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Mumbai
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Ratnagiri
Goa
Karwar
Bhatkal
Mangalore
Kozhikode
Narakkal
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Kollam
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Nagapattinam
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Tuticorin

केन्द्रीय समुद्री मात्स्यिकी अनुसंधान संस्थान
CENTRAL MARINE FISHERIES RESEARCH INSTITUTE
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CMFRI

Research **Locations**

- Headquarters
- Regional Centres
- Research Centres
- Field Centres
- Krishi Vigyan Kendra

CENTRAL MARINE FISHERIES RESEARCH INSTITUTE

(Indian Council of Agricultural Research)

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Content


Mandate
To monitor the exploited and under-exploited marine fisheries resources of the Exclusive Economic Zone (EEZ)
To understand the fluctuations in abundance of marine fisheries resources in relation to change in the environment
To develop suitable mariculture technologies for finfish, shellfish and other culturable organisms in open seas to supplement capture fishery production
To act as a repository of information on marine fishery resources with a systematic database
To conduct transfer of technology, post-graduate and specialised training, education and extension-education programmes
To provide consultancy services
CENTRAL MARINE FISHERIES RESEARCH INSTITUTE

Preface

`Team CMFRI' as my predecessor mentioned, moves forward. Writing the preface of CMFRI annual report for the first time, I feel elated and humbled. I salute my teachers and contemporaries, as I draw a lot of strength from them. Accepting appreciation as well as criticism, our mission is to forge ahead for enriching and enhancing the marine fish food basket.

The year 2013 was remarkable for Indian marine fisheries as CMFRI could accomplish significant scientific and technological contributions towards developing the sector. We released the data on marine capture fisheries of India through a press conference for the first time. Marine policy briefs of Gujarat, Karnataka and Goa were prepared. The Marine Fisheries Census is scheduled for 2015 with funding from Department of Animal Husbandry, Dairying and Fisheries (DHADF) and pre-census workshops were completed. CMFRI has taken up Chlorophyll based Remote Sensing assisted Indian Fisheries Forecasting System (ChloRIFFS) for realising the harvestable potential of marine fishes from Indian EEZ based on *in situ* measurements and satellite remote sensing. GIS maps for 1200 fish landing centres along the Indian Coast were prepared by CMFRI to aid in geo-referencing of marine fish landings. Abundance maps of oceanic squids prepared by CMFRI indicate the underexploited cephalopod wealth in our marine realm.

With the technical inputs from CMFRI, the short-neck clam fisheries is one of the few scientifically managed fisheries in India. The World Wide Fund for Nature (WWF, India) initiated steps to get the fisheries eco-labelled as per the Marine Stewardship Council (MSC). Trawl Ban committee report was prepared with experts from CMFRI contributing immensely and involving all stake holders. Satellite Telemetry Studies on Migration Patterns of Tunas in the Indian seas (SATTUNA) carried out by CMFRI in collaboration with the Indian National Centre for Ocean Information Services (INCOIS), the Fishery Survey of India (FSI) and the Centre for Marine Living Resources and Ecology (CMLRE) which helped India join the select group of nations in this endeavour.

Marine litter threats and restoration of habitats is addressed by CMFRI through rapid surveys and impact assessments. Marine biodiversity of Lakshadweep is being mapped by CMFRI after 35 years. Under the National Initiative on Climate Resilient Agriculture (NICRA) we have

quantified the impact of temperature on capture fisheries, vulnerability of fishers to climate change and mitigation measures, climate preparedness activities of coastal villages to impacts of climate change and carbon life cycle assessment.

Brood bank and seed production in Recirculating Aquaculture Systems (RAS) was strengthened at Mandapam Centre to keep our focus on mariculture development. Indigenously fabricated RAS at Mandapam and Karwar proved to be highly cost-effective venture. Pompano (*Trachinotus mookalee*) breeding at Vishakhapatnam proved availability of expertise at multiple locations in marine food fish breeding and seed production at CMFRI.

Under the National Surveillance Programme for Aquatic Animal Diseases, to profile diseases in marine aquatic systems and health management in mariculture, cost-effective DNA-based diagnostic kits prepared would help end users engaged in finfish mariculture.

The CMFRI research project on "Global learning for Local Solutions: Reducing vulnerability of marine-dependent coastal communities (GULLS)" under the theme on Coastal Vulnerability has been sanctioned under the international research project initiative by Belmont Forum and G8 Research Councils International Opportunities Fund.

In infrastructure development, notable is the procurement of 19.75 m Research Vessel F.V Silver Pompano which was commissioned with funding from NICRA. Another vessel R.V Cadalmin -1 was also added to the fleet. Vizhinjam Research Centre of CMFRI started functioning from a new building.

Krishi Vigyan Kendra (KVK), Ernakulam under CMFRI demonstrated that integration of fish culture in *pokkali* fields improves yield and income. Innovative technologies like the use of a mini tiller in pokkali fields is one of the many front line demonstrations carried out by the KVK team.

The human resource development (HRD) cell of CMFRI was instrumental in the conduct of about 20 training programmes, both in-house and sponsored. It also facilitated award of 8 Ph.D's to research fellows and staff working in different research projects of the Institute. E-prints of CMFRI is now ranked at 352nd position among about 2000 repositories the world over. For the sixth time, Rajarshi Tandon Award for the excellent implementation of official language activities for the year 2012-2013 was awarded to CMFRI.

Finally, I acknowledge the support of all the scientists and staff of CMFRI; Fisheries Division of ICAR and DG, ICAR without which the Institute could not have made such progress.

2 July 2014
Kochi

Dr A Gopalakrishnan
Director

Executive **summary**

Central Marine Fisheries Research Institute (CMFRI) constantly strives for sustainable fisheries management and develops ecofriendly mariculture technologies through its 32 in-house research projects, 33 externally funded projects and 10 consultancy projects.

The estimate of all India annual marine fish landings for the year 2013 is 3.78 million t as against the all-time high of 3.94 million t during 2012 registering a decline of 1.56 lakh t (4%). Gujarat contributed the highest at 7.17 lakh t followed by Tamil Nadu with 6.88 lakh t and Kerala with 6.71 lakh t.

Annual marine fish landings in Gujarat was estimated at 7.17 lakh t. In Maharashtra, total fish landings was estimated at 3.64 lakh t, an increase of 15.7%. In Karnataka and Goa, marine fish landings was estimated at 4.37 lakh t and 1.04 lakh t respectively. The total fish landing of 6.87 lakh t in Tamil Nadu was contributed mainly by pelagic resources (56.5%) followed by demersal (28.9%), crustacean (5.9%) and molluscan (3.8%) resources. The total marine fish landing of Andhra Pradesh was 2.66 lakh t, a decrease of 12.5% over the previous year. The total production by trawlers during 2013 along the north-east coast of India was 1.57 lakh t. Trawl landings in Andhra Pradesh was 1.36 lakh t forming 51.8% of the total marine landings. In Odisha, the trawl catch was 0.82 lakh t forming 66% of the total fish landings. The estimated total fish production in Lakshadweep Islands was 9,021 t as against the 7,683 t in 2012.

Towards modeling and estimation of potential yield from the Indian EEZ, CMFRI initiated development of database of primary production and climatology of oceanographic data sets and *in situ* measurements of environmental variables, primary/secondary and tertiary biomass through experimental trawling in different stations in designated grids. GIS based resource mapping for data from 1200 landing centres has been initiated and mapping of junveniles and spawners of important resources off Mangalore has been carried out. The rapid stock assessment to classify the resources using time series data for the period 1985-2013 in Kerala, Karnataka, Tamil Nadu and Andhra Pradesh was also carried out.

Genetic stock structure of sardine and mackerel from the Indian Coast has been evaluated. Polymorphic microsatellite markers and mitochondrial

DNA markers have been developed for these species. In the edible oyster, *Crassostrea madrasensis*, regulation of the stress management genes were found to enhance thermal tolerance, indicating higher stress tolerance ability. Abiotic stress tolerant genes have been mined from halophilic *Tetraselmis indica* and the microalgae *Scenedesmus* sp.

Several micro algal fatty acid profiles reveal nuances in their polyunsaturated fatty acid (PUFA) content. Enrichment of rotifers with indigenously developed oil emulsions proved to be good import substitutes. Fatty acid concentrates from marine fish oils were studied for their physico-chemical properties and stability of PUFA rich sardine oil has also been investigated in detail with spectroscopy. A medusoid jellyfish has been identified from the local water bodies as a good larval feed for lobsters. A freeze-dried microbial product (MP) from *Pseudomonas aeruginosa*, with antagonistic properties and high protein has been developed. This product could be used in the development of larval feeds and high health feeds, as a feed additive.

CMFRI has made significant progress in seed production of cobia and pompano with the installation of Recirculating Aquaculture Systems (RAS) at Mandapam. Grow out of these species were carried out at Karwar in Karnataka and farms in Pedda Kammavaripalem, Nagayalanka in Andhra Pradesh. Integrated Multi Trophic Aquaculture (IMTA) has also been initiated integrating the seaweed *Kappaphycus alvarezii* with cobia at Munaikadu (Palk bay) in a participatory mode with fishermen group. Identification of bivalve farming sites in coastal Maharashtra has been completed and training on bivalve farming has been imparted to farmers in association with the ICAR Research Complex, Goa. Extension studies on mussel farming have led to establishment of Value Added Processing (VAP) units in and around Kollam in Kerala.

Coral diversity and growth, fish assemblage, sponges and other bioresources associated with coral reefs in Tuticorin, Agatti, Bangaram, Kadamat and Amini Islands of Lakshadweep and Goa were investigated. Assessment of fishing impacts on the biodiversity loss, with special reference to the juveniles and threatened species was carried out. Economic valuation of marine organisms in selected marine ecosystems has also been initiated

Impact of climate change on fish production under National Initiative on Climate Resilient Agriculture (NICRA) pursued database development and modeling the impact of temperature on capture fisheries and changes in spawning season. Relationships between rainfall and spawning, reduction in length at first maturity of mackerel and shrimp were studied. Carbon Life Cycle Assessment (LCA) in fisheries and strategies to enhance adaptive capacity to climate change in vulnerable regions were also pursued under NICRA.

Valuation of fish landings and economic performance of fishing methods in Kerala, Tamil Nadu, Karnataka, Maharashtra and Gujarat was done. Fishery governance, livelihood, gender and welfare capacity development for responsible fisheries management in India were also valuated. Valuable

data on supply chain management in marine fisheries sector is also being generated by CMFRI. Global learning for local solutions: Reducing vulnerability of marine-dependent coastal communities" (GULLS) the Belmont Project is an international effort which will specifically address the Belmont Challenge priorities in the area of coastal vulnerability - challenges that arise in food security and sustaining coastal livelihoods as a result of global warming and increasing human coastal populations.

CMFRI has acquired two new fishing vessels (F.V Silver Pompano and R.V Cadalmin 1) to further strengthen the sampling and data collection from the coastal waters. The Vizhinjam Research Centre of CMFRI is now functioning from the newly constructed building.

The Krishi Vigyan Kendra (KVK), Ernakulam under CMFRI is a knowledge and resource centre for all agriculture technologies in Ernakulam District. KVK demonstrated and popularised a number of aquaculture technologies, cage culture in granite quarries, package for pokkali fields, scientific mullet farming, freshwater carp seed production and *karimeen* (pearlspot) seed production.

The Library and Documentation team made further commendable efforts to enhance the visibility of the research outputs of CMFRI through *eprints@cmfri.org.in*

कार्यकारी सारांश

केन्द्रीय समुद्री मात्स्यिकी अनुसंधान संस्थान अपने 32 गृहांदर अनुसंधान परियोजनाओं, 32 बाहरी निधिबद्ध परियोजनाओं और 10 परामर्श परियोजनाओं द्वारा टिकाऊ मात्स्यिकी प्रबंधन और परिस्थिति अनुकूल समुद्री संवर्धन प्रौद्योगिकियॉ विकसित करने का प्रयास कर रहा है.

वर्ष 2013 का अखिल भारतीय वार्षिक समुद्री मछली अवतरण 3.78 मिलियन टन आकलित किया गया है, जो वर्ष 2012 के सर्वकालीन उच्चतम अवतरण 3.94 मिलियन टन की अपेक्षा 1.56 लाख टन (4%) की घटती दिखाता है. गुजरात में 7.17 लाख टन का उच्चतम अवतरण हुआ और इस के बाद तमिल नाडु में 6.88 लाख टन और केरल में 6.71 लाख टन का मछली अवतरण हुआ.

गुजरात में वार्षिक समुद्री मछली अवतरण 7.17 लाख टन रिकार्ड किया गया जो अब तक सभी वर्षों के अवतरण से उच्च था. महाराष्ट्र में कुल मछली अवतरण 3.64 लाख टन आकलित किया गया था, जो पिछले वर्ष की तुलना में 15.7% अधिक था. कर्नाटक और गोवा में समुद्री मछली अवतरण क्रमशः 4.37 लाख टन और 1.04 टन आकलित किया गया. तमिल नाडु में कुल 6.87 लाख टन के मछली अवतरण में अधिकांश वेलापवर्ती संपदाओं (56.5%) का योगदान था और तलमज्जी मछलियों (28.9%), क्रस्टेशियनों (5.9%) और मोलस्कों (3.8%) का भी योगदान हुआ. आंध्रा प्रदेश में कुल समुद्री मछली अवतरण 2.66 लाख था, जो पिछले वर्ष की अपेक्षा 12.5% कम था. वर्ष 2013 में भारत के उत्तर पूर्व तट पर आनायकों द्वारा आकलित कुल उत्पादन 1.57 लाख टन था. आंध्रा प्रदेश में कुल आनाय अवतरण 1.36 लाख टन था, जो कुल समुद्री मछली अवतरण का ही 51.8% था. उडीषा में आनाय मछली पकड़ 0.82 लाख टल आकलित की गयी, जो कुल मछली अवतरण का 66% था. लक्षद्वीप में कुल मछली उत्पादन वर्ष 2012 के 7,683 टन की अपेक्षा इस वर्ष 9,021 टन आकलित किया गया.

भारत की अनन्य आर्थिक मेखला से शक्य प्राप्ति के मोडलिंग और आकलन के लिए सी एम एफ आर आइ ने प्राथमिक उत्पादन का डाटाबेस और महासागरीय आंकडा सेट का जलवायुविज्ञानशास्त्र और पर्यावरणीय व्यतियानों का स्वस्थाने मापन, विभिन्न स्टेशनों के निर्दिष्ट ग्रिडों में परीक्षणात्मक आनायन करके प्राथमिक / द्वितीयक और तृतीयक जैवभार विकसित करने का प्रारंभिक कदम उठाया है. 1200 अवतरण केन्द्रों से जी आइ एस पर आधारित संपदा मानचित्रण का प्रारंभ किया गया और इसके अनुसार मांगलूर में प्रमुख संपदाओं के किशारों और अंडजनकों की प्रचुरता का आकलन किया गया. समय श्रेणी आंकडा उपयुक्त करके केरल, कर्नाटक, तमिल नाडु और आंध्रा प्रदेश में वर्ष 1985 - 2013 की अवधि के दौरान की संपदाओं का वर्गीकरण करने के लिए द्रुत प्रभव निर्धारण किया गया.

भारतीय तट की तारली और बांगडा आनुवंशिक प्रभव संरचना का मूल्यांकन किया गया. इन मछली जातियों के लिए पोलीमोर्फिक माइक्रोसाटलाइट अंकक और माइटोकोन्ड्रियल डी एन ए अंकक विकसित किए गए. खाद्य शुक्ति *क्रासोस्ट्रिया माड्रासेन्सिस* में तापीय सहयता बढ़ाने वाले दबाव प्रबंधन के जीन पाए गए, जिससे उच्चतम दबाव सहयता क्षमता का संकेत मिलता है. हालोफिलिक *टेट्रासेल्मिस इंडिका* और सूक्ष्म शैवाल *सेनेडेस्मस* जाति में अजैव दबाव सहयता क्षमता वाले जीन पाए गए.

कई सूक्ष शैवाल वसा अम्ल (फैटी एसिड) रूपरेखाओं के पोली अनसैचुरेटड फैटी एसिड (पी यू एफ ए) के अंतर्निहित वस्तुओं में अति सूक्ष्म अंतर व्यक्त हो गया. स्वदेशी रूप से विकसित तेल मिश्रण से रोटिफरों

को समृद्ध बनाना बेहत्तर साबित हुआ. समुद्री मछली तेल में होने वाले भौतिक – रासायनिक गुण जानने के लिए फैटी एसिड घटकों पर अध्ययन किया गया और स्पेक्ट्रोस्कोपी द्वारा पी यू एफ ए समृद्ध तारली मछली तेल की दृढ़ता भी परिकल्पित की गयी. स्थानीय जलाशयों में पाए जाने वाले मेडूसोइड जेली

महाचिंगटों के डिंभकों का अच्छा आहार पहचाना गया. *स्यूडोमोनास अरुगिनोसा* से विरोधी गुणों और उच्च प्रोटीन युक्त हिमशीतित माइक्रोबियल उत्पाद विकसित किया गया. डिंभक खाद्य और अच्छा स्वास्थ्य आहार विकसित करने में संपूरक के रूप में इस उत्पाद का उपयोग किया जा सकता है.

सी एम एफ आर आइ ने मंडपम में पुनःसंचरण जलकृषि व्यवस्था (आर ए एस) की स्थापना द्वारा कोबिया और पोम्पानो मछलियों के संतति उत्पादन में उल्लेखनीय प्रगति हासिल की. कर्नाटक के कारवार और आंध्रा प्रदेश के पेड्डा कम्मावरिपालेम, नागयलंका के खेतों में इन मछली जातियों का पालन किया गया. मछुआरा ग्रुपों की सहकारिता से मुनैकाडु (पाक उपसागर) में समुद्री शैवाल *काप्पाफैकस अल्वरेसी* और कोबिया मछली के एकीकृत पालन से एकीकृत बहु पौष्टिक जलकृषि (आइ एम टी ए) का प्रारंभ किया गया. महाराष्ट्र के समुद्री तटों में द्विकपाटी पालन के लिए अनुकूल स्थानों का चयन किया गया और भा कृ अनु प अनुसंधान समुच्चय, गोवा की संयुक्त सहकारिता से मछुआरों को द्विकपाटी पालन में प्रशिक्षण दिया गया. केरल के कोल्लम और निकटस्थ स्थानों में मूल्य वर्धित प्रसंस्करण एककों (वी ए पी) की स्थापना के लिए शंबु पालन पर विस्तृत अध्ययन किया गया.

तूत्तुकुडी और लक्षद्वीप के अगत्ती, बंगारम, कडमत्त और अमीनी द्वीपों और गोवा में प्रवाल विविधता और बढ़ाव, मछली समुच्चयन, स्पंजों और प्रवाल भित्तियों से जुड़ी हुई अन्य जैवसंपदाओं का आकलन किया गया. जैवविविधता नाश, विशेषतः किशोर मछलियों और खतरे में पड़ गयी जातियों पर मत्स्यन संघात का निर्धारण और आर्थिक मूल्यांकन किया गया.

नेशनल इनीशिएटीव ओन क्लाइमट रिसेलिएन्ट अग्रिकल्चर (एन आइ सी आर ए) के अंदर प्रग्रहण मात्स्यिकी पर तापमान के संघात के प्रतिरूपण के डाटाबेस विकास और मछली उत्पादन पर जलवायु परिवर्तन के संघात और अंडजनन मौसम में होने वाले परिवर्तन का आकलन किया गया. बारिश और बांगडा एवं चिंगट के अंडजनन मौसम के बीच का संबंध तथा प्रथम परिपक्वता पर लंबाई में घटती पर अध्ययन किया गया. एन आइ सी आर ए के अंदर तटीय जनसंख्या और प्रग्रहण मात्स्यिकी पर चरम जलवायु घटनाओं के संघात, समुद्र कृषि के लिए चयनित मछली जातियों पर तापमान के संघात, मात्स्यिकी में कार्बन जीवन चक्र निर्धारण (एल सी ए) और सुभेद्य क्षेत्रों में जलवायु के प्रति अनुकूलन क्षमता वर्धन की रणनीतियों पर अध्ययन किया गया.

केरल, तमिल नाडु, कर्नाटक, महाराष्ट्र और गुजरात में मछली अवतरण और मत्स्यन तरीकाओं के आर्थिक निष्पादन का मूल्यांकन किया गया. भारतमें उत्तरदायित्वपूर्ण मात्स्यिकी प्रबंधन के लिए मात्स्यिकी गवेर्नन्स, आजीविका, लिंग और कल्याण क्षमता के विकास का मूल्यांकन किया गया. सी एम एफ आर आइ द्वारा समुद्री मात्स्यिकी सेक्टर में आपूर्ति श्रृंखला प्रबंधन पर मूल्यवान आंकडा विकसित किया जा रहा है. स्थानीय समाधान के लिए वैश्विक ज्ञानः समुद्र पर निर्भर स्थानीय समुदायों में सुभेद्यता कम करना (जी यू एल एल एस) – बेलमन्ट परियोजना एक अंतर्राष्ट्रीय उद्यम है, जो भौगोलिक तापन और मानव द्वारा वर्धित तटीय प्रदूषण के परिणामस्वरूप उभरकर आने वाली खाद्य सुरक्षा और तटीय आजीविका के टिकाऊपन की चुनौतियों पर संबोधन करेगा.

सी एम एफ आर आइ को तटीय समुद्र में नमूना और आंकडा संग्रहण सुगम बनाने के लिए दो नए मत्स्यन पोत (*आर वी पोम्पानो* और *आर वी कडलमीन 1*) प्राप्त हुए हैं. सी एम एफ आर आइ विषिंजम अनुसंधान केन्द्र अब नए मकान में कार्यरत है.

सी एम एफ आर आइ के अंदर कार्यरत कृषि विज्ञान केन्द्र (के वी के), एरणाकुलम जिला के समग्र कृषि प्रौद्योगिकियों का ज्ञान एवं संपदा केन्द्र है. के वी के ने कई प्रकार की कृषि प्रौद्योगिकियों जैसे ग्रानाइट खुदाई स्थानों में पिंजरों में मछली पालन, पोक्काली धान खेत पैकेज, मल्लट मछली का शास्त्रीय पालन, मीठा पानी कार्प मछली का संतति उत्पादन और *करिमीन* (पेर्ल स्पोट) संतति उत्पादन का निदर्शन और प्रचार किया है. इसके अतिरिक्त कृ वि केन्द्र वास भूमि में टिकाऊ तरकारी उत्पादन की अवधारणा से पारिवारिक तरकारी पैदावार लोकप्रिय बना रहा है.

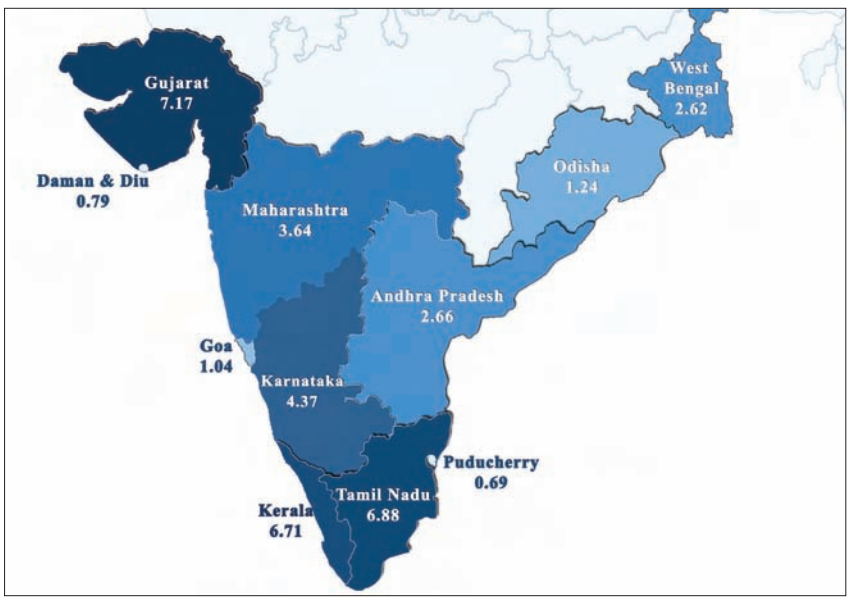
पुस्तकालय और प्रलेख टीम ने eprints@cmfri.org.in द्वारा सी एम एफ आर आइ के अनुसंधान उपलब्धियों की दृश्यमानता बढ़ाने में सराहनीय प्रयास किया है.

Fishery resource **monitoring**

Fish harvests

Research project: FISHCMFRISIL201200100001

Assessment of exploited marine fishery resources was carried out using the time tested national level scientific sampling scheme developed by CMFRI based on stratified multistage random sampling design with stratification over time and space. Resource-wise and gear-wise estimation of marine fish landings and fishing effort for the year 2013 was carried out for different fishing zones in 9 maritime states and two union territories using data collected based on the sampling design. Necessary modifications were made in the sampling design to suit the requirements for estimation of species-wise, gear-wise and fishing zone-wise monthly marine fish landings and fishing effort expended in terms of units of operation and hours of operation.



Highlights

- The estimate of all India annual marine fish landings for the year 2013 is 3.78 million t as against the all-time high of 3.94 million t during 2012 registering a reduction of about 1.56 lakh t (4%).
- Maritime states with high contributions towards total landings in the country during 2013 are Gujarat with 7.17 lakh t, Tamil Nadu with 6.88 lakh t and Kerala with 6.71 lakh t.

Marine fish landings in India during 2013

- Compared to 2012 there is increased landings in West Bengal, Puducherry, Maharashtra, Tamil Nadu, Goa and Daman & Diu and there is reduction in landings in Kerala, Odisha, Gujarat, Andhra Pradesh and Karnataka.

- Important resources that contributed to the total landings are oil sardine 6.0 lakh t (15.7%), ribbonfishes 2.5 lakh t (6.7%), non-penaeid prawns 2.1 lakh t (5.6%), Indian mackerel 2.0 lakh t (5.3%), penaeid prawns 2.0 lakh t (5.2%), and threadfin breams 1.8 lakh t (4.8%).

Variation in state-wise landings during 2012-13

- Oil sardine dominated the landings with 6.0 lakh t though compared to the record landings in 2012 there is reduction of about 1.2 lakh t.

- Hilsa landings in West Bengal showed improvement to 41,448 t from 9,981 t in 2012 but was still below the level of 84,000 t in 2010.

- The landings of Indian mackerel showed slight improvement from 1.7 lakh t in 2012 to 2.0 lakh t, still below the 2.8 lakh t mark in 2011.

- Pelagic resources dominated in the landings (56%) followed by demersal resources (26%), crustaceans (13%) and molluscs (5%).

Increase/decrease of major resources landed during 2013

Estimated Marine fish landings (tonnes) in India during 2013

Pelagic finfish

Group	2013
Wolf herring	20994
Oil sardine	595392
Other sardines	159580
Hilsa shad	41448
Other shads	14641
Coilia	30767
Setipinna	8507
Stolephorus	69481
Thrissina	0
Thryssa	42351
Other clupeids	71424
BOMBAYDUCK	124509
HALF BEAKS & FULL BEAKS	4305
FLYING FISHES	2149
RIBBONFISHES	252179
CARANGIDS	
Horse mackerel	36313
Scads	127935
Leather-jackets	14488
Other carangids	69600
MACKERELS	
Indian mackerel	199880
Other mackerels	338
SEER FISHES	
Scomberomorus commerson	27680
Scomberomorus guttatus	14008
Scomberomorus lineolatus	0
Acanthocybium spp.	37
Other seerfish	0
TUNNIES	
Euthynnus affinis	39738
Auxis spp.	7724
Katsuwonus pelamis	7078
Thunnus tonggol	12643
Other tunnies	18108
BILL FISHES	9646
BARRACUDAS	25269
MULLETS	10856
UNICORN COD	892
MISCELLANEOUS	63860
Total	**2123820**

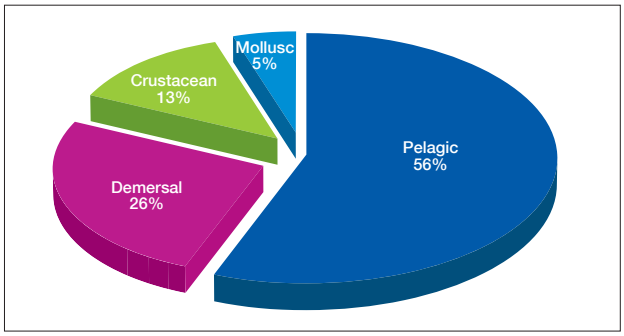
*In additoion 113858 t of bivalves
(Oysters: 294; Mussels: 6,243; Clams: 1,07,321)

Demersal finfish

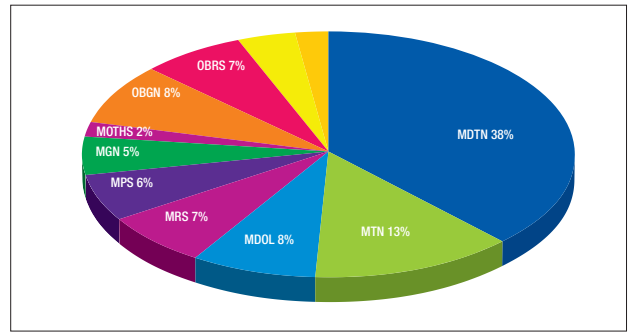
Group	2013
Sharks	21138
Skates	2347
Rays	22986
EELS	10145
CATFISHES	89141
LIZARD FISHES	56121
PERCHES	
Rock cods	44487
Snappers	6634
Pigface breams	10724
Threadfin breams	182541
Other perches	65568
GOATFISHES	25142
THREADFINS	12375
CROAKERS	177395
SILVERBELLIES	121117
WHITEFISH	7269
POMFRETS	
Black pomfret	18449
Silver pomfret	30416
Chinese pomfret	4794
FLATFISHES	
Halibut	1492
Flounders	298
Soles	45055
MISCELLANEOUS	29626
Total	**985260**

Shellfish

CRUSTACEANS	
Penaeid prawns	196942
Non-penaeid prawns	213474
Lobsters	1410
Crabs	44586
Stomatopods	20650
MOLLUSCS*	
Cephalopods	
Squids	100014
Cuttlefish	82964
Octopus	6448
Miscellaneous	6300
Total	**672788**
Grand total	**3781868**



Components of marine fish landings in India during 2013



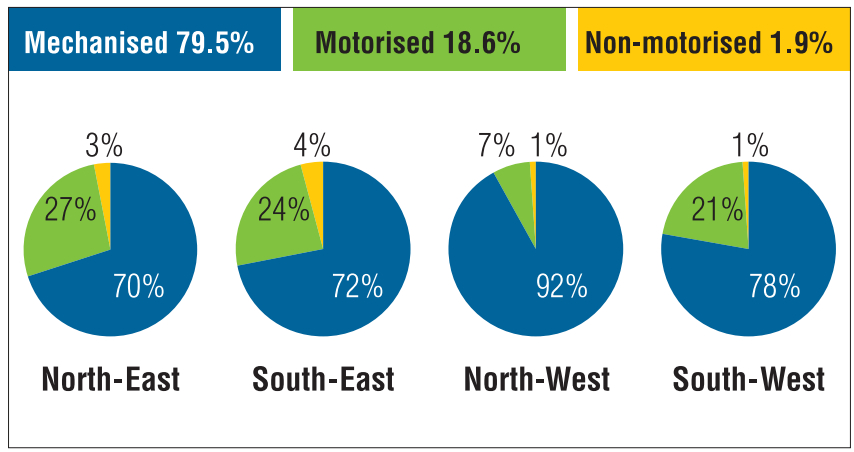
Gear-wise contribution during 2013

Pelagic	Demersal	Molluscs	Crustaceans
Oil sardine – 28%	Threadfin breams – 18%	Squids – 51%	Penaeid prawns -41%
Ribbonfishes – 12%	Croakers – 18%	Cuttlefishes – 42%	Non-penaeid prawns -45%
Carangids – 12%	Silverbellies – 12%	Octopus – 3%	Crabs – 9.4%
Mackerel – 91%	Catfishes – 9%	Bivalves – 3%	Stomatopods – 4.3%
Other sardines – 8%	Elasmobranchs –5%	Gastropods – 1%	Lobsters – 0.3%
Anchovies – 7%	Pomfrets – 5%		
Bombayduck – 6%	Lizard fishes – 6%		
Tunnies – 4%	Other perches – 13%		

Sector-wise marine fish landings during 2013

Contributions from the three sectors are mechanised 30.0 lakh t (79.5%), motorised 7.0 lakh t (18.6%) and 0.73 lakh t (1.9%) from non-mechanised.

West coast accounted for 62.8% of the total landings in the country. The south-west region comprising the states of Kerala, Karnataka and Goa is the most productive and the largest contributor to the marine fish landings in 2013. Marine fish production from this region in 2013 is 12.1 lakh t,



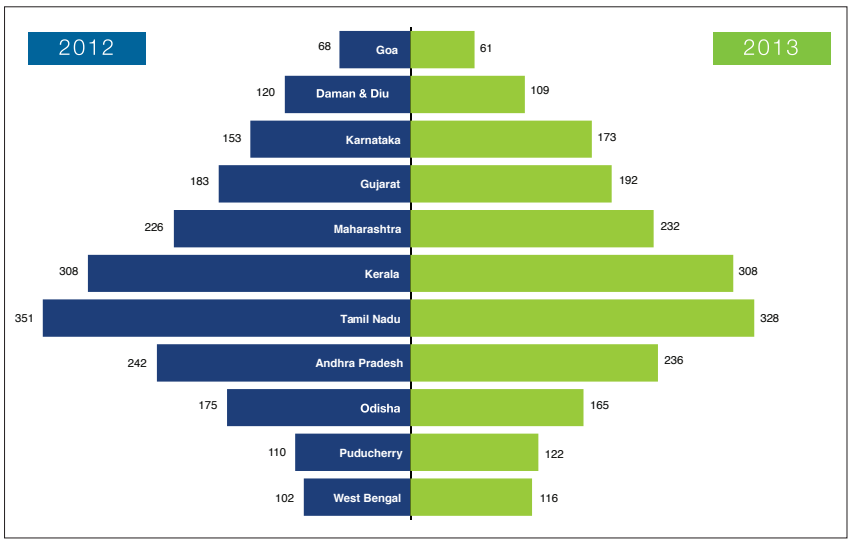
Sector wise contribution of regions

accounting 32.1% of all India landings. The contribution from north-west region comprising Maharashtra, Gujarat and Daman & Diu is 30.7% of the landings, with Gujarat at the top. The major resources that contributed to the landings in north-west region are oil sardine, mackerel, threadfin breams, croakers, ribbonfishes, non-penaeid prawns, Bombayduck and cephalopods.

The south-east region comprising Andhra Pradesh, Tamil Nadu and Puducherry with an estimate of 10.2 lakh t dominated in the east coast, Tamil Nadu being the major contributor (67%) in this region. Oil sardine, croakers, hilsa shad, silverbellies and penaeid prawns are the major components of the landings in this region.

North-east	North-west	South-east	South-west
Croakers (11.1%)	Non – Penaeid prawns (16.1%)	Oil sardine (18.7%)	Oil sardine (31.8%)
Hilsa shad (10.4%)	Ribbonfishes(13.0%)	Silverbellies (9.9%)	Indian mackerel (9.3%)
Bombayduck (9.8%)	Croakers (7.8%)	Other sardines (9.7%0	Scads (8.1%)
Penaeid prawns (6.8%)	Bombayduck(7.4%)	Penaeid prawns (5.7%)	Threadfin breams (7.2%)
Mackerel (5.8%)	Threadfin breams (6.1%)	Indian mackerel (4.9%)	Cephalopods (6.3%)

Contribution of major resources in each region



Number of species landed in each state during 2012-13

Species diversity in landings

Among 670 species landed along the Indian coast in 2013 only 15 species were landed in all states/ UTs and 254 species were landed in only one of the states/UTs. With regard to number of species landed, Tamil Nadu is at the top with 328 followed by Kerala with 308 and the minimum is 61 for Goa. Among the 308 species landed in Kerala in 2013 there are 63 species unique to the state where as 45 of the 328 species landed in Tamil Nadu are unique.

Deep-sea fishery resources of the continental slope of Indian EEZ

Research project: EF-10/MoES

One cruise (no. 322) of fourteen days duration on-board FORV Sagar Sampada covering the latitudes between 12° - 7°N on the west coast of

India was made during the period 6-01-14 to 19-01-14. Fourteen fishing stations were covered after scanning using EK 60. Fishing grounds were trawled using HSDT-CV and EXPO net. Twenty four species of finfishes were identified from different transects and their taxonomic details and biology were documented.

New records of gapers *Champsodon nudivittis* and *C. snyderi* from the northern Arabian Sea was reported. Study confirmed the presence of a *C. nudivittis* population in the northern Arabian Sea comprising of reproductively active, mature fish, which was believed to be absent so far. It is a carnivorous predator, feeding on young of several commercially important fishery resources such as the pandalid shrimps, sergestid shrimps (*Acetes*) and the Indian codlet *Bregmaceros* spp. found in the northern Arabian Sea.

Tripod fishes such as *Bathypterois articolor* Alcock 1896 and *B. guentheri* Alcock 1889 were recorded from stations at 1000 m depths.

Bathypterois guentheri

Bathypterois articolor

Oceanic tuna fisheries in Lakshadweep Sea

Research project: EF-25/NAIP

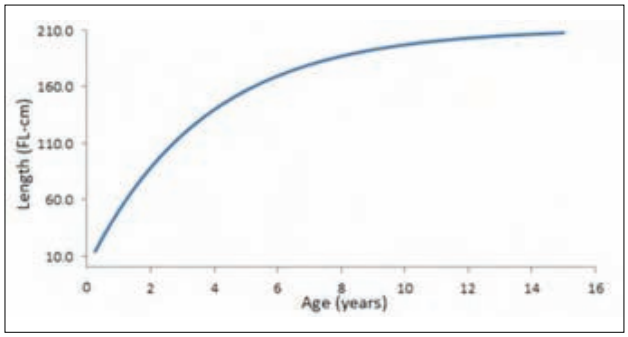
Landings of yellowfin tuna, *Thunnus albacares*, from deeper waters of the Lakshadweep Sea registered steady increase. Yellowfin landing during 2007 was at 987 t and it increased to 2,587 t in 2012 and to 2,987 t in 2013

Ageing of yellowfin tuna using hard parts

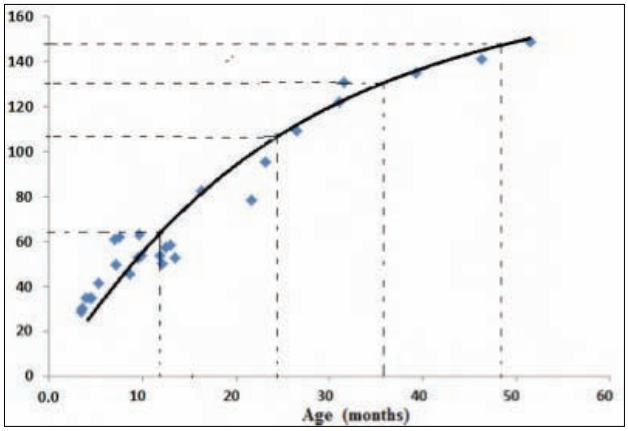
Yellowfin tuna was aged following growth inscriptions on otoliths and the results were used to validate the age estimates obtained from modal progression analysis. The results indicated that the species grow much faster than the earlier estimates.

Health of the stock

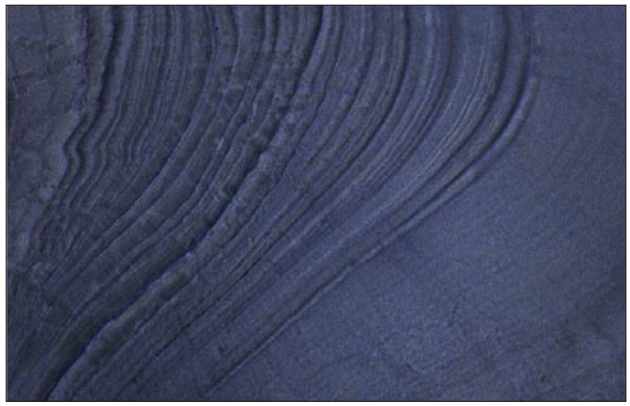
The study indicated that tunas and other large pelagics remain under exploited. Yellowfin tuna fishery is very much at its initial phase of exploitation. Fishery by Islanders is presently limited to territorial waters and adjacent seas and catch was constituted by skipjack tunas and

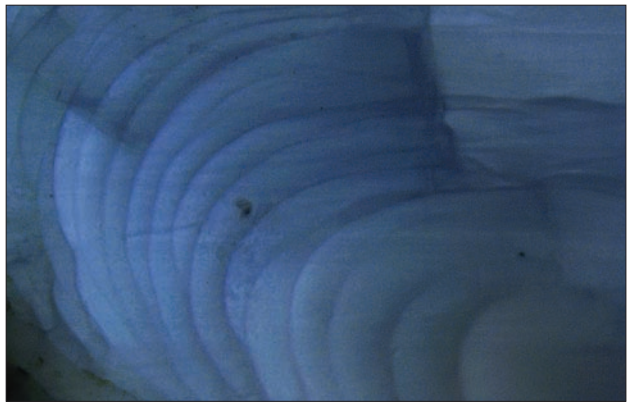


Growth following modal progression



Growth following growth rings in otolith (Yellowfin tuna)





Yellowfin tuna otolith section with age rings (daily rings)

relatively small yellowfin tunas. Large yellowfins from deeper waters remain inaccessible to them. Fishery data indicated that during 2004-2012 only around 10% of the estimated fishery potential was exploited. Large pelagics and reef associated fishes are yet to be targeted by Lakshadweep fishers.

Trophic model

The trophic model for Lakshadweep ecosystem was created using EwE Ecopath Software version 6.3 of Ecopath with Ecosim. The biotic components of the ecosystem were divided into 25 functional groups. The functional groups include marine mammals, birds, all tunas, large pelagics, small pelagics, halfbeaks and silver bellies, reef associated-herbivores, carnivores, omnivores, bait fishes, crustaceans, molluscs, seaweeds, sea grass, zooplankton, phytoplankton and detritus. Model trial runs were done for a period of 10 years and simulation was also done using Ecosim software. Model runs show that functional groups influencing pole and line fishery in Lakshadweep ecosystem are baitfishes, small pelagics, reef associated carnivores, herbivores and large pelagics.

Improvement of existing small craft and skill development

Five Pablo boats; including two department boat one each at Kavaratti

and Chetlat were modified for tuna longlining. Fifty fishermen from Agatti, Kavaratti and Androth Islands were trained in modification of Pablo boat. They were trained in splicing ropes, rigging monofilament into main line and branch lines for longlining operations

Products and processes developed

Several products (Improved Masmin, Masmin flake, Masmin powder, Smoked tuna in oil, Value added products from processing waste, Ready to eat products - Tuna kure - protein rich snack product from red meat, Ready to cook product - Tuna soup powder, pappad and wafers, Animal feeds-Silo fish feed, pig feed and pet feed, Nutraceuticals - PUFA from tuna eye & red meat, Confectionaries - Gelatin from tuna skin) were developed, which are ready for transfer to private entrepreneurs.

Processes for pulsed light treatment for shelflife enhancement and carbon monoxide treatment for tuna steaks to enhance and maintain the colour as well as appearance were standardised.

Inpact of intervention

Fishers were trained on all aspects of yellowfin tuna fishing right from modification of existing boats to fishing operation. Fishers are already skilled to divert their present fishing activities towards exploitation of large yellowfin tunas and like fishes. With increasing awareness on yellowfin tuna and its potential, enthused fishers diversified their fishing activity to harvest large size yellowfin tuna. They used double pole & line techniques, where two poles & lines were tied to a single hook for fishing. Vertical hand lines were also used for fishing in deeper waters.

Fisheries management advisories

The present situation offers considerable scope for enhancing production of tunas, other large pelagics and reef fishes from the area. However, the fishery development should be taken up in phased manner. Since, Island territory have lots of inherent limitations, all fishery development packages will be successful only if there is active participation from mainland

Since fish being highly perishable commodity and having limited internal market in the Island territory, the fishery development activity should start with the development of adequate facilities to handle, process and store or transport the surplus catches to outside market. As a natural corollary to this development and investment, adequate infrastructure by way of modern fishing harbours, fish processing estates, power and water supplies and communication as well as marketing channels need to be established.

Size of the facilities developed should be decided based on the planned production in each phase. Two or three major centres have to be identified

based on the endowment pattern from where the fishing boats are proposed to be operated and facilities like jetties, uninterrupted power supply, diesel outlets, potable water, ice plants, processing plant and cold storage to be provided.

Satellite telemetry studies on tunas

Research project: EF-7/MoES

Tagging of large sized yellowfin tunas were carried out at three locations- off Mangalore, off Lakshadweep and off Visakhapatnam. The environmental parameters at the tagging locations were collected and documented. Fin clippings were preserved for further genetic stock identification. Geo referenced data of tagging and release location were collected and tabulated. Phyto and zooplankton nets were operated at the tagging sites and major groups contributing to the plankton population were identified.

Yellowfin tuna tagging locations

The tuna fishery in general had declined during the year both in the mainland as well as in the Island systems. However, when yellowfin tuna catches were observed during January-March tagging programmes were undertaken. In all seven fishes tagged and released, five fishes were tagged off Kavaratti in Lakshadweep Islands and two off Visakhapatnam.

Yellowfin tuna tagging

Details of pop-up tags provided and deployed along the Indian coasts

Tagging details							Water quality parameters			
Tag ID & Date of tagging	Time		Capture		Release		Temp (°C)	pH	Salinity (ppt)	DO_2 (mg/l)
	Capture	Release	Latitude	Longitude	Latitude	Longitude				
111716 20.04.2013	8.30	8.35	12° 50.663'	73° 50.230'	12° 50.663'	73° 50.230'	30.1	8.06	34.6	8.0
111700 22.01.2014	14.43	14.45	10°33.815'	72°30.123'	10°33.922'	72°.30.177'	28	7.89	34.7	6.8
111711 24.01.2014	18.32	18.34	10°32.048'	72°36.341'	10°31.798'	72°36.830'	29.9	7.86	34.7	6.4
111708 25.01.2014	15.56	15.58	10°32.120'	72°36.324'	10 °32.000'	72°36.368'	28.5	8.2	34.9	6.8
111718 25.01.2014	16.21	16.23	10°31.914'	72°36.394'	10°31.744'	72°36.572'	28.5	8.2	34.9	6.8
111703 25.01.2014	18.28	18.31	10°31.896'	72°36.415'	10°31.764'	72°86.513'	28.4	8.04	34.9	6.7
111722 09.03.2014	18.00	18.03			17° 24.320'	83° 52.108'				
111720 09.03.2014	18.40	18.42			17° 25.310'	83° 52.293'				

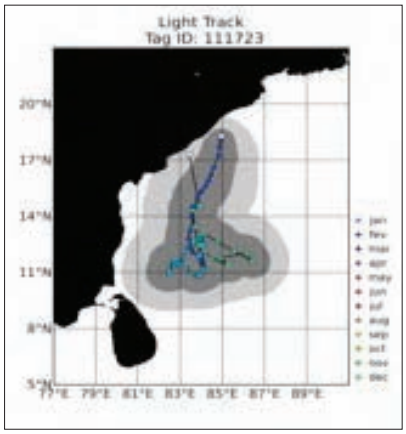
Details of plankton collected

Phytoplankton (nos. m^{-3})

Group/Genera	22.01.2014	24.01.2014	25.01.2014
Ceratium spp.	70	57	11
Fragilaria spp.	32	0	0
Rhizosolenium sp.	19	0	0
Coscinodiscus sp.	0	96	11
Biddulphia sp.	0	38	0
Thallasionema sp.	0	19	0

Zooplankton (nos. m^{-3})

Group/Genera	22.01.2014	24.01.2014	25.01.2014
Copepods	64	67	87
Cladocera	80	742	81
Sagitta sp.	9	0	17
Oikopleura sp.	6	0	0
Polychaeta	3	0	0
Fish eggs	64	0	0
Decapod larvae	0	0	11
Acanthometron	0	1	1



Preliminary results obtained by INCOIS from popped off tags

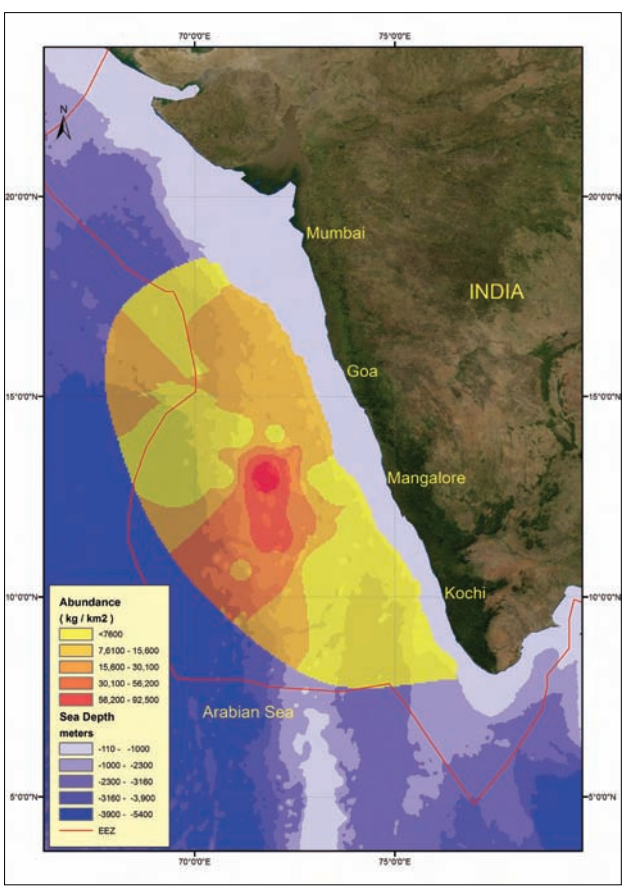
Most of the satellite tags deployed in the Indian seas during the first phase have popped off after few days to eight months duration. Data from tags that have remained out at sea for more than 3-4 weeks have been decoded and analysed by INCOIS. Preliminary information on the movement of tunas in the Indian seas has been obtained. In most of the cases, tunas have remained within the Indian EEZ. The number of dives made during a 24 h period, the temperature preference of the fish and the general track have been identified.

Oceanic squid resources in Arabian Sea

Research project: EF-24/NAIP

The Central Arabian Sea is considered as one of the richest regions for the oceanic squids (1-1.5 million t), at depths above 300 m in the region over the continental slopes. However, commercial fishing activity for this resource is non-existent due to insufficient studies on its abundance, distribution, lack of proper exploitation methods, processing and marketing information. The project was implemented for diversifying into distant-water squid fishing operations targeting the unexploited oceanic squids in the Arabian Sea.

A consortium comprising of FSI, NIFPHATT, CIFT and private partners worked collectively to develop a new commercial distant-water squid fishing operation from production to consumption. The project addressed processing aspects such as developing technologies for post-harvest handling, product development and value-addition for facilitating market-driven end products. Besides developing an ecolabelled, scientifically regulated offshore fisheries, the project aimed at promoting oceanic squid production by transferring the evolved fishing methods, post-harvest processing technologies and value-addition processes to stakeholders. Techno-economic feasibility of commercial distant water squid harvesting technique as part of the value-chain on oceanic squids is very promising. The major findings are detailed as under:



- Exploratory surveys (58 stations) using the converted squid jigger MV Titanic and FSI vessel MV Varshini, were undertaken in the oceanic waters from 8°N to 17°N latitudes and 64°E to 76°E longitudes (Eastern and Central Arabian Sea) during 2010-13.

- The modified squid jigger carried out trial fishing techniques 1) Squid jigging 2) Hand jigging 3) Scoop netting 4) Gill netting 5) Purse-seining 6) Trammel netting.

- It was established that purse seining and gillnetting with light attraction from converted 20 m LOA commercial fishing boats are the most efficient gears for exploiting oceanic squids in the Arabian Sea.

- Three lat/long grids 13°N/71°E, 11°N/72°E and 10°N/71°E had the maximum biomass of oceanic squids among the 58 stations covered. The average biomass was 4.2 t/km^2 and the maximum was 92.8 t/km^2.

- The total biomass was estimated as 2.52 million t and the annual fishable biomass (MSY) was estimated as 0.63 million t.

- Maximum abundances were related to areas with low SST (28-28.6°C), low chlorophyll (<0.4 mg/m^3), lower salinity (30.4-33.8 PSU) and high pH and dissolved oxygen values.

- Biological investigations revealed that *Sthenoteuthis oualaniensis* is a highly carnivorous and cannibalistic animal with fast and differential (between sexes and life stages) growth rate. The animal is an r-strategist with seasonal breeding and feeding migrations and vulnerability to fishing pressure is likely to be medium.

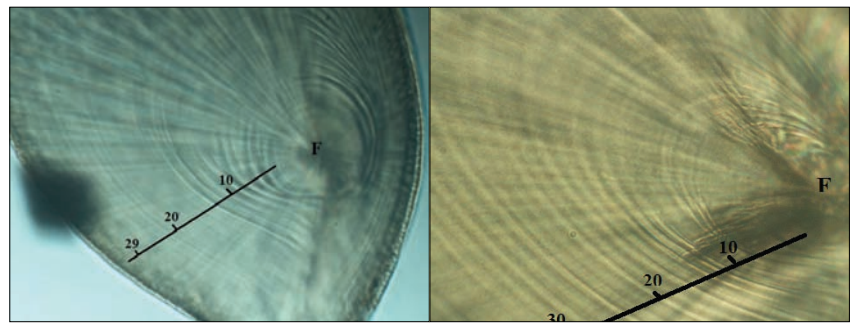
- The techno-economic feasibility analysis showed that one-boat mini PS operations for 3 months would have a capital productivity ratio of 0.41 and a rate of return on investment of 87%.

- The detailed biochemical composition of fresh, blanched and dried oceanic squid was analysed and the potential human health benefits due to high selenium content were determined.

- Three IQF ready-to-cook and 3 ready-to-eat products were developed, branded and test marketed successfully. A novel squid ink based sauce was developed which was transferred to a private entrepreneur under a MoU.

- Three fishing ports along the west coast of India, Kochi, Mangalore and Goa can become the launch pads for oceanic squid exploitation from the Arabian Sea. The lat-long grids with highest abundance are located close to these ports. The number of purse seines in Mangalore and Goa are also overcapitalised, and therefore, the Department of Fisheries of the respective states can launch appropriate incentivised schemes to promote such conversions based on the economic analysis.

This value chain project is unlike other schemes operating under CN2 of NAIP. The uniqueness is due to the fact that there is no current PCS for the



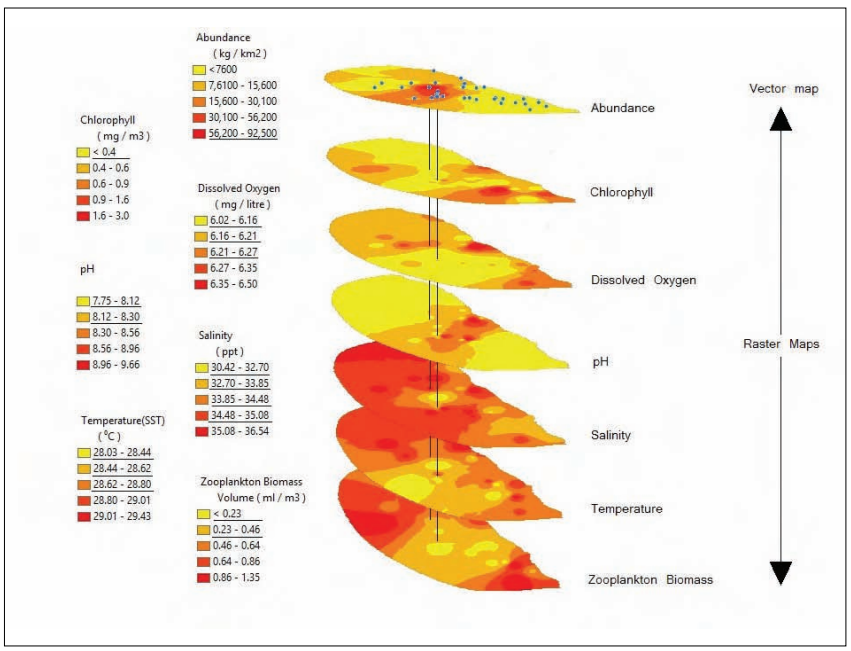
Use of statoliths to determine age in *Sthenoteuthis oualaniensis*

commodity (oceanic squids) which is targeted in the project. Although the project envisaged development of a new value chain for oceanic squids, it could not be achieved within the 4 years of project duration. However, all technological know-how is in place for the launch of the value chain in the coming years.

Total area surveyed	601,155 km^2
Number of Lat/Long grids surveyed	14
Total number of stations	58
Number of stations with OS	23
Minimum density	23.1 kg/km^2
Maximum density	92.8 t/km^2
Average density	4.21 t/km^2
Maximum biomass in Lat/Long grid	13/71 and 11/72
Total estimated biomass	2.52 million t
Estimated fishable biomass (MSY)	0.63 million t

Brief Economic Indicators for purse seine fishing of oceanic squids for 3 months in a year

Capital productivity (operating ratio) 36.9/90	0.41
Fixed ratio (fixed cost/gross revenue)	0.33
Gross ratio (total cost/gross revenue) 67/90	0.74
Labour productivity (gross catch/crew size)/trip	833.3
Rate of return to investment	87.29
Payback period (years)	4.5
Net operating income or operational surplus (gross revenue-operating cost)	53.1



Relating oceanic squid abundance to key environmental parameters using GIS based raster and vector maps

Fisheries and ecosystem **modeling**

Status of resources based on growth rates and Markov chain modeling

Research project: FISHCMFRISIL201200100001

Using resource wise all India landings during 1985-2012 annual percentage growth rates for consecutive years were computed for each resource. Nine distinct process states for Markov chain modeling based on growth rates were defined. If the percentage growth rate is less than -100 the process is considered to be in state-1, if it is between -51 to -100 the process is considered to be in state-2, and so on, if the growth rate is between 51 and 100 the process is considered to be in state-8 and if it is more than 100 the process is considered to be in state-9. Limiting probabilities to remain the process in these states were worked out separately for 64 different resources.

Limiting probabilities worked out based on Markov Chain model for different resources

Process States	Growth Rate	Sharks	Rays	Lesser sardines	Penaeid prawns	Oil sardine	Indian mackerel
State-1	< -100	0.00	0.00	0.00	0.00	0.00	0.00
State-2	-51 to -100	0.00	0.00	0.00	0.00	0.04	0.00
State-3	-26 to -50	0.08	0.04	0.04	0.00	0.11	0.22
State-4	-1 to -25	0.36	0.44	0.42	0.30	0.26	0.24
State-5	0	0.00	0.00	0.04	0.12	0.00	0.00
State-6	1 to 25	0.44	0.44	0.27	0.53	0.28	0.32
State-7	26 to 50	0.12	0.08	0.23	0.04	0.14	0.11
State-8	51 to 100	0.00	0.00	0.00	0.00	0.09	0.07
State-9	> 100	0.00	0.00	0.00	0.00	0.08	0.03

- The Markov Chain model fitted to describe the dynamics of the growth pattern in oil sardine landings during 1985 to 2012 yielded the limiting probabilities for the nine predefined states. It reveals that maximum probability is distributed among the four states namely (-26 to -50), (-1 to -25), (1 to 25) and (26 to 50) accounting for 0.789 of the total probability. Further, in the long run there is 27.7% chance for the growth rate to remain in State-6 (growth rate between 1% and 25%), 26.4% chance to remain in State-4 (growth rate between -1% and -25%), 13.6% chance to remain in State-7 (growth rate between 26% and 50%) and 11.2% chance to remain in State-3 (growth rate between -26% and -50%). All other states have only negligible probability.

- Species that have more than 90% probability to remain in states 6 and 4 are silverbellies (0.99), catfishes (0.92) and other carangids (0.96). Groups with 80% or more than 80% probability to fluctuate between states 4 and 6 are silverbellies (0.99), other carangids (0.96), catfishes (0.92), eels (0.89), croakers (0.89), rays (0.88), Bombayduck (0.87), snappers (0.86), wolf herring (0.85), other clupeids (0.85), penaeid prawns (0.84), silver pomfret (0.81), *Scomberomorus commerson* (0.81) and sharks (0.80).

- Among these species/groups, those with almost equal chance to fall in the two states so that they will have the tendency to fluctuate between the two states are silverbellies (0.50 & 0.49), catfishes (0.49 & 0.43), wolf herring (0.42, 0.42), *S. commerson* (0.42 & 0.39), other carangids (0.46 & 0.46), eels (0.48 & 0.41), croakers (0.42 & 0.46), rays (0.44 & 0.44), Bombayduck (0.43 & 0.44), snappers (0.31 & 0.55), other clupeids (0.39 & 0.46), penaeid prawns (0.30 & 0.53), silver pomfret (0.39 & 0.42) and sharks (0.36 & 0.44)

- There are 29 resource groups for which the limiting probabilities are maximum for state-6 and state-4 respectively. Out of this 10 resource groups have more than 80% chance to fall in this two states. Similarly there are 16 resources for which the limiting probabilities are maximum for state-4 followed by state-6, out of which 4 resources have more than 80% chance to fall in state-4 or state-6.

- Bivalves, *S. lineolatus* and *Acanthocybium* spp. have limiting probabilities maximum for state-2 and state-9.

Chlorophyll based Remote-sensing assisted Forecasting System (ChloRIFFS)

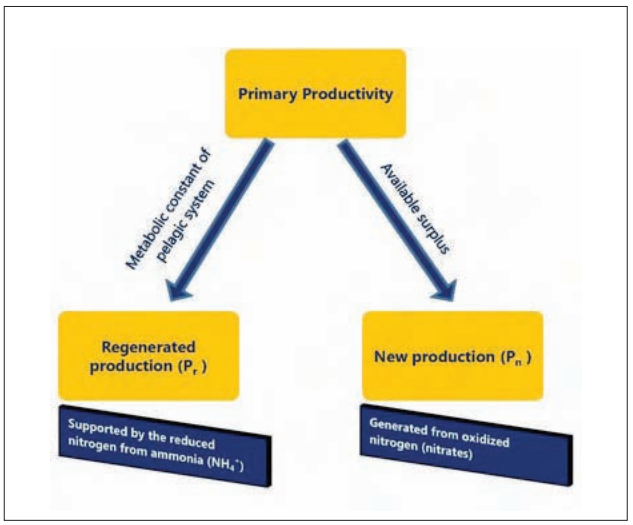
Research Project: FISHCMFRISIL201200100002

Estimation of marine fisheries potential of Indian EEZ is an important exercise performed every decade to aid planners. The approaches towards this were based either on statistical methods using time series data based on commercial landings or on productivity related information (primary and secondary productivity). Estimate of the true potential or harvestable maxima from the Indian EEZ may have to be made in shorter bursts of time instead of fixing for a decade as the causal factors are

highly fluctuating. The project is initiated with the objective of establishing a mechanism for robust estimation of the potential yield on a routine basis through modelling the resource availability at any given point of time based on biological, oceanic and climatic factors. As an initial foray into this assignment, European Space Agency's Climate Change Initiative (CCI) ocean colour data was downscaled to the Indian EEZ and various parameters of relevance were analysed for spatial and temporal trends and correlation. The decadal datasets of Net Primary Production (NPP) estimated by Vertically Generalised Production Model (VGPM) were taken as the effect for the spatio-temporal investigations with climatic parameters such as Sea Surface Temperature (SST) as the causative phenomena for the spatio-temporal domain under study. The NPP and SST show distinct climatological trend when summarised on the basis of months for the past decade. Lagged temporal correlation has been already established between them and semi-variograms and correlograms have provided the initial drive towards the modelling framework. Dynamic productivity changes indicate the active new production processes in the EEZ, which could explain the recent catch trends being observed in various parts of Indian coast.

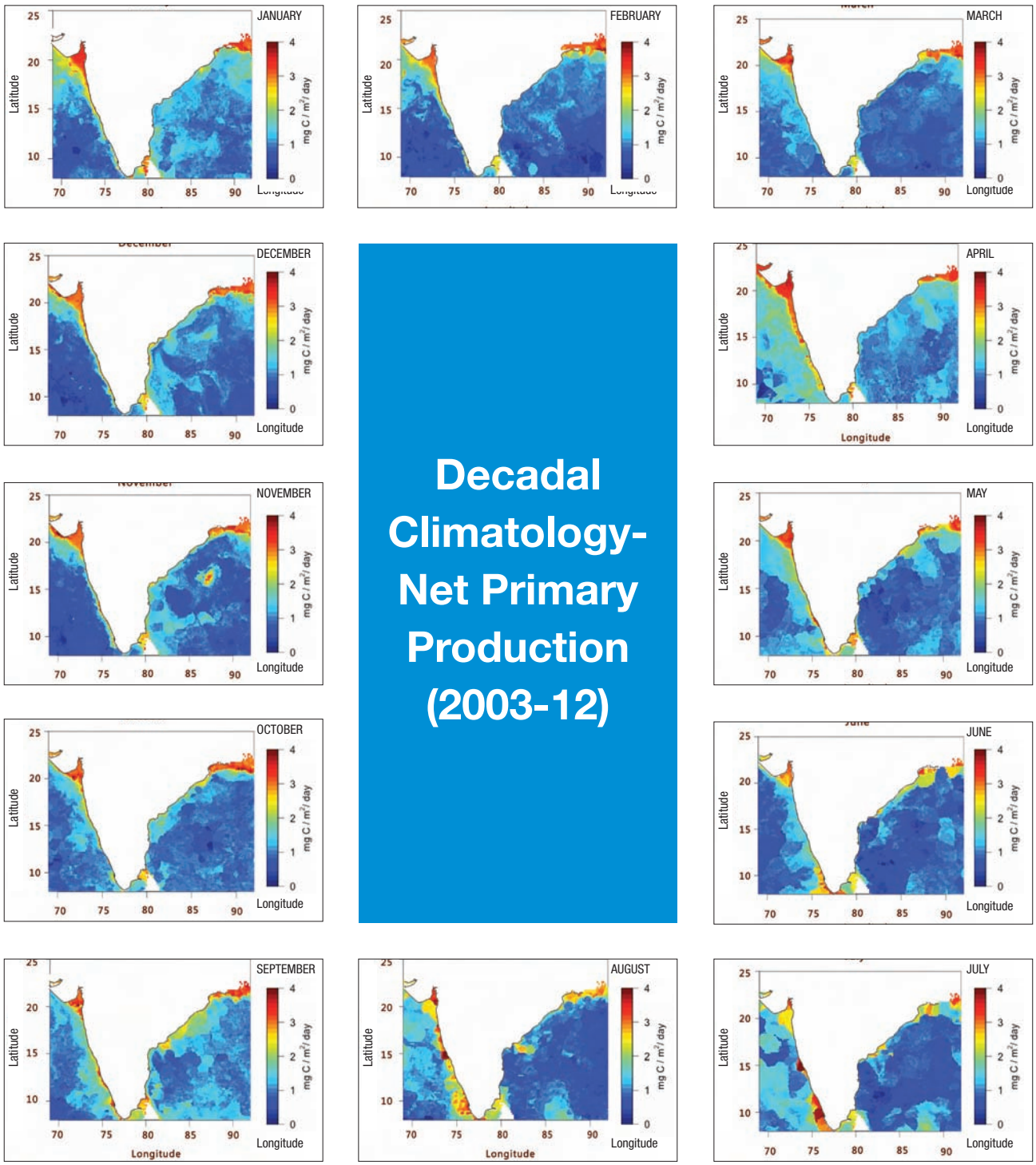
Towards establishing a working model for fishes from the primary producers, a large network of production and consumption cycles existing in the columns of oceanic regions are being focussed upon. Initially the major fish groups are generically categorised for modelling purposes as planktivorous, carnivorous and detritivorous based on heuristic studies. Similar to Zoo-Phyto-Detritus model CMFRI is working on the Yellow, Green and Brown models for assessing the potential of fishery based on the feeding groups.

Taking cue from the latest studies wherein it has been established that rate of production of chlorophyll physically seems to explain the fish production process dimensionally accurate ($ML^{-2}\ T^{-1}$) but with lot of biological complexities. Primary production in the water column can be studied in the context of bio-available nitrogen in the ocean so as to differentiate the primary production process into regenerated production (P_r) and new production (P_n). P_r is supported by the reduced nitrogen form ammonia (NH_4+) and represents the maintenance production required for sustaining the pelagic ocean systems. P_n is the available surplus in primary production generated from oxidised nitrogen (nitrates). Therefore, ideally the Pn or a fraction of P_n will contribute to the fish production process. Hence, for estimation of annual fish production in the EEZ, the surplus chlorophyll biomass generated annually in Indian EEZ in P_n is an inevitable factor and the initiative has taken steps to focus on this aspect also.



Schematic representation of new-production component which lead to fish production

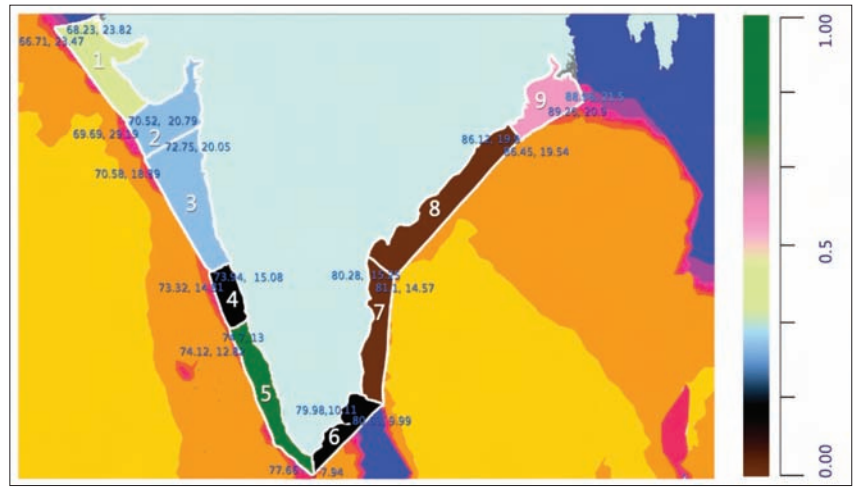
Development of databases of primary production, climatology of major oceanographic data sets and *in situ* measurements for validation of data sets were initiated. Indian EEZ was partitioned into different grids



Decadal Climatology- Net Primary Production (2003-12)

Climatology on Net Primary Production

for *in situ* measurements. Environmental variables, primary/secondary and tertiary biomass and fish landing data for the designated grids are being collected on monthly basis. Commercial and experimental trawlers are utilised for the sample collection. Sampling is carried out at 30, 20 and 10 m depths at stations located off Veraval, Okha, Mumbai, Ratnagiri, Mangalore, Kochi, Chennai and Vishakapatnam and the data collected is



Niche based similarity profile of nine spatial grids along Indian EEZ

compiled at Kochi. All the scientists involved in the sampling were trained and uniform methodology is followed in the *in situ* measurement. Data entry is in a uniform format and separate database is maintained for compilation of all *in situ* observations. Biology of the fish samples collected is carried out at different stations.

Nine spatial blocks were earmarked for *in situ* sampling. The niche based resource availability spectrum of these grids was subjected to multivariate dissimilarity analysis and results indicated that geographic contiguity held good in north-west and north-east whereas south-west grids especially the Kerala block stood out uniquely. Further the southern grids showed similarity over their latitude irrespective of the coast.

Fisheries management in GIS platform

Research project: FISHCMFRISIL201200900009

Inventory of fish landing centres

For GIS mapping the basic data requirement is information from fish landing centres like name of landing centre, its location with latitude and longitude (GPS reading), district, area of data collection, gears operated from the landing centre, seasonality of operation of each gear, distance covered for fishing from the centre, seasonal changes in direction of fishing activity and list of dominant species in each gear from each fishing centre along the Indian coast. This information forms the basic layer of the resource mapping on which resource data layer will be stacked. Data collection from 1200 landing centres along the Indian coast was completed during the year, 2013. Steps are being taken to fill the data gaps.

Temporal variation in the abundance of fishery resources

Second workshop of the project was conducted at CMFRI, Mangalore during January, 2014 with all the project associates, in which work

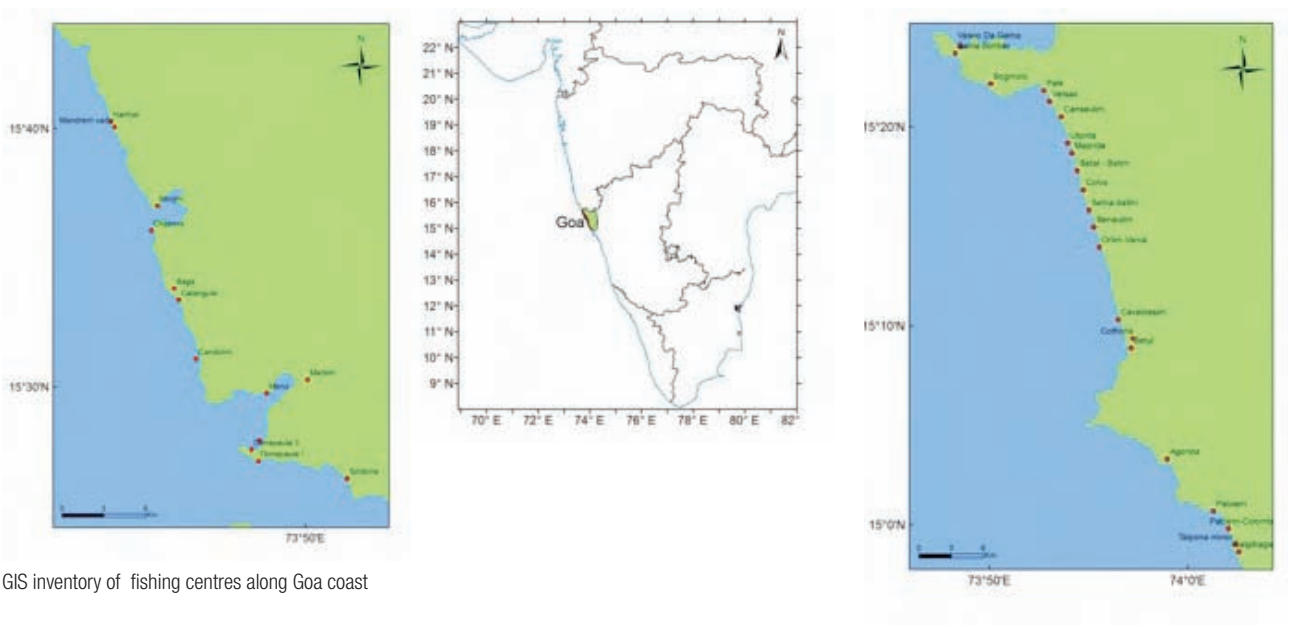
programs and the data collection done at different centres were reviewed. Important gears operated from the coast were identified for data collection to get information related to seasonal (temporal) changes of the species composition and juvenile as well as spawner composition of selected species.

Gears and species selected for different centres

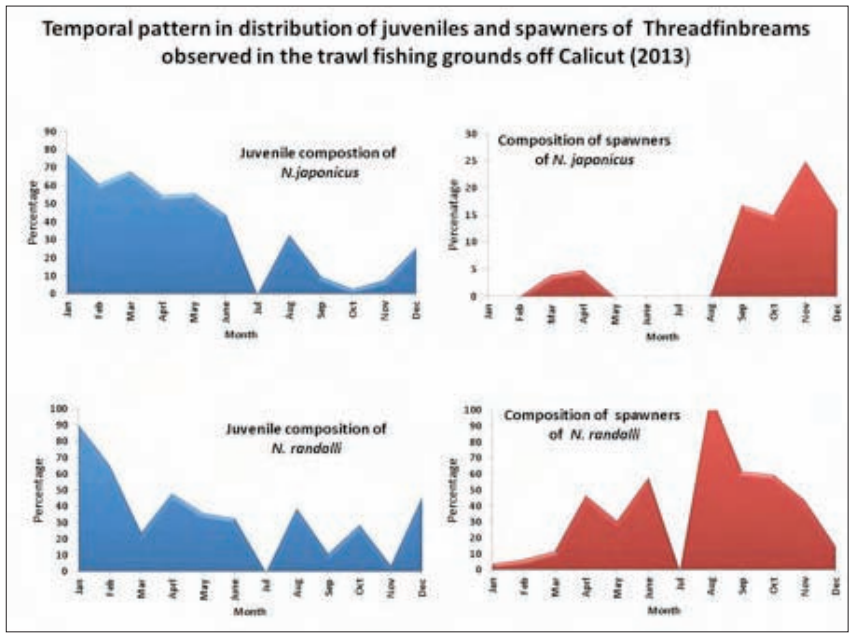
Centres	Gears studied	Species studied
Veraval	Gillnet and trawl	Tunas, Ribbonfish, Crabs, Acetes, Croakers, Perches
Mumbai	Trawl, dol net	Colia, Bombay duck, Ribbonfish
Karwar	SDF and shore seine	Shrimps and Crabs
Mangalore	Gillnet, trawl, ring seine, pusre seine	Tunas, Sardines, Stomatopods, Crabs, Threadfin breams, Whitefish, Seerfish, Mackerel
Calicut	Trawl	Croakers, Threadfin breams
Kochi	Ring seine, trawl, Chinese dip net	Crabs, Shrimps, Stomatopods, Gastropods, Shrimps, Threadfin breams, Whitefish
Vizhinjam	Gillnet and hook and line	Lobsters and Crabs
Tuticorin	Gillnet; trawl	Crabs and shrimps, Tunas , Ribbonfish,
Chennai	Gillnet, trawl, hook and line	Threadfin breams, Perches, Crabs, Stomatopods, Gastropods
Visakhapatnam	Gillnet, trawl, hook and line	Ribbonfish, Tunas, Threadfin breams, Perches, Crabs, Stomatopods, Gastropods

Juvenile and spawner exploitation by different fishing methods

Temporal pattern of abundance of juveniles and spawners of threadfin breams from trawling grounds off Calicut was studied. Similar studies are being carried out for different species along Indian coast.



GIS inventory of fishing centres along Goa coast



Temporal pattern of abundance of juveniles and spawners of threadfin breams from Calicut.

Preliminary mapping of important resources off Mangalore has been completed and demonstrated to provide an insight on the project output.

GIS based resource mapping of juvenile and spawner abundance along Indian coast will provide database for the spatial and temporal closure or restriction in trawl fishery. GIS is found to be very handy tool for fishery resource mapping. Most important feature of the GIS maps is that, information on each separate group/species/ juveniles/adults layers can be individually or collectively separated by queries and the layers can be studied in terms of its importance. GIS arranges the data collected periodically in different layers which can be retrieved as per the projections required and each layer can be analysed individually. The utility of the layer character of GIS in bycatch reduction is that, if juvenile exploitation in a specific species makes considerable impact on the stock position and economics of commercial species, effort restrictions can be imposed in that fishing ground and season with illustrative justifications. Studies on the repeatability of the juvenile abundance in these particular fishing grounds will help in identification of critical fishing ground where seasonal and spatial closure of trawl fishery can be implemented to improve the fishery production in the long run. The resource maps can be used as an excellent tool by the policy makers to weigh each fishing ground in terms of commercial value and juvenile abundance so that the policy making process is much transparent. Illustrated maps with seasonal/ fishing ground wise distribution of juveniles and commercial fishes will be a useful tool in awareness programs to extend the research findings to the stake holders.

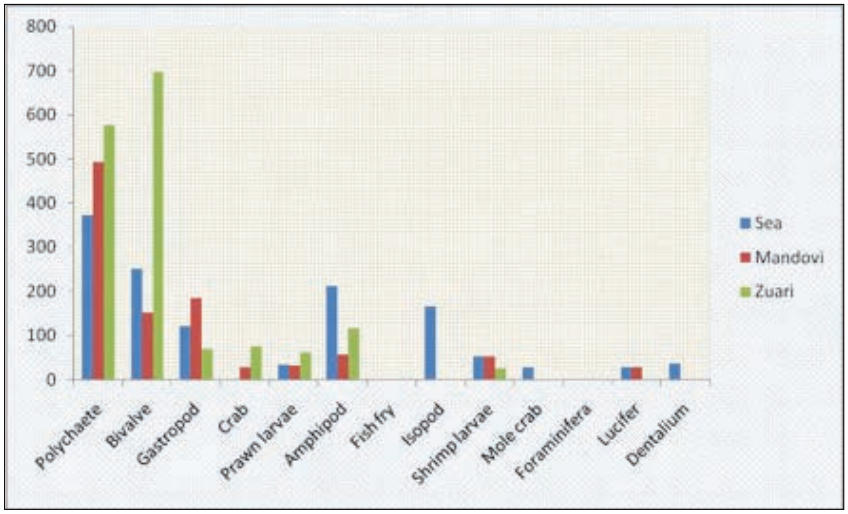
Flow of matter through trophic levels in marine and estuarine ecosystems

Research project: EF-3/MoES

Data collected from Mandovi and Zuari estuaries as well as coastal waters of Goa was analysed during the period. Data on length frequency and other population parameters for biomass estimation for 110 species completed.

Macrobenthos

The average macrobenthos in Mandovi, Zuari esturies and coastal waters of Goa were 3 g^{-2}, 11 g^{-2} and 4 g^{-2} respectively. Polycheates dominated among macrobenthos followed by bivalves and gastropods.



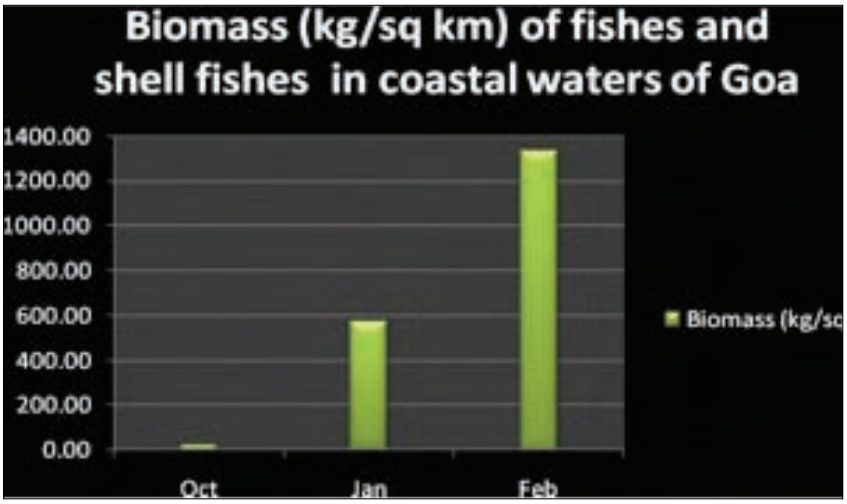
Seasonal analysis showed that there is similarity in species composition between pre-monsoon and post-monsoon, while during monsoon season there is dissimilarity which was contributed by bivalves.

Diet matrix study

The diet data was analysed using index of preponderance, volume method and percentage of occurrence. Diet matrix of 130 species of finfishes were studied. Similarity in diet composition of carnivorous fishes occurring in the estuaries was analysed to ascertain the trophic interactions between species. Cluster anlaysis showed that *Arius arius* and *Gerres filamentosus* formed one cluster and *Arius subrostrus* and *Lutjanus argentimaculatus* formed another cluster. Preliminary estimates of the biomass of different ecological groups in Mandovi, Zuari esturies and coastal waters were made. Model fitting and trial runs are in progress for the different ecosystems.

Experimental trawling in coastal waters of Goa

Experimental trawling off Goa coast was undertaken during October 2013, January 2014 and February 2014. The biomass was estimated by swept area method for the trawling grounds. In October 2013, only three species were represented in the fishery with total catch of 2.4 kg. Average biomass estimated for the month was 22 kg km^{-2}. *Charybdis lucifera* (11.11 kg), *Secutor insidiator* (6.48 kg) and *Loligo duvauceli* (4.63 kg) contributed to the biomass. In January 2014, thirty species represented the fishery with a total catch of 60.5 kg in three hauls. The estimated biomass for the month was 573 kg km^{-2}. *Charybdis lucifera* was the major species with a biomass of 151.57 kg, followed by *Opisthopterus tardoore* (72.94 kg), *Metapenaeus dobsoni* (43.58 kg), *Portunus sanguinolentus* (40.74 kg), *Lagocephalus inermis* (33.16 kg), *Leiognathus splendens* (25.58 kg); *Saurida tumbil* (21.41 kg), *Epinephelus diacanthus* (17.81 kg), *Metapenaeus affinis* (16.10 kg) and *Secutor insidiator* (14.21 kg). In February 2014, thirtyfive species were represented in the fishery with a total catch of 107.2 kg in two hauls. The estimated



biomass for the month was 1331 kg km^{-2}. *Fenneropenaeus indicus* with 153.30 kg km^{-2} was the major contributor to the biomass in Fenruary, 2014 followed by *Oratosquilla nepa* (150.41 kg), *Epinephelus diacanthus* (129.43 kg), *Charybdis hoplites* (105.04 kg), *Lagocephalus inermis* (98.69 kg), *Portunus sanguinolentus* (92.02 kg), *Leiognathus splendens* (57.43 kg), *Metapenaeus dobsoni*, (53.38 kg) and *Saurida tumbil* (49.93 kg).

Pearl oyster banks of Tuticorin

Research project: EF-16/MoEF

Tentative maps were generated for pearl bank group with in central division of the Gulf of Mannar using ARC-GIS software by collecting the basic data like topographic map, village map and GPS control point along the Tuticorin coastal area. More accurate location of the pearl beds of Gulf of Mannar was redrawn using the Arc GIS software. Area were calculated for each of the pearl beds. Individual detailed map of the pearl beds to be surveyed were created for all the 13 odd pearl banks lying in Central Division using the Tamil Nadu Fisheries Manual Pt.II Vol.1

Grid Map for survey

To conduct underwater survey, Grid Maps were prepared with help of ARC-GIS software by obtaining digital information like grid map, strip map & way point map from vessel navigation. Surveys were conducted at 6 'paars' (Devi, Cruxion, Crixion Thoondu, Vantheevu Arupagam, Nagarai, Utti) and the data obtained on environmental and topographical aspects were documented.

Nenjurichan and Pulipoondu paar groups were surveyed initially for ground truthing and environmental data, soil nature (grain size), fauna/flora availability were obtained.

For biological status, 'dives' were conducted using SCUBA on the predetermined dive spots in each dive grids (450 m^2) and data documented. No significant pearl oyster populations were observed in all the pearl beds so far surveyed. Preliminary observations showed clear damage to the near shore pearl beds. The pearl beds have become almost flat due to the physical disturbances (repeated trawling).

Prediction of recruitment success

Research project: EF-9/MoES

The main spawning period of sardine mackerel and anchovy was assessed by routine biological sampling and the occurrence of eggs and larvae were checked by plankton analysis. It was observed that the average number of eggs per 1000 m^3 at 5, 10, 20 and 30 m depth zones off Kochi were 51.8, 96.3, 4.6 and 4.60 respectively. Larvae of sardine and mackerel were observed in all depth zones. The weekly variation in gondosomatic index indicated that sardine spawn by June and anchovies by November.

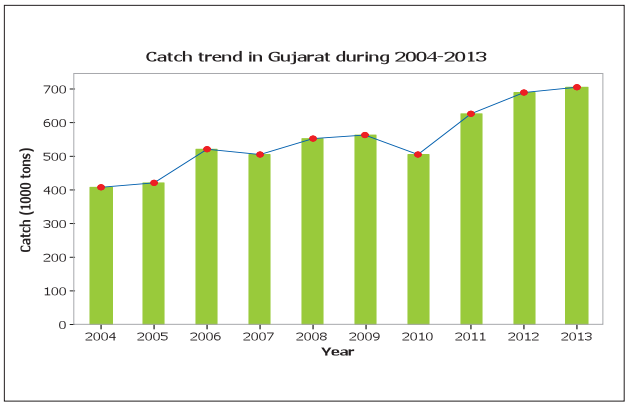
Sustainable management **of fishery resources**

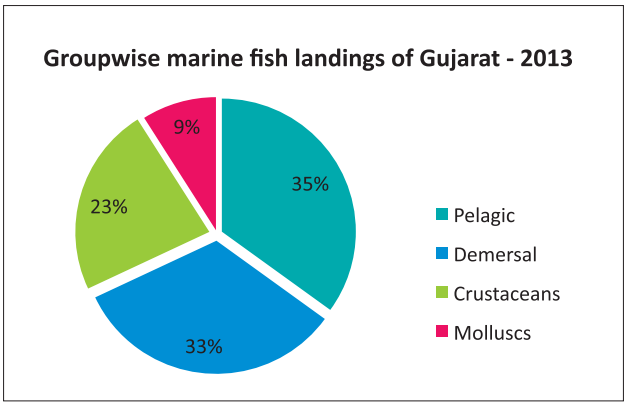
Gujarat

Research Project: FISHCMFRISIL201200400004

Annual marine fish landings in Gujarat during 2013 was 7.17 lakh t with Junagadh District being the highest contributor (3.78 lakh t). Sector-wise contribution of fish landings indicates dominance of mechanised vessels (6.36 lakh t) followed by motorised sector (0.68 lakh t) and non-motorised vessels contributing only 1,514 t. Trawl landings formed 61% of the annual fish landings followed by other gears like dolnets (26%), gillnets (12%) and others (1%).

