103	Shri. M. Thayalan	Technician
104	Shri. K. Senthil Kumar	Technician
105	Shri. M. Jayasingh	Techincian
106	Shri. Tinto Thomas	Technician
MANGALORE		
107	Shri. V. Lingappa	Technical Officer
108	Shri. U. Jeyaram	Technical Officer
109	Dr. (Smt.) Veena Shettigar	Technical Officer
110	Shri. C. G. Ulvekar	Senior Technical Assistant
111	Shri. M. Chaniappa	Senior Technical Assistant
112	Shri. P. Harshakumar	Senior Technical Assistant (Motor Driver)
113	Shri. G. D. Nataraja	Senior Technical Assistant
114	Shri. Karamathullah Sahib P.	Senior Technician
MUMBAI		
115	Shri. C. K. Sajeev	Assistant Chief Technical Officer
116	Shri. Nilesh Anil Pawar	Senior Technical Officer
117	Shri. B. B. Chavan	Technical Officer
118	Shri. Baban N. Katkar	Technical Officer
119	Shri. Jayadev S. Hotagi	Technical Officer
120	Shri. Thakurdas	Technical Officer
121	Shri. Bashir Ahmed Adam Shilodar	Technical Officer
122	Shri. S. D. Kamble	Technical Officer
123	Shri. D. G. Jadhav	Technical Officer
124	Shri. Suresh Krishnaro Kamble	Senior Technical Assistant
125	Shri. Sashikant R. Yadav	Senior Technical Assistant (Motor Driver)
126	Shri. Punam Ashok Khandagale	Senior Technical Assistant
127	Shri. Vaibhav Dinkar Mhatre	Senior Technical Assistant
128	Shri. Albert Idu K. A.	Technical Assistant
129	Shri. Umesh Hari Rane	Technical Assistant
130	Shri. Bhangare Sunil Ramachandra	Technician
TUTICORIN		
131	Shri. K. Diwakar	Assistant Chief Technical Officer
132	Shri. P. Muthukrishnan	Technical Officer (Skin Diver)
133	Shri. N. Jesuraj	Technical Officer (Skin Diver)
134	Shri. S. Enasteen	Technical Officer (Deckhand)
135	Shri. S. Mohamed Sathakathullah	Technical Officer
136	Shri. J. Padmanathan	Senior Technical Assistant
137	Shri. K. Ramaswamy	Technical Assistant (Motor Driver)
138	Shri. K. P. Kanthan	Technical Assistant
139	Smt. B. Koncies Mary	Technician
140	Shri. K. Murugan	Technician
141	Shri. S. Willington	Technician
142	Shri. N. Ramaswamy	Technician
VERAVAL R. C		
143	Shri. Suresh Kumar Mojjada	Assistant Chief Technical Officer
144	Shri. Fofandi Mahendra Kumar	Senior Technical Officer
145	Shri. Ladani Amrutlal Arjunbhai	Technical Officer
146	Shri. Polara Jamnadas Premji	Technical Officer
147	Shri. Vanvi Jayaanthilal Dayabhai	Technical Officer
148	Shri. Chudasama Ramji Raja	Senior Technical Assistant
149	Smt. Bharadiya Sangita Aravindkumar	Senior Technical Assistant
150	Shri. H. M. Bhint	Technical Assistant
151	Shri. Solanki Vipulkumar Mulajibhai	Technician
152	Ms. Gohel Jayshree Khimji	Technician
153	Shri. Chudasama Karsan Punja	Technician
154	Shri. Bhatt Bhargav Hareshbhai	Technician
VISAKHAPATNAM R.C		
155	Dr. Phalguni Pattnaik	Assistant Chief Technical Officer
156	Dr. Biswajit Dash	Assistant Chief Technical Officer
157	Dr. Madhumita Das	Assistant Chief Technical Officer
158	Shri. R. V. D. Prabhakar	Technical Officer
159	Shri. T. Nageswara Rao	Technical Officer
160	Shri. P. Venkataramana	Technical Officer
161	Shri. K. Gouri Sankara Rao	Technical Officer (Computer)
162	Shri. K. Lakshminarayana	Senior Technical Assistant (Motor Driver)
163	Shri. Mamidi Satishkumar	Senior Technical Assistant
164	Shri. Narsimhulu Sadhu	Senior Technical Assistant
165	Shri. Balla Vamsi	Technical Assistant
166	Shri. Chinni Babu Bathina	Technical Assistant
167	Shri. Suresh Kumar Pilli	Technical Assistant
168	Shri. Ravi Kumar Avadhanula	Technical Assistant
169	Shri. R. P. Venkatesh	Senior Technician (Fitter)
170	Smt. Sangaru Padmaja Rani	Senior Technician
171	Shri. Durga Suresh Relangi	Senior Technician
172	Shri. D. Bhaskara Rao	Technician

Personel: Technical / Administrative

No.	Name of Employee	Designation
173	Shri. D. Jaganna	Technician
174	Shri. C. H. Moshe	Technician
175	Shri. Jishnudev M. A.	Technician
176	Shri. Panchakarla Nagaraju	Technician
177	Shri. Rachakonda Shivaraju	Technician
VIZHINJAM R.C		
178	Shri. V. A. Leslie	Senior Technical Officer
179	Shri. K. K. Suresh	Senior Technical Officer
180	Shri. Jose Kingsly	Senior Technical Officer
181	Shri. A. Udayakumar	Senior Technical Officer
182	Shri. V. P. Benziger	Technical Officer (Deckhand)
183	Shri. C. Unnikrishnan	Technical Officer
184	Shri. B. Raju	Senior Technical Assistant
185	Shri. Midhunraj N. K.	Technician
CALICUT R.C		
186	Shri. V. A. Kunhikoya	Senior Technical Officer
187	Shri. A. Anasukoya	Technical Officer
188	Shri. N. P. Ramachandran	Senior Technical Assistant
189	Shri. C. Chandran	Senior Technical Assistant
190	Smt. P. Renuka	Technician
191	Shri. Ansar Pokkarakath	Technician
192	Smt. Silpa P. G.	Technician
193	Shri. T. Rajesh Babu	Technician
KARWAR R.C		
194	Shri. Narayan G. Vaidya	Senior Technical Officer
195	Shri. S. Satyanarayan V. Pai	Technical Officer
196	Smt. Sonali S. Mhaddolkar	Senior Technical Assistant
197	Shri. Kodi Srinivasa Rao	Senior Technical Assistant
198	Dr. Praveen Narayan Dube	Technical Assistant
199	Shri. N. Selvakumar	Senior Technician
200	Smt. Pramila Harish Borkar	Technician
KOVALAM F.L		
201	Shri. R. Ponniah	Technical Officer (Electrical)
202	Smt. I. Santhosi	Senior Technician
203	Shri. Abbas A. Muhammed	Technician
204	Shri. Anoob P. Anassery	Technician
ONGOLE F.C		
205	Shri. G. Sudhakar	Technical Officer
206	Shri. S. V. Subba Rao	Senior Technical Assistant
CUDDALORE F.C		
207	Shri. S. Pradeep	Senior Technician
SRIKAKULAM F.C		
208	Shri. Y. V. S. Suryanarayana	Senior Technical Assistant
PURI F.C		
209	Shri. P. K Harikumar	Assistant Chief Technical Officer
210	Shri. M. Kala Mallik	Technician
CONTAI F.C		
211	Shri. Swapan Kumar Kar	Technical Officer

No.	Name of Employee	Designation
212	Shri. Indranil Mukherjee	Technician
NARSAPUR F.C		
213	Shri. S. Tatabhai	Technical Assistant
PATTUKOTTAI F.C		
214	Shri. A. Kumar	Assistant Chief Technical Officer
215	Shri. S. M. Sikkender Batcha	Technician
NAGAPATTINAM F.C		
216	Shri. A. Ramesh	Technician
RATNAGIRI F.C		
217	Shri. D. D. Sawant	Technical Officer
218	Shri. Kishor Raghunath Mainkar	Technical Officer
219	Shri. Prabhakar Sankar Salvi	Senior Technician
BHATKAL F.C		
221	Shri. Udaya V. Arghekar	Technical Officer
222	Shri. Ganesh Bhatkal	Technical Officer
JAMNAGAR F.C		
223	Shri. Makadia B. V.	Technical Officer
224	Shri. Makwana Somapitha	Technician
QUILON F.C		
225	Shri. Paulose Jacob Peter	Technician
KANNUR, Data Collection Point		
226	Shri. Shiju P.	Senior Technician
GOA F.C		
227	Shri. Prakash C. Shetty	Technical Officer
KANYAKUMARI F.C		
228	Shri. P. Rajendran	Senior Technician
ALIBAG F.C		
229	Shri. Shrikrishna Pandurang Hotekar	Technician
230	Shri. M. P. Jadhav	Senior Technician

Administrative

KOCHI		
1	Shri. C. Muralidharan	Chief Administrative Officer
2	Shri. A.V. Joseph	Chief Finance & Accounts Officer
3	Shri. H. Ganesha	Finance & Accounts Officer
4	Shri. Navin Kumar Yadav	Assistant Director (OL)
5	Shri. Thomas Joy	Assistant Finance & Accounts Officer
6	Smt. Meera K. N.	Assistant Administrative Officer
7	Shri. P. V. Devassy	Assistant Administrative Officer
8	Smt. C. M. Jenny	Assistant Administrative Officer
9	Smt. V. K. Sobha	Assistant Administrative Officer
10	Smt. Ponnamma Radhakrishnan	Assistant Administrative Officer
11	Shri. K. Ramadasan	Assistant Administrative Officer
12	Smt. N. R. Lethadevi	Private Secretary
13	Smt. P. Vineetha	Private Secretary

Personel: Administrative

No.	Name of Employee	Designation
14	Smt. Febeena P. A.	Junior Accounts Officer
15	Smt. M. Safiyabi	Assistant
16	Shri. P. P. Chandrasekharan Nair	Assistant
17	Smt. G. Ambika	Assistant
18	Shri. Rishikesh Aandi	Assistant
19	Shri. D. Augustus Julin Raj	Assistant
20	Smt. V. Jayalakshmi	Assistant
21	Smt. Molly Lazer	Assistant
22	Smt. Leela C. A.	Assistant
23	Smt. Manjusha G. Menon	Assistant
24	Smt. Ramya M.	Assistant
25	Smt. Soumya Surendran	Assistant
26	Smt. Sumeena N. K.	Assistant
27	Shri. C. K. Sivadas	Assistant
28	Smt. N. G. Supriya	Assistant
29	Smt. P. K. Mary	Assistant
30	Smt. Binny Cherian	Assistant
31	Smt. Gouri Hareendran	Assistant
32	Shri. K. S. Ajith	Assistant
33	Smt. T. C. Chandrika	Assistant
34	Smt. C. Devaki	Assistant
35	Shri. Roshin Pushpan	Assistant
36	Shri. Sunil A. T.	Assistant
37	Shri. Joseph Mathew	Assistant
38	Shri. C. D. Manoharan	Personal Assistant
39	Smt. P. K. Anitha	Personal Assistant
40	Shri. K. N. Muraly	Personal Assistant
41	Smt. Bindu Sanjeev	Personal Assistant
42	Smt. Smitha K.	Personal Assistant
43	Smt. Saritha L.	Stenographer Grade III
44	Smt. Dhanya M. B.	Stenographer Grade III
45	Smt. Zulekha	Stenographer Grade III
46	Smt Annies Mary Paulose	Upper Division Clerk
47	Shri. T. K. Sumesh	Upper Division Clerk
48	Shri. Sunil Raj K. S.	Upper Division Clerk
49	Smt. Deepa P. N.	Upper Division Clerk
50	Smt. Manju Jose	Upper Division Clerk
51	Shri. Roopesh E. A.	Upper Division Clerk
52	Smt. K. K. Sujatha	Upper Division Clerk
53	Shri. S. Sreekumar	Upper Division Clerk
54	Shri. R. Balakrishnan	Upper Division Clerk
55	Smt. Sreeja N. P.	Lower Division Clerk
56	Smt. Sandhya C. K.	Lower Division Clerk
57	Shri. Rajesh. T. K.	Lower Division Clerk
KVK OF CMFRI		
58	Shri. V. C. Subhash	Assistant
59	Smt. Rincy K. R.	Stenographer Grade III
MADRAS R.C		
60	Shri. Ashish Chobey	Assistant Administrative Officer

No.	Name of Employee	Designation
61	Smt. S. Leelavathi	Private Secretary
62	Shri. S. Yuvarajan	Assistant
63	Shri. A. Yesudhas	Upper Division Clerk
64	Smt. S. Anjalidevi	Lower Division Clerk
65	Shri. S. Maharajan	Lower Division Clerk
MANDAPAM R.C		
66	Shri. C. Jayakanthan	Assistant Administrative Officer
67	Smt. M. Rameswari	Assistant
68	Smt. N. Gomathi	Private Secretary
69	Shri. B. Balasubramanian alias James	Upper Division Clerk
70	Shri. M. Shahul Hameed	Upper Division Clerk
71	Shri. M. Saravanan	Lower Division Clerk
72	Smt. M. Valarmathi	Lower Division Clerk
73	Shri. R. Saravanan	Lower Division Clerk
74	Shri. Upendar Kumar	Assistant
75	Shri. U. Purandhara Shetty	Assistant
MUMBAI R.C		
76	Smt. Ashlesha Ashok Sawant	Assistant
77	Smt. Priyanka Kumari	Assistant
78	Shri. Vinod P. Bhagayatkar	Assistant
MADRAS R.C		
79	Smt. S. Saradha	Assistant
TUTICORIN R.C		
80	Smt. C. Rajeswari	Assistant
81	Smt. T. Mahalakshmi	Assistant
82	Shri. J. Vinoth Prabhu Vaz	Assistant
83	Shri. A. Dickson Jebaraj	Assistant
84	Shri. K. Jerald Raja	Assistant
85	Shri. W. Sathyawan Neelraj	Upper Division Clerk
86	Smt. R. Anantharani	Lower Division Clerk
VERAVAL R.C		
87	Shri. Chandra Mauli Sharma	Assistant Administrative Officer
88	Shri. Vanvi Mansukhlal Madhavji	Assistant
89	Shri. Solanki Mukesh Jesabhai	Lower Division Clerk
90	Shri. Rohit A. Chavda	Lower Division Clerk
91	Shri. Pandya Jatinkumar Jethalal	Lower Division Clerk
VISAKHAPATNAM R.C		
92	Smt. G. Hemlata	Assistant Finance & Accounts Officer
93	Smt. D. Madhavi Latha	Assistant
94	Smt. N. C. Saroja	Assistant
95	Shri. L. Pydi Raju	Upper Division Clerk
VIZHINJAM R.C		
96	Smt. K. Latha	Assistant
97	Smt. Radhika Krishnan G.	Assistant
98	Smt. Kaladevi M. P.	Lower Division Clerk
CALICUT R.C		
99	Shri. R. Sreenivasan	Assistant Administrative Officer

Personel: Administrative / Skilled Support

No.	Name of Employee	Designation
100	Smt. K. Balamani	Assistant
101	Smt. K. P. Shylaja	Assistant
102	Shri. C. P. Umasankar	Upper Division Clerk
DIGHA R.C		
103	Shri. Santosh Kumar	Assistant
KARWAR R.C		
104	Shri. Ratan P. Naik	Lower Division Clerk

Skilled Support

No.	Name of Employee	Designation
KOCHI		
1	Shri. S. Mohanan	Skilled Support Staff
2	Shri. K.C. Rajappan	Skilled Support Staff
3	Smt. A. Latha	Skilled Support Staff
4	Shri. K. G. Jayaprasad	Skilled Support Staff
5	Shri. T. K. Antony	Skilled Support Staff
6	Smt. K. T. Prakasini	Skilled Support Staff
7	Smt. P. K. Usha	Skilled Support Staff
8	Shri. M. D. Suresh	Skilled Support Staff
9	Smt. Usha. S.	Skilled Support Staff
10	Smt. P. K. Sujatha	Skilled Support Staff
11	Shri. M. J. Joseph	Skilled Support Staff
12	Smt. Subaida K. S.	Skilled Support Staff
13	Smt. K. S. Jeeji	Skilled Support Staff
14	Shri. Biju George	Skilled Support Staff
15	Shri. P. M. Gireesh	Skilled Support Staff
16	Smt. T. R. Kumari	Skilled Support Staff
17	Shri. Rajesh P. A.	Skilled Support Staff
18	Smt. Unniresmi C. U.	Skilled Support Staff
19	Shri. Akhil Babu V.	Skilled Support Staff
20	Shri. Vishnu Babu T.	Skilled Support Staff
21	Smt. Rinku Joseph	Skilled Support Staff
22	Smt. Deepa R.	Skilled Support Staff
23	Smt. Vijayalakshmi V. V.	Skilled Support Staff
24	Shri. Kaushik T. R.	Skilled Support Staff
25	Shri. Jitheesh T. D.	Skilled Support Staff
26	Shri. Prashanth P. K.	Skilled Support Staff
27	Shri. Sibin P. Babu	Skilled Support Staff
28	Shri. Ratheesh M.	Skilled Support Staff
29	Ms. Sethulakshmi M.	Skilled Support Staff
30	Shri. Joby P. J.	Skilled Support Staff
31	Shri. Vishnu B.	Skilled Support Staff
32	Smt. Anaswara K. B.	Skilled Support Staff
33	Shri. Pakkri Muthu S.	Skilled Support Staff
34	Smt. Sruthy S.	Skilled Support Staff
35	Smt. Jesli Disilva	Skilled Support Staff
36	Shri. Akhildev S.	Skilled Support Staff
37	Smt. Sreelakshmi S.	Skilled Support Staff
38	Smt. Binitha Babu	Skilled Support Staff
39	Smt. Remya E. A.	Skilled Support Staff
40	Ms. Soumya K.	Skilled Support Staff
41	Shri. Ullas Shankar	Skilled Support Staff
42	Smt. Jinimol K. P.	Skilled Support Staff
43	Smt. Hima P. H.	Skilled Support Staff
44	Smt. Divya K. A.	Skilled Support Staff
45	Smt. Aswathy A. S.	Skilled Support Staff
46	Shri. Eldhose Benny	Skilled Support Staff
47	Shri. Thobias P. Antony	Skilled Support Staff
48	Shri. Vysakhan P.	Skilled Support Staff
49	Shri. Sujith R.	Skilled Support Staff
50	Smt. Marjana P. M.	Skilled Support Staff
51	Smt. Reshma K. S.	Skilled Support Staff
52	Shri. Abilash Velayudhan	Skilled Support Staff
53	Smt. Keerthy Krishna	Skilled Support Staff
54	Ms. Athira T. G.	Skilled Support Staff
55	Smt. Preethy Udayabhanu	Skilled Support Staff
56	Shri. Vipinkumar K. K.	Skilled Support Staff
57	Shri. Jerin V. Jose	Skilled Support Staff
58	Shri. Augustine Sipson N. A.	Skilled Support Staff
59	Shri. Akhil A. R.	Skilled Support Staff
60	Shri. Seban John	Skilled Support Staff
61	Smt. Shajala Banu P. M.	Skilled Support Staff
62	Smt. Emy K. Baby	Skilled Support Staff
63	Shri. M. K. Anilkumar	Skilled Support Staff
64	Smt. Nandana P. R.	Skilled Support Staff
KVK, Narakkal		
65	Shri. Jimosh Mohan C. M.	Skilled Support Staff
66	Shri. Midhun Kumar P. H.	Skilled Support Staff
MADRAS R.C		
67	Shri. P. Selvaraj	Skilled Support Staff
68	Smt. R. Kalaiselvi	Skilled Support Staff
69	Shri. R. Kumaran	Skilled Support Staff
70	Smt. R. Sarojini	Skilled Support Staff
71	Smt. R. Eswari	Skilled Support Staff
72	Smt. P. Prasannakumari	Skilled Support Staff
73	Shri. Midhun Muthayan	Skilled Support Staff
74	Shri. T. Balaraman	Skilled Support Staff
75	Shri. A. Vinoth	Skilled Support Staff
76	Shri. K. Prabhakaran	Skilled Support Staff
77	Shri. Raja Sekar R.	Skilled Support Staff
78	Shri. R. Yuvaraj	Skilled Support Staff
79	Ms. Niranjana A.	Skilled Support Staff
MANDAPAM R.C		
80	Shri. K. Thangavelu	Skilled Support Staff
81	Shri. U. Rajendran	Skilled Support Staff
82	Shri. K. Jeevanandam	Skilled Support Staff
83	Shri. N. Nagamuthu	Skilled Support Staff
84	Smt. Subbulakshmi	Skilled Support Staff