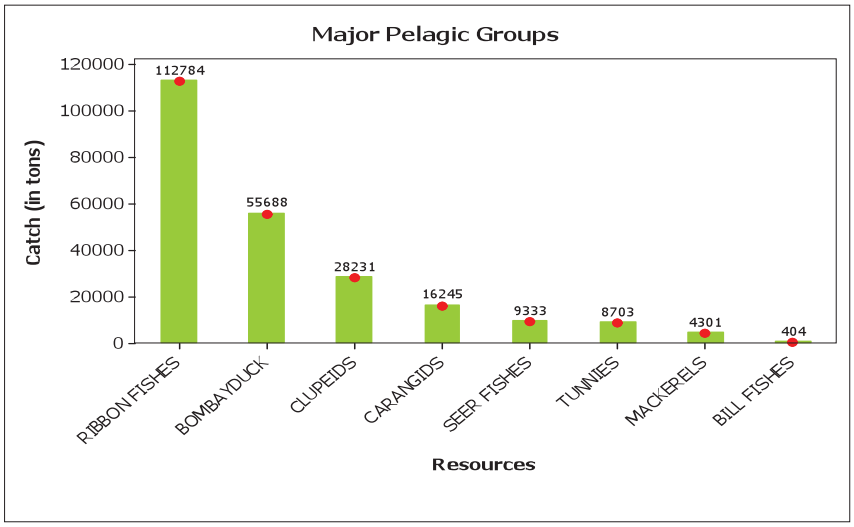
Landing by pelagic group (35%) dominated marginally over demersal group (33%). Important resources that contributed to the total landings of Gujarat were ribbonfishes (16%), non-penaeid prawns (14%), Bombayduck (7.9%), croakers (7.6%), threadfin breams (7.19%), penaeid prawns (5.16%), cuttlefish (4.20%) and catfishes (4.11%).





Pelagic resources

Pelagic fishes with a landing of 2.3 lakh t formed nearly 33% of the total marine fish landing in Gujarat during 2013. The major resources landed under this category were ribbonfish, Bombayduck, clupeids, carangids, seerfishes and tunnies.



Bombayduck: The estimated total catch of Bombayduck in Gujarat was 55,688 t registering a decline of nearly 15% over the previous year. Bombayduck landing formed 8% of the total marine fish production. Dolnet was the major gear targeting Bombayduck forming almost 25% of the total fish catch by dolnet and this formed major fishery at Nawabunder, Rajpara and Jaffrabad along the Sourashtra coast. The catch rate of Bombayduck in dolnet was 550 kg u^{-1}. Single species *Harpadon nehereus* formed the entire catch of Bombayduck.

Ribbonfish: Ribbonfish landing in 2013 was 11,2784 t registering nearly 23% increase over the previous year. Ribbonfish formed 16% of the total fish landing. Mechanised multiday trawlers alone contributed 83.6% of the total ribbonfish landing with a catch rate of 958 kg per unit and the remaining by single day trawlers, mechanised dolnetters and gillnetters. *Trichiurus lepturus* was the single species landed.

Tuna: Annual catch of tuna during 2013 was 8,703 t registering a drastic decline of 36% over the previous year. Outboard gillnetters (64%) and mechanised multiday gillnetters (27%) were the major gears which contributed to the fishery. Tuna landing in multiday trawlers were exclusively of *Euthynnus affinis*. The dominant species were *Thunnus tonggol* (59%), *E. affinis* (26%), *Auxis* sp. (4.9%), *Katsuwonus pelamis* (5.3%), *Thunnus albacares* and *Sarda orientalis* (4.9%). The length recorded for *Thunnus tonggol* was in a range of 320-819 mm with mean length of 594.2 mm. *E. affinis* ranged in length from 300-659 mm with a mean of 493.75 mm. The sex ratio of *T. tonggol* and *E. affinis* were found to be 1:3 and 1:1.95 respectively. Fecundity of *E. affinis* was found to be 4,34,227 and that for *T. tonggol* was 11,90,318.

Indian mackerel landed at Veraval

Indian mackerel: Indian mackerel landings in Gujarat during 2013 were 4,301 t recording a decline over the previous year by 21%. It formed 1.8% of the total pelagic resources landed during the year.

Mahi mahi (*Coryphaena hippurus*) landing in Veraval

Nearly 78% of the mackerel landing was by outboard gillnetters and 18.4% by mechanised multiday trawlers. November to February is the major season for mackerel landing in Gujarat with peak landing in December.

Carangids: Annual estimated landings of carangids in Gujarat during 2013 were 16,245 t registering decline over the previous year by 6.9%. Multiday trawlers (58%) and outboard gillnetters (30.5%) contributed maximum to the carangid landings. Among carangids *Megalaspis cordyla* formed 22% and *Decapterus russelli* (2%) was the next major species.

Seerfish: Seerfish landing in Gujarat during 2013 was 9,333 t mainly constituted by *Scomberomorus commerson* (51.2%) and *S. guttatus* (48.8%). Outboard gillnetters contributed 59% of the catch and the other major gears were multiday gillneters (14%) and multiday trawlers (24%). Seerfish formed 4% of the pelagic fish landing in Gujarat.

Clupeids: Clupeids with a landing of 28,231 t formed nearly 12% of the total pelagic landing. Major species or groups which formed the fishery were *Thryssa* sp. (30%), *Coilia dussumieri* (26%), *Chirocentrus dorab* (17.6%), other cluepids (15.2%), other shads (4.5%) and *Hilsa ilisha* (4.6%). Mechanised multiday trawlers landed nearly 34.6% of the clupeid resources and the main resources that formed the catch in this gear were *Thryssa* sp., wolf herring and other clupeids. Among clupeids, *Coilia dussumieri* was the main catch in mechanised dolnetters. Mechanised dolnetters contributed 19% of the clupeid landings with major species being *C. dussumieri*.

Growth and mortality parameters of important pelagic fishes off Gujarat

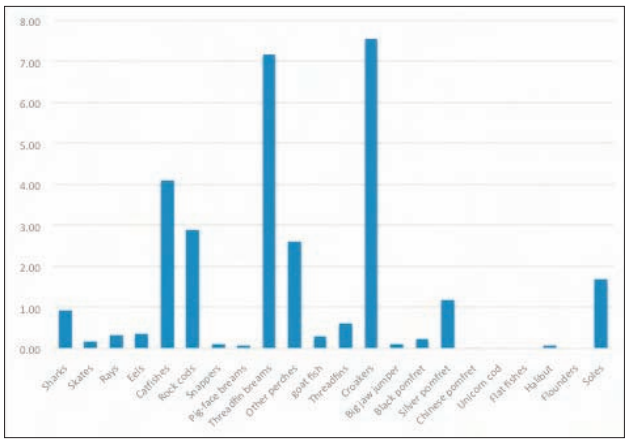
Species	L_{inf}	k/yr	M/yr	F/yr	Z/yr	E
Harpadon nehereus	390.0	0.83	0.76	5.34	6.10	0.88
Trichiurus lepturus	1218.0	0.26	1.22	0.49	0.73	0.59
Rastrelliger kanagurta	294.0	0.59	3.0	1.24	1.76	0.58
Megalaspis cordyla	500.0	0.94	0.77	4.23	5.0	0.85
Coilia dussumieri	210.0	1.35	1.24	6.19	7.43	0.83
Coryphaena hippurus	1335.0	0.25	0.25	1.48	1.73	0.83
Thunnus tonggol	1020.0	0.25	0.27	3.41	3.67	0.93
Euthynnus affinis	700.0	0.46	0.44	0.72	1.16	0.62

Demersal resources

The annual marine demersal fish landings in Gujarat were estimated as 2,14,945 t (12.71% decline from previous year) which formed 33% of total production during the year.

Threadfin breams: Threadfin bream production of Gujarat by multiday trawlers was 50,745 t, forming 12.82% of the total trawl catch with a catch rate of 6.33 kg u^{-1}. The fishery was supported predominantly by *Nemipterus japonicus* (51%) and *N. randalli* (44.8%) along with small quantities of *N. bipunctatus* (5.2%).

Sciaenids: Estimated landing of croakers by multiday trawlers, gillnetters and dolnetters was 53,424 t at a catch rate of 6 kg u^{-1}. The dominant species in the trawl fishery was *Otolithes cuvieri* (46.10%) and *Johnius glaucus* (32.38%).



Catch composition of the demersal resources in Gujarat during 2013

Juveniles of sharks landed by trawl in Veraval

Lizardfishes: Estimated lizardfish landing of Gujarat was 1,7l,359 t which was 30.41% more than 2012 at a catch rate of 2.05 kg u^{-1}. The main species contributing to the fishery was *Saurida tumbil* (63.5%) followed by *S. undosquamis* (36.48%).

Pomfrets: Total pomfret landings by trawls and gillnetters was 8,358 t at a catch rate of 1.04 kg u^{-1}. Gillnet catch rate was higher than trawl net. Length range of *Pampus argenteus* was 40-300 mm with a mean length of 134.13 mm. Sex ratio was observed to be as 1:0.98.

Catfish: Catfish landing of Gujarat was 29,006 t at a catch rate of 3.6 kg u^{-1}. Length range of *Picofollis* (=*Arius*) *tenuispinis* was 190-970 mm with a mean length 408 mm. Sex ratio (1:2.64) showed the dominance of females and fecundity ranged from 12-490.

Elasmobranchs: Elasmobranch landings during 2013 was 9,821 t. The catch in trawls at Veraval was dominated by *Scoliodon laticaudus* (35.25%) followed by *Rhinobatos* spp. (22.09%), *Dasyatis* spp. and *Himantura* spp. (21.82%), *Carcharhinus* spp. (3.05%), *Rhizoprionodon* spp. (2.89%), *Mustelus mosis* (3.74%), *Mobula* spp. (1.76%) and *Sphyrna lewinii* (0.80%). *Scoliodon laticaudus* (57.68%) was the major catch in gillnet followed by *Carcharhinus* spp. (14.55%) and *Mobula* spp. (7.58%). The length of *S. laticaudus* ranged from 250-646 mm with a mean of 455 mm and mode at 460 mm. Sex ratio for *S. laticaudus* was found to be 1:1.39 (M: F) with the dominance of females.

Growth parameters of selected demersal resources landed in Gujarat

Species	L_{inf} (cm)	K (yr^{-1})	M (yr^{-1})	F (yr^{-1})	Z (yr^{-1})	E	Lr (cm)	Lc50% (cm)	Lm50% (cm)	Recruitment (peak)
Nemipterus japonicus	41.2	0.45	0.95	1.37	2.32	0.59	10.3	17.5	18.9	April-June
Saurida undosquamis	41.46	0.35	0.80	0.72	1.52	0.47	9.6	14.34	18.67	April-Aug
Saurida tumbil	45.3	0.76	1.57	1.3	2.87	0.45	16	26.9	28.7	June-Sept
Otolithes cuvieri	37.5	0.48	1.01	1.55	2.56	0.60	10.5	14.5	23.9	March-June
Johnius glaucus	33.5	0.40	0.93	1.91	2.84	0.67	10.5	15.55	19.2	May-july
Pampus argenteus	31.5	0.95	1.67	1.56	3.23	0.48	9.5	16.5	24.7	Feb-July
Arius tenuispinis	98.0	0.41	0.70	1.28	1.98	0.64	26.6	44.0	40	Dec- Feb

Six barred grouper landed in Veraval Bhidiya Harbour

Sorting of trawl catch in an auction hall at Veraval

Crustacean resources

Crustacean landing was estimated to be 1.53 lakh t which constituted 21.72% of the total fish production from Gujarat during 2013. Compared to the previous year crustacean landing showed an increase of 11.7%. Major groups in the crustacean landing were non-penaied shrimps (64.42%) followed by penaied shrimps (25.20%), crabs (8.94%), stomatopods (1.15%) and lobsters (0.29%). Major gears contributing to crustacean landings were dolnet (58.0%) multiday trawl net (28.8%), mechanised trawl net (9.2%) and gillnet (1.0%).

Shrimps: Shrimps contributed about 1.37 lakh t forming about 89.62% of the total crustacean landings of Gujarat during 2013 which showed an increase of 17% compared to the previous year. Non-penaeid shrimp landings showed an increase of nearly 18% compared to previous year and contributed about 98,753 t forming 71.88% of total shrimp landings. Among non-penaieds *Acetes* sp. dominated the catch (91.11%) followed by *Nematopalaemon tenuipes* (7.34%) and *Exhippolysmata ensirostris* (1.55%). Non-penaied shrimp resources were mainly exploited by mechanised dolnetters (79.47%), mechanised trawlnetters (10.15%) and multiday trawlnetters (8.83%). Penaeid shrimp landings showed an increase of nearly 17% compared to previous year and contributed about 38,629 t forming 28.12% of total shrimp landings. Among penaeid shrimps, *Solenocera* sp. dominated the catch (33.37%) followed by *Parapenaeopsis* sp. (30.07%), *Metapenaeus* sp. (15.80%), *Penaeus* sp. (3.92%) and *Metapenaeopsis* spp.

Crab landing in Veraval

(0.35%). Penaied shrimp resources were mainly exploited by multiday trawlnetters (60.60%), dolnetters (22.42%), mechanised trawlnetters (7.71%) and mechanised gillnetters (3.29%).

Crabs: Crabs contributed about 13, 708 t forming about 8.94% of the crustacean landings. Crab landing showed a decline of 17.5% compared to previous year. Inedible crabs (bycatch) contributed about 75.78% of total crab landings. *Charybdis feriatus* contributed about 16% followed by *Portunus sanguinolentus* (5.03%), *Portunus pelagicus* (3.19%). Crabs were mainly exploited by multiday trawl netters (81.15%), mechanised dolnetters (7.97%), mechanised trawlnetters (4.64%) and gillnetters (0.98%).

Lobsters: Lobsters contributed 445 t forming 0.29% of the crustacean landings. Lobster landing showed an increase of 16.5% compared to the previous year. The major groups in the lobster landing were *Panulirus polyphagus* (70.60%) and *Thenus unimaculatus* (21.48%). Lobsters were mainly exploited by multiday trawlnetters (45.29%), gillnetters (14.57%), dolnetters (12.02%) and mechanised trawlnetters (3.07%).

Stomatopods: Stomatopods contributed 1,758 t forming about 1.15% of the total crustacean landings showing a decline of about 50% compared to the previous year. Stomatopod landing was solely contributed by *Oratosquilla* sp. Stomatopods were mainly exploited by multiday trawlnetters (37.38%), mechanised dolnetters (36.58%) and mechanised trawlnetters (25.74%).

Growth and mortality parameters of important crustacean resources landed at Veraval

Major crustacean sp.	Sex	L_{inf} (mm)	K (yr^{-1})	M (yr^{-1})	F (yr^{-1})	Z (yr^{-1})	E
Solenocera crassicornis	Male	132.36	1.9	3.12	3.81	6.93	0.55
	female	141.75	1.7	2.79	2.69	5.48	0.49
Parapenaeopsis stylifera	Male	131.25	1.9	3.12	3.56	6.68	0.53
	female	152.57	1.7	2.79	2.74	5.53	0.50
Meatapenaeus affinis	Male	182.23	1.7	2.79	3.61	6.40	0.56
	female	202.54	1.5	2.46	3.05	5.51	0.55
Meatapenaeus monoceros	Male	203.35	1.7	2.79	3.82	6.61	0.58
	female	234.57	1.6	2.62	3.10	5.72	0.54
Penaeus semisulcatus	Male	213.55	1.8	2.95	3.84	6.79	0.57
	female	245.26	1.7	2.79	3.66	6.45	0.57

*Natural mortality was estimated using Alagraja's formula (M=1.64*K)

Population structure of important crustacean resources during 2013

Species	Sex	Length range (mm)	Mean length (mm)	Mode length (mm)	L_r (mm)	$L_{c50\%}$ (mm)	L_m (mm)	Sex ratio(M:F)
Solenocera crassicornis	Male	45-129	89.24	85.00	45.00	78.67	84.36	1.59
	female	41-138	93.37	85.00	41.00	79.70	89.62	
Parapenaeopsis stylifera	Male	43-125	91.51	95.00	43.00	88.47	83.94	1.27
	female	47-141	102.39	95.00	47.00	73.05	96.30	
Meatapenaeus affinis	Male	88-173	131.26	135.00	88.00	122.97	114.26	1.42
	female	82-198	142.15	145.00	82.00	121.35	125.61	
Meatapenaeus monoceros	Male	85-191	145.93	145.00	85.00	125.58	125.11	1.36
	female	87-223	150.52	145.00	87.00	120.20	142.83	
Penaeus semisulcatus	Male	82-205	156.91	165.00	82.00	153.11	131.21	1.28
	female	84-231	161.74	165.00	84.00	135.63	148.59	

Molluscan resources

Cephalopods: Cephalopod landings formed 7.95% (56,092 t) of the total marine production in Gujarat, with contribution of cuttlefish (46%), squid (52%) and *Octopus* (0.45%). Cuttlefish landings (26,163 t) were dominated by *Sepia pharaonis* (60%) followed by *Sepia elliptica* (15.5%), *Sepia omani* (5.8%) and *Sepiella inermis* (8.2%). Squid catch (29,672 t) was supported mainly by *Uroteuthis duvauceli* (64.8%) *U. singhalensis* (19.6%), *U. edulis* (5%) and *U. chinensis* (8.2%). *Octopus* landed (257 t) comprised *Octopus membranaceus* (45%), *O. dollfusi* (22%) and *Cystopus indicus* (24%).

Monthwise mean length and sex ratio for different cephalopod species landed in Gujarat

Fishing months	*Uroteuthis duvauceli*		*Uroteuthis singhalensis*		*Sepia elliptica*		*Sepia omani*		*Sepia trygonina*	
	Sex ratio	Mean length (mm)	Sex ratio	Mean length (mm)	Sex ratio	Mean length (mm)	Sex ratio	Mean length (mm)	Sex ratio	Mean length (mm)
September	5	117.542	0.714	115.66	2	91.111	1.11	90.31	1	136.75
October	1.58	116.39	0.75	117.14	1	85.038	1	87.9	0.68	64.86
November	0.56	98.31	5.37	111.01	1.125	120	0.8	82.88	1.11	99.78
December	2.1	106.9	0.72	156.22	0.7	107.823	3.37	91.51	2.33	60.25
January	1.24	151.95	1.66	140.25	1.125	104.882	3	94.43	1	87.66
February	2.27	107.31	2.8	139.42	1	92.8	1.28	86.56	0.86	80.76
March	2.08	111	1.4	150.75	1.4	95.416	2	88.3	0.91	64.27

Maharashtra

Research Project: FISHCMFRISIL201201000010

Marine fish landings in Maharashtra during 2013 were estimated at 3.64 lakh t valued at ₹2,480 crores. The total fish landings increased by 15.7% and the revenue increased by 16.9%. During the year pelagic finfishes contributed 35.1% to the total landings, demersal 25.3%, crustaceans 33.4% and molluscs 6.2%. Crustacean landings increased

remarkably by 44% while pelagic and demersal fishes registered 10.4%, 3.4% increase respectively; however molluscan resources recorded 3% decline.

Major fishing gears that contributed to the landings in the state were trawl net (39.9%), bag net (36.5%), purse seine (13.6%) and gill net (8.1%), Compared to 2012, the bag net fishery recorded unprecedented increase in catch by 84% due to heavy landings of non-penaeid prawns. Owing to sparse catch rates, the trawlers mostly undertook multiday fishing trips lasting for 6-18 days.

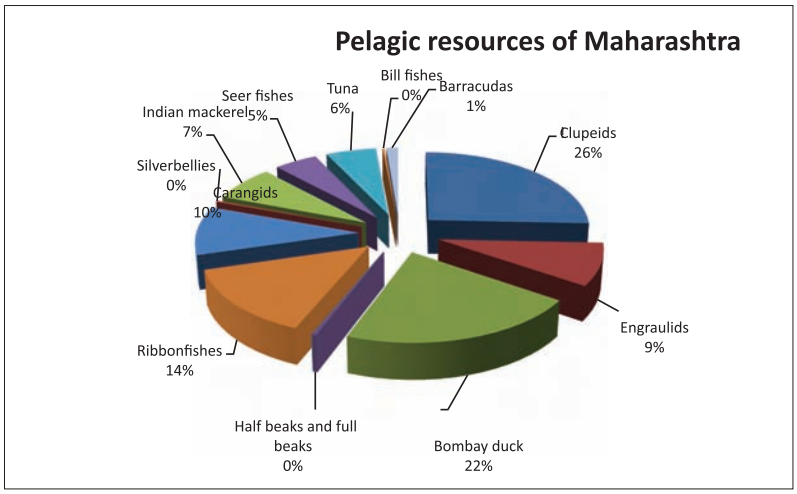
The prominent species/groups that contributed to the fishery were non-penaeid prawns (23.9%), penaeid prawns (8.1%), croakers (7.7%), Bombayduck (7.5%), squids & cuttlefishes (6.1%), catfishes (5.1%) and ribbonfish (5%). The landings of oil sardine and mackerel recorded decline in 2013 and contributed 4.7% and 2.5% respectively.

Some purse seiners targeted catfishes and Jew fish (Ghol) *Protonibea diacanthus* that fetched a fortune (with revenue exceeding ₹1 crore) in some fishing trips. Some of the fishers in Raigad District were supported by potential fishing zone (PFZ) advisories through NAIP assisted "m-Krishi" mobile service which enabled mini purse seiners with inboard as well as outboard engines to have better catch of oil sardine in the nearshore waters.

Pelagic resources

Pelagic finfishes contributed 1.27 lakh t to the total fish landings (34.8%) and recorded 6.5% decrease compared to 2012. The major pelagic finfishes were Bombayduck, carangids, anchovies, ribbonfish, wolf herring, full beaks, sardines, mackerel, seerfishes, barracuda, tuna and dolphin fishes.

Small pelagics: In the total pelagic finfishes, clupeids formed 25.67% followed by Bombayduck *Harpodon nehereus* (21.4%), ribbonfish (14.18%), carangids (10.08%), engraulids (8.79%), Indian mackerel (7.24%), tuna (5.61%), seerfish (4.86%) and barracuda (1.3%).



Oil sardine: *Sardinella longiceps* contributed 17,013 t (4.7%) to the total fish landings but showed 49% decline. Purse seine was the major gear that caught 77% of *S. longiceps*. The size of oil sardine ranged from 125 to 200 mm. Analysis of gut contents showed *Coscinodiscus*, *Foraminifera*, Tintinid, *Pleurosigma*, copepods, *Ceratium, Nitzschia, Skeletonema, Biddulphia, Dinophysis* and *Navicula* as the major food items.

Golden anchovy: *Coilia dussumieri* contributed 2.7% (9,899 t) to the total

marine fish landings and recorded 32% increase over the last year. Trawl landings contributed 53.8%, bag nets 36.3% and gill nets 9.9%. The size range of the fish was 50-204 mm with gravid females noticed from October to January. The major food consisted of Copepods and *Acetes* spp.

Indian mackerel: *R. kanagurta* contributed 2.5% (9,262 t) to the total fish landings in the State. Catch of mackerel declined by 53.9% as compared to 2012. Almost two-third (67.3%) of mackerel landing was contributed by purse seiners followed by gill netters (16.4%) and trawlers (15.3%). The size range was 120-280 mm and mature females were observed in October and January to April. Gut content analysis showed dominance of *Foraminifera*, Ostracod, *Pleurosigma*, copepods, *Coscinodiscus*, *Acetes* spp., *Lampriscus* and tintinids.

Bombayduck: With estimated catch of 27,383 t it formed nearly 7.5% of the total fish landings. Compared to 2012 the Bombayduck catch increased by 53.7% of which 83% was contributed by dol nets and the remaining 17% by trawlers. The size ranged from 45 to 389 mm with mature and gravid females dominating during March-April, November and in January. Food consisted of *N. tenuipes* as the most favourite food followed by *Acetes* spp., *Coilia dussumieri* and juveniles of Bombayduck.

Ribbonfish: Ribbonfish recorded 18,154 t (5%) showing 17% increase over last year. Trawl net contributed to the major catch (87.8%) of this resource followed by dol net (10.1%) and gill net (1.8%). *Trichiurus lepturus* was the major species with size range of 390-1169 mm. Occurrence of

Sun drying of ribbonfish at Mirkarwada, Ratnagiri

mature and gravid females was in January, March, April and December. Major food items observed were young ones of *T. lepturus*, *Acetes* spp, *Loligo* spp., *S. longiceps* and *M. stridulans*.

Large pelagics: The group constituted tunas, cobia, barracudas, fullbeaks, sailfishes, seerfishes and dolphin fishes. Among the major large pelagic groups, carangids constituted 41% followed by tunnies (22.83%), seerfishes (19.77%), barracudas (5.29%) and billfishes (0.9%).

In tuna landings 64% were contributed by *Euthynnus affinis*, followed by *T. tonggol* (29.7%), *Auxis* spp. (2.4%) and other tunnies (3.5%). Billfishes formed 289 t (0.08%) of the total marine fish landings and recorded 130% increase over last year. Two species of barracuda contributed 0.46% (1,662 t) to the total marine fish landings. Seerfishes (two species- *S. commerson* & *S. guttatus*) contributed 5,120 t (1.7%) to the total landings (37%). *T. tonggol* contributed 1.97% to the total marine fish landings of the state. Size range of *T. tonggol* was 263-650 mm and gravid females were observed during August-October. The IRI showed that the main food item was fish (64.7%) followed by cephalopods (22.3%) and crustaceans (13%). *E. affinis* formed 1.7% (4,621 t) of the total marine fish landings. The size range of *E. affinis* was 220-540 mm. Gravid specimens were seen during August-October. The major food consisted of fish, cephalopods and crustaceans. *A. thazard* formed 171 t (0.05%) of the total marine fish landings. The size range was 240-440 mm and gravid females were seen during August to October. The major food consisted of fish, cephalopods and crustaceans.

Cobia: The estimated catch of *Rachycentron canadum* at Sassoon Dock was 29 t at the catch rate of 0.02 kg/h forming about 0.1% of the total trawl landings. Size range of *R. canadum* was 246-1050 mm. Maturing specimens were recorded during November. The IRI showed that the main food item was fish (54.65%) followed by cephalopods (29.41%), crustaceans (13.72%) and bivalves (2.23%).

Full beaks: Total catch of fullbeaks and halfbeaks in Maharashtra was estimated at 496 t of which *Ablennes hians* comprised 2.5 t (1%). Groups that contributed were *Tylosurus* (48%), *Strongylura* (28%), *Hemirhamphus* (23%) and *Ablennes* (1%). Size range of *Tylosurus acus* was 450-850 mm and *A. hians* size range was 600- 987 mm. Sex ratio was 1: 0.5 and 1:0.6 respectively. The IRI showed that the main food item was fish (74%), cephalopods (23%) and crustaceans (3%).

Billfishes/Sailfishes: Billfishes contributed 289 t (0.08%) to the total marine fish landings. Among billfishes *Istiophorous platypterus* constituted 51% and *Xiphias* 49%. Size range of *I. platypterus* was 95-250 cm and sex-ratio 1:0.33. Gravid specimens were observed in September. The IRI showed that the main food item was fish (57.12%) and cephalopods (42.88%).

Barracuda: Barracuda contributed 0.46% (1,662 t) to the total marine fish landings but recorded 10% decline over the last year. The size range of *Sphyraena putnamae* was 50-204 mm and gravid females were recorded

in September. The Sex ratio was 1:0.84. The IRI showed that the main food consisted of *Decapterus russelli*, *Loligo duvauceli*, *Harpadon nehereus*, *Megalaspis cordyla* and seerfish.

Wolf herring: Wolf herring *Chirocentrus* spp. contributed 1,326 t (0.36%) to the total marine fish landings. The size range of *C. nudus* was 300-720 mm and gravid specimens were seen in April, August and September. The major food consisted of *Acetes* spp. and cephalopods.

Seerfishes: Seerfish catch was 5,120 t (1.7%). *S. commerson* (63%) and *S. guttatus* (37%) were the only two species contributing to the fishery. Size of *S. guttatus* ranged between 170-629 mm; females in mature and gravid stages were noticed in September and October. Gut content analysis showed *T. lepturus*, *E. muticus*, *Acetes* spp., *Lactarius* sp., *N. tenuipes*, *Loligo* spp. and *Stolephorus* spp.

Demersal resources

The estimated total catch of demersal resources during 2013 was 91,348 t which formed 25.3% of the total fish landings of the state. Nearly 63% of the demersal resources were landed by trawlers. When compared to 2012 the catch recorded 3.4% increase. The catch was mainly contributed by croakers (39.9%), threadfin breams (29.1%), rock cods (9.1%) and catfishes (5.1%).

Elasmobranchs: Elasmobranch catch (5,476 t) was exploited by trawlers (2,305 t), gill netters (2,386 t), dol netters (660 t) and purse seiners (125 t). Sharks were the dominant group (83%) followed by rays 14.7% and skates 2.2%. *Scoliodon laticaudus* was the dominant species in trawl (86%), gill net (49%) and dol net (85%). *S. laticaudus* ranged between 160-600 mm. Mature and gravid females were noticed in April and December. The species fed on *Solenocera* sp., *Loligo* sp., *H. nehereus*, and *Oratosquilla* sp. *Rhizoprionodon oligolinx* ranged in size from 480-820 mm and pregnant females were found in March-April and November with maximum of 6 embryos. The size of *H. imbricata* (in disc width) ranged between 140-300 mm and pregnant females were noticed in June, October and November with a single pup.

Pomfrets: An estimated catch of pomfrets in trawl, gill nets, dol nets and purse seines in Maharashtra was 1,069 t, 1,996 t, 2,480 t and 590 t respectively. *P. argenteus* was the most dominant species in dol net (85%), gill net (67%) and trawl net (41%) while *P. niger* was the most dominant in purse seine (99%). The size range of silver pomfret in dol net was 60-330 mm, in gill nets 90-320 mm and in trawl 60-300 mm. Mature and gravid females were noticed in January- March and October-November. Stomach content revealed mainly *Acetes* spp., and *Myctophum* sp. Black pomfret *P. niger* ranged in size from 110-380 mm with annual mean size at 228 mm. Mature and gravid females were noticed in June and September-October. Gut content analysis revealed mainly *Acetes* sp., cephalopods, *Myctophum* sp. and salps.

Lizard fish: Lizard fishes formed 1,028 t of the total fish catch and were

landed exclusively by bottom trawlers. *Saurida tumbil* (89%) was the dominant species followed by *S. undosquamis* (10%). *Saurida tumbil* ranged in size from 90-470 mm. Mature and gravid females were noticed in October. Mainly *N. randalli*, *Apogon* sp., *Loligo* sp. and *Decapetrus russelli* were present in the stomach.

Polynemids: An estimated catch of polynemids in trawl, gill net, dol net and purse seine in Maharashtra was 640 t, 427 t, 81 t and 2.5 t respectively. Polynemid catch was mainly contributed by *Polynemus heptadactylus* (84%) in trawl, *F. indicus* (69%) in gill nets and *E. tetradactylum* (90%) in dol nets. Size of *Polynemus heptadactylus* ranged between 82-270 mm and nearly 70% females were found in mature condition. The species fed mainly on *Acetes* sp., *Nematopalaemon tenuipes*, *Oratosquillla* sp. and *M. stridulans*.

Catfishes: Catfish catch along the coast exploited by trawlers, gill netters, dol netters, and purse seiners was 2,953 t, 3,438 t, 769 t and 11, 257 t respectively. It formed nearly 5.1% of the total fish catch. The contribution of major catfish species landed were *O. militaris* (27.5%), *Plicofollis tenuispinis* (24.8%), *A. dussumieri* (21.5%) and *A. caelatus* (19.7%). The major spawning period for *O. militaris* was October -January. The sex ratio of *Plicofollis tenuispinis* & *O. militaris* was 1:0.4 & 1:1.45 respectively. *Plicofollis tenuispinis* mainly fed on *Acetes* sp., *Cynoglossus* sp. and *Solenocera crassicornis* whereas *O. militaris* fed on *Acetes* sp., *Solenocera crassicornis*, crab, bivalve and *Squilla*. The size range of *Plicofollis tenuispinis* was 190-530 mm, *A. caelatus* 130-530, *A. dussumieri* 192-560 mm and *O. militaris* 140-430 mm.

Threadfin breams: Nemipterids landed by trawlers amounted to 16,165 t forming 4.4% of the total fish landings of the state. The major Nemipterid species landed were *N. japonicus* (55.3%), *N. randalli* (27.6%) and *N. bipunctatus* (17.2%). The major spawning period for *N. japonicus* & *N. randalli* is August-November & October-November respectively. *N. japonicus* mainly feeds on prawn appendages, crabs, *Acetes* sp., *Loligo* sp., and *N. randalli* on *Acetes* sp., *Loligo* sp., *Solenocera crassicornis*. The size range of *N. japonicus* was 70-290 mm and *N. randalli* 40-300 mm.

Groupers: Groupers were mainly landed by trawlers (5,226 t) forming about 3.6% of the total catch. The relative species abundance showed the dominance of *E. diacanthus* (85%) followed by *E. tauvina* (9.3%) and *E. latifasciatus* (3.7%). Almost 74% of *E. diacanthus* catch was dominated by juveniles.

Croakers: Sciaenid landings along the Maharashtra coast by trawlers, gill netters, dol netters and purse seiners were 22,931 t, 1,600 t, 1,896 t and 1,544 t respectively. Relative abundance showed dominance of *J. vogleri* (30.5%) followed by *O. cuvieri* (24.8%), *J. macrorhynus* (23%), and *O. biauritus* (10.5%).

Whitefish: *Lactarius lactarius* catch along the Maharashtra coast exploited by trawlers and gill netters was 690 t and 205 t respectively. The size ranged from 90-240 mm. The major spawning period for

L. lactarius was October to December. The sex ratio was 1:1.06. They mainly fed on *Acetes* spp., *Sardinella* sp. and *Bregamaceros macclellandi* and *Solenocera crassicornis*.

Crustacean resources

The estimated landing of crustacean resources was 122773 t which contributed 33.7% to the total marine fish landings of the state. Crustaceans showed 44% increase in landings over 85,262 t in 2012. Among the crustaceans, major contributors were non-penaeid prawns (71.5%), penaeid prawns (24.3%), stomatopods (3.3%), crabs (0.7%) and lobsters (0.2%). Crustaceans were mainly landed by dol nets (73.1%) and trawlers (26.4%).

Prawns: Prawns formed 95.8% of the crustacean landings. Non-penaeid prawns showed unprecedented landings (87.076 t) that were mainly contributed by bag nets (84,529 t). Among the penaeid prawns landed by trawlers *Parapenaeopsis stylifera* contributed 27% followed by *S. crassicornis* 21.4%, *Metapenaeus affinis* 19.9%, *M. monoceros* 13.3% and *Metapenaeopsis stridulans* 7.4%. Compared to previous year most of the species showed decline in the catch, but *M. stridulans*, *P. stylifera*, *M. kutchensis* and *S. crassicornis* showed increase.

Nematopalaemon tenuipes dominated the non-penaeid trawl landings by 99.4%. *Acetes* sp. and *Exhippolysmata ensirostris* formed less than 1%. Among the lobsters landed by trawlers *Panulirius polyphagus* formed 99.94% and *Thenus unimaculatus* formed less than 1%. *Charybdis feriata* contributed 62.20%, *P. sanguinolentus* 22.71%, other crabs 9.68% and *P. pelagicus* 5.38% to the crab landings by trawlers.

Cephalopod resources

The annual catch of cephalopods landed by trawlers was 20,544 t forming 5.6% of the total fish landings. The cephalopods catch decreased by 8.8%. Indian squid *Loligo duvauceli* dominated with 56% (11,515 t) followed by cuttlefish *Sepiella inermis* 15.6% (3,195 t), *Sepia elliptica* 14.1% (2,909 t), *Sepia pharaonis* 11.3% (2.316 t) and *Octopus* species, *Cistopus indicus* 3% (612 t).

The dorsal mantle length of *L. duvauceli* ranged between 10-389 mm, *S. elliptica* ranged between 20-119 mm, *S. pharaonis* between 140-319 mm and *S. inermis* between 20-74 mm.

Biology

Loligo duvauceli: Mainly fed on fish (86.9%), prawn (12.5%) and squid (0.6%). The sex-ratio was 1:0.60. Different maturity stages observed were indeterminants 6.7%, immature 3.1%, mature 69% and gravid/spent 21.3%. The fecundity ranged from 1350-29160 and the ova diameter ranged between 0.5-1 mm. Spawning stock biomass, standing stock and total yield for *L. duvauceli* was 14995 t, 15937 t and 11515 t respectively.

***Sepia pharaonis*:** Main food items recorded were fish (88.3%) followed

by prawn (4.3%), crab (7%) and squid (0.4%). The sex-ratio was 1:0.7. Indeterminants 2.1%, immature 20.5%, mature 38.4% and gravid/spent 39% were observed. Fecundity ranged between 795-4,510 and ova diameter 2-5 mm.

***Cistopus indicus*:** Mainly fed on fish (52.5%) and prawn (47.5%). The sex-ratio was 1:0.58. Percentage in different stages of maturity was immature 10.2, mature 54.7 and gravid/spent 35.2. Fecundity ranged between 930-7,290 and ova diameter 1-5 mm.

Population parameters of different species landed in Maharashtra

Species	L_∞ (mm)	K /yr	Z	M	F	E	E_{max}
H. nehereus	408.5	0.85	2.4	1.85	4.25	0.56	0.51
C. dussumieri	214	1.45	3.45	2.58	0.87	0.25	0.62
T. lepturus	1273	0.63	3.87	0.91	2.96	0.77	0.64
S. guttatus	800	0.7	2.79	1.28	1.51	0.54	0.56
R. kanagurta	280	1.2	1.12	2.4	3.5	0.32	0.36
S. longiceps	197	1.006	3.55	1.9	1.44	0.41	0.65
S. laticaudus	672	0.52	5.81	1.88	3.93	0.68	0.56
R. oligolinx	845	0.33	2.05	0.65	1.4	0.68	0.70
H. imbricata	385	0.90	5.32	1.56	3.77	0.71	0.62
P. tenuispinis	580	0.37	1.27	0.78	0.5	0.4	0.58
A. caelatus	541	0.81	2.46	1.32	1.14	0.46	0.56
A. dussumieri	667	0.55	2.53	0.95	1.57	0.62	0.49
O. militaris	440	0.74	2.46	1.32	1.14	0.46	0.58
N. japonicus	308	0.92	2.73	1.68	1.05	0.38	0.53
N. randalli	302	0.60	2.57	1.28	1.30	0.50	0.5
L. lactarius	309	0.74	3.14	1.45	1.68	0.54	0.55
P. niger	426	0.82	2.64	1.42	1.22	0.46	0.55
P. argenteus	341	0.71	2.79	1.38	1.42	0.51	0.51
P. heptadactylus	295	0.65	3.25	1.35	1.90	0.58	0.53
S. tumbil	522	0.53	1.97	1.01	0.96	0.49	0.50
J. macrorhynus	308	1.22	5.07	2.01	3.07	0.60	0.63
J. vogleri	330	0.80	2.70	1.48	1.22	0.45	0.58
J. sina	263	1.08	4.99	1.95	3.04	0.61	0.61
O. cuvieri	347	1.09	3.08	1.81	1.27	0.41	0.59
O. biauritus	1610	0.82	3.75	0.98	2.77	0.74	0.44
P. diacanthus	1367	0.92	2.1	1.11	0.99	0.47	0.44
C. arel	363	2.5	6.84	3.08	3.75	0.55	0.62
E. diacanthus	569	0.62	3.13	1.0	2.13	0.68	0.50
M. affinis (M)	183	1.9	5.02	3.12	1.90	0.38	0.6
M. affinis (F)	156	1.4	5.37	2.67	2.7	0.5	0.64

M. monoceros (M)	216	1.2	3.33	2.21	1.12	0.34	0.62
M. monoceros (F)	187	1.2	3.77	2.3	1.47	0.39	0.63
P. merguiensis (M)	252	1.2	4.56	2.11	2.46	0.54	0.61
P. merguiensis (F)	192	2.0	6.47	3.18	3.29	0.51	0.65
P. stylifera (M)	137	2.2	8.12	3.72	4.4	0.54	0.64
P. stylifera (F)	106	1.18	3.38	2.66	0.72	0.21	0.67
S. crassicornis (M)	137	1.18	5.67	2.48	3.19	0.56	0.63
S. crassicornis (F)	103	1.3	8.30	2.86	5.45	0.66	0.69
C. feriatus (M)	142	1.5	3.83	2.87	0.96	0.25	0.59
C. feriatus (F)	174	1.8	5.58	3.06	2.52	0.45	0.58
P. sanguinolentus (M)	187	1.4	3.19	2.54	0.65	0.2	0.64
P. sanguinolentus (F)	182	1.6	3.31	2.79	0.51	0.16	0.65
P. polyphagus (M)	365	1.83	6.70	2.51	4.19	0.63	0.56
P. polyphagus (F)	361	1.58	4.75	2.29	2.46	0.52	0.51
L. duvaucelli	370	0.95	4.15	1.86	2.29	0.55	0.55
S. aculeata	206	1.05	6.52	2.01	4.51	0.69	0.6
S. inermis	106	0.52	2.72	1.2	1.52	0.56	0.56
S. pharaonis	430	0.77	5.66	1.57	4.07	0.72	0.55
C. indicus	250	0.91	2.73	1.22	1.51	0.55	0.65

Heap of non-penaeid prawns landed by dol netters at Dahanu

Karnataka and Goa

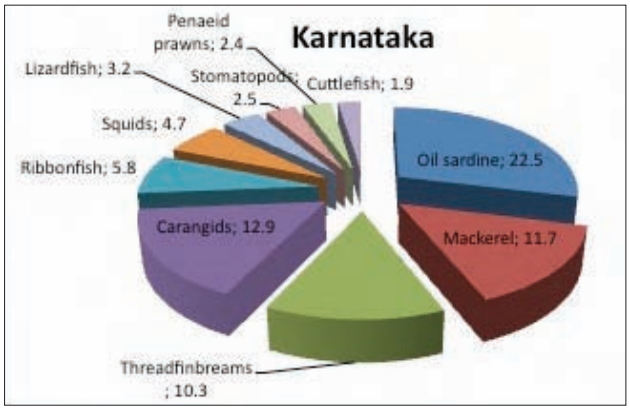
Research Project: FISHCMFRISIL201200600006

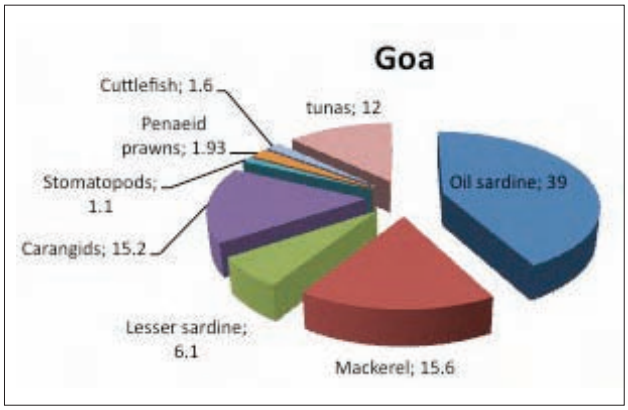
The annual marine fish catch in Karnataka and Goa during 2013 was estimated at 4.37 lakh t and 1.04 lakh t respectively. The catch during the year was 7.06% less and 44.1% more respectively than the catch estimated for 2012. Decreased landings of oil sardine and overall decline in demersal and crustacean resources led to the overall decrease in the total catch in Karnataka whereas in Goa the increased catch trend was due to increased landings of small pelagics.

The major resources in both states comprised of pelagic fishes. The oil sardine continued to dominate the catch this year also with a total landing of 98,453 t contributing 22.5% of the total catch in Karnataka and 40,633 t comprising 39% of the total catch in Goa. Other major resources that contributed to the catch in Karnataka were: carangids (12.9%), mackerel (11.7%) threadfin breams (10.3%), ribbonfish (5.8%), squids (4.7%), lizardfish (3.2%), stomatopods (2.5%), penaeid prawns (2.4%) and cuttlefish (1.9%). In Goa a similar trend was observed with oil sardine forming the major catch followed by Indian mackerel (15.6%), carangids (15.2%), tunas (12%), lesser sardines (6.1%), penaeid prawns (1.93%), stomatopods (1.1%) and cuttlefish (1.6%).

The mechanised, motorised and the non-mechanised sectors contributed 87.2%, 11.1% and 1.7% respectively to the total catch in Karnataka and 93.8%, 4% and 2.2% in Goa.

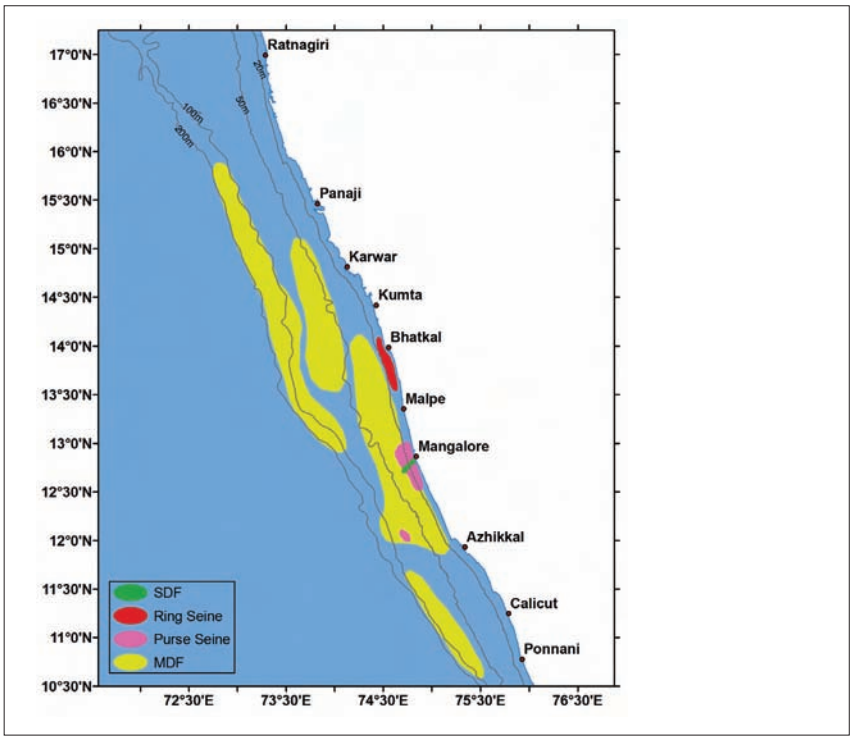
Oil sardine caught by purseseiner





Increase/decrease (%) in catch, effort and catch/effort of major gears operating off Karnataka and Goa coasts compared to 2012

	Karnataka			Goa		
	Catch (t)	Effort*	Catch/Effort	Catch (t)	Effort*	Catch/Effort
Trawls	-13.9	-11.1	-3.16	+23.6	-12.8	+437
Purseseines	+ 1.5	+ 0.7	+ 0.8	+48.7	+39.1	+6.9
Ringseines	+ 0.2	+ 22.9	-18.5	+27.6	+62.4	-25.0
Motorised gillnet	+ 51.5	+ 21.36	+ 24.79	-56.3	-22.3	-42.9
Other motorised	-0.9	13.0	+ 13.85			
All gears	-7.1			+44.05		



Map showing the operation area of multi-day trawl, single day trawl, purseseine, motorised gillnet and ringseine based on log data collected from commercial crafts operating from Mangalore Harbour.

The water quality along the coastal Karnataka was monitored for their physical, chemical and biological parameters. *In-situ* data collection of operation area, the catch and water samples collected by selected crafts/gears types registered at Dakshina Kannada and Udupi districts were continued.

Water quality (maximum and minimum) parameters observed at 10m depth off Mangalore

Parameter	S		B	
	Max	Min	Max	Min
Atmosphere temp (° C)	30.5	24.5	30.5	24.5
SST (° C)	31.5	28.6	31.5	27.5
pH	8.41	8.07	8.4	8
Salinity (ppt)	35.8	31	35.8	34.2
DO (ml/l)	6.42	3.57	6.38	2.01
Phosphate (µg-at/l)	1.13	0.316	2.47	0.432
Nitrate (µg-at/l)	1.594	0.152	6.11	0.052
Nitrite (µg-at/l)	0.994	0.0848	5.11	0.0382
Silicate (µg-at/l)	11.75	1.249	15.26	1.075
Chlorophyll a (mg/m^3)	8.99	0.29	16.432	1.291
Chlorophyll b (mg/m^3)	0.196	0	1.176	0
Chlorophyll c (mg/m^3)	4.028	0	10.784	0.62

The decadal trend of important species contributing to the fishery in Karnataka were studied. Most of the species were categorised either in the abundant (A) or less abundant (LA) group and only one perch species the pigface bream indicated a collapsed (C) status.

	Av. 3 years 2011-13	Max 1990-2013	% of Historic max	Stock status
Oil sardine	100536	119611	84.1	A
Other sardines	10178	18352	55.5	LA
Stolephorus	5348	11847	45.1	D
Ribbonfishes	24623	29468	83.6	A
Half & full beaks	358	404	88.5	A
Horse mackerel	5412	7315	74.0	A
Scads	30359	43105	70.4	A
Leather-jackets	687	979	70.2	A
Other carangids	5096	10349	49.2	D

Prawns landed by handtrawls during monsoon months at Malpe

Scombroids landed by purse seines at Goa

Rock cod landed by light fishing (purse seiner) at Mangalore

Indian mackerel	54118	77607	69.7	A
S. commerson	6276	7745	81.0	A
S. guttatus	548	1148	47.7	D
E. affinis	1995	6410	31.1	D
Auxis spp.	246	1232	19.9	D
K. pelamis	28	58	47.7	D
T. tonggol	88	1110	7.9	DE
Other tunnies	73	267	27.2	D
Billfishes	10	171	6.0	DE
Barracudas	5130	6926	74.1	A
Black pomfret	1474	3228	45.7	D
Silver pomfret	861	1081	79.6	A
Chinese pomfret	13	234	5.6	D
Sharks	728	1401	51.9	LA
Skates	203	295	68.8	LA
Rays	331	513	64.5	LA
Catfishes	2353	2769	85.0	A
Lizardfishes	17455	23907	73.0	A
Rock cods	9736	13495	72.1	A
Snappers	55	329	16.7	D
Pigface breams	1	70	1.9	C
Threadfin breams	47702	61017	78.2	A
Other perches	3721	9137	40.7	D
Croakers	5244	6544	80.1	A
Silverbellies	3839	6058	63.4	LA
Big-jawed jumpers	3376	3916	86.2	A
Flatfishes	9291	18185	51.1	LA
Soles	9291	18153	51.2	LA
Crustaceans	18791	43989	42.7	D
Penaeid prawns	12165	21507	56.6	LA
Crabs	1944	2845	68.3	LA
Stomatopods	12391	25597	48.4	D
Cephalopods	21252	26051	81.6	A
Squids	15439	18901	81.7	A
Cuttlefishes	7810	12479	62.6	LA
Octopus	651	841	77.4	A

Length frequency distribution and biological characteristics of 59 species under major groups (fishes, crustaceans and molluscs) were studied in detail to estimate the Biological Reference Points and further stock studies. Study included seasonal variations in catch; difference if any in size group, sex, maturity and feeding preferences.

Data on price structure of 45 species of fishes were collected from landing (wholesale, retail and tertiary centres) of Karnataka and Goa and spread sheets for the same prepared.

Kerala and Lakshadweep

Research Project: FISHCMFRISIL201200300003

The estimated total marine fish landings along the Kerala coast was 6.71 lakh t, registering a decline of 20% from 8.39 lakh t landed during 2012. Landings of all major demersal and pelagic resources declined contributing to an overall decrease of 1.68 lakh t. Pelagic finfishes contributed 73.27%, followed by demersals (13.97%), crustaceans (6.1%) and molluscs (6.66%). The contributions of mechanised, motorised and artisanal sectors were 70.23%, 28.60% and 1.17% respectively. Oil sardine (36.77%), Indian mackerel (6.83%), *Stolephorus* spp. (6.75%), penaeid prawns (4.45%), threadfin breams (6.3%), carangids (10.04%), cephalopods (6.66%), flatfishes (1.92%), tunas (1.94%) and ribbonfishes (5.1%) were the major groups contributing to the fishery. Major gears that supported the fishery were ringseines (50.11%), trawlers (32.49%), gillnets (4.45%), non mechanised (1.17%) and other mechanised (9.26%).

The production of pelagic resources like *Stolephorus* spp., ribbonfishes, scads, bill fishes, Indian mackerel, *Acanthocybium* spp. and other tunas recorded significant increase. Landings of demersal resources like elasmobranchs, goat fishes, big jawed jumper and pomfrets also registered an increase. Molluscan resources registered an increase of 4.72% over 2012. All major crustacean resources like penaeid prawns, crabs and stomatopods declined, while non-penaeid prawns and lobsters registered an increase in landings. Pelagic resources such as oil sardine,

Ribbonfishes caught by trawlers

other carangids, other clupeids, seerfishes, tunas and mullets were the major pelagic resources that presented decline in landings. Decline was also noticed in the landings of demersal resources like groupers, snappers and threadfin breams.

Pelagic resources

Pelagic resources contributed 4.91 lakh t (73.27%) to the total landings in Kerala, which declined by 20.14% against 2012. The major resources landed were oil sardine (50.18%), Indian mackerel (9.32%), ribbonfishes (6.96%), tunas (2.65%), *Stolephorus* spp. (9.22%), other clupeids (2.31%), carangids (13.70%), lesser sardines (1.63%) and seerfishes (0.74%).

Oil sardine: Oil sardine contributed 2.47 lakh t to the marine fish landings of Kerala in 2013, registering a decline of 38% against 2012. The resource was mainly landed by mechanised ring seines contributing 60%; outboard ring seines 32%, multiday trawl nets 3% and other gears 5%. Large scale occurrence of juveniles (<140 mm) in the landings of oil sardine was noticed off Cochin and the estimated juvenile component (in numbers landed) in the landings was as high as 90%. Spawning stock biomass for oilsardine was estimated as 37% in weight of the total standing stock. Rapid stock assessment indicated the status of oil sardine stock off Kerala as 'abundant'.

Stolephorus spp. landed at Puthiyappa, Calicut

Indian mackerel: Indian mackerel landings in Kerala was 45,289 t during 2013. Size range of 115-285 mm was observed in ring seines and 155-295 mmin trawls operated off Cochin. Juvenile (<170 mm) component was comparatively low (<4% of total numbers landed) and the spawning stock biomass (in weight) was estimated as 88% of total standing stock. The mean size of the species in the fishery is larger than the size at maturity (L_m), but Lc is slightly lower, necessitating a cautious approach in exploitation of the resource. Rapid stock assessment of Indian mackerel indicated that this resource is in the declining state.

White baits: Anchovies (*Stolephorus* spp.) contributed 45,334 t during the period with an increase of 17% from the previous year. The mean size and the length at capture (L_c) of dominant species *S. devisi* and *S. commersoni* are larger than the size at maturity (L_m) and optimum

size for exploitation (L_{opt}), which indicated exploitation of the stock at biologically safer level. Rapid stock assessment indicated the present status of the resource as 'declining.

Carangids: Contributed 10.1% to the total marine fish landings of Kerala. Catch during the year increased to 67,387 t from 58,463 t landed in 2012. Fishery during the period was supported by 27 species comprising scads (80.5%), trevallies (12.3%), horse mackerel (3.2%), rainbow runner (2.6%), black pomfrets (1%) and leather jackets (0.5%). Eight species viz., *Decapterus* russelli, *Selar crumenophthalmus*, *Alepes djedaba*, *Megalaspis cordyla*, *Elagatis bipinnulata*, *Caranx ignobilis*, *Caranx sexfasciatus* and *Caranx sem* were landed at commercial level. Scads contributed 70.4% to the total carangid landings and represented mainly by *Decapterus* spp., *Alepes* spp. and *Selar* spp. with *D. russelli* being the dominant species. Contribution of different scads were: *Decapterus* spp.69.4%, *Alepes* sp. 6.6%, *Selar* sp.15.8% and other scads 8.2%.

Biological indicators derived for the three species viz., *D. russelli*, *S. crumenophthalmus, M. cordyla* showed that mean size and length at capture (L_c) are either larger or close to size at maturity (L_m), indicating healthy fishing conditions. The maturity condition of the species in the catch indicated that large proportion of the individuals get a chance to spawn before being caught.

Rapid assessment of stock of carangids shows that presently the stock is at less abundant state.

Biological indicators of selected carangid species

Species	L_r	L_{max}	Mean	L_c	L_{mat}
D. russelli	10.6	22.5	15.8	15.2**	13.9
S. crumenophthalmus	15.7	27.9	19.4	18.2**	17.3
M. cordyla	19.5	36.4	23.8	23.4**	25.4

* Hooks & line/Gillnet, ** Trawl

Ribbonfishes: Ribbonfish production increased over the previous year by 173.7% (34,223 t). Catch was supported exclusively by *Trichiurus lepturus*. Fishery was supported by 20-91 cm along the Malabar region with 62 to 80 cm size group as fishery dominant group. Along central Kerala, 63-112 cm with 72-87 cm formed the fishery dominant group. Targeted fishery for juveniles was observed at places like Kollam, especially for bait purpose for tuna longliners and handliners. Mean size of the species in the catch was larger than the size at maturity (L_{mat}) and optimum size for exploitation (L_{opt}); whereas length at capture (L_c) is much smaller. Stock assessment studies showed that the resource is underexploited indicating scope for improved production.

Seerfishes: Seerfish catch registered a sharp decline from 11,493 t of 2012 to 3,654 t. Fishery was supported by three species dominated by *Scomberomorus commerson* (87.8%), *Scomberomorus guttatus* (11.6%) and *Acanthocybium solandri* (0.6%). Catch of *S. commerson* comprised

small fishes (16-32 cm) in trawl and ring seines. In hooks and line and gillnets catch was mainly contributed by large fishes of 47-148 cm. Catch of *A. solandri* was by 70-138 cm fishes in hooks and line and gillnets. Mean size and length at capture (L_c) of *S. commerson* in gillnet-hooks and line combination is much higher than the size at maturity (L_m). Large meshed gillnets and hooks and lines are ideal for exploiting the resource as they exploit mainly large adult fishes. Trawls on the other hand catch small fishes in their nursery grounds, however, since catch by trawl remains very low, it is not of serious concern as on now. Rapid assessment of stock shows that stock remain at less abundant state.

Biological indicators of selected seerfish species

Species	L_r	L_{max}	Mean	L_c	L_m
S. commerson	16.0	148.0	88.2	73.4*	70.1
A. solandri	70.0	138.0	102.2	92.2*	-

* Hooks & line/Gillnet,

Tuna: Catch in trawls maily comprised small ones of all species. Declining trend observed in 2012 continued during the year and dipped to 13,052 t in 2013 from 16,782 t of 2012. Fishery occurred round the year with peak during October-December for *E. affinis* and August-September for *Auxis* sp. Young ones of coastal tunas landed round the year with peak in June-September period by ring seines and trawls. Fishery was supported by five species, which together formed 55.7% of the total tuna catch. Catch was dominated by *Euthynnus affinis* (54.4%) followed by *Auxis* sp. (43.2%). Other species which supported the fishery are *Auxis thazard*, *Auxis rochei*, *Sarda orientalis* and *Thunnus tonggol*. The length at capture (L_c) and mean size of coastal tunas are almost same or larger than size at maturity (L_m) and optimum size for exploitation (L_{opt}). The presence of large spawning stock biomass (SSB) also indicated that stock along the coast is robust and healthy. Stock assessment of coastal tunas along Kerala based on past data showed that they are exploited either optimally or at slightly above the optimum level.

Biological indicators of selected tuna species

Species	L_r	L_{max}	Mean	L_c	L_m
E. affinis	20	67.2	40.3	37.2**	39.4
A. thazard	18.4	46.5	34.2	28.3 **	29.7
A. rochei	14.8	36.5	24.6	22.6**	20.7

* Hooks & line/Gillnet, ** Trawl, ***Ring-seine

Estimates of exploitation and mortality rates for tuna species

Species	Exploitation rate	Fishing mortality	Total mortality	Natural mortality	Remarks
E. affinis	0.68	2.68	3.97	1.29	Slightly overexploited
A. thazard	0.507	1.36	2.68	1.32	Optimally exploited
A. rochei	0.53	1.62	3.07	1.45	Overexploited

Rapid assessment of stock health of coastal tunas showed that stock along the coast of Kerala is in the declining phase.

Billfishes: Production registered an increase of 2,133 t during the year from 2,170 t (2012) to 4,304 t in 2013 registering 98.32% increase. They were exploited mainly by other mechanised units (68.57%), hooks and line (8.93%), gillnets (22.40%) and others. Fishery occurred round the year with peak during March and October. Billfish fishery was supported mainly by *Istiophorus platypterus* (90.3%), *Makaira* spp. (8.9%) and *Xiphias* spp. (0.8%).

Demersal resources

The total demersal fish landings in Kerala in 2013 was 93,797 t (13.97%), which declined by 27.17% compared to 2012. The major contributors were threadfin breams with 42,165 t (44.95%), soles 12,846 t (13.70%), lizard fishes 9,948 t (10.61%), croakers 5,957 t (6.35%), elasmobranchs 5,237 t (5.58%) and groupers 1,823 t (1.94%). Sharks, skates, rays, goat fishes, big jawed jumper, pomfrets, halibut, exhibited increase in the production. Resources like groupers, snappers, threadfin breams, croakers, silverbellies, flounders and soles showed decline.

Isurus oxyrinchus

Elasmobranchs: An estimated total of 5,238 t of elasmobranchs were landed in Kerala during 2013 forming only 0.79% of total marine landings and 5.6% of demersal landings of the state. Sharks contributed 50% (2,616 t) of the elasmobranch landings, followed by rays contributing 39.6% (2,077 t) and skates 10.4% (545 t).

More than 30 species were observed in the shark landings by MDNHL at Cochin, with major shares contributed by *Carcharhinus falciformis* (37.25%), *Alopias superciliosus* (11.85%), *Sphyrna lewini* (11.53%), *Alopias pelagicus* (8.53%); *Carcharhinus longimanus* (6.16%); *Isurus oxyrinchus* (4.84%) and *Carcharhinus limbatus* (3.86%).

The L_{opt} estimated for *C. limbatus* was 1144 mm. The spawning stock biomass (280 t), standing stock biomass (360 t) and yield (340 t) of

Carcharhinus falciformis

C. limbatus was estimated. The rapid stock assessment of sharks, rays and skates done using 1985-2013 data, showed that these top level predators of marine ecosystem is in declining state.

Threadfin breams: An estimated total of 42,165 t of threadfin breams were landed in all gears combined forming 6.3% of total marine landings and 44.9% of demersal landings of Kerala. Threadfin breams contributed 17.18% of the total landings by trawls. There was 28.93% decline in the landings as compared to that of 2012 (59,325 t). Maximum catch (17,939 t) was recorded during August, immediately following the monsoon trawl ban, but maximum catch rate (91.27 kg h^{-1}) was recorded in the month of October.

The exploitation ratio is currently above the optimum level in *N. randalli* (E=0.71) and *N. japonicus* (E=0.66), but the spawning stock biomass estimated in both species is more than 35% of the stock at its unexploited level. Rapid stock assessment of threadfinbreams showed that this resource is abundant off Kerala coast.

Flatfishes: Flatfish catch during the year (12,865 t) declined by 40.96% from 2012 and formed 13.72% of the demersal landings. *C. macrostomus* remained the most important species in the fishery in all gears along Malabar region. In the case of Indian halibut *Psettodes erumei* which showed slight improvement in landings during the years 2010-12, a drastic decline was noted during 2013. Virtual population analysis carried out on *C. macrostomus* shows that the spawning stock biomass estimated is more than 30% of the annual stock at its unexploited level. Rapid stock assessment using the 1985-2013 data showed that this resource to be in less abundant state.

Sciaenids: Catch during the year was 5,957 t, which declined by 35.53% over 2012, which formed 6.35% of the demersal landings and 0.89% of the total catch. *Johnieops sina* (53.66%) was the dominant species found in all the gears. Other important species found in the fishery were *Otolithes ruber* (20.22%), *O. cuvieri* (12.05%), *Johnius belangeri* (5.16%), *Nibea soldado* (2.28%) and *J. macropterus* (1.35%). *J. sina, O. ruber* and *O. cuveri* were seen in the fishery during all the months and others occasionally. Although the sciaenid resources especially *J. sina* and *O. ruber* are heavily exploited, the spawning stock biomass estimated for both the species were more than 30% of the resource at its unexploited level which is a good indicator showing capacity for revival of the fishery. Rapid stock assessment of sciaenids showed that the present status of this resource is in declining state.

Lizardfishes: Lizardfishes were mainly exploited by trawls (85%). The estimated annual landing of lizardfishes in Kerala in 2013 was 9,948 t, which formed only 1.48% of the total landings. The gearwise analysis of lizardifishes in Kerala shows that multiday trawlers contributed to the bulk of the fishery of the state (83.9%), followed by multiday trawl net with hooks and line (6.7%), single day trawl net with hooks and line and outboard boat seine (2.6%). Rapid stock assessment of lizardfishes showed that this resource is abundant in Kerala waters.

Groupers: Grouper landings during the year was 1,823 t (0.3%), which formed 1.9% of the demersal landings. The landings declined by 18.30% compared to 2012. Analysis of the landings of groupers during the period 1985 -2013 showed an increase upto 9,386 t in 2002 and a decline thereafter to 1,822 t in 2013. *Epinephelus diacanthus* was the dominant grouper species in the trawler landings as well as in hooks and lines and the other species are landed only in minor quantities.

Snappers: An estimated 1,069 t of snappers i.e., 0.16% of the total landings was constituted by snappers in Kerala. Except in May, landings of snappers were scanty. The catch rate of snappers was negligible in most of the gears. Ten species of snappers contributed to the fishery of which *Pristipomoides typus* was dominant; the other major species were *Lutjanus gibbus, Lutjanus kasmira* and *Pinjalo pinjalo.*

Priacanthids: An estimated total of 1,887 t of priacanthids were landed in all gears combined forming only 0.28% of total marine landings and 2.1% of demersal landings of the state. *Priacanthus hamrur* (88%), *Cookeolus japonicus* (10%) and *Priacanthus sagittarius* (2%) were the species landed.

Pomfrets: During 2013, the estimated landings of silver pomfrets was 1,087 t, which formed only 0.16% of the total landings in Kerala. The landings was mainly contributed by one species *Pampus argenteus*. The peak landings was observed in September (51.5%), followed by November (14.3%) and May (13.7%). The rapid stock assessment of this resource shows that the stock is in delcining state.

Catfish: A total of 222 t of marine catfishes were landed in Kerala, of which 35 t of marine catfishes were landed by the longline units forming 0.16% of total landings. *Netuma thalassina* was the only species landed at CFH. The rapid stock assessment of this resource showed that it is in collapsed state.

Pigface breams: The landings of pigface breams during the year was a meager 423 t, with peak landings during June (23.3%) followed by August (18.9%) and March (16.7%) months. The fishery was supported by 3 species belonging the genera *Lethrinus,* viz*., Lethrinus mahsena* (77%), followed by *L. elongatus* (13%) and *L. cochyliatus* (10%).

Whitefish: The estimated landing of whitefish (*Lactarius lactarius*) during 2013 was 700 t, and formed only 0.10% of the total landings of Kerala. Peak landings observed in July (34%) followed by November (18.9%), December and August (6.8%). The catch was contributed mainly by multiday trawl nets (28.1%), followed by outboard gillnets (25.6%), single day trawl nets (11.8%) and hooks and lines (9.5%).

Eels: During 2013, the estimated landings of eels (*Muraenesox* sp.) was 474 t which formed only 0.07% of the total landings of Kerala. The eel landings was mainly contributed by two species viz., *Muraenesox cinereus* which formed 59% of the total landings and the rest was contributed by *M. bagio.* The rapid stock assessment of the resource shows that this resource is abundant.

Fishery related parameters of important demersal finfish resources off Kerala

Species	Length range (mm)	Mean size (mm)	Fishery dominant size group (mm)	Exploitation rate (E)	Spawning stock biomass (t)	Standing stock biomass (t)	Yield (t)
C. limbatus	524-2174	1279.2	1100-1600	0.78	280	360	340
N. randalli	42-258	123.6	110-180	0.71	5665	8825	22085
N. japonicus	42-298	141.2	120-180	0.66	7254	9740	17428
C. macrostomus	42-167	113	90-130		5831	10192	9627
J. sina	32-249	134.2	120-180	0.72	2611	5176	3056
O. ruber	72-338	17.2	150-220	0.70	248	367	977

Crustacean resources

Total crustacean landing during the year was 40,959 t, which declined by 20.86% compared to 2012. The major contributors were penaeid shrimps 29,899 t (73.00%), nonpenaeid shrimps (6,857 t), crabs (2,758 t), stomatopods (1,125 t) and lobsters (86 t). Trawlers landed 85.5% of the crustaceans, followed by ring seines (12.46%) and other gears (2.04%). Bulk of penaeid shrimps were landed by trawlers (78.42%), followed by ring seine (16.976%), other mechanised units (3.82%) and the rest by other gears. Trawlers contributed major share of non-penaeid catch (94.64%) and the rest by others (5.36%). Penaeid catches during the year was 29,899 t, which declined by 26.87% over 2012. Non-penaeid shrimp catches during the year, 6,857 t was increased by 67.84% over 2012. Lobster catches during the year was 86 t which increased by 125.5% over 2012. Trawlers (49.43%), nonmechanised gears (45.94%), other mechanised units (2.68%) and gillnets (1.96%) were the major contributors to lobster landings. Crab catches during the year was 2,758 t, which declined by 37.08% from 2012. Trawlers (93.37%) and nonmechanised gears (4.5%) were the major contributors to crab landings. Stomatopod landings during 2013 was 1,125 t which declined by 47.44% against 2012. Major contributors of stomatopod fishery were trawlers (99.98%).

Shrimps: The total penaeid shrimp catch of Kerala during 2013 is estimated as 29,899 t and non-penaeids 6,857 t. Compared to 2012, penaeid shrimp catch decreased by 26.87%. In Kerala, *Metapenaeus dobsoni* dominated the catch (51.11%), followed by *Parapenaeopsis stylifera* (16.83%), *Metapenaeus monoceros* (7.82%), *Fenneropenaeus indicus* (3.68%), *Metapenaeus affinis* (0.79%) and *Penaeus monodon* (0.28%).

The deep sea penaeid shrimp catch at Sakthikulangara was dominated by *Aristeus alcocki* (36%) followed by *Metapenaeopsis andamanensis* (20%) while in the nonpenaeid *Heterocarpus gibbosus* (18%) dominated the catch followed by *Plesionika spinipes* (12%), *H. woodmasoni* (8%) and *P. martia* (7%). Among the deepsea nonpenaeid shrimps, *Plesionika spinipes* contributed 56.0% in south Kerala and 54.2% in central

Shrimp landings at Beypore in Calicut

Kerala landings. Other important species were *H. gibbossus* (21%) and *H. woodmasoni* (18%).

Fishery related parameters of important shrimp species

Species	L_∞	K	M	a	b	L_m	E
M. dobsoni	130	1.8	1.54	0.0000207	2.73	71.9	0.80
P. stylifera	130	1	1.4	0.0000011	3.3	85	0.83

species	Spawning stock biomass	Standing stock biomass	Total yield	Recruitment numbers
M. dobsoni	531	1688	7349	3561580
P. stylifera	4532	8192	4531	6560206

Crabs: : A total of 2,758 t of marine crabs were landed in Kerala in 2013 and catch declined by 37.08%. Multiday trawlers contributed major share (61.74%) of the catch. *Portunus sanguinolentus* dominated the catch contributing 53.6%, followed by *Charybdis feriatus* (25.4%), *Portunus pelagicus* (10.8%) and *Charybdis lucifera* (2.97%). *Charybdis natator* started coming in good quantities forming 7.02% and maximum catch was recorded from Kollam District.

Fishery related parameters of important crabs

Species	Carapace width CW (mm)	Mean CW (mm)	Dominant size group (mm)
P. sanguinolentus	66-155	98.5	91-100
C. feriatus	46-130	94.5	86-100
P. pelagicus	46-140	105.0	96-110

Lobsters: Lobster landings during the year was 86 t, forming 0.21% of the crustacean landings which increased by 125.5%. Slipper lobster, *Thenus unimaculatus* and spiny lobster, *Panulirus homarus* were the most important species landed during the year. Length-weight relationship of *T. unimaculatus* male was $W=0.077*TL^{2.78}$ ($r^2=0.9$) and female was $W=0.023*TL^{2.67}$($r^2=0.91$). Length-weight relationship showed a negative allometry in both the sexes. Thompson and Bell analysis revealed that *T. unimaculatus* is optimally exploited

Fishery related parameters of *Thenus unimaculatus*

	L_∞ mm	K	Z	M	F	E	E_{max}	L_{c50}
Male	244	0.67	3.02	0.71	2.31	0.76	0.66	121
Female	248	0.73	3.28	0.79	2.49	0.76	0.713	135

Molluscan resources

Molluscan landings in 2013 was 44,692 t which was 4.72% more compared to 2012. The major contributors were squids (49.81%), cuttlefishes (39.99%), *Octopus* (9.26%) and gastropods (0.48%). Among molluscs, squids (54.01%) and cuttlefishes (12.34%), octopus (36.48%) and gastropods (82.26%) catch showed increase. Peak breeding in both cuttlefishes and squids occur during this period, and therefore there exists great danger of recruitment overfishing.

Cuttlefishes: Cuttlefish (17,871 t) formed 40% of the total molluscan landings with 74.65% of the catch. Among cuttlefishes, 4 species belonging to the genus *Sepia* were exploited and fishery was dominated by *Sepia pharaonis* (91.5%). Other species were *Sepiella inermis*, (3.3%). *Sepia elliptica* (3.1%) and others (1.8%). *S. pharaonis* was exploited at 14.6 -16.7% below the optimum length of capture (L_{opt}) during 2012 and 2013 which was within the range observed in previous 5 years i.e., 2007-2011 (The mean lengths were 11 to 23% less than the L_{opt}). It was closest to L_{opt} in 2012 (14.6%) and farthest in 2013 (16.7%). The dorsal mantle length (DML) of *S. pharaonis* ranged from 50-350 mm. Multiple modes were seen in all the months. Peak recruitment to the fishery took place in April-May. Mature females were dominant in September-October indicating peak breeding. *Uroteuthis (Photololigo) duvauceli* had a size range of 50-350 mm DML with multiple modes in all the months and mature individuals dominated during October-February.

Squids: Squid formed 22173 t (49.61%) of the total molluscan landings. Among squids the main species exploited was *U. (P.) duvauceli* followed by *U. (P.) singhalensis* and *U. (P.) edulis*. *Sepioteuthis lessoniana* formed a very minor proportion. In case of major squid *U. (P.) duvauceli* also, the mean lengths were marginally below the optimum length of capture. The mean lengths were 19.0-21.1% less than the L_{opt} during 2012-2013. It was closest to L_{opt} in 2013 (19.0%) and farthest in 2012 (21.1%).

Octopus: Octopus (4,138 t) formed 9.25% of molluscan landings, and the catch decreased by 36.48% over 2012. In case of *Amphioctopus neglectus* the annual mean lengths were very close to the L_{opt} during

Loligo duvauceli landed at Calicut

2012-13 (3.9-5.5% less) which is very close to the range observed for the previous five years i.e., (06-12% less during 2007-2011).

Biological reference point and VPA of dominant cephalopods

Species	Parameters							
	(L_∞) mm	Growth rate (K)	Optimum length of capture (L_{opt}) mm	Mean generation time (tg) yr	Reproductive load	Mean size (mm)	SSB (t)	ST (t)*
U. (P). duvauceli	374	1.4	247.0	0.77	0.33	204	21168	24216
S. pharaonis	387	0.63	240.0	1.54	0.52	164	20866	23928
A. neglectus	107	0.81	63.5	1.11	0.30*	56	2714*	3212*

*Central Kerala

Lakshadweep fishery

The estimated total fish production in entire Lakshadweep during 2013 was 9,021 t against the 7,683 t in 2012. Major gears employed during the year were pole & line, troll line, drift gillnet, encircling gillnets, hand lines and long line. The total catch during the year increased by 17.4% (1,337 t). Tunas formed 79.8% (7,196 t), other fishes and elasmobranchs formed 20.2% (1,824 t). Apart from the estimated 7,196 t of tunas from entire Lakshadweep, Kalpeni Island recorded about 125.8 t during November-December from an unusual feeding stock appeared around Kalpeni during the period. Octopus catches also recorded increase (20-22 t in 2012 to 28-30 t in 2013) during the period.

The tuna production during the year increased by 31%, where as the production of other fishes and elasmobranchs declined by 16.7% (1,824 t in 2013 vs 2,189 t in 2012) . This is in conformity with the general trend of decline in the catches of other resources whenever the surface skipjack P & L fishery showed improvements. The trend usually reverses as and when the P & L skipjack fishery becomes weak as had happened during 2011 and 2012 period. The efforts expended in the P & L fishery has shown remarkable increase at all the observation centers.

Tuna: The estimated total tuna landings in 2013 by pole & line, troll line, drift gillnet, hand lines (open sea) and long line was 7,196 t against 5,493 t in 2012. The total catch during the year increased by 31% (1,703 t) compared to the previous year. The tuna catches during the year accounted for 79.8% (71.5% in 2012) of the total fish landings. The tuna fishery particularly the surface P&L skipjack fishery has recorded remarkable improvement throughout Lakshadweep. The tuna landings in general (5,493 t to 7,196 t) and skipjack landings in particular (2,483 t to 3,684 t) recorded considerable increase throughout Lakshadweep. This was mainly due to the comparatively better aggregations of skipjack shoals in islands like Minicoy, Androtт and Kalpeni. In Agatti, the tuna fishery though recorded comparatively very good improvements in 2013, has not yet exhibited the real recovery levels. The comparatively increased landings in 2013 too were far below the annual average production levels of 1980s and 1990s. In 2013, during October- December months there was an unusual high aggregation of surface skipjack shoals along with small shrimps concentrated within 22- 25 km radius off Kalpeni/Cheriyam islands. The aggregation yielded about 125 t during November-December months. Apart from the local Kalpeni units, the P& L units from Agatti, Kavaratti and Androtт islands also temporarily migrated to Kalpeni Island and exploited the resource during the period . The pablo boats , OBM units and the country crafts landed about 99.2 t (78.9%) , 15 t (12.1%) and 11 t (9.0%) respectively. The skipjack tunas of average 2 kg sizes constituted > 90% of the landings.

Species which supported tuna fishery were *Katsuwonus pelamis* 51.2%, *Thunnus albacares* 41.5%, *Euthynnus affinis* 4.8%, *Auxis thazard* 2.2% and *Gymnosarda unicolor* 0.3%. The estimated catches of *K. pelamis, T. albacares, E. affinis, A. thazard* and *G.unicolor* during 2013 were 3,684 t, 2,987 t, 345 t, 158 t and 22 t respectively. The landings of all 5 species recorded increase during the year. However, the trend of dominance of yellowfin tuna catches during the last 3 years ceased and once again the skipjack production retained the top position with a total production of 3,684 t during the year under report. This was mainly due to the appearance of comparatively more numbers of skipjack shoals throughout Lakshadweep. The average sizes of the individual fishes caught during the year were observed to be comparatively smaller. Exploitation of the smaller ones in large numbers during one year can adversely affect the overall production (in weight) in the ensuing years.

The fresh tuna prices during the year fluctuated from ₹50 to 350 per kg. The rates were observed to be lowest at Kalpeni and the same was highest at Androtт and Kavaratti. The *mas* prices particularly the one prepared with the undersized small tunas came down to as low as ₹150 per kg. The

prices for the good quality *mas* were also comparatively very low and the same varied from ₹200 to 600 per kg during the period under report .The prices for the varieties like wahoo, barracuda and billfishes were at par with that of tunas and at times slightly more. However, the prices for the reef fishes always remained comparatively low and the same varied from ₹50 to 150 per kg. The prices for fresh octopus ranged from ₹250 to 400 per kg and that of dried octopus was ₹1000 to 1200 per kg.

Tamil Nadu and Puducherry

Research Project: FISHCMFRISIL201200800008

The total landing of 6.87 lakh t in Tamil Nadu during the year was contributed mainly by pelagic resources (56.5%) followed by demersal (28.9%), crustacean (5.9%) and molluscs (3.8%). Among the pelagics, oil sardine formed 47.9% followed by other sardines (17.4%), carangids (11.4%), Indian mackerel (3.4%) and other clupeids 2.8%. The demersal fishes included silverbellies 41.3% followed by threadfin breams 7.26%, croakers 6.97%, pigface breams 6.03%, catfishes 4.45%, mullets 3.8% and lizardfishes 3.48%. Penaeid prawns formed 56.6% of the crustaceans followed by crabs 32%, non-penaeid prawns 6.7% and lobsters 3.9%. Squids and cuttlefishes remained the dominant groups among molluscs forming 36.2% each, followed by bivalves (15.5%), gastropods (6.5%) and octopus (5.7%).

Trawlers contributed 65% of the total catch, followed by outboard gill netters (13.4%), mechanised ring netters (7.7%) and out board ring netters (6.4%). Among the total number of gears operated, it could be seen that 62% was accounted by outboard gill netters, 12.6% by outboard hook and line, and 12.4% by mechanised trawlers

Species composition

Group	Genus/Dominant Species	Chennai	Palk Bay	GOM	Tuticorin
Threadfin breams (Chennai)	*Nemipterus japonicus*	64.3			
	N. randalli	33.3			
Croakers (Palk Bay)	*Otolithes ruber*		4		
	Nibea maculata				
	Johnius carutta				
	Pennahia macrophthalmus		63		
	Johnieops dussumieri		18		
	Dendrophysa russelli		5.6		
	Nibea soldado		4.1		
Perches	Emperor breams				
	Sweetlips				
	Snappers				
	Rabbitfish				
	Pigface breams				
	Sandwhiting				

	Parrotfish				
Flatfishes	*Psettodes erumei*	54			
	Cynoglosus spp.	46			
Pomfrets	*Parastromateus niger*	70			
	Pampus argenteus	29.6			
	Pampus chinensis	0.4			
Goatfishes	*Upeneus guttatus*	36			
	U. supravittatus	32.8			
	U. taeniopterus	11.1	12.3	16.8	
	U. sundaicus	7.6	68.4	6.9	
	U. sulphureus		11.5	10.4	
	U. tragula		7.5	63.5	
Lizardfish, Chennai (Palk Bay)	*Saurida tumbil*	91			
	Trachinocephalus myops	8			
Silverbellies	*Eubleekeria splendens*				
	Photopectoralis bindus		4.6	8.9	
	Karalla dussumieri		7.1	60.2	
	Deveximentum insidiator				
	Eubleekeria jonesi		63.5		
	L. brevirostris		16.1		
	S. ruconius		6.8	7.2	
	Gazza minuta			14.3	
	Karalla daura			8.3	
Sardines (Mandapam)	*Sardinella albella*	52.3	7.6	41.3	0.4
	S. longiceps	78 (2.56)	89.2	32.46	2.8
	S. gibbosa	22 (8.2)	3.2	26.3	81.7
	Amblygaster sirm				10.8
	A. clupeoides				4.3
Whitebaits	*Stolephorus indicus*	67			
	S. commersonii	12			
	S. bataviensis	20.4			
	S. indicus				
Mackerel	*Rastrelliger kanagurta*	100			
Seerfish	*Scomberomorus commerson*				23.9
	S. guttatus				
	Acanthocybium solandri				7.1
Tuna	*Thunnus albacares*	43			46.7
	Katsuwonus pelamis				33.2
	Euthynnus affinis	17.9			15.2
	Auxis thazard	15.3			2.2
	Katsuwonus pelamis	24.8			
Billfishes	*Istiompax indica*				60.4
	Istiophorus platypterus				27.7
	Xiphias gladius				6.32
	Tetrapterus sp.				5.7

Crustacean fishery

Trawl

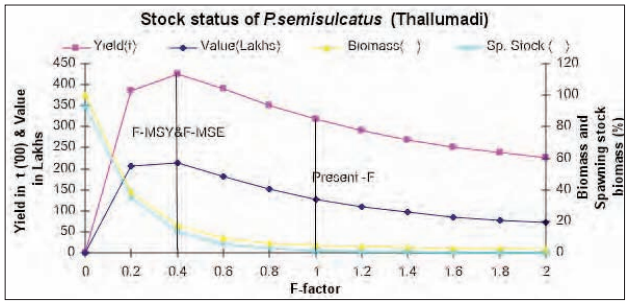
A total of 42 species were recorded in the commercial fishery and one species (*Metapenaeopsis hilarula*) from the stomach of a demersal fish. The inshore prawn catch comprised of 23 species. Among this *P. semisulcatus* (85.5%), *F. indicus* (6.9%) and *P. latisulcatus* (2.6%) were the dominant species. The other species were *P. monodon, P. penicillatus, P. merguiensis, P. canaliculatus, P. uncta, P. maxillipedo, P. sculptilis, P. aclivirostris, P. stylifera, M. moyebi, M. monoceros, M. dobsoni, M. affinis, M. toloensis, M. stridulans, M. mogiensis, T. curvirostris, T. granulosus, T. sedili* and *Alpheus rapacida*. The deep sea prawns fishery was contributed by 19 species and the dominant species were *P. spinipes* (42.7%), *S. hextii* (26.7%) and *H. gibbosus* (21.9%). The other species were *A. alcocki, P. fissuroides indicus, P. jerryi, P. martia, M. andamanensis, M. coniger, S. alfonso, P. investigatoris, Haliporoides* sp., *H. woodmsoni, N. tenuipes, P. longipes, S. choprai, S. crassicornis* and *S. koelbeli.*

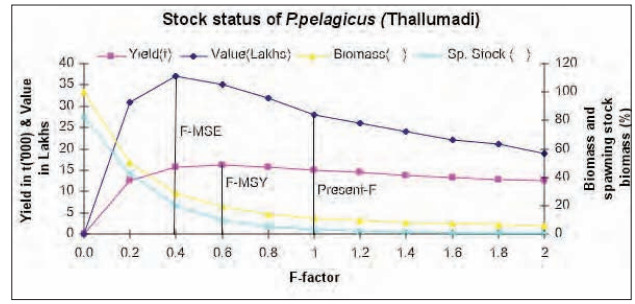
Thallumadi (indigenous trawl)

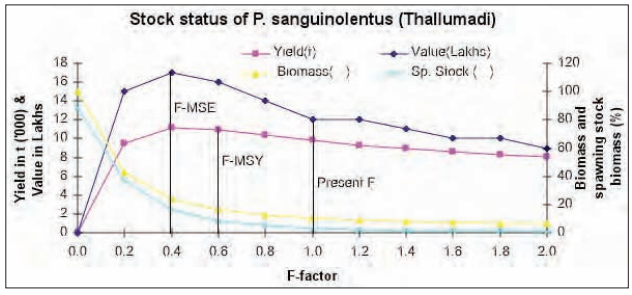
The catch comprised 17 species and among them, the dominant species was *P. semisulcatus* (92.4%). Other species were *P. latisulcatus* (2.6%), *P. maxillipedo* (1.3%), *M. moyebi* (1.8%), *F. indicus*, *P. canaliculatus*, *P. monodon, M. dobsoni P. uncta, T. curvirostris, T. granulosus, T. sedili, M. stridulans, M. mogiensis, A. rapacida* and *M. equidens*.

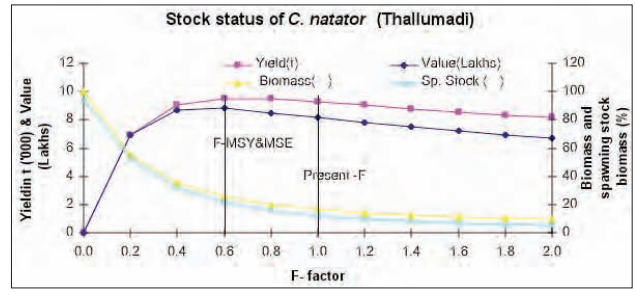
Estuarine gill net fishery

F. indicus was the dominant species (91%) in the estuary. Other species were *P. semisulcatus* (7%), *M. dobsoni* (1%), *P. monodon* (0.4%), *M. moyebi* (0.1%) and *M. monoceros* (0.002%)









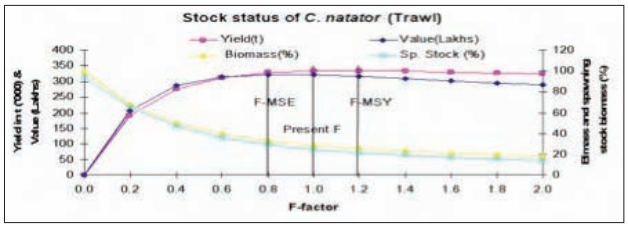
Crab fishery

Trawl

The fishery was mainly constituted by 19 species and among them *Charybdis natator* dominated (69%) followed by *Portunus sanguinolentus* (17%) and *P. haani* (12%). Other species recorded in the catch were *P. pelagicus*, *C. feriatus*, *Podopthalmus vigil*, *C. smithii*, *C. lucifera*, *C. annulata*, *C. calianassa*, *P. petreus*, *C. granulata*, *C. miles*, *Calappa bilineata*, *C. exanthematosa*, *C. gallus*, *C. pokipoki* and *C. lophos*.