Personel: Skilled Support

No.	Name of Employee	Designation
85	Shri. M. Saravana Kumar	Skilled Support Staff
86	Shri. K. Ganesan	Skilled Support Staff
87	Shri. N. Ramamoorthy	Skilled Support Staff
88	Smt. M. Sharaswathi	Skilled Support Staff
89	Shri. N. Thirupathi	Skilled Support Staff
90	Shri. A. Bose	Skilled Support Staff
91	Shri. K. Narayanan	Skilled Support Staff
92	Smt. M. Muthuvelu	Skilled Support Staff
93	Shri. T. Jothi Manikandan	Skilled Support Staff
94	Smt. S. Sabiya Begam	Skilled Support Staff
95	Shri. Suresh R.	Skilled Support Staff
96	Shri. A. Mohammed Kaleem	Skilled Support Staff
97	Smt. M. Afrin Rani	Skilled Support Staff
98	Shri. J. Ramachandran	Skilled Support Staff
99	Shri. M. Mahalingam	Skilled Support Staff
100	Smt. K. Mathavi	Skilled Support Staff
101	Shri. Ravikumar T.T.	Skilled Support Staff
102	Shri. B. Sravanakumar	Skilled Support Staff
103	Shri. R. Rajkumar	Skilled Support Staff
104	Shri. Aneesh U.	Skilled Support Staff
105	Shri. S. Joseph Jegan	Skilled Support Staff
106	Shri. V. Anand	Skilled Support Staff
107	Shri. K. Chandran	Skilled Support Staff
108	Shri. V. Jayapradeep	Skilled Support Staff
MANGALORE R.C		
109	Shri. Bisun Bhaskar	Skilled Support Staff
110	Shri. S. Mahalinga Naik	Skilled Support Staff
111	Smt. Thanujakshi	Skilled Support Staff
112	Shri. Shrinath B.	Skilled Support Staff
113	Shri. Nagaraj Somayya Gond	Skilled Support Staff
114	Smt. Sathyavathi	Skilled Support Staff
115	Smt. Pushpa K.	Skilled Support Staff
116	Shri. Abdul Hakeem M. M.	Skilled Support Staff
117	Shri. Dharmaraju L. B.	Skilled Support Staff
118	Shri. Sujith Kumar	Skilled Support Staff
119	Shri. Naveen Raju K. G. Naik	Skilled Support Staff
MUMBAI R.C		
120	Shri. K. K. Baikar	Skilled Support Staff
121	Shri. D. D. Jangam	Skilled Support Staff
122	Smt. Urmila S. Balmiki	Skilled Support Staff
123	Shri. Ashish C. S. Chaturvedi	Skilled Support Staff
124	Shri. Vicky Kumar Prajapati	Skilled Support Staff
125	Shri. Suresh	Skilled Support Staff
126	Shri. Mayank Pratap Singh	Skilled Support Staff
127	Shri. Vaibhav Milan Tawde	Skilled Support Staff
128	Shri. Vaibhav Jayant Gharat	Skilled Support Staff
129	Shri. Asharam Choudhary	Skilled Support Staff
130	Shri. Digambar Suresh Kumbhar	Skilled Support Staff
131	Shri. M. Saravanakumar	Skilled Support Staff

No.	Name of Employee	Designation
TUTICORIN R.C		
132	Shri. Santhakumar A.	Skilled Support Staff
133	Shri. S. Alagesan	Skilled Support Staff
134	Shri. I. Ravindran	Skilled Support Staff
135	Shri. S. Mariappan	Skilled Support Staff
136	Shri. M. Soundara Pandian	Skilled Support Staff
137	Shri. M. Kalimuthu	Skilled Support Staff
138	Shri. K. Subramanian	Skilled Support Staff
139	Shri. A. Paul Pondi	Skilled Support Staff
140	Smt. A. Usha Rani	Skilled Support Staff
141	Shri. C.S. Santhanakumar	Skilled Support Staff
142	Shri. K. Krishnan	Skilled Support Staff
143	Shri. K. Anandan	Skilled Support Staff
VERAVAL R.C		
144	Shri. Haridas Khimdas Makwana	Skilled Support Staff
145	Shri. Ladani Dhirajlal Jamnadas	Skilled Support Staff
146	Smt. Santok A. Bharada	Skilled Support Staff
147	Shri. Bhint Mitesh Hiralal	Skilled Support Staff
148	Shri. Chorvadi Kamlesh Kalidas	Skilled Support Staff
149	Shri. Thakar Milan Rajnikant	Skilled Support Staff
150	Shri. Sonara Yogesh Zinabhai	Skilled Support Staff
151	Shri. Mushagra Rajit Hasam	Skilled Support Staff
152	Shri. Gadhiya Noormamad Alibhai	Skilled Support Staff
VISAKHAPATNAM R.C		
153	Shri. D. Lingaraju	Skilled Support Staff
154	Shri. Oggu China Venkateswarlu	Skilled Support Staff
155	Shri. S. Srinivasulu	Skilled Support Staff
156	Shri. R. Pydi Raju	Skilled Support Staff
157	Shri. P. Venkatesh	Skilled Support Staff
158	Shri. Damodara Rao Padumu	Skilled Support Staff
159	Shri. Siram Nookaraju	Skilled Support Staff
160	Shri. Seera Harish	Skilled Support Staff
161	Shri. Potala Bhaskara Rao	Skilled Support Staff
162	Shri. Venkateswarulu Vuyyala	Skilled Support Staff
163	Shri. Yenni Prasad Babu	Skilled Support Staff
164	Shri. P. Shanmukh Deekshit Kumar	Skilled Support Staff
165	Shri. Palli Kalidasu	Skilled Support Staff
166	Shri. B. Babu	Skilled Support Staff
167	Smt. T. Jayakumari	Skilled Support Staff
168	Shri. S. Satheesh Kumar	Skilled Support Staff
169	Smt. Sharanya M. P	Skilled Support Staff
170	Smt. Krishna Priya P. M	Skilled Support Staff
171	Shri. Jithesh P. T.	Skilled Support Staff
172	Smt. Shalini O.	Skilled Support Staff
173	Smt. Nisha S.	Skilled Support Staff
174	Shri. Greever Yoyak V.	Skilled Support Staff
175	Smt. Arathy R. Pillai	Skilled Support Staff

No.	Name of Employee	Designation
CALICUT R.C		
176	Smt. Nishida P.	Skilled Support Staff
177	Shri. P. Dasan	Skilled Support Staff
178	Shri. M. K. Chandran	Skilled Support Staff
179	Shri. P. Satheeshkumar	Skilled Support Staff
180	Shri. M. P. Devadasan	Skilled Support Staff
181	Shri. P. V. Gopalan	Skilled Support Staff
182	Shri. P. B. Jeevaraj	Skilled Support Staff
183	Shri. Rajendran V.	Skilled Support Staff
184	Smt. Vijisha M.	Skilled Support Staff
185	Shri. Anoop K. G.	Skilled Support Staff
186	Shri. Anirudh K.	Skilled Support Staff
KARWAR R.C		
187	Shri. Subhash K. Naik	Skilled Support Staff
188	Shri. Ramakant Shankar Harikantra	Skilled Support Staff
189	Smt. Nandini Mayekar	Skilled Support Staff
190	Shri. T. P. Renilkumar	Skilled Support Staff
191	Ms. Pooja Mahabaleswar Gajinkar	Skilled Support Staff
192	Shri. Suraj Surendra Kalgutkar	Skilled Support Staff
193	Shri. Vineeth T.	Skilled Support Staff
194	Ms. Veena Ulhas Kamble	Skilled Support Staff
195	Shri. Ravichandra Angadi	Skilled Support Staff
196	Shri. Manoj Rajendra Hulaswar	Skilled Support Staff
197	Smt. Vijayalaxmi Y. Gamanagatti	Skilled Support Staff

Research Projects

In-house

Sl. No	Project Code	Title of the Project	PI of the Project & Division	Co-PIs	Duration
1	FRA/GIS/01	Geo-referenced online information system for marine fisheries on GIS platform to formulate management strategies for sustainable harvest of resources	Dr. T.V. Sathianandan FRAD	Dr. J. Jayasankar Dr. Somy Kuriakose Dr. Mini K.G. Dr. Grinson George Shri Vinaya Kumar Vase Shri Vivekanad Bharti Dr. Eldho Varghese Shri Wilson T. Mathew	2017-2024
2	FRA/CHL/02	Chlorophyll based Remote sensing assisted Indian marine Fisheries Forecasting System (ChloRIFFS)	Dr. J. Jayasankar FRAD	Dr. T.V. Sathianandan Dr. Prathibha Rohit Dr. Somy Kuriakose Dr. Mini K.G. Dr. R. Jeyabaskaran Dr. Grinson George Dr. Eldho Varghese Shri Vinaya Kumar Vase Dr. Amir Kumar Samal Shri Vivekanad Bharti	2017-2020
3	PEL/RMS/03	Resource assessment and management framework for sustaining marine fisheries of Karnataka and Goa	Dr. Prathibha Rohit PFD	Dr. A.P. Dineshbabu Dr. Sujitha Thomas Dr. Geetha Sasikumar Dr. Rajesh K. M. Dr. Bindu Sulochanan Dr. Purushottama G. B. Smt Divya Viswambharan Dr. Mini K.G. Dr. Swathilekshmi P.S. Dr. P. Shinoj	2017-2024
4	PEL/LPR/04	National fishery management framework for large pelagic resource	Dr. E. M. Abdussamad PFD	Shri K. P. Said Koya Dr. Prathibha Rohit Dr. M. Sivadas Dr. A. Margaret Muthu Rathinam Dr. U. Ganga Dr. Shubhadeep Ghosh Dr. Rajesh K. M. Shri K. Mohammed Koya Dr. Anulekshmi Chellappan Smt Surya S. Shri Nakhawa Ajay Dayaram	2017-2020

Research Projects: In-house

Sl. No	Project Code	Title of the Project	PI of the Project & Division	Co-PIs	Duration
				Shri Subal Kumar Roul Shri Abdul Azeez P. Shri Vinoth Kumar R. Smt Shikha Rahangdale Shri Manas K. M. Dr. Mini K.G.	
5	PEL/LAK/06	Resource assessment and management framework for sustaining marine fisheries of Lakshadweep	Shri K. Mohamed Koya PFD	Dr. Rajesh K. M Shri P. G. Ambarish Shri K. P. Said Koya Shri Subal Kumar Roul Shri Abdul Azeez P Smt Surya S Dr. Prathibha Rohit Dr. E. M. Abdussamad Dr. M. Sivadas Dr. P Shinoj Shri Vivekanad Bharti Dr. Swathilekshmi P.S. Dr. Sreenath K. R. Dr. U. Ganga Smt Remya Raj	2017-2020
6	DEM/RMS/07	Resource assessment and management framework for sustaining marine fisheries of Kerala	Dr. T. M. Najmudeen DFD	Dr. P. U. Zacharia Dr. Rekha J. Nair Dr. Livi Wilson Shri P. G. Ambarish Dr. Mahesh V Dr. E. M. Abdussamad Dr. U. Ganga Shri Subal Kumar Roul Shri K. P. Said Koya Smt Surya S Dr. G. Maheswarudu Dr. Josileen Jose Dr. S. Lakshmi Pillai Dr. Rekha Devi Chakraborty Dr. K. N. Saleela Dr. V. Venkatesan Dr. R. Vidya Dr. P. K. Asokan Dr. P. Gomathi Dr. V. Kripa Dr. D. Prema Dr. Shelton Padua Dr. Somy Kuriakose Dr. N. Aswathy Dr. Anil M. K. Shri K. Mohamed Koya	2017-2024
	DEM/RMS/SUB/07	Monitoring and assessment of juvenile fishery along the coast of Kerala	Dr. T. M. Najmudeen DFD	Dr. P. U. Zacharia Dr. T. V. Sathianandan Dr. S. Lakshmi Pillai Smt Livi Wilson	2017-2020

Research Projects: In-house

Sl. No	Project Code	Title of the Project	PI of the Project & Division	Co-PIs	Duration
				Dr. V. Venkatesan Dr. Mahesh V. Shri P. G. Ambarish Dr. K. N. Saleela Shri Subal Kumar Roul Dr. Shyam S. Salim Dr. K. N. Saleela Dr. V. Venkatesan Dr. R. Vidya Dr. P. K. Asokan Dr. P. Gomathi Dr. V. Kripa Dr. D. Prema Dr. Shelton Padua Dr. Somy Kuriakose Dr. N. Aswathy Dr. Anil M. K. Shri K. Mohamed Koya	
7	PEL/RMS/08	Resource assessment and management framework for sustaining marine fisheries of Tamilnadu and Puducherry	Dr. M. Sivadas PFD	Dr. Shoba Joe Kizhakkudan Dr. A. Margaret Muthu Rathinam Dr. P. T Sarada Ms. E. M. Chhandaprajnadarsini Dr. P. P Manoj Kumar Dr. I. Jagadis Ms. M. Kavitha Smt Shikha Rahangdale Shri Rajan Kumar Shri Vinoth Kumar R. Smt Remya L. Shri M. Rajkumar Dr. K. N. Saleela Dr. R. Narayanakumar Dr. Grinson George	2017-2024
8	DEM/RMS/09	Resource assessment and management framework for sustaining marine fisheries of Gujarat	Shri. Vinaya kumar vase FRAD	Smt Shikha Rahangdale Shri Abdul Azeez P. Shri Rajan Kumar Dr. Kapil S Sukhdhane Shri Tarachand Kumawat	2017-2022
9	DEM/RMS/10	Resource assessment and management framework for sustaining marine fisheries of Andhra Pradesh	Smt M. Muktha DFD	Dr. Shubhadeep Ghosh Dr. Indira Divipala Ms Jasmin F. Shri Loveson Edward L. Dr. S. S. Raju Shri Manas K. M. Dr. Eldho Varghese	2017-2024
10	DEM/ELS/11	Developing management plans for sustainable exploitation and conservation of elasmobranchs in India	Dr. Shoba Joe Kizhakudan DFD	Dr. Sujitha Thomas Dr. P. U. Zacharia Dr. P. P. Manoj Kumar Dr. Rekha J Nair Dr. T. M. Najmudeen	2017-2020

Research Projects: In-house

Sl. No	Project Code	Title of the Project	PI of the Project & Division	Co-PIs	Duration
				Smt Muktha Menon Dr. G. B. Purushothama Dr. Swatipriyanka Sen Dr. K. V. Akhilesh Smt Remya L Smt. Livi Wilson Shri P. G. Ambarish Dr. V. Mahesh Dr. Shikha Rahangdale Shri Subal Kumar Roul Dr. Shyam. S. Salim Dr. Rajesh Kumar Pradhan	
	DEM/ ELS/SUB/11	Assessing the status of elasmobranchs protected under the Indian Wildlife (Protection) Act 1972	Dr. K. V. Akhilesh DFD	Dr. Shoba Joe Kizhakudan Dr. Sujitha Thomas Dr. P. U. Zacharia Dr. P. P. Manoj Kumar Dr. Rekha J Nair Dr. T. M. Najmudeen Smt Muktha Menon Dr. G. B. Purushothama Dr. Swatipriyanka Sen Dr. K.V. Akhilesh Smt Remya L. Smt Livi Wilson Shri P. G. Ambarish Dr. V. Mahesh Dr. Shyam. S. Salim Shri Rajesh Kumar Pradhan	2017-2020
11	CFD/BPT/12	Development of guidelines for "Best practices" for trawl fishery in India	Dr. A.P. Dineshbabu CFD	Dr. Sujitha Thomas Dr. Anulekshmi Chellappan Dr. Indira Divipala Dr. Shubhadeep Ghosh Dr. Gyanranjan Dash Dr. Swathipriyanka Sen Shri. Rajesh Kumar Pradhan Dr. K. V. Akhilesh Shri R. Ratheeshkumar Shri Nakhawa Ajay Dayaram Dr. K. M Rajesh Dr. Purushottama G. B. Dr. Mahesh V. Dr. G. Maheswarudu Dr. Josileen Jose Dr. S. Lakshmi Pillai Dr. Rekha Devi Chakraborty Dr. Najmudeen T. M Shri Rajkumar M. Shri Rajan Kumar Dr. P. T. Sarada Dr. Sivadas M. Dr. Shoba Joe Kizhakudan	2017-2020

Research Projects: In-house

Sl. No	Project Code	Title of the Project	PI of the Project & Division	Co-PIs	Duration
				Smt. Shikha Rahandgale Dr. R. Narayanakumar Dr. Swathilekshmi P. S.	
12	CFD/RMS/13	Resource assessment and management framework for sustaining marine fisheries of Maharashtra	Dr. V. V. Singh FEMD	Dr. Anulekshmi Chellappan Dr. Ramkumar S. Dr. Akhilesh K. V. Shri R. Ratheesh Kumar Shri Nakhawa Ajay Dayaram Shri Santhosh N. Bhendekar Dr. Somy Kuriakose Dr. Shyam S. Salim	2017-2024
13	CFD/REC/14	Implications of recruitment dynamics and spatio-temporal stock assessment of marine prawns of India for fisheries management	Dr. P. T. Sarada CFD	Dr. G. Maheswarudu Dr. S. Lakshmi Pillai Dr. Rekha Devi Chakraborty Dr. K. N. Saleela Dr. A. P. Dineshbabu Shri. R. Ratheesh Kumar Dr. Gyanranjan Dash Dr. Indira Divipala Shri. Rajkumar M. Shri. Rajan Kumar	2017-2020
	CFD/REC/SUB/14	Investigations on commercial lobster fishing and live lobster trade in India	Dr. K. N. Saleela CFD	Dr. P. T. Sarada Dr. Rekha Devi Chakraborty Dr. Gyanranjan Dash Shri. R. Ratheesh Kumar Shri. Rajkumar M Shri. Rajan Kumar	2017-2020
14	MFD/BIV/15	Fishery Management Plans (FMPs) and recruitment dynamics of bivalves	Dr. Geetha Sasikumar MFD	Dr. K. S. Mohamed Dr. P. K. Asokan Dr. I. Jagadis Dr. V. Venkatesan Dr. Vidya R. Smt Jasmin F. Smt Kavitha M. Smt E. M. Chhandapranjandarsini Smt. P. Gomathi Shri Bhandekar Santhosh Nagnath	2017-2024
15	MFD/GTR/16	Assessment of ornamental gastropod fisheries and studies on the shellcraft industry in India	Dr. I. Jagadis MFD	Dr. V. Venkatesan Dr. Shyam S. Salim Smt Kavitha M Smt Jasmin F Smt E. M. Chhandaprajnadarsini Shri Rajesh Kumar Pradhan	2017-2020
16	MFD/MOL/17	Popularising eco-friendly molluscan farming strategies	Dr. P. K. Asokan MFD	Dr. K. S. Mohamed Dr. I. Jagadis Dr. M. K. Anil Dr. Geetha Sasikumar Dr. V. Kripa	2017-2024

Research Projects: In-house

Sl. No	Project Code	Title of the Project	PI of the Project & Division	Co-PIs	Duration
				Dr. P. Kaladharan Dr. Vipinkumar V. P. Dr. R. Vidya Dr. Jeena N. S. Shri Santosh Nagnath Bhendekar Smt E. M. Chhandaprajnadarsini Smt Kavitha M Shri Rajesh Kumar Pradhan	
17	MDN/HCY/18	Development of hatchery technologies for commercially important species in mariculture	Dr. A. K. Abdul Nazar MCD	Dr. Imelda Joseph Dr. K. Madhu Dr. Rema Madhu Dr. Gulshad Mohammed Dr. Boby Ignatius Dr. Shoji Joseph Dr. Joe K. Kizhakudan Dr. B. Santhosh Dr. Jayasree Loka Dr. R. Jayakumar Dr. T. Senthil Murugan Dr. G. Tamilmani Dr. Sureshbabu P.P. Dr. M. Sakthivel Dr. Ritesh Ranjan Shri C. Kalidas Dr. P. Rameshkumar Dr. Biji Xavier Shri. Rajesh N. Dr. D. Divu Dr. Amir Kumar Samal Dr. Sekar Megarajan Dr. Anikuttan K. K Smt Shilta M.T. Shri M. Sankar Shri S. Chandrasekhar Shri Sanal Ebeneezar	2017-2024
18	MDN/CGE/19	Innovations in sea cage farming & coastal mariculture	Dr. Imelda Joseph MCD	Dr. Jayasree Loka Dr. T. Senthil Murugan Smt. Saloni Shivam Shri K. Reghu Ramudu Dr. A. K. Abdul Nazar Dr. Jayakumar R. Dr. G. Tamilmani Dr. P. Rameshkumar Dr. M. Shaktivel Dr. B. Johnson Dr. Anikuttan K. K. Dr. Amir Kumar Samal Shri M. Sankar Dr. Ritesh Ranjan Dr. Biji Xavier	2017-2020

Research Projects: In-house

Sl. No	Project Code	Title of the Project	PI of the Project & Division	Co-PIs	Duration
				Dr. Sekar Megarajan Shri D. Linga Prabu Dr. K. Madhu Dr. Rema Madhu Dr. Boby Ignatius Dr. Shoji Joseph Shri. Rajesh N. Dr. N. Aswathy Shri Anuraj K Dr. A. P. Dinesh Babu Dr. Sujitha Thomas Dr. Joe K. Kizhakudan Dr. Divu D. Shri Vinaya Kumar Vase Dr. Gulshad Mohammed Dr. Sureshbabu P. P. Smt Shilta M.T Dr. P. P. Manoj Kumar Shri. C. Kalidas Dr. Santhosh B. Dr. M.K. Anil	
19	MDN/REP/20	Analysis of reproductive characteristics of selected potential species for mariculture	Dr. Imelda Joseph MCD	Dr. Shoji Joseph Dr. Boby Ignatius Dr. B. Santhosh Dr. Suresh Babu P.P. Dr. Jayasree Loka Dr. A. K. Abdul Nazar Dr. Anikuttan K. K. Dr. M. Sakthivel Dr. G. Tamilmani Smt. Muktha Menon Shri. Rajesh N Smt Shilta M. T.	2017-2020
20	MDM/FAD/21	Assessing the performance of artificial reefs deployed along north Tamil Nadu coast	Dr. Joe K. Kizhakudan MCD	Dr. P. Laxmilatha Dr. R. Narayanakumar Dr. Shoba Joe. Kizhakudan	2017-2020
21	MDN/GRO/22	Delineating the compensatory growth pattern in stunted fingerlings of marine finfishes for production enhancement	Dr. Suresh Babu P. P. MCD	Dr. Imelda Joseph Dr. Boby Ignatius Dr. R. Jayakumar Smt Shilta M. T Dr. P. Shinoj Dr. A K Abdul Nazar Dr. Anikuttan K. K. Shri M. Shankar Shri Anuraj A	2017-2020
22	MBT/HLT/23	Health management in selected finfish and shellfish & bio-prospecting from marine resources	Dr. N. K. Sanil MBTD	Dr. Sandhya Sukumaran Dr. Pradeep M. A Dr. P. K. Asokan Dr. S. R. Krupesha Sharma Dr. M. K. Anil	2017-2020