Thallumadi (Indigenous trawl)

The commercial fishery was constituted by 12 species. Out of this, *P. pelagicus* dominated (46%) followed by *C. natator* (26%), *P. sanguinolentus*. In the trash, *Thalamita integra* formed the main component. The other species were *P. haani, C. feriatus, C. annulata, C. bilineata, C. lucifera, C. helleri, P. vigil* and *P. convexus.*

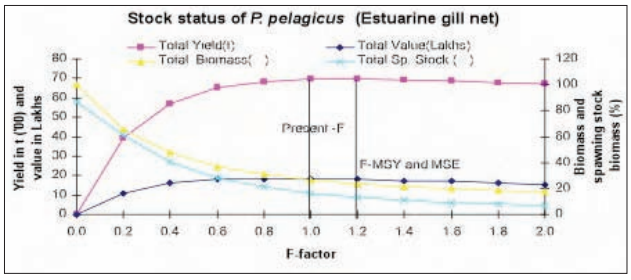


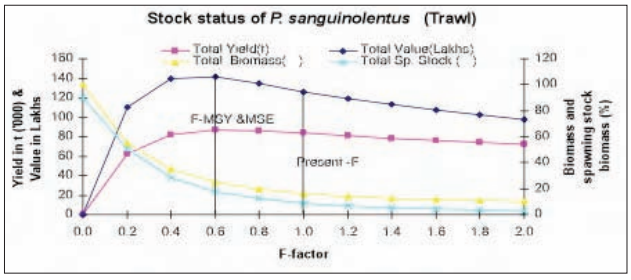
Estuarine gill net fishery

The catch comprised of 9 species and *P. sanguinolentus* dominated (55%) followed by *P. pelagicus* (16%), *C. natator* (15%) and *P. haani* (9%).

Cephalapod fishery

Cephalopod fishery in Palk Bay at Mandapam consisted of cuttlefish, squid and octopus. Cuttlefish fishery comprised *Sepia pharaonis* (56.4%) and *S. aculeata* (43.6%). The squid fishery was dominated by *Sepiotuithis lessoniana.* In Gulf of Mannar, from the same area, the cuttlefish fishery was dominated by *S. pharaonis* (71.5%) and *S. aculeata* (28.5%). The fishery of squid was comprised by *Loligo duvauceli* (85.3%) and *S. lessoniana* (14.7%).





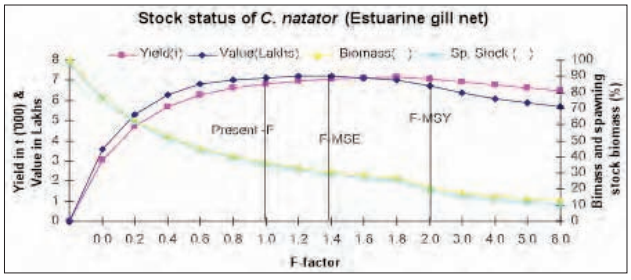
Stock status of crab and prawn resources

Thallumadi (Indigenous trawl)

This gear is being operated in coastal waters (near shore). The dominant species caught by *thallumadi* were *P. semisulcatus*, *P. pelagicus*, *P. sanguinolentus* and *C. natator*.

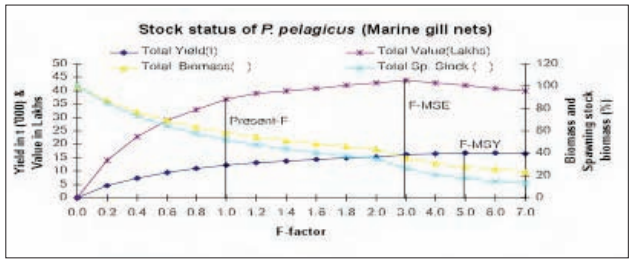
Mechanised trawl net

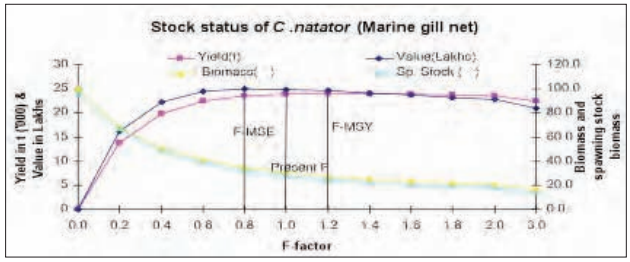
In mechanised trawl net, the dominant species of prawns and crabs were *P. semisulcatus*, *P. sanguinolentus* and *C. natator*.



Marine gill net

In marine gill nets the dominant species of crabs caught were *P. pelagicus*, *P. sanguinolentus* and *C. natator*.





The stock assessment studies of crabs and prawns showed that the juvenile stock of prawns and crabs were over-exploited by thallumadi (indigenous gill net). In the case of mechanised trawlers also the stock was slightly over-exploited. So, in order to achieve a healthy fishery the fishing pressure of the former gear has to be reduced by 60% and that of the latter gear by 40%. In the case of estuarine gill nets and marine gill nets, the present level of fishing pressure is found to be at desirable level.

The rapid stock assessment indicated that out of the 19 major resources, only one resource (shark) is found to be in declining status. Others are in abundant or less abundant category.

	Recent average (2011-2013)	Hist.maximum (2003-2010)	% of maximum	Present state
Oilsardine	144048	135306	106.5	Abundant
Other sardine	68108	55889	121.9	Abundant
Stolephorus	13096	10990	119.2	Abundant
Mackerel	21512	22974	93.6	Abundant
Tuna	18134	15314	118.4	Abundant
Seerfish	4758	7351	64.7	Less abundant
Billfishes	857	1068	80.2	Abundant
Shark	741	9822	7.5	Depleted
Rays	10420	12533	83.1	Abundant
Goatfisah	8861	8349	106.1	Abundant
Lizardfish	6246	8696	71.8	Abundant
Snappers	3945	4583	86.1	Abundant
Pigface bream	12815	15667	81.8	Abundant
Threadfin breams	12734	8848	143.9	Abundant
Silverbellies	78024	48772	160.0	Abundant
Penaeid prawn	23190	19700	117.7	Abundant
Non-penaeid prawn	1730	4797	36.1	Declining
Crab	14601	15455	94.5	Abundant
Cephalopod	18277	19201	95.2	Abundant
Total	654567	533182	122.8	Abundant

The yield and value were found to increase with the increase in effort implying that the stock is not adversely affected by fishing. However there was considerable reduction in SSB with increase in effort especially after f-Factor of 3.

***Euthynnus affinis*:** The analysis showed that even though the spawning stock biomass is very high, MSY and MSE are found at the current fishing.

***Rastrelliger kanagurta*:** Here the fishing is not found adversely affecting the catch even after increasing the effort to a very high level. The percentage of spawning stock biomass (SSB) with respect to the virgin SSB was also found to be very high.

Andhra Pradesh

Research Project: FISHCMFRISIL201201100011

The total marine landing of Andhra Pradesh during 2013 was 2.66 lakh t registering a decrease of 12.5% from the previous year. Mechanised trawls contributed 51% of total marine landings, followed by artisanal gears (14%), seines (12%), gillnets (12%) and other gears (including hooks and lines) (11%). An estimated 1.46 lakh t of pelagic resources were landed forming 55.0% of the total landings of the state, followed by demersal resources 0.75 lakh t (28.4%), crustacean resources 0.37 lakh t (13.9%) and molluscan resources 0.03 lakh t (1.3%).

The dominant groups landed were clupeids 0.46 lakh t (31.1%), mackerels 0.34 lakh t (22.9%), carangids 0.21 lakh t (14.0%), ribbonfishes 0.19 lakh t (12.8%), tunas & billfishes 0.16 lakh t (11.0%) and seerfishes 0.05 lakh t (3.4%).

The major groups that contributed to demersal landings were perches 13492 t (17.9%), sciaenids 13272 t (17.6%), pomfrets 12776 t (16.9%), silverbellies 7276 t (9.6%), goatfish 6801 t (9.0%), catfish 6333 t (8.4%) and elasmobranchs 5073 t (6.7%). The major crustacean resources were penaeid shrimps 0.29 lakh t (77.8%), crabs 0.05 lakh t (13.5%) and non-penaeid shrimps (0.03 lakh t (7.0%). The molluscan resources were cuttlefish 0.02 lakh t (59%) and squid 0.01 lakh t (41%).

Major species landed

Clupeids were the dominant pelagic group landed in the state with major contributors being lesser sardines 0.11 lakh t, oil sardine 0.07 lakh t and *Stolephorus* 0.07 lakh t. Carangids landed were contributed by horse mackerel (31.6%), scads (30.1%), leatherjackets (4.4%) and other carangids (33.9%). *Rastrelliger kanagurta* formed the bulk of mackerel landings, the rest being formed by *Rastrelliger faughni*. Seer fish catch was dominated by *Scomberomorus commerson* (72.8%) and *Scomberomorus guttatus* (27.2%).

Among tuna, the dominant species landed were *Thunnus albacares* (48.0%), followed by *Euthynnus affinis* (26.9%), *Katsuwonus pelamis* (19.1%) and *Auxis thazard* (6.0%).

The landings of billfishes and barracudas for the year were 0.03 lakh t and 0.04 lakh t, respectively.

Among the dominant demersal resource of perches, threadfin breams formed the highest component at 4527 t (33.6%) and were almost exclusively caught by mechanised trawlers which contributed to 97% of the threadfin bream landings in the state. The major species of threadfin

Fishermen carrying yellowfin tuna at Pudimadaka

breams landed by mechanised trawls were *Nemipterus japonicus* (44.4%), *N. randalli* (29.5%), *N. bipunctatus* (22.2%), *N. peronii* (2.4%) and *N. nematophorus* (1.5%).

Sciaenids were landed mainly by mechanised trawlers (50.1%), gillnets (12.7%) and artisanal gears (14.4%). The major species of sciaenids landed in Andhra Pradesh by mechanised trawlers were *Otolithes ruber* (39.7%), *Nibea maculata* (15.0%), *Johnius carutta* (14.6%), *Pennahia anea* (14.2%), *Johnius dussumieri* (4%), *Protonibea diacanthus* (3%), *Atrobucca nibe* (3%), *Chrysocheir aureus* (2.1%) and *Dendrophysa russeli* (1.6%).

An estimated 12,776 t of pomfrets were landed in the state during 2013. The landings of *Parastromateus niger* was 8,763 t, *Pampus argenteus* was 3,088 t and that of *Pampus chinensis* was 925 t. Mechanised trawls landed 9,363 t (73.3%) of pomfrets.

Major groups that contributed to flatfish landings were soles (70.0%), halibut (17.0%) and flounders (13.0%). Halibut was represented by only one species namely, *Psettodes erumei*. The common sole species landed was *Cynoglossus arel*. The major species of catfish landed was *Netuma thalassina* (50%) and *Plicofollis tenuispinis* (50%).

The catch landed by sona boats comprised 12 species, dominated by *M. monoceros* (29%), followed by *S. crassicornis* (25%), *Metapenaeopsis stridulans* (20.3%), *Parapenaeopsis stylifera* (10%), *F. indicus* (4%), *P. monodon* (3%), *M. dobsoni* (3%). The catch of small mechanised trawlers was represented by 20 species, dominated by *M. monoceros* (27.6%), followed by *M. barbata* (12%), *S. crassicornis* (11%), *Solenocera melantho* (9.4%), *M. dobsoni* (5.4%), *T. curvirostris* (4.8%) *F. indicus* (4.7%) and *P. uncta* (4.1%).

The crab catch by trawlers comprised commercial crabs 3321 t (66%) and other crabs 1678 t (34%). The catch of commercial crabs was supported by *P. sanguinolentus* (70.5%), *P. pelagicus* (19.3%) and *Charybdis* sp. (10%).

Among molluscs,*Sepia pharaonis*, *S aculeata* and *Sepiella inermis* (cuttlefish), *Loligo duvauceli*, (squids), and other species were observed in the fishery. The landings of *S. pharaonis* was 280 t (45%), *S. aculeata* 286 t (45.6%) and *Sepiella inermis* 33 t (5%). Among squids, *L. duvauceli* was the only species landed.

Biology of major species

Sardine: Length of oil sardine, *Sardinella longiceps* at Visakhapatnam ranged from 60 to 219 mm. The highest mean length of 199.20 mm was recorded in the month of January and the lowest mean length of 85 mm was recorded in October. The annual sex ratio was 1.04. Juvenile fishes were caught only during August-November. May-July is the peak breeding season of oil sardine. This is substantiated by the presence of high proportion of spawners and by high gonadosomatic index (5.92). Their average fecundity was 31200 with ova diameter varying from 0.38 to 0.54 mm. Food component analysis in gut revealed an abundance of planktonic matter. Empty or trace amounts of food in stomach was encountered in most fishes. Feeding intensity was highest in January. The length of *Sardinella fimbriata* ranged from 55 to 199 mm with all juveniles recorded during September-December. There was a preponderance of males in the catch in all months with annual sex ratio of 0.5.

Mackerel: The length of Indian mackerel, *Rastrelliger kanagurta* at Visakhapatnam ranged from 110 to 269 mm. Annual sex ratio was 2.38. Males dominated the catch in January-February and August-September while females dominated the catch in rest of the months. August appears to be the peak breeding month with all the females in mature condition and high gonadosomatic index value of 6.85. Their fecundity ranged from 81,346 to 2,70,500 with ova diameter varying from 0.28 to 1.02 mm. The analysis of food components revealed an abundance of copepods, decapods, ostracods, *Coscinodiscus*, *Foraminifera* along with minute quantities of cladocerans, fish eggs & larvae, zoea, tintinnids and nematods. For *Rastrelliger faughni*, the length varied from 190 to 279 mm. Females dominated the catches in most months with sex ratio of 1.75. April appears to be their peak spawning month with high proportion of gravid females.

Ribbonfish: *Trichiurus lepturus* was the sole species with size ranging from 380 to 1059 mm. There was a preponderance of females in the catch in all months except December. Mature females were encountered in high numbers in January and again in July-August. Highest GSI% of 5.46 was observed in August. Fecundity varied from 24,636 to 2,60,834 with ova diameter ranging from 0.31 to 0.74 mm. The high IRI values of non-penaeids, cephalopods, penaeids, clupeids, juveniles of ribbon fishes, scombrids and carangids and other teleosts and digested fish imply that they were the principal food constituents of *T. lepturus*.

Tuna: The length of skipjack tuna, *Katsuwonus pelamis* at Visakhapatnam ranged from 360 mm to 679 mm. Average gonadosomatic index was 1.15. Feeding intensity was highest in September and lowest in December. The high IRI values of cephalopod, penaeid prawn, carangid, mackerel, little tuna, sardine and anchovy along with digested food imply them to be the principal food constituents. The length of yellowfin tuna, *Thunnus albacares* at Visakhapatnam ranged from 320 to 1659 mm. Cephalopods are their preferred prey, followed by mackerel, crab, *Squilla*, coastal tunas, carangids and other scombrids. For, *Euthynnus affinis*, the length ranged from 360 to 579 mm.

Seerfish: The length of *Scomberomorus guttatus* at Visakhapatnam ranged from 200 to 379 mm. Significant dominance of females in catch was recorded in all the months. Mackerel, sardine, anchovies, non-penaeid shrimps and squid were the principal food components encountered in their gut. For, *Scomberomorus commerson*, the length varied between 560 to 1459 mm.

Barracuda: The length of *Sphyraena jello* at Visakhapatnam ranged from 180 to 599 mm. Annual sex ratio was 0.84. Average GSI% was 2.55 with mature females mostly encountered during June-July. Average fecundity was 270606 with ova diameter ranging from 0.20-0.50 mm. Feeding intensity was higher during January and August-September. The high IRI values of squid, mackerel, carangid and clupeid along with digested food imply them to be the principal food constituents. The mean length of *Sphyraena obtusata* was 238.79 mm with length ranging from 210 to 299 mm. Females were dominant and in mature state with average gonadosomatic index value of 4.22. Feeding intensity was very low in most months. Carangids were the preferred prey items.

Seerfish landed at Pudimadaka

Dolphinfish: The length of *Coryphaena hippurus* ranged from 460 to 1279 mm. Carangids, frigate tuna and sucker fishes were the principal food items encountered in their gut.

Cobia: The mean length recorded for *Rachycentron canadum* was 565.67 mm with length varying from 330 to 1139 mm. The highest mean length of 594.64 mm was recorded in November and the lowest mean length of 521.4 mm in September.

Grouper: The size of *Epinephelus coioides* ranged from 216 to 1016 mm with weights ranging from 127 g to 19.5 kg. The mean size was 506 mm.

Soles landed at Visakhapatnam Fishing Harbour

Flatfish: The size of the Indian halibut *Psettodes erumei* ranged from 165 to 605 mm with weights ranging from 73 to 3334 g. The sex ratio was 1.3. Of the females observed 52% were mature females. Fish was the predominant diet component.

Croakers: The size of *Nibea maculata* ranged from 113 to 243 mm with weights ranging from 18 to 195 g. The sex ratio was 1.2 and 70.7% of female fish were mature. The main diet components were fish, shrimps and crabs.

Catfish: The size of *Netuma thalassina* ranged from 150 to 995 mm with weights ranging from 38 g to 6.89 kg. The sex ratio was 1 indicating equal presence of male and female fish in the samples. The main diet components were fish, crab, stomatopods and shrimps.

Threadfin breams: The size of the threadfin bream *Nemipterus randalli* ranged from 99 to 265 mm with weights ranging from 5 to 94 g. The sex ratio was 1.14 and 69.3% of female fish were mature. Fish and shrimps were the main diet components.

Penaeid shrimps: The size range of *Metapenaeus dobsoni* (males) was 63-103 mm. The size range of *M. dobsoni* females was 58-123 mm. The sex ratio was 2.04.

Crabs: The size range of *Portunus sanguinolentus* (males) was 83-193 mm. The size range of *P. sanguinolentus* females was 88-168 mm. The sex ratio was 1.61.

Cuttlefish: In *Sepia aculeata*, the size range of males contributing to the fishery was 97 to 226 mm. The size range of females contributing to the fishery was 96 to 211 mm. The annual sex ratio was 1:1.4. Females dominated throughout the year except during March, April and November. Of the females, 60% were in mature condition. The diet comprised mostly digested fish such as scales and bones and digested prawn (*Acetes* sp.). In *Sepia pharaonis* the size range of males contributing to the fishery was 105 to 265 mm, size range of females contributing to the fishery 110 to 254 mm and the sex ratio was 1:0.88. The diet of *S. pharaonis* comprised of mostly prawn and fish.

Squid: The size range of *Loligo duvauceli* males contributing to the fishery was 62 to 190 mm, size range of females 63 to 170 mm. The sex ratio was 1:0.96 and 48.4% of the females were mature. The diet of *L. duvauceli* comprised of mostly shrimp (*Acetes* sp.) and fish.

Rapid stock classification of fish stocks

Rapid stock classification of fish and shellfish resources landed along Andhra Pradesh was carried out by using landing data from 1957-2012. Majority of the resources landed in the state (37.5%) were abundant, 31.25%

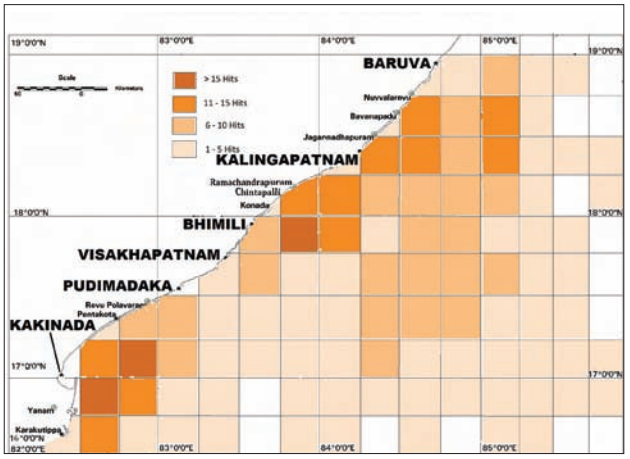
Nemipterus randalli landed by trawlers at Visakhapatnam Fishing Harbour

were less abundant, 28.1% were declining, 1.6% depleted and collapsed respectively. Majority of the pelagic groups were either less abundant or declining (35.5%), 25.8% were abundant and 3.2% (1 resource) had collapsed. Majority of the demersal resources were abundant (44%), 32% were less abundant, 20% declining and 4% (1 resource) depleted. The stock of Hilsa shad had collapsed and the stock of pigface breams, a minor resource, had depleted. Among crustaceans penaeid shrimps were abundant, non-penaeid shrimps less abundant and lobsters in declining status.

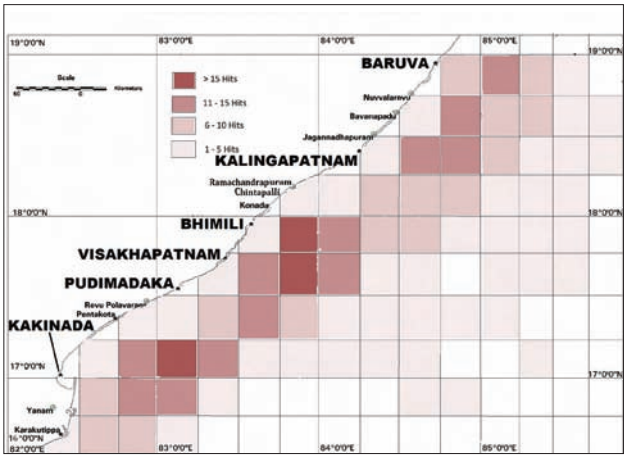
The marine environment

Seawater temperature showed a double oscillation with a major peak during May and a minor peak in September with minimum during July and December. The salinity of coastal waters showed marked seasonal fluctuations, registering low values during the north-east monsoon period and increasing gradually from Nov-Dec onwards to record the maximum values during the summer months. The coastal waters are influenced by the southerly and northerly currents alternately. During the north-east monsoon period, there is an influx of freshwater from rivers and land runoffs which bring marked lowering in salinity of the coastal waters.The nutrient salts also showed seasonal variations. During the north-east monsoon period the concentration of the nutrients went up due to the discharge of fresh and polluted waters from the rivers and land runoffs. After the cessation of the north-east monsoon the concentration decreased. The dissolved oxygen content of the coastal waters was high during the winter months, (when salinity is low) and north east monsoon period and was low during May to June. The Hydrogen-ion concentration shows a similar trend of temperature.

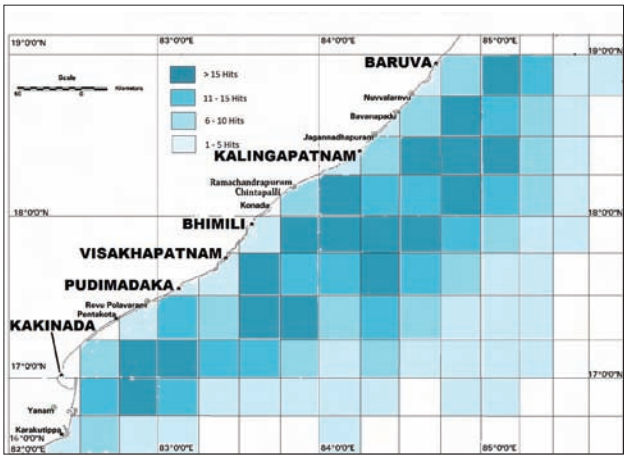
The frequency of PFZ hits were mapped along the coast based on different seasons (March to May: Summer, June to August: Pre-monsoon, September to November: Monsoon, December to February: Post-Monsoon).The study revealed that during summer months PFZs were less frequent but near coastal regions. During pre-monsoon season the PFZ's were found to be moving towards deeper waters though the frequency



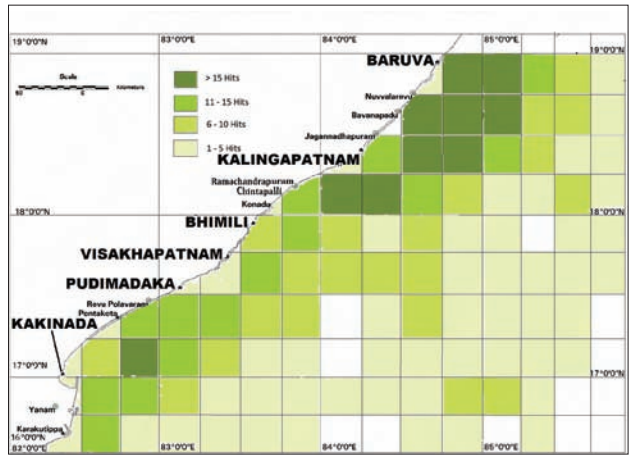
Frequency of PFZ hits along Andhra Pradesh coast (March-May)



Frequency of PFZ hits along Andhra Pradesh coast (June-August)



Frequency of PFZ hits along Andhra Pradesh coast (September-November)



Frequency of PFZ hits along Andhra Pradesh coast (December-February)

of hits remained similar. During monsoon months PFZs were found to expand to still larger areas, but with an apparent northerly movement. During post-monsoon the advisories were found to be mainly available in northern Andhra Pradesh and southern Orissa coast at near shore areas. The analysis indicated a persistent area of PFZ formation in Kakinada Bay almost throughout the year. Visakhapatnam waters were getting high intensity of PFZ hits during pre-monsoon and monsoon seasons and north AP coast during summer and post-monsoon seasons.

Trawl fishery of the north-east coast

Research Project: FISHCMFRISIL201203200032

The total production by trawlers during 2013 along the north east coast of India was 4.28 lakh t. The catch rate was 39.49 kg/h. Trawl landings in Andhra Pradesh was 1.34 lakh t forming 51.8% of the total marine landings. The overall catch rate was 25.2 kg/h for the state. The contribution of sona boats to the trawl landings of Andhra Pradesh was 96.1% and the contribution of small mechanised trawlers was 3.9%. The catch rate in sona boats was 25.3 kg/h and in small mechanised trawlers was 24.4 kg/h. In Odisha, the trawl catch was 2.13 lakh t forming 85.9% of the annual marine catches. The overall catch rate in Odisha was 80.91 kg/h. More than 95% of the catches were contributed by multiday trawlers and less than 5% were contributed by singleday trawlers. The catch rate in multiday trawlers was 79.32 kg/h and in singleday trawlers was 147.78 kg/h. In West Bengal, 0.67 lakh t was landed by trawlers at catch rate of 25.25 kg/h forming 31.4% of the total marine landings.

Catch Composition (%)

Group	Andhra Pradesh	Odisha	West Bengal
Penaeid prawns	18.3	22.3	14.6
Non-penaeid prawns		5.9	
Ribbonfishes	8.5	10.3	2.68
Croakers	5.7	19.7	12.4
Black pomfret	5.0		
Indian mackerel	4.2		

Silverbellies	3.6		3.4
Whitebaits	3.7	3.0	
Goatfishes	3.5		
Scads	3.4		
Threadfin breams	3.2		
Catfish	3.1		
Crabs	2.9	2.3	
Lizardfish	2.9		
Setipinna		3.3	4.5
Lesser sardines			3.4
Thryssa		2.9	3.1
Golden anchovy			5.6
Bombayduck			4.6
Catfish			3.3

Species Name	Fecundity	Ova diameter (microns)
Rastrelliger kanagurta	153505	0.28-1.02
Sardinella longiceps	31200	0.38-0.54
Trichiurus lepturus	139290	0.31-0.74
Otolithes ruber	147458	0.2-0.53
Nemipterus japonicus	84396	0.2-0.56
Saurida undosquamis	75932	0.26-0.67
Sphyraena jello	270606	0.20-0.50

Species Name/location	Length range (mm)		Mean length (mm)		Sex ratio		Mature %		GSI	
	Vizag	Digha	Vizag	Digha	Vizag	Digha	Vizag	Digha	Vizag	Digha
Rastrelliger kanagurta	110-269	140-259	189.9	199.3	2.3	1.1	32.7	49.8	5.5	4.4
Sardinella longiceps	60-219	130-209	126.2	168.2	1.0	1.2	4.3	27.6	5.9	7.8
Trichiurus lepturus	380-1059	480-819	582.3	596.6	3.5	1.8	24.3	24.9	3.5	4.8
Otolithes ruber	150-419	180-409	276.3	267.6	1.8	1.9	21.3	19.7	2.4	3.2
Nemipterus japonicus	110-289	110-319	184.6	200.6	1.8	3.8	39.1	13.2	3.8	3.9
Loligo duvaucelli	55-194	60-194	95.7	95.2	2.7	1.3	63.3	31.9	11.7	16.0
Saurida undosquamis	120-389		213.9		3.4		14.4		4.1	
Scomberomorus guttatus	200-379		304.2		2.4		0.0			
Katsuwonus pelamis	360-679		511.7		1.0		10.7		1.2	
Sphyraena jello	180-599		335.3		0.8		20.4		2.6	
Sphyraena obtusata	210-299		238.8		6.0		61.7		4.2	
Upeneus vittatus	100-199		146.4		1.2		33.0		3.3	
Metapenaeus monoceros	104-196		148.0		1.1		47.4		10.4	
Upeneus sulphureus		110-179		134.0		1.1		40.1		4.5
Saurida tumbil		180-379		263.1		2.0		18.3		7.0
Cynoglossus arel		160-299		235.5		1.8		13.3		5.1
Penaeus monodon		149-258		190.9		1.4		47.5		7.1

Elasmobranch resources

Research Project: FISHCMFRISIL201200500005

Production of elasmobranchs in India in 2013 was to the tune of about 47,410 t, with trawl nets accounting for 48.8%, gillnets 35.6% and hook & line units 6%. Landings declined by about 9.3% from the previous year. Sharks formed 43.3% of the total elasmobranch landings, skates, 4.9% and rays, 51.8%. Mechanised sector contributed 76% of the total elasmobranch landings in the country, while motorised sector contributed 23.7%. The role of non-mechanised sector was minimal. Tamil Nadu and Puducherry together accounted for 28.9% of the elasmobranch landings, Gujarat, Daman & Diu 23.9%, Maharashtra 11.5%, Kerala 11%, Andhra Pradesh 10.7%, West Bengal 7.6%, Odisha 3.4% and Karnataka & Goa 2.8%.

Sharks were the dominant group in Gujarat, Maharashtra, Goa, Karnataka, Kerala, West Bengal and Odisha, while rays were dominant in Andhra Pradesh, Tamil Nadu and Puducherry. Skates contributed to the fishery considerably only in Karnataka, Kerala and Maharashtra and to some extent in Andhra Pradesh, Tamil Nadu and Puducherry. Except in West Bengal and Goa, mechanised sector contributed to the major share of the elasmobranch landings. Trawlnet was the major contributor to elasmobranch landings in all the states except Daman & Diu, Maharashtra, Goa and West Bengal.

Rhinobatos annandalei with pups collected at Mumbai

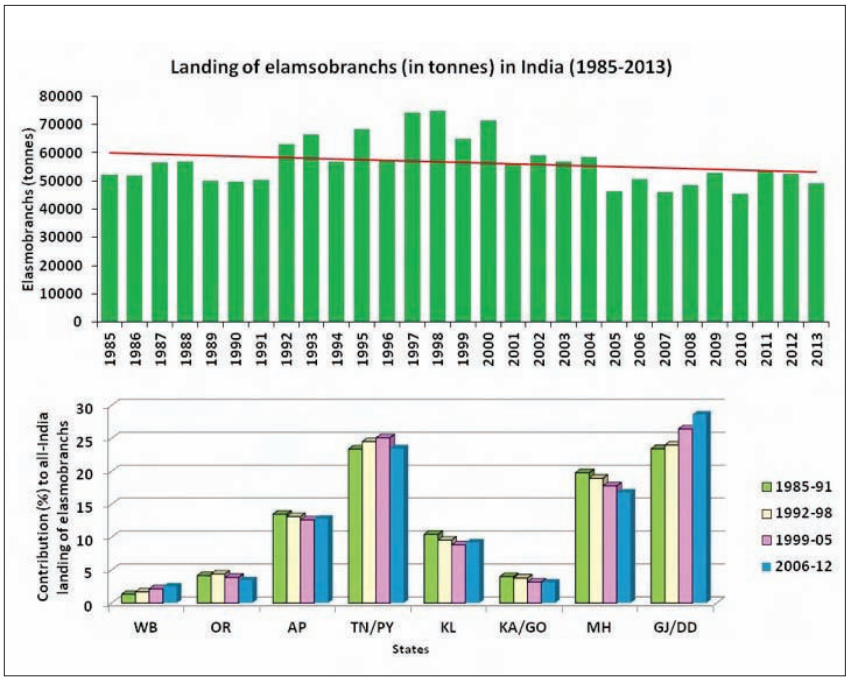
Species composition: Sharks were mainly represented by members of the families Carcharhinidae, Triakidae, Sphyrnidae, Echinorhinidae, Hemiscylliidae, Alopiidae, Lamnidae, Centrophoridae, Squalidae and Stegostomatidae. The ray fishery was dominated by Dasyatidae, Mobulidae, Myliobatidae, Gymnuridae and Rhinopteridae. Skates landed along the coast mostly belonged to the families Rhinidae and Rhinobatidae.

Rare occurrence

Occurrence of the brown guitarfish *Rhinobatos schlegelii* was recorded in the waters off south Chennai, confirming the distribution of this species in the Bay of Bengal along south-east peninsular India.

Rhinobatos schlegelli collected at Chennai

Pups of *Alopias pelagicus* collected at Chennai



Protected species: Protected species like *Rhincodon typus* (accidental entangling in drift gillnet), *Rhynchobatus djiddensis* (accidental catch in bottom set gillnet and trawlnet) were encountered at Tuticorin.

Classification of stock: Rapid stock analysis indicates that elasmobranch population along the Indian coast is either "less abundant" or "declining" in different parts of the coast. Among elasmobranchs, sharks were either "less abundant" or declining along the Indian coast, except in Tamil Nadu & Puducherry, where they could be classified as "depleted". Skates maintained their status quo in Gujarat and showed an improvement in the last three years in Karnataka & Goa, while their performance was very poor in the rest of the states. They were found to be "depleted" along Maharashtra and West Bengal, and "collapsed" along Odisha. Rays were found to have shown an improvement in Gujarat, Karnataka & Goa, Tamil Nadu and Andhra Pradesh. The status of rays remained more or less steady in the last five years, and they were classified as "abundant" along the Indian coast. At present, Gujarat as well as Karnataka & Goa on the west coast and Tamil Nadu & Puducherry and Andhra Pradesh on the east coast contribute to the sustenance of the elasmobranch fishery.

Rapid stock assessment of elasmobranchs along Indian coast

Resource	Coast	HMC (t)	3YA (T)	% of HMC	Status
	Gujarat	27985	11069	39.6	DC
	Maharashtra	12929	4034	31.2	DC
	Karnataka & Goa	2829	749	26.5	DC
Sharks	Kerala	5151	2328	45.2	DC
	Tamil Nadu & Puducherry	10934	827	7.6	DP

	Andhra Pradesh	6871	1572	22.9	DC
	Odisha	3077	1128	36.6	DC
	West Bengal	5482	3196	58.3	LA
	Gujarat	1412	1132	80.2	A
	Maharashtra	1927	131	6.8	DP
Skates	Karnataka & Goa	307	229	74.6	A
	Kerala	875	257	29.4	DC
	Tamil Nadu & Puducherry	1613	426	26.4	DC
	Andhra Pradesh	685	119	17.4	DC
	Odisha	351	6	1.6	C
	West Bengal	601	57	9.4	DP
	Gujarat	7012	2446	34.9	DC
	Maharashtra	2660	498	18.7	DC
Rays	Karnataka & Goa	2398	345	14.4	DC
	Kerala	4070	1082	26.6	DC
	Tamil Nadu & Puducherry	16429	10487	63.8	LA
	Andhra Pradesh	9971	6746	67.7	LA
	Odisha	1971	906	45.9	DC
	West Bengal	2059	831	40.4	DC

A- Abundant; LA-Less abundant; DC-Declining; DP-Depleted; C-Collapsed

Barcoding of elasmobranchs

Research Project: EF-11/MoES

Elasmobranch samples were collected from Cochin Fisheries Harbour, Colachel, Thoothoor, Muttom and Vizhinjam landing centres. Eighteen species of sharks, 14 species of rays and 3 species of skates were collected and identified. Out of these DNA barcoding studies were conducted for 9 species of elasmobranchs using mitochondrial CO1 gene and the sequences were submitted to National Center for Biotechnology Information (NCBI).

Details of gene (Mitochondrial CO1) sequence submissions of elasmobranch species

Species	NCBI Accession no:
Mobula japanica	KJ475198
Mobula tarapacana	KJ475199
Himantura gerrardi	KJ475200
Himantura fai	KJ475201
Galeocerdo cuvier	KJ475202
Mustelus mosis	KJ475203
Triaenodon obesus	KJ475204
Alopias pelagicus	KJ475205
Sphyrna lewini	KJ475206

Large pelagic resources

Research Project: FISHCMFRISIL201200700007

Fishery of large pelagics along the Indian mainland coast and Lakshadweep was monitored. Data on effort, catch and species composition in the landings were collected and the biology and taxonomy of major species were studied. A rapid stock assessment was conducted to assess the health of the stock in Indian waters.

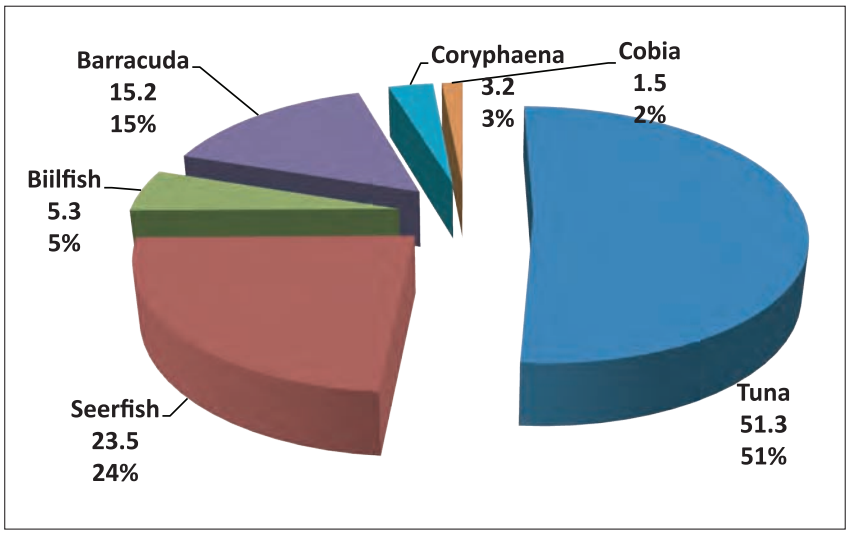
Fishery

Large pelagic fishery was supported by tunas, seerfishes, billfishes, barracudas, dolphinfishes and cobias. They constituted 180,506 t accounting 4.7% of the total marine fish production of mainland and Lakshadweep together. Major share of the catch was supported by tuna (92,555 t) followed by seerfishes and barracudas (27,382 t). Contribution of other components are biillfishes (9,646 t), dolphinfishes (5,768 t) and cobias (2,696 t).

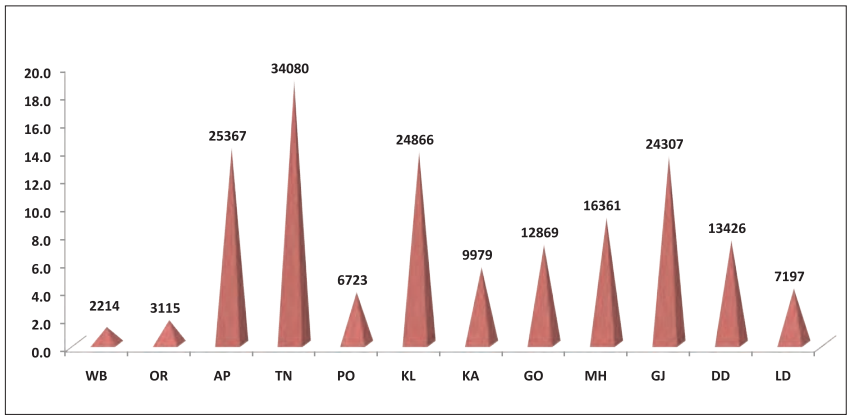
Major share of the catch was from southern states; Tamil Nadu - 18.9%, Andhra Pradesh -14.1% and Kerala -13.8%. Contribution by Gujarat was 13.5%. South-east coast contributed 36.7% of the catch, followed by south-west (26.4%) and north-west (30.0%) coast. Contribution from different states to each resource landings also varied considerably.

Rapid stock assessment and trend analysis of large pelagic stock shows that the resource as a whole is in abundant state and production is on steady increase. This is because the country was not exploiting the oceanic resources from deeper waters.

Commercial fisheries for large pelagics involves different craft and gear combinations. Most fishing units carry variety of fishing gears and operation of each depends on the resources targeted and ground conditions. Large



Composition of large pelagic in the catch



State-wise contribution of large pelagic

pelagics form aimed catch in some and bycatch in others. Almost 50% of the catch was by gillnets followed by trawls, purse seines and ring seines. Drift gillnets are generally used to capture fishes that move in the upper layers of water column and hooks and lines in deeper layers.

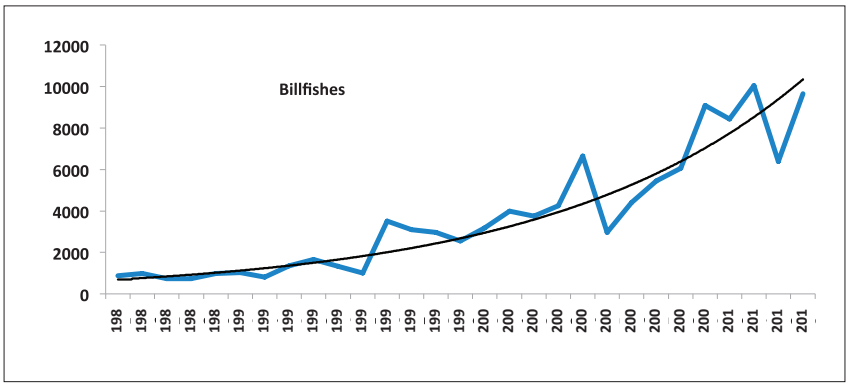
Tuna: Fishery was supported by eight species representing neritic and oceanic species. Kawakawa (*Euthynnus affinis*), frigate tuna (*Auxis thazard*), bullet tunas (*Auxis rochei*), longtail tuna (*Thunnus tonggol*) and bonito (*Sarda orientalis*) represented the netritic group, which together supported 72.7% of the total tuna catch. Oceanic group contributed 27.3% and was represented by yellowfin tuna (*Thunnus albacares*), skipjack tuna (*Katsuwonus pelamis*) and dogtooth tuna (*Gymnosarda unicolor*).

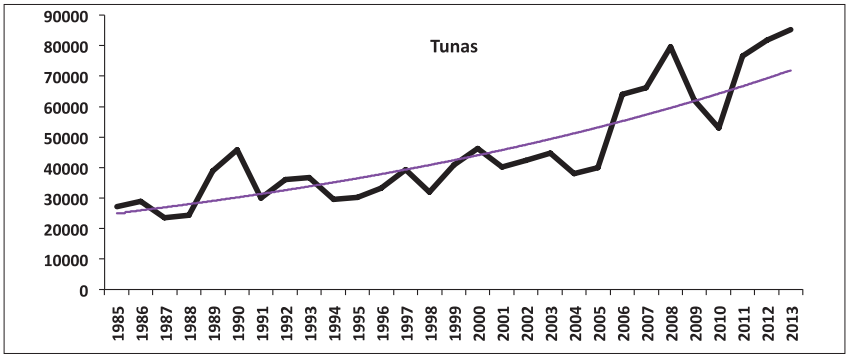
Tunas were landed by gillnets (51.6%), purse seines (19.9%), hooks and line (12.2%) and small quantities (12.1%) are landed by ringseines. Neritic tunas were exploited mainly by gillnets, purse seines, ringseines and trawls. Oceanic tunas on the other hand were harvested mainly by hooks and line.

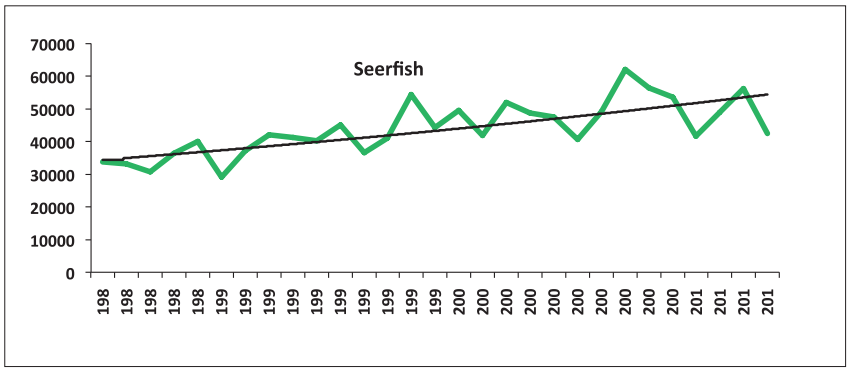
Tuna resource as a whole is in abundant state and production is on steady increase. Recent extension of efforts to deeper waters to tap hither to under-utilised oceanic tunas added considerably to the production of tunas. There exists considerable scope for further increasing their production. Major contributors to their catch were Tamilnadu (22.6%), Andhra Pradesh (15.5%), Kerala (15.3%), Goa (14.6%) and Gujarat (10.2%).

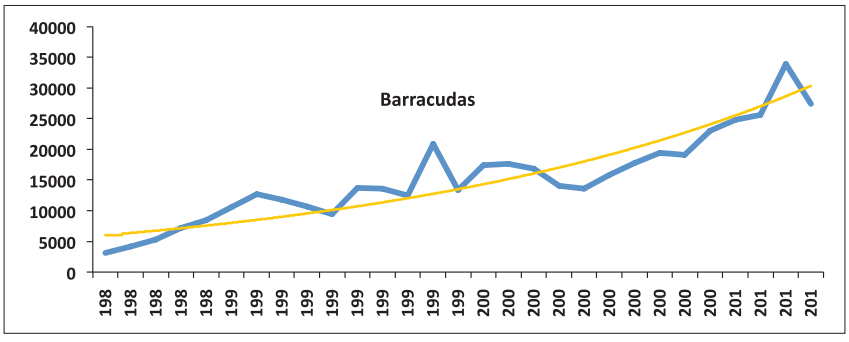
Seerfish: Fishery was supported by four species; *Scomberomorus commerson* (66.8%), *Scomberomorus guttatus* (33.0%), *Scomberomorus lineolatus* and *Acanthocybium solandri*. *S. lineolatus* supported fishery mainly along the southern coast of Tamil Nadu in small quantities.

Seerfish as a whole were landed by gillnets (62.3%), trawls (22.8%) and hooks and line (8.8%). Catch in gillnets were constituted by sub-adults and adults and in hooks and line by large adults. However, trawl catch was supported by juveniles and sub-adults. They were exploited all along the coast with major contributions from Gujarat (22.1%), Maharashtra (14.6%), Tamil Nadu (12.2%), and Andhra Pradesh (11.7%).









Production trend of large pelagics from Indian waters

The resource as a whole is in abundant state and production is on steady increase. There exists considerable scope for further increasing their production mainly through the increased contribution of wahoo.

Barracuda: Fishery was supported by seven species; *Sphyraena barracuda, Sphyraena jello, Sphyraena putnamae, Sphyraena forsteri, Sphyraena obtusata, Sphyraena picuda* and a previously non-described species *Sphyraena arabiansis* sp. nov. They were landed all along the coast with major share (26.7%) from Tamil Nadu coast. Other major contributors are Karnataka (14.8%), Andhra Pradesh(13.7%),Puducherry(11.6%), Gujarat and Kerala.

Trawls were the main gear exploiting (68.8%) barracudas. They land mainly small species and young ones of large species. Gillnets (18.4%), hooks and lines (4.6%) and purseseines (4.3%) land mainly adult specimens of larger species.

The resource as a whole is in abundant state and production is on steady increase. The trend suggests considerable scope for further increasing their production from deeper waters.

Billfish: Fishery was supported by five species; three species of marlins and one species each of sailfish and swordfish. Marlins (Family: Istiophoridae) were represented by two genera; *Makaira* and *Tetrapturus* in the catch. Common in the catches are *Makaira indica*, *Makaira mazara,* and one species under the genus *Tetrapturus*. Sailfish (Family: Istiophoridae) in the catch was represented by *Istiophorus platypterus* and

swordfish (Family Xiphidae) by *Xiphias gladius*. Catch was dominated by sailfishes (46.5%), followed by marlins and sword fishes. Billfishes were landed mainly by gillnets (56.4%), and hooks and line (39.0%). They are landed all along the coast with major share by Kerala (44.6%), Andhra Pradesh (31.1%), and Tamil Nadu (13.1%). Billfish production was on steady increase. Resource is in abundant state and in good health. Trend in production suggested scope for further increase in production.

Dolphinfish: Fishery was supported by two species; *Coryphaena hippurus* and small quantities of *Coryphaena equiselis*. They are landed all along the coast, but the major contribution was by Gujarat , Daman & Diu (54.2%). Other Major contributors are Andhra Pradesh and Kerala. Gillnets (65.7%), trawls (20.7%) and hooks and lines (12.2%) were the major gears exploiting dolphinfishes. Trawls land mainly young ones of the species. Gillnets and hooks and lines land mainly adult specimens of both species.

Cobia: Fishery was supported by single species, *Rachycentron canadum*. Their landing marginally reduced from 2,838 t in 2012 to 2,697 t in 2013. Cobia was exploited mainly from north-west coast, with Maharashtra, Gujarat, Daman & Diu as the major contributors. Gillnets (64.1%), contribute major share of the catch, followed by trawls (23.6%), and hooks and lines (11.8%). Catch in trawls are constituted by small juveniles and sub-adults.

Taxonomy

Morphometric and meristic details of representative species of the above resources were collected and a preliminary key for their field identification was prepared. The study showed presence of some species in the fishery which is (are) not described previously.

Biology

Length range in the catch, food and feeding, sex ratio, gonadal development, maturity, spawning and fecundity of major species were monitored. The size composition of species indicated that major share of the catch of most species were represented by adult population. In the case of sword fishes, *X. gladius*, large numbers of small fishes were landed occasionally at Cochin Fisheries Harbour by gillets. Small ones predominated the catch when fishing was done near seamounts and oceanic ridges.

Species	L_r	L_{max}	Mean
T. albacares	28	161	102.7
K. pelamis	32	70	47.6
T. tonggol	40	70	55.6
E. affinis	25	65	47.3
A. thazard	30	42	35.7
Scomberomorous commerson	48	132	77.8
Acantocybium solandri	70	130	92.1

Sphyraena barracuda	59	132	89.7
Sphyraena jello	26	128	83.7
Makara indica	120	280	198
Istiophorus platypterus	90	235	164.6
Xiphias gladius	58	190	97.6
Corypaena hippurus	24	143	78.8
Rachycentron canadum	30	115	

Food and feeding

Almost all species are highly predatory and carnivorous in feeding habit. Major share of the food was supported by pelagic finfishes, crabs and oceanic squids/octopus. Food of fishes caught from oceanic waters were constituted by *Decapterus*, Tunas, *A. rochei, A. thazard, K. pelamis*, flying fishes, halfbeaks, big-eye scad, pelagic crab-*Portunus* spp, squid, *Charybdis* spp., octopus and myctophids. Food of fishes caught from continental shelves consists mainly of sardines, anchovies, scads, horse mackerel, *Saurida* sp., *Chorinemus*, mackerel, *E. diacanthus*, whitebaits, shrimps and crabs.

Issues identified

Distribution of large pelagics are mainly towards oceanic water. However, the fishery is generally restricted to outer continental shelf, adjacent oceanic waters near knolls and seamounts, where these fishes frequent in large numbers for feeding, thus leaving large areas of oceanic waters and its resources unexploited by the nation.

Major issues in the development of their fishery are:

1. Lack of sufficient skilled crew.
2. Lack of scientific awareness on the spatio-temporal distribution, abundance and migration pattern of large pelagics.
3. Present coastal based oceanic fishing fleets have operational limitation for fishing in oceanic waters.

Suggestions

Skill of the fishers for oceanic fishing must be enhanced by providing adequate training on oceanic fishing practices and by disseminating scientific information on the distribution pattern of the resource. Spatio-temporal movement and abundance charts of the resource may be developed through exploratory surveys. Large long lining vessels with deep-sea going facilities, adequate carrying capacity and onboard post-harvest handling and processing facilities may be introduced for mainland and Island territories. Introduction of large factory or mother vessels with carrier vessel support should be considered, so that catch can be collected afresh in the mid-sea and processed onboard or transported to onshore facilities.

Bivalve fisheries

Research Project: FISHCMFRISIL201201200012

Bivalve production in estuaries and important landing centres along the states of Maharashtra, Karnataka, Kerala, Tamil Nadu and Andhra Pradesh were estimated by species. The annual landing of bivalves from Ratnagiri, Karwar, Mangalore, Calicut, Kochi, Vizhinjam, Tuticorin, Chennai, Visakhapatnam and Kakinada was estimated at 1,13,858 t. The estimated bivalve production registered an increase by 27% when compared to the catch in previous year (89,897t). Clams formed 94.3% of the annual bivalve production, mussels 5.5% and oysters 0.3%.

Maharashtra: Annual bivalve production from Maharashtra was estimated at 24 t. Bivalves were exploited from three major creeks, Shirgoan, Sakhartar and Bhatye creeks in Ratnagiri District. The clam fishery was dominated by *Meritrix* spp. (44%) followed by *Marcia opima* (23.6%) and *Paphia malabarica* (13.8%). Among oysters, Indian rock oyster, *Saccostrea cucullata* formed the major fishery in Mirya creek contributing 11.2 t annually. *Crassostrea* spp. are exploited from Bhatye creek. Windowpane oyster, *Placuna placenta* locally known as 'Kachga' is exploited from Kuda Creek, a bay along Rajapuri. The local fishermen hand-pick windowpane oyster from specially fabricated fiber rafts during low tide. During peak season (June-August) about 10 bags of 45-50 kg are collected per day, fetching ₹5/kg. Around 90 collectors are engaged in this fishery. The shell length of windowpane oyster ranged from 60-190 mm with the dominant size at 130-139 mm. The shells are washed, sun-dried and transported to Mumbai and Thane industrial belt. *Crassostrea* spp. are also exploited from Bhatye Creek.

Raft used for *P. placenta* fishery in Maharashtra

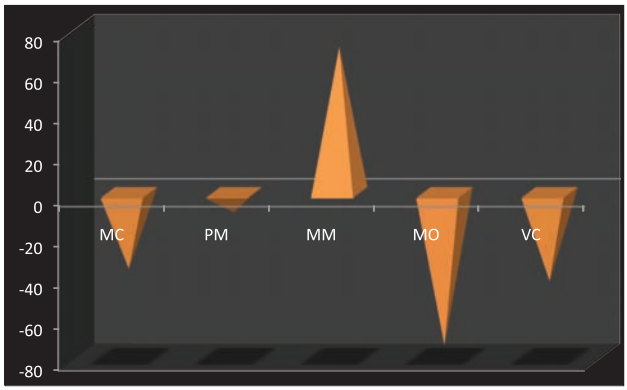
Estimated bivalve landings (t) during Jan-Dec 2013

Groups	Species	Maharashtra	Karnataka	Kerala	Tamil Nadu	Andhra Pradesh	Total (t)
Clams	*Paphia malabarica* (PM)	1.8	2772	20237	23	26	23060
	Meretrix meretrix (MM)	3.7	347		18	200	569.1
	Meretrix casta (MC)	0.5	1811	25146		1	26959
	Marcia opima (MO)	2.3	56		82	45	186.3
	Villorita cyprinoides (VC)		54	56248			56302
	Anadara granosa (AG)					224	224.4
	Gafrarium diverticulum (GD)	0.4					0.4
	Others	0.9				18	18.9
	Total	**9.5**	**5041**	**1,01,631**	**123**	**515**	**1,07,321**
Oysters	*Crassostrea madrasensis*		131	60	0	58	249.5
	Crassostrea spp.	0.6		0	0	0	0.6
	Saccostrea cucullata	11.3	9	0	0	0	19.9
	Placuna placenta	2.4		0	0	5	7.7
	Others			0	0	17	16.5
	Total	**14.3**	**140**	**60**	**0**	**80**	**294**
Mussels	*Perna viridis*	0.5	2180	3406	0	0	5586.7
	Perna indica			656			656.3
	Total	0.5	2180	4063	0		6243
	Total 2013	**24.3**	**7361**	**1,05,754**	**123**	**595**	**1,13,858**
	Total 2012	**7.8**	**12,462**	**74,622**	**1664**	**1004**	**89,897**

Placuna placenta

Saccostrea cucullata

Karnataka: In 2013, monsoon over the state of Karnataka exceeded the average by 17%, a huge jump from 2012. Following a 'break monsoon', the monsoon resumed in September, bringing a heavy downpour to the region. This resulted in a protracted low saline phase commencing from June to October, 2013 in the estuaries. Mortality of clams, *P. malabarica, M. casta, M. meretrix, M. opima* was observed in the estuaries. During 2013, the clam production in Karnataka was estimated at 5,041 t from Kalinadi, Gangavalli, Aghanashini, Sharavathi, Venkatapur, Coondapur, Uppunda, Swarna-Sita, Udyavara, Mulki, Gurupur and Nethravathi. Clam production recorded a decreasing trend by 47% due to mortality in the later half of 2013. *Meretrix casta* and *P. malabarica* contributed 91% to the total clam production. In order to meet the demand for *P. malabarica* in the states of Karnataka and Goa, clams were transported in bulk quantities by road from Kerala and transplanted in Coondapur Estuary prior to retailing. Biomass surveys were conducted in Nethravathi, Gurupur, Mulki, Sita and



Annual trends (±) in clam production along Karnataka by species

Swarna estuaries of Dakshina Kannada and Udupi districts of Karnataka. Recruitment of *P. malabarica* and *M. casta* in Swarna and Sita estuaries was observed from November-February.

Kerala: Clams formed 96.1% of bivalve production in Kerala followed by mussels (3.8%) and edible oysters (0.1%). Bivalve production along the Malabar Coast was estimated at 62,825 t contributing 59.4% to the state production. Clams, *M. casta, V. cyprinoides* and *P. malabarica* dominated the fishery (95%) contributing to 58.8% of the total clam fishery of the state. Green mussel *Perna viridis* constituted 3,103 t forming 5% of the bivalve landings.

Estuarine waters of Central Kerala contributed 41.2% to the clam production of the State. Production of *P. malabarica* in Ashtamudi Lake during March to November 2013, estimated at 10907 t recorded 2.4% decrease compared to 2012 (11,174 t). Self-imposed ban on fishing during December 2012-February 2013 for *P. malabarica* continued in the region.

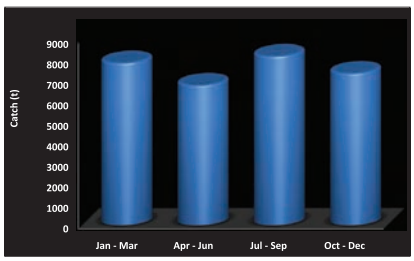
Black clam production in Vembanad during 2013 estimated at 30,178 t showed a decrease by 19% in comparison with 2012 production (36,006 t). Maximum catch was recorded from Muhamma and Vechoor clam shell society (72% of the catch) and the rest was contributed by Komalapuram, Vaikom, Thaikattusery and Kuthiathode clam society. The black clam *Villorita cyprinoides* was the major species forming as much as 62% of the total. However, the production of black clams declined from a peak of 56,700 t in 2007 to 39,481 t in 2011 and 30,178 t in 2013.

In Chettuva Estuary, *M. casta* formed the major fishery. Total estimated bivalve production was 824 t.

Brown mussel fishery was observed only along the Vizhinjam coast in the tune of 656 t, showing 44.4% reduction from that of the previous year.

Population studies: Length based stock studies of *Perna viridis* along Vizhinjam coast was carried out. Per recruit analysis (constant recruitment, knife edge selection, deterministic) using the 'YIELD' software for 2012-2013 average data gave the following F based reference points.

2013					
L_∞ (cm)	12.6	F	3.236	M	1.524
K	0.72	E	0.680	L_{opt} (cm)	7.4
Z	4.76	U	0.674	$\bar{L}$ (cm)	7.7
2012-13					
Z	3.64	F	2.12	F_{max}	8.33
E	0.581	L_{50} (cm)	6.5	$F_{0.1}$	1.57
u	0.566	$\bar{L}$ (cm)	7.9	$F_{0.2}$ SSB/ recruit/initial	2.27



Black clam catch in Vembanad

Tamil Nadu: Exploitation of clams comprising of *M. opima* (66.7%) *P. malabarica* (18.7%), and *M. meretrix* (14.6%) from Karapad Bay, Tuticorin registered four fold increase when compared to the previous year. Total annual production was estimated at 123 t for a period of 167 fishing days. The size composition of *M. opima* in the fishery ranged from 26.5 to 48.4mm; *P. malabarica* from 24.3 to 49.5 mm and *M. meretrix* from 41.4 to 74.5 mm.

Andhra Pradesh: Total bivalve landings from landing centres of Kakinada Bay was estimated at 595 t. The landings decreased by 33% compared to previous year. *Anadara granosa* contributed 44% to the clam landings followed by *M. meretrix* 39%, *M. opima* 9% and *P. malabarica* by 5.1%. The exploitation of *C. madrasensis* increased marginally (38%), with the resource contributing 73% to oyster fishery from the region. *Placuna placenta* catch decreased by 99% from Kakinada.

Clam Fisheries Governance Council and ecolabelling of short-neck clam fisheries of Ashtamudi Lake

Based on the advice of CMFRI in its Ashtamudi Lake Clam Fisheries Management Plan (FMP) publication, the Ashtamudi Lake Clam Fisheries Governance Council (ACFGC) came into existence in June 2013. The Terms of reference for ACFGC was prepared by CMFRI.

Short-neck Clam Fisheries of Ashtamudi Lake is to become the first ecolabelled fisheries in India. The WWF, India with scientific support from the CMFRI has moved the short-neck clam fisheries for full assessment under the Marine Stewardship Council (MSC) ecolabelling scheme. Currently the stakeholder consultations are on and it is expected the fishery will get the certificate by September of 2014. The certification is possible because the fishery has been managed well with sustainable catches based on CMFRI advice and the new co-management approach through the formation of the ACFGC has helped in the process.

Ornamental gastropods

Research Project: FISHCMFRISIL201201300013

Fishery and biology

Tuticorin

The major ornamental gastropods landed by bottom set gill nets are *Turbinella pyrum* and *Chicoreus ramosus.* Apart from this stray number of other ornamental gastropods such as *Murex* spp., *Lambis lambis*, *Babylonia* spp. and *Cypraea* sp. are also landed by the bottom set gill nets primarily set for lobster and crabs. In addition to the above, fossilised *Turbinella pyrum* is exploited regularly from Kalavasal. These fossilised *T. pyrum* are mostly exported to Kolkata.

A total of 40,126 nos. of live *T. pyrum* were caught at Kayalpatnam by 5,230 units. There were 212 fishing days and the cpue was estimated to be 8 chanks/man-day. The size/weight ranges of the chanks are from

128-200 mm with an average of 165 mm and 250-2,200 g with an average of 850 g respectively. Live *Chicoreus ramosus* landings was also observed throughout the year by the same gear. A total of 52,067 nos. were exploited by 5,230 boats in 212 fishing days. The CPUE was 10 nos./man-day. The size/weight ranges of the exploited *C. ramosus* ranged from 156-206 mm with an average of 188 mm and 500-1,300 g and with an average of 650 g at Kayalpattinam. The estimated exploited sacred chanks (*T. pyrum*) at Kalavasal was 35,065 nos. by 5,312 boats in 243 fishing days. The catch/unit effort worked out to be 7 chanks. The size/weight of the exploited chanks ranged from 104-193 mm with an average of 163 mm/370-950 g with an average weight of 691 g.

Live fishery for *C. ramosus* was monitored and total estimated landing was 74,151 nos. by 5,302 boats in 243 fishing days with a CPUE of 14 nos. The size/ weight range observed was 148-198 mm with an average of 176.mm and 330-1100 g with an average of 676 g at Kalavasal.

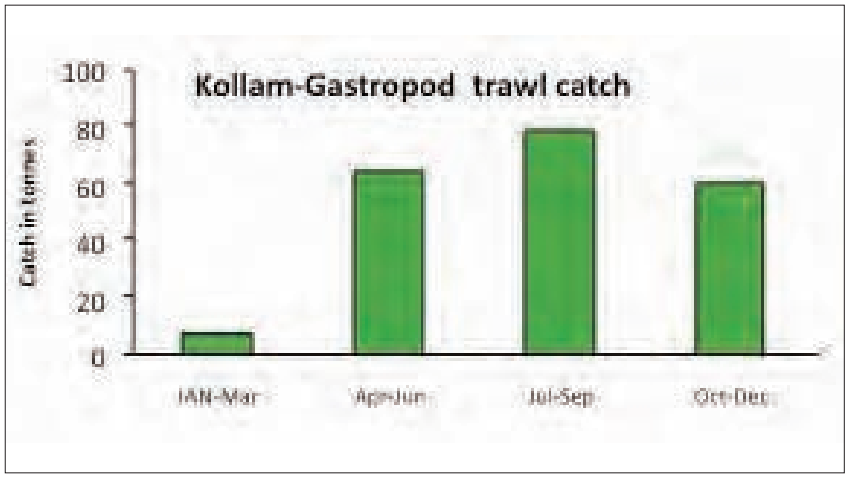
During this year the fossilised chank exploitation at Kalavasal was estimated to be 3,26,550 nos. by 12,165 boats with a CPUE of 27 chanks. The total fishing/exploitation days were 255. The size/weight range of the chanks ranged from 117-237 mm with an average of 169 mm/400-1350 g with an average of 780 g. More and more numbers of vessels are being used for the exploitation of this fossilised resource and very good revenue is generated.

Kollam

During 2013, an estimated quantity of 210.6 t of gastropods was landed by trawlers from this district. Compared to last year, the present catch showed reduction of 82%. Catch from two major landing centres namely Needankara Fishing Harbour (NFH) and Sakthikulankara Fishing Harbour (SFH) formed upto 97% of the catch landed at Kollam District. Annual average catch per unit effort at NFH and at SFH were 7.3 and 6.4 kg. The maximum catch and catch rate was observed during August at NFH and June at SFH. The highest landings were recorded during the III quarter (July-Sep); percentage contribution being 37.8% followed by II quarter (30.8%), and IV quarter (28.6%). In quarter–wise centre catch, NFH showed maximum catch in Jul to Sep while SFH showed maximum catch during Apr to June. Trawl nets operating upto 100 m depth accounted for-97.9% followed by other gears mechanised others (MOTHS) and non-mechanised (NM).

During this period, the main species exploited was *Babylonia zeylanica* followed by *Bursa margariticula, B. spinosa. Rapana rapiformis,* and *Babylonia spirata. Conus* sp., *C. virgenius*, *Natica* sp.,*Tibia curta, Fasciolaria* sp.,*Oliva* sp., *Nassarius* sp., *Ficus* sp.,*Turicula* sp. *Phalium glaucum* and *Cantharius* sp. formed a very minor proportion.

Babylonia zeylanica length in the fishery ranged from 22.39 to 45.93 mm. The total weight of *B. zeylanica* ranged between 2.19-11.44 g, and meat weight 0.64-4.55 g. The sex ratio was 1:14. The length range of *B. spirata* in the fishery ranged from 26.59 to 43.43 mm and the total weight ranged between 4.15-19.29 g and meat weight 1.48-6.48 g.



Quarter-wise gastropod production at Kollam

Bursa margariticula length in the fishery varied from 39.04 to 63.45 mm and the total weight ranged between 6.83-28.12 g and meat weight 1.5-7.49 g. The sex ratio was 1: 1.43.

The length of *B. spinosa* ranged from 46.8 to 72.21 mm and the total weight ranged between 10.53-27.7 g and meat weight 2.35-6.38 g. The sex ratio was 1: 3.25.

Kakinada

Estimated exploited ornamental gastropod species-Kakinada Estuary 2013-14

Month/Species	*Cerethidia* sp. (t)	*Thais* sp. (t)	*Telescopium* sp.	*Hemifusus* sp. (t)	*Murex* sp. (t)	*Umbonium* sp.	Other Gastropods	Total (t)	Effort Units (Nos.)	C/E (kg)	Price/kg
April 2013						No data					
May						No data					
June						No data					
July-2013	5.1	0.9	3.6	2.8	2.1	----	1.6	16.1	392	41.2	₹7 to 8
August	9.4	2	3.3	5.4	2.8	----	1.6	24.5	675	36.3	₹7 to 8
September	6.7	0.9	2.2	2.4	1.9	----	1.3	15.4	448	34.4	₹7 to 8
October	5.4	0.9	1.5	1.8	1.5	----	0.8	11.9	372	32.1	₹7 to 8
November	0.7	0.6	1.4	1.2	1.7	0.1	0.8	6.5	336	19.3	₹7 to 8
December	5.6	2.9	3	2.7	2.5	----	1.3	18.2	406	44.7	₹7 to 8
January -2014	15.4	1.9	2.4	2.8	1.7	----	---	25.5	420	61	₹7 to 8
February	33.6	3.2	5.6	4.9	3.2	----	2.8	53.3	784	68	₹7 to 8
March	21.1	4.5	5	6.5	3.6	----	2	42.7	690	62	₹7 to 8
Total	**103**	**15.8**	**28**	**30.5**	**21**	**0.1**	**12.2**	**214.1**	**4523**	**399**	

Shell-craft industry

Field survey was conducted at the important shell craft industries located along the south-east coast namely Tirunelveli, Keelakarai and Ramanathapuram during September, 2013 in order to collect data on different species of molluscs used in industry, places of collection, total number of manpower engaged in the industry, details of marketing through retail and wholesale outlets.

Shell cutting and polishing unit

Raw material production unit

The shell craft industry is dependent on the seashells of gastropods and bivalves of different shapes, size and variety which are used as raw material. These molluscs are landed as bycatch from different crafts and gears in the fish landing centres. No varieties of shells are discarded as waste material. These resources are mostly caught from trawl nets and are mostly landed as live shells. Larger to medium sized gastropods such as sacred chank *Turbinella pyrum*, *Chicoreus* sp. *Hemifusus* sp., Beggar's bowl (*Cymbium melo*) and *Strombus* sp. are given to local merchant by fishermen themselves at the landing centres. Segregated shells are packed in plastic/gunny bags and loaded in trucks for transporting to industry.

Shell processing unit

Processing and raw material units are located in one place. Large area of land (more than 2 ha) is used for this purpose. Shells unloaded at the raw material site, are segregated according to species or genera and placed in respective heaps of shells or bags.

Shell craft industry still uses crude and cost effective method to clean shells. Shells of different varieties, shape and size are stocked in open space and allowed to decay for 3-5 days. After drying the shells, they are soaked in freshwater for 2-5 days in rectangular cement tanks. This helps to remove dirt and decayed soft parts of the animals. The water along with the decayed flesh is drained out and freshwater is added periodically.

Shells are then placed in bleaching powder solution for 24h in cement tanks. Medium to large size shells are washed and rinsed individually and the encrustations are removed by a knife or rod. They are placed in bleaching powder solution again for 24h in cement tanks, followed by immersing in caustic soda solution in another tank for one hour. Shells are washed in hot water with small quantity of HCl. Then they are dried in open yard and packed in gunny bag. In order to make smaller sized shells glossy, shells are boiled in palm oil. This practice is specially done in Ramanathapuram District. In some processing centres, caustic soda and lye (mixture of sodium hydroxide and sodium carbonate) are also used to remove the calcareous castings on the shells.

Finished whole shells

Medium to large sized polished whole shells of different species like *Trochus* sp., *Turbo* sp., *Turbinella pyrum*, *Busycon* sp., *Lambis* sp., *Haliotis* sp., *Cymbium* sp., *Pinna* sp., *Strombus* sp. and *Hemifusus* sp. are used as ornamental decorations. Shells of small sized polished whole shells like *Conus* sp., *Bursa* sp. and *Strombus* sp. are used for making key chains and paper weight with engravings. Full sized top shells like *Cymbium* sp. and *Trochus* sp. are used for making table lamps, lamp shades and domes.

Decorative painted shells of *Natica* sp.

Shell crafts

Shell crafts like bangles, necklaces, ear studs, hair pin and sindur box of West Bengal are made out of chanks. Whole shells of *Umbonium* sp. and *Babylonia* sp. are stringed together to make wall and door hangings. Polished whole shells of different sizes like that of *Umbonium* sp. and *Babylonia* sp. are used in making decorated wall clocks and mirrors. Spoon, ash tray, agarbathi stand, dolls, garland, beads, flower vase, sculptures and shell screen are made out of whole, cut and carved shells of many varieties of lustrous shells such as *Trochus* sp., *Turbo* sp., *Pinctada* sp., *Pteria* sp. and *Isognomon* sp.

Fish genetics **and genomics**

Population genetics of oil sardine using mitochondrial DNA markers

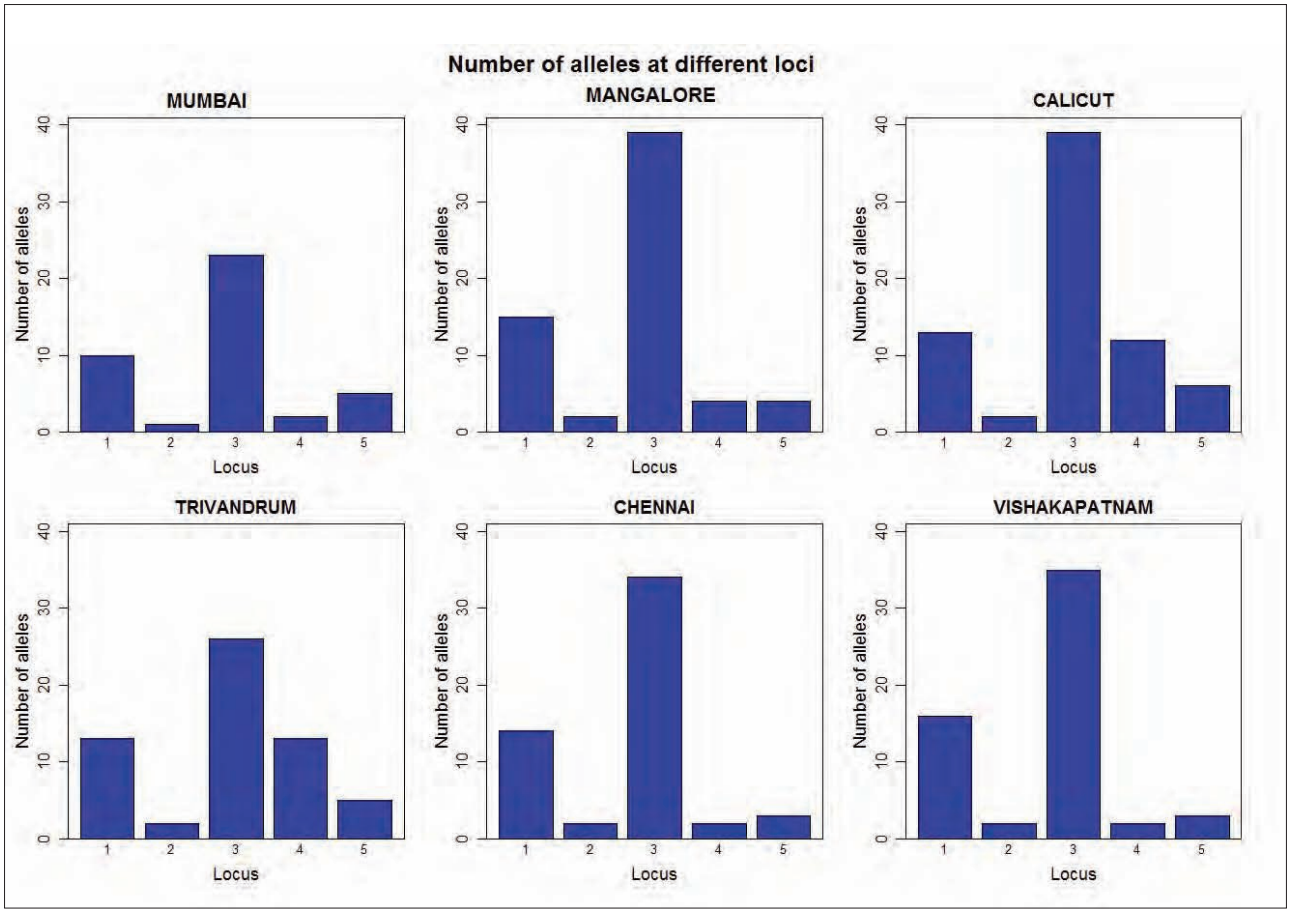
Research Project: FISHCMFRISIL201202800028

Nucleotide diversity of mitochondrial cytochrome c oxidase gene from the oil sardine, *Sardinella longiceps* was analysed by taking samples from the east and west coasts of India. *S. longiceps* collected from Veraval, Mumbai, Mangalore, Calicut, Kochi, Trivandrum, Chennai and Vizag were analysed for haplotype diversity, degree of genetic differentiation and nucleotide diversity. A total of 214 sequences were analysed from 8 sites and the number of segregating nucleotide sites was 94. Eighty unique mitochondrial haplotypes were detected with comparatively high haplotype diversity (Hd; 0.841) and nucleotide diversity values (PiT:0.004). Within-site haplotype diversity was high (Hd; 0.95) in *S. longiceps* collected from Chennai coast followed by Vizag coast (0.94). A maximum likelihood tree was constructed with a bootstrap value of 1000. *S. longiceps* collected from all the locations formed a single clade with insignificant bootstrap values. Kimura 2 parameter (K2p) distance values were the highest between *S. longiceps* collected from Chennai and Vizag (0.007) and were lowest between *S. longiceps* from Calicut and Veraval (0.002) and Kochi and Veraval (0.002). The K2p distance was not proportional with their geographic distances. The comparatively high values of haplotype and nucleotide diversity may be a reflection of the evolution taking place at genome level in response to environmental fluctuations. Recently, climate change studies have found extension of northern and eastern boundaries of oil sardine due to fluctuations in average annual sea surface temperature. The similarities in mitochondrial haplotypes collected from Kochi, Mangalore, Trivandrum, Chennai and Veraval may be due to this extension of boundaries of occurrence. Studies are in progress with more number of mitochondrial gene markers to ascertain whether different subpopulations/stocks of oil sardines exist in Indian waters.

Population genetics of oil sardine using microsatellite markers

Research Project: EF-5/DARE-ICAR-NICRA

Population genetic structure of the oil sardine, *S. longiceps* was studied using five microsatellite markers developed using cross species amplification. The populations from Mumbai, Mangalore, Calicut, Trivandrum, Chennai and Visakhapatnam were used for the study. Microsatellite genotyping was carried out on the ABI Prism genetic analyser with primers labeled using 6FAM fluorescein dye and alleles were identified using allele calls in GENEMAPPER software. Alleles were mapped for 96 samples from each location. All loci were in Hardy-Weinberg equilibrium and none of them were in linkage disequilibrium ($P<0.05$). Maximum number of alleles was observed at locus 3 in all the analysed populations. Average number of pair-wise differences was highest between Mumbai and Chennai samples and lowest between Mangalore and Trivandrum. The values of genetic differentiation were also highest between Mumbai and Chennai samples and lowest between Mangalore and Trivandrum samples. The analysis showed the presence of well differentiated samples in all the locations. Calicut and Mangalore samples showed the highest allelic diversity. Calicut



Mean number of alleles at different locations

and Mangalore are located in the Malabar upwelling zone and may be providing the most ideal conditions for sardine populations to survive and reproduce. The pair-wise genetic differentiation and pair-wise genetic differences also showed high values between Mumbai and Chennai and Mumbai and Vizag.

Genetic stock structure of Indian mackerel

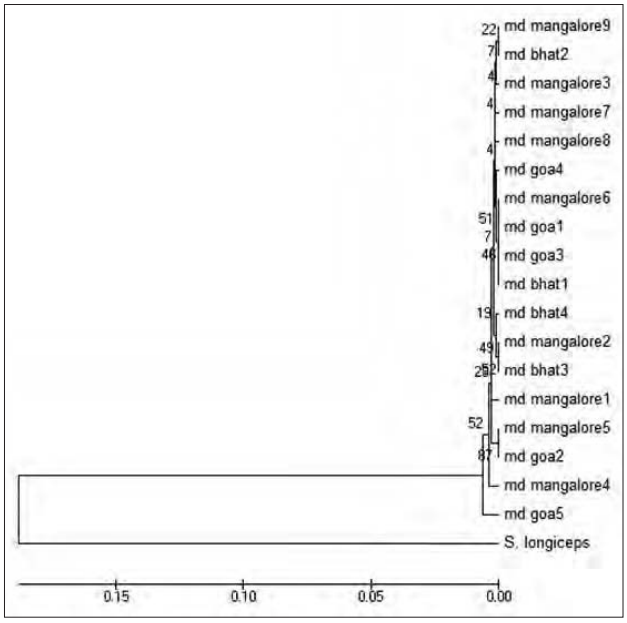
Research Project: EF-18/BOBLME

Samples of Indian mackerel *Rastrelliger kanagurta* belonging to the breeding stock (Maturity Stage IV) were collected from 7 sampling sites (Calicut, Nagapatnam, Paradeep, Tuticorin, Mumbai, Kakinada and Port Blair), along the Indian coast for microsatellite analysis. Standard operating procedures were followed for tissue sample collection and preservation. Fourteen microsatellite primers were identified for genotyping the samples collected from each location. Microsatellite genotyping was carried out on the ABI Prism genetic analyser with primers labeled using 6FAM fluorescein dye and alleles were identified using allele calls in GENEMAPPER software. Microsatellite geno typing has been completed in 30 samples of Indian mackerel, *R. kanagurta* from Tuticorin, Calicut and Nagapatnam using the first 7 labeled primers, and further analysis is in progress.

Metapenaeus dobsoni populations from Mangalore, Bhatkal and Goa

Research Project: FISHCMFRISIL201202800028

Metapenaeus dobsoni collected from Mangalore, Bhatkal and Goa showing morphological dissimilarities were studied to resolve the taxonomic ambiguities using partial sequences of mitochondrial cytochrome c oxidase gene (CO1). Gene sequences for 650 bp of the gene were generated for 9 samples from Mangalore, 4 samples from Bhatkal and 5 samples from Goa. The clustering pattern did not show any evidence of species level differentiation.



UPGMA tree generated using the mitochondrial cytochrome c oxidase gene sequences of *M. dobsoni* collected from Mangalore, Goa and Bhatkal coasts.

HSP 70 gene of *Crassostrea madrasensis*

Research Project: FISHCMFRISIL201202800028

Amino acid sequence encoded by the complete coding sequences (CDS) of HSP 70 gene was elucidated and the canonical domains were detected. BLAST search of the coding sequences have shown 93% identity with *Crassostrea gigas*, 92% with *Crassostrea ariakensis* and 92% with *Ostrea edulis*. Expression analysis of the stress management genes of the oysters were carried out. The upregulation of the stress management genes were found to result in enhanced thermo tolerance in the edible oyster, indicating higher stress tolerance ability.

Identification of abiotic stress genes

Research Project: EF-33/NAIP

Salt tolerance gene from microalga *Tetraselmis indica*

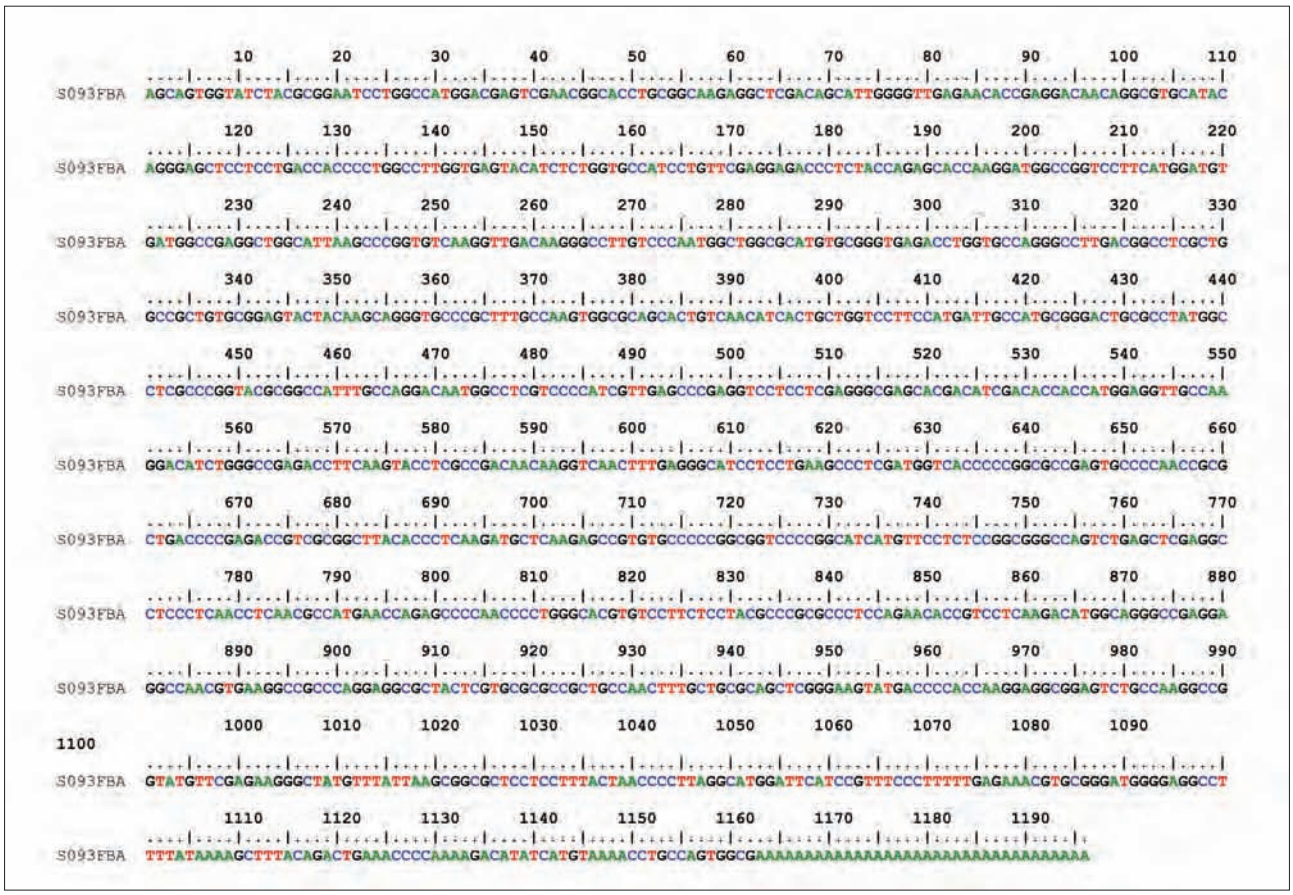
An abiotic stress gene FBP aldolase for salinity tolerance from the microalga *Tetraselmis indica*, from a hyperhaline habitat has been identified using subtractive suppression hybridisation (SSH) method and characterised using RACE-PCR method. The hyperhaline microalga isolated from the Pulicat hyper saline lake in south-east coast of India has the ability to tolerate wide range of salinities from 1M NaCl to 4M NaCl. This mined gene for salinity tolerance, FBP aldolase was 556 bp and the sequence could be useful in the transgenic studies for developing salinity tolerant organisms.

Acid tolerance gene from microalga *Dictyospherium ehrrenbergianum*

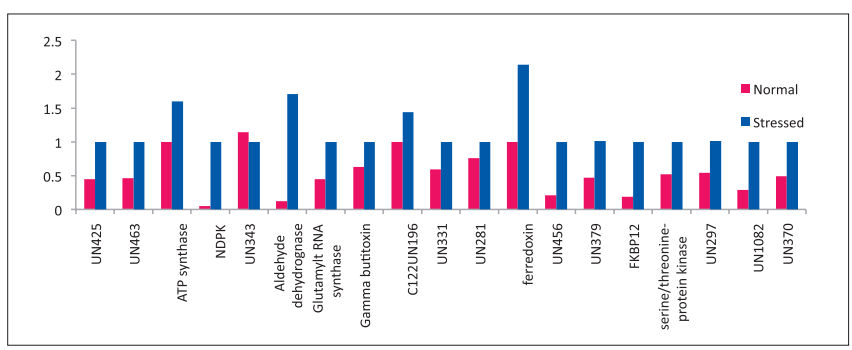
Microalga, *Dictyospherium ehrrenbergianum* isolated from Cochin estuary has wide range of salinity tolerance from 0 to 40 ppt and the saline acclimatised cells have the ability to withstand low pH (below 4). Suppressive Subtractive Hybridisation was carried out with the cells grown at pH 4 (Tester) and pH 7.5 (Driver) for the isolation and characterisation of differentially expressed genes under low pH. Total RNA was isolated during the exponential phase of growth using TRI reagent and the cDNA was synthesised with 2 µg mRNA purified from total RNA using mRNA purification Kit (Sigma). Differentially expressed genes were cloned and plasmids isolated from the positive clones were sequenced and analysed.

Temperature tolerance gene from the thermophilic microalga *Scenedesmus* sp.

Selected genes from the Suppressive Subtractive Hybridisation library of thermophilic microalga, *Scenedesmus* sp. were validated for their expression under temperature shock using Real Time PCR. A total of fifteen genes were selected and gene specific primers were designed and PCR conditions were standardised. Normalisation of the expression was carried out with 18S ribosomal reference gene. Total RNA isolated from normal cells (grown under 22 ºC) and stressed cells (42 ºC) were treated with RNase free DNase to eliminate genomic DNA contamination. Quantitative PCR data showed that all the selected genes had an upward expression under temperature shock except one gene (Metallothionin) which has shown a downward regulation. The expression profile of the unknown genes (Sc331 and Sc281) and FKBP12 gene has higher expression compared to other selected genes under heat stress.