Research Projects: In-house

Sl. No	Project Code	Title of the Project	PI of the Project & Division	Co-PIs	Duration
				Dr. Joe K. Kizhakudan Dr. Ritesh Ranjan Dr. Rameshkumar P. Smt Reshma K. J. Dr. Sumithra T. G. Ms. Saloni Shivam S. Smt Saima Rehman Shri Reghu Ramudu Dr. Jayasree Loka	
	MBT/HLT/SUB23	Development of bioactive pharmacophores from marine organisms	Dr. Kajal Chakraborty MBTD	Nil	2017-2020
23	MBT/NTM/24	Marine food fish, ornamental fish and lobster nutrition research for mariculture	Dr. P. Vijayagopal MBTD	Dr. Boby Ignatius Dr. Joe K. Kizhakudan Dr. C. P. Suja Dr. Vidya Jayasankar Dr. Kajal Chakraborty Shri Kalidas C. Shri D. Linga Prabu Shri Chandrasekar S. Shri Sanal Ebeneezar Shri Adnan Hussain Gora Smt Reshma K. J. Dr. Sumithra T. G	2017-2020
24	MBT/GEN/25	Genetic and genomic approaches for fishery resource management, conservation and sustainable mariculture	Dr. Sandhya Sukumaran MBTD	Dr. A. Gopalakrishnan Shri Srinivasa Raghavan V. Dr. Jeena N. S. Dr. Sekar Megarajan	2017-2020
25	MBT/TSU/26	Biomineralisation of mantle tissue from pearl producing molluscs	Dr. C. P. Suja MBTD	Dr. Vidya Jayasankar Shri Srinivasa Raghavan V.	2017-2018
26	FEM/HBT/27	Micro-level environmental management plans for selected critical habitats for ecosystem health and sustainable production	Dr. D. Prema FEMD	Dr. V. Kripa Dr. Shelton Padua Dr. R. Jeyabaskaran Dr. K. Vijayakumaran Dr. V. V. Singh Dr. Reeta Jayasankar Dr. Asha P. S. Dr. Bindu Sulochanan Shri Loveson Edward Shri K. S. Sukhdhane Shri Thirumalaiselvan S. Smt Ramya Abhijith Dr. R. Narayanakumar Dr. K. Sunil Kumar Mohamed Dr. P. Kaladharan	2017-2020
	FEM/HBT/SUB/27	Impact of climate extremes and disasters on ecosystem functioning with special emphasis on fisheries and mariculture	Dr. V. Kripa FEMD	Dr. K Sunil Kumar Mohamed Dr. D Prema Dr. R Jayabaskaran Dr. Shelton Padua	2017-2020

Research Projects: In-house

Sl. No	Project Code	Title of the Project	PI of the Project & Division	Co-PIs	Duration
27	FEM/PLN/28	Abatement of coastal pollution through bioremediation	Dr. Reeta Jayasankar FEMD	Dr. D. Prema Dr. P. Kaladharan Dr. K. Vijayakumaran Dr. V. V. Singh Dr. Asha P. S. Dr. Bindu Sulochanan	2017-2020
				Shri Loveson Edward Shri K. S. Sukhdhane Shri Thirumalaiselvan S.	
	FEM/PLN/SUB/28	Assessment of coastal and marine pollution in selected maritime states of India	Dr. P. S. Asha FEMD	Dr. D. Prema Dr. R. Jeyabaskaran Dr. Bindu Sulochanan Shri Loveson Edward Shri K. S. Sukhdhane Dr. Shelton Padua Shri Thirumalaiselvan S. Smt Ramya Abhijith	2017-2020
28	FEM/MPH/29	Marine macrophytes in India-resources dynamics & ecosystem services	Dr. P. Kaladharan FEMD	Dr. R. Narayanakumar Dr. R. Jeyabaskaran Dr. K. Vijayakumaran Dr. B. Johnson Shri Thirumalaiselvan S. Shri K. S. Sukhdhane Smt Remya Abhijith Dr. Reeta Jayasankar Shri Loveson Edward	2017-2020
29	MBD/CNS/30	Developing conservation plan for biologically sensitive areas along the Indian coast	Dr. K. Vinod MBD	Dr. K. K. Joshi Dr. R. Narayanakumar Dr. Molly Varghese Dr. S. Jasmine Dr. K. S. Sobhana Dr. Miriam Paul Sreeram Dr. K. R. Sreenath Shri Saravanan R Shri L. Renjith Shri S. Ramkumar Dr. Pralaya Renjan Behera Dr. Divya Viswambharan Shri Tarachand Kumawat	2017-2020
30	MBD/CRL/31	Assessment of resilience potential of coral reefs	Dr. K. R. Sreenath MBD	Dr. K. K. Joshi Dr. S. Jasmine Dr. P. Laxmilatha Dr. K. S. Sobhana Dr. Molly Varghese Dr. K. Vinod Dr. Miriam Paul Sreeram Shri Saravanan R Shri L. Renjith Shri S. Ramkumar	2017-2024

Research Projects: In-house

Sl. No	Project Code	Title of the Project	PI of the Project & Division	Co-PIs	Duration
				Dr. Pralaya Renjan Behera Dr. Divya Viswambharan Shri Tarachand Kumawat Shri. K. Mohammed Koya	
31	MBD/JLY/32	Investigations on the scyphozoan and cubozoan jellyfishes diversity and distribution along the Indian coast	Dr. Saravanan R MBD	Dr. S. Jasmine Dr. P. Laxmilatha Dr. K. Vinod Dr. K. S. Sobhana Dr. Miriam Paul Sreeram Dr. K. R. Sreenath Shri Tarachand Kumawat Shri L. Renjith Dr. Divya Viswambharan Dr. Pralaya Renjan Behera Shri S. Ramkumar	2017-2020
32	SEE/SOC/33	Socio-economic assessment of marine fisheries resource use and management in India	Dr. R. Narayanakumar SEETTD	Dr. S. S. Raju Dr. C. Ramachandran Dr. Shyam S. Salim Dr. P. S. Swathilekshmi Dr. N. Aswathy Dr. B. Johnson Dr. P. Shinoj	2017-2024
33	SEE/GOV/34	Responsible marine fisheries governance: compliance analysis and peripatetic capacity development	Dr. C. Ramachandran SEETTD	Dr. P. Shinoj Dr. S. S. Raju Dr. V. P. Vipinkumar Dr. B. Johnson Shri Tarachand Kumawat	2017-2020
	SEE/GOV/SUB/34	A study on compliance to fishery regulations along the Indian coastline	Dr. P. Shinoj SEETTD	Dr. C. Ramachandran Dr. S.S. Raju Dr. V. P. Vipinkumar Dr. B. Johnson Shri Tarachand Kumawat	2017-2020
34	SEE/DCD/35	Marine fish distribution and consumption demand in India : a policy outlook	Dr. Shyam S. Salim SEETTD	Dr. R. Narayanakumar Dr. V. P. Vipinkumar Dr. S. S. Raju Dr. P. S. Swathilekshmi Dr. Swatipriyanka Sen Dash Dr. T. V. Sathianandan	2017-2024
35	SEE/GEN/36	Alternate livelihood options and gender mainstreaming for entrepreneurship development in marine fisheries sector of India	Dr. P. S. Swathilekshm SEETTD	Dr. R. Narayanakumar Dr. V. P. Vipinkumar Dr. Shyam S. Salim Dr. Reeta Jayasankar Dr. B. Johnson Dr. Nikita Gopal (CIFT)	2017-2020
	SEE/GEN/SUB/36	Mainstreaming the gender perspective of SHGs in Indian fisheries sector	Dr. V. P. Vipinkumar SEETTD	Dr. R. Narayanakumar Dr. P. S. Swathilekshmi Dr. Shyam. S. Salim Dr. Reeta Jayasankar Dr. C. Ramachandran Dr. N. Aswathy	2017-2020
36	MBT/DNA/37	Environmental DNA (eDNA) metabarcoding – based estimation of marine stocks	Dr. P. Jayasankar MBTD	Dr. Mini K. G. Dr. Pradeep M. A.	2017-2019

Research Projects

Externally funded

Sl. No.	Title of the project	Principal Investigator	Funding Agency	Duration	Total cost (₹ lakhs)
1.	National Initiative on Climate Resilient Agriculture (NICRA)	Dr. P. U. Zacharia	DARE- ICAR	2012-2017	249.00
2.	Seed Production of Marine Food Fishes and Ornamental Fishes	Dr. K. Madhu	ICAR- Revolving Fund	2012-2017	2570.37
3.	Outreach activity on fish genetic stocks	Dr. A. Gopalakrishnan	ICAR Outreach	2012-2017	100.00
4.	Consortium Research Platform (CRP) on Vaccines and Diagnostics	Dr. N. K. Sanil	ICAR	2012-2017	363.16
5.	Nutrient profiling and evaluation of fish as a dietary component	Dr. Kajal Chakraborty	ICAR-Outreach	2012-2019	100.00
6.	Global learning for local solution: Reducing vulnerability of marine dependent coastal communities	Dr. A. Gopalakrishnan	Belmont Forum through MoES	2013-2018	165.75
7.	National Surveillance Programme for aquatic animal diseases	Shri N. K. Sanil	NFDB	2013-2018	122.01
8.	Remote sensing & GIS for ecosystem based marine living resources management	Dr. A. P. Dinesh Babu	SAC	2015- 2018	20.00
9.	Genetic tagging of spawning populations of Indian oil sardine, Sardinella longiceps along south west coast of India using microsatellite markers	Dr. Sandhya Sukumaran	KSCSTE	2015-2017	24.50
10.	Derivation and characterisation of embryonic stem (ES) cell lines from the marine ornamental maroon clown fish Premnas biaculeatus and induced pluripotent stem (iPS) cell lines from the humpback grouper Chromileptes altivelis	Dr. K. S. Sobhana	DBT	2015-2018	64.30
11.	Molecular taxonomy and phylogeny of Cones (Cone snails) and Strombs (Mollusca, Gastropoda) of the Indian coast	Dr. P. Laxmilatha	DBT	2015-2018	58.53
12.	Modelling biogeochemical cycles in coastal oceans	Dr. Vinaya Kumar Vase	SAC	2015-2018	19.14
13.	DBT Sponsored National Training Programme on molecular biology and biotechnology for fisheries professionals	Dr. P. Vijayagopal	DBT	2015-2018	48.25
14.	Advanced phytoplankton cultivation method for hatchery feed, with special emphasis on mussel seed production	Dr. M. K. Anil	KSCSTE	2016-2017	10.00
15.	Impact, Vulnerability and Adaptation Strategies for marine fisheries of India	Dr. A. Gopalakrishnan	NATCOM	2016-2018	25.30
16.	ICAR Consortium Research Platform (CRP) on Health Food: Development of nutraceuticals supplements from marine molluscs, macro-algae and shrimps	Dr. Kajal Chakraborty	ICAR	2016-2020	294.00

Sl. No.	Title of the project	Principal Investigator	Funding Agency	Duration	Total cost (₹ lakhs)
17.	Enhancing production of farmed silver pompano (Trachimotus blochii) through the establishment of broodbank, hatcheries, nursery units and farms at selected locations	Dr. M. K. Anil	NFDB	2016-2020	843.00
18.	Enhancing production of farmed cobia (Rachycentron canadum) through the establishment of broodbank, hatcheries, nursery units and farms at selected locations	Dr. A. K. Abdul Nazar	NFDB	2016-2020	813.80
19.	Biodiversity and valuation of ecosystem services of the Kadalundi–Vallikunnu Community Reserve, Kerala, India	Dr. K. Vinod	KSBB	2017-2018	9.00
20.	Piloting and upscaling of PAN India Fisher Mobile Application in Karnataka	Dr. Prathbha Rohit	MSSRF	2017-2018	6.00
21.	Bivalve farming	Dr. P. Laxmilatha	CDRP-FIMSUL	2017-2018	45.12
22.	Estimation of marine fish landings in Tamil Nadu with enhanced sampling coverage	Dr J. Jayasankar	CDRP-FIMSUL	2017-2018	98.00
23.	Identification, forecasting and monitoring of potential fishing zone for Tamil Nadu coastal and offshore waters (SAMUDRA TDP R&D)	Dr. Shoba Joe Kizhakudan	SAC-ISRO	2017-2019	33.70
24.	AINP on Fish Health	Dr. N. K. Sanil	ICAR	2017-2020	51.00
25.	AINP on Mariculture	Dr. Boby Ignatius	ICAR	2017-2020	1025.00
26.	A Model for the Primary Production in Indian Coastal Waters	Dr. Grinson George	DST	2017-2020	48.26
27.	Development of small molecular weight angiotensin II converting enzyme inhabitors from marine organisms	Dr. Kajal Chakraborty	DBT	2017-2020	54.00

Research Projects

Consultancy

Sl. No.	Client	Project	PI	Status	Cost (₹ lakhs)
1	Dept. of Fisheries, Govt. of Tamil Nadu	Installation of artificial reefs in the inshore waters of seventeen villages along Tamil Nadu coast	Scientist-in- Charge, Chennai RC	Progressing	260.8
2	The Project Director, International Fund for Agricultural Development (IFAD) assisted Post-Tsunami Sustainable Livelihood Programme (PTSLP) Tamil Nadu Corporation for development of Women, Chennai.	Consultancy on livelihood enhancement of fishermen through deployment of AR in inshore waters along the six districts of TN	Dr. Joe K. Kizhakudan	Progressing	92.98
3	M/s JSW Infrastructure Limited, JSW Centre, Bandra Kurla Complex, Bandra (East),Mumbai	Assessment of impact on fish production due to development of all-weather captive jetty at Nandgaon, Maharashtra	Dr. V. V. Singh	Progressing	68.58
4	Commissioner of Fisheries Third Floor, Block No.10, Jivraj Mehta Bhavan, Gandhi Nagar, Gujarat	Artificial fish habitat based marine ecosystem restoration in the inshore areas off Bhadreshswar, Kutch District, Gujarat.	Dr. K. R. Sreenath	Launching	359.37
5	Chief Executive Officer, Dept. of Fisheries, UT of Lakshadweep, Kavaratti–682 555	Setting up of Modern Aquarium at Dept. of Fisheries, UT of Lakshadweep, Kavaratti.	Dr. M. K. Anil	Progressing	54.7
6	M/s JSW Jaigarh Port Limited, JSW Centre, Bandra Kurla Complex, Mumbai – 400 051	Assessment of impact on fish production due to development of the Jaigarh Port at Village Jaigarh, Maharashtra,	Dr. V. V. Singh	Progressing	49.91
7	MRPL, Mangalore	Seawater and treated effluent monitoring of M/s MRPL	Dr. Prathibha Rohit	Progressing	13.34
8	Jawaharlal Nehru Port Trust, Mumbai	Impact study of proposed Vadhavan Port on coastal fisheries	Dr. Anulakshmi Chellappan	Progressing	94.08
9	M/s IntensAquatica Total Private Ltd. No. 221Y, 2nd Main, 1st Floor 4th Phase, 7th Block, Banashankari 3rd Stage, Bangalore – 560085,	Technology support for seed production of orange spotted grouper, *Epinephelus coioides*	Dr. Ritesh Ranjan	Progressing	6.62
10	Adani foundation, Mundra, Kutch	Empowerment of the Pagadia fishermen of the Sekhadiya Village (Juna Bunder), Kutch District, Gujarat through sustainable marine cage farming	Dr. D. Divu	Progressing	10.0
				TOTAL	1010.38

Research Management & Staff Welfare

37

In-house research projects, 29 Externally funded research projects worth INR 73 crores and 10 Consultancy projects worth INR 10 crores in operation

Research Advisory Committee (RAC)

The 22nd RAC meeting was held in the Committee Room of CMFRI, Cochin from 15 – 16 March, 2018. The meeting was attended by,

Prof. Dr. N.R. Menon, Co-Chairman, Board of Directors, Nansen Environmental Research Centre (India), Chairman
Dr. A.R. Thirunavukkarasu, Principal Scientist (Retd.), CIBA, Chennai, Member
Dr. Madan Mohan, ADG (Marine Fisheries, Retd.) ICAR, New Delhi & Director of Fisheries, Punjab, Member
Dr. S. K. Chakraborty, Principal Scientist (Retd.), CIFE, Mumbai, Member
Dr. V. N. Sanjeevan, former Director Centre for Marine Living Resources, Kochi, Member
Dr. Pravin Puthra, ADG (Marine Fisheries), ICAR, New Delhi, Member
Dr. A. Gopalakrishnan, Director, CMFRI, Member
Dr. P. Vijayagopal, Head in Charge & Principal Scientist, MBTD, CMFRI, Kochi, Member Secretary

Director, **Dr. Gopalakrishnan** welcomed the chairman and all the members of RAC, Heads of various divisions and Scientists in charge of different regional and research Centre's of CMFRI. He expressed happiness for receiving the letter from ICAR, handing over the administrative control of KVK in Lakshadweep to CMFRI. He thanked Dr. Menon for being instrumental in CMFRI bagging the DST Splice project and also for raising fund (4000 Euros) for Safari 2 in discussion with Dr. Ola Johansson. While presenting the salient achievements of the Institute for the previous year (2017-18), he said that the Institute has 37 in house, 29 externally funded and 17 consultancy projects. He also mentioned that a common meeting of the southern states of India (from Goa to Andhra Pradesh) under the leadership of the honorable minister for Fisheries, Harbour Engineering

Research Management & Staff Welfare

and Cashew Industry, Smt. Mercy Kutty Amma will be held soon, to decide on the Minimum Legal Size for fishes. He informed that three prioritised species in mariculture were successfully bred in captivity *Epinephelus coioides, Trachinotus mookalee* and *Pseudanthias marcia*. Three manuscripts accepted in the journal *Aquaculture*. The research achievements of different divisions were highlighted which he said will be presented in detail by the respective Heads of Divisions. He also enlightened the members about the staff strength of the Institute and the several publications/products that were brought out during the period.

Dr. Praveen informed that the ICAR is in the process of grading institutes as excellent, average and bad. The NAARM is working out the criteria for grading. RAC has a major role to play in the research activities of the institutes. The action taken report of the 21st RAC was presented by the member secretary Dr. Vijayagopal which was followed by presentations by the Heads of various divisions.

Recommendations of the 21st RAC

1. Bring out more user friendly mobile apps for stakeholder/target groups.
2. Complete all targets indicated in EFC document within the time frame. Initiate steps to complete the pending targets.
3. Collect data on picoplankton from cage culture site as they form the food for larvae and zooplankton.
4. Equip with database on the economics of cage culture and environmental parameters at culture site–cage/pen etc. and make readily available as and when required.
5. Collect time series of in situ data at all Centre's–fish eggs, larvae, size class of phytoplankton and composition of zooplankton for interpreting changes happening in the ecosystem.
6. Make available all the technologies developed by CMFRI in e-portal.
7. Explore possibilities for collaborative projects with sister institutes–CIFT and CIFRI at headquarters and Centres. This can check overlapping of same work by different Institutes and also utilise expertise available with other ICAR Institutes.
8. Initiate steps to popularise fish consumption by the general public as available for egg and milk
9. For doubling of farmer's income, CMFRI should look into wealth from fish waste.
10. Study the abundance of jelly fishes in the ecosystem in relation to trophic changes.
11. As the scientific strength of CMFRI is 150, each scientist should produce at least 2 papers/year in refereed journals so as to generate 300 papers for the Institute. Document the changes that happened post *Ockhi*–silt accumulation changes in marine biodiversity etc. along southern Kerala coast.

24th IRC meeting of CMFRI

Institute Research Council (IRC)

The 24th Institute Research Council (IRC) Meeting was held at CMFRI Headquarters from 15th to 19th May 2017 (5 days). On the first day, meetings were conducted at respective Divisions as per the schedule of the 24th IRC. 24th IRC commenced with the welcome address by Dr. K.S. Mohamed, IRC Member Secretary. Dr. Mohamed welcomed new members of IRC particularly Dr. P. Jayasankar, former Director of CIFA and 13 newly joined scientists of the Institute to the 24th IRC.

Institute Management Committee (IMC)

The 82nd Meeting of Institute Management Committee of CMFRI was held on 11.01.2018. at CMFRI Hqrs., Kochi. The Director and Chairman, IMC presented a brief about the new project sanctioned by Department of Animal Husbandry, dairying and Fisheries (DAHDF), Govt. of India. It was informed that this is the highest ever sanctioned project in CMFRI. He also informed that fish catch data of CMFRI has been approved in national level.