Full-length cDNA sequence of *Tetraselmis indica* FBP Aldolase derived through RACE.

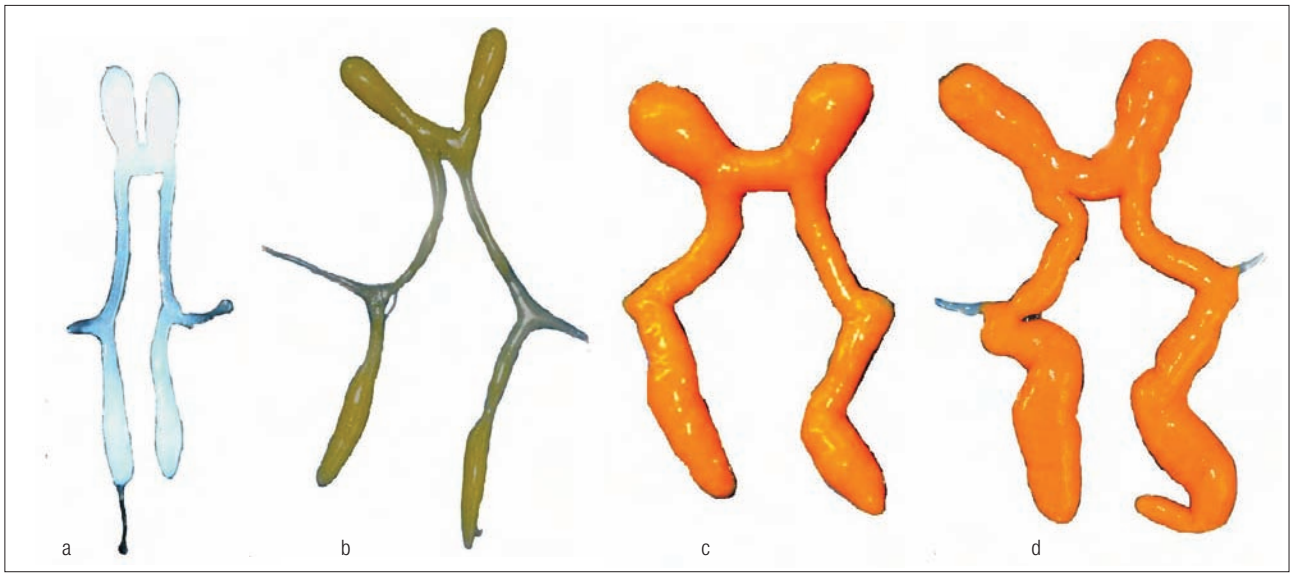


Quantitative gene expression profile of the selected gene fragments differentially expressed under heat shock.

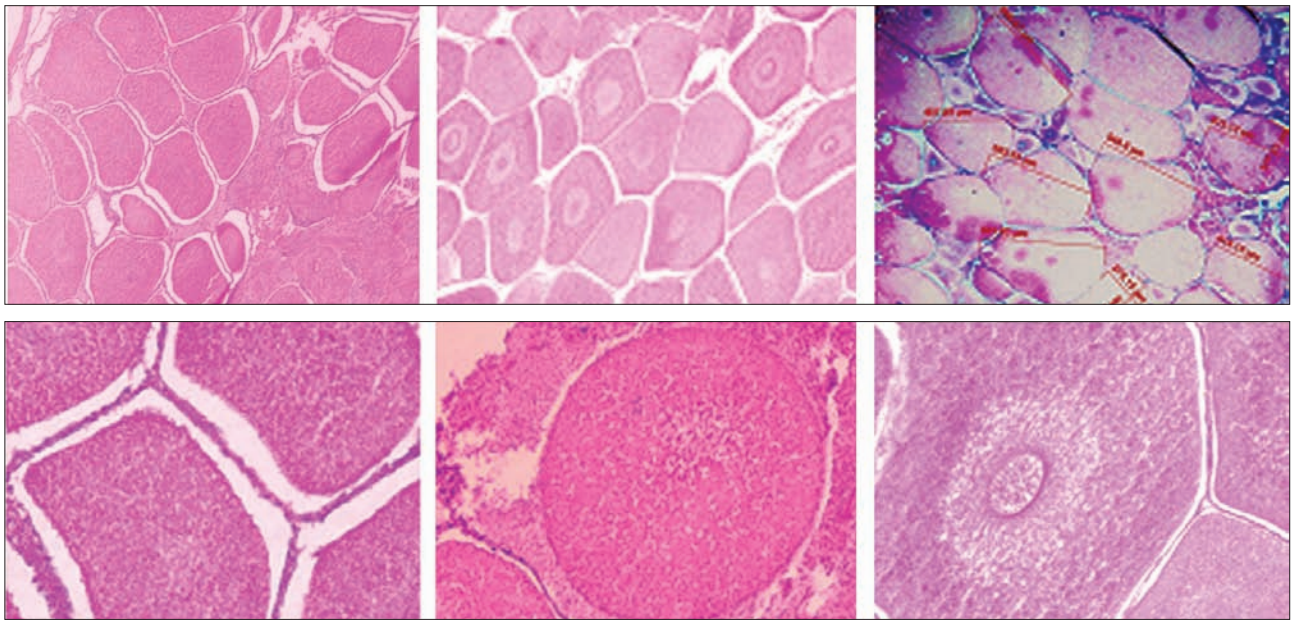
Reproductive physiology

Research Project: FISHCMFRISIL201202800028

Deciphering the changes in the ovary during the reproductive cycle of the sand lobster, *Thenus unimaculatus:* Based on morphological, histological and biochemical observations, the changes in the ovary during the reproductive cycle was studied. The ovarian stages were distinguished as immature, early maturing, maturing and fully mature based on the morphological characteristics such as colour of the ovary and Gonadosomatic Index (GSI). Histological analysis of the ovary from the



Ovarian stages of the sand lobsters sampled from the wild: a. Immature b. Early maturing c. Maturing d. Fully mature.



Histological sections of different stages of *Thenus unimaculatus* ovary in order of least developed to fully mature stage

different developmental stages sampled was carried out.

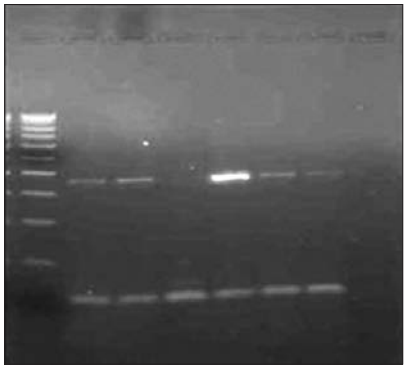
Estimation of total protein in hemolymph and tissue samples showed an increase in protein level in the ovary as gonad development progressed. In the hepatopancreas, total protein content increased in the initial stages of development, decreased a little as ovarian development progressed and remained more or less constant thereafter. Protein levels in the hemolymph however, increased steadily in the initial stages, and then showed a decrease during the later stages of maturation.

Molecular characterisation of genes involved in yolk protein synthesis of sand lobster, *Thenus unimaculatus*

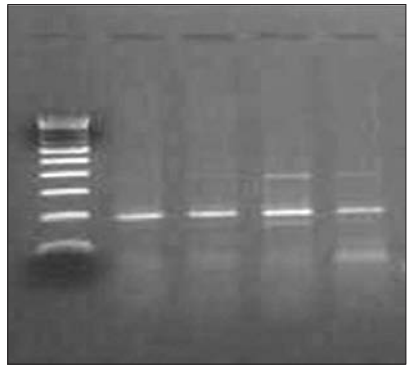
Research Project: FISHCMFRISIL201202800028

Tissue samples from sand lobsters at different reproductive developmental stages were collected. Literature reported primers based on the vitellogenin cDNA sequences of other crustaceans available in the database were custom synthesised for the amplification and molecular characterisation of vitellogenin gene involved in yolk protein synthesis.

At 45°C annealing temperature, a mild intense product was obtained in hepatopancreas and ovary, giving a good band resolution with an appropriate product size of around 200 bp. The amplified product was purified and sequenced for further molecular characterisation. The 200 bp amplified product had a readable sequence length of around 160 bp which was further trimmed down to remove sequence errors. The trimmed sequence on further analysis with NCBI BLAST tool revealed a 100% similarity with *Marsupenaeus japonicus* vitellogenin gene coding sequence/mRNA.



cDNA of vitellogenin gene from hepatopancreas and ovary of *Thenus unimaculatus*



PCR product of vitellogenin gene from hepatopancreas (Lanes 2-3) and ovary (Lanes 4-5) at annealing temperature 45 °c

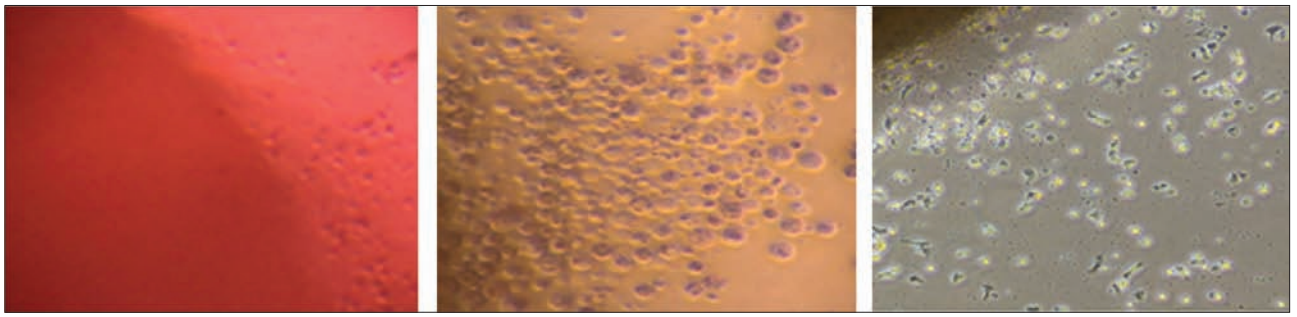
Bivalve tissue culture

Research Project: FISHCMFRISIL201202900029

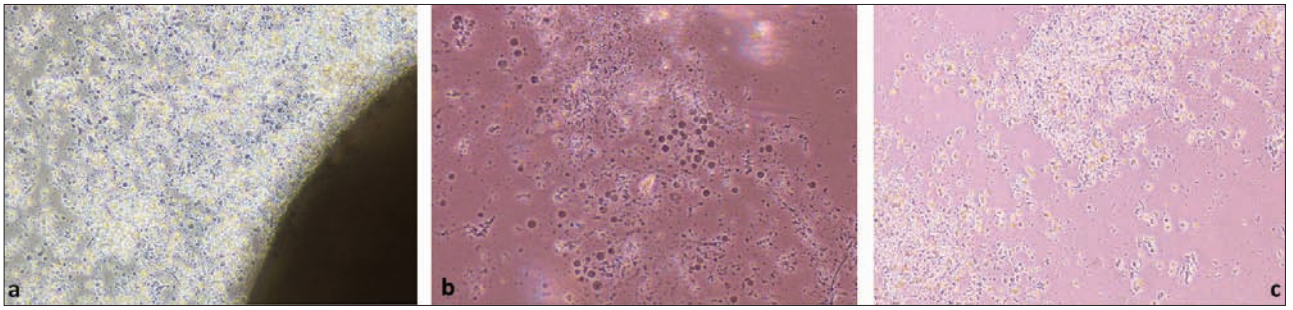
In vitro tissue culture experiments with the mantle tissue of green mussel, *Perna viridis* and black-lip pearl oyster, *Pinctada margaritifera* were carried out using different tissue culture media including Leibovitz's L-15 medium, Medium 199 (M199) and sterile seawater. Cell cultures were assessed in terms of culture initiation, cell yield and susceptibility to contamination. After 8-10 days of culture, cell counts were made and cell size was measured for each treatment. Cells were observed to migrate from the periphery of the explant within 24 h after initiation of culture and aggregate into groups. The liberated cells were mostly round and were either granulocytes or hyalinocytes. Fibroblast-like cells were also occasionally observed.

For the culture of *P. viridis* mantle tissues, L-15 medium was found to be better compared to M199 with respect to cell number and density. Addition of supplements-10% FCS and 0.1% yeast extract, improved cell proliferation with increased cell number and cell size. Among the four different concentrations of yeast extract (50, 75, 100 &150 µl/ml) tested in different experiments, 100 µl/ml concentration of yeast extract gave best results with respect to cell size and number.

Out of the 3 experiments conducted with sterile seawater as culture



In vitro culture of the mantle tissue from the green mussel *Perna viridis*

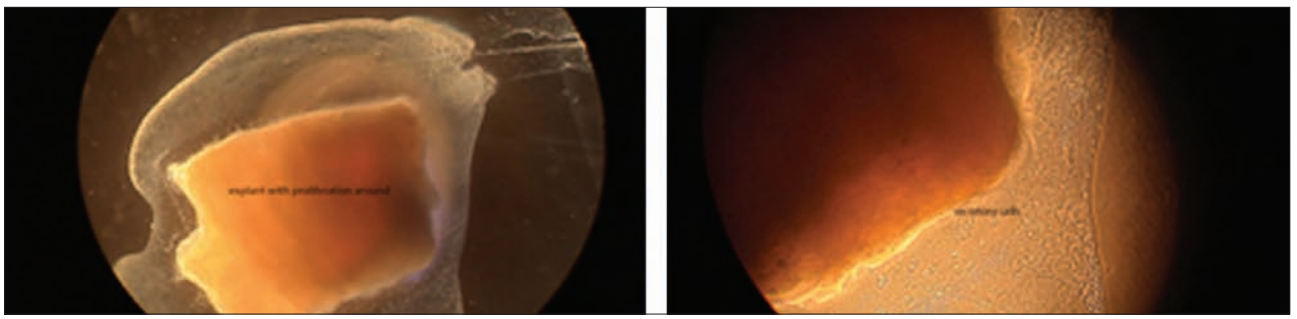


In vitro cultures of the mantle tissue from *Pinctada margaritifera*

medium, cell size and number were more when compared to L-15 and M199 media. Better proliferation was observed with the supplementation of 10% FCS and 0.1% yeast extract. Pseudopodial formation and fibroblast network formation was also noted with seawater medium. Experiments have to be continued to study the long term survival of cells.

In vitro culture of mantle tissue of *Pinctada margaritifera* was done using L-15, sterile seawater and a 1:1 combination of L-15 and sterile seawater. Preliminary observations from short-term experiments suggested that seawater medium was better suited for the culture of mantle tissue explants, followed by the 1:1 combination of L-15 and sterile seawater. Fibroblast-like cells were observed in large numbers within 24 h after initiation of cultures. Supplementation of culture media with FCS and yeast extract improved both cell number and size.

Muscle tissue culture in Abalone: Abalone foot muscle attached to the shell region were excised, cut into small explants and treated with



In vitro culture of muscle tissue of abalone

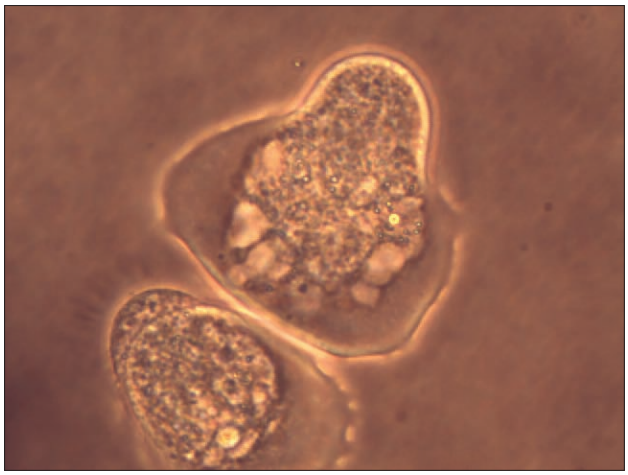
antibiotics before inoculation. The explant was inoculated in cell plate of 6 wells with one explant in each well. Out of the 6 explants, one tissue gave promising result of tissue out growth. The growth comprised of different types of cells characteristic of foot muscle and included secretary cells as well as microvillous like cells. The tissue survived for one month and further studies are in progress.

Culture of fish embryonic stem cells

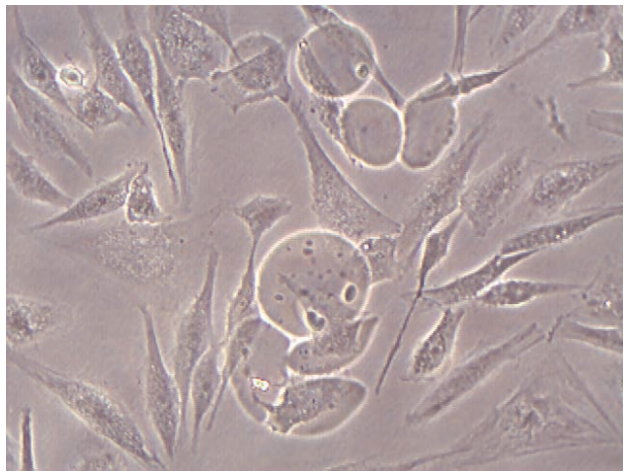
Research Project: FISHCMFRISIL201203100031

Attempts were made to initiate primary embryonic stem cell cultures from the orange clown fish *Amphiprion ocellaris* and the maroon clown fish *Premnas biaculeatus* embryos. Enzymatic treatment and mechanical separation were attempted for isolating blastomeres from the embryos and the latter method gave better results with minimum interference of yolk globules. In order to standardise the optimum stage of the embryos for initiating primary stem cell culture, blastomeres were isolated at different stages viz., 16, 32, 64, 128 and 256 cell stage embryos and it was found that in *A. ocellaris*, mid blastula stage with 256 cell stage gave better blastomere attachment and multiplication. In *P. biaculeatus*, both 128 and 256 cell stage embryos were found to be fine for blastomere attachment.

Substrates for blastomere attachment: Among the different substrates used for the efficacy of blastomere attachment, feeder layer and glass dishes were found to have better blastomere attachment and multiplication.



Blastomere attachment on glass dishes 36 h post-seeding (X400)



Blastomere attachment on feeder layer 24 h post-seeding (X200)

Fish nutrition

Nutritional evaluation of feeds designed for pompano

Research project: FISHCMFRISIL201202700027

Feed formulations for cage reared pompano (*Trachinotus blotchii*) using eight experimental feeds showed that the formulation containing 50% protein and 9% lipid registered highest growth among the feed combinations.

There were eight treatments of protein and fat percent of 30: 15, 40: 12, 50: 9, 60: 6, 30: 6, 40: 9, 50: 12, and 60: 15. Using 200 l PVC tanks, this nutritional evaluation was conducted at the Vizhinjam Research Centre. Biochemical analysis of feeds used and body composition was also done to ascertain the feed induced changes in tissue fatty acids as shown below.

Fatty acid profile of Pompano (*Trachinotus blochii*)

Fatty acids	Initial A	Initial N	Final A	Final N
Saturated (Fatty acids, % total fatty acids)				
14:0	3.24	4.40	2.06	6.64
15:0	3.46	3.32	4.28	0.97
16:0	23.26	23.42	22.16	23.10
17:0	0.82	0.99	0.89	1.11
18:0	9.10	9.84	12.40	12.93
20:0	1.12	1.19	0.99	0.52
22:0	0.52	0.35	0.34	0.36
24:0	0.37	0.62	0.99	0.06
∑SFA	41.89	44.12	44.11	45.68
Monounsaturated (Fatty acids, % total fatty acids)				
14:1	0.52	0.31	0.55	0.13
15:1	0.15	0.11	0.36	0.11
16:1	7.83	5.02	3.13	8.52
18:1n9	16.48	16.56	18.04	15.45

20:1	0.17	0.22	0.40	0.99
22:1	1.95	2.58	3.45	2.45
24:1	0.60	0.93	1.15	0.74
∑MUFA	27.70	25.74	27.07	28.40
Polyunsaturated (Fatty acids, % total fatty acids)				
18:2n6	7.54	2.84	2.91	3.85
18:3n6	1.84	6.91	0.95	0.89
18:3n3	0.78	1.26	0.40	0.67
20-2n6	1.82	1.59	1.72	0.88
20:3n6	0.52	0.53	0.95	1.80
20:4n6	0.87	2.27	2.02	0.50
20:5n3	3.07	2.57	2.58	3.90
22:6n3	7.76	6.83	10.18	6.11
∑PUFA	24.21	24.81	21.71	18.58
Others (Unidentified)	6.21	5.33	7.11	7.34

Protein requirement studies in the ornamental fish, honey gourami (*Trichogaster chuna*): revealed the required optimum range of 30% protein and 6% fat for normal growth and rearing and 40% protein and 6% fat for broodstocks. This information will be used in the development of scientifically evaluated extruded feed for ornamental rearing, as such feeds are not available in the Indian market.

Fishmeal replacement

Studies using leaf protein concentrate (LPC) prepared from locally available Tapioca (*Manihot esculenta*) in freshwater ornamental fishes (mollies and platys) through in an inter-institutional collaborative work with Central Tuber Crops Research Institute (CTCRI), Thriuvananthapuram, revealed that this product can be included up to 20% in the formulation, replacing fish meal. The potential of this product as a cost effective replacement for fish meal is promising.

Production and sale of ornamental fish feed *Varna*

The *Varna* series of ornamental feeds developed for marine ornamentals by is produced on a regular basis using the laboratory extruder and sold through ATIC which remains to be a sought after product by the ornamental fish farmers all over Kerala. Efforts are on to commercialise the feed.

Development of functional feed additives

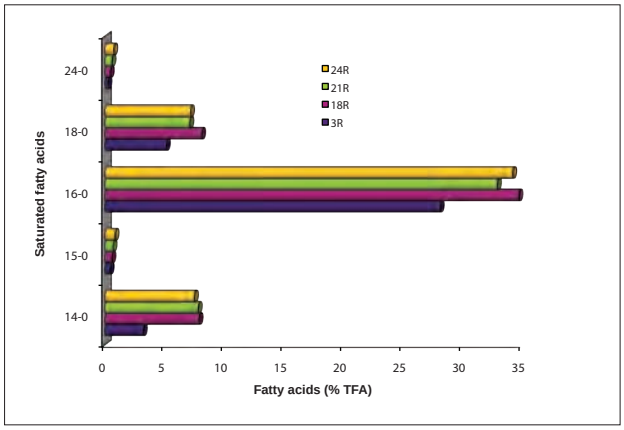
A method has been standardised for the isolation of acidic aqueous soluble portion of brown seaweed by alcohol fractionation to the tune of 1.8% yield. Similarly, method has also been standardised for the preparation of cream coloured calcium salt of algin with bleaching in a single step process.

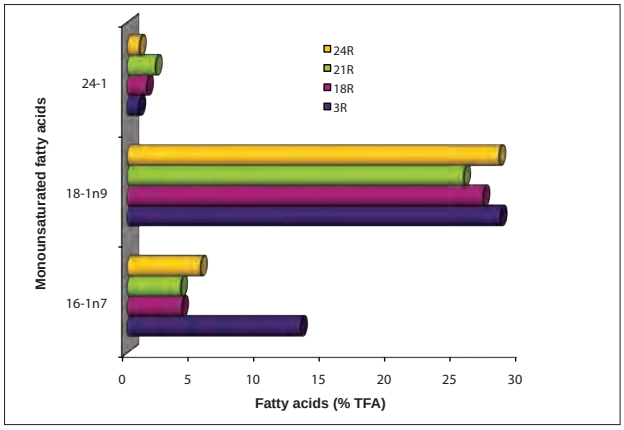
Fatty acid composition of rotifers enriched with PUFA

Research project: EF-30/ICAR OUTREACH

An experiment was conducted in which rotifer (*Brachionus plicatilis*) were fed with fish oil polyunsaturated fatty acids (PUFA) concentrate to determine whether enrichment with these diets would increase fatty acid composition of rotifers.

After 3 h enrichment of the rotifers by PUFA rich emulsion, the DHA content increased to 0.4%, and after 9 h it reached a maximum to 0.82%. However EPA content increased to 2.08% after 12 h of enrichment and after 15 h, a reduced content was recorded (1.56%). Other n3 fatty acids like 18:3n3 recorded higher values after 15 h of enrichment (2.25%). Rotifers were enriched with PUFA rich emulsion for 6 h exhibited total saturated fatty acids (SFA) content as 40% and after 15 h as 51% total fatty acids. Enrichment of the rotifers for 12 h led to highest values of eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), and after that there was no further increase in fatty acid concentrations.



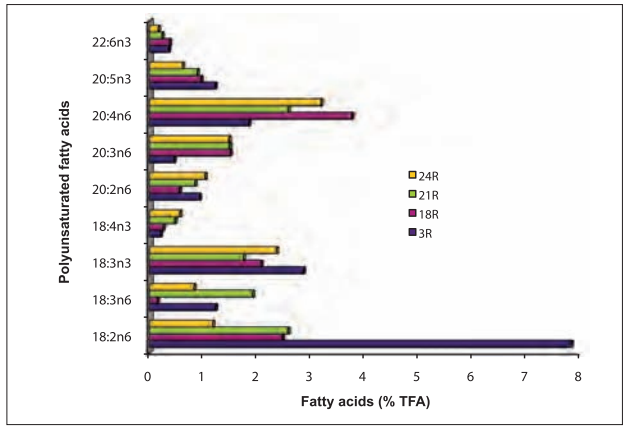


Fatty acid composition of the enriched rotifers

Inter-annual and seasonal dynamics in amino acid, vitamin and mineral composition of oil sardine

Research project: EF-29/ICAR OUTREACH

Indian oil sardine, *S. longiceps* was studied for the spatial (south-west and south-east coast of India), annual (2008, 2009, 2010 and 2011) and seasonal (pre-monsoon, monsoon and post-monsoon) variations for protein, amino acids, minerals and vitamins. The chlorophyll-*a* concentration and sea



surface temperature of its habitats were taken into account to understand their effect on the nutrient signatures of oil sardine throughout the study period and locations. Mean protein content attained its maximum during pre-monsoon along both SW and SE coasts, with high proportions of essential amino acids. Essential to non-essential amino acid ratio, total aromatic (TArAA) and total sulfated amino acids (TSAA) recorded monsoon maxima along the study locations. Amino acid scores were also observed during monsoon and post-monsoon maxima along the SW and SE coasts, respectively. Minerals were significantly higher during monsoon along the SE coast. Significant seasonal variations in vitamin content were observed along the study locations with high vitamin A, D3 and C on SW coast and higher vitamin E and K in SE coast.

Fatty acid composition of candidate microalgal species for use in mariculture

The abundance of the polyunsaturated fatty acid content of *Chaetoceros* sp. was 18:2n6 (7.3%)> 20:4n6 (5.95%) > 22:6n3 (4.14%) > 20:5n3 (3.53%), in decreasing order.

Chaetoceros sp. exhibited an EPA:DHA concentration of 1:1 of approximately 4% total fatty acids. The predominant fatty acids were found to be linoleic acid (7-8%) total fatty acids (TFA) and oleic acid (6-11% TFA).

The microalga *Nannochloropsis* sp. exhibited a higher EPA content (12-15% TFA) than DHA concentration (<2% total fatty acids).

Among n3 fatty acids, DHA (1.75%) and 20:5n3 (3.03%) were found to be the most abundant in *Tetraselmis* sp.

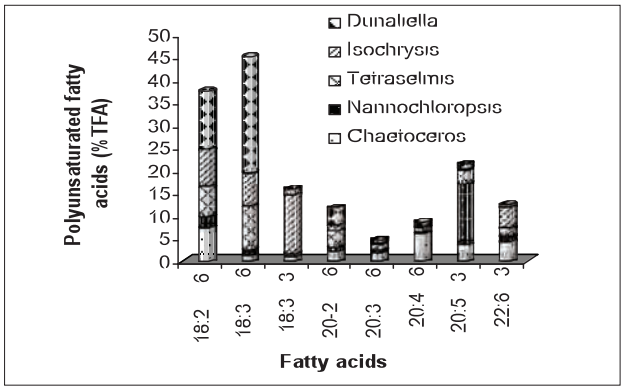
Dunaliella sp. exhibited the highest content of polyunsaturated fatty acids than other microalgal species.

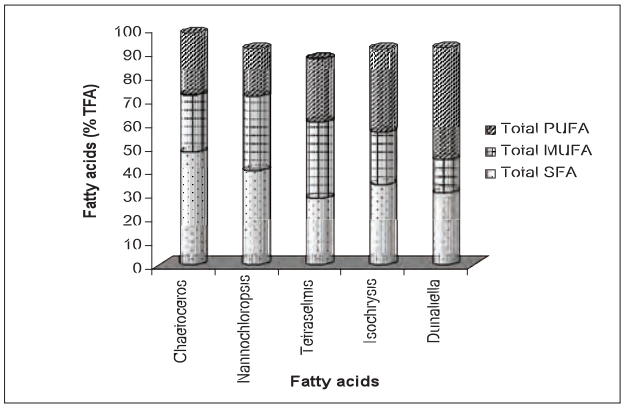
Total SFA content of *Chaetoceros* sp. and *Nannochloropsis* sp. were found to be comparatively higher (>40% TFA) than in *Tetraselmis* sp. (28.3%), *Dunaliella* (30.6%) and *I. galbana* (34.2).

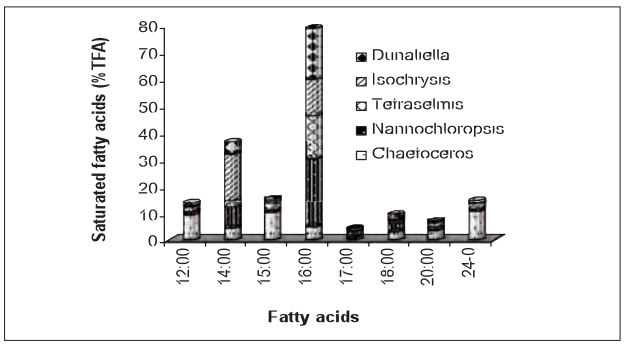
Among SFAs, 15:0 was found to be the most dominant contributing 10.27% of TFAs. The predominant fatty acids were found to be linoleic acid (2% TFA), stearedonic acid (12-18%), and oleic acid (5-9%),

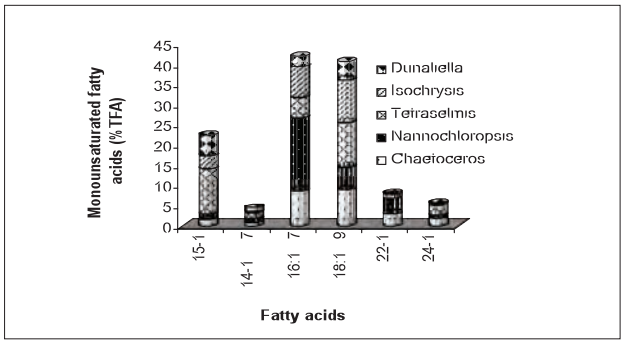
A total of 35% PUFA was recorded in the logarithmic phase *I. galbana*. Monounsaturated fatty acids (MUFA) were recorded to be 22% and SFAs were 44% of TFA with 16:0 and 14:0 being the major components (17 and 13%, respectively).

The microalga *I. galbana* S002 exhibited a higher DHA content (maximum of 7% TFA) than EPA concentration (<2% total fatty acids). The predominant fatty acids were found to be linoleic acid (3-8% TFA), γ-linolenic acid (3-7%), stearedonic acid (3-6%), and oleic acid (maximum of 22%).









Fatty acid profile changes in microalgae with varying nutrient inputs

Fatty acid analyses of five species of short listed microalgal samples reared varying the nutrient composition in the culture medium (particularly nitrate) and salinities (three ranges) have been carried out to understand the effect of these two parameters on fatty acid composition of these microalgal species.

Chaetoceros sp. S172 exhibited a balanced EPA and DHA concentration (1:1, ~4% total fatty acids) and at higher NO_3- and salinity showed higher DHA concentration.

Nannochloropsis sp. S078 exhibited a higher EPA content (12-15% TFA) than DHA concentration (<2% total fatty acids) and at higher NO_3- and salinity have positive effects on total PUFA concentration (~22% TFA) than other treatments.

The microalga *I. galbana* S002 exhibited a higher DHA content (maximum of 7% TFA) than EPA concentration (<2% total fatty acids) and higher NO_3- and salinity indicates positive correlation on the fatty acid composition. *Dunaliella salina* S135 showed higher EPA (3-8% TFA) and DHA (3-4% TFA) at higher salinity and nitrate concentration.

Fatty acid concentrates from marine fish oil

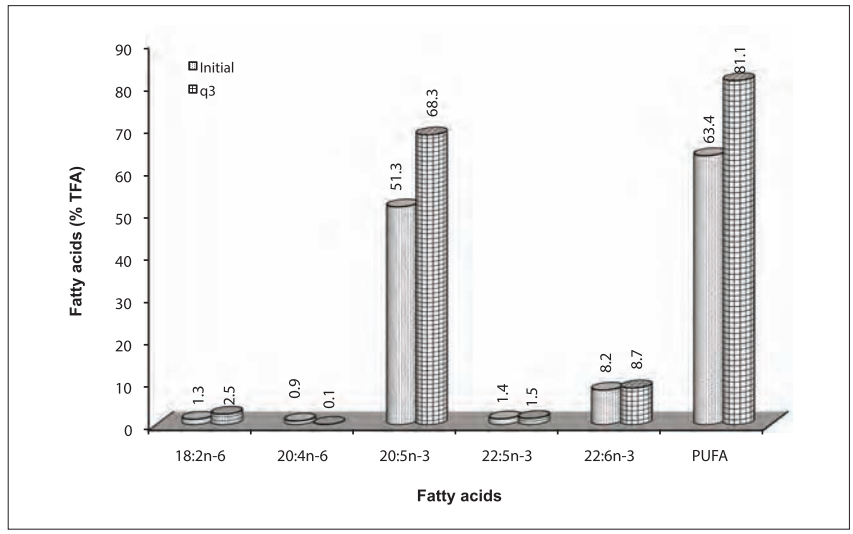
PUFA concentrates were prepared from the locally available sardine oil. Different physicochemical procedures have been followed to enrich the content of polyunsaturated fatty acids from the crude starting material. The chromatographic analysis showed high percentage of total polyunsaturated fatty acid (PUFA) for H_2SO_4 /MeOH system (TG: MeOH, 1:90, w/v; H_2SO_4 2%), which was 23.56%. A significant increment of one of the major PUFAs, 20:5n-3 (13.48% to 14.23%) was observed for H_2SO_4/MeOH system and 22:6n-3 was increased to 3.9% from a baseline value of 3.69%. The fatty acids thus obtained were further concentrated by repeated chromatographic procedures.

Selective chromatography-based purification of polyunsaturated fatty acids led to an increment of LC-

PUFAs such as EPA and DHA. EPA has been concentrated to a purity of 68% TFA. However, the concentration of DHA could not be increased (a maximum of 8.7%) due to an increased number of olefinic double bonds in the system resulting in lower stability of the fatty acids. The total polyunsaturated fatty acids increased to more than 80% of the total fatty acids after repeated chromatography.

Spectroscopy based stability studies of PUFA enriched sardine oil

Solvent extraction followed by argentated chromatography based purification techniques resulted in the PUFA concentrate with more than 80% PUFA. Better yield of PUFA has been realised by using



Enrichment of polyunsaturated fatty acids after repeated chromatography using incremental polar solvents

optimum sets of solvent extraction techniques and solvent systems in argentated chromatography. Stability of the resulting PUFA concentrate has been evaluated by detailed spectroscopic techniques to understand the molecular signature features of PUFA. This will lead to a precise understanding of the molecular features and hydrogen signature peaks of the PUFA. This technique can be used to quantify the native form of PUFA because they are highly prone to degradation on shelf.

Lobster nutrition

Diets having protein contents of 43%, 38% and 39% were formulated using fish meal, oyster meal and cephalopod meal respectively as the main ingredient (46%), supplemented with wheat flour, soy flour, shrimp head meal and soy lecithin. These diets were tested as grow-out feeds for juvenile sand lobsters, *Thenus unimaculatus*.

A new medusoid jellyfish has been identified in local water bodies which when chopped and fed to the *Thenus* larvae induced immediate reception and feeding. From gut to abdomen ratio and width of gut analysis, the

feeding indicated positive response. However, the nutritive value and conversion efficiency is being tested, biochemical analysis and storage and live holding trials are progressing.

Chromide nutrition

(Reserch project: EF-30/ICAR OUTREACH)

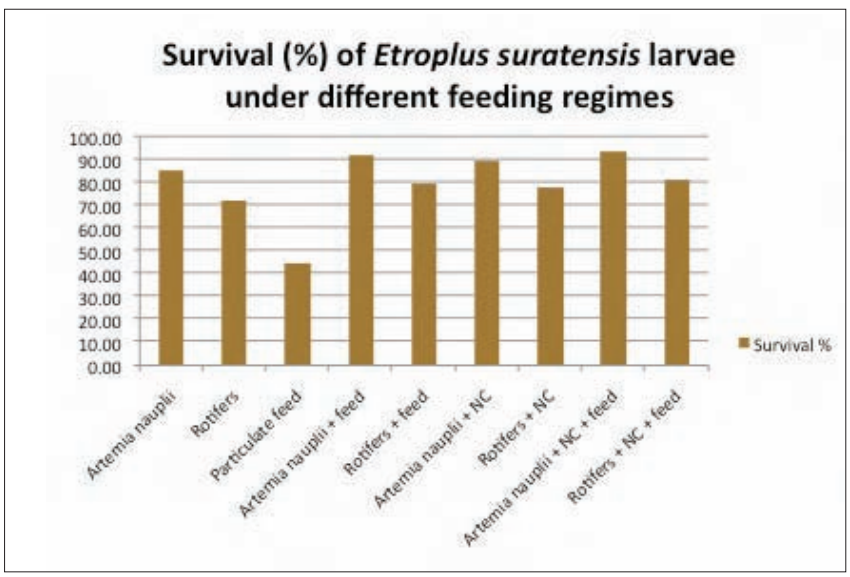
Chromides are very attractive euryhaline fish in which two species are of importance currently. Green chromide or 'pearl spot' is recognised as the state fish by the Government of Kerala which is a delicacy as a food fish fetching very good price. Culture of this fish is found to gain momentum recently for which seed and feed are the main constraints in its production. Orange chromide is a smaller species highly amenable to indoor conditions of culture which can also be used as a model fish for experimentation.

In a larval rearing experiment, 9 dietary combinations were evaluated. It was found that co-feeding with live feeds phytoplankton, zooplankton and a formulated feed resulted in maximum survival of larvae in tanks indoors.

Eight feeds of varying protein: lipid ratios were formulated and produced for evaluation in green chromides (*Etroplus suratnesis*) and orange chromides (*Etroplus maculatus*). The formulations were designated as ES3015, ES4012, ES509, ES306, ES409, ES5012 and ES 6015 based on their macronutrient levels.

Eight feeds containing protein: lipid in the ratios 30:15, 40:12, 50:9, 60:6,30:6, 40:9, 50:12 and 60:15 were formulated using natural ingredients and produced through twin-screw extrusion and evaluated for their propensity to serve as brood stock diets in *E. maculatus*. The feed having the combination 50: 12 resulted in the significantly high ($P<0.05$) number of eggs produced.

The same feeds were also evaluated for growth in *E. suratensis* (2.00 g initial weight) for 90 days in a freshwater recirculation system. No statistically significant differences were noticed in the final weight gain ($P>0.05$) during the aforementioned experimental duration. Percent weight gain was significantly higher ($P<0.05$) with the feeds having the protein: lipid combinations 50:9 and 50:12. Significantly high ($P<0.05$) food conversion efficiency (approx. 40%) was also recorded with the feed containing 50:12 protein: lipid ratio. Even though, slow growing in clear water indoor recirculation systems, there is a requirement of high level of protein and lipid in this fish to realise maximum growth.



Proximate analysis of feeds (on DM basis %)

Feed Nos.	ES3015	ES4012	ES509	ES606	ES306	ES409	ES5012	ES6015
Crude protein	30.22	41.32	50.71	60.36	32.94	41.45	50.74	60.72
Crude fat	15.58	12.31	9.48	6.34	6.46	9.05	12.06	15.70
Soluble Carbohydrates	43.00	32.65	20.63	9.32	49.04	34.43	19.70	0.35
Crude fibre	0.63	0.70	2.25	1.19	0.73	1.82	1.45	1.01
Ash	9.67	11.69	14.93	19.63	9.87	11.96	14.32	18.86
Acid insoluble ash	0.90	1.33	1.99	3.16	0.97	1.29	1.74	3.36

Growth of *Etroplus suratensis*

Feed Nos. (Protein: Fat)	ES3015	ES4012	ES509	ES606	ES306	ES409	ES5012	ES6015	Statistics
Initial weight	2.08	1.86	1.83	2.25	2.37	2.27	2.12	2.28	NS
Final weight	2.35	2.21	2.25	2.57	2.67	2.66	2.59	2.62	NS
Weight gain	0.26	0.36	0.43	0.32	0.31	0.38	0.47	0.34	S
Percent gain	2.60	3.88	4.68	2.86	2.62	3.39	4.43	3.02	S
SGR	0.14	0.20	0.23	0.15	0.14	0.17	0.22	0.16	S
PER	0.77	0.53	0.59	0.41	0.65	0.64	0.78	0.41	S
FCR	4.31	4.74	3.35	4.09	4.95	3.74	2.57	3.97	S
FCE	28.79	27.77	33.10	29.64	27.44	31.12	38.99	30.12	S

NS – not significant, S – significant ($P<0.05$)

Pearlspot feed

A cost effective feed formulation for pearlspot, *Etroplus suratensis* was evaluated on farm, with encouraging results. This feed is bulk produced through outsourcing and sold as a product by Krishi Vigyan Kendra (KVK) of CMFRI. Further refinement of the formulation for higher FCR is contemplated.

Fish health and **bioprospecting**

Disease investigations in finfishes

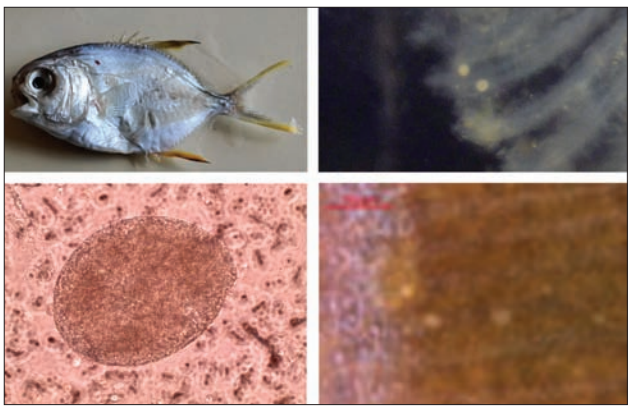
Research Project: FISHCMFRISIL201202600026

Parasitic infections

Commercially important species of fishes were screened for major parasites/parasitic infections. Screening of red snappers (*Lutjanus argentimaculatus*) and groupers (*Epinephelus malabaricus*) collected from Cochin backwaters revealed heavy infections with the acanthocephalan parasite, *Tenuiproboscis* sp. in their intestines.

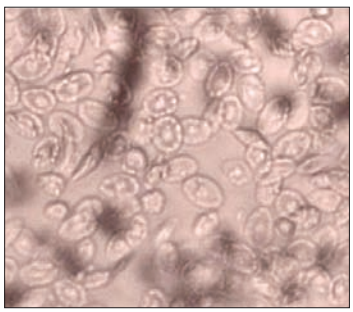
Disease outbreak caused by *Amyloodinium ocellatum* was reported from the gill tissues of pompano (*Trachinotus blochii*) causing irritation, excess mucus secretion and respiratory distress leading to mortalities. Developmental stages including trophont & tomont were recovered. Treatment with 250 mg chloroquine diphosphate (Nivaquine-P) tablets with a dosage of 5 mg/l for 10 days was able to control the disease.

Oodinium sp. infestations were reported from the gills of blue damsel and moorish idol. The infestation initially appeared in the gills and then

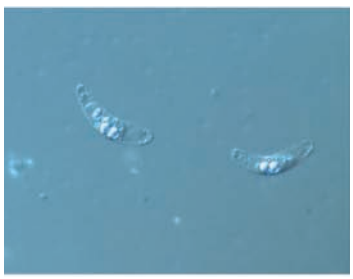


Amyloodinium ocellatum infection in pompano

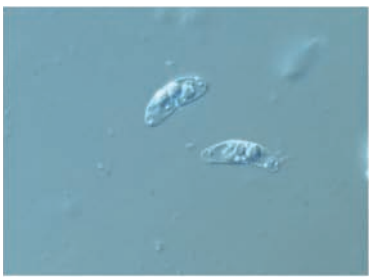
Oodinium sp. infection in blue damsel and moorish idol



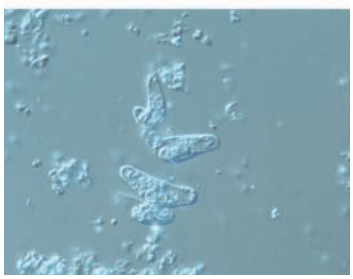
Chilodonella sp. infection in pompano



Ceratomyxa sp. from *Abudefduf saxatilis*



Ceratomyxa sp. from *Chaetodon decussatus*



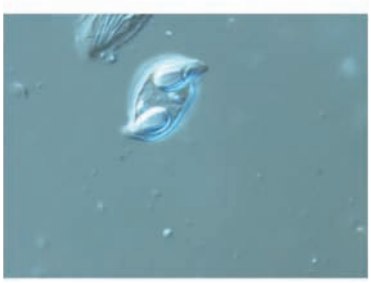
Ceratomyxa sp. from *Acanthurus mata*

Ceratomyxa sp. from *Chaetodon collare*

Ceratomyxa sp. from *Abudefduf sordidus*

Zschokkella sp. from *Arothron hispidus*

Myxidium sp. from *Neopomacentrus nemurus*



Myxidium sp. from *Abudefduf sordidus*

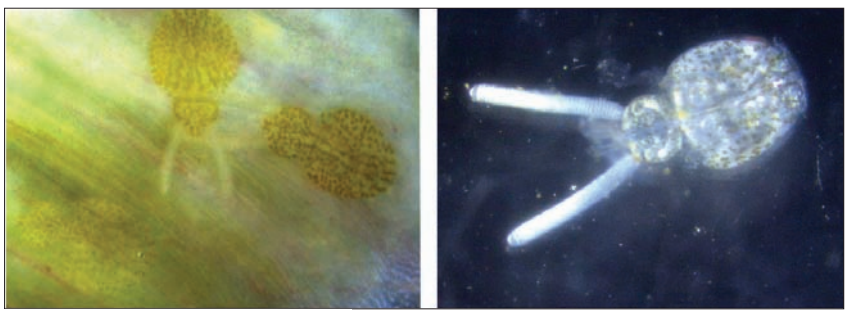
rapidly progressed to the skin and body. Clinically the disease was characterised by signs of body surface irritation, loss of appetite, erratic swimming, rapid gill movement, excess mucous secretion and respiratory distress. Treatment with 250 mg Chloroquine diphosphate (Nivaquine-P) tablets with a dosage of 5 mg/l for 10 days proved to be effective in controlling the infestation.

Infection with *Chilodonella* sp. was reported from the gill tissues of pompano fingerlings. The symptoms were characterised by signs of severe respiratory distress, exophthalmia, excess mucus secretion and erratic swimming finally leading to death. A combination of Acriflavin – methylene blue was found effective in the treatment of this infection.

Screening of marine ornamental fishes, *Chaetodon collare* (redtail butterfly), *Chaetodon decussatus* (Indian vagabond butterfly), *Neopomacentrus nemurus* (damsel fish), *Abudefduf saxatilis* (sergeant major), *Abudefduf sordidus* (black spotted sergeant), *Acanthurus mata* (bluelined surgeon fish), *Arothron hispidus* (white spotted puffer), *Arothron immaculatus* (immaculate blow fish), *Chlorurus sordidus* (parrot fish) and *Thalassoma lunare* (moon wrasse) from Vizhinjam, Kerala revealed the presence of myxosporeans belonging to two families - Ceratomyxidae (*Ceratomyxa* sp.) and Myxidiidae, (*Myxidium* sp., *Zschokkella* sp.). Twelve out of 29 fishes examined were found to be infected with myxosporeans (prevalence of 41.37%) of which 8 were infected with *Ceratomyxa* spp. (prevalence 27.59%), 4 with *Myxidium* sp. (prevalence 13.79%) and 2 with *Zschokkella* sp. (prevalence 6.9 %). Both the red tail and Indian vagabond butterfly fishes were infected with *Ceratomyxa* sp. only, while damsel, sergeant major and black spot sergeant showed multiple infections with *Ceratomyxa* sp. and *Myxidium* sp. *Zschokkella* sp. was observed only in white spotted puffer fish which may indicate high host specificity.

Sea lice infections were recorded from marine ornamentals. *Caligus* spp. infections were recorded from various species of fishes. Heavy infestation with *Lepeophtheirus* sp. was observed in the puffer fish *A. hispidus*. *Caligus* spp. infections were also reported from the skin and gills of bat fish and Koran angel.

Heavy infestation with *Lepeophtheirus* sp. was observed in the puffer fish *A. hispidus*. Life-cycle stages of *Lepeophtheirus* sp. were elucidated experimentally. The life-cycle of *Lepeophtheirus* sp. is as follows: adult parasite on the fish host, the eggs hatch into free swimming nuaplii which included two naupliiar stages and an infective copepodid stage. The copepodid seeks and settles on the host and undergoes moulting through a series of four different chalimus stages (chalimus 1-4). Sexual dimorphism is apparent by 4th stage and the chalimus passes through a young adult stage before they mature to adult stage.



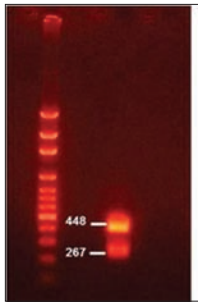
Caligus sp. infection on gills and skin

Life cycle stages of *Lepeophtheirus* sp

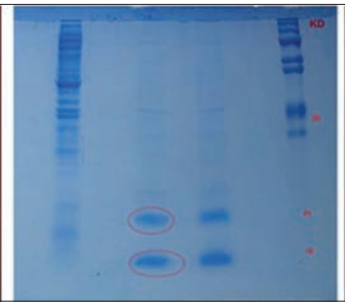
Bacterial infections

Infection of cobia (*R. canadum*) with *Photobacterium damselae* sub spp. *damselae* was confirmed by multiplex PCR. SDS-PAGE profile of extracellular products (ECP) of *P. damselae* isolated from cobia revealed the presence of two distinct protein bands of 21000 da and 16000 da. The ECP was pathogenic to juvenile cobia and the LD_{50} was 1.86 µg protein/g of fish. Experimental infection of cobia juveniles with whole bacterial cells revealed that the LD_{50} was 1.08 X 10^4 CFU/g fish. The enzymatic activity of the ECP revealed that the ECP exhibited caseinase activity and negative gelatinase activity.

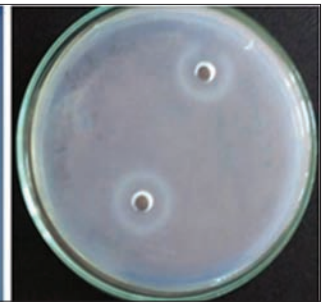
Multiple infection caused by *Vibrio harveyi*, *V. alginolyticus* and *P. damselae* characterised histopathologically by extreme haemorrhage, necrosis and inflammation of kidneys was reported from cage reared cobia (*Rachycentron canadum*).



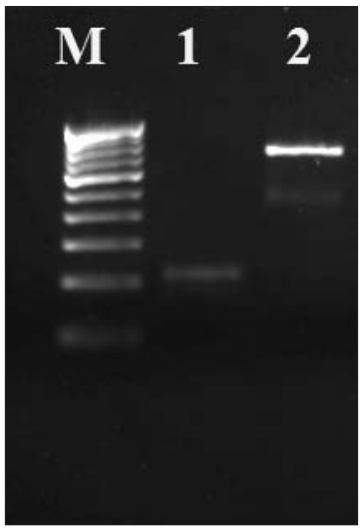
Multiplex PCR for the identification of *P. damselae*



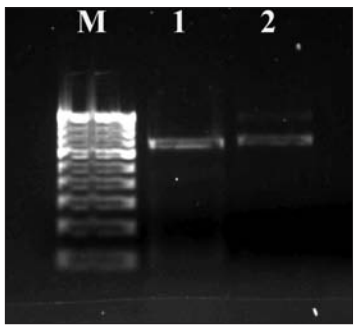
SDS – PAGE profile of ECP of *P. damselae*



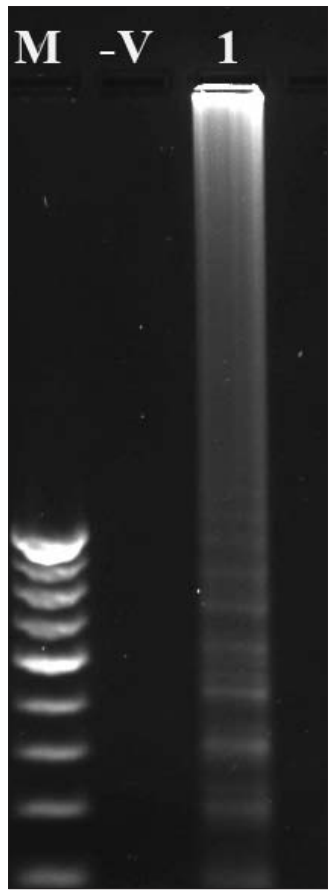
Caseinase activity of *P. damselae*



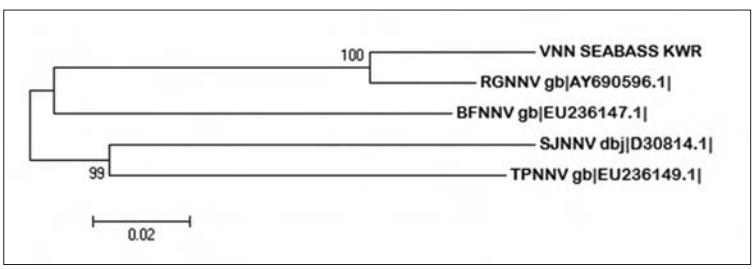
RT-PCR from infected fish. M - Marker



RT-PCR from VNN recovered fish. M - Marker, 1 & 2 – Sample



RT-LAMP from VNN infected fish. M - Marker, -V - Negative Control, 1 - Sample



Evolutionary relationship of VNN (Karwar Isolate)

Viral infections

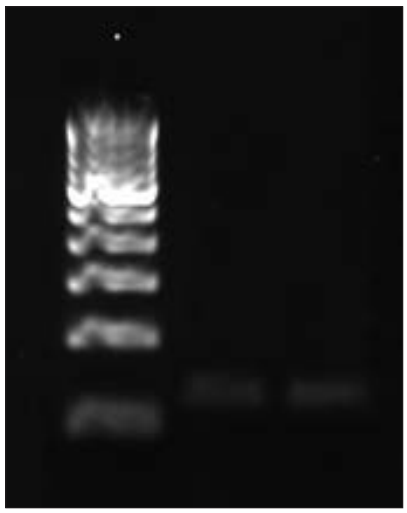
Screening of cage reared finfishes, snapper (*Lutjanus argentimaculatus*), pearlspot (*Etroplus suratensis*), mullet (*Mugil cephalus*), Asian seabass (*Lates calcarifer*) and tilapia (*Oreochromis mosambicus*), revealed the presence of viral nervous necrosis (VNN), an OIE listed viral disease. The fish were screened using RT-PCR, RT-nested PCR and RT- LAMP and all the three amplification techniques employed, presented positive results. The results were confirmed through cloning and sequencing of the amplified products.

Mass mortality associated with abnormal swimming pattern was observed in 7 day old tilapia fry in the CMFRI experimental aquaculture facility. Both live and dead tilapia fry were screened using RT-LAMP and RT/nested PCR. The results confirmed the presence of VNN by both the techniques employed.

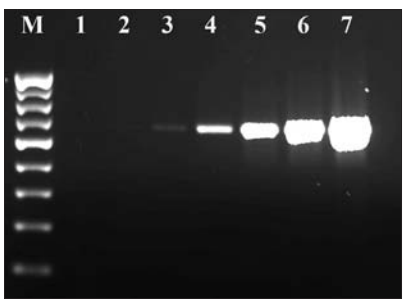
Molecular cloning of coat protein gene from nervous necrosis virus: Coat protein gene from red spotted grouper nervous necrosis virus was isolated from infected cage farmed seabass. The gene was then cloned into pJET1.2 cloning vector and sequenced. The phylogenic relationship of the VNN (Karwar isolate) was determined using Neighbour-joining method, with the help of Mega software version 5.1

Development of molecular diagnostic tools

Development of reverse transcriptase - Loop-mediated isothermal amplification for detection of betanoda virus: A Reverse transcriptase- Loop mediated isothermal amplification (RT- LAMP) was developed for detecting Betanoda virus infection. The RT-LAMP developed is capable of detecting a single copy of the viral RNA. Primers were designed for detection based on conserved regions of RNA2 coat protein of the four



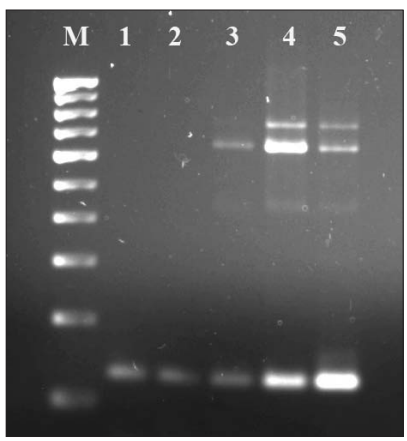
RT-Nested PCR for VNN detection in tilapia fry



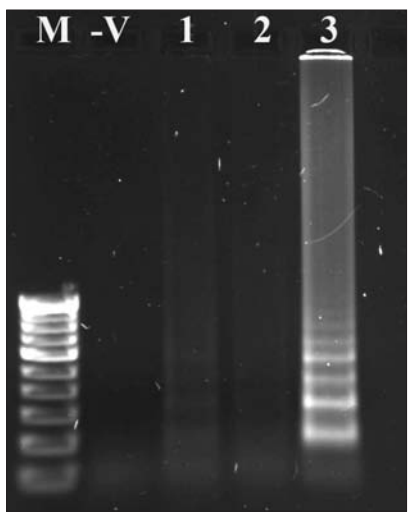
RT-PCR detection of VNN
M - Marker, 1 - 1 copies, 2 - 10 copies, 3 - 102 copies, 4 - 103 copies, 5 - 104 copies, 6 - 105 copies, 7 - 106 copies

different forms of betanoda virus namely Striped jack nervous necrosis virus (SJNNV), Barfin flounder nervous necrosis virus (BFNNV), Tiger puffer nervous necrosis virus (TPNNV) and red-spotted grouper nervous necrosis virus (RGNNV).

Development of RT-PCR/Nested PCR for detection of betanoda virus: RT-PCR and Nested PCR were developed for detecting Betanoda virus infection. The primer pairs were designed based on the conserved regions of RNA2 coat protein and are capable of detecting all the four forms of VNN (verified by in-silico analysis), namely Striped jack nervous necrosis virus (SJNNV), Barfin flounder nervous necrosis virus (BFNNV), Tiger puffer nervous necrosis virus (TPNNV) and Red-spotted grouper nervous necrosis virus (RGNNV). The RT-PCR step is capable of detecting upto 10 copies of the virus and the nested RT-PCR is capable of detecting a single copy of the viral DNA.



Nested RT-PCR detection of VNN
M - Marker, 1 - 1 copies, 2 - 10 copies, 3 - 102 copies, 4 - 103 copies, 5 - 104 copies



RT-LAMP M - Marker, -V - Negative Control, 1 - 10 copies, 2 - 5 copies, 3 - sample from infected fish

Shell disease in Lobsters

Health status of lobsters maintained in captive conditions was monitored in different lobster holding facilities located around Kanyakumari. Infections in telson and appendages, associated with inflammation and appearance of black spots in the abdomen were recorded as common problems in the live lobsters (*Panulirus homarus* & *P. versicolor*) maintained in captive conditions. Bacterial examination of the infected lobsters revealed the association of 6 different isolates of which one exhibited high protease enzyme production. Results of antibiotic sensitivity revealed that chloramphenicol, tetracycline, erythromycin and ciprofloxacin in the decreasing order as effective

Shell diseases in Lobster

inhibitory agents. During the sampling period, the microbial load in water varied from $4X10^6$ to $5.3X10^8$ CFU/ml.

Coliform bacterial monitoring in Vizhinjam Bay: The occurrence of coliform bacteria in Vizhinjam Bay was monitored periodically. The observations revealed that the coliform load of bacteria ranged from 1.2×10^3 (during June 2013) to 2×10^6 CFU/ml (in August 2013).

Aquatic animal disease surveillance

Research Project: EF-22/NFDB

A new national project entitled 'National surveillance programme for aquatic animal diseases' (NSPAAD) funded by NFDB has been initiated. Under the project, 5 districts were identified within the state of Kerala for regular screening of bivalves for OIE listed diseases. Farmer's meetings were organised at Ernakulam, Malappuram and Kasaragode districts. Ten farms from each district were identified and base line data/information from the farmers along with the GPS locations of the farms was collected.

An investigation on the mortality in the mussel (*Perna viridis*) farms at Edayilakkadu, Kasaragode was carried out. The role of OIE listed pathogens (*Perkinsus* sp., *Bonamia* sp. and *Marteilia* sp.) were investigated, but OIE suggested diagnostics did not reveal the presence of these pathogens. However, studies using nested PCR developed by CMFRI, followed by sequencing and bioinformatics analysis revealed the presence of *Perkinsus olseni*, an OIE listed pathogen in the *P. viridis* samples examined.

Collection of wild bivalve samples along the east and west coasts of India (Gujarat, Kerala, and Odisha) was initiated.

Development of microbial product (MP)

Research Project: EF-14/ICAR-AMAAS

A freeze dried microbial product (MP) from *Pseudomonas aeruginosa*, with antagonistic properties and high protein content has been developed. This product could be used in the development of larval feeds and high health feeds, as a feed additive. The antibacterial compound isolated from *Pseudomonas* sp. was characterised as octahydromethyl-dimethylphenazinecarboxylate. After mass production, heat inactivation was carried out and spray drying of heat inactivated broth was performed to make it into a fine powder which can serve as microbial products (MPs')

Nutrient profiling: Nutritional content of the spray dried powder of *Pseudomonas aeruginosa* MBTDCMFRI Ps04 was evaluated to be used as feed additive.

Nutritional content of the spray dried powder of Ps04

Sample	% Dry matter	% Moisture	% Crude protein	% Crude fat	% Crude ash	% Crude fiber	% Acid insoluble ash	% Nitrogen free extract
Spray dried powder Ps04	100	NIL	14.63	0.403	73.68	0.48	0	11.29

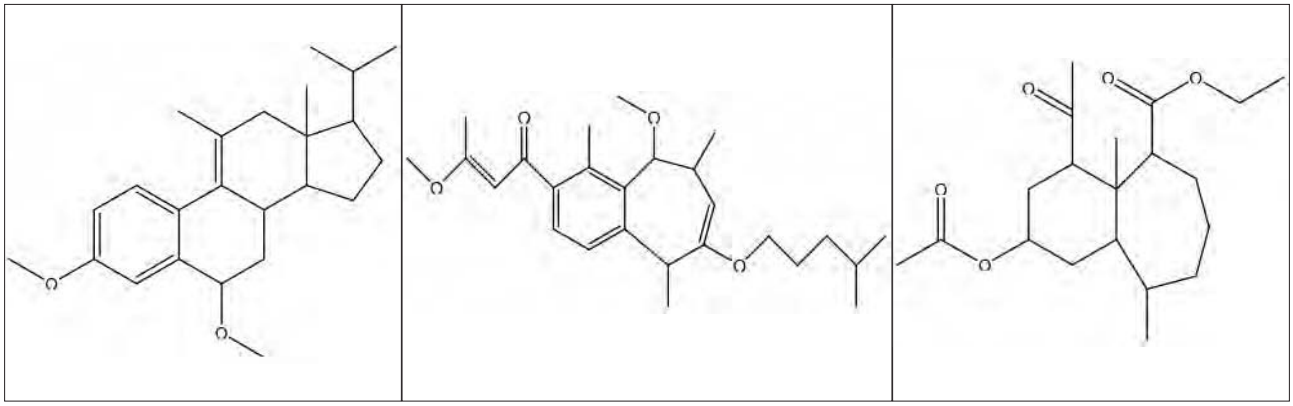
Mass production of Ps04 using biofermenter: the cells were heat killed and spray dried. The spray dried form was estimated for activity and packed

Isolation and characterisation of potential antibacterial leads from *Bacillus* and *Pseudomonas* spp.

Identification of bioactive compounds: Structural characterisation of *Bacillus* sp. Ba37 by pluralities of spectroscopy revealed the bioactive principles responsible for antagonistic activity.

The bioactive leads isolated from *Bacillus* sp. Ba37 are (a) Octahydroisopropyl dimethyldimethoxy-cyclopentphenanthrene, (b) Methylpentyloxymethoxy-trimethylbenzoannulenyl-methoxybutenone and (c) Acetoxyeth-acetyl-dimethylbenzoannulenecarboxylate.

Octahydroisopropyl-dimethyldimethoxy-cyclopentphenanthrene has been purified from *Bacillus* sp., Ba37 and the structure has been elucidated by



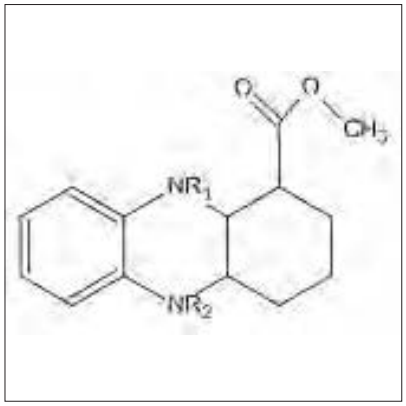
Bio active compounds from *Bacillus* sp. Ba 37

detailed spectroscopic techniques. The characteristic methylene signals at δ1.9 and 1.6 appeared downfield due to the presence of -O-C and -C=C groups at its close proximity around the -CH_2 group. The CH groups around δ1.5-1.8 are due to the presence of the cyclohexene/cyclopentane ring systems of the dimethylcyclopentphenanthrene system. The CH_3 signals at δ1.16, δ3.7 (as multiplets) are due to the deshielding effects of -O-C groups situated at the Cα position to the target group. Other upfield methyl groups appeared at δ1.01-1.7 as complex multiplets.

The compound 2 from *Bacillus* sp. Ba37 has been identified as methylpentyloxymethoxy-trimethylbenzoannulenyl-methoxybutenone. The olefinic proton at δ4.8 are due to the olefinic groups and closely situated at -C=O and OC groups. There are unaccounted protons near δ4 and δ1.5 which are due to moisture and impurities in the compounds. The methylene groups at δ3.96 and δ3.2 appeared close to the -O-C=C (in the annulenyl ring) and -O-C groups (in the butanone system) respectively, and therefore deshielded. Partial deshielding of the CH_3 groups at δ1.2-1.7 appeared to be due to the vinylic moiety. The compound 3 from *Bacillus* sp. Ba37 has been identified as acetoxyeth-acetyl-dimethylbenzoannulenecarboxylate. The methine groups at δCH 4 is attributed due to cyclohexane group proximal to -OCO group. The methine proton at δ 1.64 is conspicuous to the ring system, whereas the methyl signals at δ1-2 also are explained due to the acetyldimethylbenzoannulene system.

Bioprospecting antibacterial molecules from *Pseudomonas* sp.: The antibacterial compound isolated from *Pseudomonas* sp. was elucidated as octahydromethyl-dimethylphenazinecarboxylate derivative with the unaccounted substitute on the electronegative nitrogen atom. The base peak observed at the mass spectrum is at δ70.9, which also support the structure of the compound. The other compounds from this species have been identified as phenethyl formylformate with major peaks at m/e 143, 147 and 137. One glyoxylate derivative with butyl side chain has been purified from *Pseudomonas* sp. The major peaks were demonstrated to be present at m/e 130 and 57.

Fatty acid profile of three potential antagonistic bacterial species belonging to *Bacillus* and *Pseudomonas*: Three potential antagonistic bacterial species belonging to *Bacillus* (*B. subtilis* Ba37) and *Pseudomonas* (*Pseudomonas* sp. P104CB and *Pseudomonas* sp. P104) isolated from coastal ecosystems have been evaluated for fatty acid profile. The fatty acid C14:1n-7 is predominant in *B. subtilis* Ba37, whereas this monounsaturated fatty acid is absent in *Pseudomonas* sp. P104 and *Pseudomonas* sp. P104CB. Likewise C18:1n-9 and C16:OH fatty acids were found to be absent in *B. subtilis* Ba37, although they were found to be characteristic of *Pseudomonas* sp. P104 (C18:1n-9 and C16:OH, 28.3 and 3.6%, respectively) and *Pseudomonas* sp. P104CB (C18:1n-9 and C16:OH, 32.6 and 4.1%, respectively). Among saturated fatty acids, C16:0 was recorded to be the predominant fatty acid (32-41%) in these species, although *B. subtilis* Ba37 recorded higher C16:0 (~41%) than in *Pseudomonas* sp. (32-35%).



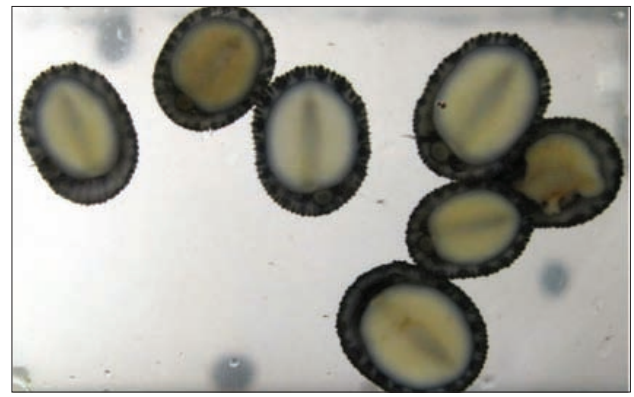
Substituted phenazine from *Pseudomonas* sp.

Bioprospecting of marine microbes from sponges and seaweeds

Research Project: FISHCMFRISIL201202600026

The aqueous extract of the marine sponge *Callyspongia diffusa* was exerting antifouling activity towards the limpet, *Patella vulgata* which was evaluated through the 'Limpet Foot Adherence Assay' perfected in the laboratory. The sponge-specific bacterial extract from *Shewanella algae* also exhibited similar activity towards the limpets suggesting the lead antifouling compound/s from the sponge and its associated bacteria. The *B. subtilis* VCDA strain recorded as a culturable co-inhabitant in the sponge *Callyspongia diffusa* and characterised by 16S rRNA sequencing, displayed high protease and antibacterial activities.

Callyspongia diffusa



Limpet, *Patella vulgata*

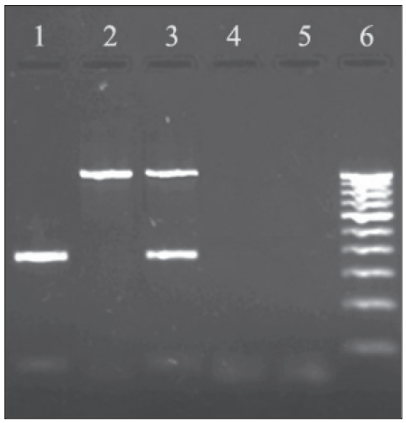
Preparation of algin oligosaccharides

Brown seaweed varieties of *Sargassum polycystum*, *S. plagiophyllum* and *Pocokiella variegata* were processed to extract algin. Aligns were prepared in the form of sodium salt by alcohol fractionation. The final product was found to contain 18% of align. Mannuronic acid enriched fraction having beneficial properties has been obtained from the fractionation of sodium alginate solution using KCl solution. Standardisation of the method is in progress. A process was standardised using hypochlorite to get bleached algin directly from sodium alginate.

Development of colony multiplex PCR (cmPCR)

A novel Colony multiplex PCR (cmPCR), a molecular approach for the rapid detection of *Bacillus* and *Pseudomonas* genera - dominant antagonistic groups - from diverse ecological niches has been developed:

Bacillus and *Pseudomonas* are the dominant groups of bacteria known for their antagonistic potential against pathogens. Presently, exploration of these genera with antagonistic property for disease management of aquaculture system is gaining more importance to overcome the use of antibiotics and related resistance issues. Rapid screening and



Agarose gel showing the PCR product of 400 bp and 1000 bp, obtained by multiplex PCR reaction.
Lane 1: *Pseudomonas* sp.
Lane 2: *Bacillus* sp.
Lane 3: *Pseudomonas* + *Bacillus*
Lane 4: *Vibrio* sp.
Lane 5: Negative control
Lane 6: 100.bp ladder

identification of these genera from diverse bacterial populations by conventional methods is laborious, cost-intensive, and time consuming. To overcome these limiting factors, in the present study, a colony multiplex PCR (cmPCR) method was developed and evaluated for the rapid detection of *Bacillus* and *Pseudomonas*. The technique amplifies the partial 16S rRNA gene of *Bacillus* and *Pseudomonas* with a product size of ~1,100 and ~375 bp, respectively, using single forward (BSF2) and two reverse primers (PAGSR and BK1R). Reliability of the cmPCR method was confirmed by screening 472 isolates obtained from ten different eco-stations, of which 133 isolates belonged to *Bacillus* and 32 to *Pseudomonas*. The cmPCR method also helped to identify six different *Pseudomonas* spp. and 14 different *Bacillus* spp. from environmental samples. Of the total 472 isolates studied, 46 showed antagonistic activity, among which 63 % were *Bacillus* and 17.4 % were *Pseudomonas*. Thus, the newly developed molecular approach provides a quick, sensitive, and potential screening tool to detect novel, antagonistically important *Bacillus* and *Pseudomonas* genera for their use in aquaculture. Further, it can also act as a taxonomic tool to understand the distribution of these genera from wide ecological niches and their exploitation for diverse biotechnological applications.

Nutrient profiling and evaluation of fish and shell fish

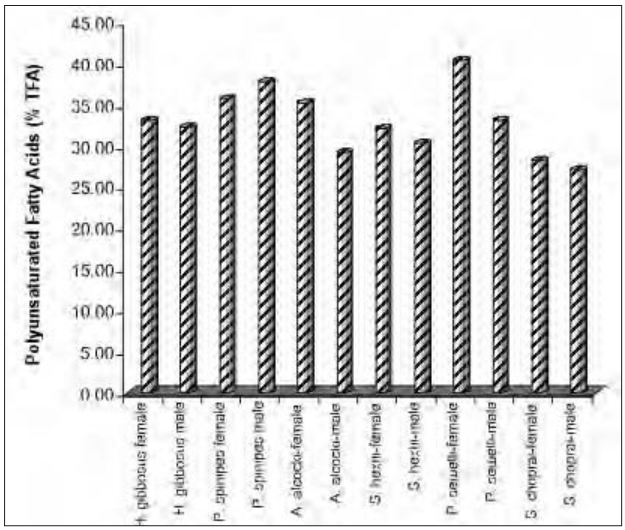
Research Project: EF-29/ICAR-Outreach

Nutritional evaluation of lobsters and shrimps

The shrimp and lobster species analysed are *Heterocarpus gibbosus*, *Plesionika spinipes*, *Aristeus alcocki*, *Solenocera hextii*, *Puerulus sewelli,* and *Solenocera choprai*. Among the saturated fatty acids, 16:0 constituted the major share (8-16%, depending upon the species). The concentration of saturated fatty acids were found to be higher (~36%) in *S. hextii* and *P. spinipes* than other species. The monounsaturated fatty acids such as 18:1n9, 16:1n-7 and 22:1 were found to be predominant in these species. *S. choprai* and *A. alcocki* registered higher content of monounsaturated fatty acids (~35% TFA) than those noted in other candidate species. The PUFA content realised 30-40% concentration of total fatty acids, and their contents have been uniformly recorded among the experimental species expect that recorded in *P. sewelli* (>40% TFA). The female of *P. sewelli* recorded the highest EPA (14.5% TFA) and DHA (19.5% TFA) contents than other species.

The cholesterol contents of female *P. sewelli* was found to be least (23.4%) followed by *H. gibbosus* (26.8%). The cholesterol contents of shrimps were found to be lower than 50 mg/100 g expect *P. spinipes* that recorded more cholesterol contents (125 mg/100 g in female and 82 mg/100 g for male species). The female of *A. alcocki* recorded higher content of ether extract (2.3%) followed by *P. spinipes* (~0.9%).

The mineral contents were found to be higher in the male species of *S. choprai* (5.9%) followed by the female of *A. alcocki* (3.9%). Expect *P.*



Fatty acid composition of deep sea shrimps and lobster

spinipes (1.2-1.5%), the fibre contents of these species were found to be very less indicating good digestibility.

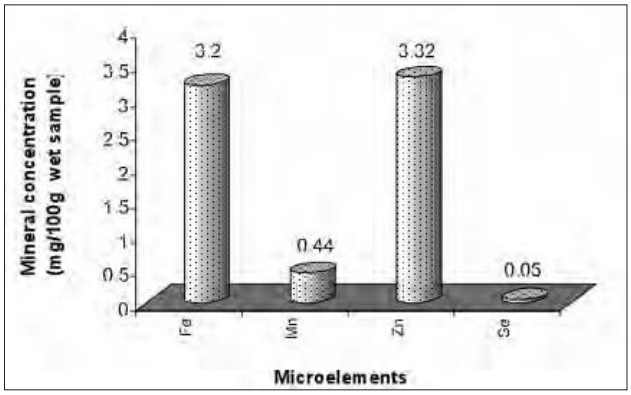
Nutritional composition of edible oyster

Analysis of *Crassostrea madrasensis* revelaed that palmitic acid (C16:0) was the primary Saturated Fatty Acid (SFA) found in the oysters contributing 28% to the total SFA content. The total Mono Unsaturated Fatty Acids (MUFA) in oyster samples ranged from 13.2 to 22% The first and second abundant MUFAs detected were 18:1n-9 and 16:1n-7, the diatom markers. The oyster samples recorded PUFA content ranging from 26.7-35.8%. The total content of n-6 PUFAs and n-3 PUFAs (EPA and DHA) were recorded to be significantly higher ($p < 0.05$) in oyster samples collected. The edible oysters recorded significantly higher C18 and C 20 PUFAs.The n-3/n-6 ratio ranged from 1.28-1.70 in oyster samples. Also, the n-6/n-3 ratio ranged from 0.59-0.78 in these samples. No significant differences were observed in both this ratio among wild and cultured oysters during the studied periods. The significantly higher ∑PUFA / ∑SFA ratio in oyster samples was mainly contributed by n-3 fatty acids particularly 20:5n-3, 22:5n-3, and 22:6n-3.

Seventeen amino acids (expressed as g/100 g protein) were identified and quantified in the oyster. The samples exhibited high total essential and non-essential amino acid content. The most abundant essential amino acid was found to be arginine (3.19-3.31 g/100 g protein), followed by leucine and lysine. Among the non-essential amino acids, glutamic acid constitute the major share followed by glycine (2.86-2.93 g/100 g protein). Cysteine, a non-essential sulfated amino acid and total sulfated amino acid content showed significantly higher amount in the oysters.

The fat soluble vitamins A, D3, E, K and water soluble vitamin, C were recorded in oysters. Vitamin D precursors constitute a large proportion of the unsaponifiable fraction of oyster lipid fraction. The levels of α-tocopherol, a vitamin with antioxidant properties (0.18-0.24 IU) showed no significant difference among the samples. Phylloquinone (K1) and vitamin C registered significantly higher values in edible oyster samples. Selenium (Se), the antioxidant element was found to vary between 0.01-0.05 mg/100 g wet sample. Selenium was found to vary between 0.05-0.09 mg /100 g among the cephalopods.

Among the minor unsaponifiable components, oxygenated carotenoids were recorded, characterised by typical absorption spectra and prevalent over the less polar, late-eluting carotenes. Due to the lack of suitable standard compounds, the early-eluting xanthophylls were not identified. Phosphorus was found to constitute a significant portion of the macro-minerals, and the presence of a higher K/Na ratio signified the therapeutic value of the edible oyster species.



Mineral contents of *C. madrasensis*

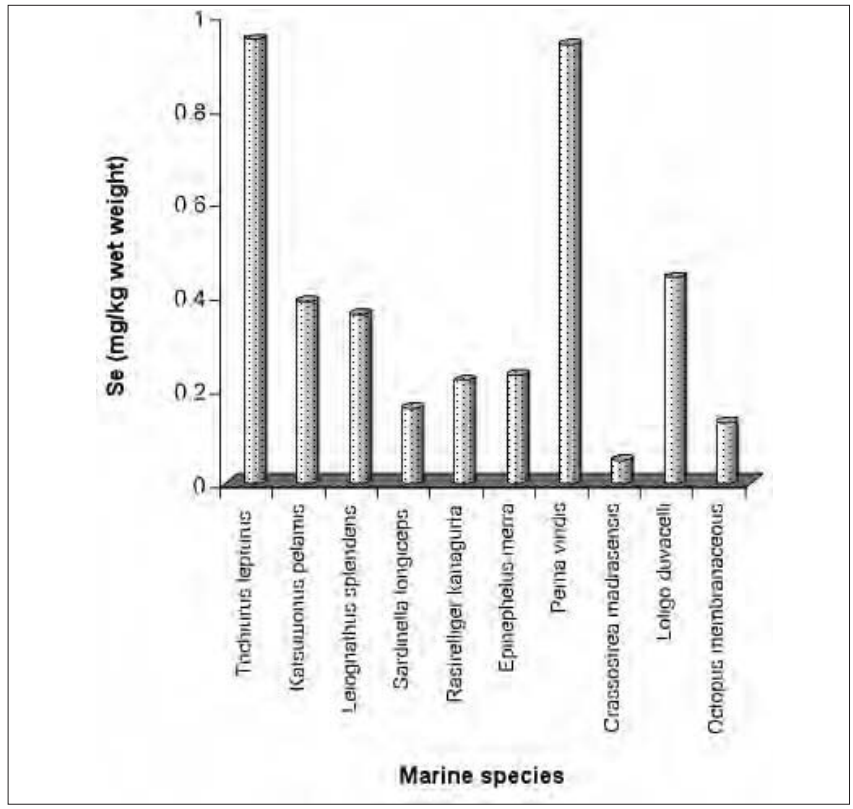
Evaluation of marine fish and molluscs for the micronutrient selenium in bioavailable form

Among different fish species, *Trichiurus lepturus* registered the highest Se content (0.95 mg/kg) followed by *Katsuwonus pelamis* (0.39 mg/kg) and *Leiognathus splendens* (0.36 mg/kg). Other fish species registered lower content of Se (<0.2 mg/kg). Among the molluscs, *Perna viridis* recorded Se content to the tune of 0.94 mg/kg and *Loligo duvacelli* 0.44 mg/kg.

Antioxidant potential of the seaweeds and spectroscopy-based functional group analyses

Research Project: FISHCMFRISIL201202600026

Gelidiella acerosa and *Acanthophora spicifera* were evaluated for their antioxidant activities by different *in vitro* systems and total phenolic contents (TPC). The aqeous extracts (AE) of *G. acerosa* exhibited highest free radical (95.34%) and hydroxyl radical scavenging activities (29.49%). AE of *G. acerosa* and *A. spicifera* showed higher hydrogen peroxide radical scavenging activity (49.82%). AE of *G. acerosa* exhibited



Selenium content of different finfish and mollusc species

a higher absorbance ($p<0.01$) at 700 nm (0.34) indicating a higher reducing power by these extracts. A significant correlation was also observed between the antioxidant activity and phenolic content, indicating the important role of algal phenols or compounds with active proton donating capacities as chain-breaking antioxidants. Antioxidant and anti-inflammatory activities of extracts (AE and TCP) from seaweeds harvested from Gulf of Mannar of peninsular India were evaluated by different *in vitro* and *in vivo* systems. AE realised high total phenolic content (288.19 GE/g), radical scavenging ability (82%, 0.6 mg/ml) and Fe^{2+} chelating ability (48%, 0.6 mg/ml). The structures of the purified compounds have been established by detailed spectroscopic experiments. A comparable inhibition of AE with aspirin (>87%, 1 mg/ml) was found on inhibiting pro-inflammatory enzyme 5-LOX.

Isolation and characterisation of antioxidative and anti-inflammatory bioactives from bivalves

Paphia malabarica and *Villorita cyprinoides* are common sea foods in coastal regions of India, and utilize self-defense systems to overcome free-radical induced oxidative stress diseases. *V. cyprinoides* was found to possess phenolics (3.50 mg/GAE) as antioxidant principles, which led to high antioxidative capacity (36.4%). The major bioactive compounds of which fatty acyl ester, methyl hexadeca-7, 9-dienoate, 2-methyl-3-hydroxy-3, 5-dien-hept-1-amine, phenolic compounds, furan analogues (phenyl-dihydrobenzofuranol) and keto derivatives (methyl phenylpropionylhexanoate) were identified. The free radical scavenging activity of *P. malabarica* showed higher activity (76% at 2000 ppm, ABTS) than those in black clam (58%, 2000 ppm) due to higher total phenolic content (91%) than that in *V. cyprinoides* (74%). Anti-inflammatory biocatalysts such as cox-II (>78%, 5000 ppm) and 5-LOX (80%, 5000 ppm) were significantly arrested by the solvent extracts of *P. malabarica* than that of *V. cyprinoides* (65 and 78%, respectively in that order). These results indicated that *P. malabarica* and *V. cyprinoides* can be used to isolate bioactive molecules with potential medicinal properties.

Broodstock **development** and **seed production**

National marine finfish brood bank

Research Project: FISHCMFRISIL201202400024

National Marine Fish Brood Bank at Mandapam Regional Centre of CMFRI was established to hold broodstocks of commercially important marine finfishes and to supply quality eggs/newly hatched larvae to hatcheries for fingerling production. The broodstock tanks with continuous bio-filtration system are used to maintain broodstock of high value marine finfishes like cobia, silver pompano, groupers, snappers and breams in healthy condition.

Broodstock of cobia in brood bank

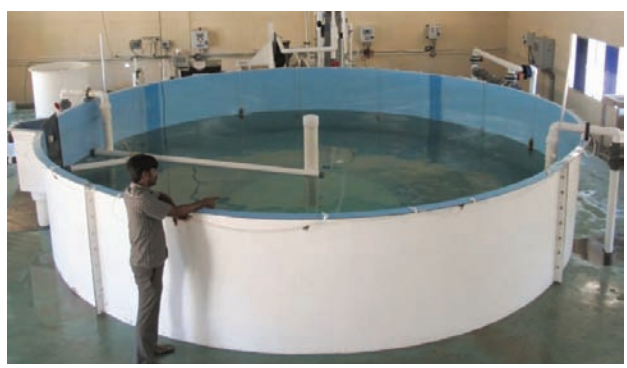
Commissioning of National Marine finfish brood bank

Director General, ICAR, examining a brood fish

Recirculating Aquaculture System (RAS)

The RAS facility was installed at Mandapam by importing sophisticated equipment from M/s. Aquatic Ecosystems, USA. A recirculating aquaculture system with components such as drum filter, fluidized-bed bioreactor, protein skimmer, UV sterilizer and egg collection facility assures healthy maintenance of the marine finfish broodstocks and year-round seed production. The system will serve to develop the broodstocks into spawners in captivity. The photo-thermal conditioning for accelerating maturation can also be incorporated into the system. Subsequently, a more cost effective indigenous RAS was designed and installed in the Centre. Broodstock development of *Lutjanus argentimaculatus* was initiated in the indigenous RAS system.

Imported RAS components (Sump, Drum filter & Protein skimmer)



Imported RAS facility showing the main reservoir for broodstock holding

Unveiling of plaque by District Collector

Hon'ble DG viewing the RAS facility

Indigenous RAS components (UV filter, Bead filter, Protein skimmer & Reactors)

Broodstock holding tank of the indigenous RAS Unit

Broodstock development and breeding of marine finfishes

Cobia *Rachycentron canadum*

Seven successful spawnings of cobia were obtained during 2013-14. Five spawnings were carried out in tanks with recirculating aquaculture system (RAS) and two in the spawning tanks without RAS. The eggs per spawning ranged from 0.20 to 3.70 million and the fertilization rate varied from 3.5 to 87.0%. Total number of newly hatched larvae ranged from 0.08 to 1.80 million. The hatching percentage ranged from 41.1 to 89.1.

S.No	Date of experiment	No. of eggs (lakhs)	Fertilization rate (%)	Hatching rate (%)	No. of larvae used for fingerling production	No. of fingerlings produced
1	23.05.2013	0.7	58.0	75.0	1.5	4050
2	27.05.2013	0.7	66.0	89.0	0.5	3500
3	10.06.2013	2.2	87.0	84.0	1.0	4200
4	20.09.2013	2.3	85.0	88.0	2.0	3600
5	06.10.2013	3.7	3.5	57.0	0.7	3900
6	29.10.2013	1.3	0.27	41.1	Nil	Nil
7	22.11.2013	0.75	Nil	Nil	Nil	Nil
8	02.12.2013	0.20	65.9	43.4	0.057	3000
9	14.12.2013	3.10	27.4	72.7	0.62	4500
10	17.01.2014	0.02	Nil	Nil	Nil	Nil

Volitional spawning of cobia in RCC tanks

Two sets of cobia broodstock, each with one female and two males, which were maintained at the National Marine Fish Brood Bank facility at the Mandapam Regional Centre, spawned volitionally without any hormonal induction during the month of May 2013. The water quality parameters were maintained at highest standards with indigenously designed filtration systems. The broodstock were fed with good quality squid and crabs. A total of 2.5 million fertilized eggs were obtained and 85% hatching was achieved in the volitional spawning.