Action taken on the items considered during the previous meeting held on 07.10.2016 at CMFRI was reviewed. The IMC of CMFRI nominated Dr. T. V, Sathiannadan, Principal Scientist and Head, FRAD, CMFRI, Shri C. Muralidharan, Chief Administrative Officer, CMFRI and Shri A.V. Joseph, Chief Finance & Accounts Officer, CMFRI as members to the Grievance Committee of CMFRI. The IMC recommended to provide hostel facility to the regular staff of CMFRI, initially for a period of 3 months which can be extended by another 3 months with the approval of the Director, CMFRI, subject to deduction of applicable HRA and license fee from the salary of the concerned staff. The IMC recommended the proposal for civil works under the project "Enhancing production of farmed pompano (*Trachinotus blochii*) through the establishment of broodstock and supply of larvae to State for seed production" subject to technical vetting of the CPWD estimate by the Council. The IMC also recommended outsourcing of Security Staff at CMFRI Hqrs. & Regional/ Research Centres for the year 2018-19.

The 83rd meeting of Institute Management Committee of CMFRI was held on 19.03.2018 at CMFRI Hqrs. The Chairman & members of IMC expressed deep sorrow on the untimely demise of Prof. (Dr.) N.R. Menon, Chairman, and RAC of CMFRI. Action taken on the previous meeting held on 11.01.2018 at CMFRI was reviewed. The IMC recommended the proposal for condemnation of RV Cadalmin IV (IND-TN-12-MM-4618) at Tuticorin RC of CMFRI and procurement of a new vessel in its place. The IMC also recommended the proposal for the construction of Residential Quarters and Training Hostel for CMFRI at Veraval. The IMC also suggested getting the land on lease, if Govt. of Gujarat is not ready to give the land free of cost. The IMC recommended for the initiation of the electrical works for the supply, installation, testing and commissioning of additional 400KVA, dry Type transformer and HT/LT Panels at CMFRI Headquarters building, Kochi. The IMC recommended to prepone the work approved for the financial year 2018-19 to 2017-18 by re appropriation of an amount of ₹96 Lakhs from the head, Capital-Works-Land and ₹22 Lakhs from head-Equipment.

Institute Joint Staff Council (IJSC)

The fourth meeting of 13th IJSC was held on 29.06.2017 at CMFRI, Kochi. Various issues of the staff members were discussed and settled in the meeting.

Institute Joint Staff Council meeting on 29-06-2017

Human Resource Development Cell

Training programmes conducted

The Institute organised several national and international short-term training and winter/summer schools in specialised areas for the scientists. Special training courses were also organised for the benefit of government officials, professionals, farmers and fishermen. CMFRI organised 17 training programmes during 2017-18 in various aspects of marine fisheries and mariculture.

Skill development programme on marine cage culture was organised with financial support from NFDB, Hyderabad, for 500 farmers at 10 locations in 5 maritime states of the country.

Capacity building programmes for employees

Annual Training Plan

Annual training plan (ATP) for the various categories of CMFRI employees were prepared after assessing the training needs of individual employees. ATP for 2017-2018 were prepared and submitted to HRM division of ICAR.

Sl. No.	Subject of training	Place of training
1	Training programme to staff of state fisheries department, Kerala	CMFRI, Kochi
2	Sustainable management of marine fisheries for conserving coastal and marine resources.	Veraval RC
3	Open sea cage culture	Mumbai RC
4	Thinking beyond science for co- scripting the next chapter in life at CMFRI, Kochi	Chennai RC
5	Molecular and microbiological techniques	Karwar
6	Skilled development programme on cage culture	CMFRI, Kochi
7	Identification of marine macrophytes and assessment of sea grass ecosystem services	CMFRI, Kochi
8	Workshop use of catch MSY for the Assessment of Indian fish stocks in a data poor environment	CMFRI, Kochi
9	Management plans for the marine fisheries of Gujarat	Veraval RC
10	Training to Dept. of fisheries officials, Govt. of Kerala	Mandapam RC
11	Demonstration workshop for data collection through focus group discuss for BPT	Visakhapatnam RC
12	Job training programme for s students	CMFRI, Kochi
13	Live feed culture–Training to the Tech. Officers of the CMFRI	CMFRI Vizhinjam
14	Short course on histological techniques	CMFRI,Kochi
15	MIS-FMS e-procurement	CMFRI, Kochi.
16	Training for e-procurement	CMFRI, Kochi.
17	Training in Public Finance Management System (PFMS)	CMFRI, Kochi.

Human Resource Development Cell

Training programmes attended by staff of CMFRI during 2017-18

Sl No	Name of the training program	Organisations/Place
1	Training for e-procurement	CMFRI, Kochi
2	Ecosystem- based Fisheries Management using Ecopath and Ecosim	Indo-German Biodiversity Programme, Goa
3	Geographical Information Systems (GIS) application for coastal zone management	INCOIS, Hyderabad
4	Development winning research proposals in agriculture research	NAARM, Hyderabad
5	Management Information System (MIS)-Financial Management System (FMS) e-procurement	CMFRI, Kochi
6	Training in Public Financial Management System (PFMS)	CMFRI, Kochi
7	Advanced statistical techniques in biometrics	IASRI, New Deli
8	Analysis of experimental data	NAARM, Hyderabad
9	Satellite Altimetry Emphasis to SARAL Altika	SAC, Ahmedabad
10	Role or ICAR-NAARM in shaping agricultural research education system management for 2030	NAARM, Hyderabad
11	Recent advances of bioinformatics in agricultural research	IASRI, New Delhi
12	Advances in instructional technologies for enhancing Teaching learning and training	IASRI, New Delhi
13	Thinking beyond science–An interactive communion for co-scripting the next chapter in life	CMFRI, Karwar
14	Multivariate data analysis	NAARM, Hyderabad
15	Marine nutrients for fighting malnutrition–Recent advances in marine biomolecular for human nutrition and health care	CIFT, Kochi
16	Application of OMICS tools and techniques for agricultural germplasm improvement	IASRI, New Delhi
17	Managing innovation and technology competitiveness	DST, New Delhi
18	Entrepreneurship development and management	EDII, Gandhinagar
19	Utilisation of proteins extracted from leaves and non-edible seeds for preparing fish feed	CIFE, Mumbai
20	Big data analytics in agriculture	NAARM, Hyderabad
21	Agriculture knowledge management	MANAGE, Hyderabad
21	Technological empowerment of women	NASI, Allahabad
22	Short course on histological techniques	CMFRI, Kochi
23	Sexual harassment of women at workplace (Prevention, Prohibition and Redressal) Act 2013	ICAR, New Delhi
24	Microbiological examination of sea food	CIFT, Kochi
25	Automobile maintenance, road safety and behaviour skills 19-23 Sept. 2017	CIAE, Bhopal
26	ICAR-Enterprise Resource Planning(ERP)for Technical Officers	IARI, New Delhi
27	Advance instrumental analytical techniques	NEERI, Nagpur
28	Networking basics of management	IASRI, New Delhi
29	PFMS Training	CMFRI, Kochi-18
30	Certificate programme in book publishing conducted	National Book Trust India CUSAT, Kochi
31	Entrepreneurship development and management	EDI, Ahmadabad
32	Training on molecular biology	CMFRI, Kochi
33	Advanced training on aquaculture nutrition	CIBA, Chennai
34	Training for e-procurement	CMFRI, Kochi
35	Workshop on sexual harassment of women's at work place (Prevention, prohibition and Redressal) Act 2013	ICAR, New Delhi
36	Office management on administrative matters	CMFRI, Kochi
37	General Financial Rules (GFR) 2017	ISTM New Delhi
38	MFS–FMS–e-procurement	CMFRI, Kochi
39	General Sales Tax (GST)	ISTM, New Delhi
40	PFMS training	CMFRI, Kochi
41	Training programme on MS-EXCEL	ISTM, New Delhi
42	GFR 2017	ISTM, New Delhi
43	Enhancing efficiency and behaviour skills for stenographers Gr. III/PA/PS/PPS /Sr.PPS of ICAR	NAARM, Hyderabad

ATP was prepared in such a manner that 20-25% of the employees will be attending on training programmes in a year, i.e., once in 4 years each employee will be attending a training programme to improve his skill and efficiency.

Staff of CMFRI from various categories attended various training programmes at various institutes in the country as part of the capacity building programmes during 2017-18. During this year, 83 scientists, 15 technical and 89 administrative attended various trainings programmes at CMFRI and other institutes.

Ph.D. Programme

Scientists of CMFRI are recognised guides under various reputed universities like Cochin University of Science and Technology (CUSAT), Mangalore University, Mahatma Gandhi University, Andhra University, Madras University, Kerala University

67 scholars who are awarded with CSIR/UGC JRF-SRF, DBT Inspire fellowships aprt from the SRF in research projects are pursuing their doctoral degree programmes at CMFRI, Kochi and its centers under various universities.

Winter school

Three winter schools were organised during 2017-18.

“Advanced Methods for Fish Stock Assessment and Fisheries Management”, during 12th July to 01st Aug., 2017 Course director Dr. Somy Kuriakose, Pr. Scientist FRAD.

“Structural function of the marine eco system: Fisheries”, during 01-21, Dec. 2017, Course director Dr. Grinson George, Sr. Scientist, FRAD.

“Recent advances in bioactive compounds from marine organisms and development of high value products for health management”, during 23rd Jan. to 12th Feb. 2018, Course director Dr. Kajal Chakraborty, Sr. Scientist, MBTD.

International Training Programme

International training programme on Fisheries and Aquaculture was held at CMFRI during 14-28 March, 2018 at CMFRI, Kochi. 16 participants from 13 countries attended the programme sponsored by African-Asian Rural Development Organisation, (AARDO), New Delhi, India

Distinguished Visitors

Mandapam Regional Centre

Hon'ble Smt. Krishna Raj, Minister of State for Agriculture and Farmers Welfare, 17.09.2017.

Shri.Devendra Chaudhary, Secretary to the Department of Animal Husbandry, Dairying and Fisheries (DAHDF), Ministry of Agriculture and Farmers Welfare 08.06.2017 & 09.06.2017.

Smt. I. Rani Kumudini, IAS, Chief Executive, NFDB, Ministry of Agriculture & Farmers Welfare, Government of India, 12.03.2018 & 13.03.2018.

Shri. Chhabilendra Roul, IAS, Additional Secretary (DARE) & Secretary (ICAR), Ministry of Agriculture and Farmers' Welfare, New Delhi, 29.12.2017.

Shri.Aditya Kumar Joshi, Joint Secretary, DAHDF, 09.06.2017

Shri.Gagandeep Singh Bedi, Principal Secretary to Govt. of Tamil Nadu, 09.06.2017

Shri. V. P. Thandapani, Director of Fisheries, Tamil Nadu, 09.06.2017

Shri. S. Natarajan, District Collector, Ramanathapuram, 09.06.2017 and 12.03.2018

Shri. Ram Sankar Naik, Commissioner of Fisheries, Govt. of Andhra Pradesh, 09.06.2017 & 11.01.2018

Dr Pravin Puthran, ADG (M. Fy.), ICAR, 09.06.2017 & 13.09.2017

Shri. Issac Jayakumar, Deputy Director of Fisheries, Ramanathapuram 11.05.2017

Dr. P. S. B. R. James, Former Director, CMFRI and Dr. Ambekar E. Eknath, Former Director General, NACA, 03.03. 2018 to 06.03.2018.

Tutiorin Research Centre

Mr. V. P. Prem Nema, General Manager, Heavy Water Plant,Tuticorin on 10.10.2017

Dr. Bhumesh Singh and team, Wildlife Institute of India, Dehradun on 17.11.2017

Dr. B. Sukumar, Regional Director, IGNOU Regional Centre, Trivandrum on 18.12.2017

Shri. S. Saravanan IAS, Assistant Collector, Tuticorin District on 03.02.2018

Dr. G. Sugumar, Dean, Fisheries College and Research Institute, Thoothukudi, on 03.02.2018

Vizhinjam Research Centre

Shri. Sudharshan Bhagat, Union Minister of State, Ministry of Agriculture and Farmers Welfare,Government of India on 28-01-2017

Dr. Shashi Tharoor, Member of Parliament, Lok Sabha on 22-04-2017

Dr. Ian W. Low, Principal Scientist, International Potato Centre, Nairobi, Kenya on 18-05-2018

Dr. R. R. Hanchinal, Former Chairperson, Protection of Plant varieties Authority, Govt. of India and former Vice chancellor, University of Agricultural Sciences, Dharwad, Karnataka on 19-06-2018

Dr. Abhai Sinha,Director General,CPWD, Nirman Bhawan, New Delhi on 05-7-2018

Dr. N. K. Krishna Kumar, Former DDG,Horticulture, ICAR, New Delhi on 19-06-2018

Dr. Nirmal Babu,Director, ICAR-IISR, Kozhikode, Kerala on 28-10-2017

Dr. Sudha Mysore, Chairperson, ZTMC and ABI, ICAR-IIHR-Bangalore on 28-10-2017

Dr. Trilochan Mohapatra, Secretary, DARE and Director General, ICAR,New Delhi on 28-10-2017

Dr. N. P. Singh, Director, ICAR-NIASM, Baramati, Pune, Maharashtra on 27-11-2017

Distinguished Visitors

Shri. A. J. Desai, Judge, High Court of Gujarat, Ahmedabad on 3-01-2018

Dr. Pravin Puthra, Assiatnt Director General, Marine fisheries, ICAR, New Delhi on 19-01-2018

Mr.Patrick Medecin, Ambassador of Morocco, Kingdom of Morocco on 3-02-2018

Dr. T. Janakiram, Assistant Director General (HS), ICAR, New Delhi on 28-04-2018

Shri Deepak V. Kesarkar, Minister of State, Home and Finance, 501, Mantralaya, Mumbai, Maharashtra on 3-05-2018

Dr. John Kurien, Visiting Professor, Azim Premji University, Bangalore and former faculty CDS, Thiruvananthapuram on 25-06-2018.

Veraval Regional Centre

Dr. Ravishankar, Director, ICAR-Central Institute of Fisheries Technology, Kochi on 19.07.2017.Shri. K. A. Gandhi, Deputy Conservator of Forests, Gir-Somnath District, Govt. of Gujarat on 30.08.2017.

Shri. Md. Tahir, Assistant Director, Department of Fisheries, Andaman Administration on 06.09.2017.

Dr. Sanjay Pandey, Assistant Commissioner (Fy.), Department of Animal Husbandry, Dairying & Fisheries (DADF), Ministry of Agriculture & Farmers Welfare, Govt. of India on 11.10.2017.

R. Viswanathan, Senior Safeguards Specialist, Asian Development Bank, Manila on 20.03.2018.

Dr. C. R. K. Reddy, Chief Scientist, CSIR-CSMCRI, Bhavnagar 11.02.2018.

Smt. I. Rani Kumudini, IAS, Chief Executive, National Fisheries Development Board, Ministry of Agriculture & Farmers Welfare, Government of India on 11.02.2018.

Dr. Trilochan Mahapatra, Secretary (DARE) and DG (ICAR), Ministry of Agriculture and Farmers Welfare, Government of India on 07.04.2018.

Headquarters, Cochin

Mr. Mohammad Nurul Aamin, Joint Director, (Fisheries), Rural Development Academy (RDA), Bogra, Bangladesh.

Mr. Chin, Chien-Pang, Assistant Research Fellow, Fisheries Research Institute, Council of Agriculture, Keelung, Republic of China (Taiwan)

Mr. Kamal Shawkat Jawameer, Head, Department of Fish Farming and Water Bodies, Management, Ministry of Agriculture, Zayton Street, Abu Garib, Baghdad, Republic of Iraq.

Mr. Wesam Mohammad Musa al – Nawaiseh, Researcher, National Center for Agriculture and Extension (NCARE), Rabba Centre, Alkarak-NCARE Chour Alsafi, Jordan

Mr. Omar Odeh Abdl –Mutee al-Rawashdeh, Veterinary Officer, National Center for Agriculture and Extension (NCARE), Rabba Centre, Alkarak-NCARE Chour Alsafi, Jordan.

Mr. Ali Mohammad Nassar, Head, Forestry and Fishing Center, Ministry of Agriculture, Beirut, Lebanon.

Mr. Ali Mohammed Meelad Shafran, Ministry of Agriculture, Animal and Marine Wealth, Government of Libya, Al-Shat Road, Tripoli, Libya.

Mr. Mohamed Elhashmi Mohamed Elsharef, Ministry of Agriculture, Animal and Marine Wealth, Government of Libya, Al-Shat Road, Tripoli, Libya.

Dr. (Ms.) Nur Leena Wong Wai Sin, Senior Lecturer, Department of Aquaculture, Faculty of Agriculture, Universiti Putra Malaysia, Selangor-Malaysia.

Mr. Titus Bandulo Phiri, Principal Fisheries Officer, Department of Fisheries, Salima Fisheries Research Centre (SFRC), Salima, Malawi.

Ms. Anisha Ramtohul Roopun, Technical Officer (Fisheries), Ministry of Ocean Economy, Marine Resources, Fisheries and Shipping, Albion Fisheries Research Centre, Albion, Petite, Riviere, Mauritius.

Mr. Ali Rajab Ali Al-Mashikhi, Aquaculture Specialist, Fisheries Research Centre,

Ministry of Agriculture and Fisheries Wealth, Oman.

Mr. Samer H. A. Hanani, Chairman, Fisheries Sector, Ministry of Agriculture, Agriculture Department Nablus-West Park, Ramallah, Palestine.

Mr. Hafiz Hassan Ibrahim Tamrab, Fish Inspector, Marine Fisheries Administration,

Directorate General of Fisheries, Ministry of Animal Resources, Khartoum, Sudan.

Ms. Whiba Ben Farhat Ep Zroud, Senior Fishery Engineer, Regional Commissary for Agricultural Development, Ministry of Agriculture Hydraulic Resources and Fisheries, Mahdia-Tunisia.

Mr. Mohamed Amin Ben Elhadj, Senior Fishery Engineer, Engineer Charged of Shell Fish Production, Ministry of Agriculture Hydraulic Resources and Fisheries, Tunisia.

All the above as participants of an international training programme from "Fisheries and Aquaculture" sponsored by African Asian Rural Development Organisation (AARDO), Ministry of Rural Development, Govt of India from 14-28 March 2018.

Dr. Lasse Petterson, Research Coordinator, NANSEN, Norway on 15.1.2018

Major Events

1. CMFRI releases 2016 marine fish landing data in a press meet on 19 May 2017
2. CMFRI wins ICAR south zone sports championship third time in a row
3. Director CMFRI hands over Ockhi disaster relief collection to Hon'ble Chief Minister Govt. of Kerala on 20-02-2018
4. DBT Task force in Marine Biotechnology meets at CMFRI on 7-8 December 2017
5. Empowering fisher women youth

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Major Events

1. ICAR Winter School in marine bioprospecting in January 2018
2. ICAR Winter School in marine ecosystems in December 2018
3. Ms. Rani Kumudini IAS at CMFRI on 30 October 2017
4. Dr. Devendra Chaudhary visited CMFRI on 22 July 2017
5. Open house at CMFRI on 3 February 2018
6. Prof. Ramesh Chand, Member NITI Aayog was at CMRI on 17 November 2017
7. Workshop on sustainable development goal 14 at CMFRI from 4-5 July 2017

Women's Cell Activities

Talk on Know Stroke: No Stroke by Dr. Vivek Nambiar, Head, Stroke medicine, AIMS, Kochi

The women cell of CMFRI, Kochi organised a talk in association with Stroke Survivors Unite on `Know Stroke: No Stroke' by Dr. Vivek Nambiar, Head, Stroke medicine, AIMS, Kochi on 19.9.17. Shri Dominic Presentation M.L.A, Adv. Abraham Lawrence, Prof. Devaki Antharjanam, Volunteers of Stroke Survivors Unite also spoke on the occasion.

Women Empowerment programme

The Women' cell of CMFRI, Kochi organised a Women empowerment programme through arranging a motivational talk by Veteran actor and Ex-MP, Urvasi Sharada. While sharing her life experience, Smt. Sharada emphasised that real empowerment lies in women recognising their own strength. She had also interacted with the women staff of CMFRI.

Women's day, 2018

As a part of International Women's Day Celebrations, Women's Cell of CMFRI, Kochi organised a Colloquium on "Kidney Diseases: What One Should Know" by a Team of Doctors headed by Dr. Rajesh R. Nair, Head, Department of Nephrology, Amrita Institute of Medical Sciences, Kochi on 8th March 2018.

Cine actress and Ex-MP Urvasi Sharada addressing CMFRI staff

Smt.Sharada along with Director, CMFRI interacting with women staff of CMFRI

Women's day, 2018

Marine Biodiversity Museum

Specimens deposited during 2017

A total of 108 species were deposited in the Marine Biodiversity Museum which comprised of 59 fishes, 35 crustaceans, 7 molluscs, 3 echinoderms, 3 miscellaneous and one cnidarian.

fISHES

1	*Tentoriceps cristatus* (Klunzinger, 1884)	GB.31.153.9.5
2	*Pseudalutarius nasicornis* (Temminck & Schlegel, 1850)	GB.43.4.15.8
3	*Filimanus similis* Feltes, 1991	GB.31.119.2.5
4	*Scolopsis xenochrous* Günther, 1872	GB.31.98.5.17
5	*Dactyloptena macracantha* (Bleeker, 1855)	GB.38.12.1.2.1
6	*Paratriacanthodes retrospinis* Fowler, 1934	GB.43.8.10.5
7	*Lagocephalus guentheri* Miranda Ribeiro, 1915	GB.43.6.15.2
8	*Uranoscopus guttatus* Cuvier, 1829	GB.31.155.8.5
9	*Holapogon maximus* (Boulenger, 1888)	GB.31.9.4.1.1
10	*Albula vulpes* (Linnaeus, 1758)	GB.2.1.1.6.1
11	*Sphyraena putnamae* Jordan & Seale, 1905	GB.31.143.1.1
12	*Xiphasia setifer* Swainson, 1839	GB.31.3.1.1
13	*Etelis carbunculus* Cuvier, 1828	GB.31.88.3.1
14	*Champsodon sagittus* Nemeth, 1994	GB.31.133.2.8
15	*Apogonichthyoides pseudotaeniatus* (Gon, 1986)	GB.31.9.1.10
16	*Anabas testudineus* (Bloch, 1792)	GB.31.7.7.1
17	*Dactyloptena gilberti* Synder, 1909	GB.38.12.1.1
18	*Alepocephalus bicolor* Alcock, 1891	GB.30.5.2.1
19	*Alepocephalus* sp.	GB.30.5..2.5
20	*Bathypterois phenax* Parr, 1928	GB.3.5.1.4
21	*Bembrops caudimacula* Steindachner, 1876	GB.31.113.1.5.1
22	*Benthobatis moresbyi* Alcock, 1898	GA.14.1.1.1.1
23	*Chaunax pictus* Lowe, 1846	GB.25.15.3.3
24	*Chelidoperca investigatoris* (Alcock, 1890)	GB.31.131.16.2.1

Marine Biodiversity Museum

25	*Dicrolene multifilis* (Alcock, 1890)	GB.28.4.18.5
26	*Iago* Sp.	GA.1.8.7.5
27	*Chlorophthalmus corniger* Alcock, 1894	GB.8.6.1.4.1
28	*Nemichthys scolopaceus* Richardson, 1848	GB.4.11.3.3.1
29	*Neoepinnula orientalis* (Gilchrist & Von Bonde, 1924)	GB.31.62.6.2.1
30	*Psenopsis cyanea* (Alcock, 1890)	GB.31.29.4.1.1
31	*Xenocephalus elongatus* (Temminck & Schlegel, 1843)	GB.31.155.3.8
32	*Lamprogrammus niger* Alcock, 1891	GB.28.4.5.6
33	*Bassozetus* sp.	GB.28.4.5.4
34	*Hoplostethus mediterraneus* Cuvier, 1829	GB.11.6.4.2
35	*Coloconger* sp	GB.4.1.3.3
36	*Champsodon* spp.	GB.31.133.2.4
37	*Atherinomorus lacunosus* Forster, 1801	GB.24.1.1.1
38	*Setarches guentheri* Johnson, 1862	GB.45.1.2.7
39	*Prometichthys prometheus* (Cuvier, 1832)	GB.31.62.2.8
40	*Chascanopsetta prognatha* Norman, 1939	GB.33.3.6.9
41	*Zenopsis conchifer* (Lowe, 1852)	GB.44.5.1.1.1
42	*Epinephelus morrhua* (Valenciennes, 1833)	GB.31.139.22.70
43	*Chaetodon gardineri* Norman, 1939	GB.31.33.2.19.1
44	*Erythrocles schlegelii* (Richardson, 1846)	GB.31.58.2.4.1
45	*Bothus pantherinus* (Ruppell, 1830)	GB.33.3.3.11.1
46	*Ostorhinchus pleuron* (Fraser, 2005)	GB.31.9.1.7
47	*Histrio histrio* (Linnaeus, 1758)	GB.25.1.6.1.1
48	*Naso reticulatus* Randall, 2001	GB.31.1.3.11
49	*Etelis coruscans* Valenciennes, 1862	GB.31.88.3.15
50	*Upeneus margarethae* Uiblein & Heemstra, 2010	GB.31.95.6.14
51	*Synchiropus splendidus* (Herre, 1927)	GB.31.22.3.10
52	*Eupleurogrammus muticus* (Gray, 1831)	GB.31.152.5.2.1
53	*Chlorurus sordidus* (Forsskal, 1775)	GB.31.131.4.15
54	*Pteroplatytrygon violacea* (Bonaparte, 1832)	GA.7.1.3.1.1
55	*Neotrygon kuhlii* (Müller & Henle, 1841)	GA.7.1.4.1.1
56	*Rhinobatos variegatus* Nair & Lal Mohan, 1973	GA.11.4.2.3.1
57	*Thyrsitoides marleyi* Fowler, 1929	GB.31.62.20.5
58	*Scolopsis xenochrous* Gunther, 1872	GB.31.98.5.17
59	*Dactyloptena macracantha* (Bleeker,1855)	GB.38.12.1.2.1
Crustaceans		
60	*Alpheus euphrosyne* de Man, 1897	ED.2.5.1.6
61	*Charybdis (Charybdis) brevispinosa* Leene, 1937	ED.5.5.1.4
62	*Plesionika persica* (Kemp, 1925)	ED.2.4.3.5
63	*Paramaja gibba* (Alcock, 1985)	ED.5.5.3.8
64	Carcinoplax indica Doflein, 1904	ED.5.15.2.3
65	*Albunea occulta* Boyko, 2002	ED.4.4.1.2
66	*Charybdis feriatus* (Linnaeus, 1758)	ED.5.5.1.1.1
67	*Aristaeopsis edwardsiana* (Johnson,1868)	ED.1.6.1.1.1
68	*Aristeus alcocki* Ramadan, 1938	ED.1.2.1.1.1
69	*Nephropsis stewarti* Wood –Mason, 1872	ED.3.1.1.2.1
70	*Acanthephyra fimbriata* Alcock & Anderson, 1894	ED.5.9.5.1.1

Marine Biodiversity Museum

71	*Acanthephyra sanguinea* Wood – Mason & Alcock, 1892	ED.2.1.1.2.1
72	*Oplophorus typus* H. Milne Edwards, 1837	ED.2.3.1.3
73	*Heterocarpus gibbosus* Spence Bate, 1888	ED.2.4.1.1.1
74	*Plesionika martia* (A. Milne- Edwards,1883)	ED.2.4.3.2.1
75	*Plesionika quasigrandis* Chace, 1985	ED.2.4.2.8.1
76	*Sicyonia parajaponica* Crosnier, 2003	ED.1.4.1.2.1
77	*Puerulus sewelli* Ramadan, 1938	ED.3.2.4.1.1
78	*Nematocarcinus gracilis* Spence Bate, 1888	ED.1.4.2.1.1
79	*Heterocarpus woodmasoni* Alcock, 1901	ED.2.4.1.2.1
80	*Metapenaeopsis andamanensis* Wood Mason, 1891	ED.1.3.3.1.1
81	*Charybdis smithii* Macheay 1838	ED.5.5.3.2.1
82	*Solenocera hextii* Wood – Mason and Alcock, 1891	ED.1.1.1.3.1
83	*Plesionika reflexa* Chace 1985	ED.2.4.3.8
84	*Plesionika semilaevis* Spence Bate, 1888	ED.2.4.5.1
85	*Solenocera annectens* (Wood–Mason & Alcock, 1891)	ED.1.1.1.5
86	*Solenocera pectinata* (Spence Bate, 1888)	ED.1.1.1.7
87	*Solenocera rathbuni* Ramadan 1938	ED.1.1.1.8
88	*Hymenopenaeus equalis* (Spence Bate, 1888)	ED.1.1.2.1
89	*Pontocaris affinis* affinis (Alcock, 1901)	ED.2.6.1.5
90	*Pontocaris propensalata* Spence Bate, 1888	ED.2.6.1.3
91	*Litopenaeus vannamei* (Boone, 1931)	ED.1.3.9.3
92	*Homolax megalops* (Alcock, 1894)	ED.2.3.4.4
93	*Macrobrachium indicum* Jayachandran & Joseph,1986	ED.2.2.1.8; 8.1;8.2;8.3
94	*Oplophorus typus* H.Milne Edwards, 1837	ED.2.3.1.3
Cnidaria		
95	*Chloromyxum argusi*	CB.7.1.1
Echinodermata		
96	*Asterodiscides elegans* (Gray, 1847)	FA.2.2.2
97	*Stellaster childreni* Gray, 1840	FA.3.3.3
98	*Pentaceraster affinis* (Muller & Troschel, 1842)	FA.8.1.1
Molluscs		
99	*Dolabella auricularia* (Lightfoot, 1786)	DB.1.3.1
100	*Conus* sp.nov	DB.35.1.26
101	*Octopoteuthis* sp nov	DF.2.5.2.1.
102	*Tremoctopus gracilis* (Souleyet, 1852)	DE.2.1.1.1
103	*Abralia siedleckyi* Lipinski, 1983	Dh.1.1.1.1
104	*Ommastrephes bartramii* (Lesueur, 1821)	DE.2.1.5.4
105	*Todarodes filippovae* Adam, 1975	DE.2.1.5.6
Misc.		
106	Egg case of Alopias pelagicus	Misc.39
107	*Ardenna carneipes* (Gould, 1844)	Misc.36
108	*Colurella adriatica* Eherenberg,1831	RA.1.5.35

Marine Biodiversity Museum

Visitors during 2017-18

Period 2017-2018	No. of schools	No. of students	No. of college	No. of students	Public	Total
April 2017	0	0	3	126	206	332
May 2017	0	0	3	88	583	671
June 2017	0	0	7	258	83	341
July 2017	2	164	8	228	127	519
August 2017	1	48	11	544	120	712
September 2017	5	267	13	838	247	1352
October 2017	9	834	6	125	174	1133
November 2017	14	800	7	159	215	1174
December 2017	12	833	15	474	283	1590
January 2018	16	952	11	421	502	1875
February 2018	24	1084	23	982	1827	3893
March 2019	8	467	19	621	232	1320
Total						14912

List of VIPs during 2017-2018

Sl. No	Name
1	Akshay Tanna, Blue Resources, Sri Lanka
2	Smt Krishna Raj, Minister of State Ministry of Agriculture and Farmers Welfare
3	Lasse H. Pettersson, Research Coordinator, Job Position: Ocean and Sea Ice Remote Sensing
4	Dr. J K Sundaray, CIFA
5	Dr. R K Gupta, CIPHET, Ludhiana
6	Mr. Ramesh Verma, IAS
7	Dr. Kailash Chandra, ZSI
8	Mr. Sudarshan Bhagat, Minister of State Ministry Of Tribal Affairs

Krishi Vigyan Kendra, Ernakulam

KVK is focussed on promoting safe food production through supply of quality inputs and seeds through its Satellite production centres. Commendable outreach programmes were conducted.

263

Farmer producer companies formed with funding from NABARD to empower farmers in direct marketing of their produce.

KVK's satellite packing unit commenced at SubJail, Ernakulam

KVK's satellite packing unit was inaugurated at SubJail, Ernakulam on 11th May 2017 by Director, Deputy Inspector General of Prisons (South Zone), Shri. Pradeep B. Sub jail Superintendent Mr. Somarajan K, Kochi Municipal Corporation ward councillor Smt. Gracy Babu, and KVK Head Dr. Shinoj Subramannian were present. The earnings for the sub jail per month during this report period were ₹2,000.

Farmer Producer company shareholder's meet conducted

KVK conducted a meet of shareholders of two farmer producer companies registered by it, *viz.,* Periyar valley spices farmer producer company Ltd. and *Pokkali* farmer producer company Ltd., on 2nd August 2017 at CMFRI, Kochi. The shareholders were given orientation on probable business ventures that can be taken up in the initial stage of their establishment. There was also a lead lecture on '*Company incorporation act and follow up procedures*' by Mr. Joel George, Chartered Accountant, Ernakulam.

KVK organised Sankalp Se Siddhi programme

KVK organised the New India Manthan: Sankalp Se Siddhi programme on 24thAugust 2017 at the ICAR-CMFRI, Kochi. Prof. K V Thomas, Member of Parliament, Ernakulam inaugurated the programme and administered New India pledge. Dr Pravin Puthra, Additional Director General of Indian Council of Agricultural Research (ICAR) explained the seven-point development strategies and Govt. of India for doubling farmers' income by 2022. Dr. A. Gopalakrishnan, Director, CMFRI presided over. In addition, a farmer-scientist interface meeting was also conducted.

Soil-less planting medium launched

KVK launched planting media devoid of soil during a sales mela conducted at CMFRI, Kochi on 21st September,

1. *Inauguration of the satellite packing unit at the sub-jail, Ernakulam*
2. *Shareholders meeting of farmer Producer Company*
3. *SANKALP SE SIDDHI–inaugural address by Prof K. V. Thomas MP*

1. Sales mela–Soil less planting media conducted at CMFRI
2. Demonstration of mechanised production techniques of soil-less media
3. Inauguration of World fisheries day by Mr. Antony John MLA

KVK launched soil-less planting medium based on composted press-mud as a major move to resolve the issue faced by the urban farmers in homestead agriculture owing to soil scarcity.

2017. The media is composed of composted press mud; a by-product from sugar mills, coir pith and powdered cow dung. It also contains neem cake, dolomite and biocontrol agents. The media can be used as an alternative to soil in farming. Approximately 1000 city residents visited the mela and 2000 packets each 10 kg were sold.

Entrepreneurship development programme (EDP) on Soil less media

KVK conducted Entrepreneurship development programme (EDP) on Soil less media: Production and marketing at CMFRI on 8th November 2017. During the programme, technology of the soil-less mix was transferred to the participants. 25 participants from various parts of Kerala attended the programme. Demonstration of mechanised production and class on marketing strategies held.

World Fisheries Day celebrated

KVK celebrated World Fisheries Day on 21st November 2017 at Kothamangalam by conducting inland fish farmers' meet. 100 progressive inland fish farmers attended the programme. Shri. Antony John MLA inaugurated. The meet suggested to venture into farm tourism to enhance farmer's earnings considering the strategic location of the place. In addition, business plans for fish seed rearing, feed supply, farmer operated fish market and inland fish farmer's task force were chalked out.

Sales melas conducted

KVK conducted 2 sales melas at its sales counter during report period. Curry leaf-coriander sales mela was conducted with the objective of propagating safe to eat homestead cultivation of coriander

1. *Curry leaf–Coriander sales mela*
2. *Sales mela of fruit plants*
3. *Curry leaf kit distribution*

and curry leaf as these are the ones that contains maximum pesticide residues. The event was conducted at CMFRI on 31st August, 2017. About 490 people participated in the mela in which 1100 kits of curry leaf seedlings and coriander seeds were distributed. Another sales mela cum exhibition of fruit plants conducted at CMFRI on 26th to 28th September, 2017. Around 700 farmers attended and 2200 different fruit tree saplings like mango, jack, jamun, pomegranate, guava, sapota, different citrus species, etc., comprising of good quality graft and layers were distributed in the programme.

Curry leaf kit distributed to school children

KVK distributed 10,000 curry leaf kits to Higher secondary school children in Ernakulam district as part of *Karshakamithram,* a programme conducted by Vidhyadhanam trust run by Ernakulam MP, Prof K V Thomas. The seedlings were supplied along with dolomite kits and leaflets. The inauguration of the programme was conducted at SDPY School, Palluruthy on 15th December, 2017.

Swachh Evam Swashth Bharat

1. CMFRI Receiving Best Swachh Bharath Abhiyan Implementing Institute 08 March 2018.jpgClean India campaign - Chennai
2. Campus cleaning at Mandapam
3. Beach cleaning at MumbaiMumbai_beach_cleaning
4. Office cleaning - Mumbai

Swachh Evam Swashth Bharat

ICAR- CMFRI initiatives

Since the launch of Swachh Bharat Mission (SBM), a lot of momentum has been built up and significant progress has been made. The *Swachh Bharat* Mission is a massive movement that seeks to create a clean India. The intensive national cleanliness campaign started from 2nd October 2014. The Honourable Prime Minister said, it is our social responsibility as citizens of India to help fulfil Mahatma Gandhi's vision of Clean India, by his 150th birth anniversary in 2019.

CMFRI considering it as our moral duty and social responsibility diligently organizes Cleanliness Campaign *"SWACHHTA MISSION"* every month. The key objective is to create the environment conducive for the cleanliness drive and also offer a variety of programme include creating awareness among public entities,decomposition of degradable and non-degradable waste; tree plantation, usage of eco-friendly technologies, lesser use of plastics vegetable gardening, cleaning the public utility areas like harbour, hospitals, schools, parks, beaches, bus shelters, boat jetty's, public walkways, playgrounds; cleaning the office premises, promotes organic farming by creating compost pit dug for producing organic manure from biodegradable waste from the office premises, encourages vermi-compost for plantation and biogas generation for cooking etc.,in order to activate the process of behavioural changes.It benefits also to make realize that any work is best done when it is carried out by a person himself.

In addition, ICAR-CMFRI had launched cleanliness drive in the premises of major fishing harbours and the beaches across the country by ensuring public participation. Besides the Kochi centre, the cleanliness drive was carried out by all regional research centres of the CMFRI located in various parts of the country, viz., Veraval, Mumbai, Karwar, Visakhapatnam, Mandapam, Tuticorin, Chennai, Mangalore, Calicut and Vizhinjam.

Three years down the line, *Swachh Bharat Abhiyan* is a mixed bag of success as ICAR-Central Marine Fisheries Research Institute (ICAR-CMFRI) received the prestigious *'Swachhta Pakhwada'* award from Shri Radha Mohan Singh, Hon'ble Union Minister for Agriculture and Farmers Welfare in presence of Shri. Gajendra Singh Shekhawat, Hon'ble Union Minister of State for Agriculture and Farmers Welfare; Dr. Trilochan Mohapatra, Secretary, DARE and Director General, ICAR and Prof. Ramesh Chand, Member, NITI Aayog on 08 March 2018 at a function in New Delhi. The CMFRI won second prize at the national level among the institutes functioning under Indian Council of Agricultural Research (ICAR) in recognition of its implementation of *Swachh Bharat* activities across the country by introducing innovative methods last year.During the previous year, ICAR-CMFRI had formulated a *Swachhata* action plan in public-private partnership which included treatment of wastes, usage of eco-friendly technologies, awareness in health and yoga, ensuring public participation in cleanliness drives, campaigns against plastic usage, measures for water conservation and awareness on plastic wastes in coastal water bodies etc. Moreover, the setting up of 'Fish Cemetery', an art installation to create awareness about the danger of dumping plastic wastes into sea, helped the institute win the prestigious award considering it as an innovative method.

Office cleaning at KVK Narakkal

Diversification in agriculture: Story of an agrarian couple

Where there is a will, there is a way. The human will is undeniably powerful. Once a stern commitment is made to carry through with a project or goal, there's little to stop. A rural couple Mrs. Hema Vijayakumar and Mr. Vijayakumar of village Pazhoor, Kerala, have set an example, how the farming could be a good source of income.

With a very small hilly area of around 2347.26 sq. m. with laterite soil, they have started integrated organic farming of vegetables along with ornamental plants, the variety of trees, poultry, cattle rearing and aquaculture. The challenge was to make the hilly area with laterite soil into a fertile productive land suitable for integrated farming with horticultural plants. It became more challenging when the couple determined to make it fully organic cultivation.

When they were trying to find out a solution desperately, come to know about "*Mera Gaon Mera Gaurav*" programme which was launched by ICAR to promote interface of scientists with the farmers to hasten the lab to land process with an objective to provide farmers with required information, knowledge and advisories on regular basis.

Scientist couple from ICAR-Central Marine Fisheries Research Institute, Kochi, Dr. P. Jayasankar and Dr. Reeta Jayasankar has reached out to an upstart couple Hema and Vijayakumar. The story of success begins with the help of new research findings and technologies and active support of scientist couple from ICAR-CMFRI.

Now plant varieties available in their farm include cashew, mango, jackfruit, coconut,

Aquaponics

Swachh Evam Swashth Bharat

1. *Farm produce*
2. *Scientists with agrarian couple*
3. *Longest snake goud*
4. *Vechur cow*

palm, coffee, pepper, gooseberry, neem, cinnamon, guava, orange, tapioca, citrus, teak, *anjili* (wildjack), banana, moringa, grape, nutmeg, castor bean, rubber, Malabar tamarind, *peepul* (banyan), *bael* (wood apple), and many more. Further, the couple is also growing capsicum, turmeric, arrowroot, ginger, chilly, tomato, brinjal, snake gourd and ash gourd etc. almost like a green cover in a small area in most scientific way with organic fertilizer. The farm also has an office, residential quarters, stores and lab for conducting basic tests. Besides they have developed a rooftop rain harvesting system too to collect the rainwater which goes waste in the hilly area along with a small pond for aquaculture.

In spite of facing significant challenges of marketing of their produce, their experiment is going on with success. Lot of appreciation was received by Hema Vijayakumar and Vijayakumar for their untiring effort to take up organic agriculture along with fish culture in the hilly area. The local Municipality has recognised them as model farmers of the area who could motivate many of the small and marginal farmers to take up this venture. Local print and electronic media gave wide publicity for this work.