Spawning of cobia in RAS

The first successful spawning of cobia in RAS was achieved at Mandapam on 20 September 2013. The RAS facility established at the centre was effectively utilised for the maintenance of cobia brooders. One female and two male brooders were kept in the system. The brooders were induced with HCG after the ova size was assessed by cannulation. The total number of eggs released was 2.40 million and the fertilization percentage was 86.1. The temperature range was 27.5-29°C. The hatching started by late evening and completed by early morning. A total of 1.80 million larvae hatched out with a hatching percentage of 86.7%.

Volitional spawning of cobia in RAS

The brooders of cobia maintained in the RAS by keeping optimal water

quality parameters spawned volitionally on 29 October 2013. The total number of eggs spawned was 1.3 million. Since the spawning happened unexpectedly, arrangements for facilitating maximum fertilization rate could not be made in the system which resulted in low fertilization rate. The temperature maintained was 30.5°C, pH 8.2, DO 4.98 ml/l and salinity at 36 ppt.

Off-season spawning of cobia

Experiments by thermal regulation conducted in the RAS resulted in off season spawning of cobia during the month of December 2013. During this season the temperature of source seawater was 25.1 to 26.0°C and it was regulated to 29.7 to 30.3°C by using titanium heaters. The cobia brooders were healthy and broodstock development was continued in the RAS by regulating the temperature. Intra-ovarian biopsy revealed the maturation of ova in the altered temperature. The female cobia weighed 9.29 kg and males were 9.89 kg & 10.34 kg. The present success is a major breakthrough which can pave way for the successful spawning and seed production of cobia throughout the year.

Silver pompano *Trachinotus blochii*

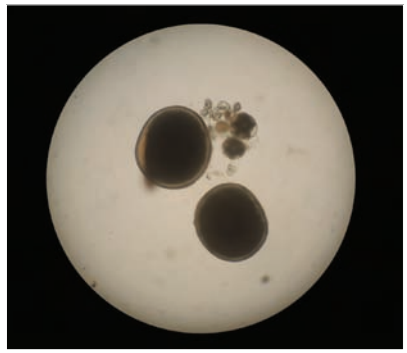
Nine successful spawnings of silver pompano were obtained during 2013-14 and number of eggs per spawning ranged from 0.14 to 4.89 lakhs. The fertilization rate ranged from 6.9 to 91.1% and hatching percentage ranged from 41.8 to 88.4. A total of 1,74,000 fingerlings of silver pompano was produced and supplied to farmers, fishermen, entrepreneurs, government programmes and researchers. Four sets of silver pompano broodstocks are being developed under photothermal regulation for controlled spawning throughout the year. Temperature range of 28 to 31°C was found to be ideal for successful spawning, good fertilization and hatching rate for both cobia and silver pompano.

S.No	Date of experiment	No. of eggs (lakhs)	Fertilization (%)	Hatching (%)	No. of larvae used for fingerling production	No. of fingerlings produced
1	22.04.2013	1.23	79.1	56.1	54000	10500
2	08.06.2013	2.83	91.1	66.2	165000	36400
3	08.06.2013	1.86	83.9	84.5	129000	29100
4	17.07.2013	4.89	80.5	72.6	285926	14900
5	17.07.2013	2.50	76.0	81.2	75000	12400
6	04.08.2013	0.14	6.9	78.2	750	300
7	22.08.2013	1.19	Nil	Nil	Nil	Nil
8	13.09.2013	2.84	74.7	80.5	168000	43600
9	20.10.2013	2.94	89.5	88.4	110000	35000
10	21.11.2013	Nil	Nil	Nil	Nil	Nil
11	31.12.2013	0.42	10.4	41.8	1850	1000
12	31.12.2013	Nil	Nil	Nil	Nil	Nil
13	30.01.2014	Nil	Nil	Nil	Nil	Nil

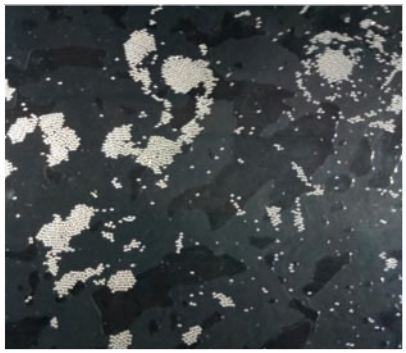
Indian pompano *Trachinotus mookalee*

The Indian pompano *Trachinotus mookalee* is one of the ideal candidate species for mariculture mainly due to its good meat quality and high market demand. It is one of the fast growing carangid and is encountered rarely in the capture fisheries. The species is able to acclimatise and grow well even at a lower salinity of about 15 ppt and hence it is suitable for farming in the vast low saline ponds of our country besides its huge potential for sea cage farming.

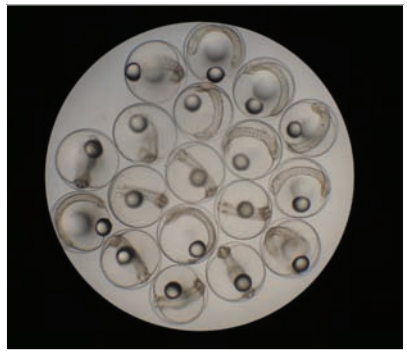
Brooder of *Trachinotus mookalee*



Intra- ovarian eggs of *T.mookalee*



Fertilized eggs of *T. mookalee*



Embryonic development in *T. mookalee*

Successful broodstock development, induced spawning and larval rearing of Indian pompano was achieved at Visakhapatnam Regional Centre of CMFRI. Wild collected pompano of size ranging from 2 to 4 kg were stocked in sea cages. The fishes were fed twice a day with squids and sardines @ 5% of body weight supplemented with vitamin and mineral mixture. After one year of rearing in sea cages, the brooders attained a size range of 4 to 5.5 kg. The sexes were determined by intra-ovarian biopsy and males and females were segregated and stocked in separate cages. Intra-ovarian biopsy of females was done at regular intervals to assess the size of the intra ovarian eggs.

Two females with mature ova and two oozing males were selected for induced breeding. The females weighed 4.5 kg and 4.0 kg where as males were 5.0 kg and 4.5 kg in weight. Selected males and females were stocked in hapa of 3 m depth and 2 m diameter, which was fixed inside a 6 m diameter sea cage and induced for spawning with a single dose of hCG in the early morning of 26 February 2014. Spawning was observed 36 h after injection. The floating eggs were collected with a scoop net of 500 µ mesh and finally the hapa was lifted for collecting the remaining eggs. The total eggs spawned were estimated to be around 80,000.

Grouper *Epinephelus coioides*

Successful induced spawnings of orange-spotted grouper (*Epinephelus coioides)* were achieved during the period. The female was administered with two doses of HCG @500 IU/kg BW at 24 h interval and male was given single dose of HCG on 2nd day. Two cycles of successful larval rearing were carried out during the period.

Breeding hapa inside cage for *Epinephelus coioides*

Juveniles of *E. coioides*

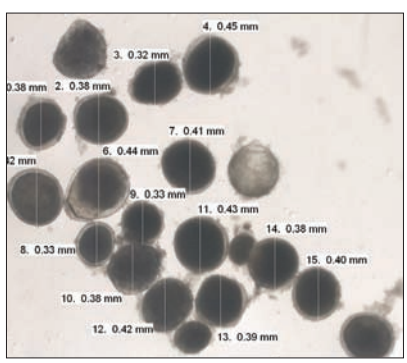
Red snapper *Lutjanus argentimaculatus*

Broodstock development of *Lutjanus argentimaculatus* is progressing at Chellanam near Kochi. The fishes reached 3.5 to 6.0 kg in weight in circular cage. The fishes were fed with wet feeds such as squid, sardine and green mussel @ 5% of their body weight in two doses. The fishes were tagged. Cannulation was carried out twice in a month to track the gonadal developments. Cannulation showed that most of the specimens were males. In the females, ova size ranged from 340 to 420 microns.

Indian halibut *Psettodes erumei*

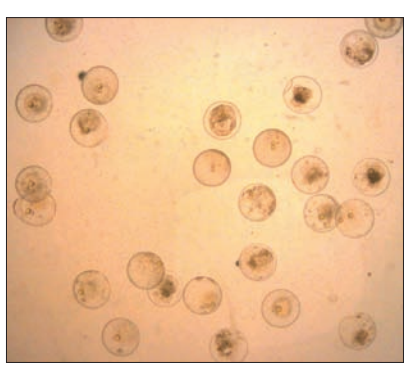
Broodstock of Indian Halibut *Psettodes erumei* raised at the Kovalam Field Laboratory spawned twice in captive conditions, one spawning yielded fertilized eggs with development for 16 h, the next spawning did not synchronise with male response and thus the eggs were not fertilized.

Broodstock of *L. argentimaculatus* in cage



Cannulated eggs of *L. argentimaculatus*

Fertilized eggs of *P. erumei*



Embryonic development of eggs of *P.erumei*

Broodstock development and breeding of Shellfishes

Breeders of sand lobster *Thenus unimaculatus* were developed in the Kovalam Field lab facility and twelve spawnings were obtained. More than 60 brooders of *Petrarctus rugosus* were developed and several spawnings were obtained. A pair of the deep sea scyllarid lobster *Scyllarides tridacnophaga* spawned in capivity in August 2013. Three egg bearing females of the portunid crab

Portunus pelagicus released zoeae. A new crab rearing facility was set up for rearing the larvae with rotifer and microalgal culture. Larval development progressed till the second zoeal stage. Wild spawners are being used for further broodstock development and spawning trials.

Larviculture and seed production

Cobia

Larviculture experiments revealed that maintaining a larval density of 5 nos./l and live feed (rotifer) at a density of 35- 40 nos./ml up to 18 days post-hatch (dph), early grading starting from 10 dph onwards and continuing on a daily basis yielded better survival for cobia larvae. Maximum survival rate obtained was 8.4%. A few tanks with better light intensity and extended duration of higher temperature yielded up to 10% survival in cobia.

Cobia fingerlings

Effect of temperature on larval growth

Growth was retarded and metamorphosis period extended during the larviculture trial of cobia at a lower temperature range of 23-25°C. It was possible to obtain the fingerlings of 10-12 cm size by 45 dph in the normal temperature range of 28-31°C, whereas the same length range could be obtained only after 55 dph at the temperature range of 23-25°C.

Effect of temperature on embryogenesis and early larval growth

The effect of temperature on the yolk-sac utilisation and growth in length of cobia larvae was investigated. Five temperature regimes viz., 29, 30, 31, 32 and 33°C were experimented with newly hatched larvae for a duration of 52 h post hatch. A clear cut trend of increase in larval length with increase in temperature was noted. The maximum length recorded was 4.41 ± 0.11 at 33°C at the end of the experiment. The yolk-sac volume decreased proportionate to the rise in temperature. At the end of 52 h, the lowest yolk-sac volume was recorded at a temperature range of 31 to 33°C. The results suggest that temperature plays a vital role in the yolk-sac utilisation as well as growth in length of the larvae of cobia.

Fingerling production

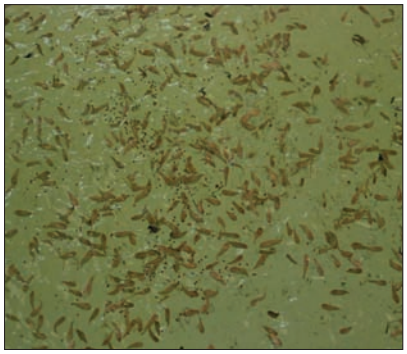
A total of 41950 fingerlings of cobia was produced during 2013-14 at Mandapam centre and were supplied to farmers, fishermen, entrepreneurs and for research as well as development programmes.

Sl. No.	Details of the beneficiaries under demonstration of the technology		Quantity of Seed (nos.)
1.	Mr. Raghu Sekar, Nagailanka, Andhra Pradesh	:	2000
2.	M/s Vitality Aquaculture, Tuticorin, Tamil Nadu	:	4000
3.	Self Help Group, Maraikkayarpatnam, Tamil Nadu	:	1000
4.	KRC of CMFRI, Karwar, Karnataka	:	16000
5.	NIOT, Chennai, Tamil Nadu	:	1500
6.	MRC of CMFRI, Mandapam, Tamil Nadu	:	15000
7.	N. Ashraf Ali, Vedalai	:	2450
TOTAL		**:**	**41,950**

Silver pompano *Trachinotus blochii*

Larval density of 10 larvae/litre and live feed (rotifer) at a density of 35-40 nos./ml yielded better survival in pompano larviculture. Maximum survival rate obtained in larviculture trials was 31%.

Temperature and light intensity effects on larval growth



Larviculture of *T. blochii*

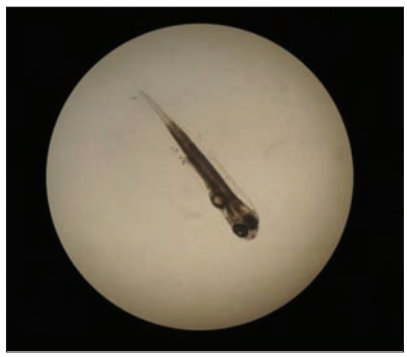
Pompano fingerlings

The average increase of 2°C in water temperature resulted in reduced larval growth of about 10 to 33% from 7 dph to 12 dph in pompano larviculture. Thereafter, the reduction percentage was stabilised. A delay of 3 days was noted in the metamorphosis in the high temperature set. The larval pigmentation became translucent white (8 to 14 dph), brown (15 to 20 dph) and silver (21 dph onwards) in the higher temperature set. The reduced growth rate coupled with change in pigmentation of larvae can be taken as the resilience response of the larvae to combat the temperature stress. The larvae of marine finfishes are very sensitive to water temperature. The anticipated seawater temperature rise due to climate change may adversely affect the fish eggs and larvae of many species. As part of the assessment of climate resilient species for coastal aquaculture, the impact of high temperature and light intensity on the growth and metamorphosis of hatchery reared silver pompano larvae were studied.

Indian pompano *Trachinotus mookalee*

The first successful larval rearing of Indian pompano was accomplished at Visakhapatnam centre of CMFRI. The fertilized eggs were treated with 15 ppm iodophore solution for 10 min. to avoid contamination and stocked for incubation. The size of the fertilized eggs was 950-1000 µ. The eggs hatched out after 22-24 h of incubation at a temperature range of 28-30°C. The hatching rate was estimated to be 80%. The newly hatched larvae measured from 2.1-2.2 mm in total length. The mouth opening was formed after 42-46 h post-hatch. Green water was used for larval

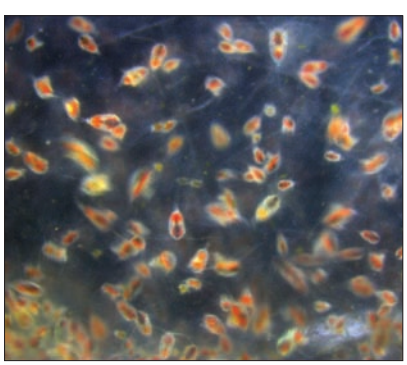
Newly hatched larvae of *T. mookalee*



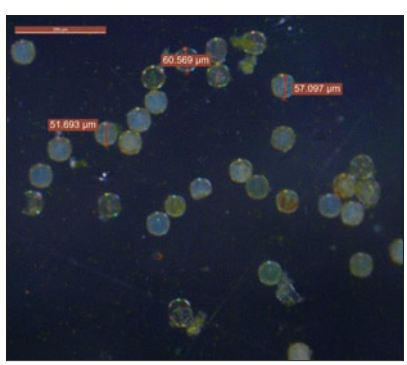
Larvae of *T. mookalee* (2 dph)

Larvae of *T. mookalee* (6 dph)

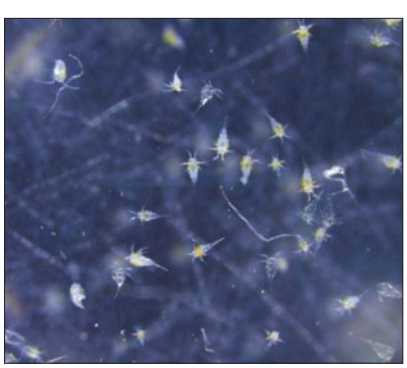
Metamorphosed fry of Indian pompano



Temora turbinata (live)



Eggs of *Temora turbinata*



Nauplii (5 days old) of *T.turbinata*

Juvenile of *A. frenatus* fed with copepod on 30th day

rearing. Artemia nauplii were also used in larval rearing tank from 9th day onwards. Weaning of larvae with inert diet was started from 15th day onwards. Metamorphosis of the larvae started from 17th day onwards and was completed by 22nd day. The size of the metamorphosed fry ranged from 16 to 17 mm. This success will go a long way in promoting mariculture in cages as well as in grow-out ponds in the country.

Mass production of calanoid copepod

Mass production technique for calanoid copepod *Temora turbinata* has been standardised. For adults an intensity of 1000/l and for naupliar stages 2000-2500/l can be achieved by this method. The culture was mainly fed with a combination of *Isochrysis galbana* and *Nannochloropsis* sp. Protocols for feeding, rearing, isolation, cleaning, and maintaining culture without any contamination were also developed. Continuous culture of another promising species of copepod *Pseudodiaptomus serricaudatus* was maintained. Mass culture of *P. serricaudatus* was initiated in tanks of 1000 l capacity. For adults an intensity of 600-800/l could be obtained. The culture was mainly fed with a combination of *Isochrysis galbana* and *Nannochloropsis* sp. Protocols for feeding, rearing, isolation, cleaning, and maintaining culture without any contamination were also standardised. Larviculture trials were conducted using copepod (*T. turbinata*) naupliar stages as feed for larvae of *Amphiprion frenatus* against the traditional practice of rotifer and artemia nauplii combination. A 30 day trial gave 24.5% better survival, better growth and brighter colouration in copepod fed larvae.

Supply of pompano seed under technology demonstration

Research Project: EF-6/ICAR

Details of the beneficiaries under demonstration of the technology		Quantity of Seed (nos.)
Mr. Ramana Reddy, Karwar, Karnataka	:	6000
Mr. Raghu Sekar, Nagailanka, Andhra Pradesh	:	16000
Mr. P. Ravi, Chidhambaram, Tamil Nadu	:	8800
Mr. Kevin Saldhana, Perupalam, West Godavari district, A.P.	:	21800
Mr. M.V.S. Subba Raju, Bhimavaram, Andhra Pradesh	:	45000
M/s Vitality Aquaculture, Tuticorin, Tamil Nadu	:	3000
KVK, Narakkal, Kerala	:	6000
KRC of CMFRI, Karwar, Karnataka	:	3000
NIOT, Chennai, Tamil Nadu	:	3000
Mr. Abubakkar, Thondi, Tamil Nadu	:	2500
CMFRI Head Quarters, Kochi, Kerala (NICRA)	:	3000
MRC of CMFRI, Mandapam, Tamil Nadu	:	6000
Mr. Jignesh U. Contractor, Surat, Gujarat	:	24000
Mr. Koteswara Raju, Peddapatnam, Krishna District, A.P.	:	14000
Mangalore Research Centre of CMFRI	:	5000
Calicut Research Centre of CMFRI	:	1500
Vizhinjam Research Centre of CMFRI	:	200
Mumbai Research Centre of CMFRI	:	1200
Karwar Research Centre of CMFRI (Maharashtra Cage Project)	:	4000
TOTAL	**:**	**1,74,000**

DDG (Fisheries), ICAR visiting the seed packing site

Dr.G. Gopakumar, SIC & Head Mariculture Division handing over the seeds to aquafarmers

Off season spawned egg strands of *Lambis lambis*

Gastropods

Chicoreus ramosus

A set of 10 no. of brooders of *Chicoreus ramosus* belonging to muricids and *Lambis lambis* belonging to Strombids were maintained in Tuticorin laboratory.

During the current year more specific feed protocol was done and the brooders were fed with encrusted algae on boulders introduced into the tanks. The total calculated algal surface area per feeding time was kept at 800 sq inches (algal wet weight calculated) once in 4 days/10 brooders.

Off season spawning for strombids (*Lambis lambis*) was observed during the month of March 2014. The egg strands were healthy and was maintained for hatching under standard conditions. The incubation period of the egg strand was bit longer compared to normal seasonal spawned egg strands.

Hemifusus pugilinus

Hatchlings of *Hemifusus pugilinus* was produced in the Visakhapatnam Marine hatchery for the first time and exhibited fast growth under captive conditions; it is a suitable candidate for mariculture.

Feed preference and growth of hatchlings: A feeding experiment was conducted to understand the feed preference and growth of the hatchlings produced in the hatchery. The hatchlings were fed with five different diets and the most favoured feed was mussel meat followed by clam meat. The least preferred was oyster meat. Higher growth rate was observed in hatchlings fed with mussel meat and clam meat.

Hatchlings of *Hemifusus pugilinus* fed on mussel and oyster meat

F1 generation produced in the hatchery

Hatchlings produced were reared to maturity and second generation of hatchlings of *H. pugilinus* was produced in the hatchery.

Hatchery produced hatchlings can be sea ranched for wild stock replenishment since they are highly targeted for their ornamental shells and operculum which is used in Unani medicine.

Grow-out **technologies**

Cage farming of cobia, *Rachycentron canadum*

Research Project: FISHCMFRISIL201202500025

During 2013-14, sea cage farming trials and demonstrations of cobia were carried out at different locations of the country.

Participatory cage farming of cobia by two SHGs with Mandapam Regional Centre of CMFRI was carried out at Gulf of Mannar. About 1,800 hatchery produced cobia seeds were stocked in four circular GI metal cages of 7 m diameter and 3.5 m depth. The initial length and weight of fingerlings ranged from 10 to 15 cm and 20 to 30 g respectively. The stocking density was 4.1/m^3. They were fed with trash fish *ad libitum* twice a day. During the farming period of 7 months they reached a size range of 2.0 to 3.5 kg weight, with an average size of 2.5 kg. The calculated FCR was 5.9.

A total of 4 t of cobia was produced and a farm gate price of ₹250/kg was realised. The cost of production was ₹134/- per kg fish with the net income of ₹4, 64,000/-. After successful harvest of cobia, these self help groups

Cobia fingerlings in cage

Cobia fingerlings in demonstration cage

Cobia grow-out fish

Cobia sampling from demonstration cage

Dr. S. Ayyappan DG ICAR, Dr. B. Meenakumari DDG (Fy.) and Dr. Madan Mohan ADG (Marine Fy.) witnessing harvest of seacage farmed cobia

are self motivated and came forward to undertake the sea-cage farming of cobia by bearing all the expenditure including the cost of cage, seed and feed. Currently, cobia seeds produced by the Mandapam Regional Centre are being farmed in cages deployed in 7 locations in the states of Tamil Nadu, Karnataka, Kerala, Goa and Maharashtra.

Sea cage farming demonstration of cobia through participatory mode with Cobia Aquaculture Fishermen Welfare Society, Rameshwaram

Nine sea cages made up of GI pipes were fabricated by the private fishermen society, the Cobia Aquaculture Fishermen Welfare Society and installed in Gulf of Mannar with the technical guidance from CMFRI. The circular cages of 6 m diameter and 3 m depth were fabricated and installed. About 6000 nos. of cobia fingerlings of 12 cm length and an average weight of 20 g were stocked. The fishes were fed *ad libitum* twice daily with low value fish. The water temperature in the cage sites are being recorded at regular intervals. The cost of cages, feed and labour are fully borne by the society. The hatchery produced seeds and technical inputs are provided by the institute. The farming demonstration is in progress.

Demonstration of cage farming of cobia through participatory mode at Gulf of Mannar

A total of four numbers of sea cages made up of GI pipes were fabricated by a private entrepreneur and installed in Gulf of Mannar with the technical guidance from CMFRI. The circular cages of 6 m diameter and 3 m depth were fabricated and installed. About 2000 nos. of cobia fingerlings of 12 cm length and an average weight of 20 g were stocked. The fishes were fed *ad libitum* once in a day with low value fish. The water temperature in the cage sites are being recorded at regular intervals. The cost of cages, feed and labour are fully borne by the entrepreneur. The hatchery produced seeds and technical inputs are provided by the institute. The farming demonstration is in progress.

Demonstration of cobia farming in sea cages in participatory mode with fishermen group of Maraikayarpatinam Village

Harvested farmed cobia

Two numbers of sea cages made up of GI pipes were fabricated by the private entrepreneur and installed in Gulf of Mannar with the technical guidance from CMFRI. The circular cages of 6 m diameter and 3 m depth were fabricated and installed. About 400 nos. of cobia fingerlings of 15 cm length and an average weight of 25 g and 2000 nos. of fingerlings of 10 cm length with an average weight of 18 g were stocked. The fishes were fed *ad libitum* once in a day with low value fish. The water temperature, salinity and pH in the cage sites are being recorded at regular intervals. The cost of cages, feed and labour are fully borne by the fishermen themselves. The hatchery produced seeds and technical inputs are provided by the institute. Farming demonstration is in progress.

Farming of silver pompano, *Trachinotus blochii*

Bulk transportation of silver pompano seeds

Bulk transportation was done in a truck by employing 1 t capacity tanks (10 nos.) fitted with oxygen cylinders. Each tank was stocked with 5000 numbers of pompano seeds. The average length and weight of fingerlings was 4.2 cm and 0.85 g. Ice bags were placed in each tank to reduce water temperature. The seeds were transported from Mandapam, Tamil Nadu to Dilsumaru and Thurpputhallu villages of West Godavari District, Andhra Pradesh by travelling on road for 29 h. The seeds reached the farming sites without any mortality and were acclimatised to appropriate salinity and temperature and stocked in pens erected inside the ponds. They were fed with formulated feed and were fully acclimatised to the nursery conditions. Subsequently, bulk transportation of silver pompano seeds was carried out to Navsari, Gujarat (24,000), Perupalem, West Godavari District, Andhra Pradesh (21,800) and Peddapatnam, Krishna District, Andhra Pradesh (14,000). Currently, silver pompano farming in cages and ponds are being carried out in 19 locations in the states of Tamil Nadu, Andhra Pradesh, Kerala, Karnataka, Gujarat and Maharashtra.

Co-culture of pompano and *L. vannamei*

Demonstration of pond farming of silver pompano through participatory mode in Chidambaram, Tamil Nadu

About 1000 nos. of pompano fingerlings of 6.5 cm length and an average weight of 8.7 g were stocked in a one acre pond. The growth of pompano in six months culture period was observed to be an average length of 20.5 cm and a weight of 135.0 g. Another batch of about 1400 nos. of pompano fingerlings of 5.0 cm length and an average weight of 7.2 g were stocked. The growth of pompano in three months period of culture was observed to be an average length of 14.2 cm and a weight of 50.3 g. The demonstration is in progress.

Cage farming of pompano in Nagayalanka, Krishna District, Andhra Pradesh

Sampling of pompano cultured at South Pichavaram, Chidambaram, Tamil Nadu

Demonstration of silver pompano farming at Pedda Kammavaripalem, Nagayalanka , Krishna District, Andhra Pradesh

About 3,500 nos. of pompano fingerlings of 6.5 cm length and an average weight of 8.7 g were stocked in a one acre pond. In the same pond *Litopenaeus vannamei* seeds were stocked to study the possibility of co-culture of silver pompano with *L. vannamei*. In eight months culture period fishes attained an average length of 21.8 cm and a weight of 150 g. This slow growth was due to zero salinity prevailed for a period of 3 months in the water source and pond. Whereas *L. vannamei* reached an average size of 120 g and were harvested. Another batch of about 3,500 nos. of pompano fingerlings of 5 cm length and an average weight of 7.2 g were stocked in the HDPE cages by the farmer in the Krishna River and being reared by feeding with low value fishes and the farming is in progress.

Participatory cage farming of spiny lobster at Kovalam, Chennai

Small scale participatory cage farming of spiny lobster, *Panulirus homarus* with fishermen society of Kovalam Village near Chennai was undertaken. A total of 50 days fattening of lobster by feeding with tilapia discards was carried out.

Spiny lobsters fattening in sea cage

Cage farming in West Coast

Along the west coast, cage farming is carried out in the open sea, estuaries and brackish water bodies at Veraval in Gujarat, Ratnagiri and Malwan in Maharashtra, Talpone and Polem in Goa, Karwar, Kumta, Mangalore in Karnataka, Calicut, Thrissur, Ernakulam, Kottayam and Alleppy in Kerala. A total of 139 cages of various dimensions ranging from 5 to 12 m are being used for open sea cage farming and 65 cages of various dimensions ranging from 2.5 m length to 6 m diameter are being used for estuarine and brackish water farming along the west coast.

Open sea cage farming

Gujarat

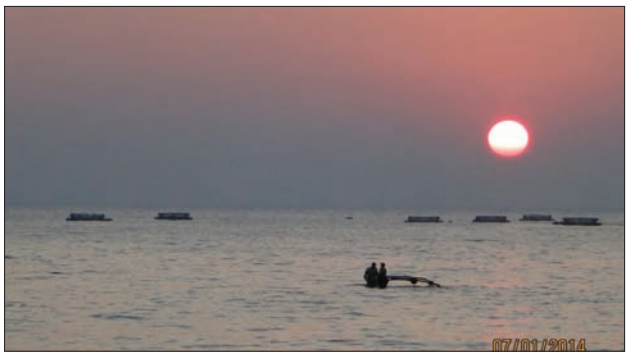
Veraval: At Veraval spiny lobster *Panulirus homarus* was cultured in 25 cages in the marine cage farm of CMFRI at Veraval. A total of 1.5 t was harvested during the current year.

Maharashtra

Ratnagiri: Karwar Research centre has trained 50 fishermen sponsored by Maharashtra Fisheries Development Corporation (MFDC) from Ratnagiri. Cage farming is undertaken by these fishermen groups under MFDC with the technical supervision of Karwar RC of CMFRI. A total of 25 Cages were deployed in Ratnagiri Bay out of which 20 cages were stocked with Asian seabass @2500 seeds/cage and 5 cages with cobia @750 seeds/cage. Average growth of cobia was 600 g in 60 days of culture (DOC). Average seabass growth was 400 g in 120 DOC.

Malwan: Farming of pompano is being carried out in Achara backwaters in Malwan in Maharashtra. Four cages of 6 m x 6 m x 5 m size were deployed in the backwater. Pompano seeds (5000 nos.) collected from the Mandapam Regional centre of CMFRI is being cultured in these cages.

Cage farm at Achara (Malwan)



Cage farm at Polem

Hon. Minister for Fisheries, Goa Shri. Avertano Fotardo stocking the cages

The Norwegian Delegation in the Karwar Cage farm

Goa

Farming of seabass and cobia was initiated at two locations in Goa. A total of 25 cages of 6 m diameter are deployed at Talpone and another 25 at Polem. seabass is cultured in 18 cages and cobia in 6 cages. A total of 6.5 t of cobia and 6 t sea bass was harvested and sold @ ₹300/kg for cobia and ₹400/kg for seabass. A total of ₹43.5 lakhs was generated.

Karnataka

Karwar and Kumta: Open sea cage farming for cobia, seabass, pompano and snappers are being carried out in the marine cage farm of CMFRI at Karwar. 1000 numbers of cobia fingerlings were transported from Mandapam Regional Centre of CMFRI during October 2013 and were stocked in two 6 m diameter cages at a density of 500 numbers in each cage. The initial weight of cobia at the time of stocking was 28 g. Feeding was initially done with pellet feed @10% body weight for two months. Cobia shifted to 12 m dia GI cage after attaining a size of 50 g. Regular monitoring of Growth and environmental parameters were carried out at fortnightly intervals. Average growth recorded at 150 DOC was 1.5 kg. and 1.5 t of cobia was harvested in August 2013.

Fingerlings (8000 nos.) of Asian seabass with an average weight of 4 g were stocked during December 2013 in four 6 m dia cages @2000 fingerlings/cage. The fishes were fed initially with pellet feed @10% biomass for 20 days and later they were fed with oil sardines @6% body weight. The average survival was 65%. Growth and environmental parameters were monitored regularly at fortnightly intervals in all the cages. The average initial weight of fish in all the cages ranged between 10-13 g. The growth of fish in weight (g) at 120 DOC varied between 177 to 259 g.

Thousand numbers of pompano, *T. blochii* were transported from Mandapam Regional Centre of CMFRI and stocked in a 6 m. dia. steel cage during the month of October 2013. Initial average weight of fish was 10 g. Fishes were fed with formulated pellet feed @10% biomass and average weight of fish at 150 DOC was 130 g. Farming is continuing.

At Karwar, CMFRI initated participatory farming of cobia in open sea cages. During 2013-14 the Centre had trained 20 fishermen from Kumta and 20 fishermen from Karwar. Fishermen formed 2 self help groups each at Kumta and at Karwar and cage farming is undertaken by these groups under the technical supervision of Karwar RC of CMFRI. Five cages were deployed in Vanahalli Bay, Kumta and four cages in Karwar. Asian seabass

Cage in the Vanahalli Bay in Kumta

was stocked in four cages @2500 seeds/cage at Kumta and Karwar and the rest four were stocked with cobia @750 seeds/cage. Feeding is done with chopped trash fishes. Average growth of cobia was 100 g in 30 DOC and that of seabass was 300 g in 90 DOC.

Estuarine and brackish water cage farming

Karnataka

Mangalore: After successful cage culture in Kundapur area in Karnataka, the cage designs were modified many times to suit various conditions in the estuaries of Karnataka. Modifications were made according to the depths of the water, water currents, tidal influx, bottom nature, easiness of operation, economic viability as well as availability of the fabrication material.

Rearing experiments by keeping cage in saline creeks for two years (including monsoon months) led to a record production of 1.3 t. The maximum growth achieved was 5.2 kg with average weight of 4.3 kg. With a farm gate price of ₹400/kg and the total income was ₹5.2 lakhs.

In 2013 cage culture of seabass and red snapper was again commenced in 4 m x 2 m x 2 m GI pipe framed cages and is being continued at Thallur Creek in Kundapur Estuary. This demonstration created interest in cage farming in Dakshina Kannada and in 2013 three GI framed cages of 6 m x 2 m x 2 m was installed in Mulky Estuary in Dakshina Kannda and seabass culture is being done. All weather mooring was tested in Mulky Estuary also to give a period of at least two seasons for the growth of seabass in cages.

Estuarine cages in Upunda Creek,Kundapur.

GIFT tilapia harvest at Panampukad, Ernakulam District

Kerala

Pooyappilly, North Paravur, Ernakulam: A 6 m diameter dismantling and reassembling type GI cage as well as a 6 m diameter HDPE cage was installed in the open waters at Pooyappilly. Each cage stocked with 1500 nos. of pearl spot *Etroplus suratensis* and 500 nos. of *Mugil cephalus* during January 2013. After a grow-out period of one year, the fishes were harvested. Size at harvest for pearlspot was ranging from 150 to 250 g and mullet 400-500 g. Fishes were sold at a farm gate price of ₹500/kg.

Kaipamangalam, Thrissur: A 6 m diameter HDPE cage installed in Kanoli canal in Kaipamangalam, Thrissur District . The cage was stocked with 1500 nos. of 10 g size *M. cephalus* and 2000 nos. of 10-15 g sized pearlspot *E. suratensis*. The fish were harvested after a grow-out period of one year and the size at harvest for pearlspot was150-210 g and mullet 400-450 g. The fish were sold at ₹400/kg at farm gate. The maximum size for pearlspot was 350 g.

Cage culture of GIFT Tilapia: Technology demonstration

As a farming option during south-west monsoon season in Kerala when the traditional shrimp farms remain barren due to the heavy freshwater influx, cage culture of GIFT tilapia was found as a viable alternative. The cage was moored in the sluice pit away from the sluice gate using bamboo poles fixed at four corners. During June 2013, GIFT seed measuring 5 cm on an average, procured from RGCA were reared for two months in a closed nursery pond of about 5 cents area. After attaining 25-35 g, about 1500 nos. were transferred to the GI cage measuring 4 m x 4 m inner frame and 4.5 m x 4.5 m outer frame. The net was of 3.5 m depth with a volume of 56 m^3. After three months of grow-out period in the cage, the fish had attained an average weight of 450 g. On harvest about 600 kg of fish were caught. The price realised at farm gate was ₹200/kg. The cage frame as well as net can be re-used for many cultures and it was observed that GIFT tilapia is a good option for farming during monsoon season under fresh to low saline (0-15 ppt) conditions.

Cages in Peruman, Ashtamudi Lake, Kollam District

Poothotta, Kottayam: Steel Square cage of 6 m x 6 m were fabricated and installed in the open backwaters of Poothotta in Kottayam District. Juveniles of red snapper of size 7-11 cm (50-70 g) pearlspot of size 4-5 cm (30-60 g) were stocked. Growth of pearlspot was very fast and reached a size of 120-300 g and snappers grown to a size of 200-450 g in 3 months.

Dismantling type steel cages

Perumon, Ashtamudi Lake, Kollam: Culture of pearlspot *Etroplus suratensis* in backwater cages at Kollam, Kerala was carried. Growth was less may be due to high salinity at the site and stocking density. Harvesting was done after 8 months with a survival of 85%. During harvest, the fishes reached a maximum size of 75 g with an average weight of 45 g. Juveniles of rabbitfishes entered and yielded around 35 kg from each cage.

Fabrication and installation of dismantling type steel cage

One 6 m dia steel cage was fabricated at CMFRI headquarters campus with provision for dismantling into three pieces and re-assembling at the site. The cage has been installed at Pooyappilly, Chittattukara Panchayat, Ernakulam District.

Establishment of sea cage farm for the *Sidi* tribals of Gujarat and capacity building (under Tribal Sub Plan)

Sidi or *Habshi* is a unique tribal group that has an African ancestry and lives in many parts of South Asia. In Gujarat they live mainly in villages adjacent to the Gir Forest areas in Junagadh District and mainly depend on forest products and services for their livelihood. The *Sidi* tribals have been categorised as primitive tribal group considering their general backwardness and stagnancy in population. Under the Tribal Sub Plan (TSP) outlay of the Institute, CMFRI organised a training programme for the *Sidi* community at Karwar Research Centre of Institute. Having trained, the tribals were financially and technically assisted to have a sea cage farm comprising of 20 circular GI cages of 5 m diameter during November, 2012. Financial and Technical assistance was provided to the tribals during the farming seasons 2012-13 and 2013-14 and crops of lobsters and cobia were raised by the tribals. The first crop of the farm was harvested during April, 2013 and the harvest programme was flagged off by Dr. S. Ayyappan, the Honourable Director General of ICAR on 13 April, 2013. The farm yielded 2 t of lobsters and 0.3 t of cobia worth ₹22,50,000/- which was handed over to the Tribals by the Honourable Director General, ICAR in the presence of many dignitaries from the ICAR, Junagadh Agricultural University and Department of Fisheries, Gujarat. The farm assets valued at ₹33 lakhs was also handed over to the Society for continued farming during the ensuing season.

Steel cages fabricated under TSP

A *Sidhi* tribal displaying harvested losters

Sl.No	Details of the beneficiaries under technology demonstration
1.	Mr. Ramana Reddy, Karwar, Karnataka
2.	Mr. Raghu Sekar, Nagailanka, Andhra Pradesh
3.	Mr. P. Ravi, Chidhambaram, Tamil Nadu
4.	Mr. Kevin Saldhana, Perupalam, West Godavari District, Andhra Pradesh
5.	Mr. M.V.S. Subba Raju, Bhimavaram, Andhra Pradesh
6.	M/s Vitality Aquaculture, Tuticorin, Tamil Nadu
7.	Mr. Abubakkar, Thondi, Tamil Nadu
8.	Mr. Jignesh U. Contractor, Surat, Gujarat
9.	Mr. Koteswara Raju, Peddapatnam, Krishna District, Andhra Pradesh
10.	Mr. Appal Raju, Bhimavaram, Andhra Pradesh

The harvest details from demonstration of cage farming

Sl. No.	Details of the beneficiaries under demonstration of the technology	Species		Quantity of production (t)
1.	M/s Vitality Aquaculture, Tuticorin, Tamil Nadu	Cobia	:	1.8
2.	Self Help Group, Maraikkayarpatnam, Tamil Nadu	Cobia	:	1.2
3.	KRC of CMFRI, Karwar, Karnataka	Cobia	:	1.5
4.	VRC of CMFRI, Veraval, Gujarat	Cobia	:	0.5
5.	MRC of CMFRI, Mandapam, Tamil Nadu	Cobia	:	1.5
6.	MRC of CMFRI, Mandapam, Tamil Nadu	Pompano	:	0.8
TOTAL				7.30

A. ocellatum infestation in pompano broodstock gill lamellae

Disease management

Studies in cage farming revealed that the dinoflagellate *Amyloodinium ocellatum* is one of the most important pathogenic ectoprarasite affecting the cultured marine and brackish water fish, causing Amyloodiniosis. Broodstock of silver pompano *T. blochii* with an average length and weight of 20 cm and 900 g respectively infected with ectoparasite showed difficulties in breathing, loss of appetite, rubbing of body on the sides of the tank/ objects in the tank and also an erratic swimming behavior and finally caused acute mortality. Grossly, the operculum showed focal area of erosion. Gill showed excessive mucus secretion and pale discolouration. Microscopic examination of the fresh gill filaments showed the presence of adult parasite feeding stage (trophont). Histopathologically, the gill showed erosion and necrosis of primary and secondary lamellar filament. The causative organism *A. ocellatum* was identified based on the clinical signs, gross and microscopic lesions. Fresh water dip and 5 per cent Povidone Iodine dip treatment was effective to control the condition in affected fish.

Integrated Multi Trophic Aquaculture (IMTA)

Integrated Multi Trophic Aquaculture (IMTA) by integrating the seaweed *Kappaphycus alvarezii* with cobia was initiated at Munaikadu (Palk Bay) in a participatory mode with fishermen group. Hatchery produced 400 cobia fingerlings (average length: 20.3 cm; weight: 49.2 g) were stocked in three cages (133 nos. in each cage) of 4.5×4.5 m outer dimension and 3.5 × 3.5 m inner dimension. The stocking density was between 5-6 numbers per cubic meter. The fishes are being fed with trash fish twice a day.

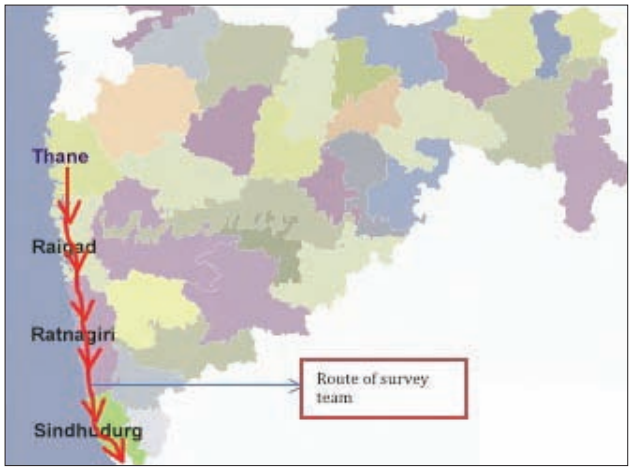
Launching of cages for IMTA trial

Launching of cages near the seaweed farm

Sustainable molluscan mariculture practices

Identification of bivalve farming sites along coastal Maharashtra

Surveys were undertaken in October 2013 along the coastal districts of Maharashtra for identification of suitable sites for bivalve farming.



Training in bivalve farming

Training on 'mussel and oyster farming technique' was imparted to fishermen in Kalbadevi area of Ratnagiri in collaboration with MPEDA.

Training on 'edible oyster and green mussel farming' was jointly organised by CMFRI, MPEDA and NETFISH at Ratnagiri on 7 October 2013 for 40 participants. HRD programme on 'molluscan farming' demonstration was jointly organised with MPEDA, Mumbai, and CMFRI from 12 to 14 December 2013 at Ratnagiri for 25 farmers. Demonstration racks were fabricated using bamboo poles at 2-3 m water depth for mussel farming.

As part of the training programme on 'mariculture' organised jointly by ICAR Research Complex for Goa and CMFRI, training on various aspects of mussel and oyster farming was imparted for fishermen and shrimp farmers of Goa under the technical session on 'bivalve mariculture' on 12 February, 2014 at Goa.

Training on 'bivalve farming' was given to 42 participants as part of the HRD training on 'Capture based aquaculture' from 2-4 December 2013 at CMFRI, Mangalore.

Farming trials of *Saccostrea cucullata* in Mulki Estuary: Rock oysters of 32.8±4.03 mm in the size range of 25-38 mm were stocked in netlon trays of 50 x 50 x 10 cm @16 kg/sq.m during November 2013 in Mulki Estuary. The salinity in the culture site varied between 32 to 34.5 psu. The growth rates and survival of the oysters in the trays were monitored. The mean monthly growth rate recorded was 1.87 mm ranging from 0.86 to 2.89 mm in different units.

Conducted training for 60 fisherwomen on mussel farming for the Kudumbashree units (SHG) of the Balathurithi area under the Vallikunnu Grama Panchayat on 16 November 2013. All the SHG's were assured subsidy for the culture of mussels in the backwaters of Kadalundi Estuary.

Bivalve farming training at Kalbhadevi, Ratnagiri

Training on mussel farming at Mangalore.

Mussel farming training at Balaathurithi, Malappuram

Mortality of farmed mussels at Padanna

Conducted study on the cause of motality of farmed mussels at Edayilakadu Estuary and submitted the report entitled "Investigative report on mortality of farmed mussel in parts of Padanna Kayal, Kasargod District, Kerala during 2013-14" to the District fishery officials. Some of the suggested improvements were with regard to the construction of bund which causes reduction in the flow of food material for the mussels and also leads to eutrophication of the water body and hence recommended construction of proper pillar bridges at Edayilakkadu and at Udumbanthala-Madakkal road. Also recommended restriction on the number of mussel farms to 75 from the subsequent farming season onwards based on the carrying capacity of the Edayilakkadu area. There was no evident pathological condition in the dead mussels. The loss was estimated as 790 t worth about ₹4 crores.

Dead mussels on culture rope, Edayilakkadu, Padanne, Kasargod

Farming trials of *Saccostrea cucullata* in Mulki Estuary

Rock oyster culture trials in Mulki Estuary, Karnataka

The rock oysters of 32.8±4.03 mm in the size range of 25-38 mm were stocked in netlon trays of 50 x 50 x 10 cm @16 kg/sq.m during November 2013 in Mulki Estuary. The salinity in the culture site varied between 32 to 34.5 psu. The growth rates and survival of the oysters in the trays were monitored. The mean monthly growth rate recorded was 1.87mm ranging from 0.86 to 2.89 mm in different units.

Mussel farmer receives Zilla Rajyostsava Award

Shri. Shankar Kundar, mussel farmer from Kodikanyan, Udupi District of Karnataka was conferred with "Zilla Rajyotsava Prashasti, 2013" under the category "Agriculture" for adopting and practicing scientific mussel farming

The Zilla Rajyotsava Prashasti, 2013 awardees with Shri. Vinaya Kumar Sorake, Hon. Minister for Urban development and Shri Promodh Madhwaraj, MLA

in Karnataka. The award was presented by Shri. Vinaya Kumar Sorake, Hon. Minister for Urban development and Udupi District in-Charge and Shri Promodh Madhwaraj, MLA.

Mabe pearl oyster

As per the request from the Director of Fisheries, Government of Kerala, regarding implementation of a pilot project on pearl culture, a Frontline demonstration project was prepared and submitted to the state government and it has been included in the budget and same will be taken up soon. Kerala government requested CMFRI to facilitate training of their staff in pearl culture to take up the project.

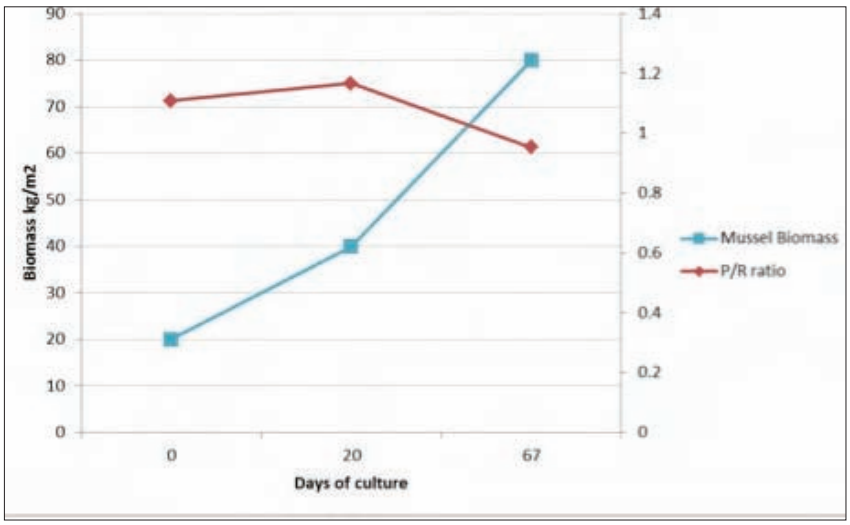
Three days training program on 'Image Pearl Production' was organised at Vizhinjam Research Centre of CMFRI from 19-21 February 2014. Twenty four participants from different parts of the country attended the training.

Image implantation practical training

Trials were conducted to study the effect of area of implantation of nuclei on pearl production. About 400 image nuclei were produced and were implanted in 200 oysters of 55 to 80 mm DVM, under the project. The implanted oysters were stocked in cages at the rate of 50 numbers per cage. Oysters were harvested 52 days after implantation. Nacre coating ranged from 65.1 to 93.02 micron at various sites of implantation. Nucleus implanted close to the mantle edge gave darker shades and thicker coating. The regions nearer to the body mass gave silvery colouration and the coating was thinner. Left valve gave more space for implantation that larger nucleus could be implanted.

Carrying capacity of estuaries for mussel farming

The ratio between production (P) and consumption (R) of dissolved oxygen in an aquatic ecosystem decides the state of health and the trophic status of the system. In the green mussel farming areas of Padanna Estuary recorded P/R values more than one indicating an autotrophic nature during the early stages of farming season. Subsequently as the farmed mussels grow and attain biomass, the P/R values reduced, indicating heterotrophic conditions. This observed relationship between the farmed biomass increase and the shift in the trophic levels in the farming area indicates the need to either thin down the existing biomass or to increase the farming area in vertical or horizontal proportions which can be achieved by allowing influx of more seawater to flow through the farms. In summary, the farmed biomass exceeds the carrying capacity of the ecosystem.



Extension studies on mussel farming

Ownership of mussel culture enterprise

The women SHG members of Kudumbashree CDS of Vallikkunnu grama panchayat take loan at their own responsibility with a reasonable amount as beneficiary contribution along with the subsidy component of the government for mussel culture enterprise. The five members of each SHG take the joint responsibility through a strong internal arrangement with a firm base of interpersonal trust. Each SHG will have an elected president, secretary and treasurer.

The major independent variables were quantified and the average score obtained for the respondents (members of SHG) were converted into percentage values.

Quantification of independent variables in Malabar locations

Variable	Malabar location
Credit orientation	71.5%
Economic motivation	66.0%
Scientific orientation	59.5%
Risk orientation	61.0%
Socio-economic status	46.5%
Social participation	78.0%
Extension orientation	59.5%
Mass media participation	79.0%
Cosmopoliteness	67.0%

The cost dynamics of each SHG of 5 members were also collected and are presented in table as projection for the next five years.

Profit and Loss account (₹)

Particulars	I Year	II Year	III Year	IV Year	V Year
Sales revenue	245147	247404	270274	283787	307075
Total variable cost	74000	77700	81585	85664	89946
Total fixed cost	146350	144460	142950	141790	140945
Net profit	24797	25244	45739	56333	761184

Commercial viability of black pearl production in the Andamans and conservation mariculture of ETP gastropods

Research Project: EF-1/MoES

The influence of microalgal size, density and salinity gradients on filter feeding of *Pinctada margaritifera* spat produced in the hatchery was studied.

The study revealed that the feeding performance of pearl oyster *P. margaritifera* spat was comparatively better in salinities ranging from 28 to 37 ppt among the tested salinities. But a perfect feeding performance was noticed with a narrow range of salinity between 31 to 34 ppt. Clearance rate, ingestion rate and retention efficiency of different sized algae showed that in these salinities spat are able to do normal feeding activities in all the tested seston concentrations. The performances of these parameters were better in the optimal algal concentration of 50 x 10^3 cells ml^{-1} with filter pumping processes at its full capacity. Higher concentrations of phytoplankton, cause reduction of the valve gape and retraction of mantle edges and siphons, correlated with reduced water pumping. Clearance rate and ingestion rate lower with diatoms than flagellates.

Salinity, size of the food particle and its concentrations are also important factors influencing the ingestion rate along with morphology of pearl oyster. Spat showed more clearance and ingestion rate in the order of *Chaetoceros calcitrans, Isochrysis galbana, Pavlova salina, Chlorella marina* and *Nannochloropsis oculata*. The ingestion rate proportionally increased with food concentration but the retention efficiency was inversely proportional. The smaller sized *Chlorella marina* and *N. oculata* showed less retention than that of the other larger algal species, *Pavlova salina*, *I. galbana* and *C. calcitrans*. The study has revealed that the best live feed for the blacklip pearl oyster spat should have a size of above 3 µm with cell concentration of 25 to 50 $x10^3$ cells ml^{-1} for nursery rearing.

Variations in clearance rate (CR), ingestion rate (IR) and retention efficency (RE) of pearl oyster *P. margaritifera* spat of algal species in different food concentrations. All results are significant (P<0.01) except those with asterisk.

Food Concentration	Source of Variation	F value of CR	P value	F value of IR	P value	F value of RE	P value
100 x 10^3	Salinities	6.31	0.000	8.206	0.000	6.626	0.000
	Algal species	2.045	0.112*	5.831	0.001	3.645	0.015
75 x 10^3	Salinities	10.679	0.000	10.011	0.000	7.300	0.000
	Algal species	5.326	0.002	10.960	0.000	2.270	0.083*
50 x 10^3	Salinities	4.402	0.001	5.361	0.000	5.321	0.000
	Algal species	7.344	0.000	4.697	0.004	3.106	0.029
25 x 10^3	Salinities	5.955	0.000	9.706	0.000	7.819	0.000
	Algal species	11.129	0.000	6.100	0.001	3.762	0.013

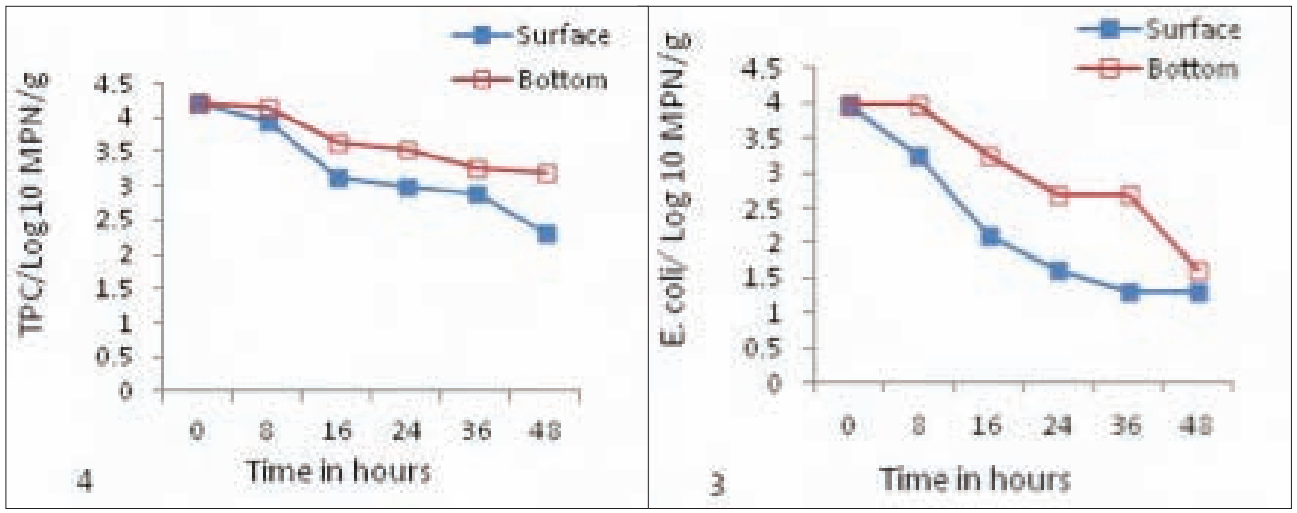
A value chain on high value shellfishes from mariculture systems

Research Project: EF-27/NAIP

Protocols for depuration of bacterial populations in the Indian backwater oyster *Crassostrea madrasensis* developed. The efficiency of depuration of the Indian backwater oyster *Crassostrea madrasensis* using the fill-draw method (static method) with high-loading density was evaluated in a study. Depuration experiments were conducted with cartridge-filtered and UV-treated seawater at a salinity of 30.3 PSU, pH of 8.3 and temperature of 29.5°C. The oysters located in trays on the surface and on the bottom were compared for microbial loads. Samples were taken at 0 h, 8 h, 16 h, 24 h, 36 h, and 48 h of depuration. The results showed that in winter monsoon-sampled non-depurated oysters, the most probable number of fecal coliforms and *Escherichia coli* were greater than the limits according to NSSP and European Union regulations. The surface-held oysters took 24 h to reduce the coliforms and *E. coli* levels to below safe limits whereas for bottom-held oysters it took 48 h. *Salmonella* was never detected in the oysters sampled, whereas *Vibrio* spp. were present in the non-depurated oysters and were eliminated completely after 8 h of depuration. Variation in depuration of total coliforms, fecal coliforms, *E. coli*, total plate count, and fecal *Streptococci* in oysters were significant (P<0.05) between surface and bottom oysters. The study results recommend a loading density of 2 oysters/l water stacked in 1 layer as the optimum loading density for commercial depuration completed within 24 h.

Levels of total coliforms (TC), fecal coliforms (FC), *Escherichia coli (E. coli)*, total plate count (TPC), and fecal *streptococci* (FS) for surface-layer and bottom-held oysters at different depuration times. All values are $\log_{10}$ mean ± SD. Non-identical superscript letters within columns indicate a significant difference at P>0.05. The TPCs between the surface and bottom oysters were not significantly different (t-test, P = 0.426). MPN: most probable number

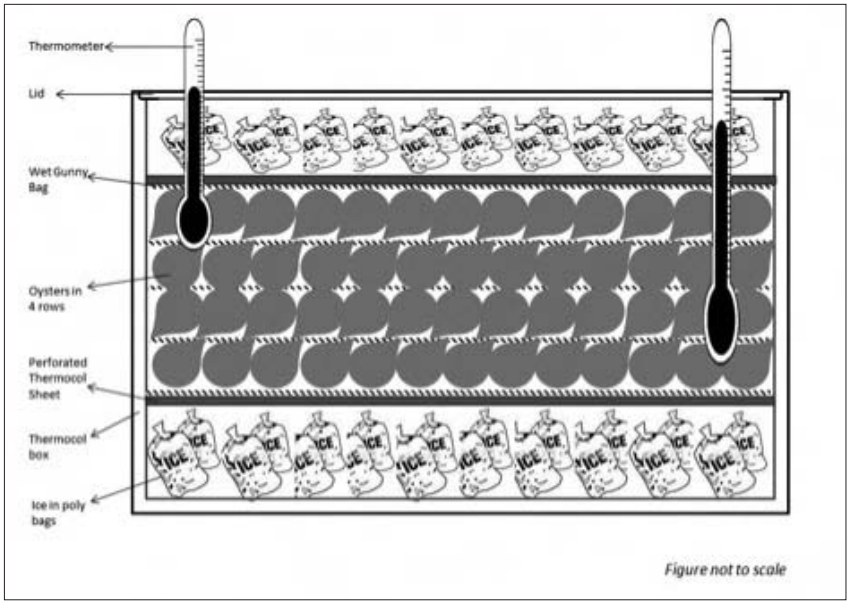
Sample	Time(h)	TC(MPN/ g)	FC (MPN/g)	*E. coli* (MPN/ g)	TPC (CFU/ g)	FS (CFU/ g)
Surface	0	4.16±0.17a	4.06±0.17a	3.88±0.13a	4.23±0.12	1.46±0.30a
	8	3.45±0.23b	3.29±0.04b	3.22±0.02b	3.87±0.21	0.99±0.26b
	16	2.97±0.30c	2.85±0.41c	2.25±0.24c	3.22±0.63	0.81±0.14b
	24	2.18±0.03d	1.84±0.10d	1.60±0.20d	3.00±0.10	0.001±0c
	36	2.18±0.03d	1.81±0.23d	1.30±0.30d	2.76±0.11	0.001±0c
	48	1.88±0.05d	1.32±0.26e	1.26±0.17d	2.27±0.34	0.001±0c
Bottom	0	4.16±0.17a	4.06±0.17a	3.88±0.13a	4.23±0.12	1.46±0.30a
	8	4.16±0.17a	4.06±0.17a	3.88±0.13a	4.12±0.03	1.36±0.02a
	16	4.06±0.17a	3.88±0.13a	3.34±0.17b	3.70±0.62	1.30±0.21a
	24	3.59±0.23b	3.34±0.03b	2.84±0.25c	3.47±0.49	1.07±0.19a
	36	3.49±0.20b	3.34±0.03b	2.71±0.60c	3.33±0.56	0.93±0.05a
	48	2.05±0.09c	1.58±0.03c	1.58±0.03d	3.16±0.18	0.36±0.30b



Depuration of *E. coli* and TPC in oysters located in trays on the surface and bottom at different time intervals

Protocols for long distance/duration transport of live oyster

Oyster is very rich in protein and minerals and is generally sold with shell-on and consumed fresh throughout the world. Eating oyster in raw form is good for health because cooking reduces the quantity of amino acids. Most oysters produced in the UK are distributed live and are frequently eaten raw or sometimes lightly cooked. In India, edible oyster, *Crassostrea madrasensis* farming is being practised by several farmers, especially women Self-Help Groups in central Kerala employing the rack and ren method in the estuaries and backwaters. However, farmed oysters do



Cross section of rectangular thermacol-transport box with oysters

not find ready market acceptability and good price. After introduction of depuration system for high-end restaurants, the live oyster value chain has been developed in the city of Kochi and has great scope to expand to other metro cities. It is generally understood that to maintain high survival rate and good meat quality throughout storage, one must pay careful attention to many factors including condition of the oysters, packaging, humidity and temperature. If the live value chain has to expand in other cities, there is a need for long distance transportation of live oysters and for its survival in a display unit or tank.

Survival of *C. madrasensis* was examined under ice-storage in a rectangular thermocol-transport box for a period of 48 h. A total of 100 two-year old farmed oysters were used for the experimental transportation. Inside the box, all oysters were arranged in four layers covered with wet-gunny bags and lined on the top and bottom with ice. Surface and bottom temperature of the transport box varied from 9.7 to 25.2°C and 9.7 to 28.4°C respectively during the 48 h exposure. The patterns of changing temperature at both surface and bottom were found to be different. Recoveries of the oysters at every two hours till 48 h were monitored by taking random samples from the box. All the oysters recovered within 1 h of being placed back into seawater and there was close to 100% recovery within 2 h. Survival was more than 90% after 8 days of the experiment.

Adoption of oyster VAP technology by QSSS, Kollam

The Quilon Social Service Society (QSSS) has adopted the oyster depuration and processing technologies developed under the NAIP scheme on High-value shellfish for processing yellow foot clam (*Paphia malabarica*) in Ashtamudi Lake. A small beginning to popularise clam products in the domestic market has been made by the QSSS by producing quality assured yellow-foot clam products. The meat is produced from depurated clams and 3 min pressurised steaming is used for shucking.

On 14 June 2013 the product was launched under the trade name “Ashtamudi Clams”. The Hon. Minister for Fisheries, Govt. of Kerala, Sri. K. Babu inaugurated the function and Hon. Minister for Labour Sri. Shibu Baby John presided over the function. The first sale of the ready to cook yellow foot clam meat was handed over to Smt. Beena Dayal, President, Thekkumbhagam Grama Panchayath by Sri. N. Peethambara Kurup,

Hon. Member of Parliament, Kollam. The" Samruddhi" Shellfish Value Added production unit was also inaugurated by the Hon. Minister Sri. K. Babu and he took keen interest to see the activities in the VAP unit.

Women SHG members processing clams in the new VAP unit set up by QSSS at Kollam

Clams processed by the new steaming technique developed by CMFRI is more juicy and succulent

Marine **biodiversity**

Coral reef ecosystems

Research project: FISHCMFRISIL201201600016

Survey and inventorying of bio-resources

GOMBR (Tuticorin): Hard Corals

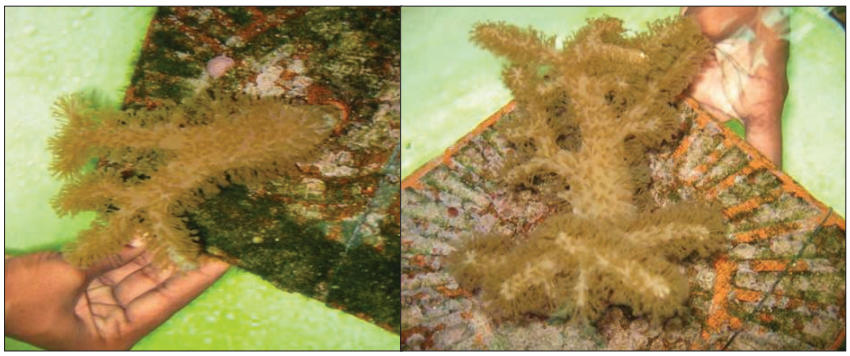
Underwater coral surveys were carried out at ten different sites within three zones (Sites I, II & III (inner zone), sites IV, V & VI (middle zone) and sites VII-X (outlet zone)) in Tuticorin Harbour waters (Gulf of Mannar Biosphere Reserve), south-east coast of India (Lat. 08°45 01'.79" N; Long. 78° 12 10'.75" E) following Line Intercept Transect method.

The percentage of live and dead coral cover, relative abundance, mortality index, taxonomic status and taxonomic independent conservation classes were calculated in the surveyed sites. In the entire reef, 30 species of hard corals belonging to 9 genera and 5 families were recorded. The total coral cover in the entire transect area recorded 25.91% live corals, 30.6% dead corals, 17.9% dead corals with algae and the rest 25.6% was contributed by sand, stones and concrete blocks.

The survey also revealed that the massive corals were dominant in most of the areas followed by foliose and branching forms. The live corals were represented by Favidae (18.4%), Dendrophyllidae (6.1%), Acroporidae (1.0%), and Poritidae (0.4%). Faviids were dominated by *Favia* spp. and *Favites* spp.; *Turbinaria* sp. dominated the dendrophyllids and acroporids were represented by *Acropora* spp.

GOMBR (Mandapam): Soft corals

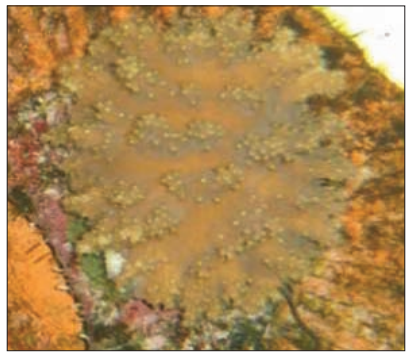
Removal of explants by tying noose in soft coral *Sinularia kavarattiensis*: Removal of explants by slicing with razor blades leads to injury to both the parent as well as the explant. When the explants are removed by tying noose to the parent colonies using cotton thread, it is possible to get injury-free explants. A total of 13 explants were removed successfully from 4 parent colonies of *Sinularia kavarattiensis*. The noose is tightened on alternate days and it was found that the explants get detached in a span of 15 to 20 days. The explants thus detached were planted on red tile (burnt pressed clay tile). The explants were found to

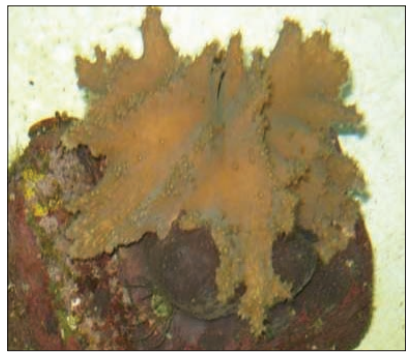


Newly developed colonies of *Sinularia kavarattiensis*

attach to the substratum in a span of 2 weeks. The increase in biomass of individual colonies ranged from 48.9 to 53.4 g and the average increase in number of lobes was 4.

Growth performance of explants of *Dampia pocilloporaeformis*: The explants were removed from the parent colonies using a sharp razor blade. Concrete blocks, red tile, floor tile and granite stones were used as substratum. All the substrates used facilitated attachment of explants and the time taken for attachment ranged from 14 to 21 days. The growth increment of individual colonies ranged from 10 to 37 mm during a culture period of 120 days.





Newly developed colonies of *Dampia Pocilloporaeformis*

Growth performance of a single colony of *Cladiella laciniosa* in captive condition: A colony of *Cladiella laciniosa* was developed on a concrete block and cultured for a period of 120 days. The maximum spread which was 95 mm increased to 125 mm during the culture period.

Goa

The patchy coral cover and diversity in Grande Island, Goa was assessed using Line Intercept Transect method. The survey was carried out in three locations: Site 1. Lobster Avenue: GPS: 15°20.99' N and 73°46 .53'E, Site 2. Chow Point: GPS: 15°21.03' N and 73°47 .03'E, Site 3. Jetty: GPS: 15°21.18' N and 73°45 .96'E.

Site 1: In Lobster Avenue, the entire transect area recorded 75.56% live corals, 5.0% bleached corals, 12.5% dead corals with algae and rest 6.94% comprised of sand, stones and seaweeds (*Padina* spp.). The live coral cover was represented by hard coral species belonging to six families namely Poritidae (9.11%), Merulinidae (19.13%), Faviidae (4.53%), Agariciidae (1.13%), Psammocoridae (2.64%) and Dendrophyllidae (39.76%).

Site 2: Chow Point registered 62.5% live coral, 21.5% dead corals with algae and rest 16.5% by sand, stones and boulders. Hard coral species

belonging to four families namely Dendrophyllidae (28.4%), Poritidae (22.8%), Merulinidae (7.7%), and Faviidae (3.4%) were dominant among the live coral cover.

Site 3: Jetty, recorded 21.5% live corals, 35.6% dead corals with algae and rest 16.2% was contributed by sand, seaweeds (*Caulerpa* spp., *Sargassum* sp., *Padina* sp.) and boulders. The live coral cover recorded hard coral species which belonged to four families namely Dendrophyllidae (14.02%), Poritidae (2.26%), Merulinidae (1.15%), and Faviidae (0.78%) and gorgonids (3.3%). Coral mortality indices revealed that the first two sites were in healthy condition and since the Site 3 recorded a CMI of 0. 623 which are above normal value of 0.33 and therefore categorised as 'sick'.

Lakshadweep islands

The hard corals collected during the underwater surveys following Line Intercept Transect method in Agatti and Bangaram islands of Lakshadweep during March 2013 were identified and recorded on a GIS platform.

Agatti and Bangaram

Line Intercept Transect method was adopted to describe coral community and composition. At Agatti a total of 10 transects of 30 m each with three replicates set apart by 5 m were placed parallel to the reef break at 1 to 3 m deep areas of lagoon. At Bangaram, two transects were set at the deeper areas between Bangaram and Tinnakkara islands and a single transect was made at the eastern part of Tinnakkara Island. All data were recorded by observers experienced in the field identification of corals using scuba and snorkel.

Sampling sites of Agatti Lagoon

Sampling sites of Bengaram-Tinnakkara Lagoon

In Agatti Island, total of 70 scleractinian species belonging to 25 genera were recorded during the survey. Genera *Acropora* (37%) and *Porites* (35%) showed maximum abundance followed by *Pocillopora* and *Platygyra* (4% each). The other genera recorded were *Psammacora*, *Gardineroseris, Pavona, Turbinaria*, *Cyphastrea, Leptoria, Leptastrea, Galaxea, Echinopora, Astreopora*, *Pocillopora, Goniastrea* and *Agaricia*. Bleaching was not noticed in any site in the surveyed areas, although sites with dead corals were noticed. The non-scleractanian corals were

Dominant hard coral species of Agatti and Bengaram

Acropora formosa

Porites lutea

Other important coral species

Heliopora coerulea

Goniopora sp.

Acropora palifera

represented by *Millepora exesa* and *Heliopora coerulea*.

Relative Abundance Analysis revealed 3 species as 'abundant' viz., *Acropora formosa*, *Porites lobata* and *Porites lutea*; 20 as 'common', 34 'uncommon' species and 13 as 'Rare' species. Coral Mortality Indices showed lesser rate of mortality in the south eastern part of the atoll. In the lagoon which lies on the western side of island, the southern most station (S3) showed maximum mortality. As most of the sites had a MI value >0.33, they can be classified as near to 'sick'. *Porites lobata* and *Porites lutea* inside lagoon (Station S6) supported a variety of *Acropora* spp. Occurrence of algal growth on dead corals and fewer incidences of freshly bleached corals showed that the incidence which caused the mortality has not occurred in the recent past.

Bangaram A total of 40 species of corals were recorded from Bangaram atoll. Acroporids of selected areas were found dead and were covered with algae.

Amini and Kadamat Islands

In January-February 2014, Amini and Kadamat islands of Lakshadweep were surveyed and the biodiversity was assessed by Line Intercept Transect and Visual Census methods. The hard corals (55 and 72 species and from Amini and Kadamat islands), 26 species of molluscs (24 gastropods, 1 giant clam and 1 octopus), 20 species of sea weeds, 8 species of holothurians, 3 species of sea hares, 1 feather star, 4 species of brittle stars, 1 pin cushion star and 1 isopod species were recorded. Quantification of the coral fishes and hydrological analysis were also carried out.

Molluscan biodiversity in Amini and Kadamat Islands: The molluscan resources in the coral reefs of the two islands were recorded through underwater survey (Line transect method) of the coral reefs. Intertidal species of molluscs distributed along the two islands were also collected during low tides and recorded. The major mollusc resources recorded were gastropods, giant clams and octopus. These have an important bearing on sustainability of the coral reefs. Artisanal fishery for octopus and cowries is a major livelihood activity in the Lakhshadweep islands.

Tridacna maxima

Lambis chiragra

Amini women with her prized catch *Octopus cyanae*

Amini Island: Molluscs in the lagoon/reef of Amini Island was represented by 2 families of gastropods, 1 bivalve and 1 octopus The gastropods *Lambis chiragra*, *Plueroplaca (=Fasciolaria) trapezium* and the giant clam *Tridacna maxima* are protected species listed under Schedule IV of the Wildlife Protection Act, 1972.

Molluscs in the intertidal flats of Amini Island were represented by 4 families of gastropods. Six species of *Cypraea*, 3 species of *Strombus*, 2 species of *Nerita* and 1 *Littorina* species were recorded

Kadamat Island: 11 families of gastropods, 2 families of bivalves and 1 octopus were recorded from the lagoon waters of Kadamat Island. Three species of *Cypraea*, 3 species of muricids, 4 species of *Strombus*, 3 species of *Vasum* and 1 each of *Cerithium* sp., *Tonna* sp., *Trochus* sp., *Turbo* sp., *Oliva* sp. and *Plueroplaca trapezium* were recorded. The giant clam *Tridacna maxima* and *Octopus cyanae* were also recorded from Kadamat Island.

The intertidal flats of Kadamat Island had high species diversity. Gastropods representing 9 families were recorded among which 4 *Conus* sp., 6 *Cypraea* sp., 5 muricids, 3 neretids, 1 *Terebra* sp., 2 *Cymatium* sp., 2 trochid sp and 1 *Vasum* sp. were recorded.

Other resources recorded from the coral reefs of Amini and Kadamat islands are holothurians (5 species), brittle stars (4 species), feather star (1 species), cushion star (1 species), sea hares (3 species), isopod (1 species).

Ophiocomina nigra (Black feather star)

Linckia leavigata

Cypreae caputserpentis

Holothuria fuscogilva

Holothuria hilla

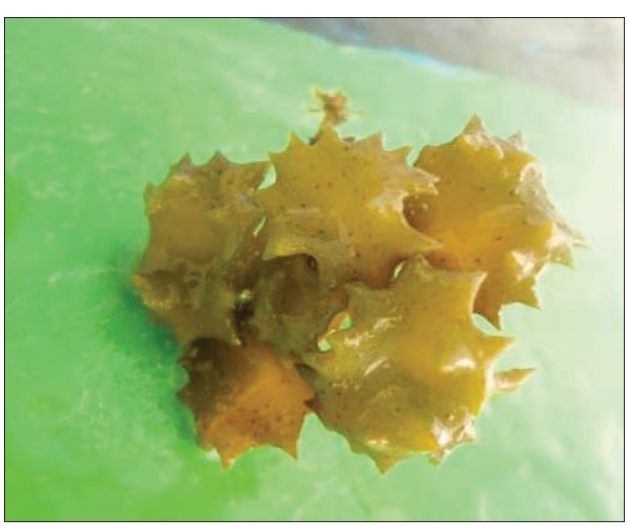
Holothuria spinifera

Aplysia oculifera

Culcita novaeguineae (Pin cushion star)

Halimeda macroloba

Amphiroa anceps



Turbinaria ornata

Halimeda sp.

Seaweeds observed in Amini and Kadamat: Altogether around 20 species were observed. *Padina* sp. was found to dominate in Amini. Species diversity was found to be more in Amini than in Kadmath Island.

Other resources

Sponges: Underwater surveys conducted in the shallow coastal waters extending from Enayam to Kollam, southern India revealed a total of 24 species of sponges which were identified during the study and belonged to 20 genera, 13 families and 6 orders. The specimens have been deposited to the Designated Repository, Cochin.

Fishing impacts on the biodiversity loss

Reserch project: FISHCMFRISIL201201700017

Vizhinjam

In Muttom, a large mesh-sized bottom set gill net, Ottakunduvala entangled huge quantities of live rocks along with large sized rare bivalves and gastropods like *Malleus malleus*, *Pinna bicolor*, *P. muricata*, *Lambis crocata*, star fish *Protoreaster lincki* and cushion star, *Culcita novaeguineae*. Along with targeted species of rays and fishes (*Lutjanus* spp. and Lethrinids). fairly good number of big sized ornamental fishes such as *Chlorurus sordidus*, *Plectorhincus* spp., *Scarus* spp. also were entangled in the net.

In Neendakara trawl landings, large quantities of juvenile *Decapterus russelli* was recorded in September 2013.

Cochin

During November-December 2013, discards from trawl boats (MDTN) operating from Cochin Fisheries Harbour (4-5 days trip) and Kalamukku Fisheries Harbour (15 days trips) were collected. The discards from trawl catches comprised of significant quantities of juveniles of several species of fish, shrimps, squilla, crabs, and squids. They also comprised of live and dead shells of bivalves and gastropods which are generally discarded into the sea. Berried crabs were also noticed. Egg capsules of cephalopod attached to coconut fronds and empty egg capsules of gastropod were also recorded. Jelly fish (2 species) and seaweeds (4 species) occurred in the month of December. Juveniles of flat fish (*Cynoglossus macrostomus*), pipe fish (*Fistularia commersoni*), squid (*Loligo duvaucelli*), Cuttlefish (*Sepia elliptica*), shark (*Iago omanaensis*), grouper (*Epinephelus diacanthus*) were recorded.

Among the sharks landed by gears other than trawl (gill nets, hooks & lines, purse seines, ring seines and drift nets), 1 species was endangered (*Sphyrna lewini*), 4 species were vulnerable (*Stegostoma fasciatum, Taeniura meyeni* and *Rhina ancylostoma*), as per the IUCN Red List.

Mumbai

The most vulnerable groups in the trawl net are the juveniles of commercially important species that are being caught as bycatch. Fifteen species of

Star fish entangled in Ottakunduvala
(Bottom set gill net)

Lambis crocata

Juveniles of *Sphyraena putnamae*

teleosts had 69% of their catch consisting of juveniles while 45% of the elasmobranch catch and 25% of cephalopod catch comprised juveniles.

Rare species landed in trawl net are *Colletteichthys dussumieri, Antennarius striatus, Torpedo marmorata, Galeocerdo cuvier, Rhynchobatus djiddensis, Oratosquilla naperpensa* and *Oratosquilla kempi.*

Visakhapatnam

Analysis of bycatch sample from single day as well as multiday trawlers revealed an altogether 11 different groups of biota, of which finfishes were the most dominant group in terms of biomass.

A total of 130 species were identified from the discard samples during June 2013 to December 2013, which comprised of 95 species of finfishes, 4 species of gastropods, 1 species of bivalve, 6 species of cephalopods, 13 species of shrimps, 2 species of stomatopods, 8 species of crabs, 1 species of lobster and juveniles of unidentified sharks and rays.

Landings of juveniles of tiger shark as well as protected species of skates and turtles were observed along Visakhapatnam coast.

Tuticorin

The major vulnerable groups encountered in gill net & trawl nets were: elasmobranchs (*Rhincodon typus* and

Juveniles of *Parastromateus niger*

Bow-mouth guitarfish

Juvenile of tiger shark

Rhynchobatus djiddensis) gastropods (*Lambis crocata* and *Pleuroploca trapezium*), hard corals (*Acropora* sp., *Pocillopora* sp., *Turbinaria* sp., *Montipora* sp. and *Cycloseris* sp.), gorgonids, sponges and sea cucumbers were encountered in the gill nets and trawl nets. Other groups like sea grass, sea urchins and starfish occurrence were high in gill nets and juvenile fishes dominate in trawl nets.

Rare species like *Neoharriotta pinnata*, *Galeocerdo cuvier*, *Echinorhinus brucus*, *E. cookei*, *Pseudocarcharias kamoharai* and *Rhina ancylostoma* were recorded.

Mandapam

The mini trawls locally called *thallu valai* operated in the sea grass beds off Devipattinam and Thiruppalaikudi in the Gulf of Mannar remove 10 to 15 kg of sea grass during a single operation; while the targeted juveniles of *Penaeus semisulcatus* constituted about 3 kg star fish (*Pentaceraster* spp.), gastropods, large number of juvenile crabs (*Portunus pelagicus*) are also caught. Highly endangered groups like sea cucumber and pipe fish are also caught in this gear.

The bottom set lobster gill net locally called Singhi valai operated in the Gulf of Mannar is found to be destructive to the many non-target resources. The targeted lobsters are caught in very few numbers. The non-targeted resources that are caught include the live rocks (about 10 kg), gorgonids, gastropods (*Bursa spinosa*, *Hemifusus* sp., *Turbinella pyrum*, *Murex* spp., *Chicoreus* spp., *Pteria* sp.) and many species of non-edible crabs.

A large number of bottom set crab gill net locally called Nandu valai is operated in the Gulf of Mannar. The targeted crabs (*Portunus pelagicus*) constitute about 5 to 15 kg and a small income is obtained from the catch of the gastropod *Turbinella pyrum*. The other molluscs include *Murex virgineus*, *Hemifusus* sp., *Conus* spp. and *Chicoreus* sp., sponges, starfish and different species of non-edible crabs are also caught in this gear.

List of threatened species listed in the Indian Wildlife Protection Act, 1972 and the gears in which they are caught (Gulf of Mannar and Palk Bay)

Species	Gear	Status
Rhincodon typus	Gill net	Schedule I Part II-A
Rhynchobatus djiddensis	Trawl net	Schedule I Part II-A
Sygnathids	Mini trawl	Schedule I Part II- A
Sea cucumber	Mini trawl	Schedule I Part IV-C
Pleuroploca (=Fasciolaria) trapezium	Gill net	Schedule IV
Sponges	Gill net	Schedule III
Gorgonids	Gill net; Trawl net	Schedule I Part IV-A
Hard corals	Gill net	Schedule I Part IV-A

Bioinventorying and biodiversity valuation of marine organisms in selected marine ecosystems

Research project: FISHCMFRISIL201201500015

A total of 35 species of fin fishes were collected and deposited in the reference repository of marine museum (CMFRI). Of these 10 species are new records from India.

Check list of phytoplankters from the southwest coast of India was prepared by compiling information which contains 493 species belonging to 174 genera, 105 families and 65 orders under 13 classes.

A total of 110 species of finfishes under 76 genera and 38 families were recorded from Vizhinjam

Bioinventory of the Opisthobranch fauna (molluscs) of the south-west coast of India was done. A list of 97 species of opisthobranchs from various families were compiled which belong to 5 orders (Anaspidea, Cephalaspidea, Nudibranchia, Pleurobranchomorpha and Sacoglossa); 26 families and 54 genera.

A list of 122 species of stomatopods from the Arabian Sea and Bay of Bengal was compiled.

List of marine fauna of Vishakhapatnam coast was compiled and it contains 453 species of fin fishes, 42 species crustaceans, 48 molluscs, 4 echinoderms, 2 reptiles, 4 mammals and 2 coelenterates

Phytoplankters from southwest coast of India (Numbers)

Classes	Orders	Families	Genera	Species
Bacillariophyceae	35	56	103	326
Dinophyceae	10	24	38	128
Cyanophyceae	4	6	12	15
Dictyochophyceae	1	1	2	5
Trebouxiophyceae	1	2	2	2
Ulvophyceae	2	2	2	2
Chlorophyceae	4	6	7	7
Raphidophyceae	1	1	1	1
Euglenophyceae	1	1	1	1
Coccolithophyceae	3	3	3	3
Chlorodendrophyceae	1	1	1	1
Charophyceae	1	1	1	1
Pedinophyceae	1	1	1	1
13	65	105	174	493

List of families of fishes recorded from Vizhinjam

Family	No. of Genera	No. of Species
Alopiidae	1	2
Ambassidae	1	3
Apogonidae	1	1
Ariidae	1	1
Ballistidae	4	4
Belinidae	2	2
Bothidae	1	2
Carcharhinidae	1	1
Carangidae	12	16
Chirocentridae	1	1
Clupeidae	3	6
Drepanidae	1	1
Engraulidae	3	6
Exocoetidae	1	1
Hemiramphidae	1	1
Haemulidae	1	2
Hemiscyllidae	1	1
Istiophoridae	1	1
Leiognathidae	3	7

Family	No. of Genera	No. of Species
Lutjanidae	3	4
Menidae	1	1
Mugilidae	1	1
Mullidae	2	4
Nemipteridae	2	2
Priacanthidae	1	1
Rachycentridae	1	1
Rhinobatidae	1	1
Scatophagidae	1	1
Scolopsidae	1	1
Scombridae	8	11
Sciaenidae	2	3
Serranidae	4	8
Siganidae	1	2
Sparidae	1	1
Sphyreanidae	1	3
Theraponidae	2	3
Triacanthidae	2	2
Trichuridae	1	1

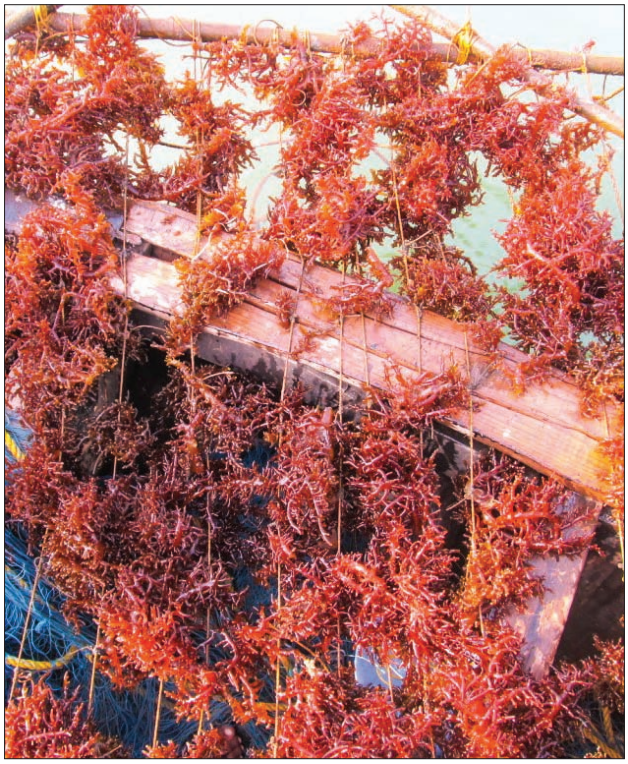
Total numbers of species of different marine fauna distributed along Visakhapatnam.

Groups	Orders	Families	Genus	Species
Finfishes	19	98	245	453
Crustaceans	2	10	18	42
Molluscs	16	24	37	48
Echinoderms	4	4	4	4
Poriferans (sponges)	1	1	1	1
Coelenterates (softcorals)	1	1	1	1
Reptiles (turtles)	1	1	2	2
Mammals	1	2	3	4
Total	45	141	311	555

Diversity of seaweed along the west coast of India

(Research project: EF-8/ICAR - NFBSFARA)

Based on the survey, water analysis and suitable geographical conditions, sites suitable for cultivation of commercially important seaweeds were identified viz., Adgaon, Shrivardhan, Velas (Dist. Ratnagiri), Kelshi, Palshet, Vetye, Kiranpani (Maharashtra State), Terekhol, Shiroda, Satarda, Keri (Goa State). Out of these sites, *Kappaphycus* and *Gracillaria* cultivation was carried out at 4 sites, Palshet, Ladghar, Terekhol and Redi using Floating-raft and Monoline-rope method.



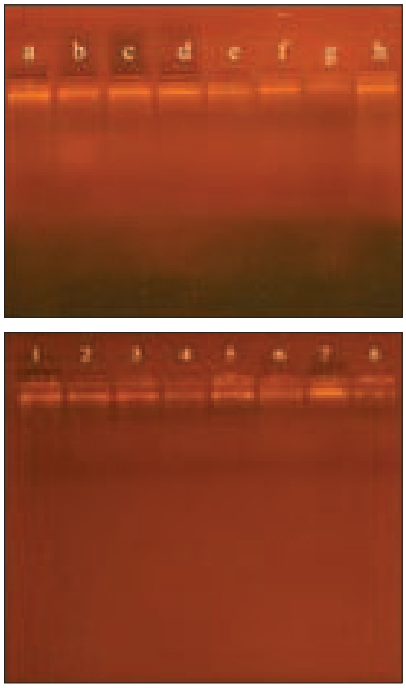
One month old raft culture at Palshet

Seaweed culture in wooden rafts, Terekhol

Taxonomy of deep sea shrimp resources

Research project: EF-13/DST

Deep sea shrimp samples were collected from Sakthikulangara and Kalamukku fishing harbours in Kerala and from Tuticorin Fisheries Harbour in Tamil Nadu.



Agarose gel electrophoresis (0.8%) showing DNA isolated from deepsea shrimps

Deep sea shrimp species namely *Aristeus alcocki, Metapenaeopsis andamanensis, Solenocera hextii, Parapenaeus investigatoris, Penaeopsis jerryi, Heterocarpus woodmasoni* and *Heterocarpus gibbosus* belonging to the major families Penaeidae, Aristeidae, Pandalidae and Solenoceridae were collected. Identification of these deep sea shrimps to species level was done following the standard conventional taxonomical procedures by morphometric and meristic characters. Diagnostic characters for shrimp include: body length, color of the specimen, carapace with crests and grooves, rostral teeth on the dorsal and ventral side, presence of pincers on the pereiopods, specific shape and structure of the copulatory organs i.e., petasma in males and thelycum in females and several other minute characteristics.

Samples were further segregated according to sex (male & female) and preserved in 4% formalin separately. Identification using various morphometric measurements was made to get a clear understanding of the stock. The truss network system used for identification using various landmarks 35 distances were measured on the body of the shrimp.

Molecular outputs

DNA from 5 species of deep sea shrimp was extracted following standard protocol. The extracted DNA was electrophoresed through 0.8% agarose gel containing ethidium bromide and quantified by using UV spectroscopy. The polymerase chain reaction (PCR) standardised to amplify target regions of two mitochondrial genes 16S rRNA and COI and the same have been amplified in 3 species of deep sea shrimps. PCR products were purified by purificiation kit. The PCR products were viewed by electrophoresis (1.5% agarose gel containing ethidium bromide). PCR products were sequenced for both forward and reverse strands, edited and confirmed sequences were deposited in NCBI-GenBank.

Marine habitats

Marine litter density in different states

Research project: FISHCMFRISIL201201900019

A rapid survey covering the entire state coastline to assess the quantity of litter in various beaches was carried out in Kerala, Karnataka, Tamil Nadu and Andhra Pradesh. In Lakshadweep Islands, Gujarat and Maharashtra, part of the states coastline was covered. Among the states covered, low densities of less than 10 g m^{-2} were observed in Kerala, Lakshadweep, south Tamil Nadu and Andhra Pradesh. Beach cleaning was observed only in less than 10% of the beaches. The state-wise summary is given below.

Kerala: In the 54 beaches surveyed, average litter density was 3.85 g m^{-2} ranging from 0-22.2 g m^{-2}. Three beaches were completely clean without any litter. In one of the beaches, cleaning twice a day by local self help groups was being done.

Karnataka: Average litter density was 178 g m^{-2} ranging from 3-1240 g m^{-2} Among the 33 beaches studied, Uttara Kannada beaches had low levels while Mulky, Katpadimattu and Byndoor beaches had very high litter.

South Tamil Nadu: 14 beaches were surveyed, and the average was 2.94 g m^{-2} ranging from 0.18-9.79 g m^{-2} .

Andhra Pradesh: 18 beaches were covered and the litter density ranged from 0.4-9.06 g m^{-2} and the average was 3.5 g m^{-2}.

Lakshadweep Islands: Mean litter density was 7.71 g m^{-2}. In the 4 inhabited islands the litter density ranged from 2-11 g m^{-2}.

Gujarat: Only two beaches were surveyed; the average density was 328 g m^{-2} ; the litter density at Madhavpur was 30 g m^{-2} and at Porbandar 520 g m^{-2}.

Micro plastics in Gulf of Mannar

A proportionate decrease in the biomass of micro plastics with respect to depth was observed. However, there was not much variation in the size range of micro plastics with respect to depth.

The density was comparatively higher at 5 m depth and varied between 2.5 nos. ml^{-1} during September to 6.5 nos. ml^{-1} during June 2013. The size of the particles varied between a minimum of 0.006 mm to a maximum of 0.164 mm at 20 m depth.

Micro plastics in the food chain

During the mud bank period (August 2013), of the 16 nos. of anchovies (average 9.06 cm, average weight 6.6 g) analysed, 6 nos. were found to have micro plastics of length ranging from1.14 mm to 2.5 mm. The main food items were phytoplankton, zooplankton (*Lucifer*, copepod, tintinnids) bivalves and prawn (nekton). In December, when there was no mud bank, oil sardine collected from the same area had micro plastics in the gut and mud was observed in the gill region of these fishes.

'Mussel Watch' in Vembanad Lake

Mussels are known to be good indicators of pollution in the environment because of their filtration capacity. To study the gradation or level of heavy metals (Cu, Zn, Pd, Ni, Mn, Hg and As), pesticides and also the bacterial load (TPC and *E. coli*) in the environment and the fauna, an experiment was conducted from December 2012 to June 2013. The Cu and Zn content in water and tissue were below permissible level. The growth and survival of mussels was similar in the marine zone but very poor in southern sites where there was no good water flow

The content of lead (Pb), cadmium (Cd), copper (Cu) and zinc (Zn) in water samples of selected locations of Vembanad Lake (VL) at Moothakunnam, Munambam, Cherai , Njarakkal, IFP Jetty and Chellanam showed seasonal variations. The Pb and Cd were not detected during March-May but detected in June but were below permissible level of 50 ppb and 10 ppb as per the stipulated limit of USEPA, 1986.

In all stations TPC and *E. coli* showed an increasing trend from February to June. The increase in microbial load was coincident with freshwater influx.

Impact assessment of thermal power plant and port activities in Gulf of Mannar

Impact of anthropogenic activities of the coal fired thermal power plant effluents like fly ash containing slurry and hot water discharge and the impact of handling hazardous chemicals through loading and unloading activities at the major port on the Tuticorin coastal water ecosystem were studied.

Evaluation of ecosystem services of Vembanad Lake

Research project: FISHCMFRISIL201201800018

Data for valuation of provisional services of Vembanad lake mainly related

to fisheries and aquaculture were gathered. The main activities were shrimp farming (prawn filtration and semi-intensive) fish farming, paddy cum prawn culture, oyster farming, shrimp hatcheries, fish breeding units, aquarium fish breeding, fixed net operations, other traditional fishing gear operations and clam fishing.

The Water Quality Index (WQI; as per USPEA grading method) of Vembanad Lake and the coastal waters (upto 20 m depth) during the last 5 years was calculated. This indicated that the western part which is the main industrial area of Vembanad Lake was consistently 'poor' and central part covering the harbour and backwater region with high anthropogenic activities was 'fair'.

Towards the sea, in 5 m depth WQI became "fair" only during 2010 and in other years it was "good" and the inshore regions were found not affected and were found to be of "good" water quality index. Overall WQI remained "good" from 2008-13 at 20 m and 10 m depths.

Both fisheries and aquaculture activities depend on the water quality of Vembanad Lake and it is evident that the brackish water region is not healthy and the services are negatively impacted.

Purakkad mud bank, Alappuzha District, Kerala

Environmental variables of mud bank: The ecological characteristics of the mud banks was studied from July to January. Of the 16 abiotic parameters, significant variation between the surface and bottom water was observed for most variables like temperature, salinity, dissolved oxygen, TSS nutrients and chlorophyll. Bottom water had comparatively lower temperature (25.3°C) than SST (26°C). In the mud bank region. Also higher salinity of the bottom water and low oxygen (4.06 mg l^{-1}) content than surface water (7.83 mg l^{-1}) and higher nutrients indicate upwelled water. Very high level of TSS in surface and bottom water of the mud bank region compared to the non mud bank region is also characteristic.

Variation of environmental variables in Purakadu mud bank (July, 2014)

Parameter	Mud bank		Non mud bank		Parameter	Mud bank		Non mud bank	
	S	B	S	B		S	B	S	B
Temp °C	26	25.3	26.7	26	Chl a µg l^{-1}	0.15	0.63	0.61	0.18
Salinity (ppt)	26.1	30.6	25.5	28.8	Chl b µg l^{-1}	0	0.04	0.04	0
DO mg l^{-1}	7.837	4.063	6.894	6.76	Chl c µg l^{-1}	0.04	0.16	0.30	0
SiO_3 mg l^{-1}	0.324	0.64	0.475	0.351	TSS	91.18	112	44.2	35.4
PO_4 mg l^{-1}	0.005	0.01	0.007	0.01	GPP mg C^{-1} l^{-1} h^{-1}	0.015	0	0	0.001
NO_2 mg l^{-1}	0.003	0.005	0.004	0.002	NPP	0	0	0	0
NO_3 mg l^{-1}	0.008	0.011	0	0.001	Turbidity NTU	1.32	38.32	2.7	5.43
NH_3 mg l^{-1}	0.018	0.011	0.02	0.042	pH (Water)	8.4	8.25	8.59	8.59

Zooplankton community

The zooplankton diversity during the mud bank was low. Lucifer was the dominant zooplankton followed by cladocerans. However, in the same area, the community was dominated by fish eggs. During the mud bank, the zooplankton biomass was comparatively more (0.42) in the mud bank region than the non mud bank area.

Phytoplankton community

The phytoplankton community consisted of 24 main species and was dominated by *Chaetoceros* (27%) followed by *Peridinium depressum* (10%), *Coscinodiscus gigantium* (8%), *Nitszschia seriata* and *Fragilaria* sp. (6% each). The density was 2.2 lakh cells l^{-1}. In the non mud bank area, the community structure was only slightly different and the density was 1.62 lakh cells l^{-1}.

Benthos: The benthic biomass was very high in the mud bank area (1.29 g m^{-3}) compared to the non mud bank area (0.002 g m^{-3}). In the same area, during the post monsoon period, the benthic biomass decreased considerably (0.008 g m^{-3}). Polychaetes formed 62% mainly contributed by *Eunicids* and *Sternaspis scutata* and bivalve spat 38% of the benthic community.

Gut content of sardine and anchovies: The gut content analysis of sardine and anchovies was done mainly to understand the link between the phytoplankton, zooplankton and benthic communities. It was observed that the food of anchovies consisted mainly of zooplankton (copepods, tintinnids, *Lucifer* and siphonophores) and benthos (bivalves and polychaetes). Apart from these, small fishes and shrimps also were observed. Food of sardine consisted mainly of phytoplankton, especially *Nitzchia, Fragilaria, Thalassiosira* and *Dinophysis*. Apart from this copepods and tintinnids were also observed. The analysis indicates that these fishes maily prey on phytoplankton, zooplankton and benthos of the mud bank area.

Ecology of sea grass and mangrove ecosystems

The ecology of mangrove and sea grass beds of Gulf of Mannar was studied.

GPP and NPP were comparatively higher in the mangrove beds. The mean values were 3.7± 2.8 mg C l^{-1} day^{-1} ; 3.1±2.4 mg C l^{-1} day^{-1} and 5.6±1.4 mg C l^{-1} day^{-1}; 4.8±1.8 mg C l^{-1} day^{-1} for GPP and NPP in the sea grass beds and mangrove swarms respectively. High positive correlation was noticed between GPP and NPP ($P<0.05$) .

The chlorophyll concentration was comparatively higher in the mangrove bed with a mean value of 6.18±1.9 µg l^{-1}. At the sea grass bed, the chlorophyll ranged between 0.24-2.9 µg l^{-1} with a mean of 1.34±0.27µg l^{-1}. A high positive correlation was noticed between chlorophyll and nitrate and silicate concentration ($P<0.001$). The TSS and TDS were also comparatively higher in the mangrove beds.

Ammonia concentration was comparatively higher in the mangrove beds and varied between 0.05-0.352 µg l^{-1} (1.48±0.04 µg l^{-1}) and 0.025-0.099 (0.12±0.02 µg l^{-1}) for mangrove and sea grass beds respectively.

Nutrients were unusually higher in the mangrove beds with the highest mean of 1.52±0.4 µg l^{-1}; 9.6±5.8 µg l^{-1}; 39.9±7.02 and 19.02±3.7 µg l^{-1} for nitrite, phosphate, silicate and nitrate respectively. In the sea grass beds, the nutrients ranged between 0.02-0.8 µg l^{-1} for nitrite, 1.4-4.8 µg l^{-1} for phosphate, 7.4-36.7 µg l^{-1} for silicate and 0-7.6 µg l^{-1} for nitrate respectively.

Sediment characteristics and sea grass productivity

The sediment in the sea grass bed was constituted mainly by fine sand (66.8%) followed by clay (11.3%); silt (5.85%) and coarse sand (3.4%). In the mangrove ecosytem, the fine sand and coarse sand proportion was almost equal (25.7% and 25.9% respectively) followed by clay (19.01%).

The percentage of organic matter, organic carbon and N_2 were also comparatively higher in the mangrove beds with the highest means of 0.91±0.14%; 1.6±0.24% and 0.08±0.012% respectively for organic carbon, organic matter and nitrogen respectively. In the sea grass beds, the values were 0.45±0.26%; 0.79±0.5% and 0.04±0.02% for organic carbon, organic matter and nitrogen respectively. Statistically significant positive correlation was noticed between organic carbon, organic matter and nitrogen.

In the sea grass beds, the population was mainly constituted by two species: *Halodule uninervis* and *Halophila ovalis*. The productivity of *H. uninervis* varied between 46 g m^{-2} in July to 380 g m^{-2} in May with a mean of 119.7±27.8 g m^{-2} where as the population of *H. ovalis* varied between 52 g m^{-2} during September to 280 g m^{-2} during October with a mean of 110.8±18.5 g m^{-2}.

Muthupet mangroves

Muthupet (meaning land of pearls) is the biggest mangrove forest in Tamil Nadu. It is located along the Palk Strait covering an area of approximately 12000 ha. The Muthupet mangrove ecosystem is characterised by the presence of *Avicennia marina, Aegiceras corniculatum, Excocaria agallocha, Acanthus ilicifolius, Rhizophora mucronatoa* and *Lumnitzera racemosa. Avicennia marina,* the dominant mangrove species in Muthupettai covers about 95% of vegetation.

Diatoms are the dominant groups of phytoplankton followed by dinoflagellates, chlorophyceans and cyanophyceans. Among the zooplankton, copepods dominated and other groups were tintinnids and rotifers.

Traditional fishing method known as canal fishing is being practiced and 30 species of finfishes are commonly caught in the region. Apart from fish, the lagoon is rich in prawns and crabs.

The underwater exploration revealed that three types of sea grass beds are present in Palk Bay such as: (i) Coral reef associated sea grass bed as observed in Mandapam area, (ii) Mangrove associated sea grass bed as in Adirampattinam, Mallipattinam and Sethupavachatram area and (iii) Shallow sandy bottom sea grass bed as found in Thondi, Kottaipattinam and Jegathapattinam area. The seagrass meadows were important fishing grounds for shrimps, crabs and also formed breeding grounds especially for egg laying of squids.

Traditional fishing methods like stake net (Adappu valai), squid fishing (Kanava maaru), shore gill net (Nandu valai) and single trawl net (Oththai madi) are used in this area. Apart from assessing the sea grass community structure, the ecology of these unique habitats and the avian fauna associated with these ecosystems were also studied in detail.

Sea grass beds of North Kerala

Hydrography and growth rates of mangrove saplings in two important restoration areas viz., Kadalundi and Dharmadom along Malabar coast was studied. Net Primary Productivity (NPP) of Kadalundi area was estimated to 0.31 mg C/l/day and the vertical growth rate of *Sonneratia* was found to be 6-8 cm/month. However, the *Rhizophora* plants from Dharmadom area registered mean vertical growth rate of 2.5 cm/month with NPP of 0.789 mg C/l/day and a gross primary productivity (GPP) of 0.404 mg C/l/day.

Squid egg mass in the sea grass habitat

The Kadalundi Estuary has a seagrass ecosystem formed of *Halophila beccarrii* in association with seaweeds, *Enteromorpha*, *Chaetomorpha* and some times the long thalloid *Gracilariopsis lemaneiformis*. The density of *Halophila* plants ranged from nil during June July to 420 g/m^2 during December-January. This seagrass bed harbour large quantities of benthic organisms such as *Cerithium* sp., polycheates, crab larvae, tanaids (crustacean), isopod, amphipod, cray fish juveniles and eel juveniles.

Sea grass beds of Lakshadweeps islands

Sea grass beds of Minicoy, Kiltan, Chetalt, Kavarathi and Agathi atolls of Lakshadweep Archipelago were monitored for their herbivory by green turtles and for any anthropogenic activities. It was observed that the wet biomass of underground parts of the sea grass vegetation comprising rhizomes and roots were always higher than that of the shoots comprising leaves and leaf sheaths.

Habitat dependent species: sea birds and coastal birds

Tuticorin

The diversity and population size of avian fauna were observed relatively higher in the calm sea region. The fauna mainly comprised medium to larger birds like painted stork, grey heron, little egret, great egret, terek sand piper and lesser crested tern.

Lesser crested tern was the major group and their population was higher during January to May and the numbers sighted varied between 193.6±12 during high tide and 121±16 during low tide. White little egret comprised the second major group, their dominance was prominent during March, November and December. The average numbers sighted were 33.17±11.5 during high tide and 19.7±5.5 during low tide.

In the salt pan area, the avian fauna was comprised mainly by medium to smaller sized birds like Eurasian oyster catcher, curlew sand piper and grey heron. Curlew sand piper constituted the dominant group during November and December. The average numbers sighted were 18.3±4.9 during high tide and 8.9±2.1 during low tide. Oyster catcher was the second major bird sighted during April, May, June, September and December (average numbers sighted: 10.7±2.3 during high tide and 8.8±2.1 during low tide).

There was a proportionate increase in the population size and diversity of avian fauna observed with increase in tidal amplitude at both stations.

Karnataka

Along Karnataka coast a total of 41 species of sea and coastal birds were identified and photographed by conducting survey off the shores of Ullal, Someshwar, Bunder, Bengre, Kudroli, Hegemadikodi, Mulki, Kapu, Uppunda and Murudeshwar during the period from October 2012 till December 2013.

Andhra Pradesh

Along Visakhapatnam, 15 surveys were conducted to record the avian fauna associated with the marine habitats in the coastal hamlets like Visakhapatnam Harbour, Chintapalli, Nagamayipalem, Pudimadaka, Yarada, Bhimili, Rishikonda, Mangamaripeta, Thotlakonda, Jalaripeta and R.K. Beach.

Kerala

During the post and pre monsoon seasons, flocks of sea birds migrate to coastal areas and this year, a detailed study was done in the Purakkad region of Alapuzha District where more than 2000 birds were observed to be associated with the fishery. Since bird castings in this region was

more, an analysis of the dissolved inorganic nitrogen (DIN) and dissolved inorganic phosphorous (DIP) from beach sediments where the birds perched regularly was done and this was compared with an area where there were no birds.

Dissolved inorganic nitrogen (DIN) and dissolved inorganic phosphorus (DIP) were derived from the above analytical results. The DIN from bird area sediment was 4 times more than that of non bird area sediment. The DIP from bird area sediment was 16 times more than that of non bird area sediment.

Marine mammal survey and sighting

Karnataka

Interview conducted with fishermen indicated that most of the Indo-pacific humpback dolphins are sighted near shore while the spinner dolphin is sighted away from shore at greater than 50 m depth.

More sightings usually occur during October and November month. Sighting surveys' conducted along the shore of Karnataka coast also indicated that the Indo-pacific humpback dolphin were located in 6 to 15 m depth. The presence of fish shoals of oilsardine and mackerel were also observed near shore indicating that the dolphins were driving the fishes towards shore.

Finless porpoise *Neophocaena phocaenoides* (7 nos.) belonging to the family Phocaenidae was incidentally caught in purse seine off Mangalore during March 2013. The length ranged from 1-1.35 m. One of the females had a young male porpoise of size 46.5 cm.

A baleen whale was found stranded (N 13° 03.643', E 74° 46.737') on 13 September 2013 in the Sasihitlu beach of Karnataka.

Dugong habitats in Palk Bay

The dugongs (*Dugong dugong)* are the only strictly-marine herbivorous mammals depending on sea grass for subsistence. One of the important habitats of dugongs is the sea grass beds of Palk Bay along the south-east coast of India and their population has drastically depleted and is nearing extinction. In order to find the present status of sea grass communities in the Palk Bay, underwater explorative survey was done during the period 18th to 29th September by using video transects method.

About eight species of sea grasses such as *Cymodocea serrulata, Enhalus acoroides, Syringodium isoetifolium, Halophila ovalis, Halophila beccarii, Halodule pinifolia* and *Halodule uninervis* were observed during the survey. Among these, fresh dugong feeding scars were observed in *Cymodcea serrulata* and *Syringodium isotifolium* beds in Sethupavachatram and Manamelkudi area. Fishers from these villages opined that dugongs which are locally called "avolia" are frequently seen in this area.

Sea birds in Purakkad beach, Kerala

Spawning biomass of major fishes in PFZ area

Research project: EF-12/MoES

Spawning stock of sardine: During August to February, fully mature sardine were not observed and the advisories are not a threat to sardine fishery sustainability. The peak spawning period was during June and July and during this period there is no advisory and the trawl ban period also is during this period

Spawning stock of anchovy: Anchovies in the fishery were fully mature during Nov-Dec between Kollam and Kannur and after that also mature fishes formed less than 20% of the fish caught in the fishery. More over their occurrence in the PFZ area was low and hence the advisories are not a threat to sustainability of the stock.

Spawning stock of mackerel: In July 2013, fully mature mackerel formed 100% of the exploited stock in Zone 3, 4 and 5 and since the advisories were not released during this period, the chance of overexploitation of spawning stock during its peak spawning period is non-existent.

Validation of advisories in Lakshadweep waters

The tuna advisories were validated through observation of landings at Minicoy, Agathi and Androth in Lakshadweep Islands. Cheriyakara was the island which most frequently occurred as a PFZ area (19 times; 11% of the pooled PFZs) followed by Minicoy (17 times; 10% of the pooled data).

Climate change & **marine fisheries**

National Initiative on Climate Resilient Agriculture (NICRA)

Research Project: EF-5/DARE-NICRA

Database development and modeling: Impact of temperature in capture fisheries

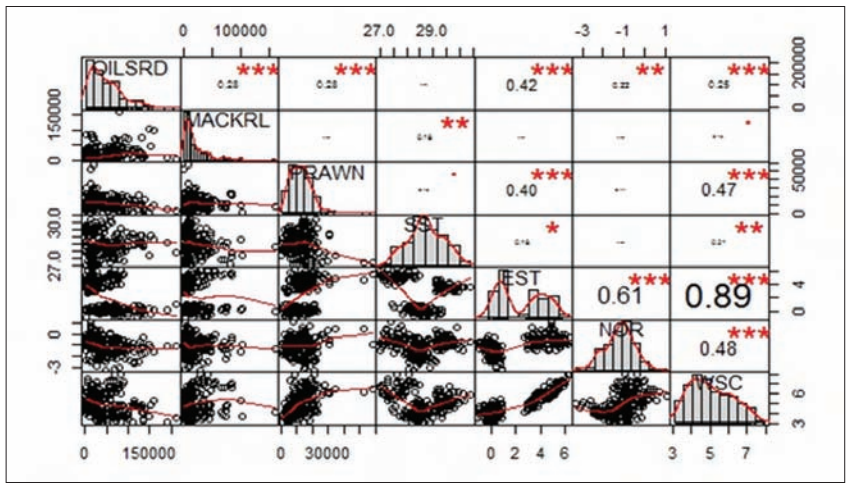
Historical environmental data for the period 1960-2014 for the parameters viz., SST, air temperature, specific humidity, relative humidity, scalar wind, vector wind, sea level pressure, chlorophyll, rainfall, particulate inorganic carbon and upwelling index were downloaded from various sources for south-west (Kochi and Mangalore), south-east (Chennai) and north-east (Visakhapatnam) coasts.

Parameters	Source	Period	Annual/Monthly /Daily	Comments
Sea surface temperature	ICOADS	1960-2014	Monthly	All India
Air temperature	ICOADS	1960-2014	Monthly	All India
Specific humidity	ICOADS	1960-2014	Monthly	All India
Relative humidity	ICOADS	1960-2014	Monthly	All India
Scalar wind	ICOADS	1960-2014	Monthly	All India
Vector wind (eastward component)	ICOADS	1960-2014	Monthly	All India
Vector wind (northward component)	ICOADS	1960-2014	Monthly	All India
Sea level pressure	ICOADS	1960-2014	Monthly	All India
Total cloudiness	ICOADS	1960-2014	Monthly	All India
Chlorophyll	SeaWiFS	1996-2012	Monthly	All India
Ocean productivity	Global ocean productivity	2002-2013	Monthly	All India
Rainfall	IMD	Last 5 years	Monthly	Districtwise (all India)
Upwelling Index	NOAA	1996-2013	Monthly	All India

Correlation analysis was done on the environmental parameters such as SST, eastward wind, northward wind, and WSC with the resources data. The relationship among the climatic variables and species are depicted in the chart. The chart produces a scatterplot matrix with histograms, Kernel density overlays, significant asterisks (0.05[*], 0.01[**], 0.001[***]) and absolute correlations.

Oil sardine as well as prawn had highly significant correlation between both eastward wind (U) and scalar wind (W), while in the case of mackerel much more influencial factor is SST than the wind components.

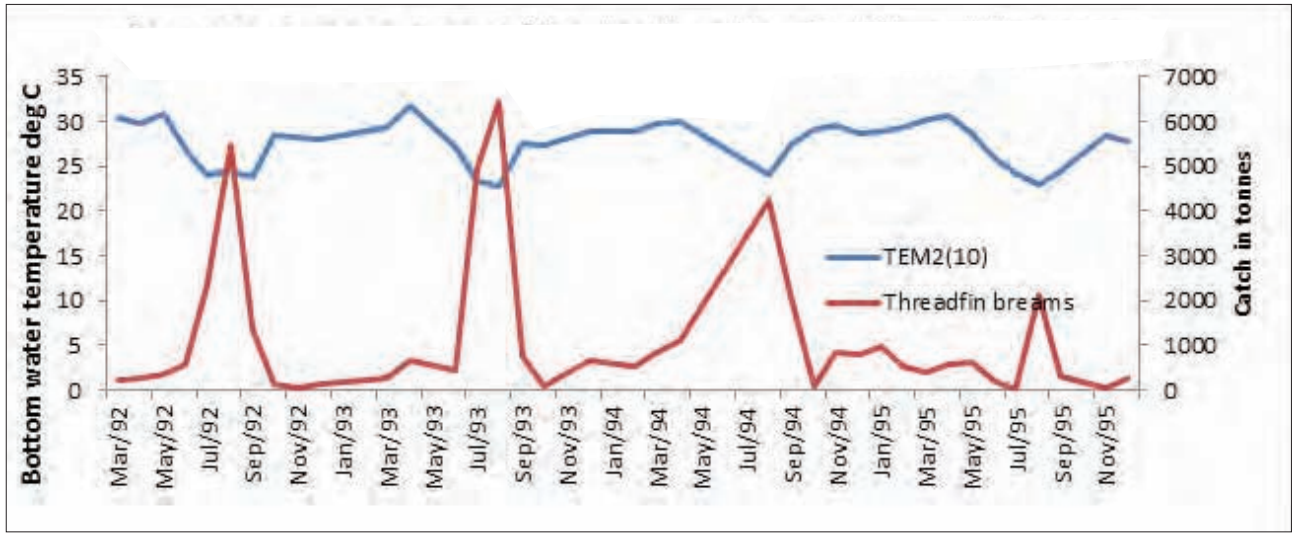
Off Kochi, threadfin breams showed very strong relation to bottom water temperature and the preferred temperature was seen to be 23.8°C. Highest catch of the decade was 6,453 t when the bottom water temperature was 22.8°C.



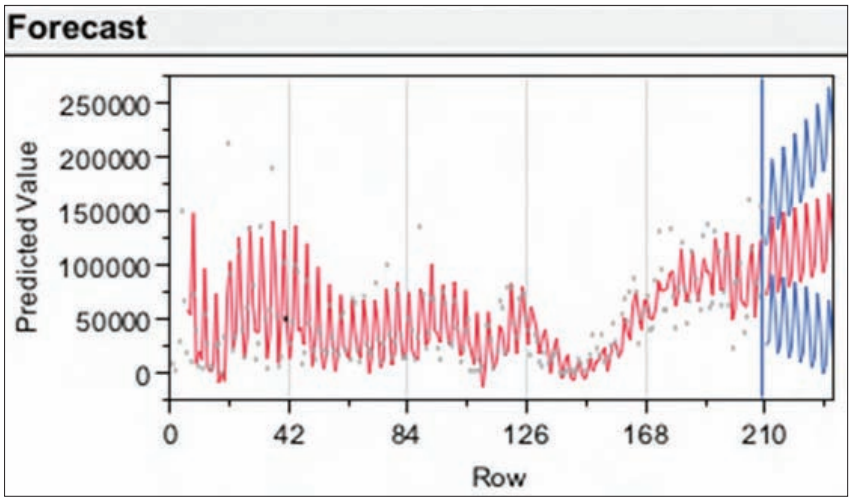
Correlation analysis of Environmental variables vs Marine species

A strong negative correlation was found between sea surface temperature and mean length of the mackerel (r=0.79).

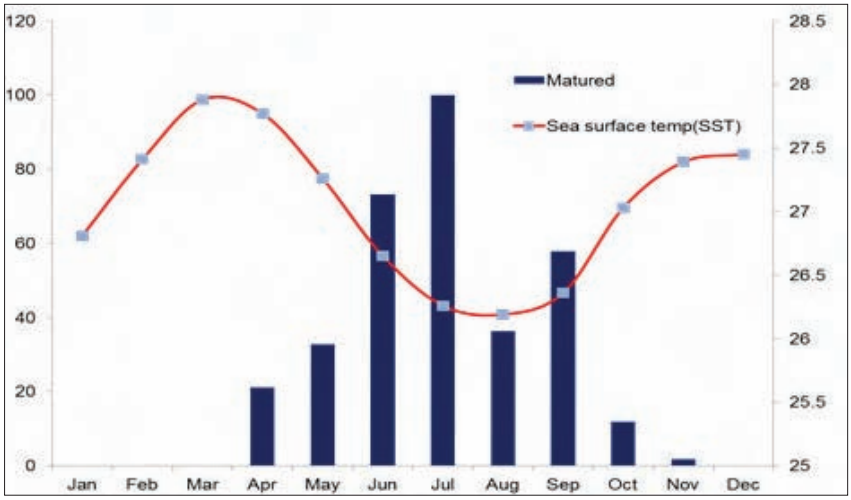
Oil sardine catch in south-west coast has been showing an increasing trend. The fitted model, seasonal ARIMA, with 61% variance clearly shows that this trend is not going to buck in imminent quarters. By 2018, the catch is bound to hover around 170 thousand tonnes. The trend factor is quite prominent as indicated by the stationarity



Seawater temperature at 10 m depth and catch of threadfin breams (1992 to 1995)



Seasonal ARIMA model for Catch forecasting for oil sardine along SW coast



Correlation analysis of spawning season of oil sardine catch with SST

tests. Although total catch may not be a fool-proof indicator of abundance, comparing quarterly cycles of adjacent epochs (time) indicate sustenance of exploitation with near constant efforts indicate enhancement in harvestable stock even in traditionally focussed grounds.

The average annual catch of Oil sardine during 2010-13 was 4,00,000 t. The predicted annual catch in 2018 will be stagnated at around 6,80,000 t.

In such scenario of increase in catch of Oil sardine, the best way to utilise the additional catch will be through value chain approach. Suggestions on governance mechanism to sustain production at the highest level after 2018 has to be evolved.

Real time data on spawning season of Oil sardine showed significant negative correlation with SST. These databases collected along the coast could be used for developing scenarios 2030 and 2050 for studying the effect of temperature on spawning of fishes.

Change in spawning season

Nemipterus randalli: Published literature shows spawning season of *N. randalli* to be October – March along south-west coast; but now a change in the spawning period to August – November is seen during recent years.

Reduction in mean size in the fishery

Along Kerala coast, the mean length of *Nemipterus japonicus* was 179 mm when the SST was 28.72°C; the mean length then decreased slowly to 132 mm in 2011 when SST increased to 28.84°C. A negative correlation was observed between sea surface temperature (SST) and mean length of mackerel (-0.7909) showing declining mean length with increasing sea surface temperature in the south-west coast of India.

Relation between rainy days and spawning of *Nemipterus japonicus* along SE coast

The number of rainy days during April-September (SW monsoon) declined from 57 in 1981-'85 to 49 in 2011-'13. The number of rainy days during October-March (NE monsoon) increased from 40 in 1981-'85 to 49 in 2011-'13. A positive correlation was noted between spawning activity of *Nemipterus japonicus* with number of rainy days. Spawning activity increased during NE monsoon when number of rainy days was more and the temperature was low.

Reduction in length at first maturity (mackerel and coastal prawns)

Changes in size at maturity of coastal prawns at Mangalore

Real time data collection on biology and feeding regime of prawns *Fenneropenaeus indicus*, *Metapenaeus dobsoni* and *Metapenaeus monoceros* was done. Reproductive biology of three species was studied to ascertain the spawning period of the species and its relation to environmental parameters. Changes were recorded in size at maturity of coastal shrimps at Mangalore in 30 years. The L_m of *M. dobsoni* decreased from 80 to 71 mm and and that of *M. monoceros* fell from 135.5 mm (1981-1985) to 116 mm during the present study.

It is established that the reduction in size at first maturity reduces egg production of individuals. In the case of *M. dobsoni*, reduction in number of eggs at size of maturity per individual was estimated as 14,505 and percentage of loss per individual as 28%. In *M. monoceros*, reduction of number of eggs at size of maturity per individual estimated as 58,143 and percentage of loss per individual as 41%. The egg loss happening due to observed reduction of the size at maturity of prawn species has been estimated, which can be a good input in projection scenarios

Reduction in size at first maturity of mackerel

Length at first maturity (L_m) of mackerel on the west coast of India decreased from 22.4 cm in 1960 to 18.38 cm in 2012. The SST in 1960 was 28.21 which increased by 28.691 in 2012. L_m shows a strong negative correlation (-0.61) with temperature which indicates spawning is taking place early in the life cycle.

Change in diet composition (oil sardine)

Analysis of gut content of oil sardine based on published literature over the years 1948-2013 indicated changes in the occurrence of the predominant plankton. *Fragilaria* was noticed in the gut of oil sardines during November 2012-February 2013 after a long gap.

With increase in SST, evidences are now available for :

- Increase in dispersal and abundance of small pelagics (oil sardine and mackerel)
- Reduction in mean size in the fishery (mackerel, *Nemipterus*)
- Reduction in length at first maturity (mackerel, coastal prawns)
- Reduction in fecundity (coastal prawns)
- Change in spawning season (*Nemipterus*)
- Change in diet composition (oil sardine)

Impact of extreme climatic events on coastal population and capture fisheries

The impact was assessed for 2000-2013. During the period, 21 cyclones hit the coastal states and the most affected are the states in the east coast.

Loss of life and value owing to extreme climatic events during 2000-2013

No. of cyclones	Loss of life	Loss in fishing days	Loss in terms of catch (t)	Loss in terms of value (₹)
21	9,805	167	171,347.24	19,854 crores

The loss of life and property has considerably reduced during recent years by early forecast and warning as well as better disaster management systems in place. However, there is still scope for improving the warning and disaster management systems. It is hoped that ITKs and awareness building and effective networking will further reduce the losses.

Impact of temperature on candidate species for mariculture

In an anticipated scenario of global warming and climate change, temperature increase would become a severe threat to fish eggs and larvae in the wild. The climate resilience of eggs and larvae of cobia (*Rachycentron canadum*) and silver pompano (*Trachinotus blochii*) were assessed by experimental studies in order to elucidate the optimum temperature range required for obtaining maximum seed production.

Experiments were conducted to assess the effect of temperature on:
- incubation, hatching, development and growth of larvae
- yolk-sac larvae in terms of yolk utilisation and growth and
- impact of light intensity on growth and metamorphosis

Cobia: It was observed that temperature plays vital role in yolk-sac utilisation as well as on growth of cobia larvae. At the end of 52 h post-hatch, the lowest yolk-sac volume and maximum length was recorded at a temperature range of 31 to 33 °C.

Silver pompano: Increase in temperature reduced the hatching rate, time taken for mouth as well as anal opening and metamorphosis. Survival rate proportionately declined with increase in temperature. A temperature range

of 29-31°C may be advantageous in the larviculture of silver pompano for better survival as well as growth rate. The average increase of 2 °C in water temperature resulted in reduced growth of about 10 to 33% from 7 dph to 12 dph. The reduced growth rate coupled with change in pigmentation of larvae can be taken as the resilience response of silver pompano larvae to combat the temperature stress.

Integrated district level adaptation and mitigation (IDLAM)

As part of IDLAM, assessed the perception of fishermen on causal factors as well as different effects of climate change to develop a bottom up approach in climate change mitigation and adaptations. For this, vulnerability of coastal districts and its fishermen population to climate change were assessed from selected districts of Kerala, Karnataka and Gujarat in the west coast and Tamil Nadu in the east coast.

Details of IDLAM survey areas

State	District	Villages surveyed
Kerala	Alapuzha (971 households)	Arthungal, Chethy, Thumboly South
Karnataka	Udupi (750 housholds)	Thenkayermal, Mattu, Kadekar, Udyavara, Paduthonse, Maravanthe
Gujarat	Junagadh (1500 housholds)	Old light house, Bhidiya, Navabunder, Rajpara
Tamil Nadu	Cuddalore (800 housholds)	Pettodai, Reddiarpettai, Sothikuppam, Thammnampettai, Sonankuppam, Pudukuppam, Chitiraipettai, Rasapettai, Thalanguda, Pillumedu
	Rameswaram (400 housholds)	Mandapam, Rameswaram, Valinokkam, Natarajapuram (Dhanuskodi), Pamban, Nambuthalai
	Nagapattinam (300 housholds)	Seruthur, Tharangambadi, Arkattuthurai, Poompuhar, Nagore, Pattinachery

The level of awareness of fisherfolk to climate change is low which indicates that the fishers couldn't correlate environmental changes consequent to climate change to their livelihood. Fishers were prone to loss in fishing days and erratic monsoon. There is need to improve on the awareness of the fishers knowledge to climate change by involving them in the disaster preparedness and planning process. The alternative avocations available across the different fishing villages need to be strengthened in order to negate the different risks and uncertainties of climate change and in ensuring a climate change informed fishers in the future.

Major factors which increase the vulnerability of fishers to climate change in the villages which were surveyed in the four states

S. No.	Factors which increase vulnerability of fishers	How vulnerability is increased
1	Low level of awareness about climate change	Makes fishers more vulnerable to CC impact
2	Low literacy rate (except Kerala)	Unable to accept/adopt protective measures
3	Lack/inadequate level of sanitation and health care facilities	Fishers more vulnerable to spread of epidemics consequent to flood/ inundations/cyclones
4	Lack of protection shelters, wireless weather communication tools, poor/bad roads	Exposes fishers to more vulnerable situations
5	Distance between residential area and the coastline very low (Varied from 330 to 925 m in Gujarat; within 100 m in Cuddalore (TN);	High vulnerability to sea erosion; sea level rise
6	Unplanned developmental activities (construction and destruction of habitats)	Led to seawater intrusion during high tides since most villages are low lying areas (especially Udupi in Karnataka)

The major Climate Preparedness Activities (CPAs) recommended as management advisories for increasing the preparedness of coastal villages to impacts of climate change

S. No.	Climate Preparedness Activity (CPA)	Implementing authorities		
		Fishers	Local village administration	District administration
1	Increase awareness among fishers on climate change (CC) and related threats to livelihood	✓	✓	✓
2	Increase the adaptation and preparedness through proper scientific interactions and trainings	✓	✓	
3	Strengthen alternative avocations available across the different fishing villages to negate the risks and uncertainties of CC		✓	✓
4	Develop location specific elevation levels for new settlement areas under the town planning acts after proper assessments to avoid damage to sea erosion. Rules to be strictly enforced		✓	✓
5	Develop local infrastructure (roads, health supports and protection shelters) for reducing CC vulnerability		✓	✓
6	Training and involvement of fishers in disaster preparedness/evacuation (eg., Jana Jagrithi Samithi in Kerala)	✓	✓	✓
7	Strictly regulate unplanned coastal activities which would affect tidal amplitudes in village canals/riparian areas		✓	✓
8	Since fishermen are forced to move out to deeper areas, protection aids must be made available even for traditional /artisanal fishers.	✓	✓	✓
9	Strengthen seawalls and bioshields (eg., programs like Theeravanam/ coastal forestry in Kerala	✓	✓	✓

Mitigation

Mangrove planting in shallow extensive and semi-intensive shrimp ponds was demonstrated to increase carbon sequestration. Vetiver slips was planted in sandy soil along the seashore of Alapuzha District to prevent erosion due to sea level rise since mangroves could not be planted there.

Carbon Life Cycle Assessment (LCA) in fisheries

Carbon emission from fishing activities viz., pre-harvesting, harvesting and post-harvesting was estimated from Mangalore, Mumbai, Veraval, Tuiticorin, Chennai and Vishakhapatnam. At Visakhapatnam, emission from harvest accounted for 90% of carbon emission. LCA analysis of mechanised and motorised vessels from Vishakhapatnam showed that C emitted per kg of fish was least for motorised boats (0.186) compared to mechanised boats (0.466).

C and CO_2 (kg) emission per kg of fish during different activities by mechanised and motorised sectors off Vishakapatnam

	Catch in mechanised boats		Catch in motorised boats		Total catch	
	C per kg fish	CO_2 per kg fish	C per kg fish	CO_2 per kg fish	C per kg fish	CO_2 per kg fish
Pre-harvest	0.002	0.006				
Harvest	0.436	1.604	0.131	0.481	0.345	1.267
Post-harvest						
Dried fish	0.002	0.007	0.001	0.004	0.002	0.006
Iced fish	0.009	0.032	0.009	0.032	0.009	0.032
Processed fish	0.013	0.048	0.043	0.157	0.022	0.081
Fresh fish	0.004	0.015	0.002	0.007	0.004	0.013
Total	0.466	1.712	0.186	0.685	0.382	1.404

Technology demonstration

Technology demonstrations were undertaken at four centres viz., Mandapam and Visakhapatnam Regional Centres along the east coast and Karwar Research Centre and KVK, Ernakulam along the west coast.

Demonstration programmes were undertaken at Karwar and Kumta in Karnataka, Polem, Talpone in Goa and Ratnagiri in Maharastra under the Karwar Research Centre of CMFRI. Under this programme, 9 training programmes on open sea cage farming, including demonstration of cost effective cage designing and all weather mooring technology, efficient net exchange technology, and nursery rearing technology were conducted during the period. The centre also initiated cage farming by trained private entrepreneurs on a participatory mode. Two farmers who underwent training at the centre were selected for participatory farming at Karwar. Cobia (6000 numbers) and pampano (2000 numbers) seeds procured from Mandapam Regional Centre were cultured in 6 m and 10 m diameter cages as participatory programme. In addition to this programme, the centre also helped the trained fishermen of Karnataka, Goa and Maharashtra to form self help groups (SHGs) to undertake cage culture. Groups of ten fishermen each were formed and each group were provided with 5 cages in Ratnagiri, 10 cages in Goa and 2 cages in Karnataka.

In Kerala, field demonstrations are being carried out in three *Pokkali* farms in Nedungad, Kumbalangi and Kadamakkudy for pearlspot, mullet

and silver pompano. Fish seeds were introduced in the cages during November. Silver pompano (*Trachinotus blochii*), a new candidate species was introduced for culture in low saline waters for the first time in Kerala and the species is performing well in *pokkali* fields. Demonstration of finfish cage culture in *pokkali* fields resulted in an additional net income of ₹0.80 lakhs ha^{-1} resulting in a total net income of ₹1.3 lakhs ha^{-1}. The net income in case of paddy cultivation alone would be ₹0.15 lakhs ha^{-1}, while paddy and shrimp together give an income of only ₹0.50 lakhs ha^{-1}.

Formulated pellet feed *Pearl Plus* for pearlspot, *Etroplus suratensis* larvae and juveniles was developed under CADALMIN™ brand, for feeding pearlspot during *pokkali* integrated farming.

Success story

Aiming at sustainability of pokkali farming system in Kerala, a package was developed for pokkali fields by KVK (Ernakulam) of CMFRI under NICRA, which helped to increase the income from unit area by integrating high value finfish farming in cages. The KVK team gave training to Mr. Saigal, a young farmer from Ezhikkara, Ernakulam District on aspects like pond preparation, cage construction, nursery rearing, fish seed transportation, feeding and cage maintenance, in order to conduct the new experiment in his pokkali field. Small cages were placed in the field using PVC material as floats, sinkers and top cover.

Nursery reared Mullet (*Mugil cephalus*) and pearlspot (*Etroplus suratensis*) were stocked in cages during the 1st week of September. The initial stocking density of mullet was 250 nos. and that of pearlspot was 500 nos. per cage. Mullet attained an average size of 400 g with survival of 60% and pearlspot attained 180 g with 90% survival.

Strategies to enhance adaptive capacity to climate change in vulnerable regions

Research Project: EF-26/NAIP-GEF

Two hundred and twenty six mKRISHI® and mKRISHI®Fisheries mobile handsets were distributed to beneficiaries who can relay advisory information to the community in selected villages. Field validation of the efficiency of the mKRISHI® Fisheries Service technology was done by undertaking several validation cruises off the coast of Maharashtra.

Propagation of other interventions such as SRT, Wheeled ice boxes with pulling handles and ice boxes with lifting mechanism, GPS devices and Improved Agriculture, Aquaculture and Allied practices have been successfully achieved as part of the project. Through PPP mode, mKRISHI® fisheries mobile technology was released for public on 6 March 2014 in Raigad District by CMFRI with TTSL and TCS which will be expanded later to other districts of Maharashtra and also to other states.

Economic sustainability **and Socio-economics**

Valuation of marine fish landings

Research Projects: FISHCMFRISIL201202000020

The provisional estimate of the value of marine fish landings at landing centre level was ₹29,372 crores, i.e., an increase of 18% over 2012. The unit price per kg of fish at landing centre was ₹88.38, an increase of 19%. At the retail level, the estimated value was ₹46,710 crores registering an increase of 21% over the previous year. The unit price at the retail market level was ₹140 an increase of 25% over last year.

Economic performance of fishing operations in west coast

Kerala

Data collection was initiated from Cochin, Munambam, Beypore, Puthiappa, Kalamukku, Chavakkad and Punnapra landing centres for the mechanised and non-mechanised units during the post-monsoon season in 2013. The economics of fishing of trawlers using high speed Chinese engines were collected from Ernakulum and Calicut districts. The costs of the Chinese engines varied from ₹11-15 lakhs. The hauling speed varied from 2.5-4.5 nautical miles per hour. The horse power of the engines varied from 280 to 427 hp. In Puthiappa, Beypore and Munambam harbours nearly 90% of the indigenous engines were replaced by Chinese engines. The reasons for conversion to Chinese engines were increased towing and hauling speeds which helped to reach farther fishing grounds and enabled pelagic trawling. The average diesel consumption was 300-400 liters per day in the case of Chinese engines whereas the average diesel consumption was 200 liters per day for Leyland engine fitted boats.

The capital productivity of multiday trawlers (>6 days) with Chinese engines was lower in Beypore Harbour (Kozhikkode) than in Munambam. The capital productivity of multiday trawlers (>6 days) with Leyland engine was lower than that of MD trawlers (<6days) operating in Cochin Fisheries Harbour. Among the mechanised units, the multiday trawlers (>6 days)

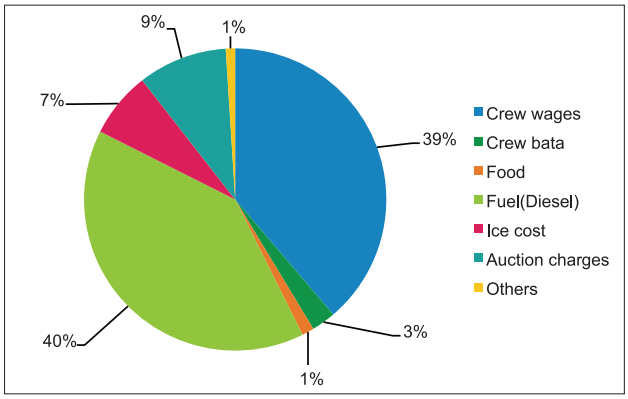
Economic performance of different fishing units in Kerala

Fishing method	Centre	Total Operating Cost (₹)	Gross revenue (₹)	Operational surplus (₹)	Capital productivity	Labour productivity (kg/crew/trip)
Mechanised						
MDF Trawl (>6 days Chinese)	Munambum*	3,59,003	6,33,000	2,73,997	0.57	586
	Kozhikode*	2,59,279	3,98,818	1,39,538	0.65	275
	Average	3,09,141	5,15,909	2,06,768	0.61	431
MDF trawl (>6 days Leyland)	Cochin#	2,24,502	3,43,771	1,19,269	0.65	277
MDF trawl (<6 days Leyland)	Cochin#	1,95,643	3,15,500	1,19,858	0.62	192
	Kozhikode#	85,041	1,20,370	35,329	0.71	157
	Average	1,40,342	2,17,935	77,594	0.665	175
MDF trawl (<6 days Chinese)	Kozhikode*	1,44,141	2,07,170	63,029	0.7	335
Motorised						
Inboard ring seine	Punnapra	65,554	1,10,209	44,655	0.59	79
	Kalamukku	23,374	36,653	13,280	0.64	51
	Beypore	40,764	85,991	45,227	0.47	48
	Average	43,231	77,618	34,387	0.57	59
Drift net	Punnapra	4,627	7,725	3,098	0.60	52
	Beypore	4,386	8,944	4,558	0.49	21
	Average	4,507	8,335	3,828	0.55	37
Hooks & lines	Beypore	13,280	6,421	596	0.91	10
Non-motorised						
Thermocol with ring seine	Punnapra	614	1,181	568	0.52	13
Thermocol with driftnet	Punnapra	388	845	457	0.46	16

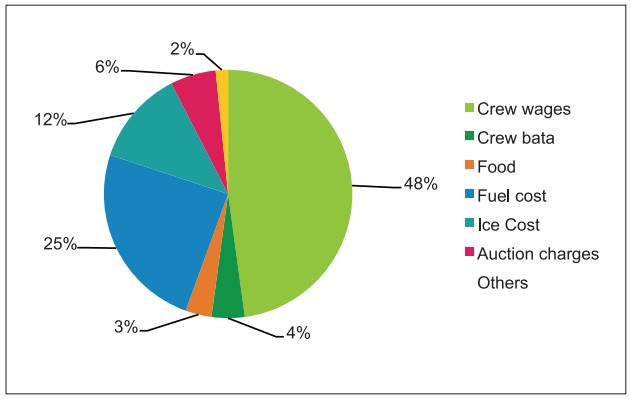
* Chinese engines # Indigenous Leyland engine

operating with Chinese engine in Munambam had the highest labour productivity of 586 kg/labour/trip and multiday trawlers (<6 days) with Leyland engines operating in Beypore had the lowest labour productivity (157 kg/labour/trip).

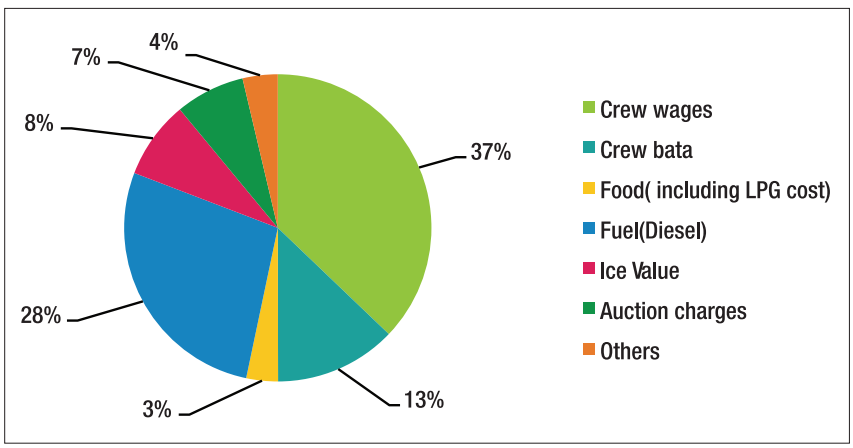
For the motorised units with inboard engine, the capital productivity was highest in Beypore (0.47) and least in Kalamukku (0.64). The labour productivity was highest in Punnapra (79 kg/crew/trip) and lowest in Beypore (48 kg/crew/trip). Among the outboard motorised units, the drift netters operating in Beypore had the highest capital productivity and the hooks and line units operating in Beypore had the lowest capital productivity. The driftnet units operating in Punnapra had the highest labour productivity of 52 kg/labour/trip and the hooks and line units had the least labour productivity of 10 kg/labour/trip. For single day trawlers in Beypore, Kozhikode, the total operating cost and gross revenue were ₹19, 495 and ₹28,486 with operating ratio of 0.68.



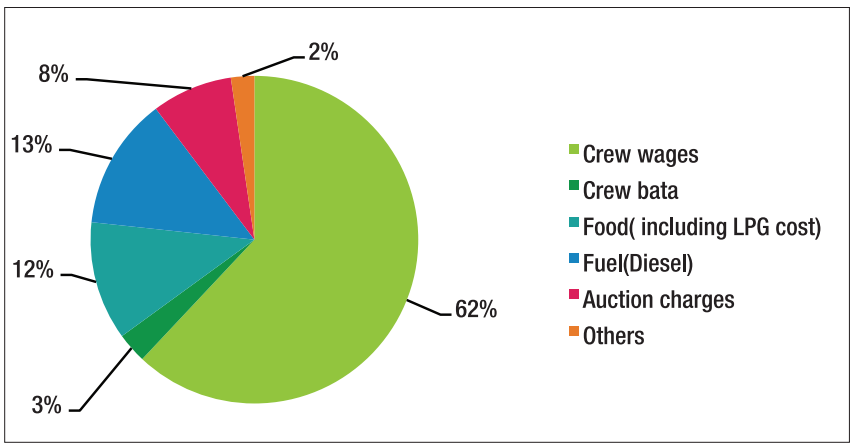
Composition of operating costs for MDF trawlers (>6days) with Chinese engine, Kerala



Composition of operating costs for MDF trawler (<6 days) with Leyland engine, Kerala



Composition of operating costs for SD trawler in Kerala



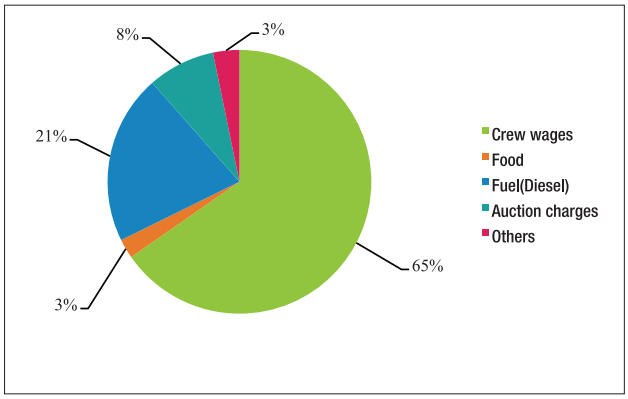
Composition of operating costs for gill netter at Cochin Fisheries Harbour

For the mechanised gillnetters operating in Cochin Fisheries Harbour the average operating cost was ₹2.26 lakhs and gross revenue was ₹3.6 lakhs with an operating ratio of 0.63.

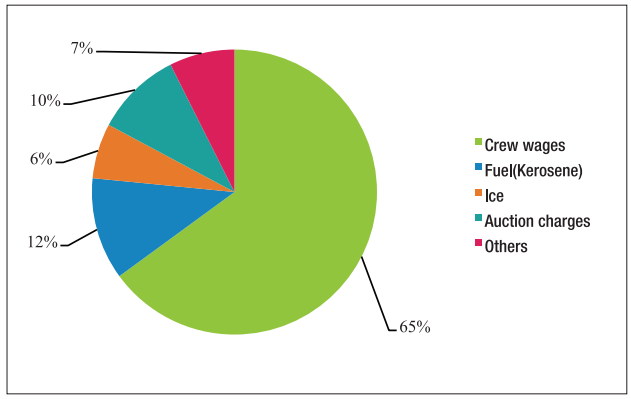
Comparison of the costs and revenues for inboard ring seiners of Kerala across 3 different landing centres viz., Punnapra, Kalamukku and Beypore showed that the total operating cost was high in Punnapra followed by Beypore and Kalamukku with ₹65,554, ₹40,764 and ₹23,374. The same pattern was observed in gross revenue and the highest revenue reported was in Punnapra ₹1,10,209 followed by Beypore (₹85,991) and Kalamukku (₹36,653).

For the outboard driftnet units in Punnapra, the average operating cost was ₹4,627 and gross revenue was ₹7,725 with operating ratio of 0.60. Where as in the case of Beypore the average operating cost was ₹4,386 and gross revenue was ₹8,944 with operating ratio of 0.49.

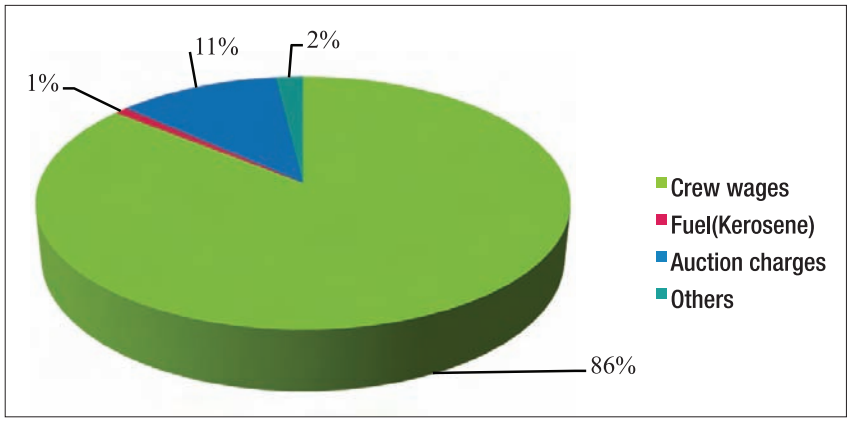
In the case of motorised hooks and lines, the average operating cost per trip was ₹5, 171, gross revenue was ₹6,421 and the operating ratio was 0.81. In the case of outboard



Composition of operating cost for inboard ring seiners in Kerala



Composition of operating cost for outboard drift netters in Kerala



Composition of operating cost for outboard Gillnetter in Beypore

gillnetters, the operating cost was ₹14, 771, gross revenue was ₹26,255 with operating ratio of 0.44.

For the non- mechanised thermocol boats with driftnet, the gross revenue was ₹845 and operating cost was ₹388 with operating ratio 0.46.The average catch varied from 10-20 kg and the major resources caught were scads, white sardines, croakers and *Metapenaeus dobsoni*. In the case of non-motorised thermocol units with ringseines, the operating cost was ₹614, gross revenue ₹1,181 per trip and the operating ratio was 0.52. The average catch varied from 15-30 kg per trip and the major species caught were Malabar anchovies, croakers, white sardines, oil sardines and *M. dobsoni*.

Karnataka

Among the different mechanised crafts, the purse seiners operating in Mangalore had the highest capital productivity with operating ratio of 0.36. The mechanised multiday trawlers (>6 days) operating in Malpe had the highest labour productivity of 700 kg/labour/trip whereas the singleday trawlers operating in Malpe had the lowest labour productivity of 58 kg/labour/trip.

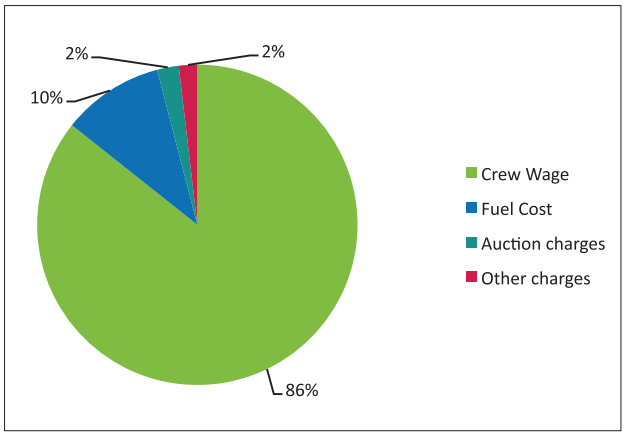
Inboard ring seiners landed at Kalamukku

Economic performance of different fishing units in Karnataka

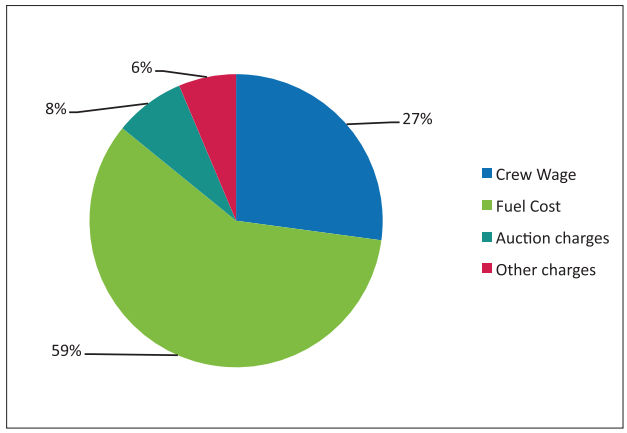
Fishing method	Centre	Total operating cost (₹)	Gross revenue (₹)	Operational surplus (₹)	Capital productivity	Labour productivity (kg/crew/trip)
MDF trawler (<6 day)	Malpe	66,790	1,03,811	37,021	0.70	290
MDF trawler (>6days)	Malpe	1,65,375	2,57,067	88,213	0.66	700
	Mangalore	1,42,093	2,42,423	1,00,041	0.68	612
	Average	1,53,734	2,49,745	94,127	0.67	656
Purse seiner	Malpe	78,385	1,35,982	57,597	0.61	161
	Mangalore	47,295	1,59,070	1,11,775	0.36	98
	Average	62,840	1,47,526	84,686	0.49	130
Single day trawler	Malpe	6,898	10,722	3,824	0.71	58
Motorised gillnetter	Mangalore	44,308	1,14,372	69,997	0.60	35

For the motorised gillnetters operating in Mangalore, the total operating cost was ₹44,308 and gross revenue was ₹1,14,372 with operating ratio of 0.60. The labour productivity was 35 kg/ labour/trip. For the multiday trawlers (<6 days), the operating cost was ₹66,790 and gross revenue was ₹1,03,811 with operating ratio of 0.70. For the multiday trawlers (>6days), the operating cost and gross revenue were ₹1,65,375 and ₹2,57,067 respectively with operating ratio of 0.66. The labour productivity was 290 kg/labour/trip.

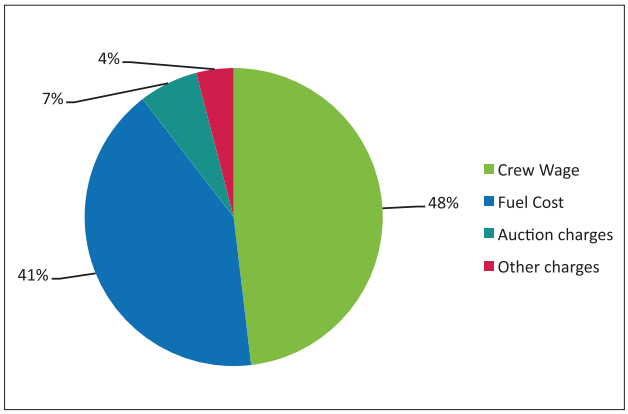
The capital productivity of mechanised purse seiners operating in Mangalore was higher than that of purse seiners operating in Malpe whereas the labour productivity was more for the purse seiners operating in Malpe (161 kg/labour/trip) than those in Mangalore (98 kg/labour/trip).



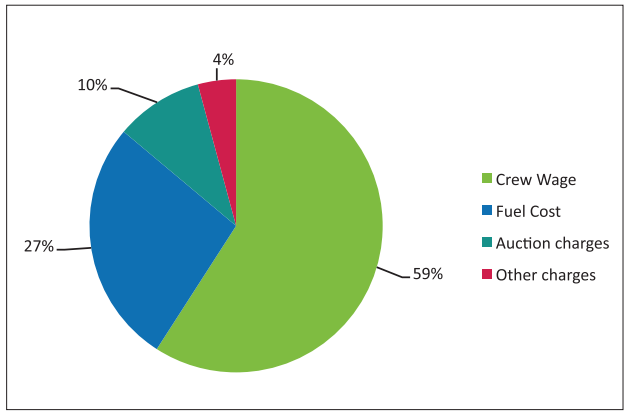
Composition of operating cost for motorised gillnetter



Composition of operating cost for multi-day trawler (>6 day),



Composition of operating cost for mechanised trawler (<6 days) in Karnataka



Composition of operating cost for mechanised purse seiners in Karnataka

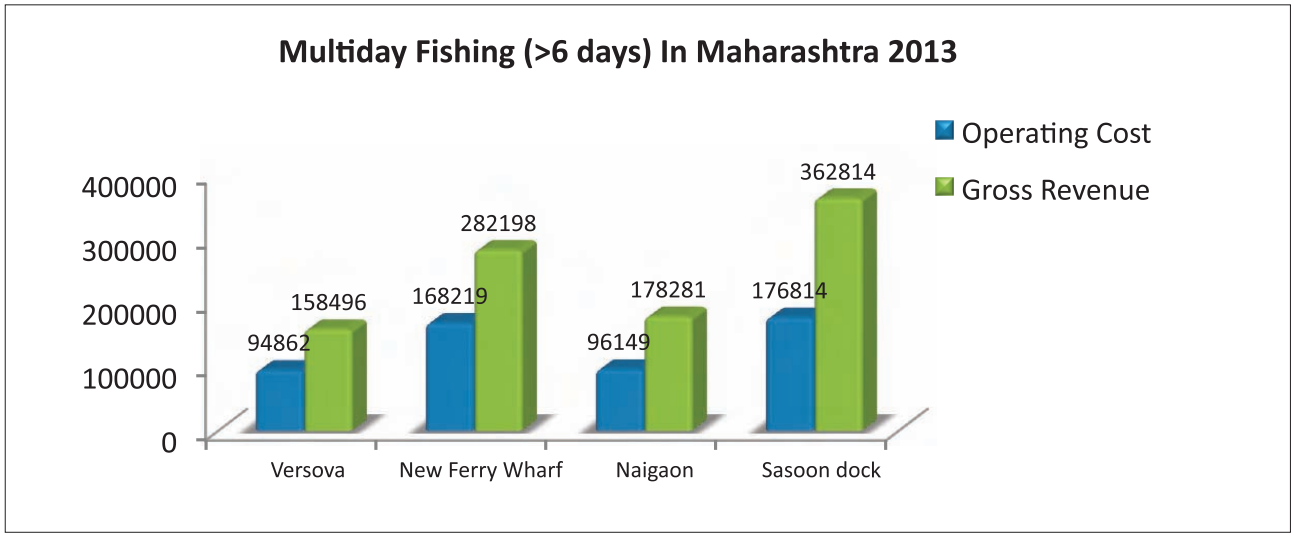
Maharashtra

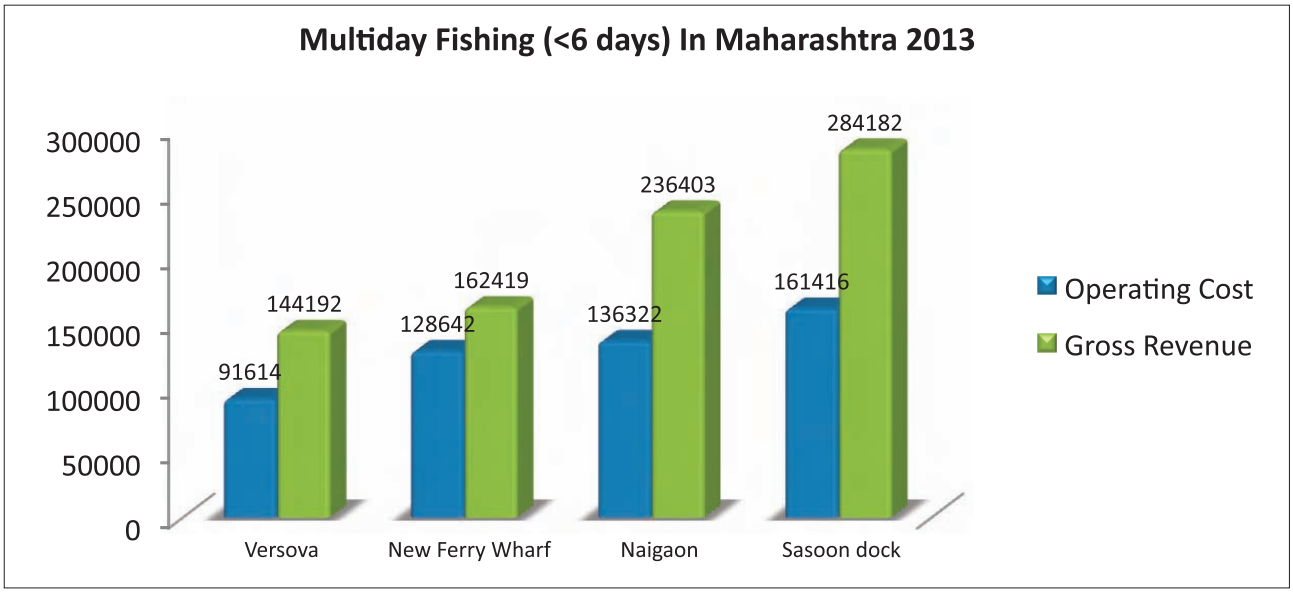
Data were collected on the operational cost and returns of the different fishing crafts operating in Maharashtra for the year 2013. The data were collected from the coastal districts of Greater Mumbai, Thane and Ratnagiri.

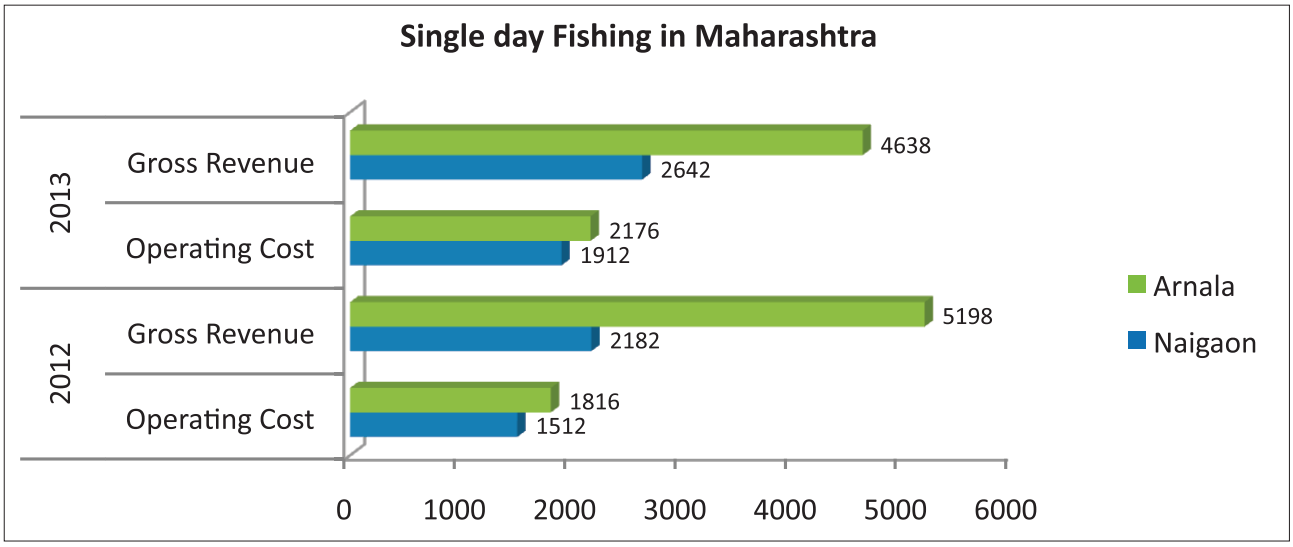
Economic performance of fishing units in Maharashtra

Fishing method	Centre	Total operating cost (₹)	Gross revenue (₹)	Operational surplus (₹)	Capital productivity	Labour productivity (kg/crew/trip)
MDF trawling (>6days)	Versova	94,862	1,58,496	63,634	0.59	151
MDF trawling (>6days)	New Ferry Wharf	1,68,219	2,82,198	1,13,979	0.59	269
MDF trawling(>6days)	Sasoon Dock	1,76,814	3,62,814	1,86,000	0.48	346
Average		1,46,632	2,67,836	1,21,204	0.55	255
MDF trawling (<6 days)	New Ferry Wharf (pre monsoon)	96,149	1,78,281	82,132	0.53	170
MDF trawling (<6 days)	New Ferry Wharf (post monsoon)	1,61,416	2,84,182	1,22,766	0.56	271
MDF trawling (<6 days)	Versova	91,614	1,44,192	52,578	0.63	137
MDF trawling (<6 days)	Sasoon Dock	1,28,642	1,62,419	33,777	0.79	155
	Average	1,19,455	1,92,269	72,813	0.63	183
Dolnet multi day	Naigaon (post-monsoon)	1,78,462	3,24,186	1,45,724	0.55	720
Dolnet multi day	Naigaon (pre-monsoon)	94,182	1,48,619	54,437	0.63	198
	Average	1,36,322	2,36,403	1,00,081	0.59	459
Dolnet single day	Naigaon	1,912	2,642	730	0.72	9
Dolnet single day	Arnala (pre-monsoon)	2,862	5,148	2,286	0.55	17
Dolnet single day	Arnala (post-monsoon)	1,489	4,128	2,639	0.36	9
	Average	2,088	3,973	1,885	0.54	12
Trawl net single day	Arnala	1,912	2,642	730	0.72	6
Trawl net single day	Naigaon	2,176	4,638	2,462	0.47	8
	Average	2,044	3,640	1,596	0.60	7

In multiday trawling (MDF) of more than six days duration, the operational surplus (net operating income) ranged from ₹63,634 in Versoa to ₹1,86,000 in Sasoon dock. Efficient capital use was observed in Sasoon Dock (lowest







operating ratio of 0.48), while the average capital productivity was 0.55 in the state. In MDF of less than six days, the operational surplus was highest in New Ferry Wharf at ₹1,22,766 with the average operational surplus at ₹72,813. The capital productivity of MDF (<6days) was highest in 0.53, while the average capital productivity worked out at 0.63

In the multi-day dolnet operation on Naigaon, the capital productivity was higher in post-monsoon period than the premonsoon (0.63) while the average capital productivity was 0.59. The labour productivity was higher in post-monsoon period with 720 kg per labour per trip than the pre-monsoon period (198 kg/labour/trip). For single day dolnet operation, the average operational surplus was ₹1,885 per trip with an operating ratio of 0.54. The average labour productivity was 12 kg per labour per tirp.

In single day trawl operation, the capital efficiency was higher in Naigon with the lowest operating ratio of 0.47 than Arnala, where the operating ratio was 0.72.

Gujarat

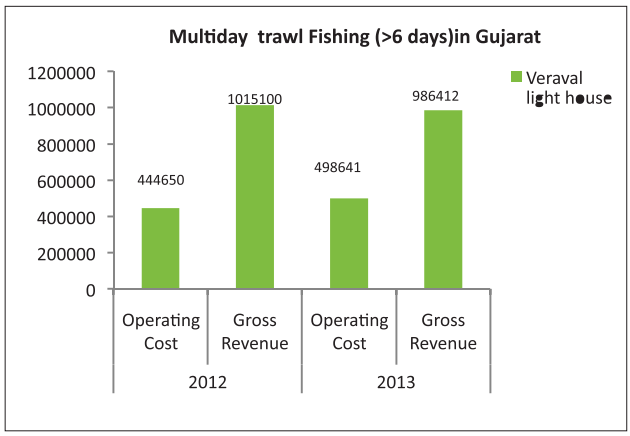
Data on the operational cost and returns of the different fishing crafts were collected from Veraval, Bhidhiya and Veraval Light house harbours in Junagadh District. The single day trawling in Veraval earned an operational surplus of ₹70,872 per trip with the Bhidiya landing centre recording the maximum of ₹1,31,344. The labour productivity was also high in Bhidhiya (39 kg/labour/trip) against the average labour productivity of 31 kg/labour/trip.

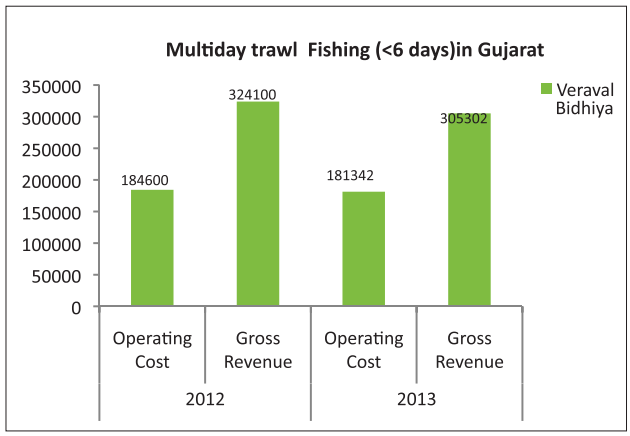
Efficient use of capital was observed in multi-day trawling (>six days) in Veraval (Bhidhiya) with a lower operating ratio of 0.50 abainst 0.63 at Veraval (Light house). The labour productivity was also higher in Veraval (Bhidhiya) at 939 kg/labour/trip than in Veraval (Light house) at 301 kg.

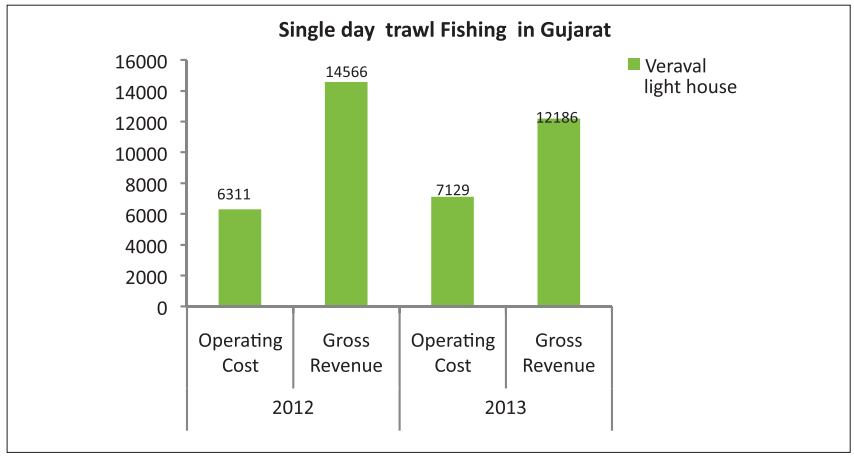
In case of multi-day trawling (<6 days), both the capital and labour productivities were higher at Veraval, Bhidhiya (0.51 and 141kg/labour/trip) than at Veraval, Light house (0.63 and 120 kg)

Economic performance of fishing units in Gujarat

Fishing method	Centre	Total operating cost (₹)	Gross revenue (₹)	Operational surplus (₹)	Capital productivity	Labour productivity (kg/crew/trip)
Single day trawl	Veraval Bidhiya	16,284	29,418	1,31,344	0.55	39
Single day trawl	Veraval Light House	7,129	17,528	10,399	0.41	23
Single day trawl	Average	11,707	23,473	70,872	0.48	31
MDF trawling (>6days)	Veraval Bidhiya	4,98,641	9,86,412	4,87,771	0.5	939
MDF trawling (>6days)	Veraval Light House	1,99,842	3,16,418	1,16,576	0.63	301
MDF trawling (>6days)	Average	3,49,242	6,51,415	3,02,174	0.57	620
MDF trawling (<6days)	Veraval Bidhiya	76,842	1,48,618	71,776	0.51	141
MDF trawling (<6days)	Veraval Light House	79,482	1,26,162	46,680	0.63	120
MDF trawling (<6days)	Average	78,162	1,37,390	59,228	0.57	131







Economics of fishing operations in East coast

Tamil Nadu

The operational cost & returns and fixed cost details in various mechanised and motorised units were collected from Chennai, Nagapattinam and Ramanathapuram fisheries harbours.

Economic performance of mechanised fishing units in Tamil Nadu

Fishing method	Centre	Total operating cost (₹)	Gross revenue (₹)	Operational surplus (₹)	Capital productivity	Labour productivity (GR/man days)
Single day trawl	Nagapattinam	12,037	16,810	4,773	0.72	4,203
Multi day trawl (<6)	Nagapattinam	12,308	17,040	4,732	0.72	3,408
Multi day trawl (>6)	Chennai	27,276	35,936	8,660	0.76	4,492
Multi day trawl (>6)	Nagapattinam	16,273	23,194	6,921	0.7	3,866
Multi day trawl (>6)	Average	18,619	25,390	6,771	0.73	3,922
Multi day gill net	Chennai	21,694	30,165	8,471	0.72	3,770
Multi day gill net	Nagapattinam	12,264	21,149	8,885	0.58	2,644
Multi day gill net	Average	16,979	25,657	8,678	0.65	3,207

In the multi-day trawling (>6 days), the capital efficiency was less in all the centres as the operating ratio was above 0.70 indicating that nearly 75% of the revenue is spent on the expense. This may be due to the high fuel cost incurred in fishing.

In multi-day gillnetting, the capital productivity was higher (indicated by the lowest operating ratio) in Nagapattinam (0.58) than in Chennai (0.72). The labour productivity in terms of gross revenue per labour was higher at Chennai (₹3,922) than at Nagapattinam (₹2,644).

Among the different gears operated by the motorised crafts, the capital productivity was highest in single day bottom-set gill net used in Chennai with the lowest operating ratio of 0.58.

Economic performance of motorised fishing units in Tamil Nadu

Fishing method	Centre	Total operating cost (₹)	Gross revenue (₹)	Operational surplus (₹)	Capital productivity	Labour productivity (GR/man days)
Hooks & Line single day	Chennai	1,940	3,169	1,229	0.61	1,056
Trammel net single day	Chennai	672	1,055	383	0.64	351
Drift gill net single day	Chennai	1,447	2,300	853	0.63	766
Drift gill net single day	Nagapattinam	6,769	9,822	3,053	0.69	2,455
Drift gill net single day	Average	4,108	6,061	1,953	0.66	1,611
Bottom set gill net single day	Chennai	998	1,731	733	0.58	577
Bottom set gill net single day	Nagapattinam	3,598	5,050	1,452	0.71	1,262
Bottom set gill net single day	Ramanathapuram	2,591	4,194	1,603	0.62	
Bottom set gill net single day	Average	2,396	3,658	1,263	0.64	920

Overall, the capital productivity of all other gears operated in motorised crafts like drift gillnet (average 0.64), bottom set gill net (average 0.64) are above 0.60 indicating that their capital efficiencies are marginally higher since the operators are left with only about 35% of the gross revenue to meet the other expenses.

Andhra Pradesh

The operational cost and returns and fixed cost details in various mechanised and motorised units were collected from Nizampatnam Fisheries Harbour of Guntur District. For multi-day trawling operation of less than 6 days in Nizampatnam landing centre, the average operating cost worked out to be ₹28,598 per unit with an average gross return of ₹39,818. The average capital productivity ratio worked out to be 0.72 and labour productivity ₹4,977. In case of multi day gill net operation of more than 6 days in Nizampatnam landing centre, the average operating cost worked out to be ₹16,403 per unit with an average gross return of ₹27,638. The average capital productivity ratio worked out to be 0.59 and labour productivity is ₹3,071.

For single day mini trawl net operation in Nizampatnam landing centre, the average operating cost worked out to be ₹5,594 per unit with an average gross return of ₹17,189. The average capital productivity ratio worked out to be 0.33 and labour productivity is ₹4,297. For single day drift gill net operation in Nizampatnam landing centre, the average operating cost worked out to be ₹4,586 per unit with an average gross return of ₹5,946. The average capital productivity ratio worked out to be 0.77 and labour productivity is ₹1,982.

Economic performance of fishing units in Andhra Pradesh

Fishing method	Centre	Total operating cost (₹)	Gross revenue (₹)	Operational surplus (₹)	Capital productivity	Labour productivity (GR/man days)
MDF trawling (<6days)	Nizampatnam	28,598	39,818	11,220	0.72	4,977
Multi day gill net (>6 days)	Nizampatnam	16,403	27,638	11,235	0.59	3,071
Mini trawl net- Single day	Nizampatnam	5,594	17,189	11,595	0.33	4,297
Drift gill net- Single Day	Nizampatnam	4,586	5,946	1,360	0.77	1,982

The bio-economic parameters for mechanised trawlers operating in Tuticorin Fishing Harbour were analysed for developing the input-output model. The model was developed as a constraint optimisation model which will optimize the gross revenue from trawl fishing in Tuticorin fishing harbour subject to a set of constraints like days of fishing, cost per fishing hour, catch per fishing hour, average price of species, average employment and stock growth parameters of different species caught by trawlers. The biological parameters like stock and stock growth rate were developed based on fishing mortality, natural mortality and 'z' values. The exploitation rate in south-east coast region which included Tuticorin harbour varied from 0.34 for silverbellies to 0.88 for sharks.

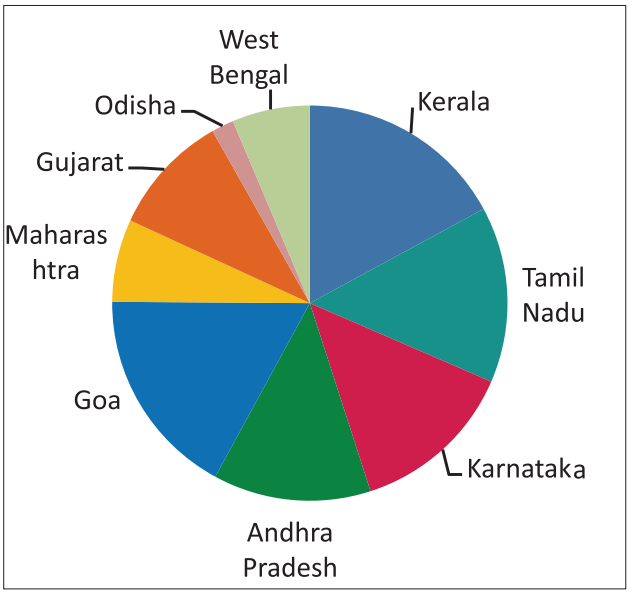
Fishery governance, livelihood, gender and welfare

Research Projects: FISHCMFRISIL201202200022

Capacity development for Ecosystem Based Responsible Fisheries Management

Assessment of capacity deficiency and Information needs were done using Multi-Dimensional indices and matrices in the selected locale of Kerala, Karnataka and Tamil Nadu. Capacity characterisation using different indices was attempted across the maritime states in India. The Landing Centre intensity index was found to be the highest for the state of Goa (0.846) followed by Kerala (0.842) Tamil Nadu (0.710), Karnataka (0.666), Andhra Pradesh (0.636), Gujarat (0.489), Maharashtra (0.333) and West Bengal (0.314). Odisha ranked the lowest (0.089).

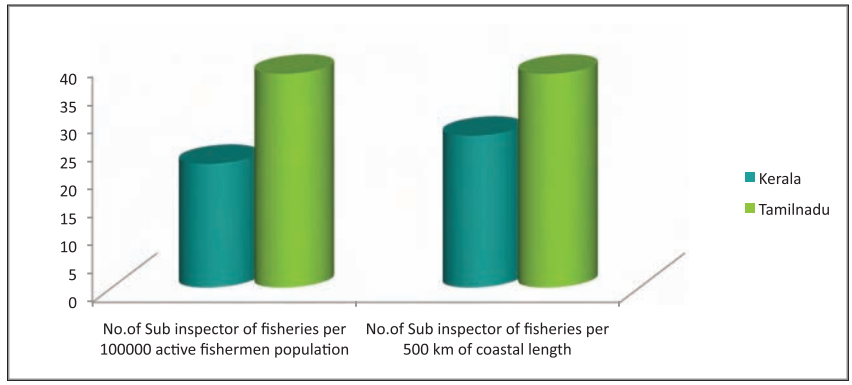
Using the Safety at Sea Index it was found that in terms of capacity endowment for sea safety, Tamil Nadu outperforms other states. Fishing gear Diversity index indicated that out of the most common 15 types of fishing gears gill net fishing is mostly used in majority of coastal states followed by cast net.



Landing Centre Intensity Index

Post-Harvest Capacity Index found Gujarat (0.85) leading the list followed by Kerala (0.60) and Karnataka (0.43). Research Trajectory Analysis (RTA) revealed that the process of multidisciplinary synthesis leading to management advisory needs restructuring and strengthening both in its epistemology and methodology.