Official Language Implementation

531

Officers and staff members were trained to do their work in Hindi and to increase the use of Official Language in day to day work

1. Dr. G. Maheswarudu receiving the Rolling Trophy, TOLIC Kochi
2. Ms. Saloni Shivam and Shri Narayan G. Vaidya receiving the Award, TOLIC Karwar
3. Shri Upendra Kumar, Assistant receiving Award

Awards and Achievements

Town Official Language Implementation Committee Rolling Trophy

ICAR-Central Marine Fisheries Research Institute, Kochi bagged Rajbhasha Rolling Trophy (Ist Position) of Kochi Town Official Language Implementation Committee for the best implementation of Official Language during 2016-17. Dr. G. Maheswarudu, Principal Scientist received the Rolling Trophy from Principal Chief Commissioner of Income Tax, Kochi in the meeting held at Income Tax Office, Kochi on 08.11.2017. Dr. Susmita Bhatacharya, Assistant Director (Impl.), Regional Implementation Office, Kochi was also present

Karwar TOLIC Rajbhasha Rolling Trophy

Karwar Research Centre of CMFRI won the *Rajbhasha* Rolling Trophy for implementation of Official Language among the Central Government offices located in Karwar. Ms. Saloni Shivam, Scientist and Shri Narayan G. Vaidya, Sr. Technical Officer received the Award from Shri Tekchand, Dy. Director (Impl.), Department of Official Language, Bengaluru on 30 June, 2017 during the Half yearly meeting of Karwar TOLIC.

Mangalore TOLIC Rajbhasha Rolling Trophy

Mangalore Research Centre of CMFRI won the *Rajbhasha* Rolling Trophy for best implementation of Official Language Policy during the year 2016-17.

Official Language Implementation

Extension activities

Hindi Fortnight Celebration

With a view to encourage staff members to do their work in Hindi, Hindi Fortnight was observed at ICAR-CMFRI Headquarters, Kochi. Various competitions such as Hindi Noting, Drafting & Terminology, Memory test, Hindi typing in Computer, Hindi Conversation and Speech were conducted. Officers and staff members participated in these competitions with interest and enthusiasm.

As part of Platinum Jubilee Celebration of the Institute, an Essay competition on 'Marine Biodiversity: Challenges and Solution' was conducted as special programme for the High school students of the schools located in Kochi.

Shri K. K. Ramachandran, Dy. Director (OL), Income Tax Office, Kochi & Secretary, Kochi TOLIC was the Chief Guest of Valedictory function of Hindi Fortnight Celebration. Chief Guest distributed prizes to the winners of competitions and to those who participated in the Incentive schemes.

Rajbhasha Rolling Trophy was awarded to Fisheries Resource Assessment Division.

Hindi Week / Fortnight was celebrated in all Regional and Research Centres of CMFRI with various programmes and competitions.

Special incentive scheme: Cash incentives were presented to 9 Officers and staff at Headquarters under CMFRI special incentive scheme.

Participation in Joint Official Language Celebration 2017

Officers and staff of the Institute participated and won prizes in various competitions of Kochi Town Official Language Implementation Committee Joint Official Language celebration 2017 held at Income Tax Office, Cochin.

1. *Chief Guest addressing the gathering*
2. *Hindi conversation competition*
3. *Rajbhasha rolling trophy*
4. *Platinum jubilee competition*

Official Language Implementation

Hindi workshop at Vizhinjam RC

Hindi workshops

In order to motivate staff members to do their work in Hindi and to increase the use of Official Language in day to day work. Hindi workshops were conducted and total 531 Officers and staff members were trained at Headquarters, Cochin as well as Outstations during the period as follows:

Headquarters, Kochi: 17.06.2017, 17.07.2017, 22.12.2017 and 27.02. 2018.
Mandapam RC: 03.08.2017, 01.12.2017 & 09.03.2018
Veraval RC: 28.06.2017
Madras RC: 23.08.2017 & 14.09.2017
Tuticorin RC: 02.06.2017, 22.08.2017, 16.12.2017 & 24.02.2018
Mangalore RC: 06.09. 2017 & 23.12.2017
Mumbai RC: 15.09.2017 & 23.02.2018
Karwar RC: 31.08.2017, 29.12.2017 & 17.03.2018
Vizhinjam RC: 29.06.2017
Calicut RC: 30.06.2017 & 26.09.2017

Article Publication

Article on 'Towards Enhancing the Income of Marine Fisher Folk in India' written by Dr. Shinoj P., Scientist was published in the January, 2018 issue of ICAR Hindi Magazine Kheti.

Meetings / Trainings

Quarterly meetings of Official Language Implementation Committee

During the year, 4 meetings of the Official Language Implementation Committee of the Institute were conducted on 09.05.2017, 23.08.2017, 18.12.2017 and 31.03.2018.

Half yearly meeting of Town Official Language Implementation Committee

Attended meetings of Town Official Language Implementation Committee at Income Tax Office, Kochi on 08.11.2017 and 06.03.2018.

Participation in Conference / Training

ACTO (Hindi) attended Regional Conference of Department of Official Language, Ministry of Home Affairs, New Delhi held at Visakhapatnam on 08.12.2017.

Technical Assistant (Hindi Translator) attended 5 days Short Term Translation Training course conducted by Central Translation Bureau at CIFNET, Kochi during 11-15 December 2017 and attended Technical Hindi Workshop at BSNL Bhavan, Kochi on 16.01.2018.

Inspections

Parliamentary Committee inspections

The Second Sub Committee of the Committee of Parliament on Official Language inspected the Official Language

Official Language Implementation

Parliamentary Inspection meetings – Mumbai, Mandapam and Headquarters, Kochi

implementation activities of Mumbai Research Centre of CMFRI on 3 May, 2017, Mandapam Regional Centre on 12 September, 2017 and Headquarters, Kochi on 22 January 2018.

The inspection committee comprised Dr. Satyanarayan Jatiya, Convener, Dr. Prasanna Kumar Patsani, MP (Lok Sabha), Dr. Sunil Baliram Gaikwad, MP (Lok Sabha), Shri Laxmi Narayan Yadav, MP (Lok Sabha), Dr. Sathyendra Singh, Senior Research Officer, Ms. Abhilasha Mishra, Hindi Officer, Shri Vikas Varma, Hindi Officer, Shri Nikhil Arora, Senior Translator, Smt. Neeraja, Research Assistant and Shri Abdul Moheeb, Assistant.

Inspection by ICAR

Dr. P. Pravin, Assistant Director General (Marine Fisheries), ICAR inspected the Official Language activities of CMFRI Headquarters, Kochi on 05.07.2017 and Vizhinjam Research Centre on 19.01.2018.

Shri Om Prakash Joshi, ACTO (Hindi), ICAR inspected the OL implementation of Mumbai RC of CMFRI on 16.11.2017.

Inspection by Department of Official Language

Assistant Director (Impl.), Regional Implementation Office, D/o Official Language, Kakkanad, Kochi inspected the Official Language implementation activities of CMFRI Headquarters on 18.04.2017.

Official Language inspections at Outstations

Dr. Imelda Joseph, Head in Charge, Mariculture Division inspected the Official Language Implementation of Karwar RC of CMFRI on 14.11.2017 and Veraval Regional Centre on 20.02.2018.

Assistant Director (OL), CMFRI, Kochi inspected the OL implementation of Vizhinjam RC of CMFRI on 09.06.2017.

Official Language Implementation

First issue of CMFRI In-house Magazine in Hindi 'Matsyagandha' was released

Review of Official Language implementation activities of Outstations and guidance

The Official Language implementation activities of all Regional and Research Centres were reviewed in every quarter and necessary suggestions were given for improvement.

Special focus to complete obligatory training in Regional / Research Centres in Tamil Nadu

Scientists, Technical and Administrative staff of Mandapam Regional Centre of CMFRI are trained by the Institutional arrangements in Hindi Prabodh and Praveen courses.

A word a Day: Under A word a day programme around 286 Hindi words with English equivalents were displayed on Electronic display board and circulated among staff members of Headquarters and Outstations.

Bilingualisation and targets of correspondence

During the period, all the documents (688) under Section 3(3) of Official Language Act 1963 were issued in bilingual. Out of 732 letters received in Hindi, 697 were replied in Hindi. Percentage of Hindi correspondence during the year was 60.9% against the target of 55%.

Under bilingualisation programme during the period 32 name plates, 16 rubber stamps, 53 Identity cards of staff members, 6 Charts, Certificates of Headquarters and KVK training programmes, Banners of various programmes were prepared bilingually.

Institute Publication in Hindi

CMFRI in House Magazine Matsyagandha

First issue of CMFRI In House Magazine in Hindi Matsyagandha was released in the meeting of Official Language Implementation Committee held on 31.03.2018. CMFRI Newsletter Cadalmin in Hindi - Issue Nos. 152 & 153 were also published.

Release of Matsyagandha

Publications

Peer Reviewed Articles

Abdussamad, E. M., Mini, K. G., Gireesh, R., Prakasan, D., Retheesh, T. B., Prathibha Rohit and Gopalakrishnan, A. 2018. Systematics, fishery and biology of the white sardine *Escualosa thoracata* (Valenciennes, 1847) exploited off Kerala, south-west coast of India. *Indian J. Fish.*, 65 (1): 26-31.

Adhikari, S., Pani, K. C., Mandal, R. N., Chakrabarti, P. P., Giri, B. S. and Jayasankar, P. 2017. Water budgets for freshwater fish ponds of Andhra Pradesh, Orissa and West Bengal, India. *Water Sci. Technol.: Water Supply*, 1: 835-841.

Adnan Hussain Gora, Narottam Prasad Sahu, Sujata Sahoo, Saima Rehman, Irshad Ahmad, Deepak Agarwal, Showkat Ahmad Dar and Sheikh Irfan Rasool 2018. Metabolic and haematological responses of *Labeo rohita* to dietary fucoidan. *J. Appl. Anim. Res.*, 46: 1042-1060.

Adnan Hussain Gora, Saima Rehman, Deepak Agarwal and Sheikh Irfan Rasool 2018. Seaweeds: A sustainable resource for food and pharmaceutical Industry in India. *Eco. Env. Cons*, 24: 259-268.

Ajith K. Thomas, Reni Louise and Vipinkumar, V. P. 2018. Impact of visual merchandising, on impulse buying behaviour of retail customers. *Int. J. Res. Appl. Sci. Engg. Technol.*, 6 (2): 74-83.

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KVK Publications

Books/Leaflets

Shoji Joy Edison 2017. *Cultivation practices of coriander and curry leaf.*

Shoji Joy Edison, Shinoj Subramannian and Pushparaj Anjelo, F. 2017. *How to grow curry leaf.*

Popular/ Technical Articles

Vikas, P. A. and Shinoj Subramannian 2017. Fish farming. In: *Theeranaipunya III Scaling up Fisher Youth Domains in Cognitive development.* ICAR-Central Marine Fisheries Research Institute, Kochi, p. 397-410.

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Vikas, P. A. and Shinoj Subramannian 2017. Doubts and clarifications in cage fish culture *Kerala Karshakan*, 63(1): 44-48.

Vikas, P. A. and Shinoj Subramannian 2017. Fishes for pond cleaning. *Kerala Karshakan*, 63(5): 49-50.

Posters

Vikas, P. A. and Shinoj Subramannian 2017. *Significance of nature synchronised cage aquaculture pattern in Kerala; a case study.*

Sreenivasan, V., Dinesh, R., Praveena, R., Hamza, S., Lijo Thomas, Maria Dainy, M. S., Shoji Joy Edison and Rathakrishnan, P. 2018. *Site specific fertility management for productivity enhancement of black pepper and nutmeg. SASRD Poster No.23/2018.*

Video

Shinoj Subramanniyan, Vikas, P. A. Vipinkumar, V. P., Uma, E. K., Shoji Joy Edison, Pushparaj Anjelo, F., Sreekala, P. and Gopalakrishnan, A. 2017. *Achievement through determination* (Malayalam translated version of Movie *Sankalp Se Sidhi*)

Participations

Conferences/Meetings/Workshops/Symposia/Trainings/Deputations

Dr. A. Gopalakrishnan, Director

Cadre review meeting of scientific staff under the chairmanship of DDG (FS), Pusa, New Delhi, 6–7 April 2017

Meeting with DDG (FS) and Secretary, ICAR on expanding seaweed culture activities along the Indian coast, New Delhi, 12 April 2017

Meeting of the "State Co-ordination Committee on doubling of farmers' income by March 2022" Thiruvananthapuram, 21 April 2017

NICRA Technical programme finalisation workshop chaired by DDG (FS), Pusa, New Delhi, 27 May 2017

Meeting on National Policy on Marine Fisheries (NPMF) chaired by State Fisheries Minister, Thiruvananthapuram, 2 June 2017

Meeting on presentation of the of SFC of the Institute before Secretary, DARE and DG ICAR, New Delhi, 19–20 June 2017

RAC meeting of CMLRE, Kochi, 21–22 June 2017

Workshop on "Sustainable Development Goal 14: Life below water. Effective and inclusive management of Marine and Coastal Ecosystems to promote Human well-being and sustainable development", CMFRI, Kochi, 4-5 July 2017

89th ICAR Foundation Day, ICAR Award Ceremony and ICAR Directors' Conference, Pusa, New Delhi, 16 July 2017

31st Executive Committee Meeting of NFDB chaired by Secretary (ADF), Hyderabad, 29 July 2017

53rd Board of Management Meeting and 25th Management Council meeting of Kerala Veterinary & Animal Sciences University, Peroorkada, Trivandrum, 29–31 August 2017

Review of research and other activities of the Vizhinjam Research Centre of CMFRI and Meeting with the CPWD officials to finalise the civil construction activities at Vizhinjam Research Centre of CMFRI under DADF-NFDB-CMFRI Project, 29–31 August 2017

DADF-NFDB-CMFRI Project Review meeting chaired by the Secretary (ADF), New Delhi, 4 September 2017

Inspection of Second Sub-Committee of Committee of Parliament on Official Language, Mandapam Regional Centre of CMFRI, Mandapam Camp, 12 September 2017

Assessment Committee meeting for Career Advancement Scheme of Scientists, ASRB, New Delhi, 21 September 2017

Writeshop for preparation of Guidelines on Open Sea Cage Culture in marine waters of India conducted under the chairmanship of Chief Executive, NFDB, Hyderabad, 13 October 2017

Centre-State Interactive meeting at CTCRI, Thiruvananthapuram, 28 October 2017

Meeting of the "State level Co-ordination Committees on Doubling Farmers' Income by March 2022" under the Chairmanship of Prof. M. S. Swaminathan, renowned Agriculture Scientist and the Father of Indian Green Revolution, Pusa, New Delhi, 3 November 2017

Meeting with Hon'ble Minister for Fisheries to discuss on the conduct of an interstate Conference of the Fisheries Ministers, 9 November 2017

Task-Force Committee Meeting for the National Mission-Mode Programme on "Trans-Disciplinary Research for Improved Forecasting of Indian Marine Fisheries (TRIMFish)" under the chairmanship of Dr. Sunil Kumar Singh, CSIR-NIO, Goa, 14–15 November 2017

11th Indian Fisheries and Aquaculture Forum, Fostering Innovations in Fisheries and Aquaculture: Focus on Sustainability and Safety. ICAR-Central Institute of Fisheries Technology, Kochi and Asian Fisheries Society, Indian Branch, Kochi, 21-24 November 2017

Launch Workshop of the In-house project "Resource assessment and management framework for sustainable marine fisheries of Lakshadweep", Kavaratti, 30 November 2017

Meeting to revise/frame Recruitment Rules for fishing vessel crew for Fisheries Research Institutes under the chairmanship of Secretary, DARE & DG, ICAR, New Delhi, 6 December 2017

Meeting with DG, ICAR to finalise the book on New Species described by CMFRI, 2- 3 January 2018

Second International Sympsium on Societal Applications in Fisheries and Aquaculture using Remote Sensing Imagery (SAFARI 2) on "Remote Sensing for Ecosystem Analysis and Fisheries", ICAR CMFRI, Kochi, India, 15-17 January 2018

Meeting with the Chief Minister of Kerala and handed over the Ockhi Relief Fund collected from the staff of CMFRI, 20 February 2018

ICAR Directors' Conference, Pusa, New Delhi, 8–9 March 2018

Shri P. Abdul Azeez National Natural Resources Management System (NNRMS). ISRO Dehradun, 1 June–23 July 2017

Winter School on Structure and Function of the Marine Ecosystem: Fisheries. ICAR-CMFRI, Kochi, 1-21 December 2017

Dr. A. K. Abdul Nazar Meeting on NFDB Funded Project, Krishi Bhawan, New Delhi, 15 April 2017

NFDB Project Review Meeting. DADF, Ministry of Agriculture & Farmers Welfare, New Delhi, 4 September 2017

Field Day on Integrated Pond Aquaculture Technology (IPAT), US Soyabean Export Council, Koduru Village, Gudivada Mandal, Andhra Pradesh, 10 January 2018

Inauguration of Lab-cum-Administrative building and Staff quarters, ANCOST, Port Blair, February 2018

Review meeting of NFDB project with the Chief Executive, NFDB, Hyderabad, March 2018

Dr. A. K. Abdul Nazar and Dr. R. Jayakumar NFDB project review meeting and cage manufacturers meeting, NFDB, Hyderabad, 21 September 2017

Dr. A. K. Abdul Nazar, Dr. Joe K. Kizhaudan, Dr. R. Jayakumar, Dr. G. Tamilmani, Dr. M. Sakthivel, Dr. P. Rameshkumar, Shri. C. Kalidas, Dr. B. Johnson, Dr. K. K. Anikuttan, Dr. Raju Saravanan, Shri. S. Chandrasekar, Shri. M. Rajkumar, Smt. L. Remya, Shri S. Thirumalaiselvan, Shri. M. Sankar Shri R. Vinothkumar and Dr. Sekar Megarajan National Consultation Meet on Open Sea Cage Farming and Mariculture Policy, Mandapam, 8-9 June 2017

Shri Ambarish P. Gop Training on Ecosystem based Fisheries Management using Ecopath with Ecosim, Goa, 8 -12 May 2017

Dr. K. K. Anikuttan and Shri Ambarish P. Gop AINP-HRD Training on Live Feed culture with special emphasis on copepod culture, Vizhinjam Research Centre of CMFRI, Vizhinjam, Kerala, India, 13-16 December 2017

Partcipations

Dr. P. S. Asha 14th Scientific Advisory Committee meeting of Krishi Vigyan Kendra, ICAR. SCAD KVK, Tuticorin, 29 November 2017

International training workshop on Meiofauna, School of Marine Sciences, CUSAT, Kochi, 6–9 February 2018

Dr. P. K. Asokan and Dr. K. Vinod Consultation Workshop on Ecosystem valuation in Kadalundi-Vallikunnu Community Reserve organised by the Kerala State Biodiversity Board (KSBB), Calicut Research Centre of ICAR-CMFRI, 1 July 2017

Meeting of the Kerala State Biodiversity Board to discuss the terms of reference of the project 'Valuation of marine and coastal ecosystem in Kadalundi Community Reserve of Kerala', Calicut Research Centre of CMFRI, 27 September 2017

Matsyotsavam and Matsya Adalat organised by the Department of Fisheries, Government of Kerala, Calicut, Kerala, 21 November 2017

Meeting with the Chairman, Kerala State Biodiversity Board to appraise the research progress made in the KSBB funded project 'Valuation of marine and coastal ecosystem in Kadalundi Community Reserve of Kerala', Calicut Research Centre of CMFRI, 5 April 2018

Dr. N. Aswathy Matsya Adalath, Kollam, 27-29 May 2017

Motivational visit and Student-Scientist interactive session under 'Walk with the scholar programme', Kottayam, 5 July 2017

Fish Festival and Fish Adalat, organised by the Department of Fisheries, Government of Kerala, Tanur, 7-9 July 2017

Matsyotsav, Alapuzha, 13-15 August 2017

Sankalp se Sidhi Progarmme, CMFRI, Kochi, 24 August 2017

Utilisation of marine bio-resources, market linkages and access benefit sharing in marine fisheries sector of Karnataka, Karnataka Biodiversity Board, Bengaluru, 29 August 2017

Training programme on Advances in Fisheries and Aquaculture, CMFRI, Kochi, 27 October–2 November 2017

Science Exhibition, Jama-ath Residential Public School, Padamugal, Kochi, 1-2 November 2017

World Food India Exhibition, New Delhi, 3- 5 November 2017

25th Annual conference of Agricultural Economics Research Association (AERA), NAARM, Hyderabad, 7-17 November 2017

Matsyotsavam and Matsya Adalat, organised by the Department of Fisheries, Government of Kerala. Calicut, 19-21 November 2017

World Fisheries Day Exhibition, Pusa, New Delhi, 21-23 November 2017

Open House "Shastrayan" organised by Government College, Kodanchery. Calicut, Kerala, 26-27 February 2018

Dr. D. Divu Half yearly TOLIC Committee meeting of Veraval Region, Veraval, 22 August 2017

The New India Manthan, Sankalp Se Sidhi, Krishi Vigyan Kendra, Kodinar, Gujarat, 29 August 2017

Midterm Review Meeting of XXIV ICAR Regional Committee and Kisanmela, ICAR-CAZRI, Jodhpur, 22-23 September 2017

All India Network Project on Mariculture (AINP) review meeting, Karwar RC of CMFRI, 26-27 September 2017

Dr. Eldho Varghese Winter school on advanced statistical tools and techniques for modelling and forecasting agricultural data, IASRI, New Delhi, 8-28 November 2017

Dr. Gulshad Mohammed Olavanna Panchayat Biodiversity Committee meeting, Kambaliparambu, Kozhikode, 29 November 2017

Talk on 'River conservation measures and pollution problems' organised by the Kerala State Fisheries Department, Kozhikode, 15 March 2018; Chelanur, Kozhikode, 21 March 2018

Dr. Imelda Joseph and Dr. N. Aswathy National Conference on "Technological Empowerment of Women" organised by the National Academy of Sciences, Vigyan Bhawan, New Delhi, 8 -9 March 2018

Dr. F. Jasmin Official language conference for South and South West regions, Visakhapatnam, 8 October 2017

Dr. I. Jagadis and Shri. L. Ranjith Street Play for creating awareness among the fishermen on the sustainable fishing, hygienic handling, conservation of endangered species and critical ecosystem, organised by NETFISH-MPEDA, Tuticorin, 27 July 2017

Official language conference for South and South west regions, Visakhapatnam, 8 October 2017

Dr. R. Jayakumar IPAT Field Day organised by the USSEC and Unibait Feeds, Koduru Village, Andhra Pradesh 10 January 2018

Dr. Joe K. Kizhakudan Delivered lecture at the National Symposium on Recent advances in marine Sciences, Satyabama University, Chennai, 14 September 2017

Delivered lecture for the benefit of the staff of the Fisheries Staff Training Institute. Fisheries Staff Training Institute, TNAU, Chennai, 11 October 2017

IMC meeting of ICAR-CIBA, Chennai, 28 October 2017

Training programme on "Managing Innovations and Technology for Competitiveness," Administrative Staff College of India, Hyderabad, 22 January–02 February 2018

Dr. B. Johnson Brainstorming session on Seaweed Farming and its Utilisation, Veraval, Gujarat, 9 May 2017

National Seaweed Conference of India, Chennai, 16 September 2017

Symposium on 'Building Resilience for Sustaining Development', Madurai, 21 September 2017

National Symposium on 'Algal Diversity and Resource Status: Current Trends in Utilisation and Prospects for Innovations', Tuticorin, 22-23 September 2017

Centre for Advanced Faculty Training (CAFT) on Advances in Instructional Technologies in Enhancing Teaching-Learning and Training Competencies, IARI, New Delhi, 13 October –2 November 2017

Consultation meeting organised by Gulf of Mannar Biosphere Reserve Trust (GoMBRT), Ramanathapuram, 12 January 2018

Dr. K. K. Joshi, Dr. Molly Varghese, Dr. S. Jasmine, Dr. K. S. Sobhana, Dr. K. Vinod, Dr. Miriam Paul Sreeram, Dr. K. R. Sreenath, Dr, Raju Saravanan, Dr. L. Ranjith, Dr. S. Ram Kumar, Dr. Pralay Ranjan Behera, Dr. Divya Viswambharan and Shri. Tarachand Kumavat Inception Workshop of the in-house project "Developing Conservation Plan for Biologically Sensitive Areas along the Indian Coast, CMFRI, Kochi, 19-20 June 2017

Dr. K. K. Joshi, Dr. P. Laxmilatha, Dr. Molly Varghese, Dr. S. Jasmine, Dr. K. S. Sobhana, Dr. K. Vinod, Dr. Miriam Paul Sreeram, Dr. K. R. Sreenath, Dr, Raju Saravanan, Dr. L. Ranjith, Dr. S. Ram Kumar, Dr. Pralay Ranjan Behera, Dr. Divya Viswambharan and Shri. Tarachand Kumavat Inception workshop of the project "Investigations on the scyphozoan and cubozoan jelly fishes diversity and distribution along the Indian coast, CMFRI, Kochi, 21 June 2017

Dr. K. K. Joshi, Dr. P. Laxmilatha, Dr. Molly Varghese, Dr. S. Jasmine, Dr. K. S. Sobhana, Dr. K. Vinod, Dr. Miriam Paul Sreeram, Dr. K. R. Sreenath, Dr, Raju Saravanan, Dr. L. Ranjith, Dr. S. Ram Kumar, Dr. Pralay Ranjan Behera, Dr. Divya Viswambharan and Shri. Tarachand Kumavat Inception workshop of the project "Assessment of resilience potential of coral reefs", CMFRI, Kochi, 22-23 June, 2017

Dr. Josileen Jose and Dr. Rekha Devi Chakraborty International workshop on Taxonomy of hermit crabs organised by Department of Aquatic Biology & Fisheries, University of Kerala, Thiruvananthapuram, 20-21 February 2018

Shri. C. Kalidas Training programme on live feed culture techniques, CMFRI, Vizhinjam, 13-16 December, 2017

Training on Marine finfishes larvae culture, CMFRI, Vizhinjam, 22-27 January 2018

Workshop on *Spirulina* in aquaculture at Kamaraj College. Thoothukudi, 22 February 2018

Shri. Kapil S. Sukhdhane 'Policies to Action National Workshop on Coastal Zone Management' by Gujarat Ecological Education and Research (GEER) Foundation, Govt.

Partcipations

of Gujarat, Gandhinagar, Gujarat, 12-13 January 2018

Smt. M. Kavitha, Smt. Remya, Shri. S. Vinothkumar and Shri. M. Rajkumar ICAR sponsored Summer School on Advanced methods for Fish Stock Assessment and Management, CMFRI, Kochi, 12 July–1 August 2017

Dr. V. Kripa Skill development programme Training on assembling LED bulbs (to reduce carbon foot print) and fabrication of eco-friendly bags and paper bags to reduce use of plastic carry bags, Vayanashaala NSS Hall, Cheranalloor, 6 May 2017

Hands-on training on production of eco-friendly cloth bags, and paper bags to reduce use of plastic carry bags, Chernalloor, 14 June 2017.

Awareness programme for youth – Impact on climate change on coastal ecosystem, SN College, Nattika, Thrissur, 20 June 2017

Awareness class on plastic pollution in water bodies, Govt. HSS, Elamakkara, 8 September 2017

Invited speaker for Workshop on 'Climate Change Resilience Management' organised by Institute for Management in Government, Thiruvananthapuram, Kerala, 20 December 2017

Delivered invited lecture on 'Impact of Urbanisation on Wet lands' on World Wet lands Day, Sacred Hearts College, Thevara, 2 February 2018

Delivered invited lecture – on 'How to protect our wet lands' for World wet land day celebration, St. Michael's College, Cherthala, 5 February 2018

Round Table Conference on Climate Change and Wetlands of Kerala, Institute for Climate Change Studies, Kottayam, 9 February 2018

Awareness programme to control plastic wastes for marine debris management, St. James School, Cheranalloor, 8 March 2018

Invited speaker of the National seminar on impairment of ocean health due to inadequate waste management on the terrains organised by Cochin University of Science and Technology, Kochi, 9 March 2018

Global Challenges Research Fund (GCRF) sponsored Plastics in Society Research & Innovation Hub India Workshop, Indian Institute of Science, Bangalore, 28 – 29 March 2018

Dr. V. Kripa, Dr. Sunil Mohamed, Dr. Imelda Joseph, Dr. Reeta Jayasankar, Dr, D. Prema, Dr. R. Jeyabaskaran and Dr. Shelton Padua Model coastal village development programme in collaboration with Mulavukadu Panchayath, Mulavukadu, Ernakulam, 27 February 2018

Dr. P. Laxmilatha First meeting of the Committee constituted by the Dept. of Environment as per guidance issued by Govt. of Tamil Nadu, to assess environmental impact and suggest remedial measures on oil spill at Ennore, due to collision of fishing boats, Tamil Nadu Forest Department, Chennai, 4 April 2017

Special guest in a one-day workshop organised by FICCI-CIBA on "Revitalising Fisheries in Tamil Nadu", CIBA, Chennai, 30 May 2017

Training programme on PFMS conducted by ICICI and Axis banks, CMFRI, Kochi, 20 September 2017

Foundation Day of the Marine Biodiversity Authority held at National Biodiversity Authority, Chennai, 3 October 2017

Meeting with the Fisheries Expert from World Bank Mission with regard to progress on bivalve farming, fisheries database development and fish seed production for cage culture FIMSUL II, Directorate of Fisheries, TNFD, Chennai, 4 October 2017

Dr. P. Laxmilatha and Dr. J. Jayashankar Meeting with officials of Tamil Nadu Fisheries Department to discuss about the issues and progress made in the implementation of FIMSUL II project, Chennai, 1 December 2017

Dr. P. Laxmilatha and Dr. Joe K. Kizhakudan Training for FMS and E-procurement, CMFRI, Kochi, 20-21 June 2017

Meeting to discuss about the implementation of open sea cage culture programme and conduct of scoping studies in UT of Puducherry as part of the CSS Blue Revolution scheme at the Department for Fisheries and Fishermen Welfare, Puducherry, 6 December 2017

Oyster-mussel farming stakeholder meet for site selection and beneficiary identification in Cuddalore and Kancheepuram districts for the FIMSUL II project onn bivalve farming, Chinna Cuddalore and Kottaikaadu, Kanchipuram District, 31 March 2018

Dr. P. Laxmilatha, Dr. Vidya Jayasankar and Dr. V. Srinivasa Raghavan Meeting convened by the Director of Environment, Chennai to review the items of works to be taken up through various Departments/Institutions based on the report of the Expert Committee held at Department of Environment, Govt. of Tamil Nadu, Chennai, 5 January 2018

Dr. Loveson L. Edward Orientation programme on the usage and analysis of antibiotics, chemicals, feed additives and other aqua inputs for aqua stakeholders. Visakhapatnam, 14 December 2017

District level Awareness Workshop on Bio-Diversity conservation, Visakhapatnam, 30 January 2018

AP Fish Tech – 2018, Visakhapatnam, 23–24 March 2018

Dr. Loveson, L. Edward, Smt. Ramya Abhijith and Shri. Kapil S. Sukhdhane Inception workshop on Identification of Marine Macrophytes and Assessment of Seagrass Ecosystem Services (IMASES-2017), Mandapam, 4-6 October 2017

Dr. G. Maheswarudu Meeting with the Director, Trade Policy Division, Department of Commerce, Government of India, MPEDA, Kochi, 6 July 2017

Annual meeting of Board of Studies in Department of Marine Living Resource, Andhra University, Visakhapatnam, 15 July 2017

Dr. G. Maheswarudu, Dr. Josileen Jose and Dr. Rekha Devi Chakraborty Workshop on 'Silt in Vembanad–advantages and disadvantages', CMFRI, Kochi, 22 April 2017

Dr. G. Maheswarudu, Dr. Josileen Jose, Dr. A. P. Dineshbabu,Dr. S. Lakshmi Pillai, Dr. P. T. Sarada, Dr. K. N. Saleela, Dr. Rekha Devi Chakraborty, Dr. Ratheesh Kumar, Shri. Rajkumar, Shri. Rajan Kumar and Dr. V. Mahesh Inception workshop of the project "Development of guidelines for Best practices for trawl fishery in India" and a divisional workshop for the Crustacean Fisheries Division Scientists, Mangalore Research Centre of CMFRI, 3-4 August 2017

Dr. G. Maheswarudu, Dr. S. S. Raju, Ms. Indira Divipala, Dr. F. Jasmin and Dr. Loveson, L. Edward National level Demonstration Workshop on "Data Collection through Focus Group Discussion (FGD) for best practices for trawl fishery in India, Visakhapatnam Regional Centre of CMFRI, 14–16 November 2017

Dr. P. P. Manojkumar Role of ICAR-NAARM in Shaping Agricultural Research and Education System Management for 2030, NAARM, Hyderabad, 31 August–1 September 2017

42nd Foundation Day Celebration of NAARM, NAARM, Hyderabad, 31 August–1 September 2017

Dr. P. P. Manojkumar and Dr. I. Jagadis Harvest of lobsters under FIMSUL project organised by Tamil Nadu State Fisheries Department, Sippikulam, Tuticorin, 16 December 2017

Dr. P. P. Manojkumar, Dr. I. Jagadis and Dr. L. Ranjith Lobster harvest programme under FIMSUL II organised by State Fisheries Department. Sippikulam, Tuticorin, 13 July 2017

Dr. P. P. Manojkumar, Dr. I. Jagadis, Dr. P. S. Asha, Dr. C. P. Suja, Shri. C. Kalidas and Dr. L. Ranjith Workshop on dissemination of innovative technology, jointly organised by the Aditanar College of Arts and Science and ICAR-TRC of CMFRI, CMFRI, Tuticorin, 26 September 2017

Dr. P. P. Manojkumar and Dr. L. Ranjith Regional Dialogue on Management of Highly Migratory Fish Species in the Bay of Bengal, organised by Bay of Bengal Programme Inter-Governmental Organisation, CIFT, Kochi, 23 November 2017

Dr. K. S. Mohamed Fisheries Stakeholders Meeting at Thiruvananthapuram, 22 May 2017

Meeting to discuss on the topic, "International legally binding instrument under the United Nations Convention on the Law of the Sea (UNCLOS) on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction" at CMLRE, Kochi, 20 June 2017

Co-chaired the Technical Session of the OSICON-17 Conference organised by NCESS, Thiruvananthapuram, 29 August 2017

One day National Seminar on "Harmonising

Partcipations

coastal industrialisation with marine ecosystem", Mangalore, 25 September 2017

Meeting on Impact of LED light fishing in coastal states chaired by Minister of Fisheries, Govt. of Goa, Panaji, Goa, 4 October 2017

Meeting for discussing data collection system for marine fisheries landings and Marine Fisheries Code at Krishi Bhavan, New Delhi, 24 October 2017

First Meeting of the Expert Committee for revalidation of potential fishery resources in the Indian EEZ at Fishery Survey of India, Mumbai, 4 November 2017

Meeting on the issues related to establishment of commercial Pearl Production in A&N Islands at Raj Niwas, Port Blair, 8 March 2018

Dr. K. S. Mohamed, Dr. P. K. Asokan, Dr. I. Jagadis, Dr. M. K. Anil, Dr. Geetha Sasikumar, Dr. V. Venkatesan, Dr. R. Vidya, Shri. Rajaesh Kumar Pradhan, Shri. S. N. Bhendekar, Smt. M. Kavitha, Smt. F. Jasmin and Smt. P. Gomathi Workshop on Taxonomy of commercial molluscs - Moll Taxa, CMFRI, Kochi, 27-28 November 2017

Dr. K. S. Mohamed, Dr. P. Vijayagopal, P. K. Asokan and Dr. N. Aswathy Aquaculture Kerala 2018 – A Blue Revolution Initiative, Kanur, 10-11 February 2018

Dr. K. S. Mohamed, Dr. Josileen Jose and Dr. B. Johnson Stakeholder Meeting on Blue Swimming Crab for MSC Certification at Mandapam Regional Centre of ICAR-CMFRI, 6 January 2018.

Dr. K. Mohammed Koya Consultative Group Meeting, Fishery Surevey of India (FSI), Visakhapatnam, 9 February 2018

Dr. K. Mohammed Koya, Dr. K. R. Sreenath, Dr. D. Divu, Dr. Vinay Kumar Vase, Dr. Kapil S. Sukhdhane and Dr. Rajesh Kumar Pradhan Training expeditions on "Sustainable management of Marine Fisheries for Conserving Coastal and Marine resources" organised jointly by GIZ and Veraval RC of ICAR-CMFRI, Veraval, 19-21 April 2017

Dr. K. Mohammed Koya, Dr. K. R. Sreenath, Dr. D. Divu, Dr. Vinaya Kumar Vase, Dr. Kapil S. Sukhdhane, Shri. P. Abdul Azeez and Shri. Tarachand Kumawat Training expeditions on "Sustainable management of Marine Fisheries for Conserving Coastal and Marine resources' organised jointly by GIZ and Veraval RC of ICAR-CMFRI, 24-26 April 2017

Dr. K. Mohammed Koya, Dr. Kapil S. Sukhdhane, Dr. D. Divu, Dr. Rajesh Kumar Pradhan, Dr. K. R. Sreenath, Dr. Vinay Kumar Vase and Shri. Tarachand Kumawat "Brainstorming session on seaweed farming and its utilisation in Gujarat". Veraval RC of ICAR-CMFRI, 9 May 2017

Dr. T. M. Najmudeen NICRA review workshop on Modelling technical programmes, IARI, New Delhi, 12-13 February 2018

Dr. T. M. Najmudeen and Shri. C. Kalidas Training Programme on "Developing winning research proposals in agricultural research, ICAR-NAARM, Hyderabad, 1-5 August 2017

Dr. Raju Saravanan Centre for Advanced Faculty Training (CAFT) on Recent analytical techniques in statistical genetics and genomics, ICAR-IASRI, New Delhi, 17 January- 6 February 2017

Tarunotsav programme, Kendriya Vidyalaya, Mandapam, 22 February 2018

Dr. L. Ranjith State level Steering Committee Meeting on Annual Plan of Operation for the Conservation of Mangroves, Wetlands and Coral Reefs in Tamil Nadu, Tamil Nadu Forest Department, Chennai, 25 April 2017

Fisherman and stakeholders meet on doubling the farmer's income under PMs New India movement, SCAD KVK, Tuticorin, 30 August 2017

Resource person for the one day training programme on Tuna Processing–Tharuvaikulam, Tuticorin, 13 September 2017

Meeting on proposed Water Sports Activity at Tuticorin in the Sub-Collector's Office, Tuticorin, 3 November 2017

Delivered lecture in the Workshop on the Conservation and management of Marine resource in Gulf of Mannar, G. Venkataswamy Naidu College, Kovilpatti, 11 January 2018

Dr. L. Ranjith, Shri. Vinay Kumar Vase and Shri. P. Abdul Azeez SAFARI-2 Pre-symposium training related to latest tutorials in satellite data for fisheries and aquaculture applications, ICAR-CMFRI, Kochi, 12-14 January, 2018

Smt. L. Remya Consultation workshop on Preparation of management plan of Gulf of Mannar National Park and Biosphere Reserve for the period 2017-18 to 2026-27, Ramanathapuram, Tamil Nadu, 27 June 2017

Smt. R. Remya Climate change impacts: Reflections and upshots on Indian marine ecosystem. Winter School on Structure and Function of the Marine Ecosystem: Fisheries, Kochi, 1-21 December 2017

Smt. K. J. Reshma 'KSCSTE sponsored National Seminar on Molecular Tools and Disease Diagnosis', Thrissur, 15-16 March 2018

Dr. M. Sakthivel Centre for Advanced Faculty Training (CAFT) on Advanced Statistical Techniques in Biometrics, ICAR-IASRI, New Delhi, 10-30 August 2017

Meeting on Formulation of guidelines for Green Certification of marine ornamental fish sales, ICAR-CMFRI, Kochi, 25 October 2017

National Review Workshop on 11th Review on the progress under Blue Revolution. Union Secretary, DAHDF, Govt. of India, New Delhi, 10 November 2017

National Workshop on Potential and viability of culturing endemic and exotic species, ICAR-CIBA, Chennai, 29 December 2017

Workshop on Genetic Improvement Programme in Cobia, ICAR-CMFRI, Kochi, 5 January 2018

Meeting with Vice Admiral A. R. Karve, PVSM, C-in-C, Southern Naval Command, Kochi, 17 March 2018

Shri. Sanal Ebeneezar National Training programme in Molecular Biology and Biotechnology for Fisheries Professionals, sponsored by Department of Biotechnology, Govt. of India, ICAR-CMFRI, Kochi, 15 February–15 May 2017

'Workshop on Next Generation Sequencing and its applications in Fisheries and Agricultural Sciences for Beginners', organised by ICAR-CMFRI, Kochi and AgriGenome Labs Private Limited, ICAR-CMFRI, Kochi, 7-8 November 2017

Winter School on 'Marine nutrients for fighting malnutrition: Recent Advances in marine biomolecules for human nutrition and health care', ICAR-CIFT, Kochi, 01-21 February 2018

Centre for Advanced Faculty Training (CAFT) in Fisheries Science, ICAR sponsored National Training Programme on Utilisation of proteins extracted from leaves and non-edible seeds for preparing fish feed, ICAR-CIFE, Mumbai, 6-16 March 2018

Dr. Sandhya Sukumaran 30th Kerala Science Congress, Govt. Brennen College, Thalassery, 28-30 January 2018

Workshop on Big Data Analytics in Agriculture, ICAR- National Academy of Agricultural Research Management (NAARM), Hyderabad, India, 08-09 February 2018

NextGen Genomics, Biology, Bioinformatics and Technologies" (NGBT 2017) Conference organised by SciGenom, Bhubaneswar, Odisha, 2-04 October 2017

International Virology Meet-2017, Mascot Hotel, Trivandrum, 4 December 2017

Dr. T. V. Sathianandan, Dr. J. Jayasankar, Dr. Somy Kuriakose, Dr. K. G. Mini, Dr. S. Lakshmi Pillai, Dr. U. Ganga, Dr. T. M. Najmudeen, Dr. Dineshbabu, Dr. Geetha Sasikumar, Dr. Shoba Joe Kizhakudan, Dr. Eldho Varghese, Shri. Vivekanand Bharti, Dr. K. M. Rajesh, Dr. Gyan Ranjan Dash, Dr. M. Muktha, Dr. F. Jasmin and Smt. M. Kavitha and Dr. K. Mohammed Koya Use of Catch-MSY tool for assessment of Indian fish stocks in a data poor environment, ICAR-CMFRI, Kochi, 5-6 October 2017

Dr. T. V. Sathianandan, Dr. P. U. Zacharia, Dr. G. Maheswarudu, Dr. J. Jayasankar, Dr. Somy Kuriakose, Dr. K. G. Mini, Dr. T. M. Najmudeen, Dr. Grinson George, Dr. Eldho Varghese and Shri. Vivekanand Bharti Workshop on potential yield estimation from Indian EEZ, CMFRI, Kochi, 5-6 March 2018