EBRFM based Conservation Orientation Index done under the Information needs assessment showed a perceptible gravitation towards responsible fishing practices across the states. Community based *Sui generis* institutions offer scope for contextualised capacity enhancement. In Olaikuda village, Ramanathapuram the association members decided to completely ban the dynamite method of fishing and coral mining 15



Enforcement capacity index in Kerala and Tamil Nadu state

years ago. They also imposed a fine of ₹10,000/- if anyone caught using the above banned method.

Enforcement capacity in terms of the primary sentinels namely Fisheries Sub-Inspectors shows that there are hardly 30 officers, on average, for every one lakh active fishers in Kerala and Tamil Nadu.

Markets trade and environment

Research Projects: FISHCMFRISIL201202300023

Supply chain management in marine fisheries sector

During the year 2013-14 the fish price data was collected from the different landing centres as well as markets and analysed. The details about the different dimensions of the market structure were collected across 300 markets

During the year 2013-14 the fish exports from India was found to be 0.98 million t with value earnings of ₹30213 crores worth 5.07 billion dollars. The exports registered an increase of 5.98% in quantity, 60.23% in rupee value and 42.60% in dollar realisation.

Ten dimensions of the market structure were collected for over 200 fish markets (wholesale/ retail) in coastal states of Kerala, Karnataka, Tamil Nadu, Gujarat and Maharashtra. The major constraints faced by the marketers were high marketing and transportation cost followed by lack of infrastructure amenities. Even though the market is controlled by the local bodies, they are not properly maintained. The infrastructure facilities like parking area, facilities for freezing, icing and drying is almost lacking in all the markets. There has also been a paradigm shift in the consumption behaviours towards fish purchase. They tend to “buy fish while they travel rather than travel to buy fish”. It was observed that sardine and mackerel which were counted in the category of low value fishes have become costlier with prices consistently remaining more than ₹100 and ₹160 in the domestic market.

Valuation of landings

Analysis of species composition for the valuation of all India landings showed that oil sardines contributed the maximum in terms of quantity landed (15.79%), while *S. commersoni* contributed the least (0.77%). The share in point of first sales of oil sardines was 8.62% and share in point of last sales 8.52%. The other species which contributed significantly include, ribbonfish, non penaeid shrimps and Indian mackerel. It was found that penaeid shrimps accounted for highest share in sales both in point of first and last sales with 17.17 and 18.42% respectively, followed by non-penaeid shrimps and oil sardine. The least share of sales was incurred by *S. commerson* both in points of first and last sale

Species composition for the valuation of landings (%)

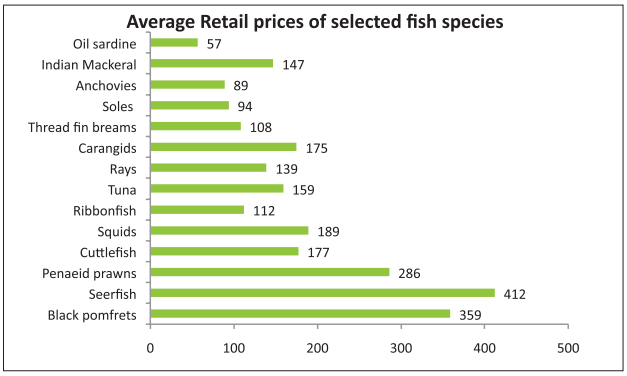
Species	Share in Qty	Share in point of first sales	Share in point of last sales
Penaeid shrimps	5.24	17.17	18.42
Non-penaeid shrimps	5.67	8.85	8.35
Oil sardine	15.79	8.62	8.52
Ribbon fishes	6.60	7.29	6.64
Indian mackerel	5.32	5.53	5.48
Croakers	4.75	4.82	4.58
Squids	2.40	4.19	3.93
Cuttlefish	2.19	3.47	3.26
Scads	3.33	2.95	2.59
S. commerson	0.77	2.78	2.70

Average fish prices and fisherman share of consumer's price

The data on average landing centre prices of selected fish species across different states indicated that the prices of the selected species were different across the states probably on account of difference in operational efficiencies. The average landing price across the states was highest for seerfish (₹279), with a range between ₹180 in Gujarat to ₹374 in Tamil Nadu

Average landing centre prices of important fish species across the coastal states (₹)

Species	Gujarat	Maharashtra	Goa	Karnataka	Kerala	Tamil Nadu	Andhra Pradesh
Oil Sardine	15	50	24	18	28	14	10
Indian mackerel	60	101	108	74	80	88	70
Anchovies	40	51	15	32	80	106	30
Soles	75	68	47	36	46	55	20
Threadfin breams	32	70	35	54	28	187	53
Carangids	150	120	140	130	126	120	120
Rays	75	90	88	160	85	80	40
Tuna	80	142	76	59	112	90	100
Ribbonfish	63	69	91	67	102	74	30
Squids	150	159	178	104	113	155	92
Cuttlefish	80	132	178	122	103	125	92
Penaeid Shrimps	171	225	251	180	196	215	225
Seerfish	180	248	317	223	300	374	196
Black pomfrets	140	348	249	210	290	240	200



The average retail centre prices of important fish species across different states indicated that the prices of different species were different across the states probably on account of difference in consumption behaviour. The average retail price across the states was highest for seerfish (₹412), with a range between ₹248 in Gujarat to ₹567 in Goa.

Fishermen's share in consumer rupee

The average fishermen share of consumer's rupee was highest for carangids (77%), with a share ranging from 64% in Kerala to 83% in Gujarat and Maharashtra. The lowest fishermen share of consumer's rupee was lowest for oil sardine with a share of 24% in Karnataka to 60% in Gujarat.

Average Fishermen share of consumer's rupee of important fish species across the coastal states

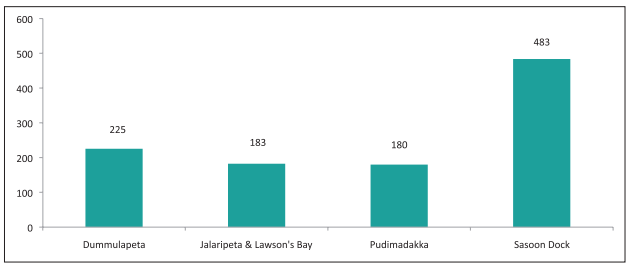
Species	Gujarat	Maharashtra	Goa	Karnataka	Kerala	Tamil Nadu	Andhra Pradesh
Oil Sardine	60	51	32	24	46	42	33
Indian Mackerel	67	67	54	42	63	53	70
Anchovies	67	67	50	53	73	58	50
Soles	83	83	48	24	59	69	50
Threadfin breams	53	53	50	68	43	71	76
Carangids	83	83	78	76	64	77	75
Rays	79	79	58	68	63	62	57
Tuna	50	50	55	66	67	62	83
Ribbonfish	66	66	64	61	65	67	50
Squids	75	75	85	72	66	65	58
Cuttlefish	40	40	85	74	64	69	58
Penaeid shrimps	78	78	69	84	66	74	75
Seerfish	78	81	56	50	58	78	61
Black pomfrets	56	56	61	65	68	64	67

Spatial price differential of commercially important fish species

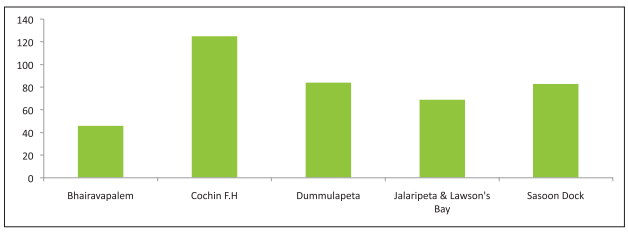
Catfish: Among the different stations, Jalaripeta and Lawson's Bay and Pudimadika and Sasoon Dock accounted the highest average price of ₹67 and 65/kg for the catfish landed. Bhairavpalem and Dummulapeta had a similar average price of ₹43/kg for the catfish.

Black pomfret: Sasoon Dock accounted the record average price of ₹483/kg for the black pomfret followed by Dummulapeta (₹225/kg), Jalaripeta & Lawson's Bay (₹183/kg) and Pudimadika (₹180/kg)

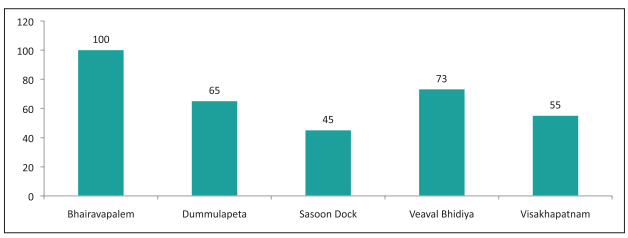
Average price of catfish in different stations



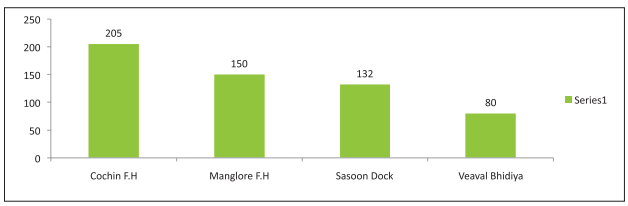
Average price of black pomfret in different stations



Average prices of carangids in different stations



Average price of croakers in different stations



Average price of cuttlefish in different stations

Carangids: Cochin Fisheries Harbour recorded the highest average price (₹125/kg) from carangids among the different stations followed by Dummulapeta (₹85/kg). Lowest price was obtained from Bhairavpalem (₹46/kg).

Croakers: The highest average price of croakers was obtained from Bhairavpalem Station (₹100/kg) followed by Veraval Bhidiya (73/kg), Dummulapeta (₹65/kg) and Vishakhapatnam (₹55/kg). The lowest price was from Sasson Dock (₹45/kg)

Cuttlefish: Cochin F.H. accounted for the highest cuttlefish price of ₹205/kg followed by Mangalore Fisheries Harbour (₹150/kg) and Sasoon Dock (₹132/kg). The least price of cuttlefish was obtained from Veraval Bhidiya landing centre with an average price of ₹80/kg.

Mackerel: Sasoon Dock recorded the highest mackerel price of ₹101/kg followed by Cochin F.H. (₹91/kg) and Mangalore F.H. (₹87/kg). The Vishakhapatnam F.H. accounted the least price of ₹57/kg which was just the half of Sasoon Dock.

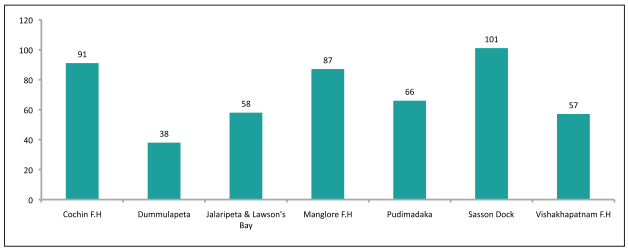
Oil Sardine: Highest average price oil sardine was obtained from Cochin F.H (₹35/kg) followed by Jalaripeta and Lawson's Bay (₹28/kg), Mangalore F.H. (₹17/kg) and Pudimadika (₹20/kg).The least price was obtained from Dummulapeta of ₹13

Penaeid shrimp: The average price of penaeid shrimp was highest in Sasoon Dock with a record value of ₹472/kg followed by Jalaripeta and Lawson's Bay (₹348/kg) and Visakhapatnam F.H (₹341/kg) the lowest price was obtained from Veraval Bhidiya (₹171/kg)

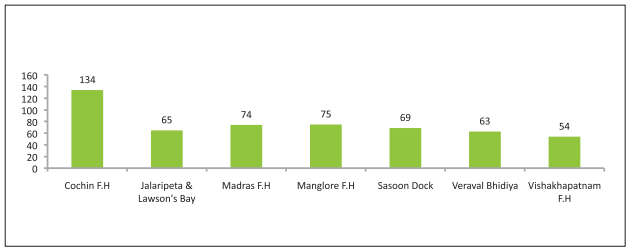
Ribbonfish: Cochin F.H accounted for the highest average price of ribbonfish (₹134/kg) followed by Madras F.H and Mangalore F.H (₹74/kg and ₹75/kg). Lowest average price was obtained from Visakhapatnam F.H (₹54/kg)

Threadfin bream: The top average price of thread fin breams was obtained from Madras F.H (₹73/kg) followed by Mangalore F.H (₹54/kg) and Visakhapatnam F.H (₹53/kg). Sasoon Dock and Veraval Bhidiya accounted the least average price of ₹31/kg and 32/kg.

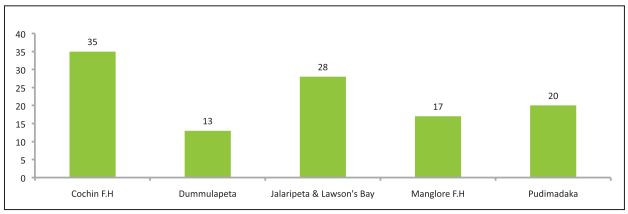
Non penaeid shrimp: Average non penaeid shrimp price was maximum in Pudimadika of ₹283/kg followed by Sasoon Dock of ₹230/kg. The least price was obtained from Bhairavpalem of ₹111/kg.



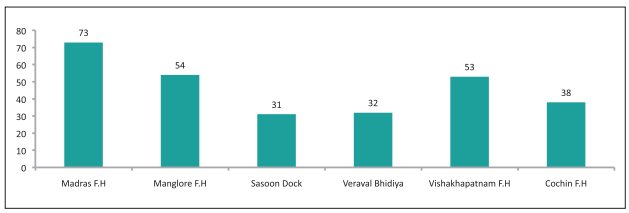
Average price of mackerel in different stations



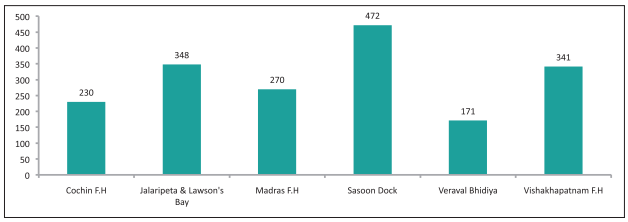
Average price of ribbonfish in different stations



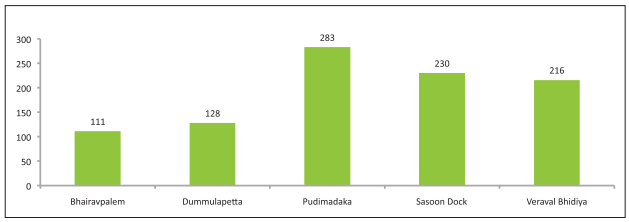
Average price of oil sardine in different stations



Average price of threadfin breams in different stations



Average price of penaeid shrimp in different stations



Average price of non penaeid shrimp in different stations

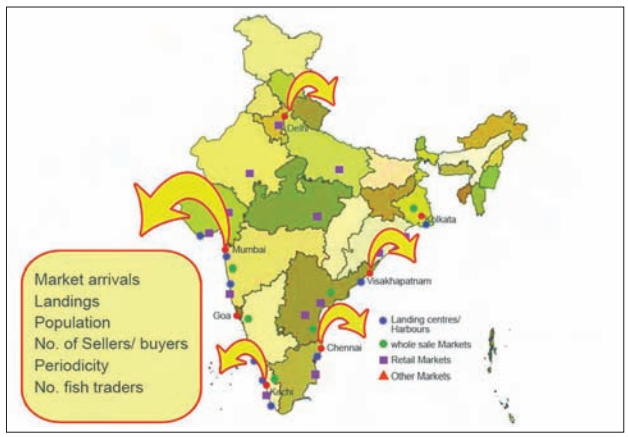
Fish market grid of India

Fish market grid prototype for indian marine fisheries sector

Research Projects: FISHCMFRISIL201202300023

Fish is a highly perishable commodity, with seasonal distribution, inelastic supply and spatio-temporal price differentials. Decision support systems eliciting the fish market structure and its prices would be highly advantageous to the different stakeholders with the following outcomes.

Fishers	-	Identifying best target market for disposal
Marketers and traders	-	Determining fish arrivals/ disposal
Consumers	-	Rational buying decision
Exporters	-	Capacity utilisation
Policy planners	-	Developing market regulations



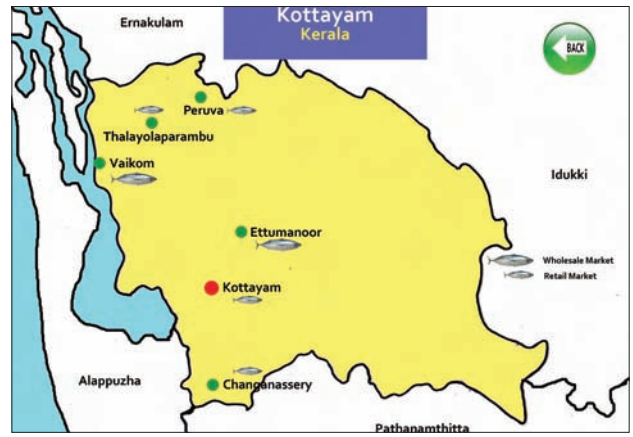
Detailed fish market grid across the coastal states of India

Fish market grid of Kerala

The outcomes generated will act as an effective decision making tool for identifying better target markets and remunerative prices

A Decision Support System with development of a market grid on a spatio-temporal platform was attempted during 2013-14. The spatio-temporal market and price database for Indian fisheries sector with user driven decision making based on structured and customised queries would be available. The system would include identification of innovative commodity specific fish value chains whose attributes could be replicated in other locations. Emphasis will be given to species, markets and prices in an integrated format which would facilitate market information flows across the stakeholders ensuring affordability and would have a check on national food security. The market grid encompasses different information related to the market structure which includes selected ten dimensions of Location, Access, Timing, Conduct, Species, Arrivals, Disposals, Adequacy, Regulations and Intelligence. These inputs were collected from around 100 markets of the coastal states of Kerala (Ernakulam, Kottayam, Trivandrum, Kollam, Kozhikode, Pathanamthitta and Alappuzha) Karnataka, Tamil Nadu, Maharashtra and Gujarat. This prototype would aid in developing appropriate domestic policy framework for effective marketing/consumption and an over-arching policy development framework at the centre and state specific marketing policies.

Fish market grid of Ernakulum



Fish market grid of Kottayam

Chambakkara

Parameter	Details
Locale	T- WS A-Central junction
Access	LC-Thoppumpady, D-20km RS-Tripunithara, D-5km BS- Tripunithara, D-5km A-Nedumbassery, D-30km S- Kochi, D-20km
Timings	Daily-4-8hrs Remains closed on occasions - No
Conduct	D, W, R, Ca- Present
Species	Sardine,Mackerel
Arrivals	Thopumpady, Munambam, Vaikom, Thripunithura, Muvattupuzha, Piravom Qty -22 tonnes/week
Disposals	Vaikom, Ettumanoor, Piravom, Thripunithura, Muvattupuzha, Thalayolaparambu, Chambakkara, Vyttila Qty -22 tonnes/week
Adequacy	P- 10cents T- 50cents
Regulations	R-Yes C-No CITU-40nos

Piravom

Parameter	Details
Locale	T- WS A- Piravom
Access	LC-Chambakkara, D-26km RS-Piravom road, D-0km BS- Piravam, D-200m A-Nedumbassery, D-50km S- Kochi, D-45km
Timings	Daily-4-8hrs Remains closed on occasions - Yes
Conduct	D -50,Yr-2007 W -30, Yr-1962 R -20,Yr-2002 Mm -15
Species	Sardine, Mackerel, Stolephorus, Surgeon Fish
Arrivals	Vaikom, Cochin, Chambakkara, Ettumanoor Qty -3tonnes/week
Disposals	Velloor, Mukkulam, Kakkad Qty -3tonnes/week
Adequacy	P, T - Yes
Regulations	R-Yes C-No CITU-20nos

Changanassery

Parameters	Details
Locale	T-R A-50 cents
Access	LC-Punnapra, D-43km RS-Changanassery, D-2km BS- Changanassery, D-2km A-Nedumbassery, D-100km S- Kochi, D-86km
Timings	Daily- 4-8hrs Remains closed on occasions- Yes
Conduct	D-150-200 W-6 R-20
Species	Sardines, Mackerel, Shrimp, Nemipterus, Stolephorus
Arrivals	Pondicherry, Tuticorin, Punnapra, Goa, Kochi, Neendakara Qty -21 tonnes/week
Disposals	Goa Qty -21 tonnes/week
Adequacy	P,T-Yes
Regulations	R-Yes

Ettumanoor

Parameters	Details
Locale	T-WS A-Ettumanoor
Access	LC-Vaikom, D-25km RS-Ettumanoor , D-3km BS- Ettumanoor, D-0km A-Nedumbassery, D-65km S- Kochi, D-50km
Timings	Daily-8-12 hrs Remains closed on occasions- Yes
Conduct	D -10,Yr-1960 W -10, Yr-1960 R -100,Yr-1982 M-150,Yr-2002 Ca -8,Yr-1950 R -50,Yr-1960 Mm -25,Yr-1960 B -10,Yr-1960
Species	Sardines, Mackerel
Arrivals	Vaikom, Thoppumpady, Chambakkara Qty -22 tonnes/week
Disposals	Kottayam, Muvattupuzha, Thalayolaparambu, Kadathuruthy, Peruva, Piravam Qty -22 tonnes/week
Adequacy	P- Yes T - Yes
Regulations	R-Yes C-No CITU-20nos

Market structure information output

Intellectual property **management**

(Reserch project: EF-32/IP&TM-ICAR)

Key considerations given by the Institute Technology Management Unit (ITMU) of CMFRI is to prioritise the cutting-edge technologies for the sustainable use of marine natural resources. Protection of public sector research can be used as a defence mechanism to keep innovations in the public domain. Intellectual Property Rights (IPR) enabled technologies from marine resources could be utilised to negotiate/ bargain access to strategic research tools and technology from the private sector, and technology transfer of the Intellectual Property (IP) protected technologies for greater benefits to society and mankind.

Overview of IP assets

No. of technologies available with Institute	:	22
No. of technologies licensed (exclusive / non-exclusive)	:	3
No. of patents (applied)	:	20
No. of Trademarks	:	1
No. of Copyrights	:	4

Patents

	Application Number	Transfer/ Commercialisation status	Title
1	2281/CHE/2013 (Complete Patent Filed)	A modified version used by a NGO in Ashtamudi lake	A device and process to separate oyster meat from shell using pressurised steam
2	2965/CHE/2013 (Complete Patent Filed)	Partnership developed with Rudra Technofeeds Private Limited, Bhimavaram, Andhra Pradesh and used for silver pompano mariculture	Growout pellet feed for silver pompano *Trachinotus blotchii* (Lacepede) and a process therefore to incorporate essential nutritional elements in fish
3	2972/CHE/2013 (Patent of addition: Complete Patent Filed)	The technology has been commercialised with Celestial Biolabs Limited, a Hyderabad based BioPharmaceutical Company on 14 February, 2013 at NASC Conference Hall in Delhi	Anti-inflammatory principles in a preparation of brown seaweed

4	5197/CHE/2012 (Examination request filed)	Technology has been offered on consultancy mode to (1) Tamil Nadu Fisheries Department, Commissioner of Fisheries, Department of Fisheries, Tamil Nadu Government, Chennai – 600 006 (2) Tamil Nadu Corporation for Development of Women, Project Director, IFAD assisted PTSLP (Tamil Nadu Corporation for Development of Women Ltd, Government of Tamil Nadu Undertaking), 100 Anna Salai, Guindy, Chennai – 600 032	Cement & concrete moulded artificial reef apparatus to aggregate marine fish
5	5196/CHE/2012 (Examination request filed)	Demonstrated to the tribals (under TSP programme), Fishermen, fishermen co-operatives and SHG's involved in the open sea cage culture	Development of galvanised iron cage for finfish culture in open sea
6	5198/CHE/2012 (Examination request filed)	The technology has been commercialised with Accelerated Freeze Drying Company Pvt. Ltd., a FDA, ISO 22000 FSSC 22000:2011 certified flag Ship Company of Amalgam Group of Companies	A process to isolate anti-Inflammatory principles from green mussel Perna viridis L. to prepare a stabilised nutraceutical supplement against inflammatory disorders and a product thereof
7	5199/CHE/2012 (Examination request filed)	The technology has been commercialised with Celestial Biolabs Limited, a Hyderabad based BioPharmaceutical Company on 14th February, 2013 at NASC Conference Hall in Delhi	A product containing anti-inflammatory principles from brown seaweeds and a process therof

Examination report has been received (date of issue of FER: 21/07/2013) for the following patent with reference to the RQ No. 5818/RQ-DEL/2009. Examination has been conducted under Section 12 and 13 of the Patents Act 1970 by the Asst. Controller of Patents & Designs, Government of India Patent Office. The details are as follows:

Date of Patent Application					
Appl. Number	Title	Provisional	Complete	Publication date	Present Status
3455/DEL/05	Hatchery technology for production of clown fish by G. Gopakumar	N/A	23/12/05	14/11/07	Examination report has been received

Trademarks

The Trademarks Registrar has called for a detailed hearing on the registerability of the CMFRI Trade Mark "Cadalmin" application numbered 1833767 and 1833768 in class 31 and 35 at the Office of the Trademark Registrar, Chennai on 23 December 2013. As the trademark has been officially acknowledged and numbered by the trademarks registry of Intellectual Property, India, CMFRI can use 'cadalmin™' for the products and services of the institute. After the clearance of the formal procedures of legal official hearing and issue of the approved certificate of the registry, within a couple of months, Cadalmin® will be the permanent trademark of CMFRI for all the products and services of the institute.

Trademark		Registration No
Class 31 (Food for fish, seeds)	Cadalmin™	Registration No: 1833767
Class 35 (Trading and Marketing)	Cadalmin™	Registration No: 1833768

Collaborative R&D

CMFRI has collaborative R&D arrangements with the following Indian companies for commercialisation of technologies:

1) Raju's Bluefield Inc., Palakol, West Godavari District, Andhra Pradesh
2) Rudra Technofeeds Private Limited, Bhimavaram, Andhra Pradesh
3) Celestial Biolabs Limited, Hyderabad based Biopharmaceutical Company
4) Accelerated Freeze Drying Company Pvt. Ltd. Cochin

Publications

Publications related to the cutting-edge technologies of the institute:

- Cage farming of cobia (*Rachycentron canadum*)
- Farming of silver pompano *Trachinotus blochii* in coastal aquaculture ponds
- Broodstock development and seed production of cobia, *Rachycentron canadum*
- Broodstock development and seed production of silver pompano *Trachinotus blochii*

- A compendium of technologies developed through various R & D projects of CMFRI. A contribution from the ICAR IP&TM funded project XI Plan scheme Intellectual Property Management and Transfer/ Commercialisation of Agricultural Technology.

- Album on "Nutraceutical products developed by CMFRI" 2013. Kajal Chakraborty. A contribution from the ICAR IP&TM funded project XI Plan scheme Intellectual Property Management and Transfer/ Commercialisation of Agricultural Technology, 16 pp.

Video

A movie on "Successful sea cage farming by Sidi tribals of Gujarat" (renamed as "Cage Farming Technology for Community Benefit") released by the Hon'ble DG and Secretary DARE Dr S. Ayyappan on 12th May 2013 at Mandapam Regional Centre of CMFRI

This movie emphasises how CMFRI imparted the technical know-how to the Sidhi tribal communities under the Tribal Sub Plan (TSP) of ICAR. These tribals developed a sea cage farm off Somnath coast in the Arabian Sea for their benefit under TSP with their active participation. The produce from this farm reaped benefits of about ₹26 lakhs. The contents of this movie also describe how CMFRI under ICAR has empowered these tribals with permanent livelihood option from the stage of hunger. This movie also describes how Central Marine Fisheries Research Institute imparted skills in fabrication of galvanised iron cages, mooring, net handling, feeding and other farm management practices required for sea farming to the tribal communities in India under the Tribal Sub Plan programme of ICAR.

Library and **documentation**

Institutional Repository eprints@cmfri

The Library and Documentation Centre has developed it's open access Institutional Repository, eprints@cmfri for Institutional publications. The Institutional repository facilitates browsing by year of publication, author, department, document type and subject. Advanced search is also possible with many options. Nearly 450 full text articles contributed by the scientists and staff of CMFRI were uploaded during the year 2013-14, and are available in 'eprints@cmfri'. Over 10000 scientific papers have been uploaded to date.

Status of CMFRI Repository

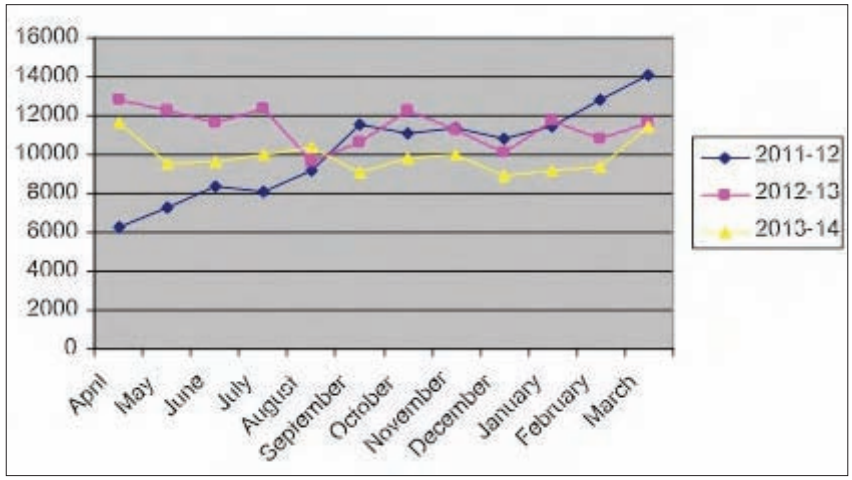
Our Institute's Repository eprints@cmfri got 352nd World Rank among 2000 repositories in the world. Our Repository scores first place among the Indian Repositories, with the world rank of 275 in Google Scholar and third place among all good Indian Repositories and first place among all ICAR Institutes.

Top 10 countries usage report during 2013-14

	Country / Territory	Visits
1	India	74575 (62.66%)
2	United States	6,047 (5.08%)
3	Philippines	3,115 (2.62%)
4	Malaysia	2,584 (2.17%)
5	Indonesia	2,022 (1.70%)
6	United Kingdom	1,689 (1.42%)
7	Australia	1,350 (1.13%)
8	Thailand	1142 (0.96%)
9	Iran	1,089 (0.92%)
10	China	1,086 (0.91%)

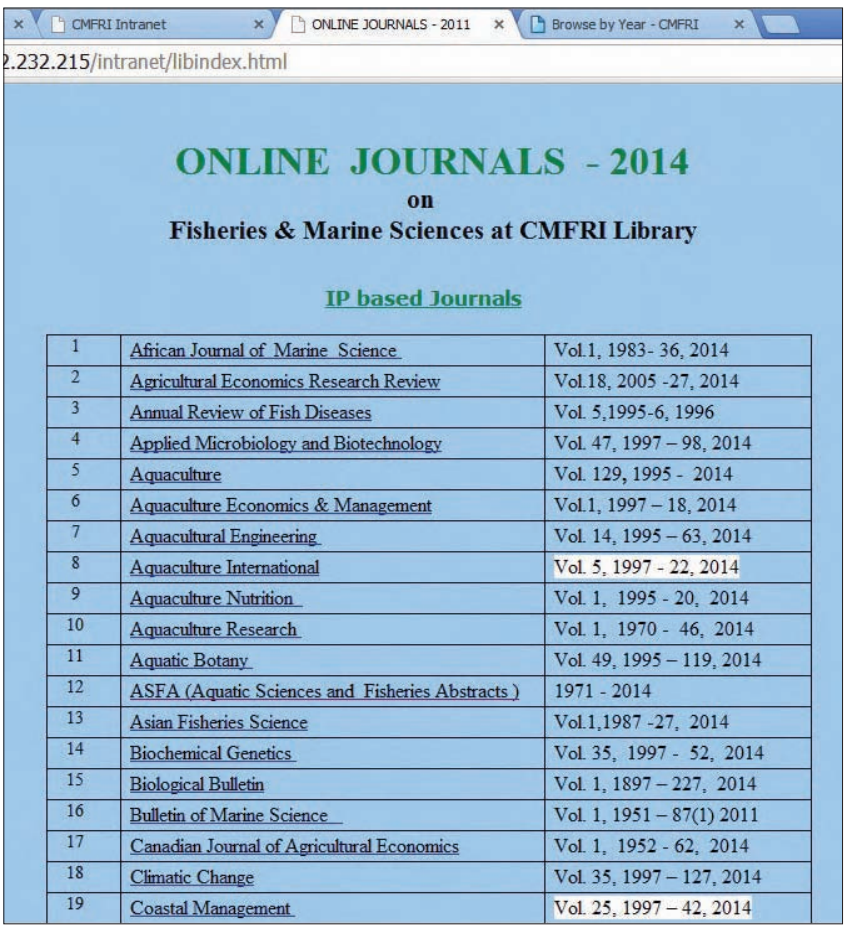
The usage of eprints@cmfri for the period 1 April, 2013 to 31 March 2014 has been recorded by Google Analytics. More than 209 countries used the repository and 1,19,015 times visited and downloaded full text of scientific papers. Notably, visits from India are highest with 74,575 times followed by USA 6047, Philippines 3115, Malaysia 2584, Indonesia 2022, UK 1689, Australia 1350, Thailand 1142, Iran 1089, China 1086 times and so on. The trend of usage of Institutional Repository for the year 2011-12 to 2013-14 is appended in graph.

Usage of Institutional Repository for the year 2011-12 to 2013-14



India's Best Institutional Repository Award 2012 for eprints@cmfri

Registry of Indian Open Access Repositories, a part of Open Access Journals Search Engine (www.oajse.com) had conducted a survey to get Best Institutional Repository in India. After proper verification and evaluation of various parameters, eprints@cmfri (http://eprints.cmfri.org.in) has been selected for India's Best Institutional Repository Award 2012. The award along with a certificate has been received on 05 May 2013.



ONLINE JOURNALS - 2014

on

Fisheries & Marine Sciences at CMFRI Library

IP based Journals

1	African Journal of Marine Science	Vol.1, 1983- 36, 2014
2	Agricultural Economics Research Review	Vol.18, 2005 -27, 2014
3	Annual Review of Fish Diseases	Vol. 5,1995-6, 1996
4	Applied Microbiology and Biotechnology	Vol. 47, 1997 – 98, 2014
5	Aquaculture	Vol. 129, 1995 - 2014
6	Aquaculture Economics & Management	Vol.1, 1997 – 18, 2014
7	Aquacultural Engineering	Vol. 14, 1995 – 63, 2014
8	Aquaculture International	Vol. 5, 1997 - 22, 2014
9	Aquaculture Nutrition	Vol. 1, 1995 - 20, 2014
10	Aquaculture Research	Vol. 1, 1970 - 46, 2014
11	Aquatic Botany	Vol. 49, 1995 – 119, 2014
12	ASFA (Aquatic Sciences and Fisheries Abstracts)	1971 - 2014
13	Asian Fisheries Science	Vol.1,1987 -27, 2014
14	Biochemical Genetics	Vol. 35, 1997 - 52, 2014
15	Biological Bulletin	Vol. 1, 1897 – 227, 2014
16	Bulletin of Marine Science	Vol. 1, 1951 – 87(1) 2011
17	Canadian Journal of Agricultural Economics	Vol. 1, 1952 - 62, 2014
18	Climatic Change	Vol. 35, 1997 – 127, 2014
19	Coastal Management	Vol. 25, 1997 – 42, 2014

Online Journals

During the year 2013, the Library subscribed 64 national and international journals including online versions. Online journals and databases can be accessed at HQs, Regional and Research Centres of CMFRI through Institute website. ASFA Online Database is subscribed from 1971- 2014 and Wiley online journals from Vol.1 onwards. Access to more than 3500 online journals on agriculture and allied subjects including Springer and Elsevier journals is made available to CMFRI HQs and RCs.

Impact factor for Indian Journal of Fisheries increased

The Library & Documentation Centre has taken earnest efforts to index Indian Journal of Fisheries in Thomson Reuter's Science Citation Index and Elsevier's Scopus and other databases in 2011. Indian Journal of Fisheries got an increased International Impact Factor for 2013 from 0.04 to 0.195. The NAAS Rating of Indian Journal of Fisheries has also been increased from 4.5 to 6.2.

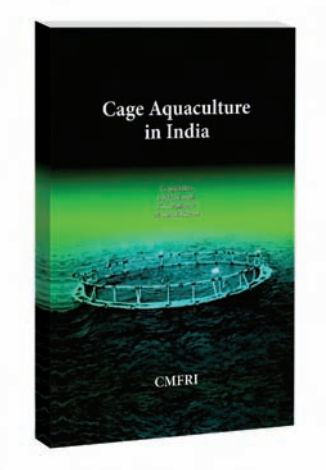
Current Awareness Service

The monthly Content Page Service for selected journals prepared in digital format and hosted in the intranet of CMFRI website for the users at HQs and Regional/ Research Centres.

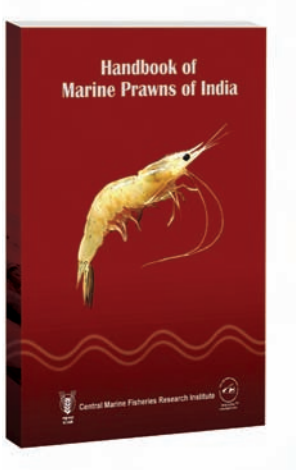
CMFRI Publications

1. Indian Journal of Fisheries : Vol. 60(1-4)
2. Marine Fisheries Information Service : Nos. 216, 217, 218 (English)
3. Marine Fisheries Information Service : Nos. 210-215 (Hindi)
4. Cadalmin: CMFRI Newsletter Nos. 137-139 (English & Hindi)
5. Special Publication : Nos. 110-114
6. Annual Report : 2012-13
7. Books
   - Indian Sacred Chank
   - Handbook of Marine Prawns of India
   - Cage Aquaculture in India
   - Indigenous Technical Knowledge (ITKs') of Indian Marine Fishermen with reference to Climate Change
   - Bharath ki samudri sastaniyam (Marine Mammal Species of India)
8. Pamphlets
   - Dismantling and re-assembling type cages for open water aquaculture
   - Culture of grey mullet *Mugil cephalus* in backwater cage
   - Broodstock development and seed production of silver pompano
   - Cage farming of cobia
   - Broodstock development and seed production of cobia
   - Farming of silver pompano in coastal aquaculture ponds
9. Posters
   - Carangids in the seas around India Part I & II
   - Seaweeds and Seagrasses
   - Ornamental Fishes of Indian Coast Part I & II

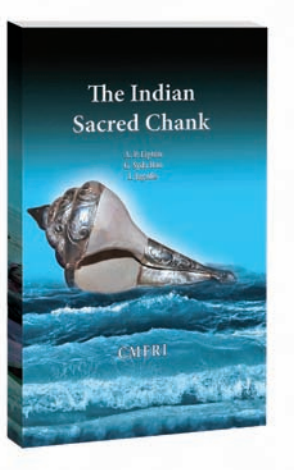
Books



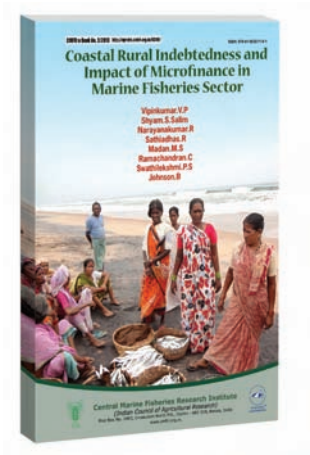
Cage Aquaculture in India



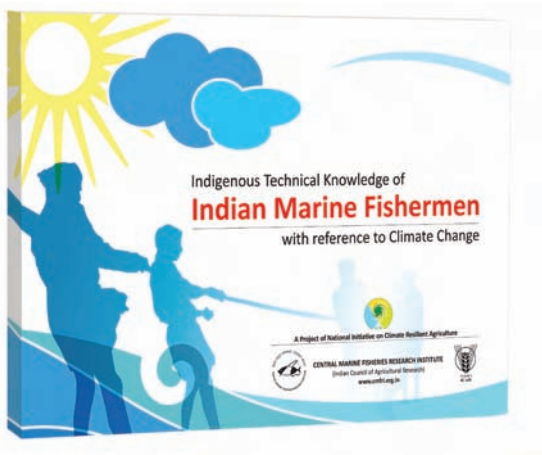
Handbook of Marine Prawns of India



Indian Sacred Chank

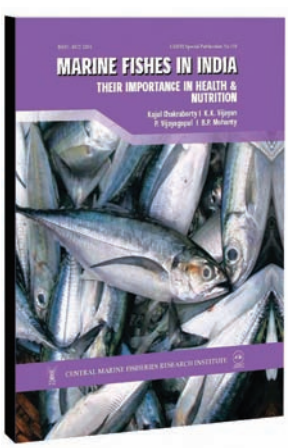


Coastal Rural Indebtedness and Impact of Microfinance in Marine Fisheries Sector

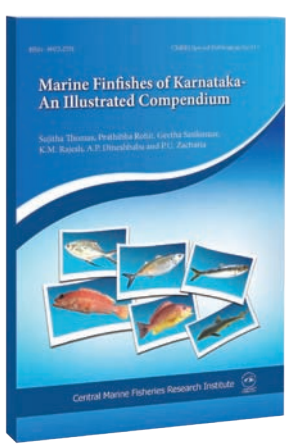


Indigenous Technical Knowledge (ITKs') of Indian Marine Fishermen with reference to Climate Change

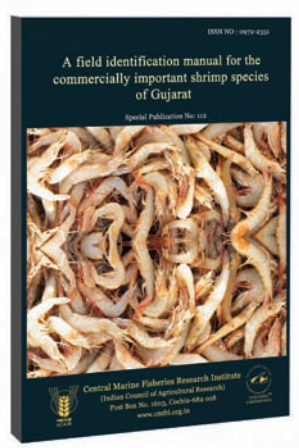
Special Publications



Marine fishes in India: Their importance in health & nutrition



Marine Finfishes of Karnataka- An Illustrated Compendium

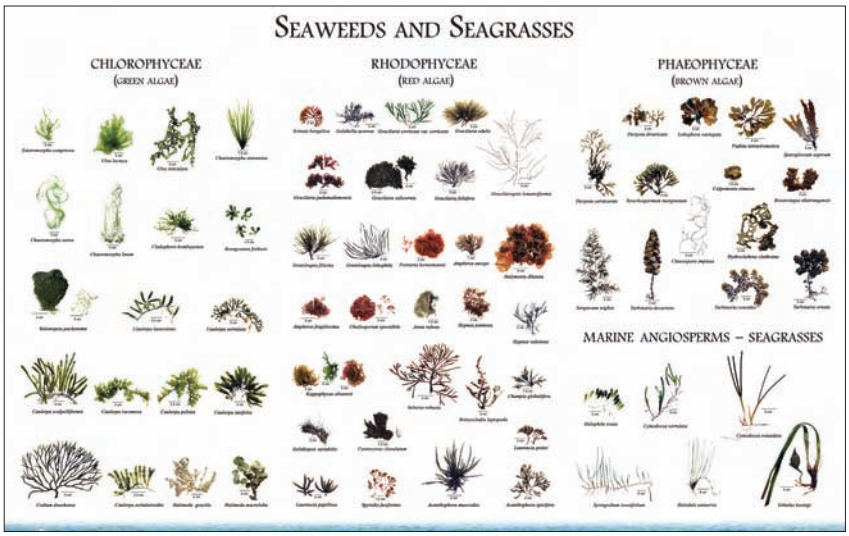


Field identification manual for the commercially important shrimp species of Gujarat

CMFRI Posters

Carangids in the Seas around India-1

Carangids in the Seas around India-2



Seaweeds and Seagrasses

Ornamental Fishes of Indian Coast-1

Ornamental Fishes of Indian Coast-2

Budget 2013-14

The Budget and Expenditure under Non-Plan and Plan for the financial year 2013-14 in respect of CMFRI (₹ In lakhs)

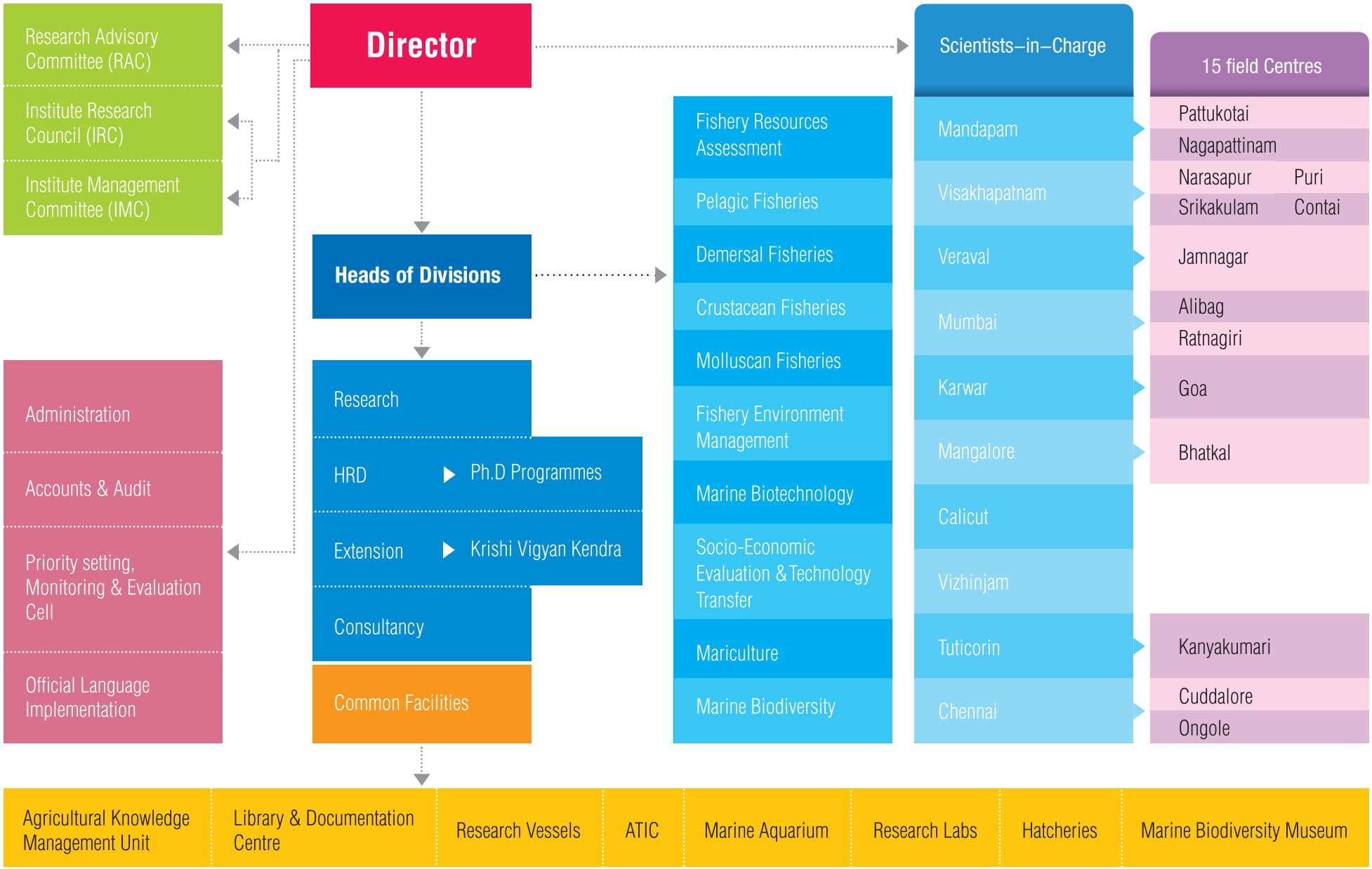
Budget Head	Non-Plan		Plan	
	Budget	Expenditure	Budget	Expenditure
Revenue				
Establishment charges	3860.00	3860.00	0.00	0.00
Overtime Allowance	0.51	0.51	0.00	0.00
Travelling Allowance	22.00	22.00	120.00	120.00
Research & Operational Expenses	105.00	105.00	465.00	465.00
Administrative Expenses	325.00	325.00	438.23	438.23
Miscellaneous Expenses including HRD	29.40	29.40	30.00	30.00
Works Repair & Maintenance				
Office Building	90.00	90.00	0.00	0.00
Residential Building	25.00	25.00	0.00	0.00
Minor Work - Revenue	1.00	1.00	26.77	26.77
TSP-Operational Expenses	0.00	0.00	45.00	45.00
Total	4457.91	4457.91	1125.00	1125.00
Capital				
Information Technology	1.50	1.50	50.00	50.00
Equipment	5.00	5.00	219.25	219.25
Furniture	3.00	3.00	60.00	60.00
Library	0.00	0.00	50.00	50.00
Vessel	0.00	0.00	0.75	0.75
Works	58.67	58.67	299.76	299.76
TSP - Capital	0.00	0.00	15.00	15.00
Total	68.17	68.17	694.76	694.76
Grand Total	4526.08	4526.08	1819.76	1819.76

	Budget	Expenditure
Pension & Other Retirement Benefits	3520.00	3520.00
Loans & Advances	30.00	26.86

Other Projects	Expenditure
Non-Plan Schemes	18.13
NAIP	341.29
Other Plan Schemes	59.88
Deposit Schemes	180.16
Krishi Vigyan Kendra, Narakkal	102.45
Consultancies	26.69
NICRA	244.17

Revenue Receipts 2013-14	Target	Achievement
Revenue receipts	122.60	122.90
Interest on Short Term Deposits		58.05
Recovery of Loans and Advances		40.13

CMFRI Organogram



Personnel

As on 31-03-2014 | Not a gradation list

SCIENTIFIC

Sl. No.	Name of Employee	Designation
CMFRI, Kochi		
1.	Dr. A. Gopalakrishnan	**Director**
2.	Dr. (Mrs.) V. Kripa	Principal Scientist & Head, FEMD
3.	Dr. K. Sunilkumar Mohammed	Principal Scientist & Head, MFD
4.	Dr. P.U. Zachariah	Principal Scientist & Head, DFD
5.	Dr. K.K. Vijayan	Principal Scientist & Head, MBTD
6.	Dr. R. Narayanakumar	Principal Scientist &Head, SEETTD
7.	Dr. G. Maheswarudu	Principal Scientist & Head, CFD
8.	Dr. P.C. Thomas	Principal Scientist & Head-in-charge, PFD
9.	Dr. T.V. Sathianandan	Principal Scientist & Head-in-charge, FRAD
10.	Dr. P. Kaladharan	Principal Scientist
11.	Dr. K.K. Joshi	Principal Scientist
12.	Dr. P. Laxmilatha	Principal Scientist
13.	Dr. (Mrs.) Imelda Joseph	Principal Scientist
14.	Dr. E.M. Abdusamad	Principal Scientist
15.	Dr. (Mrs.) Josileen Jose	Principal Scientist
16.	Dr. (Mrs.) K.S. Sobhana	Principal Scientist
17.	Dr. P. Vijayagopal	Principal Scientist
18.	Dr. K. Madhu	Principal Scientist
19.	Dr. (Mrs.) Rema Madhu	Principal Scientist
20.	Dr. Boby Ignatius	Principal Scientist
21.	Dr. (Mrs.) Shoji Joseph	Principal Scientist
22.	Dr. J. Jayasankar	Principal Scientist
23.	Dr. (Mrs.) D. Prema	Principal Scientist
24.	Dr. C. Ramachandran	Principal Scientist
25.	Dr. (Mrs.) Molly Varghese	Principal Scientist
26.	Dr. (Mrs.) Somy Kuriakose	Senior Scientist
27.	Dr. V.P. Vipin Kumar	Senior Scientist
28.	Dr. T.M. Najmudeen	Senior Scientist
29.	Dr. Shyam S. Salim	Senior Scientist
30.	Dr. R. Jeyabaskaran	Senior Scientist
31.	Dr. Mini. K.G.	Senior Scientist
32.	Dr. Grinson George	Senior Scientist
33.	Dr. U. Ganga	Senior Scientist
34.	Dr. Rekha J. Nair	Senior Scientist
35.	Dr. Kajal Chakraborty	Senior Scientist
36.	Dr. S.Lakshmi Pillai	Senior Scientist
37.	Dr. Rekhadevi Chakraborty	Senior Scientist
38.	Dr. N. Aswathy	Senior Scientist
39.	Shri N.K. Sanil	Scientist
40.	Shri Wilson T. Mathew	Scientist
41.	Dr. V. Venkatesan	Scientist
42.	Dr. Pradeep M.A	Scientist
43.	Mrs. Sandhya Sukumaran	Scientist
44.	Smt. Divya Viswabharan	Scientist
Mandapam R.C		
45.	Dr. G. Gopakumar	Principal Scientist, Head-In-Charge, Mariculture Division & SIC
46.	Dr. I. Rajendran	Senior Scientist
47.	Dr. A.K. Abdul Nazar	Senior Scientist
48.	Dr. Rengarajan Jayakumar	Senior Scientist
49.	Shri C Kalidas	Scientist
50.	Dr. G. Tamilmani	Scientist
51.	Dr.M. Sakthivel	Scientist
52.	Shri Johnson B.	Scientist
53.	Dr. P. Rameshkumar	Scientist
54.	Shri Saravanan R.	Scientist
55.	Dr. Amir Kumar Samal	Scientist
Visakhapatnam R.C		
56.	Dr. Shubhadeep Ghosh	Senior Scientist & SIC
57.	Shri Ritesh Ranjan	Scientist
58.	Smt. Biji Xavier	Scientist
59.	Smt. Muktha M.	Scientist
60.	Shri Loveson Edward L.	Scientist
61.	Shri Nenavath Rajendra Naik	Scientist
62.	Shri Pralaya Ranjan Behera	Scientist
63.	Dr. Sekar Megarajan	Scientist
Veraval R.C		
64.	Shri K. Mohammed Koya	Scientist &SIC
65.	Shri Sreenath K.R.	Scientist
66.	Shri Gyanranjan Dash	Scientist
67.	Smt. Swathipriyanka Sen Dash	Scientist
68.	Shri Vinaya Kumar Vase	Scientist
Madras R.C		
69.	Dr. K. Vinod	Principal Scientist & SIC
70.	Dr. (Ms.) A. Margaret Muthu Rathinam	Principal Scientist
71.	Dr. K. Vijayakumaran	Principal Scientist
72.	Dr. Joe K. Kizhakudan	Senior Scientist
73.	Dr. Vidya Jayasankar	Senior Scientist
74.	Dr. Sobha Joe Kizhakudan	Scientist
75.	Smt. P. Hemasankari	Scientist
76.	Dr. Satyanarayan Sethi	Scientist
77.	Dr. (Mrs.) R. Geetha	Scientist
78.	Dr. Srinivasa Raghavan V	Scientist
79.	Ms. Indira Divipala	Scientist
Mangalore R.C		
80.	Dr. Prathibha Rohit	Principal Scientist &SIC
81.	Dr. A.P. Dinesh Babu	Principal Scientist
82.	Dr. Sujitha Thomas	Senior Scientist
83.	Dr. K.M. Rajesh	Senior Scientist
84.	Dr. Bindu Sulochanan	Senior Scientist
85.	Dr. Geetha Sasikumar	Senior Scientist
86.	Dr. P.S. Swathilekshmi	Senior Scientist
Calicut R.C		
87.	Dr. P.K. Asokan	Principal Scientist & SIC
88.	Dr. Gulshad Mohamed	Principal Scientist
89.	Dr. P.P. Manoj Kumar	Principal Scientist
90.	Shri K.P. Said Koya	Scientist
Karwar R.C		
91.	Dr. K.K. Philipose	Principal Scientist & SIC
92.	Dr. Jayasree Loka	Senior Scientist
93.	Dr. S.R. Krupesha Sharma	Senior Scientist
94.	Dr. Senthil Murugan	Senior Scientist
95.	Dr. Divu Damodaran	Scientist
Mumbai R.C		
96.	Dr. Veerendra Veer Singh	Principal Scientist & SIC
97.	Smt. Anulekshmi Chellappan	Scientist

98.	Shri Purushottama G.B.	Scientist
99.	Shri S. Ramkumar	Scientist
100.	Smt.. Karhireddy Shyamala	Scientist
Tuticorin R.C		
101.	Dr. M.S. Madan	Principal Scientist & SIC
102.	Dr. I. Jagadis	Principal Scientist
103.	Dr. M. Sivadas	Principal Scientist
104.	Dr. P.T. Sarada	Senior Scientist
105.	Dr. (Mrs.) C.P. Suja	Senior Scientist
106.	Dr. (Smt.) Asha. P.S.	Senior Scientist
107.	Shri Renjith. L	Scientist
Vizhinjam R.C		
108.	Dr. (Mrs.) Rani Mary George	Principal Scientist & SIC
109.	Dr. A.P. Lipton	Principal Scientist
110.	Dr. M.K. Anil	Principal Scientist
111.	Dr. B. Santhosh	Principal Scientist
112.	Dr. S. Jasmine	Senior Scientist
113.	Smt. K.N. Saleela	Scientist
Puri F.C		
114.	Dr. (Mrs.) Reeta Jayasankar	Principal Scientist
KVK, Narakkal		
115.	Dr. Shinoj Subramanian	Programme Coordinator

TECHNICAL

Sl. No.	Name of Employee	Designation
CMFRI, Kochi		
1.	Shri N. Venugopal	Chief Technical Officer
2.	Shri P.K. Harikumar	Assistant Chief Technical Officer
3.	Shri V. Edwin Joseph	Assistant Chief Technical Officer (Library)
4.	Shri J. Sreenivasan	Assistant Chief Technical Officer
5.	Shri N. Viswanathan	Assistant Chief Technical Officer (Civil)
6.	Smt. E.K. Uma	Assistant Chief Technical Officer (Hindi Translator)
7.	Shri S. Haja Najeemudeen	Senior Technical Officer
8.	Smt. K. Ramani	Senior Technical Officer
9.	Shri P.S. Anilkumar	Senior Technical Officer
10.	Dr. V. Mohan	Senior Technical Officer (Library)
11.	Smt. P. Geetha	Senior Technical Officer (Library)
12.	Smt. G. Shylaja	Senior Technical Officer
13.	Smt. E. Sasikala	Senior Technical Officer (Hindi Translator)
14.	Shri M.G. Sivadasan	Technical Officer (Electrical)
15.	Shri S. Yadavayya	Technical Officer (Motor Driver)
16.	Shri K.K. Sankaran	Technical Officer (Artist)
17.	Shri M.P. Paulton	Senior Technical Officer (Training)
18.	Smt. Jenni. B	Senior Technical Officer
19.	Shri L.R. Khambadkar	Technical Officer
20.	Smt. K.V. Rema	Technical Officer
21.	Smt. P.M. Geetha	Technical Officer (Museum)
22.	Smt. K.P. Salini	Technical Officer
23.	Shri K.M. Venugopalan	Technical Officer
24.	Shri K.K. Surendran	Technical Officer
25.	Shri V.J. Thomas	Technical Officer
26.	Smt. P.K. Seetha	Technical Officer
27.	Shri K.P. George	Technical Officer
28.	Smt. M.R. Beena	Technical Officer
29.	Shri M.B. Seynudeen	Technical Officer
30.	Smt. Lata L. Khambadkar	Technical Officer
31.	Shri Sijo Paul	Technical Officer
32.	Shri A. Padmanabha	Technical Officer (Electrical)
33.	Shri K.N. Pushkaran	Senior Technical Assistant
34.	Shri P.K. Baby	Senior Technical Assistant
35.	Shri A.Y. Jacob	Senior Technical Assistant
36.	Shri K.G. Baby	Senior Technical Assistant
37.	Smt. Sindhu K. Augustine	Senior Technical Assistant
38.	Shri V.K. Suresh	Senior Technical Assistant
39.	Shri K.G. Radhakrishnan Nair	Senior Technical Assistant (Motor Driver)
40.	Shri S. Nandakumar Rao	Technical Assistant
41.	Shri N.K. Harshan	Technical Assistant
42.	Shri D. Prakasan	Technical Assistant
43.	Shri P.S. Alloycious	Technical Assistant
44.	Shri K.C. Hezhakiel	Technical Assistant
45.	Shri Baby Mathew	Technical Assistant (Motor Driver)
46.	Shri Arun Surendran P.S	Technical Assistant
47.	Shri Retheesh T.	Technical Assistant
48.	Shri K. Solaman	T-I-3 (Technical Assistant)
49.	Shri M.N. Sathyan	Senior Technician (Motor Driver)
50.	Shri C.V. Jayakumar	Senior Technician (Press & Editorial)
51.	Shri K.M. David	Senior Technician(Artist)
52.	Shri Manjeesh .R	Senior Technician (Computer Application)
53.	Shri P.R. Abhilash	Senior Technician (Exhibition Assistant)
54.	Shri David Babu	Senior Technician
55.	Shri M. Radhakrishnan	Technician
56.	Smt. Dhanya G.	Technician
57.	Shri M.P. Mohandas	Technician
58.	Shri V.H. Venu	Technician
59.	Smt. J. Sudhadevi	Technician
60.	Smt. Shyamala. M.P.	Technician
61.	Shri P.V. Sunil	Technician
62.	Shri Shaji. A.K.	Technician
63.	Smt. Sheela. P.P.	Technician
64.	Shri Jestin Joy. K.M.	Technician
65	K. M. Sreekumar	Technician
66	M. T, Vijayan	Technician
Quilon F.C		
67.	Shri Thomas Kuruvila	Senior Technical Assistant
Mandapam R.C		
68.	Shri P. Chithamparam	Senior Technical Officer (Library)
69.	Shri N. Ramamurthy	Senior Technical Officer (Museum)
70.	Shri I. Mendonza Xavier	Technical Officer (Draughtsman)
71.	Shri P.M.A. Muheedu	Technical Officer (Deckhand)
72.	Shri D. Anandan	Technical Officer (Deckhand)
73.	Shri G. Subbaraman	Technical Officer
74.	Shri P. Muthukrishnan	Technical Officer (Skin Diver)
75.	Shri A. Gandhi	Senior Technical Assistant
76.	Shri V. Sethuraman	Senior Technical Assistant
77.	Shri A. Vairamani	Senior Technical Assistant
78.	Shri A. Shanmughavel	Senior Technical Assistant
79.	Shri V. Sathyanesan	Senior Technical Assistant(Library)
80.	Shri.P.Villan	Technical Assistant
81.	Shri N. Boominathan	Technical Assistant
82.	Shri M. Asokan	Technical Assistant (Painter-cum-Polisher)
83.	Shri G. Hanumantha Rao	Technical Assistant
84.	Shri M. Anbarasu	Technical Assistant
85.	Shri Ashok Maharshi	Technical Assistant
86.	Shri K.U. Raman	T-I-3 (Motor Driver)
87.	Shri Vijaya Karthikeyan	Senior Technician (Electrician)
88.	Shri M. Palanichamy	Senior Technician (Electrician)
89.	Shri K. Shanmughanathan	Technician
90.	Shri R. Selvakumar	Technician
91.	Shri S. Murugaboopathy	Technician
92.	Shri N. Ramakrishnan	Technician
93.	Shri P. Rajendran	Technician
94.	Shri S.M. Sikkender Batcha	Technician
95.	Shri I. Syed Sadiq	Technician
96.	Shri V. Muniasamy	Technician
97.	Shri B. Kathiresan	Technician
Pattukottai F.C		
98.	Shri A. Kumar	Senior Technical Officer
99.	Shri A. Ramakrishnan	Technical Officer
Visakhapatnam R.C		
100.	Dr. Biswajit Dash	Senior Technical Officer
101.	Dr. Madhumita Das	Senior Technical Officer
102.	Dr. Phalguni Pattnaik	Senior Technical Officer
103.	Shri R.V.D. Prabhakar	Technical Officer
104.	Shri J. Bhuvaneswara Verma	Technical Officer
105.	Shri M. Samuel Sumithrudu	Technical Officer
106.	Shri M. Prasada Rao	Technical Officer
107.	Shri S. Nageswara Rao	Technical Officer
108.	Shri P. Venkataramana	Senior Technical Assistant
109.	Ms. Veena Shettigar	Senior Technical Assistant
110.	Shri Mamidi Satishkumar	Technical Assistant
111.	Shri K. Lakshminarayana	Technical Assistant (Motor Driver)
112.	Shri R.P. Venkatesh	Senior Technician (Fitter)
113.	Shri Sangaru Padmaja Rani	Technician
114.	Shri Durga Suresh Relangi	Technician
115.	Shri D. Bhaskara Rao	Technician

116.	Shri D. Jaganna	Technician
117.	Shri C.H. Moshe	Technician
Narsapur F.C		
118.	Shri S. Tatabhai	Senior Technician
Contai F.C		
119.	Shri Pulin Behari Dey	Technical Officer
120.	Shri Swapan Kumar Kar	Senior Technical Assistant
121.	Shri Bijoy Krishna Burman	Senior Technical Assistant
Puri F.C		
122.	Shri Sukhdev Bar	Technical Officer
Srikakulam F.C		
123.	Shri Y.V.S. Suryanarayana	Technical Assistant
Veraval R.C		
124.	Shri Suresh Kumar Mojjada	Senior Technical Officer
125.	Shri H.K. Dhokia	Technical Officer
126.	Shri Mangalsingh Surajsingh Zala	Technical Officer
127.	Shri Vanvi Jayaanthilal Dayabhai	Senior Technical Assistant
128.	Shri Ladani Amrutlal Arjunbhai	Senior Technical Assistant
129.	Shri Polara Jamnadas Premji	Senior Technical Assistant
130.	Shri Chudasama Ramji Raja	Technical Assistant
131.	Ms. Bharadiya Sangita Aravindkumar	Technical Assistant
132.	Shri H.M. Bhint	Senior Technician
133.	Shri Shiju P.	Technician
134.	Shri S. Pradeep	Technician
135.	Shri Makwana Somapitha	Technician
Jamnagar F.C		
136.	Shri Makadia B.V.	Technical Officer
Madras R.C		
137.	Shri D. Pugazhendi	Senior Technical Officer
138.	Shri P. Thirumilu	Senior Technical Officer
139.	Shri S. Mohan	Senior Technical Officer
140.	Shri S. Chandrasekhar	Senior Technical Officer
141.	Shri Ahmed Kamal Basha	Technical Officer
142.	Smt. S. Gomathy	Senior Technical Officer
143.	Shri N. Rudhramurthy	Technical Officer
144.	Shri C. Manibal	Technical Officer (Deckhand)
145.	Shri S. Ganesan	Technical Officer (Deckhand)
146.	Shri V.S. Gopal	Technical Officer
147.	Shri S. Rajan	Senior Technical Assistant
148.	Shri P. Jaiganesh	Senior Technical Assistant
149.	Shri K.S. Shiak Mohamed Yousuf	Technical Assistant
150.	Shri S. Selvanidhi	Technical Assistant
151.	Shri M. Ravindran	Senior Technician
152.	Smt. I. Santhosi	Senior Technician
153.	Shri R. Sunder	Technician
154.	Shri R. Vasu	Senior Technician
155.	Shri V. Joseph Xavier	Technician
156.	Shri Bareen Mohamed	Technician
Kovalam F.L		
157.	Shri R. Ponniah	Senior Technical Assistant (Electrician)
Ongole F.C		
158.	Shri G. Sudhakar	Senior Technical Assistant
159.	Shri S.V. Subba Rao	Technical Assistant
Cuddalore F.C		
160.	Shri M. Manivasagam	Senior Technical Officer
161.	Shri T. Nagalingam	Senior Technician
Mangalore R.C		
162.	Shri S. Kemparaju	Technical Officer
163.	Shri B. Sridhara	Technical Officer
164.	Shri N. Chennappa Gowda	Technical Officer
165.	Shri Y. Muniyappa	Technical Officer
166.	Shri V. Lingappa	Senior Technical Assistant
167.	Shri M. Chaniappa	Senior Technical Assistant
168.	Shri R. Appayya Naik	Senior Technical Assistant
169.	Shri G.D. Nataraja	Senior Technical Assistant
170.	Shri G. Sampathkumar	Senior Technical Assistant
171.	Shri P. Harshakumar	Technical Assistant (Motor Driver)
172.	Ms. Lavanya S.	Technical Assistant
173.	Shri Karamathullah Sahib. P	Technician
Bhatkal F.C		
174.	Shri Udaya V. Arghekar	Technical Officer
175.	Shri Ganesh Bhatkal	Technical Officer
Calicut R.C		
176.	Shri V.A. Kunhikoya	Senior Technical Officer
177.	Smt. V.K. Janaki	Technical Officer
178.	Shri M.P. Sivadasan	Technical Officer
179.	Shri P.P. Pavithran	Technical Officer
180.	Shri M.M. Bhaskaran	Senior Technical Assistant
181.	Shri K.C. Pradeep Kumar	Senior Technical Assistant
182.	Shri A. Anasukoya	Senior Technical Assistant
183.	Smt. M.V. Valsala	Technical Assistant
184.	Shri N.P. Ramachandran	Senior Technical Assistant
185.	Shri C. Chandran	Technical Assistant
186.	Smt. P. Renuka	Technician
Karwar R.C		
187.	Shri Fofandi Mahendra Kumar	Senior Technical Officer
188.	Shri K.C. Pandurangachar	Technical Officer
189.	Shri Narayan G. Vaidya	Technical Officer
190.	Shri S. Satyanarayan V. Pai	Technical Officer
191.	Shri C.G. Ulvekar	Technical Assistant
192.	Shri Narsimhulu Sadhu	Technical Assistant
193.	Ms. Sonali S. Mhaddolkar	Technical Assistant
194.	Shri Kodi Srinivasa Rao	Technical Assistant
195.	Shri Laxman Shanker Korabu	Senior Technician (Skin Diver)
196.	Shri N. Selvakumar	Technician
197.	Shri Rajendra D. Hulswar	Technician
198.	Smt. Pramila Harish Borkar	Technician
Goa F.C		
199.	Shri Prakash C. Shetty	Technical Officer
Mumbai R.C		
200.	Shri C.K. Sajeev	Senior Technical Officer
201.	Shri Nilesh Anil Pawar	SeniorTechnical Officer
202.	Shri A.D. Sawant	Technical Officer
203.	Shri R. Dias Johny	Technical Officer
204.	Shri B.B. Chavan	Technical Officer
205.	Shri J.D. Sarang	Technical Officer
206.	Shri Baban N. Katkar	Technical Officer
207.	Shri S.D. Kamble	Technical Officer
208.	Shri A.Y. Mestry	Technical Officer
209.	Shri Sujit S.K.	Senior Technical Assistant
210.	Shri D.G. Jadhav	Senior Technical Assistant
211.	Shri Jayadev S. Hotagi	Senior Technical Assistant
212.	Shri Thakurdas	Senior Technical Assistant
213.	Shri Punam Ashok Khandagle	Technical Assistant
214.	Shri Suresh Krishnaro Kamble	Technical Assistant
215.	Shri Sashikant R. Yadav	Technical Assistant (Motor Driver)
216.	Shri Vaibhav Dinkar Mhatre	Technical Assistant
217.	Shri Umesh Hari Rane	Senior Technician
218.	Shri Prabhakar Sankar Salvi	Senior Technician
219.	Shri M.P. Jadhav	Technician
220	Shri. Bhangare Sunil Ramachandra	Technician
Ratnagiri F.C		
221.	Shri Bashir Ahmed Adam Shilodar	Senior Technical Assistant
222.	Shri D.D. Sawant	Senior Technical Assistant
223.	Shri Kishor Raghunath Mainkar	Senior Technical Assistant
Tuticorin R.C		
224.	Shri K. Diwakar	Senior Technical Officer
225.	Shri R. Sekhar	Technical Officer (Deckhand)
226.	Shri S. Enasteen	Technical Officer (Deckhand)
227.	Shri S. Mohamed Sathakathullah	Senior Technical Assistant
228.	Shri U. Jeyaram	Senior Technical Assistant
229.	Shri N. Jesuraj	Technical Officer (Skin Diver)
230.	Shri S. Sekar V. Rayer	Senior Technical Assistant (Skin Diver)
231.	Shri J. Padmanathan	Technical Assistant
232.	Shri K. Muthuvel	Technical Assistant (Motor Driver)
233.	Shri K.P. Kanthan	Senior Technician
234.	Shri K. John James	Senior Technician
235.	Smt. B. Koncies Mary	Technician
236.	Shri K. Murugan	Technician
Kanyakumari F.C		
237.	Shri A. Prosper	Technical Officer
Vizhinjam R.C		
238.	Shri S. Ramachandran Nair	Technical Officer (Motor Driver)
239.	Shri K.K. Suresh	Technical Officer
240.	Shri K.T. Thomas	Technical Officer
241.	Smt. T.A. Omana	Technical Officer

242.	Shri Jose Kingsly	Technical Officer
243.	Shri P. Hillary	Technical Officer (Deckhand)
244.	Shri V.P. Benziger	Technical Officer (Deckhand)
245.	Shri A. Udayakumar	Technical Officer
246.	Shri V.A. Laslie	Senior Technical Officer
247.	Shri C. Unnikrishnan	Senior Technical Assistant
248.	Shri B. Raju	Technical Assistant
KVK, Narakkal		
249.	Smt. P. Sreelatha	Assistant Chief Technical Officer
250.	Shri B. Suresh Kumar	Senior Technical Officer (Training)
251.	Shri Shoji Joy Edison	Senior Technical Officer (SMS- Horticulture)
252.	Shri Vijendra Kumar Meena	Senior Technical Officer (SMS- Agronomy/Soil Science)
253.	Shri F. Pushparaj Anjelo	Senior Technical Officer (SMS- Agricultural Extension)
254.	Dr. Karikkathil Smitha Sivadasan	Senior Technical Officer (SMS- Animal Husbandry)
255.	Shri Vikas P.A	Senior Technical Officer (SMS- Fisheries)
256.	Shri V.K. Manu	Senior Technical Assistant (Programme Assistant - Computer)
257.	Ms. Dipti N.V	Senior Technical Assistant (Programme Assistant - Laboratory Technician)

ADMINISTRATIVE

Sl. No.	Name of Employee	Designation
CMFRI, Kochi		
1.	Shri Rakesh Kumar	Chief Administrative Officer
2.	Shri A.V. Joseph	Chief Finance & Accounts Officer
3.	Smt. P.J. Sheela	Deputy Director (OL)
4.	Shri V. Mohanan	Administrative Officer
5.	Smt. Christina Joseph	Assistant Administrative Officer
6.	Shri P. Krishnakumaran	Assistant Finance & Accounts Officer
7.	Shri Thomas Joy	Assistant Finance & Accounts Officer
8.	Shri P.V. Devassy	Assistant Administrative Officer
9.	Smt. C.M. Jenny	Assistant Administrative Officer
10.	Smt. V.K. Sobha	Assistant Administrative Officer
11.	Smt. Meera. K.N.	Assistant Administrative Officer
12.	Smt. Ponnamma Radhakrishnan	Assistant Administrative Officer
13.	Shri C.N. Chandrasekharan	Private Secretary
14.	Smt. N.R. Lethadevi	Private Secretary
15.	Smt. K.V. Sajitha	Private Secretary
16.	Shri K. Ramadasan	Assistant
17.	Smt. M.G.Chandramathy	Assistant
18.	Smt. M. Safiyabi	Assistant
19.	Shri C. Jayakanthan	Assistant
20.	Shri P.P. Chandrasekharan Nair	Assistant
21.	Shri Rishikesh Aandi	Assistant
22.	Smt. Moly Lazer	Assistant
23.	Smt. G. Ambika	Assistant
24.	Smt. N.K. Suseela	Assistant
25.	Shri K. Baburajan	Assistant
26.	Smt. V. Jayalakshmi	Assistant
27.	Smt. C.A. Leela	Assistant
28.	Smt. Manjusha G. Menon	Assistant
29.	Smt. Radhika Krishnan	Assistant
30.	Ms. Soumya Surendran	Assistant
31.	Ms. Ramya M	Assistant
32.	Shri C.K. Sivadas	Assistant
33.	Smt. P.K. Mary	Assistant
34.	Smt. Binny Cherian	Assistant
35.	Shri Santosh Kumar	Assistant
36.	Smt. Gouri Hareendran	Assistant
37.	Smt. T.C. Chandrika	Assistant
38.	Shri R. Chandrakesa Shenoi	Personal Assistant
39.	Smt. P.K. Anitha	Personal Assistant
40.	Shri C.D. Manoharan	Personal Assistant
41.	Smt. P. Vineetha	Personal Assistant
42.	Shri K.N. Murali	Personal Assistant
43.	Smt. Bindu Sanjeev	Personal Assistant
44.	Smt. K. Smitha	Stenographer Grade III
45.	Smt. Saritha L.	Stenographer Grade III
46.	Smt. Dhanya M.B	Stenographer Grade III
47.	Shri A.K. Kunjipalu	Upper Division Clerk
48.	Smt. C. Devaki	Upper Division Clerk
49.	Shri K.S. Ajith	Assistant
50.	Shri K. Jerald Raja	Upper Division Clerk
51.	Shri K.P. John	Upper Division Clerk
52.	Smt Annies Mary Paulose	Upper Division Clerk
53.	Shri T.K. Sumesh	Upper Division Clerk
54.	Shri K.S. Sunil Raj	Upper Division Clerk
55.	Shri Sunil A.T	Upper Division Clerk
56.	Shri Joseph Mathew	Upper Division Clerk
57.	Smt. Deepa P.N.	Upper Division Clerk
58.	Smt. Febeena P.A.	Upper Division Clerk
59.	Smt. Manju Jose	Upper Division Clerk
60.	Shri E.A. Roopesh	Upper Division Clerk
61.	Smt. Sujatha K.K	Lower Division Clerk
62.	Shri S. Sreekumar	Lower Division Clerk
Mandapam R.C		
63.	Smt. P.S. Sumathy	Assistant Administrative Officer
64.	Smt. N. Gomathi	Private Secretary
65.	Smt. S. Parisa	Assistant
66.	Smt. M. Rameswari	Assistant
67.	Ms. Sumeena	Assistant
68.	Shri G.K. Rajan	Upper Division Clerk
69.	Shri M. Shahul Hameed	Lower Division Clerk
70.	Shri B. Balasubramanian alias James	Lower Division Clerk
Visakhapatnam R.C		
71.	Shri Ashish Chobey	Assistant Administrative Officer
72.	Smt. G. Hemlata	Assistant Finance & Accounts Officer
73.	Smt. B. Gauri	Assistant
74.	Smt. D. Madhavi Latha	Assistant
75.	Smt. N.C. Saroja	Upper Division Clerk
76.	Shri L. Pydi Raju	Lower Division Clerk
Veraval R.C		
77.	Shri Chandra Mauli Sharma	Assistant Administrative Officer
78.	Shri Upendar Kumar	Assistant
79.	Shri Vanvi Mansukhlal Madhavji	Assistant
Mangalore R.C		
80.	Shri V.C. Subhash	Assistant Administrative Officer
81.	Smt. Martha R. Mascarenhas	Assistant
82.	Shri U. Purandhara Shetty	Assistant
Mumbai R.C		
83.	Smt. Ashlesha Ashok Sawant	Assistant
84.	Ms. Priyankakumari	Assistant
85.	Shri Vinod P. Bhagayatkar	Upper Division Clerk
Tuticorin R.C		
86.	Smt. S. Sarada	Assistant
87.	Smt. C. Rajeswari	Assistant
88.	Shri M. Samuthiram	Assistant
89.	Smt. T. Mahalakshmi	Upper Division Clerk
90.	Shri J. Vinoth Prabhu Vaz	Upper Division Clerk
91.	Smt. C. Pushparani	Upper Division Clerk
92.	Shri A. Dickson Jebaraj	Upper Division Clerk
93.	Shri W. Sathyavan Neelraj	Upper Division Clerk
94.	Smt. R. Anantharani	Lower Division Clerk
Madras R.C		
95.	Smt. Leelavathi	Personal Assistant
96.	Smt. G. Abitha	Assistant Administrative Officer
97.	Smt. P. Thankaleelal	Assistant
98.	Shri S. Yuvarajan	Upper Division Clerk
99.	Smt. S. Anjalidevi	Lower Division Clerk
Karwar R.C		
100.	Shri Ratan P. Naik	Lower Division Clerk
Vizhinjam R.C		
101.	Smt. K. Latha	Assistant
102.	Shri A. Yesudhas	Lower Division Clerk
103.	Shri R. Balakrishnan	Lower Division Clerk
104.	Smt. M.P. Kaladevi	Lower Division Clerk
Calicut R.C		
105.	Shri R. Sreenivasan	Assistant
106.	Smt. K.P. Shylaja	Assistant
107.	Smt. K. Balamani	Assistant
108.	Smt. N.G. Supriya	Assistant
109.	Shri C.P. Umasankar	Lower Division Clerk

KVK, Narakkal		
110.	Shri Augustus Julin Raj	Assistant
111.	Smt. Rincy K.R.	Stenographer Grade III

SUPPORTING

Sl. No.	Name of Employee	Grade
CMFRI, Kochi		
1.	Shri T. Sreedharan	Skilled Support Staff
2.	Shri T.I. Soman	Skilled Support Staff
3.	Shri N.P. Mohanan	Skilled Support Staff
4.	Shri K.C. Rajappan	Skilled Support Staff
5.	Shri V.T. Ravi	Skilled Support Staff
6.	Smt. A. Latha	Skilled Support Staff
7.	Shri K.G. Jayaprasad	Skilled Support Staff
8.	Shri T.K. Antony	Skilled Support Staff
9.	Smt. K.T. Prakasini	Skilled Support Staff
10.	Smt. P.K. Usha	Skilled Support Staff
11.	Shri K. Thankappan	Skilled Support Staff
12.	Shri M.D. Suresh	Skilled Support Staff
13.	Smt. Usha. S.	Skilled Support Staff
14.	Shri V. Rajendran	Skilled Support Staff
15.	Smt. P.K. Sujatha	Skilled Support Staff
16.	Shri M.J. Joseph	Skilled Support Staff
17.	Smt. Subaida. K.S.	Skilled Support Staff
18.	Smt. S. Prasannakumari	Skilled Support Staff
19.	Smt. K.S. Jeeji	Skilled Support Staff
20.	Shri C.R. Mohanan	Skilled Support Staff
21.	Smt. K. Parukutty	Skilled Support Staff
22.	Shri Biju George	Skilled Support Staff
23.	Shri T. Rajesh Babu	Skilled Support Staff
24.	Shri P.M. Gireesh	Skilled Support Staff
25.	Smt. T.R. Kumari	Skilled Support Staff
26.	Shri Rajesh P.A	Skilled Support Staff
27.	Shri Rajesh T.K	Skilled Support Staff
Mandapam R.C		
28.	Shri R. Sonaimuthu	Skilled Support Staff
29.	Shri S. Murugan	Skilled Support Staff
30.	Shri V. Narasimhabharathi	Skilled Support Staff
31.	Shri P. Ramu	Skilled Support Staff
32.	Shri J. Hameed Sultan	Skilled Support Staff
33.	Shri K. Thangavelu	Skilled Support Staff
34.	Shri U. Rajendran	Skilled Support Staff
35.	Shri K. Jeevanandam	Skilled Support Staff
36.	Shri N. Nagamuthu	Skilled Support Staff
37.	Smt. Subbulakshmi	Skilled Support Staff
38.	Shri M. Saravana Kumar	Skilled Support Staff
39.	Shri K. Anandan	Skilled Support Staff
40.	Shri K. Ganesan	Skilled Support Staff
41.	Shri K. Chandran	Skilled Support Staff
42.	Shri N. Ramamoorthy	Skilled Support Staff
43.	Shri K. Muniyasamy	Skilled Support Staff
44.	Shri M. Ganesan	Skilled Support Staff
45.	Shri M. Thayalan	Skilled Support Staff
46.	Shri M. Saravanan	Skilled Support Staff
47.	Shri K. Senthil Kumar	Skilled Support Staff
48.	Smt. M. Saraswathi	Skilled Support Staff
49.	Shri N. Thirupathi	Skilled Support Staff
50.	Shri M. Jayasingh	Skilled Support Staff
51.	Shri A. Bose	Skilled Support Staff
52.	Shri K. Narayanan	Skilled Support Staff
53.	Shri K. Krishnan	Skilled Support Staff
54.	Smt. M. Muthuvelu	Skilled Support Staff
Visakhapatnam R.C		
55.	Shri R. Kanaka Raju	Skilled Support Staff
56.	Shri D. Lingaraju	Skilled Support Staff
57.	Shri Oggu China Venkateswarlu	Skilled Support Staff
58.	Shri S. Srinivasulu	Skilled Support Staff
59.	Shri R. Pydi Raju	Skilled Support Staff
Veraval R.C		
60.	Shri Haridas Khimdas Makwana	Skilled Support Staff
61.	Shri Ladani Dhirajlal Jamnadas	Skilled Support Staff
62.	Shri Chudasama Karsan Punja	Skilled Support Staff
63.	Shri Sangabhai Lakhabhai Paredi	Skilled Support Staff
64.	Smt. Santok A. Bharada	Skilled Support Staff
65.	Smt. Bhanuben L. Waghela	Skilled Support Staff
Mumbai R.C		
66.	Shri S.M. Tandel	Skilled Support Staff
67.	Shri K.K. Baikar	Skilled Support Staff
68.	Shri D.D. Jangam	Skilled Support Staff
69.	Smt. Urmila S. Balmiki	Skilled Support Staff
Karwar R.C		
70.	Shri Subhash K. Naik	Skilled Support Staff
71.	Shri Gopi X. Chodenkar	Skilled Support Staff
72.	Smt. Somi M. Harijan	Skilled Support Staff
73.	Shri Ramakant Shankar Harikantra	Skilled Support Staff
74.	Shri Suresh Rumo Majalikar	Skilled Support Staff
75.	Smt. Vijayalakshmi Y. Gamanagatti	Skilled Support Staff
76.	Smt. Nandini Mayekar	Skilled Support Staff
77.	Shri T.P. Renilkumar	Skilled Support Staff
Calicut R.C		
78.	Shri A. Sivadasan	Skilled Support Staff
79.	Shri P. Dassan	Skilled Support Staff
80.	Shri M.K. Chandran	Skilled Support Staff
81.	Shri K.T. Mohanan	Skilled Support Staff
82.	Shri P. Satheeshkumar	Skilled Support Staff
83.	Shri M.P. Devadasan	Skilled Support Staff
84.	Shri P.V. Gopalan	Skilled Support Staff
85.	Shri P.B. Jeevaraj	Skilled Support Staff
Mangalore R.C		
86.	Shri U.B. Sadasiva	Skilled Support Staff
87.	Shri A. Keshava	Skilled Support Staff
88.	Shri L.K. Suvarna	Skilled Support Staff
89.	Shri D. Gangadhara Gowda	Skilled Support Staff
90.	Shri S. Mahalinga Naik	Skilled Support Staff
Tuticorin R.C		
91.	Shri K. Thankaraj	Skilled Support Staff
92.	Shri S. Alagesan	Skilled Support Staff
93.	Shri I. Ravindran	Skilled Support Staff
94.	Shri S. Mariappan	Skilled Support Staff
95.	Shri M. Soundrapandian	Skilled Support Staff
96.	Shri M. Kalimuthu	Skilled Support Staff
97.	Shri K. Subramanian	Skilled Support Staff
98.	Shri S. Willington	Skilled Support Staff
99.	Shri N. Ramaswamy	Skilled Support Staff
100.	Shri A. Paul Pondi	Skilled Support Staff
101.	Smt. A. Usha Rani	Skilled Support Staff
102.	Shri C.S. Santhanakumar	Skilled Support Staff
Vizhinjam R.C		
103.	Shri B. Babu	Skilled Support Staff
104.	Shri S. Mohanan	Skilled Support Staff
105.	Smt. T. Jayakumari	Skilled Support Staff
106.	Shri S. Satheesh Kumar	Skilled Support Staff
Chennai R.C		
107.	Shri A. Janakiraman	Skilled Support Staff
108.	Shri G. Chakrapani	Skilled Support Staff
109.	Shri P. Selvaraj	Skilled Support Staff
110.	Shri S. Imbamani	Skilled Support Staff
111.	Shri V. Sitaramacharyulu	Skilled Support Staff
112.	Shri S. Chandrasekharan	Skilled Support Staff
113.	Smt. R. Kalaiselvi	Skilled Support Staff
114.	Shri R. Kumaran	Skilled Support Staff
115.	Smt. R. Sarojini	Skilled Support Staff
116.	Smt. M. Sundari	Skilled Support Staff
117.	Smt. R. Eswari	Skilled Support Staff
KVK, Narakkal		
1.	Shri M.K. Anilkumar	Skilled Support Staff

CANTEEN STAFF

Sl. No.	Name of Employee	Grade
CMFRI, Kochi		
1.	Shri P.V. George	Canteen Attendant
2.	Shri M.V. Devassykutty	Canteen Attendant
3.	Shri Purushan P.K	Canteen Attendant

Research projects **in-house**

12th Plan (2012-2017)