Dr. T. V. Sathianandan, Dr. K. S. Mohamed, Dr. J. Jayasankar, Dr. Somy Kuriakose, Dr. K. G. Mini, Dr. Grinson George, Dr. Eldho Varghese and Shri. Vivekanand Bharti 2nd Meeting of the Expert Committee for revalidation of potential fishery resources in the Indian EEZ, CMFRI Kochi, 9 March 2018

Dr. Sekar Megarajan Training programme on analysis of experimental data, ICAR-NAARM, Hyderabad, 03-09 August 2017

Partcipations

Promotion of Mariculture in coastal waters of Andhra Pradesh, Fisheries Department, Vijayawada, 14 September 2017

Smt. Shikha Rahangdale Training workshop on biodiversity conservation for women Scientists/ technologists, WII, Dehradun, 19-23 March 2018

Smt. M. T. Shilta Training on 'Histological Techniques' at ICAR-CMFRI, Kochi, 8–12 January 2018

Hands-on training on 'Microbiological Techniques' at ICAR-CMFRI, Kochi, 2 to 6 April 2018

Dr. P. Shinoj 'National Consultation Meet on Fisheries Policy' organised by NABARD, Kochi, 24-25 April 2017

Applications of GAMS for policy analysis in Agriculture at Department of Agricultural Economics, Thrissur, 6 June 2017

Doubling Farmers Income by 2022, KAB II, Pusa, 7 June, 2017

'Fish for Food' Project Workshop, Chennai, 2 August 2017

'Network Project Planning Workshop, New Delhi, 30-31 August 2017

'Doubling Farmers' Income, Krishi Bhavan, 10 October 2017

'Doubling Farmers' Income at NASC, New Delhi, 3 November 2017

Task force on Fishery Subsidies, Krishi Bhavan, New Delhi, 28 February 2018

Dr. Shoba Joe Kizhakudan 12th CITES Cell Meeting, Ministry of Environment, Forest and Climate Change, New Delhi, 31 May 2017

Dr. Shyam S. Salim Methodological approaches for socio-economic vulnerability assessment in marine fisheries sector" sponsored by MoEFCC-NCSCM, Chennai, NAARM Hyderabad, 6 April 2017

Tropical Marine Fisheries Governance–the way forward, Kochi, 17 April, 2017

Theeramythri Ekadina Shilpashala, Kochi, 29 April 2017

Theeravasantham programme, Kochi, 8 May 2017

Presentation on "Climate change: Unfurling the science and gearing up for the future", Beemapally UP School, 11 May 2017

CMFRI involvement in Women's Empowerment initiatives in Kerala, CMFRI, Kochi, 8 June 2017

Gender concerns and Mainstreaming during an off campus training programme in Managerial skills for extension professional for the officers of the Fisheries Department, NIFAM East Kadungaloor, Aluva, 14 July 2017

Delivered talk on "Fish trade, price realisation and market interventions in Kerala" for the Fish4food Workshop, Chennai, 2 August 2017

Delivered talk on "Careers in feeding the masses", a career oriented presentation programme for higher secondary students from different schools, organised by KVK, Njarakkaal, 27 October 2017

Meeting on Objectives and work plan of the project on developing a Solar City Master Plan Kochi, 28 October 2017

E-marketing portal on fish markets and prices, Hyderabad, 7-8 November 2017

World Fisheries Day, New Delhi, 20-21 November 2017

NICRA–Training on Multivendor E-commerce Website and Mobile App for Fish Farmers, Kochi, 16 December 2017

Project Appraisal and Monitoring Committee (PAMC) on Ocean Science and Resources. Hyderabad, 11-12 January 2018

Low-carbon urban energy, mobility and waste management solutions, Kochi, 22 January 2018

Fishery Performance Indicators for Yellow fin Tuna and Skipjack Tuna, Chennai, 12-13 March 2018

Crises in Fisheries Sector and Regulatory measures on sustainable development, Kochi, 20 March 2018

INTERACT 'Bio: Integrated sub-national action for Biodiversity' Supporting implementation of National Biodiversity Strategy and Action Plan (NBSAP)', Kochi, 28 March 2018

Fisher Marginalisation with Technological Improvements and Climate Change in Kerala, Thiruvananthapuram, 26-28 March 2018

International Symposium on Aquaculture and Fisheries Education, ICAR-CIFE, Mumbai, India, 16–18 May 2018

Dr. M. Sivadas, Dr. P. P. Manojkumar, Dr. I. Jagadis, Dr. A. Margaret Muthurathinam, Dr. Shoba Joe Kizhakudan, Dr. P. T. Sarada, Smt. M. Kavitha, Smt. Remya, Shri. Rajan Kumar and Smt. Shikha Rahangdale Inception workshop of the project "Resource Assessment and Management Framework for Sustainable Marine Fisheries of Tamil Nadu and Puducherry", Madras RC of CMFRI, Chennai, 18-19 August 2017

Dr. M. Sivadas and Dr. Shoba Joe Kizhakudan Final workshop on Life-Cycle Assessment under NICRA, CMFRI, Kochi, 25-27 October 2017

Dr. M. Sivadas and Dr. Shoba Joe Kizhakudan "One-day Skill Development Workshop towards building Climate-smart Fishing Communities in Thiruvallur District, Tamil Nadu", Nettukuppam, Thiruvallur District, 9 March 2018

Dr. K. S. Sobhana National Consultation Meet on "Faster reach of innovations from Aquaculture Research through Media: A Science communication perspective', ICAR-CIFA, Bhubaneswar, 27 October 2017

National Workshop on "Copyright considerations for Digital Libraries" organised by the of the National Digital Library (NDLI) project of Ministry of Human Resource Development (MHRD). 8-10 February 2018

Dr. C. P. Suja Research Board Meeting of the Manonmaniam Sundaranar University, Tirunelveli, 29 November 2017

Dr. T. G. Sumithra 27th Swadeshi Science Congress, Amrita School of Engineering, Vallikkavu, Kollam, Kerala, 7-9 November 2017

ICAR sponsored winter school on "Antimicrobial resistance in fish and aquatic environment and its impact on human health. ICAR-CIFT, Kochi, 1-21 December 2017

Scientific review of the project entitled, State laboratory for Livestock Marine and Agricultural Products (SLMAP), Ernakulam, 3 February 2018

Meeting for the Technical programme Presentation of students of B. Sc.-M. Sc. (Integrated) Biotechnology students, College of Agriculture, Vellayani, Thiruvananthapuram, 20 March 2018

Dr. K. Vijayakumaran Member of the committee for assessing environmental impact of oil spill in consequence of the collision of 2 ships in the sea off Ennore. Kamarajar Port Ltd., Chennai, 6 June 2017

4th State Level Technical Committee meeting of the CDRRP (Coastal Disaster Risk Reduction Programme) FIMSUL II (Fisheries Management for Sustainable Livelihoods II) Project held at Directorate of Fisheries, Tamil Nadu Fisheries Department, Chennai, 25 July 2017

Represented CMFRI at the first meeting of the revised committee on International Indian Ocean Expedition II (IIOE II), Prithvi Bhavan, Ministry of Earth Sciences, New Delhi, 28 July 2017

Plenary talk on "In search of right incentives and drivers in scientific research- A freewheeling exploration in Indian scientific landscapes" at the National Seminar on "Reaching the Unreached conducted by Sree Narayana College, Kollam, 12-14 February 2018

Dr. K. Vijayakumaran, Dr. K. K. Phillipose, Dr. G. Maheshwarudu, Dr. P. Kaladharan, Dr. P. Jayashankar, Dr. P. U. Zacharia, Dr. M. Sivadas, Dr. I. Jagadis and Dr. P. Vijayagopal Thinking beyond science–An interactive communion for co-scripting the next chapter in life, Karwar RC of CMFRI, 14-15 September 2017

Shri. Vinay Kumar Vase Training on "Ecopath with Ecosystem (EwE)' conducted by Internationale Zusammenarbeit (GIZ) GmbH, Biodiversity Programme Office, New Delhi, India. Goa, 8-12 May 2017

Shri. Vinay Kumar Vase and Shri. Tarachand Kumawat Stakeholder Consultation on 'Marine Conservation in Gujarat' by WWF India and GEER Foundation, Govt. of Gujarat. Gandhinagar, Gujarat, 14 September 2017

Dr. K. Vinod 4th College-level Council Meeting

Partcipations

for finalisation of project technical programme of 2013 batch students at the Academy of Climate Change Education and Research (ACCER), Kerala Agricultural University, KAU, 21 July 2017

Meeting on the occasion of World Fisheries Day celebration organised at Deputy Director of Fisheries Office (Regional), Ramanathapuram, Tamil Nadu, 21 November 2017

Consultative Workshop on ‘Preparation of India’s Sixth National Report to Convention on Biological Diversity and Reporting on the Progress Achieved on India’s National Biodiversity, Wildlife Institute of India, Dehradun, 19 February 2018

Dr. K. Vinod and Dr. S. Jasmine Meeting convened by the Chairman, Kerala State Biodiversity Board to discuss the work plan of the proposed project on ‘Valuation of marine and coastal ecosystem in Kadalundi Community Reserve, Thiruvananthapuram, 7 December 2017

Dr. V. P. Vipinkumar SHG meet for women. Poyya, Thrissur, 5 August 2017

Meeting with SHGs. Thayyil, Kannur, 17 August 2017

Meeting with Fertifish SHGs, Munambam and Snehatheeram, 22 September 2017

Dr. P. Vijayagopal Society of Aquauclture Professionals (SAP) Symposium on key topics in aquaculture nutrition, Chennai, 1 February 2018

Dr. P. U. Zacharia, Dr. V. Kripa, Dr. G. Maheswarudu, Dr. T. V. Sathianandan, Dr. K. K. Joshi, Dr. Prathibha Rohit, Dr. R. Narayanakumar, Dr. C. Ramachandran, Dr. U. Ganga, Dr. V. Venkatesan, Shri. K. Mohammed Koya, Dr. Grinson George, Dr. K. R. Sreenath, Dr. P. Shinoj, Dr. S. S. Raju and Dr. Shubhadeep Ghosh Workshop on “Sustainable development Goal 14: Life Below Water. Effective and inclusive management of Marine and Coastal Ecosystems to promote Human well-being and sustainable development”, CMFRI, Kochi, 4-5 July 2017

Dr. P. U. Zacharia, Dr. K. S. Mohamed, Dr. V. Kripa, Dr. G. Maheswarudu, Dr. T. V. Sathianandan, Dr. R. Narayanakumar, Dr. K. K. Joshi, Dr. Imelda Joseph, Dr. P. Vijayagopal, Dr. E. M. Abdussamad, Dr. P. Kaladharan, Dr. Josileen Jose, Dr. K. S. Sobhana, Dr. K. Madhu, Dr. Shoji Joseph, Dr. Molly Varghese, Dr. C. Ramachandran, Dr. J. Jayasankar, Dr. Boby Ignatius, Dr. Rema Madhu, Dr. D. Prema, Dr. S. Lakshmi Pillai, Dr. Rekha J. Nair, Dr. V. P. Vipinkumar, Dr. Shyam S. Salim, Dr. Miriam Paul Sreeeam, Dr. T. M. Najmudeen, Dr. R. Jeyabaskaran, Dr. N. Aswathy, Dr. Rekha Devi Chakraborty, Dr. V. Venkatesan, Dr. Grinson George, Dr. Sandhya Sukumaran, Dr. Shelton Padua, Dr. S. R. Krupesha Sharma, Dr. M. A. Pradeep, Shri. K. Mohammed Koya, Dr. K. R. Sreenath, Dr. P. Shinoj, Dr. R. Vidya, Shri. Sanal Ebeneezar, Dr. T. G. Sumithra, Smt. Livi Wilson, Dr. D. Divu, Dr. Vinaya Kumar Vase, Dr. Rajesh Kumar Pradhan, Shri. Tarachand Kumavat, Shri. P. Abdul Azeez, Dr. Anulekshmi Chellappan, Dr. K. V. Akhilesh, Dr. S. Ramkumar, Shri. M. Rajkumar, Shri. D. Ajay Nakhava, Shri. S. N. Bhendekar, Shri. R. Rateesh Kumar, Dr. Jayashree Loka, Dr. P. P. Suresh Babu, Shri. A. Anuraj, Dr. Prathibha Rohit, Dr. A. P. Dineshbabu, Dr. Sujitha Thomas, Dr. Geetha Sasikumar, Dr. Bindu Sulochanan, Dr. K. M. Rajesh, Dr. G. B. Purushothama, Dr. Divya Viswambharan, Dr. P. P. Manojkumar, Dr. C. P. Suja, Shri. C. Kalidas, Dr. L. Ranjith, Shri. D. Linga Prabu, Smt. M. Kavitha, Shri. Rajan Kumar, Smt. Shikha Rahangdale, Dr. M. K. Anil, Dr. B. Santhosh, Dr. P. S. Swathi Lekshmi, Dr. S. Jasmine, Smt. P. Gomathi, Smt. S. Surya, Shri Ambarish P. Gop, Dr. V. Mahesh, Smt. M. T. Shilta, Shri. Kapil S. Sukhdhane, Dr. B. Johnson, Dr. P. Ramesh Kumar, Dr. M. Sakthivel, Dr. K. K. Anikuttan, Dr. Raju Saravanan, Smt. L. Remya, Shri. S. Chandrasekhar, Shri. S. Thirumalaiselvan, Shri. M. Sankar, Dr. P. Laxmilatha, Dr. M. Sivadas, Dr. P. T. Sarada, Dr. Joe K. Kizhakudan, Dr. Shob Joe Kizhakudan, Dr. Vidya Jayashankar, Dr. Srinivasa Raghavan, Smt. E. M. Chhandaprajnadarsini, Shri. Adnan Hussain Gora, Smt. Salma Rehman, Dr. Shubhadeep Ghosh, Dr. S. S. Raju, Dr. Biji Xavier, Dr. Ritesh Ranjan, Dr. M. Muktha, Dr. Pralaya Ranjan Behera, Dr. Sekar Megarajan, Shri. L. Loveson Edward, Smt. Indira Divipala, Smt. F. Jasmin and Shri. Subal Kumar Roul. 11th Indian Fisheries and Aquaculture Forum, Fostering Innovations in Fisheries and Aquaculture: Focus on Sustainability and Safety. ICAR-Central Institute of Fisheries Technology, Kochi and Asian Fisheries Society, Indian Branch, Kochi, 21-24 November 2017

Dr. P. U. Zacharia, Dr. K. S. Mohamed, Dr. V. Kripa, Dr. G. Maheswarudu, Dr. P. Jayasankar, Dr. T. V. Sathianandan, Dr. R. Narayanakumar, Dr. K. K. Joshi, Dr. Imelda Joseph, Dr. P. Vijayagopal, Dr. P. Kaladharan, Dr. Reeta Jayasankar, Dr. Josileen Jose, Dr. K. S. Sobhana, Dr. Molly Varghese, Dr. J. Jayasankar, Dr. Boby Ignatius, Dr, D. Prema, Dr. S. Lakshmi Pillai, Dr. N. K. Sanil, Dr. Somy Kuriakose, Dr. Rekha J. Nair, Dr. V. P. Vipinkumar, Dr. Shyam S. Salim, Dr. Miriam Paul Sreeeam, Dr. K. G. Mini, Dr. N. Aswathy, Dr. Rekha Devi Chakraborty, Dr. Grinson George, Dr. Eldho Varghese, Dr. Sandhya Sukumaran, Dr. V. Venkatesan, Dr. Shinoj Subramannian Dr. Shelton Padua, Shri. N. Rajesh, Shri K. Mohammed Koya, Dr. K. R. Sreenath, Shri. P. Shinoj, Dr. Eldho Varghese, Shri. Vivekanand Bharti, Shri. Sanal Ebeneezar, Dr. D. Divu, Dr. Vinaya Kumar Vase, Shri. P. Abdul Azeez, Shri. R. Ratheesh Kumar, Shri. Nakhava Ajay Dayaram, Shri. S. N. Bhendekar, Dr. Prathibha Rohit, Dr. A. P. Dineshbabu, Dr. P. P. Manojkumar, Dr. L. Ranjith, Dr. M. K. Anil, Dr. P. S. Swathi Lekshmi, Dr. P. K. Asokan, Dr. K. Vinod, Dr. P. Laxmilatha, Dr. Joe K. Kizhakudan, Dr. M. Muktha and Dr. Gyanaranjan Dash Second International Sympsium on Societal Applications in Fisheries and Aquaculture using Remote Sensing Imagery (SAFARI 2) on “Remote Sensing for Ecosystem Analysis and Fisheries”, ICAR-CMFRI, Kochi, 15-17 January 2018

Dr. P. U. Zacharia, Dr. P. P. Manojkumar, Dr. Rekha J. Nair, Dr. T. M. Najmudeen, Dr. Shoba Joe Kizhakudan, Dr. Sujitha Thomas, Dr. K. V. Akhilesh, Dr. M. Muktha, Smt. Shikha Rahangdale and Dr. V. Mahesh Training workshop on Elasmobranch Taxonomy, CMFRI, Kochi, 23-25 January 2018

Deputation Abroad

Dr. K. S. Mohamed Technical Advisory Board (TAB) as a Member of the Marine Stewardship Council (MSC) at London, United Kingdom, 3–7 July 2017

Technical Advisory Board (TAB) as a Member of the Marine Stewardship Council (MSC), Merida, Mexico, 11– 12 December 2017

Dr. M. Muktha Workshop on Best-practices for the production and reporting of SDG Indicator FAO, Rome, Italy, 21-24 November 2017

Shri. Vinay Kumar Vase Regional Ocean Governance Framework, Implementation of the United Nations Convention on The Law of The Sea (UNCLOS) and its related instruments in the Southeast Asian and the Indian Ocean, Hua Hin, Prachuap Khiri Khan, Thailand, 2-27 July 2017

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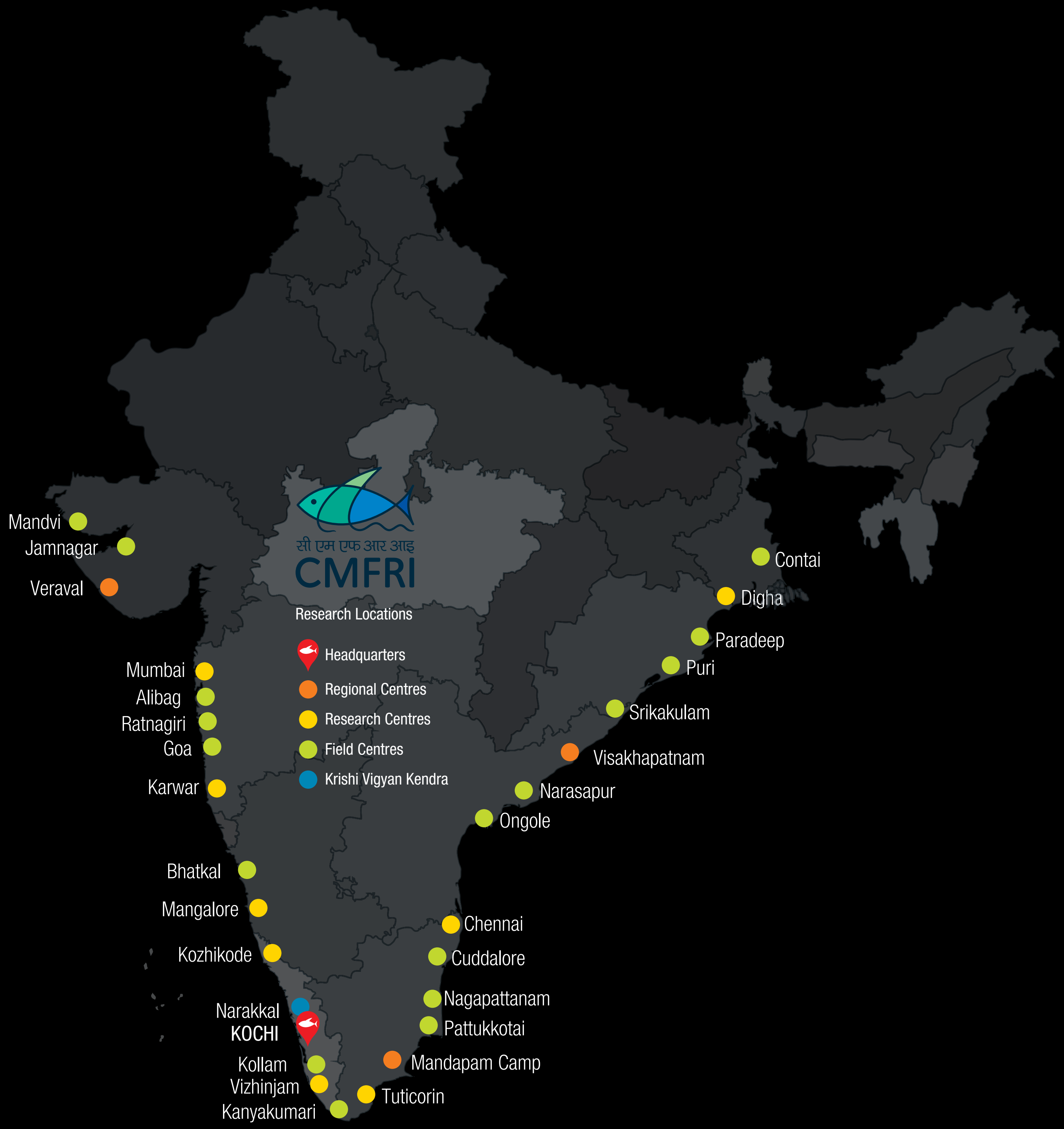

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