Sl.No	Project Code	Title of the Project	PI of the project & Division	Co-PIs	Duration	Total Cost (₹ in Lakhs)	Location
1.	FISHCMFRISIL201200100001	GIS based management advisory support information system for the marine fisheries sector	Dr.T.V. Sathianandan FRAD	Dr. J. Jayasankar Dr. Somy Kuriakose Dr. K.G. Mini Shri. Wilson T Mathew Dr. Grinson George	2012 - 2017	2822.00	Kochi
2.	FISHCMFRISIL201200200002	Remote sensing assisted oceanologic biodynamic forecasting paradigm for Indian marine resources	Dr. J. Jayasankar FRAD	Dr. Somy Kuriakose, Dr. K.G. Mini, Shri. Wilson T Mathew, Dr. Prathibha Rohit, Dr. Sreenath.K.R, Beena Kumari, Dr. Gyanaranjan Dash, Smt..Anulekshmi Chellappan, Mr. Ranjith L, Dr. Johnson B, Ms. Indira, Divipala, Mr. N.R. Naik, Dr. Grinson George	2012 - 2017	454.68	Kochi Visakhapatnam Veraval
3.	FISHCMFRISIL201200300003	Development of Fishery Management Plans for Sustaining Marine Fisheries of Kerala and Lakshadweep	Dr. P.P Manojkumar DFD	Dr. Rekha. J. Nair, Dr. P. U. Zacharia, Dr. K. S. Shobana, Dr. T. M. Najmudeen, Shri. V. Venkatesan, Dr. G. Maheswarudu, Dr. Josileen Jose, Dr. S. Lakshmi Pillai, Dr. Rekhs Devi Chakraborty, Dr. E. M. Abdusammad, Dr. U. Ganga, Dr. K. P. Said Koya, Dr. P. K. Asokan, Dr. N. Ramachandran, Dr. K.N. Saleela, Dr. B. Santosh	2012 - 2017	955.33	Kochi Calicut Vizhinjam
4.	FISHCMFRISIL201200400004	Development of Fishery Management Plans for Sustaining Marine Fisheries of Gujarat	Shri. K. Mohammed Koya PFD	Dr. Swatipriyanka Sen, Dr. Gyanaranjan Dash, Shri. Sreenath K.R	2012 - 2017	711.28	Veraval
5.	FISHCMFRISIL201200500005	Assessment Of Elasmobranch Resources In The Indian Seas	Dr. Shoba Joe Kizhakudan DFD	Dr. K. S. Shobana, Dr. P. U. Zacharia, T. M. Najmudeen, Dr. Rekha. J. Nair, Dr. P.P. Manojkumar, Dr. Sujitha Thomas, Smt. Muktha M, Dr. G. B. Purushottama, Ms. Swaipriyanka Sen, Dr. B. Santosh, Shri. R. Saravanan, Shri. L.Ranjith	2012 - 2017	492.70	Vizhinjam Kochi Calicut Mangalore Visakhapatnam Mumbai Veraval
6.	FISHCMFRISIL201200600006	Development of fishery management plans for sustaining marine fisheries of Karnataka and Goa	Dr. Prathibha Rohit PFD	Dr. A. P. Dineshbabu, Dr. Sujitha Thomas, Dr. Rajesh K.M, Dr. Geetha Sasikumar, Dr. Swatilekshmi P.S, Dr. Bindu Sulochanan	2012 - 2017	447.50	Mangalore
7.	FISHCMFRISIL201200700007	Development of strategies to sustain the stock and fishery of large pelagics in Indian waters	Dr. E.M. Abdussamad PFD	Dr. K.P. Said Koya, Dr. Mohammed Koya, Smt. Anulekshmi C., Dr. Prathibha Rohit, Dr. Rajesh K. M., Dr. U. Ganga, Dr. S. Jasmine, Dr. M. Sivadas, Dr. A. Margaret Muthu Rathinam, Dr. Shubhadeep Ghosh	2012 - 2017	686.50	Calicut Veraval Mumbai Visakhapatnam Mangalore Kochi Vizhinjam Tuticorin Chennai
8.	FISHCMFRISIL201200800008	Development of Fishery Management Plans for sustaining Marine Fisheries of Tamil Nadu and Puducherry	Dr.M.Sivadas PFD	Dr. I. Jagdis, Dr. P. T. Sarada, Dr. Sobha Joe Kizhakkudan, Dr. Margaret Muthu Rathinam, Dr. S. N. Sethi, Dr. Indira Divibala, Dr. K. N. Saleela, Dr. R. Saravanan	2012 - 2017	450.638	Tuticorin Chennai Vizhinjam Mandapam

9.	FISHCMFRISIL201200900009	GIS based resource mapping of distribution and abundance of finfishes and shellfishes off Indian coast for suggesting operational based strategies for fisheries management	Dr. A.P. Dinesh Babu CFD	Shri. Muhammed Koya, Shri. Dash Gyanranjan, Smt. Swatipriyanka, Dr. V. D. Deshmukh, Smt. Anulekshmi C., Dr. Prathibha Rohit, Dr. Sujitha Thomas, Dr. K. M. Rajesh, Dr. Senthil Murugan, Dr. P. P. Manojkumar, Dr. Josileen Jose, Dr. Lekshmi Pillai, Dr. Rekha Devi, Dr. Najmudeen T.M, Smt. Saleela K. N, Dr. P. T. Sarada, Dr. Sivadas, Dr. Shobha Joe, Kum. Indira Divipala, Dr. Shubhadeep Ghosh, Smt. Muktha. M, Shri. N. Rajendra Naik	2012 - 2017	795.88	Veraval Mumbai Visakhapatnam Mangalore Karwar Calicut Kochi Vizhinjam Tuticorin Chennai
10.	FISHCMFRISIL201201000010	Development of fishery management plans for sustaining marine fisheries of Maharashtra	Dr. V.V. Singh CFD	Dr. Veerendra Veer, Smt. Anulekshmi C., Dr. Purushottama G. B., Mr. Ramkumar. S	2012 - 2017	1135.66	Mumbai
11	FISHCMFRISIL201201100011	Development of Fisheries Management Plans (FMPs) for Sustaining marine fisheries of Andhra Pradesh	Dr.P.Laxmilatha MFD	Dr. G. Maheswarurdu, Dr. Shubhadeep Ghosh, Smt. Muktha M., Shri. Loveson Edward, Shri. N. Rajendra Naik	2012 - 2017	589.20	Visakhapatna
12	FISHCMFRISIL201201200012	Development of Fishery Management Plans (FMPs) for the bivalve fisheries of India.	Dr. Geetha Sasikumar MFD	Dr. P. Laxmilatha, Dr. Sathyanarayan Sethi, Dr. I. Jagdis, Dr. N. Ramachandran, Dr. K. S. Mohamed, Shri. V. Venkateshan, P. K. Ashokan, Dr. Reeta Jayasankar	2012 - 2017	515.20	Visakhapatnam Mangalore Tuticorin Kochi Vizhinjam Calicut
13	FISHCMFRISIL201201300013	Evaluation of ornamental gastropod fisheries in India and assessment of shell craft industry	Dr. I. Jagadis MFD	Dr. Laxmilatha, Dr. S. N. Sethi, Shri. V. Venkatesan, Dr. Shyam. S. Salim, Shri. C. Kalidas	2012 - 2015	166.96	Visakhapatnam Chennai Kochi Mandapam
14	FISHCMFRISIL201201400014	Sustainable molluscan mariculture practices	Dr.P.K. Asokan MFD	Dr. K. S. Mohamed, Dr. P. Laxmilatha, Dr. I. Jagdis, Dr. Geetha Sasikumar, Dr. M. K. Anil, Dr. V. Kripa, Dr. P. Kaladharan, Dr. Vipinkumar. V. P	2012 - 2017	408.30	Kochi Visakhapatnam Tuticorin Mangalore Visakhapatnam Calicut
15	FISHCMFRISIL201201500015	Bioinventorying and biodiversity valuation of marine organisms in selected marine ecosystems along the Indian coast	Dr. K. K. Joshi MBD	Dr. Molly Varghese, Dr. S. Jasmine, Dr. R. Narayanakumar, Shri. K. R. Sreenath, Shri. R. Saravanan, Shri. Renjith. L, Shri. Pralaya Ranjan Behera, Shri. Ramkumar. R, FRAD	2012 - 2017	460.00	Kochi Vizhinjam Veraval Mandapam Tuticorin Visakhapatnam Mumbai
16	FISHCMFRISIL201201600016	Investigations on vulnerable coral reef ecosystems of Indian waters with special emphasis on formulation of management measures for conservation	Dr. Rani Mary George MBD	Dr. S. Jasmine, Dr. K. Vinod, Dr. Molly Varghese, Dr. K. S. Sobhana, Shri. K. R. Sreenath, Shri. R. Saravanan, Shri. Ranjith. L, Shri. Pralaya Ranjan Behera, Shri. Ramkumar. S	2012 - 2017	645.70	Vizhinjam Chennai Kochi Veraval Mandapam Visakhapatnam Tuticorin
17	FISHCMFRISIL201201700017	Assessment of fishing impacts on biodiversity loss, with special reference to the threatened species, to formulate management options for their protection	Dr.K.Vinod MBD	Dr. K. K. Joshi, Dr. Molly Varghese, Dr. S. Jasmine, Shri. K. R. Sreenath, Shri. Saravanan, Shri. Ranjith. L, Shri. Pralaya Ranjan Behara, Shri. Ramkumar. R, Dr. R. Geetha	2012 - 2015	280.803	Kochi Vizhinjam Veraval Mandapam Tuticorin Visakhapatnam Mumbai Chennai
18	FISHCMFRISIL201201800018	Ecosystem process of critical marine habitats and development of protocols for restoration	Dr.V.Kripa FEMD	Dr. D. Prema, Dr. R. Jayabhaskaran, Dr. P. Kaladharan, Dr. Bindhu Sulochanan, Dr. V. V. Singh, Dr. P. S. Asha, Smt. Hemasankari, Shri. Loveson Edward, Dr. Geetha Sasikumar,	2012 - 2017	1095.00	Kochi Calicut Mangalore Mumbai Tuticorin Chennai Visakhapatnam Mangalore
19	FISHCMFRISIL201201900019	Pollution and litter in the coastal and marine ecosystem and their impact	Dr.P.Kaladharan FEMD	Dr. V. Kripa, Dr. D. Prema, Dr. R. Jayabaskaran, Dr. Bindhu Sulochanan, Dr. V. V. Singh, Dr. P. S. Asha, Smt. Hemasankari, Shri. Loveson Edward	2012 - 2017	1337.70	Kochi Mangalore Mumbai Tuticorin Chennai Visakhapatnam
20	FISHCMFRISIL201202000020	Economics of marine fisheries and sustainable management: Policy Issues and Interventions	Dr.R.Narayanakumar SEETTD	Dr. R. Sathiadhas, Dr. M. S. Madan, Dr. C. Ramachandran, Dr. Shyam. S. Salim, Dr. P. S. Swathilekshmi, Dr. N. Aswathy, Dr. R. Geetha, Dr. B. Johnson,	2012 - 2017	237.00	Vizhinjam Tuticorin Kochi Mangalore Chennai Mandapam

21	FISHCMFRISIL201202100021	An Input Output Economic Optimization Model for Marine Fisheries at Tuticorin Fishing Harbour	Dr. M.S. Madan SEETTD	Dr. N. Aswathy, Dr. M. Sivadas, Mr. L. Ranjit	2012 - 2015	72.01	Kochi Tuticorin
22	FISHCMFRISIL201202200022	Capacity Development for Ecosystem Based Responsible Fisheries Management in India - A Co-Learning action research	Dr.C.Ramachandran SEETTD	Dr. Vipinkumar V. P, Dr. Swathilakshmi. P. S, Dr. Johnson. B, Dr. Sathiadhas. R.	2012 - 2017	103.75	Kochi Mangalore Mandapam Vizhinjam
23	FISHCMFRISIL201202300023	Supply chain management of marine fisheries sector In India	Dr.Shyam.S.Salim SEETTD	Dr. R. Narayanakumar, Dr. R. Sathiadhas, Dr. M. S. Madan, Dr. T. V. Sathianandan, Dr. Vipinkumar, Dr. N. Aswathy, Dr. R. Geetha, Dr. B. Johnson	2012 - 2017	239.72	Kochi Vizhinjam Tuticorin Chennai Mandapam
24	FISHCMFRISIL201202400024	Development and standardization of seed production technologies for selected high value finfishes and shellfishes	Dr. G.Gopakumar MD	Dr. A. K. Abdul Nazar, Dr. R. Jayakumar, Dr. G. Tamilmani, Dr. M. Sakthivel, Dr. P. Rameshkumar, Shri. C. Kalidas, Dr. K. Madhu, Dr. Rema Madhu, Dr. Boby Ignatitius, Dr. Imelda Joseph, Dr. Shoji Joseph, Dr. C. P. Suja, Dr. Ritesh Ranjan, Smt. Biji Xavier, Dr. B. Santhosh, Dr. K. K. Philipose, Dr. Loka Jayashree, Dr. T. Senthil Murugan, Dr. Krupesha Sarma, Dr. D. Divu, Dr. Joe. K. Kizhakudan, Dr. Gulshad Mohammed, Shri. Loveson Edward, Shri. Pralaya Ranjan Behera,	2012 - 2017	3621.85	Mandapam Kochi Tuticorin Visakhapatnam Vizhinjam Karwar Chennai Calicut
25	FISHCMFRISIL201202500025	Innovations in Sea cage farming & Coastal mariculture	Dr.K.K.Philipose MD	Dr. Jayasree Loka, Dr. Senthil Murugan, Dr. Krupesha Sarma, Dr. D. Divu, Dr. Gopakumar, Dr. Abdul Nazar, Dr. Jayakumar, Dr. G. Tamilmani, Dr. Ramesh Kumar, Dr. M. Saktivel, Sri. Kalidas, Dr. C. Johnson, Dr. Ritesh Ranjan, Smt. Biji Xavier, Dr. Rema Madhu, Dr. K. Madhu, Dr. Boby Ignatitius, Dr. Imelda Joseph, Dr. Shoji Joseph, Dr. N. Aswathi, Dr. Dinesh Babu, Dr. Sujitha Thomas, Dr. Joe Kizhakudan, Dr. Mohammed Koya, Dr. Gulshad Mohammed, Dr. P. P. Manoj Kumar, Dr. Reeta Jayasankar	2012 - 2017	2304.40	Karwar Mandapam Visakhapatnam Kochi Mangalore Chennai Veraval Calicut
26	FISHCMFRISIL201202600026	Health Management in selected finfish and shellfish for mariculture and aquariculture & bioprospecting from marine resources	Dr. K.K. Vijayan MBTD	Dr. A. P. Lipton, Dr. P. Vijayagopal, Shri. N. K. Sanil, Dr. Kajal Chakraborty, Dr. Pradeep M. A, Dr. Sandhya Sukumaran, Dr. P. K. Asokan, Dr. I. Rajendran, Dr. Krupesha Sharma, Dr. Jayasree Loka, Dr. M. K. Anil, Dr. Joe. K. Kizhakudan, Dr. Vidya Jayasankar, Dr. Srinivasa Raghavan. V, Dr. Rithesh Ranjan, Dr. Ramesh Kumar. P.	2012 - 2017	1026.00	Kochi Vizhinjam Calicut Mandapam Karwar Vizhinjam Chennai Visakhapatnam
27	FISHCMFRISIL201202700027	Aquatic feed biotechnology for mariculture and aquariculture	Dr. P. Vijayagopal MBTD	Dr. I. Rajendran, Dr. K. K. Vijayan, Dr. Pradeep. M. A, Dr. M. K. Anil, Dr. Joe K. Kizhakudan, Dr. Boby Ignatius, Dr. Krupesha Sharma, Dr. Vidya Jayasankar, Dr. Kajal Chakraborty, Shri. Kalidas. C, Dr. Bala Nambisan	2012 - 2017	1356.00	Kochi Mandapam Vizhinjam Chennai Karwar
28	FISHCMFRISIL201202800028	Genetics, genomics and biotechnological applications in mariculture and fishery resources management	Dr.P.C.Thomas MBTD	Dr. K. K. Vijayan, Dr. Vidya Jayasankar, Dr. Sandhya Sukumaran, Dr. Srinivasa Raghavan. V, Dr. Pradeep M. A, Dr. Joe. K. Kizhakudan	2012 - 2017	394.50	Kochi Chennai
29	FISHCMFRISIL201202900029	Development of tissue culture technology for *in vitro* production of pearls from the blacklip pearl oyster *Pinctada margaritifera* and refinement of *in vitro* pearl formation in *Pinctada fucata*	Dr. K.K. Vijayan MBTD	Dr. Vidya Jayasankar, Dr. C. P. Suja, Dr. Srinivasa Raghavan. V, Smt. Indira Divipala,	2012 - 2015	351.00	Kochi Tuticorin Chennai
30	FISHCMFRISIL201203000030	Integrated approaches for improving the reproductive performance of selected marine food fishes	Dr. Divu. D MD	Dr. Senthil Murugan, Dr. Jayasree Loka, Dr. Krupesh Sharma	2012 - 2015	74.89	Karwar
31	FISHCMFRISIL201203100031	Derivation and characterisation of embryonic (ES) and induced pluripotent (iPS) stem cell from selected marine fish species aimed at mariculture/ conservation	Dr. K. S. Sobhana DFD	Dr. K. Madhu, Dr. Reema Madhu, Shri. C. Kalidas, Dr. M. Sakthivel	2012 - 2017	144.00	Kochi Mandapam
32	FISHCMFRISIL201203200032	Trawl fishery of the North east coast of India: An appraisal	Dr. Shubhadeep Ghosh PFD	Dr. G. Maheswarudu, Dr. Reeta Jayasankar, Dr. P. Laxmilatha, Dr. Muktha. M, Dr. Pralaya Ranjan Behera, Dr. N. Rajendra Naik	2012 - 2015	101.70	Visakhapatnam

Research projects **(externally funded)**

Sl.No	Title of the Project	PI of the project	Funding Agency
1	Commercial viability of black pearl production in the A&N Islands and Conservation mariculture of ETP gastropods	Dr. K.S. Mohammed	MoES
2	Impact, Adaptation and Vulnerability of Indian Agriculture to Climate Change – Marine Fisheries	Dr. V. Kripa	ICAR-Network
3	Flow of matter through trophic levels and biogeochemical cycles in marine and estuarine ecosystems	Dr. Sujitha Thomas	MoES
4	Microbial Diversity and Identification – Fish Microbes which are of application in aquaculture and / or allied industries	Dr. Imelda Joseph	ICAR-AMAAS
5	National Initiative on Climate Resilient Agriculture (NICRA)	Dr. P.U. Zacharia	DARE-ICAR-NICRA
6	Seed Production of Marine Food Fishes and Ornamental Fishes	Dr. K. Madhu	ICAR-Revolving Fund
7	Satellite telemetry studies for understanding environmental preferences and migratory patterns of yellowfin tuna, *Thunnus albacares* in the Indian Ocean	Dr. Prathibha Rohit	MoES- INCOIS
8	State of diversity of commercially important seaweeds along the West Coast of India	Dr. V.V. Singh	ICAR-NFBSFARA
9	Towards developing models for prediction of recruitment success in major Indian marine fish stocks	Dr. V. Kripa	MoES
10	Assessment of Deep-Sea Fishery Resources of the Continental slope of the Indian EEZ	Dr. U. Ganga	MoES
11	Resources assessment and Barcoding of Elasmobranches	Dr. P.U.Zacharia	MoES
12	Eco-biological investigations on major pelagic fishes and eco biological modelling of the epipelagic habitat off Kerala and Lakshadweep	Dr. V. Kripa	MoES-INCOIS
13	Integrative taxonomy of Deep Sea Shrimp Resources among the Southern Coast of India	Dr. Rekhadevi Chakraborty	DST
14	Development of a library putative probionts from marine environment belonging to the genus *Pseudomonas, Micrococcus* and *Bacillus* for application in mariculture systems	Dr. K.K. Vijayan	ICAR-AMAAS
15	Stock characterization, captive breeding, seed production and culture of hilsa (*Tenualosa ilisha*)	Dr. Ritesh Ranjan	ICAR-NFBSFARA
16	Mapping and Resource Assessment of Pearl Oyster banks of Tuticorin(Central)Division of Gulf of Mannar.	Dr. J. Jagadis	MoEF
17	Value adding the marine gastropod fisheries in molluscs for nutraceutical development India and Australia: Sustainable mariculture and strategic research into Muricidae	Dr. K.K. Vijayan	DST-AISRF
18	Studies on the genetic stock structure Mackerel, *Rastrelliger kanagurta*	Dr. K.K. Vijayan	FAO-BOBLEME
19	Polyunsaturated fatty acid enriched formulations from locally available low value fish and fishery by-catch for use as nutraceuticals and aquafeed	Dr. Kajal Chakraborty	DST
20	Development of antimicrobial, anti-inflammatory and anticancer agents from the marine organisms and micro-organisms	Dr. Kajal Chakraborty	MoES
21	Global learning for local solution: Reducing vulnerability of marine dependent coastal communities	Dr. A. Gopalakrishnan	Belmont Forum through MoES
22	National Surveillance Programme for aquatic animal diseases	Shri N.K. Sanil	NFDB
23	Development of protocols and capacity building on stranding beaching and post-mortum analysis of Cetaceans	Dr. M. Sakthivel	GOI-UNDP-GEF
24	Utilisation strategy for oceanic squids in Arabian sea: A Value chain approach	Dr.K.S. Mohammed	NAIP
25	A Value chain oceanic tuna fisheries in Lakshadweep Sea	Dr. E.M. Abdussamad	NAIP
26	Strategies to enhance adaptive capacity to climate change in vulnerable regions- World Bank-GEF	Dr. V. V. Singh	NAIP-GEF
27	A Value chain on high value shellfish mariculture	Dr. V. Venkatesan	NAIP
28	Outreach activity on fish genetic stocks	Dr. P.C. Thomas	ICAR-Outreach
29	Nutrient profiling and evaluation of fish as a dietary component	Dr. Kajal Chakraborty	ICAR-Outreach
30	ICAR Outreach activity on fish feeds	Dr. P. Vijayagopal	ICAR-Outreach
31	Characterisation of Poly saccharides and Phenolics from Marine Macroalgae as Defense metabolites against oxidative stress and inflammation.	Dr. Kajal Chakraborty	DST
32	Intellectual property management and transfer/commercialization of Agricultural technology scheme	Dr. Kajal Chakraborty	IP & TM (ICAR)
33	Bioprospecting of genes and allele mining for abiotic stress tolerance	Dr. K. K. Vijayan	NAIP

Consultancy projects **2013-2014**

Client	Project title	PI	Duration	Amount
Mott Mac Donald Pvt. Ltd (MMPL) 7th Floor, A-Wing Prism Tower Mindspace, Behind Hypercity Malad-Goregaon Link Road, Goregaon - (W)	Consensus Building and Environmental Studies on Marine Outfall for Mumbai Sewage Disposal Project (MSDP) Phase II	Dr. V.V. Singh	26 March 2010 - 25 Dec. 2010 to Dec 2013	2546430
Dr. Suparna Mulick, M/s Asian Consulting Engineers (Pvt.) Ltd., New Delhi-110 048	Baseline data collection and monitoring for environment and social impact assessment for the development of Vizhinjam Port	Dr. M.K. Anil	April 2011-Dec.2013	2967200
The Project Director, IFAD assisted PTSLP, TN Corpn. for Development of Women, 100 Anna Salai Rd, Guindy, Chennai	Consultancy on artificial reefs in inshore waters of two districts of Tamil Nadu	Dr. Shoba Joe Kizhakkudan	16 Months From 22-6-2011.	793000
The Project Director, IFAD assisted PTSLP, TN Corpn. for development of women, 100 Anna Salai Rd, Guindy, Chennai	Consultancy on artificial reefs in inshore waters of four districts of Tamil Nadu	Dr. Shoba Joe Kizhakkudan	Dec.2011-17 months	1990000
Commissioner of Fisheries, Dept. of fisheries, Govt. of TN	Installation of artificial reefs in inshore waters of two villages in Kancheepuram District of Tamil Nadu	Dr. Shoba Joe Kizhakkudan	Dec 2011-mar 2013	3000000
NIO, Mumbai Regional Centre, 4 Bungalow, Versova, Andheri- (W) MUMBAI	Rapid assessment of fishery resources of Vasishty river estuarine system and possible impact of intake and discharge of water from thermal power plant on it	Dr. V. D. Deshmukh	Feb2012-July 2012	1464630
TATA consulting Engineers Ltd,4th Floor, Tower A,247 Park, LBS Marg, Vikhroli, Mumbai-400 083	Baseline Marine Ecology Study and Impact Assessment of the barging operations for the proposed expansion project at TPL Trombay, Mahul Village, Mumbai	Dr. V. V.Singh	Jun 2012- 7th Jun 2013	4534874
Director of Fisheries, Dept. Of Fisheries, Tamil Nadu	Installation of artificial reefs in the inshore waters of seventeen villages along Tamil Nadu coast	Dr. K. Vinod	Apr 2012-Mar 2015	26080000
P. Koteswara Rao, Joint Director of Fisheries, Visakh, AP	Installation of artificial reef at a selected site off Visakhapatnam, Andhra Pradesh	Shri. Loveson Edward	Sept. 2013- Dec.2014	3031664
Mr. Edgar Endrukaitis, Director, Biodiversity Programme, A-2/18, Safdarjung Enclave, New Delhi – 110 029	Assessment of eco-labeling as tool for conservation and sustainable use of biodiversity in Ashtamudi Lake, Kerala (Southwest coast of India)	Dr. K. Sunil Mohamed	Dec 2013-Sept 2014	3677235
TOTAL				**47538603**

Human resource **development**

Summary

No. of HRD Programmes attended by CMFRI Staff	:	60
No. of CMFRI Staff who attended the Programmes	:	48
No. of HRD Programmes conducted by CMFRI for Outsiders	:	57
No.of outside participants who attended CMFRI Programmes	:	1088

Ph.D Programme

CMFRI is a recognized center for Ph.D programme of Cochin University of Science and Technology(CUSAT) as well as the Mangalore University		
Course work and research work of both universities are being carried out at CMFRI		
Total No. of scholars of CMFRI, Kochi pursuing Ph. D	:	71
(CUSAT: 26; Mangalore Univeristy: 45)		

NET ICAR-2013 Exam. — Date:27.10.2013

No. of Candidates	:	621
No. of Disciplines	:	50
No. of class rooms	:	18
No.of Centre	:	1
No. of staff deputed	:	55

ARS Exam.-2013 — Date:29.12.2013

No. of Candidates	:	674
No. of Disciplines	:	45
No. of class rooms	:	19
No.of Centre	:	1
No. of staff deputed	:	58

NET ICAR ONLINE Exam. — Date:26.03.2014 to 04.04.2014

No. of Candidates	:	709
No. of slots	:	19
Name of the Centre	:	ASRB Online Examination Centre, CMFRI Campus
No. of staff deputed	:	30

ICAR-UG-Exam. — Date:20.04.2013

No. of Candidates	:	4649
No.of Centre	:	6
No. of staff deputed	:	398

Women's cell

Towards helping the less privileged women who are affected by the devastating cyclones along the Indian coast, the Women's Cell CMFRI organised a charity drive for collection of clothes for the victims of West Bengal under the auspices of Dr. B. Meenakumari DDG (Fy), ICAR, New Delhi.

The International Women's Day 2013 was observed by the Women's Cell. Dr. Mary Matilda, Principal Special Grade (Retd.), Maharaja's College, Ernakulam was the Chief Guest. She delivered a talk on "Women empowerment through Education and Career" for all staff and students of CMFRI, CIFRI and NBFGR Cochin Unit.

Dr. Mary Matilda, Principal Special Grade (Retd.), Maharaja's College, addressing the gathering

Research management **programmes**

Institute Research Council (IRC)

The 20th IRC meeting was held at CMFRI HQ, Kochi from 10 to 14 June 2013. The progress of work in the Division, projects both in-house (32) and externally funded (19) and various sections during the period 2012-13 under various research projects were presented by the respective Heads of Divisions, Principal Investigators and Scientists / Officers-in-charge of the concerned sections. The presentations were followed by critical evaluation and discussions.

Institute Management Committee (IMC)

The 74th meeting of the IMC was held on 18 June 2013 at CMFRI HQ, Kochi. Review of the action taken on the items considered during the 73rd meeting held on 23 July 2012 was done. IMC placed on record the recommendation for procurement of minor equipments/furniture & fixtures during the year 2013-14. Expenditure of the amount allotted under Plan and Non-Plan 'Works' for the financial year 2013-14 was reviewed. Expenditure on various maintenance works at Headquarters and Regional/ Research Centres under Plan and Non-Plan 'Works' for the financial year 2012-13 was also reviewed.

The 75th meeting of the IMC was held on 25 February 2014 at CMFRI HQ, Kochi. Reviewed action taken on the items considered during the 74th meeting held on 18 June 2013. The IMC approved the additional expenditure of ₹ 21.75 Lakhs incurred towards construction of Laboratory-cum-office building at Vizhinjam RC of CMFRI under Plan. IMC also approved the Consultancy Projects costing more than ₹25 Lakhs which are active/initiated during the period 2013-14.

Research Advisory Committee (RAC)

The 17th RAC of CMFRI was held at Mandapam Regional Centre on 25 April 2013 Dr. M. V.Gupta, Chairman, RAC gave the introductory remarks. Dr. G. Syda Rao, Director, CMFRI presented the highlights of institute research activities for the year 2012-2013. Dr. R. Narayanakumar, Head, SEETT Division & Member Secretary, RAC, presented the Action taken report of 16th RAC Meeting. Division-wise as well as centre-wise presentations were made by the respective Heads of the Divisions and Scientists in-Charge.

The 18th RAC meeting was held at CMFRI HQ, Kochi during 26-27 March 2014. Dr. B. N. Desai, Former Director, NIO Goa and Chairman RAC gave the introductory remarks. Dr. A. Gopalakrishnan, Director, CMFRI presented the highlights of institute research activities for the year 2013-2014. Reviewed of the actions taken on the items suggested during the 17th RAC meeting held on 25 April 2013 at Mandapam RC of CMFRI. Dr. P. U. Zacharia Head, Demersal Fisheires Division & Member Secretary RAC, presented the Action taken report of 17th RAC Meeting. All Heads of Divisions and SICs of Regional/Research Centres made presentations on the progress of work with reference to their Divisions/Centres for the period 2013-14. Subsequently there was critical evaluation and discussions followed by formulation of recommendations.

The 18th RAC meeting was held at CMFRI HQ, Kochi during 26-27 March 2014

Major events

Hon'ble Union Minister for Agriculture and President, ICAR Shri. Sharad Pawar, visiting the marine cage farm at Karwar, 19 April 2013

Harvest function of TSP seacage farm established for the Sidi tribals in Veraval and Talala of Junagadh District, Gujarat. Harvest was inaugurated by Dr. S. Ayyappan, Secretary DARE and Director General, ICAR on 13 April 2013. The farm was established under the Tribal Sub Plan (TSP) outlay of the Institute for 2012-13 for the benefit of 20 selected families of the Sidi tribe through a cooperative society of the tribals as a livelihood support

Commissioning of National Marine Finfish Brood Bank at Mandapam Regional Centre of CMFRI by Dr. S. Ayyappan, Secretary, DARE and Director General ICAR, 12 May 2013

Inauguration of Research and Administrative Block at Mandapam Regional Centre by Dr. B. Meenakumari DDG (Fy.), 12 May 2013

Inaugural function of the CMFRI-SAARC International Workshop on "Status of Good Practices and Lessons Learnt in Aquaculture in the SAARC Region" held at CMFRI, Kochi, 5 June 2013 i

Dr. G. Syda Rao retires and Dr. A. Gopalakrishnan takes over as Director CMFRI on 31 July 2013

Inauguration of the Extended Laboratory-cum-Office Building of Tuticorin Research Centre of CMFRI by Dr. B. Meenakumari, DDG (Fy.) ICAR, 21 April 2013

Dr. S. Ayyappan, Secretary DARE and Director General, ICAR, inaugurating the lab cum office floor of Mumbai RC, 27 May 2013

NAIP Review meeting held at CMFRI Kochi, 3 March 2014

Inaugural function of the "Customised training in mariculture for Maldivian officials held at CMFRI during 18 November to 13 December 2013

Releasing the course manual of the Winter School on "ICT oriented extension strategies for Responsible Fisheries Management" held at CMFRI, 5-25 November 2013

NICRA Thematic review meeting held at CMFRI Kochi, 18 March 2014

Inauguration of the Shellfish food festival - ShellCon 2014 organised by CMFRI, Kochi during 22 to 23 March 2014 under the NAIP Value chain on high value shellfish

Dr. S. Ayyappan, Secretary, DARE and DG ICAR, along with Dr. A. Gopalakrishnan, Director, CMFRI interacting with the staff of Mangalore RC, 9 March 2014

Norwegian delegates in the marine cage farm of Karwar RC, 8 January 2014

Dr. A. Goplakrishnan, Director CMFRI inaugurating the National Science Day celebration on 28 February 2014.

Launching of the Fisheries Research Vessel *Silver Pompano* at CMFRI Kochi, 1 June 2013

Open house and Foundation Day celebrations at CMFRI Kochi, 3 February 2014

Chief Guest, Shri. Siddique popular film Director, presenting trophy to the winners of Pookalam competition held in connection with onam celebrations at CMFRI HQ, Kochi, 11 September 2013

Distinguished **visitors**

CMFRI HQ, Kochi

Dr. B. Meenakumari, Deputy Director General (Fy.), ICAR New Delhi
Prof. Dr. K. M. L. Pathak, DDG (Animal Sciences), ICAR New Delhi
Dr. Madan Mohan, ADG (Marine Fy.), ICAR New Delhi
Dr. Trevor Platt, FRS and Dr. Shubha Sathyendranath, Plymouth Marine Laboratory, UK
Dr. S. K. Mamgain, Dy. Director, SAARC Coastal Zone Management Centre (CZMC), Maldives
Dr. Kirsten Benkendorff, Southern Cross University, Lismore, Australia
Dr. John Gunn, Chief Executive Officer, Australian Institute of Marine Sciences, Townsville, Queensland, Australia
Dr. John Richard Candy, PBS Genetics Lab, Fisheries and Oceans, Canada
Dr. Rudolf Hermes, Chief Tachnical Officer, BOBLME, Phuket, Thailand
Mr. Jasimuddin Mohammad, Advisor (Asia Region), Governance and Institutional Development Division, Commonwealth Secretariat, London
Dr. Zekeria Abdulkerim, Dean, College of Marine Science and Technology (COMSAT), Eritrea
Dr. K. Kasturirangan, Member (Science), Planning Commission, Govt. of India
Dr. S. W. A. Naqvi, Director, NIO Goa
Dr. R. Paul Raj, Member Secretary, Coastal Aquaculture Authority, Chennai
Dr. Dilip Kumar, Former Director, CIFE, Mumbai
Dr. J. R. Bhatt, Advisor MoEF, Govt. of Inida
Dr. J. K. Jena, Director, NBFGR Lucknow
Dr. P. Jayasankar, Director, CIFA Bhubaneswar
Dr. R. Ezekiel, National Coordinator (NAIP), ICAR New Delhi
Dr. Narayana Gowda, Vice Chancellor, Univeristy of Agricultural Sciences, Bangalore
Dr. V. K. Taneja, Vice Chancellor, Guru Angad Dev Veterinary and Animal Sciences University (GADVASU), Ludhiana
Dr. A. G. Ponniah, Director, CIBA Chennai
Dr. T. K. Srinivasagopal, Director, CIFT Cochin
Dr. Y. S. Yadava, Director, BOBP IGO Chennai
Shri. Anup Kumar Thakur, IAS, Secretary, DAHD, Ministry of Agriculture, Krishi Bhavan, New Delhi
Dr. Rondolph Payet, Executive Secretary, IOTC, Victoria, Seychelles
Dr. S. Girija, Director, National Institute of Fisheries Post Harvest Technology and Training (NIFPHATT), Kochi
Dr. K. Vijayakumaran, Director General, FSI
Dr. Pradeep Kathiha, Principal Scientist, NIU, NAIP, ICAR New Delhi
Dr. Raj Pathak, Associate Vice President, GARWARE WALL ROPES Ltd., Pune
Dr. Sreenath Dixit, Director, Zonal Project Directorate of ICAR, Bangalore
Dr. E. G. Silas, Firmer Vice Chancellor, Kerala Agricultural University
Dr. K. G. Padmakumar, Former Professor and Associate Director, Kerala Agricultural University RARS, Kumarakam
Dr. Madan Mohan, Assistant Director General (M. Fy.), ICAR New Delhi
Dr. B. N. Desai, Former Director, NIO Goa and Chairman, RAC, CMFRI
Dr. Senthil Vinayagam, Director (Extn.), MANAGE, Hyderabad
Dr. S. D. Tripathi, Former Director and Vice Chancellor, CIFE, Mumbai
Dr.T.Balasubramaniam, Former Dean, CAS Marine Biology and Member RAC, CMFRI

Dr. R.A.Selvakumar, Former ADG (M. Fy), ICAR and Member RAC, CMFRI
Dr. E. Vivekanandan, Former Principal Scientist and Member RAC, CMFRI
Dr. P. S. B. R.James, Former Director, CMFRI and Chairman NAIP
Dr. A.Thirunavakkarasu, Former Principal Scientist, CIBA, Chennai
Dr. N. R.Menon, Former Director, School of Marine Sciences, CUSAT, Kochi
Dr. K.K. Appukuttan, Former Principal Scientist, CMFRI
Dr. M. Maheswari, Director (Acting), CRIDA & Principal Investigator, NICRA
Dr. V. V. Sugunan, Former Director, CIFRI, Kolkata and Review Expert, NICRA
Dr.K. K. Vaas, Former Director, CIFRI, Kolkata and Review Expert, NICRA

Mandapam Regional Centre
Dr. S. Ayyappan, Secretary DARE and Director General, ICAR New Delhi
Dr. B. Meenakumari, Deputy Director General (Fy.), ICAR New Delhi
Dr. Madan Mohan, Assistant Director General (M.Fy.), ICAR New Delhi
Shri. K. Nanthakumar, IAS, District Collector, Ramanathapuram District
Commandant H. H. More, Commanding Officer, Indian Coast Guard, Mandapam

Veraval Regional Centre
Dr. S. Ayyappan, Secretary DARE and Director General, ICAR New Delhi
Dr. N. C. Patel, Vice Chancellor, Junagadh Agricultural University, Junagadh
Shri. Darbar, IAS, Commissioner of Fisheries, Gujarat
Dr. Madan Mohan, ADG (M. Fy.)
Dr. T. K. Srinivasagopal, Director CIFT Cochin
Dr. Mishra, Director, Directorate of Groundnut Research, Junagadh

Visakhapatnam Regional Centre
Shri. Tariq Anwar, Hon'ble Union Minister of State for Agriculture and Food Processing
Dr. M. V. Rao, Chief Executive, NFDB

Karwar Research Centre
Shri. Sharad Pawar, Hon'ble Union Minister for Agriculture and President, ICAR New Delhi
Dr. S. Ayyappan, Secretary DARE and Director General, ICAR New Delhi
Shri G. C. Pati, Secretary, Dept. of Animal Husbandry, Dairying and Fisheries
Dr. N. P. Singh, Director, ICAR Research Complex for Goa
Fifteen member Norwegian delegation
Shri. Shreeshan Raghavan, Joint Secretary, Department of Biotechnology, New Delhi

Mumbai Research Centre
Dr. S. Ayyappan, Secretary DARE and Director General, ICAR New Delhi

Mangalore Research Centre
Dr. S. Ayyappan, Secretary DARE and Director General, ICAR New Delhi
Mr. Ricks Bosch, Eco Coast Consultant,Euroconsult MMD, Netherlands
Ms. Maya Sivakumar, Regional Officer, United States-India Educational Foundation
Shri. U. Mahesh Kumar, Regional Director (Environment) of CRZ, Mangalore
Shri. R. K. Singh, Additional Principal Chief Conservator of Forests and Member Secretary, Karnataka Biodiversity Board, Govt. of Karnataka

Tuticorin Research Centre
Dr. B. Meenakumari, DDG (Fy.), ICAR New Delhi
Shri. S. Natarajan, Deputy Chairman, VOC Port Trust, Tuticorin

Madras Research Centre
Dr. S. Ayyappan, Secretary DARE and Director General, ICAR New Delhi
Shri. A. A. Hebbar, TM, Deputy Inspector General & Director (Environment), Indian Coast Guard Headquarters, New Delhi

Vizhinjam Research Centre
Dr. B. Meenakumari, DDG (Fy.), ICAR New Delhi

Marine **biodiversity museum**

The Designated National Repository Museum of CMFRI, recognised by the Government of India is authorised to keep in safe custody specimens of different categories of biological material. Currently the museum houses 1732 specimens belonging to different groups of marine organisms.

New additions to the Biodiversity Museum

Total specimens: 83
New species: 3

Holotype specimens

1. *Chelidoperca caudimaculan*
2. *Sphyraena arabiansis* (Abdussamad and Rateesh 2013)
3. *Harpadon nudus* (Ganga *et al.*)

Govt. of India officials visiting the Marine Biodiversity Musuem

Sponges

1. *Aulenella clathria* (*wilsonella*) *foraminifera* (Burton & Rao,1932)
2. *Aulospongus tubulatus* (Bowerbank, 1873)
3. *Axinella donnani* (Bowerbank, 1873)
4. *Callyspongia (Cladochalina) diffusa* (Ridley,1884)
5. *Callyspongia (Cladochalina) fibrosa* (Ridley & Dendy, 1886)
6. *Calyspongia reticutis var. salmonensis* (Dendy,1922)
7. *Clathria fruticosa* (Dendy)
8. *Clathria (Thalysias) procera* (Ridley, 1884)

9. *Cliona vastifica* (Hancock, 1849)
10. *Endectyon (Endectyon) fruticosum* (Dendy, 1887)
11. *Epipolasis topsenti* (Dendy)
12. *Halichondria (Halichondria) panicea* (Pallas,1965)
13. *Ircinia fusca* (Carter, 1880)
14. *Mycale (carmia) mytilorum* Annandale, 1914
15. *Myxilla arenaria* Dendy
16. *Neopetrosia similis* (Ridley & Dendy, 1886)
17. *Amorphinopsis foetida* (Dendy, 1889)
18. *Pseudosuberites andrewsii* Kirkpatrick1900
19. *Pterosia similis* Ridley and Dendy
20. *Gelloides carnosa* (Dendy, 1889)
21. *Spongia* sp.
22. *Halicona (Gellius) toxia* (Topsent, 1897)
23. *Topsentia Halichondrioides* (Dendy, 1905)
24. *Mycale (Zygomycale) parishii* (Bowerbank, 1875)

Cephalopods

1. *Sepia arabica* Massy, 1916
2. *Sepia kobiensis* Hoyle, 1885
3. *Sepia brevimana* Steenstrup, 1875

Nudibranchs

1. *Hydatina zonata* (Lightfoot, 1786)
2. *Doriprismatica atromarginata* (Cuvier, 1864)

Isopods

1. *Anilorca dimidiate* Bleeker, 1857
2. *Cymothoa eremita* (brunnich, 1783)
3. *Mothocya plagulophora* (Haller, 1880)
4. *Mothocya renardi* (Bleeker, 1857)
5. *Nerocila exocoeti* Pillai, 1954
6. *Nerocila serra* Schiodte & Meinert, 1881

Lobster

1. *Eumunida funambulus* Gordon, 1930

Fishes

1. *Ablabys binotatus* (Peters, 1855)
2. *Acropoma hanedai* Matsubara, 1953
3. *Alopias supercilliosus* Lowe,1841
4. *Apogon queketti* Gilchrist, 1903
5. *Apsilus fuscus* Valenciennes, 1830
6. *Beryx splendens* Lowe, 1834
7. *Caesio varilineata* (Carpenter,1987)
8. *Caesio xanthonotus* Bleeker,1853
9. *Callionymus sagitta* (Pallas,1770)
10. *Cephalopholis sexmaculata* (Ruppell,1830)
11. *Chaetodon lineolatus* Cuvier, 1831
12. *Champsodon nudivittis* (Ogilby, 1895)
13. *Champsodon synderi* Franz,1910
14. *Cheilodipterus macrodon* (Lacepède, 1802)
15. *Cheilopogon cyanopterus* (Valenciennes, 1847)
16. *Chiloscyllium arabicum* (Gubanov,1980)
17. *Dactyloptena macracantha* (Bleeker, 1855)
18. *Dactyloptena papilio* (Ogilby, 1910)
19. *Epinephelus miliaris* (Valenciennes,1830)
20. *Epinephelus ongus* (Bloch,1790)
21. *Euleptorhamphus viridis* (van Hasselt, 1823)
22. *Iniistius bimaculatus* (Ruppell,1829)
23. *Isurus paucus* Guitart, 1966
24. *Lepidocybium flavobrunneum* (Smith, 1843)
25. *Melichthys indicus* (Randall & Klausewitz,1973)
26. *Minous inermis* (Alcock, 1889)
27. *Minous trachycephalus* (Bleeker,1855)
28. *Monodactylus argenteus* (Linnaeus,1758)
29. *Mulloidichthys vanicolensis* (Valenciennes, 1831)
30. *Oxyporhamphus micropterus micropterus* (Valenciennes, 1847)
31. *Pampus chinensis* (Euphrasen,1788)
32. *Parapercis nebulosa* (Quoy & Gaimard, 1825)
33. *Pristiapogon kallopterus* (Bleeker, 1856)
34. *Pristipomoides filamentosus* (Valenciennes,1830)
35. *Pterygotrigla arabica* (Boulenger, 1888)
36. *Pyramodon ventralis* Smith and Radcliffe,1913
37. *Remora remora* (Linnaeus, 1758)
38. *Sacura boulengeri* (Heemstra, 1973)
39. *Scorpaena scrofa* (Linnaeus,1758)
40. *Scorpaenopsis neglecta* Haeckel,1837
41. *Sirembo jerdoni* (Day, 1888)
42. *Stegostoma fasciatum* (Hermann,1783)
43. *Tylosurusacus melanotus* (Bleeker,1850)
44. *Valenciennea helsdingenii* (Bleeker, 1858)

Visitors to the Marine Biodiversity Museum

- A total of 7783 visitors from 14 States and 1 Union Territory of the country visited the Marine Biodiversity Museum, CMFRI, Cochin during 2013
- Students from 56 schools and 136 colleges visited the Museum
- 99 International delegates representing Australia, Belgium, China, Kenya, Liberia, Italy, Malavi, Maldives, Myanmar, Pakistan, South Africa and USA visited the Marine Biodiversity Museum.

International delegates (Kenya, Liberia) in the Marine Biodiversity Museum

Visitors to the Marine Biodiversity Museum

Month	No. of School	Students	No. of College	Students	Public	Total
January	14	457	29	644	34	1135
February	16	1085	43	1125	83	2293
March	5	247	17	414	58	719
April	_	_	3	95	85	180
May	1	66	3	58	168	292
June	1	61	5	187	76	324
July	_	_	2	91	43	134
August	2	102	5	266	70	438
September	_	_	8	361	54	415
October	4	161	5	233	77	471
November	10	482	6	152	92	726
December	3	187	8	271	198	656
Total	56	2848	134	3897	1038	7783

Krishi vigyan kendra

On Farm Testing (OFT) programmes

- Precautionary spray of botanical pesticide *Nanma* developed by Central Tuber Crops Research Institute (CTCRI), Thiruvananthapuram was found effective in controlling banana pseudostem weevil.

- Palak varieties *All green* and *Harith shobha* are found suitable for growing in Ernakulam District. Average yield of *All green* is 1.3 MT per ha and *Harith shobha* is 1.6 MT per ha.

- Tomato variety *Arka Samrat* developed by Indian Institute of Horticultural Research (IIHR), Bengaluru was proved to be a disease resistant variety suitable for Ernakulam climate. The yield of *Arka samrat* is 30 MT per ha.

- Application of plant growth promoting *Rhizobacterium* (PGPR) mix I, a consortium of microbes which provides nutrients to soil developed by Kerala Agricultural University is found effective in organic farming of cowpea. The yield of cowpea variety *Anaswara* increased by 25% upon application of PGPR mix I.

- Application of PGPR mix II, a consortium of microbes against pests and diseases in plants developed by Kerala Agricultural University reduced disease incidence in cowpea by 15%. Cowpea ranks second among high pesticide residue vegetables available in the market.

Arka Samrat tomato variety

- Cage culture of pearlspot in brackishwater by feeding formulated floating pellet feed was proved as a suitable alternative for traditional shrimp farms running in loss due to disease. Square type floating cages of 5 year durability costing ₹ 4500 and a net income of ₹ 7110/- can be assured from one cage in 9 months.

Cage culture unit in granite quarries

- Cage culture in granite quarries - *Tilapia nilotica*, *Etroplus suratensis* and *Pangasianodon hypophthalmus* (=*Pangasius sutchi*) were found suitable for cage farming in granite quarries. Water quality needs to be studied before introducing fish in quarries.

- Improved pokkali variety VTL-8 yielded 3.75 MT per ha comparing to local pokkali paddy variety (1.5 MT per ha).

- Commercial probiotic administration in goat kids resulted in no incidence of diarrhea and related mortality. Probiotic administration accelerated body weight gain in goats to the tune of 600-900 g at fortnightly intervals.

- Rain shelter farming can ensure local production of vegetables in rainy season also. Vegetable farming in rain shelters increased yield by 2.5 times.

- Sweet corn variety *Madhuri* released by IARI, New Delhi was found suitable for Ernakulam conditions. It gave 7 MT fresh cobs per ha. The crop duration is 70-80 days.

- The yard long bean variety, *Arka mangala* released by IIHR, Bengaluru was tested suitable for growing in Ernakulam with a yield of 8 MT per ha. The crop duration is 3-4 months.

Front Line Demonstration (FLD) programmes

- **Bypass fat supplementation for high yielding cows:** This technology resulted in increase in milk yield by 22% and milk fat increased from 3.3 to 4.2%. In addition, bypass fat supplementation lowered incidence of ketosis occurring due to energy deficit.

- **Freshwater fish seed production in farmer's field using portable carp hatchery:** The initial investment is ₹1.5 lakhs and net annual income is ₹1.2 lakhs for a unit producing 1.2 lakh no. of fingerlings in an year.

- **Farming of organic vegetables in roof tops in urban clusters:** KVK trained urban families on organic farming of vegetables. Supplied

quality vegetable seedlings and set up more than 350 roof top gardens in Ernakulam.

- **Revised deworming schedule in calves:** The new schedule prevented spread of Toxocarasis and 80% of treated calves indicated recovery.

- **Scientific farming of Japanese Quail:** Egg yield increased by 21% and mortality reduced by 50%.

- **Scientific farming and kit production of Soviet chinchilla rabbits:** The feed conversion ratio in this breed is high. A systematic schedule for scientific breeding was developed and farmers were trained.

- **Weed control in vegetables using plastic mulching:** This technology saved labour by 35%. In addition, the reflective property increased photosynthetic efficiency and thereby the production increased.

- **Cultivation of sugar baby water melon in summer paddy fallows:** Sugar baby gave yield of 40-45 MT per ha and fetched additional income of ₹45,000 per ha in 4 months from fallow paddy lands.

- **Athulya poultry in cage system for urban households:** The egg yield is 300 per bird per year. Though the egg production cost is high, the unit is suitable for rearing poultry in limited space in urban areas towards home produced quality eggs.

- **Effective microorganism (EM) solution for odour control in poultry and animal houses:** In addition to odour control, the litter/ droppings are composted in short time.

- **System of Rice Intensification (SRI) method of paddy cultivation:** SRI method resulted in 27% additional production. Cost of cultivation is only ₹23000 per ha comparing to ₹35000 per ha in conventional farming

- **Scientific farming of mullet in brackish water:** Systematic farming of mullet yielded ₹2.4 lakhs net income from 1 acre pond.

- **Fish-prawn-paddy integrated culture in Pokkali fields:** New method of integrating cage fish culture in pokkali fields resulted in additional income of ₹0.80 lakhs per ha.

- **Foliar spray of micronutrient mix in Nendran banana:** Micronutrient mix for banana developed by Indian Institute of Horticultural Research, resulted in increase in yield by 18-20%.

- **Foliar spray of micronutrient mix in vegetables:** Micronutrient mix for vegetables developed by Indian Institute of Horticultural Research resulted in increase in yield by 15%. Low infestation of fungal diseases was observed and incidence of flower as well as pin size fruit drop reduced.

- **Short duration tapioca variety, *Vellayani harswa*:** A KAU developed early maturing and high yielding tapioca variety. It matures in 5-6 months in comparison to 8 to 10 months in case of local varieties. Its cooking quality is excellent and KVK's farmers certifies that the variety is less susceptible to viral disease.

Other Events

Entrepreneurship development programme (EDP)

Entrepreneurship development programme on mushroom cultivation was conducted at Thevara on 26 April, 2013 where in 30 prospective entrepreneurs attended. Another EDP on Value added products from nutmeg rind was conducted at Samskara, Kothamangalam on 24 May 2013 which was attended by 80 prospective entrepreneurs.

EDP on Mushroom cultivation

EDP on nutmeg rind value addition

National level officer's training programme on Aquaculture

National training programme on 'Recent advances in aquaculture for popularisation through KVKs' for fisheries SMSs during 15 to 20 July 2013 at CMFRI, Kochi

State level workshop in Aquaculture

One day state level workshop on breeding and seed production of freshwater carp at Kothamangalam on 30 August 2013.

Mullet (*Thirutha*) Harvest Mela

Demonstrated scientific farming of Mullet (*Thirutha*) at Kumbalangi, Ernakulam District and organised harvest mela on 17 September 2013.

Farmer-Scientist interaction on climate change

KVK organised and facilitated farmer interface with the scientists team from National Academy of Agricultural Research Management (NAARM). The team as part of National Initiative on Climate Resilient Agriculture (NICRA) project, evaluated information from various stakeholders on

different aspects of climate change, its impact on fisheries and adaptation as well as mitigation strategies followed. The programmes were organised at Nayarambalam, Kadamakkudy and Kothamangalam during 18 and 19 September 2013.

ATMA technology meet

Training to fisheries officials of Kerala

Organised one day field training on Prospects and recent trends in Aquaculture for Sub Inspectors of Fisheries from Dept. of Fisheries, Govt. of Kerala on 23 Novermber 2013.

Technology meet cum exhibition

KVK in collaboration with Ernakulam District Agricultural Technology Management Agency (ATMA) conducted technology meet cum exhibition at EEC market place, Muvattupuzha during 1 to 8 December 2013.

Introduction of NIANP technology in Ernakulam

Silage from pineapple fruit residue

KVK introduced the technology for making silage from pineapple fruit residue developed by National Institute of Animal Nutrition and Physiology (NIANP), Bengaluru during the technology meet conducted at Muvattupuzha in December 2013. The silage produced has a shelf life of 8 months and is a good source of energy for dairy cattle and the nutritive value is better than that of green fodder. The silage can be mixed with concentrate feed and fed to cattle. It can also be mixed with other feed ingredients and fed as total mixed ration.

Participation in Krishi Vasant, 2014 at Nagpur

KVK set up exhibition stall in the agricultural exhibition, Krishi Vasant, 2014, jointly organised by Government of India, Government of Maharashtra and Confederation of Indian Industries at Nagpur during 9 to 13 February 2014.

KVK exhibition stall at Krishi Vasant 2014 at Nagpur

Technology backstopping to Men's Self Help Group

Provided technology backstopping to 'Friends Men's Self Help Group' from Sreemoolanagaram, Ernakulam District towards developing sustainable farming models in entrepreneurship mode by involving rural youth towards self employment in the district. The programme was launched on 13 March 2014 with one day training for the members on freshwater fish culture.

Harvest mela of Paddy-Shrimp-Fish integrated farming

The harvest mela of Paddy-Shrimp-Fish integrated farming demonstrations in Pokkali fields was conducted on 10 April, 2013 at Ezhikkara Vadakkumbhagam Padasekharam as part of the National Initiative on Climate Resilient Agriculture (NICRA) Project.

Shri. Srinivasan, actor inaugurating the harvest-mela

District Monthly Technology Advisory (MTA) service

Agricultural Technology Management Agency (ATMA) in collaboration with KVK organised 9 Monthly Technology Advisory meetings during the report period. The Agricultural/Fishery/Veterinary extension officers in the district interacted with KVK scientists and selected experts during monthly MTA meetings and the field problems for the next month identified and solutions were recommended in each meeting. Subsequently, month specific technology advice in print form was circulated among farmers of the district through various offices.

Documentation of farmers innovations in Ernakulam District

Documented 13 farmers innovations from Ernakulam District as part of the Kerala State Planning Board funded project on Identification and mapping of farmer's innovations in Agriculture. Total of 20 farmers presented 48 innovations before a multi-disciplinary screening committee meeting held on 29 July 2013 at CMFRI, Kochi and 13 innovations were selected by the team, based on various criteria specified by the Planning Board. Shri. Sachidanandan from Aduvassery who invented a nutmeg seed decorticator was selected as the best farmer innovator.

Help desk for registering farmer's varieties and creating awareness on farmer's rights

The Protection of Plant Varieties and Farmers Rights Authority (PPV & FRA) has entrusted KVK, Ernakulam to create awareness on the provisions of the

Protection of Plant Varieties and Farmers Rights Act, 2001 in the district. A help desk has been opened at KVK to facilitate farmers, farmer communities and tribals in registering their varieties. Awareness programmes were conducted for farmers and field extension officers through interactions and also by distributing booklets and posters containing provisions of the Act.

Satellite Production Centres (SPCs) in collaboration with Kudumbashree mission

KVK collaborated with Kudumbashree Mission in creating entrepreneurship among women self help groups in Ernakulam by creating Satellite Production Centres (SPCs) across the district. KVK's Satellite micronutrient production centre started functioning at Edakkattuvayal, Ernakulam District.

Products

Vegetable top up

Vegetable top up contain secondary elements like Magnesium, Calcium, and micronutrients like Zinc, Boron, Iron, Copper, Manganese and Molybdenum. The sprays of *vegetable top up* at critical growing stages enhances the yield in vegetables by 15-20%. KVK received bulk orders from Department of Agriculture, Govt. of Kerala for its micronutrient mix *Vegetable top up* for distribution to all 14 districts of Kerala.

Organo excel

Organic fertilizer cum insect repellent formulation - *Organo excel* was launched on 2 December 2013 at Muvattupuzha. The formulation contains Neem cake and Ground nut cake. *Organo excel*, which is a rich source of NPK improves soil aeration, water holding capacity, accelerates activity of beneficial microbes, enhances root development and accelerates growth in plants.

Amino plus

KVK initiated production and marketing of fish amino acid in the trade name *Amino plus* in 200 ml bottles. It's a unique organic nutrient made from sea fish for improving health and productivity of crops. It acts as a plant growth promoter and improves the immune support system in plants. When applied as foliar spray, it helps to increase chlorophyll concentration in plants and makes the crops lush green. The product can also be incorporated directly in the soil which helps in improving soil microflora, which in turn facilitates assimilation of nutrients. It also induces synthesis of flower and fruit related hormones, increase pollen germination, improves quality and shelf life of fruits & vegetables and helps in proper ripening and uniform colouring in fruits. It is also found effective against mites and white flies. Fish amino acid spray also helps to reduce the sucking pest population, especially the rice and cowpea bugs.

Amino plus

Fruit fly trap

KVK designed an eco-friendly fruit fly trap using coconut shells with fruits and jaggery mix to attract fruit flies. A small quantity of chemical supplied in the kit need to be mixed with this to make a bait in the coconut shell. This fruit fly trap can dramatically reduce the amounts of pesticides being used. Although the trap contains very small amount of chemicals, this is not directly in contact with vegetables and there is no danger of drift as there is with sprays. Fruit fly trap is more useful for kitchen gardens.

Fruit fly trap in farmer's field

Fruit fly trap for sale

Vegetable seedlings

KVK produced and supplied 27,000 numbers of vegetable seedlings during the period under report. Pro-tray grown seedlings in coir pith compost medium were made available round the year. Good quality seedlings of cool season vegetables such as cauliflower and cabbage were supplied in addition to seedlings of cowpea, tomato, brinjal, okra, bitterguard and chilly.

Seedlings ready for sale in KVK seedling production unit

Radio programmes

- Talk on Opportunities of Fisheries and Aquaculture sector in Ernakulam, broadcasted on 19 September 2013 by AIR Kochi - Dr. Vikas P. A.
- Talk on Koodumalsyakrishi, broadcasted on 6 July 2013 by AIR Trichur - Dr. Vikas P. A.
- Documentary on activities of KVK (Ernakulam) of CMFRI, broadcasted by AIR Kochi on 30 August 2013.
- Talk on activities of KVK (Ernakulam) of CMFRI, broadcasted on 5 September 2013 by AIR Kochi -Dr. Shinoj Subramannian.

- Talk on Freshwater fish culture broadcasted on 25 January 2014 by AIR Trichur in VayalumVeedum Programme - Dr. Vikas P. A.

- Live phone-in programme on Prospects of onion cultivation in Kerala, broadcasted on 12 November 2013 by 94.3 Club FM - Dr. Shoji Joy Edison.

Television programmes (Doordarshan-Malayalam)

- Live phone-in programme with Dr. Shinoj Subramannian, Programme coordinator telecasted on 2 August 2013.

- Documentary on KVK's cage culture interventions telecasted on 3 June 2013.

- Documentary on KVK's Scientific rabbit breeding, Milk replacer for calves and Scientific vegetable seedling production telecasted on 31 October 2013.

- Documentary on Paddy-shrimp-finfish integrated farming in pokkali fields, Power weeder in paddy fields, Open precision farming, Organic products of KVK Ernakulam, telecasted on 7 November 2013.

- Documentary on Pearlspot seed production technology, Scientific mullet farming, Carp seed production in portable carp hatchery, telecasted on 21 November 2013

Official language **implementation**

Ensurance of bilingualisation and targets of correspondence

During the year cent percent issue of Section 3(3) documents in bilingual form (706), reply to letters received in Hindi (542) and target of Hindi correspondence (70.5%) against the target of 55% was ensured.

Under bilingualisation programme during the period, 43 name plates, 25 rubber stamps, 58 identity cards of staff members, pensioners and research fellows, 3 charts, 1 plaque, certificates of training programmes conducted by CMFRI HQ. and KVK were prepared bilingually.

Official Language Implementation Committee meetings organised/attended

Four meetings of the Official Language Implementation Committee of the Institute were conducted on 27.06.2013, 26.09.2013, 31.12.2013 and 31.03.2014.

Attended Half yearly meeting of Town Official Language Implementation Committee at Income Tax Office, Cochin on 09.01.2014.

Review of OL activities of Regional/Research Centres

The Official Language implementation activities of all Regional and Research Centres were reviewed and necessary suggestions were given for improvement.

Inspection at centres

Official Language implementation activities of Mangalore and Calicut

Research Centres were inspected on 25.10.2013 and 07.11.2013 respectively.

HRD programmes

Hindi Workshops: Inorder to encourage the staff to work in Hindi and speak Hindi without hesitation 11 Hindi workshops were conducted during the period as follows:

Four Hindi workshops were conducted at Headquarters, Cochin on 5 - 6 June 2013 on Unicode; on 03.09.2013 on E-application; on 11-13 December 2013 and 18-19 February 2014 on Spoken Hindi.

- One Day Hindi workshop at Visakhapatnam Regional Centre of CMFRI on 31.08.2013 on Computer application in Hindi.
- Hindi workshop on the subject *Apna parichay karayie* at Madras Research Centre of CMFRI on 03.12.2013.
- Hindi workshop at Tuticorin RC on 24.08.2013 on Hindi Grammar.
- Hindi workshop at Karwar RC on 28.09.2013 on Official Hindi and correspondence.
- Hindi workshop at Calicut RC on 24.11.2013 on Hindi correspondence.
- Hindi workshop at Mangalore RC on 18.09.2013 on Hindi Grammar.
- Hindi workshop at Mandapam RC on 27.06.2013 on General Hindi and correspondence.

Totally, 264 Officers and staff were trained in these workshops during the year.

Special focus to complete obligatory training in CMFRI centres in Tamil Nadu

Twenty Scientists and Technical staff of Mandapam Regional Centre of CMFRI passed various Hindi courses and cash incentives were sanctioned.

Nineteen Officers and staff of Madras Research Centre are undergoing various Hindi courses.

A word a Day: Under *A word a day programme*, 214 Hindi words with English equivalents were displayed on display board and circulated among staff members of Headquarters and Outstations.

Special incentive scheme: Under CMFRI special incentive scheme cash incentives were granted to 5 officers and staff at Headquarters.

Extension programmes

Hindi Chethana Mas Celebration: *Hindi Chethana Mas* was observed at CMFRI Headquarters, Cochin from 03.09.2013 to 28.09.2013 by giving special emphasis on National integration and linguistic harmony. Programmes of *Hindi Chethana Mas* was initiated with a Workshop on E-application. Various competitions such as Hindi Translation and correspondence, Hindi speech, Quiz and E-governance were conducted during the period. The valedictory function of Hindi Chethana Mas was organised on 28.09.2013. Dr. A. Gopalakrishnan, Director, CMFRI chaired the function. Dr. P. T. Lakshmanan, Director-in-Charge, CIFT, Cochin was the Chief Guest. Winners of competitions and overall contributors for the year were felicitated during the function.

Cultural programme '*Navjaagaran*' on National Integration was also organised by the staff and Research scholars of the Institute on the occasion.

Hindi Day/Week/Fortnight was observed in all Regional and Research Centres of CMFRI with various programmes.

Participation in Joint Official Language Celebration-2013: Members of staff of the Institute took part in various cometitions of Joint Official Language celebration held at Cochin and various Centres and won prizes and admiration certificates.

Institute publications (Hindi)

- Quarterly bilingual periodicals
- MFIS-Issue Nos. 211, 212, 213, 214 & 215
- CMFRI Newsletter Cadalmin-Issue Nos. 136, 137 & 138
- Special Publication *Matsyagandha* 2011 - 12
- Hindi Book: Hindi book *Bharat ki samudri sasthaniyam*

Chief Guest Dr.P.T.Lakshmanan, Director-in-Charge, CIFT Addressing the audience

Presidential address by Dr. A. Gopalakrishnan, Director CMFRI

Prize distribution

Cultural programme: Hindi Week celebration at Headquarters

Hindi Week celebration at Mandapam RC

Hindi Week celebration at Visakhapatnam RC

E- Governance programmes

(i) Web display of advertisement/tenders
(ii) Use of bilingual software for fishing data collection
(iii) Digital display of Institute's Hindi publications
(iv) The terminology bank on fisheries.

Special delegation of ICAR

The Deputy Director (OL) and Asst. Chief Technical Officer (Hindi) were delegated to inspect the Official Language implementation activities of ICAR Institutes-Directorate of Cashew Research, Puttur, Karnataka, Indian Institute of Spices Research, Calicut and National Banana Research Centre, Thiruchirapally, Tamil Nadu. The inspection reports and suggestions after discussion with the Directors of Institutes were sent in due time to ICAR.

Recognitions

Rajarshi Tandon Award

CMFRI bagged the Rajarshi Tandon Award for the 6th time introduced by ICAR for the Excellent Official Language activities among the Institutes situated in 'C' Region for the year 2012-2013. In the function organised at ICAR in New Delhi on 28.04.2014, Dr. A. Gopalakrishnan, Director, CMFRI received the award from Dr. S. Ayyappan, Secretary, DARE & Director General, ICAR in the presence of Dr. Gurbachan Singh, Chairman, ASRB

Dr. A. Gopalakrishnan, Director, CMFRI receiving Rajarshi Tandon Award

and Shri Arvind Kaushal, IAS, Additional Secretary (DARE) and Secretary (ICAR).

Town Official Language Award

CMFRI bagged Rajbhasha Rolling Trophy of Kochi Town Official Language Implementation Committee for the best implementation of Official Language during 2012-13. In the meeting held at Income Tax Office, Cochin Shri Rakesh Kumar, Chief Administrative Officer received the Trophy from Shri Kaushal Kumar Sharma, IRS, Commissioner of Income Tax.

Shri Rakesh Kumar, Chief Administrative Officer receiving the Rajbhasha Rolling Trophy

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Anil, M.K., Jasmine, S., George, Rani Mary; Raju, B., Kingsly, H. Jose and Salini, K.P. 2014. Ornamental Fishes of Indian Coast-2.

Manisseri, Mary K., Naomi, T.S., Antony, Geetha; Vinod, K., George, Rani Mary; Rao, M. Umamaheswara; Ramalingam, J.R., Gopakumar, G., Jasmine, S., Reshmi, E.G. Venkatesan, V., Thomas, V.J., Geetha, P.M. and Sreekumar, K.M. 2014. Seawe*eds* and Seagrasses.

Video

Rao, G. Syda (2013) Cage Farming Technology for Community Benefit. [Video]

KVK publications

Booklets

Shinoj Subramannian; Pushparaj Anjelo, F. and Shoji Joy Edison 2014. N*adan vithinangalude registrationum karshakarude anubandha avakasangalum.* Shinoj Subramannian (Ed.), Krishi Vigyan Kendra, Ernakulam.

Shoji Joy Edison and Pushparaj Anjelo, F. 2013. *Jaiva sookshmaanu valangal, Jaiva sookshmaanu keedanaashinikal, jaiva sookshmaanu valarcha thwaragangal-Oru parichayam* (Shinoj Subramannian, Ed.), Agricultural Technology Management Agency, Ernakulam.

Leaflets

Shinoj Subramannian, Pushparaj Anjelo, F. and Anu Ray Mathew. 2013. *Nelkrishiyile Yanthra valkaranam*, Agricultural Technology Management Agency (ATMA), Ernakulam.

Shoji Joy Edison. 2014. Vegetable Topup, KVK series- 1/2014, Krishi Vigyan Kendra (Ernakulam).

Smita K. Sivadasan; Vikas, P.A. and Pushparaj Anjelo, F. 2013. *Karshaka pankalitha samrambhangal*, Agricultural Technology Management Agency (ATMA), Ernakulam.

Smita K. Sivadasan and Pushparaj Anjelo, F. 2013. *Kannukalikalkku Probiotiksum Bypass kozhuppum*, Agricultural Technology Management Agency (ATMA), Ernakulam.

Vikas, P.A. 2013. *Karimeen krishi*, Agricultural Technology Management Agency (ATMA), Ernakulam.

Vikas, P.A. 2013. *Paramadakalile Koodu malsyakrishi*, Agricultural Technology Management Agency (ATMA), Ernakulam.

Vikas, P.A. and Zacharia, P.U. 2013. *Pokkali Punarujjeevanathinu Puthiya Krishireethi,* KVK series- 1/2013, Krishi Vigyan Kendra (Ernakulam).

Popular articles

Pushparaj Anjelo, F. and Shoji Joy Edison 2013. *Mettupalayathe Parambaragatha Kariveppukrishi.* Karshakan, Volume 21 No.06.

Shoji Joy Edison. 2013. *Chenayude Manjaalipperuma*, Karshakashree, 19(5)

Smita, K. Sivadasan 2013. *Anayasam aadayam* (Quail farming). Karshakashree, Volume 19, No.8

Smita, K. Sivadasan 2013. *Pashukidangalkum kuppipalu* (Milk replacer). Kerala Karshakan Volume 58 No.12

Smita, K. Sivadasan 2013. *Vegamvalaran probiotics*. Karshakasree, Volume 19, No.7

Vikas, P.A. 2013. Carp *Malsyakrishi Reethikalum Sadhyathakalum.* (Carp farming prospects and methods). Kerala Karshakan, July. 2013. pp 56-57

Vikas, P.A. 2013. *Koodukalmeeninu Veedukal*, (Cages: Home for the fishes) Karshakasree. Book 19. Issue 2. pp 74.75

Vikas, P.A. and Shinoj Subramannaian. 2013. *Parasparapoorakam pokkalikrishi.* (Mutual benefiting Pokali Farming) Karshakasree, September 2013. Book 19. Issue 2. pp 44-45

Vikas, P.A. and Shinoj Subramannaian. 2013. *Pokkalipadathum Kuttile Matsyakrishi.* (Cage fish farming in Pokkali fields) Karshakasree, September 2013. pp 74-75

Vikas, P.A. and Shinoj Subramannaian. 2013. *Thirutha Valarthanumundu Shastram.* (Scientific Mullet farming), Kerala Karshakan, November 2013. Book 59. Issue 4. pp 34-35

Training manuals

Shinoj Subramannian and Pushparaj Anjelo, F. 2013. Recent advances in Aquaculture for popularization through KVKs. KVK Training manual.

Conference proceedings

Smita, K. Sivadasan 2013. Kadaknath - *Nadan Kozhikalile Rani.* Sovenier 'Smarnika'12' of Mahatma Nature and Animal Conservation society, Kottayam, January 2013.

Vikas, P.A. and Shinoj Subramannian 2014. Transforming a traditional fisherman into successful aquapreneur. *Souvenir of International conference on Management of Agri-business and Entrepreneurship development* jointly organized by Technocrats Institute of Technology-MBA and Central Institute of Agricultural Engineering, Bhopal, Jan.6th -7th.

Shinoj Subramannian, Sreeletha, P., Pushparaj Anjelo, F. and Vikas, P.A. 2014. Innovative programme for creating entrepreneurs: Success stories in sea food micro enterprises. *Souvenir of International conference on Management of Agri business and Entrepreneurship development* jointly organized by Technocrats Institute of Technology-MBA and Central Institute of Agricultural Engineering, Bhopal, Jan.6th -7th.

Vikas P.A., ShinojSubramannian and F.Pushparaj Anjelo.2014. Fresh water seed production: Transformation of a farmer to a breeder cum entrepreneur. *Souvenir of International conference on Management of Agri business and Entrepreneurship development* jointly organized by Technocrats Institute of Technology-MBA and Central Institute of Agricultural Engineering, Bhopal, Jan.6th -7th.

Vikas P.A., Shinoj Subramannian, John Bose, Rao, G. Syda and Zakkariah, P.U.2014. Package for enhancing the income from Pokkali farming-A successful agribuisiness model. *Souvenir of International conference on Management of Agri business and Entrepreneurship development* jointly organized by Technocrats Institute of Technology-MBA and Central Institute of Agricultural Engineering, Bhopal, Jan.6th -7th.

Vikas P.A., Pushparaj Anjelo, F. and Shinoj Subramannian. 2014. Ornamental fish rearing in shallow ponds: A farmers successful practice. Ornamentals Kerala 2014, 26-27 January 2014, pp 29

Shoji Joy Edison 2013. *Jaathiyude krishireethikal, In: Panam kaykkum jaathimaram* - A compendium prepared as part of state level SHM sponsored seminar on Nutmeg production and marketing December 17-18, 2013, KVK Thrissur.

Shoji Joy Edison.2013. *Kochukudi Jose Mathew* (a write up on Kochukudi variety of nutmeg developed by Jose Mathew). In: *Panam kaykkum jaathimaram* - A compendium prepared as part of state level SHM sponsored seminar on Nutmeg production and marketing December 17-18, 2013, KVK Thrissur.

Participation in **conferences | meetings | workshops | symposia | trainings | deputations**

Participations

Dr. A Gopalakrishnan, Director BOBLME/FAO/NBFGR International Harmonisation Workshop on Indian Mackerel Genetics at NBFGR Kochi Unit - Served as resource person, 20-27 August 2013

Meeting convened for reviewing and finalising the All India Co-ordinated Research Projects and Network Projects of all Divisions and the Agri-Consortia Research Platform at Krishi Bhavan, New Delhi under the chairmanship of Secretary, DARE & Director General, ICAR, 29-31 August 2013

Oyster Farmer's Award ceremony at Moothakunnam, Ernakulam District, 27 September 2013

TSP meeting at Bali, Sunderbans and Hilsa meeting at Gadkhali, Kolkata, chaired by the Director General, ICAR, 2-3 October 2013

High level meeting of ICAR officials and Garware leadership convened by the Director General, ICAR at Garware Wall Ropes Unit Wai, Pune, 7 October 2013

Second meeting of the Scientific Panel on Fish and Fisheries Products at Food Safety and Standard Authority of India, New Delhi, 15 October 2013

Reviewed the research and other activities of the Visakhapatnam Regional Centre and had discussions with the field staff on damages caused to the marine fisheries sector by the Phalin cyclone, 24 and 25 October 2013

Second meeting of Expert Committee for Comprehensive Review of Deep Sea Fishing Policy and Guidelines at CIBA, Chennai, 31 October 2013

Chaired the Workshop on 'Species Prioritisation' to identify suitable species for mariculture technology development held at Mandapam Regional Centre of CMFRI, 4-5 November 2013

Third meeting of the Expert Committee for Comprehensive Review of Deep sea Fishing Policy and Guidelines at Krishi Bhavan, New Delhi, 21-22 November 2013

Consultative meeting on "Fisheries Development in the State of West Bengal: Research, Extension & Development Support" by the ICAR Fisheries Research Institutes at Kolkata, 23 November 2013

Interactive Workshop on Administrative and Financial matters for the ICAR Institutes located in Southern region at NAARM, Hyderabad, 9 -10 December 2013

Indo-Norwegian Working Group meeting under the chairmanship of Dr. Rajasekhar Vundru, Joint Secretary, Dept. of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture at NASC, New Delhi, 6 January 2014

Meeting of Standing Committee on Time and Cost Over-run for construction of Laboratory-cum Office Building of Vizhinjam Research Centre under the chairmanship of DDG (Horticulture) at New Delhi, 13 January 2014

Interaction meeting of Vice Chancellors, Directors of ICAR Institutes and Progressive Farmers at Baramati, Pune, 19 January 2014

Directors' Conference at Pune, 20 January 2014

Meeting convened by DG, ICAR for preparing the presentation on cage culture for presenting before the Hon. Union Agriculture Minister at New Delhi, 28 January 2014

Meeting on cage culture at Krishi Bhavan, New Delhi under the chairmanship of Hon. Union Agriculture Minister, 29 January 2014

Visited CPCRI, Kasaragod in connection with the inauguration of Bio-control Laboratory and Directorate of Cashew Research (DCR), Puthur in connection with the inauguration of Plant Protection Laboratory, 8 March .2014

Reviewed the research and other activities of the Mangalore Research Centre and had discussions with the Staff, 10 March 2014

Dr. E. M. Abdussamad NAIP-World Bank-ICAR-ISI Cross-Learning Evaluation Workshop organised by Sampling and Official Statistics Unit (SOSU) and Agricultural and Ecological Research Unit, ISI, Kolkata, 3-4 December 2013

Dr. E. M. Abdussamad, Dr. U. Ganga and **Dr. Sandhya Sukumaran** International workshop on "MSC certification-Review of Indian oil sardine Fishery Improvement Plan (FIP)" at Kochi organised by World Wildlife Fund, India and Marine Stewardship Council, U.K., 24-25 September 2013

Dr. A. K. Abdul Nazar, Dr. R. Jayakumar and **Dr. G. Tamilmani** 'Aqua-India-2014' organised by Society of Aquaculture Professional (SAP) at Vijayawada, 24- 25 January 2014

Dr. Amir Kumar Samal Winter School on "Advances in molecular and serological tools in fish disease diagnosis'" at Central Institute of Freshwater Aquaculture, Bhubaneswar, 9-21 November 2013

Dr. M. K. Anil MDP Workshop on Priority setting, Monitoring and Evaluation (PME) of Agricultural Research Projects at NAARM, Hyderabad, 19-23 November 2013

Smt. Anulekshmi Chellapan Workshop for building awareness about the need and nature of basic/strategic research in agriculture System at CIFE, Mumbai, 27-28 September 2013

Dr. P. S. Asha ICSF-BOBLME training programme on enhancing capacities of fishing communities for resource management at Akkalmadam and Ramnad in Ramanathapuram District, Tamil Nadu, 23-26 October 2013

Dr. P. K. Asokan Judging panel of Best paper and poster in Fisheries and Veterinary Sciences session in connection with the 26th Kerala Science Congress (KSC), 28 January 2014

Dr. Biswajit Dash Hilsa project review meeting chaired by the Director General, ICAR at CIFRI, Kolkata, 1 March 2014

Shri. P. Chidambaram Short training course on Knowledge Management at ISTM, Delhi, 7-9 October 2013

Dr. A. P. Dineshbabu Co-ordination Committee meeting with fishermen co-operatives regarding site survey under the project "Stock characterisation, captive breeding, seed production and culture of Hilsa (Tenualosa ilisha)" at CIFRI, Barrackpore, 15 -19 August 2013

National symposium on "Taxonomy and Biogeography" conducted by Department of studies in Marine Biology, Karnataka University at Karwar, 7 December 2013

Dr. A. P. Dineshbabu and **Dr. P. S. Swathi Lekshmi** Second annual workshop of NICRA at IARI, New Delhi, 17-19 June 2013

Dr. A. P. Dineshbabu and **Dr. Sujitha Thomas** National review meeting of "SIBER India" project at NIO Goa, 16 September 2013

Dr. G. Gopakumar Meeting convened by the Director General, ICAR, New Delhi to finalise the Network project proposals at Krishi Bhavan, New Delhi, 29-31 August 2013

Discussion on cage culture potential of India with Norwegian delegates at New Delhi, 5-6 January 2014

Institute Management Committee meeting at CMFRI, Kochi, 25 February 2014

Dr. G. Gopakumar, Dr. K. Madhu and **Dr. Rema Madhu** International Seminar on Advances in Agricultural Technologies at All Saints College, Thiruvanathapuram, 18-19 July 2013

Dr. G. Gopakumar, Dr. A. P. Lipton, Dr. M. K. Anil, Dr. B. Santhosh, Dr. S. Jasmine and **Smt. K. N. Saleela** International Seminar on Ornamentals Kerala-2014 at Kochi, 26-27 January 2014

Dr. Grinson George Delivered lecture in the short term training programme for engineering college teachers on "Imaging Techniques-ImTec '13" at CUSAT, Cochin, 17-21 June 2013

Brain storming session to discuss and finalise the reprocessing chain of different OCM LAC-360 m data at National Remote Sensing Centre Hyderabad, 27 August 2013

Ms. Indira Divipala Training on "Geo-spatial technologies and applications" conducted by National Remote sensing Centre, Hyderabad, 3 June to 23 August 2013

Dr. S. Jasmine, Dr. U. Ganga and D**r. Rekha J. Nair** Training programme on 'Integrated Scientific Project Management for Women Scientists/Technologists' at the Centre for Organisation Development, Hyderabad, 18 to 22 November 2013

Delivered a lecture on 'Marine Environmental Conservation' at V.O. Chidambaram College, Thoothukudi, Tamilnadu, 10 October 2013

Dr. R. Jayakumar Interaction meeting on 'Impact of shrimp farm effluents on marine fish population' with the fishermen association, organised by SIFFs at Pattukottai, 5 March 2014

Dr. J. Jayasankar IV Meeting of the committee to work out the fleet size of EEZ conducted by DAHD & F at New Delhi, 11 September 2013

Dr. J Jayasankar, Dr. K. G Mini, Shri. J. Srinivasan and **Shri. S. Haja Najeemudeen** Pre-Census Workshop under the Central Sector Scheme on "Strengthening of Database and Geographical Information System for fisheries sector-Marine Fisheries Census" funded by DAHDF, Ministry of Agriculture, New Delhi at Visakhapatnam Regional Centre of CMFRI, 10-11 December 2013

Dr. Jayasree Loka and **Dr. Senthil Murugan** Aqua Goa festival at Navelim Goa and presented a paper on open Sea cage farming in the scientific session, 1 February 2014

Dr. R. Jeyabaskaran Coastal Protection and Development Advisory Committee (CPDAC) meeting in context of Anti Sea Erosion Measures in Lakshadweep organised by coastal Erosion Directorate, Central Water Commission, New Delhi, 16-20 April 2013

Workshop on 'Conservation and sustainable management of Existing and Potential coastal and marine Protected Area' jointly organised by Ministry of Environment & Forests and GIZ at New Delhi, 5-6 September 2013

Delivered a lecture on 'Marine Environmental Conservation' at V. O. Chidambaram College, Thoothukudi, Tamilnadu, 10 October 2013

IUCN-MFF Project Planning Meeting held at Chennai Research Centre of CMFRI, 5 March 2014

Annual Review Meeting of INCOIS funded project held at INCOIS, Hyderabad, 19 March 2014

Dr. B. Johnson Workshop on 'Fisheries and Human Well Being at Gulf of Mannar' at National Centre for Sustainable Coastal Management (NCSCM), Chennai, 30 September 2013

ICSF-BOBLME Training programme for fishing communities at Pamban and Ramanathapuram organised by ICSF, Chennai, 23 to 26 October 2013

Interaction meeting with the representatives of 50 Country Craft fishermen of three coastal districts to ascertain their views on 45 days fishing ban at Thondi, organised by the State Fisheries Department, Tamil Nadu, 17 January 2014

Delivered a lecture on "Mariculture as alternate livelihood options for Responsible Fisheries Management" to 75 fishermen in the Training programme on 'Responsible Fishing' organised by Fisheries College, Tuticorin, 14 February 2014

Dr. Joe K. Kizhakudan Meeting on "Water Resilient Aquaculture-Vision for 2050" organised by the Central Institute of Freshwater Aquaculture (CIFA) at Bhubaneswar, 6 September 2013

State Level Workshop conducted by IFAD Assisted Post Tsunami Sustainable Livelihood Programme (P TSLP) at Chennai, 17 May 2013 and 23 July 2013

Interactive meeting with members of the Irula tribe in Oyyalikuppam (Kancheepuram District), at Oyyalikuppam on 29 November 2013 Delivered a talk on "Strides in Mariculture Development" at the Fisheries Training College, Tamil Nadu Fisheries Department, 16 December 2013

Dr. Joe K. Kizhakudan and **Dr. S.N. Sethi** Workshop on Sustainable Fisheries organised by MPEDA at Puducherry, 27 August.2013

Dr. K. K. Joshi Meeting for Alteration of Schedules of the Wild Life (Protection) Act, 1972, at Paryavaran Bhavan, MoEF, New Delhi, 21 May 2013

Workshop on "Indo- German research cooperation in support of the management of coastal and marine biodiversity in India" sponsored by MoEF and GIZ held at New Delhi, 5-6 September 2013

'General Management Programme for Scientists' sponsored by Department of Science and Technology, Govt . of India at Administrative Staff College of India, Hyderabad, 30 December 2013 to10 January 2014

Dr. Josileen Jose ICPA, WWF & CMFRI Sustainability Meeting to discuss the Blue swimmer crab fishery and work plan for MSC pre-assessment and FIP in Ramnad District of Tamil Nadu at Tuticorin, 26 November 2013

Dr. Kajal Chakraborty Indo-US DST funding committee meeting as subject expert to evaluate Indo-US project proposal under Indo-US Science & Technology Forum of Department of Science and Technology, June 2013

National Seminar on Therapeutics of Marine Bioactive Compounds at Gandhigram Rural Institute, Gandhigram, Tamil Nadu, 9 -10 December 2013

Workshop on "Valuation and Pricing of Agricultural Technologies" organised by Agrinnovate India Limited (AgIn) in collaboration with IP&TM Unit of ICAR, New Delhi, 26 December.2013

Dr. P. Kaladharan Served as member of Scientific Advisory Committee of IISR's KVK, Peruvannamuzhi till September 2013

Ms. Karthireddy Syamala Special translation training course conducted by Central Translation Bureau (Department of Official Language, Ministry of Home Affairs) at Bandra, 13 -18 January 2014

Dr. V. Kripa Institute Management Committee meeting of ICAR Research Complex, Goa, 19 July 2013

NOAA-MoES workshop on 'Marine Fishery Prediction and Harmful Algal Bloom' at Kochi, 23-27 September 2013

Institute Management Committeee meeting at CIFT, Kochi, 22 November 2013

Clam Council meeting with District Collector at the Collectorate, Kollam, 28 November 2013

High-level meeting to discuss the State Action Plan for Climate Change and identify suitable projects and specific agencies for implementing climate change adaptation projects at NABARD Regional Office, Thiruvananthapuram, 28 November 2013

GIZ project initiation workshop on ecosystem services for the Consultancy project on 'Assessment of eco-labeling as tool for conservation and sustainable use of biodiversity in Ashtamudi Lake (south-west coast of India) (GIZ-TEEB) at New Delhi, 17 January 2014

UN workshop on Global Marine Assessment: Northern Indian Ocean at Chennai and presented a National Status paper on 'Food Security', 26-28 January 2014

Brainstorming workshop on 'Mud banks of Kerala: the Known and the Unknown" organised by CSIR-NIO, at Ashirbhavan, Kacheripady, 20-21 January 2014

National Seminar on 'Climate Change and Marine Ecosystems organised by Cochin University of Science and Technology at Kochi, 20-21 March 2014

Dr. V. Kripa, Dr. K. S. Mohamed, Dr. K. Vinod and D**r. R. Jeyabaskaran** Indo-German Project Planning Workshop conducted by MoEF at India Habitat Centre, New Delhi, 13-14 May 2013

Dr. V. Kripa, Dr. K. S. Mohamed, Dr. R. Narayanakumar, Dr. T. V. Sathianandan, Dr. P. Kaladharan, Dr. D. Prema, Dr. A. P. Dineshbabu, Dr. Sujitha Thomas, Dr. V. P. Vipinkumar, Dr. Shyam S. Salim, Dr. Grinson George, Dr. N. Aswathy and **Shri. K. Mohammed Koya** International Symposium 'Greening Fisheries'- Towards Green Technologies in Fisheries organised by the Society for Fisheries Technologists (India) at CIFT, Cochin, 21-23 May 2013

Dr. S. Lakshmi Pillai 5th PAC meeting (Animal Sciences) SERB, DST at JNCASR, Bangalore, 14 February 2014

Dr. G. Maheswarudu 42nd Institute Management Committee meeting of CIBA, Chennai, 01 July 2013

Session on "Opportunities in financing to Mariculture activities" at NIRD, Hyderabad, 30 April 2013

IMC meeting of Central Institute of Brackishwater Aquaculture (CIBA), Chennai, 1 July 2013.

43rd Institute Management Committee meeting of CIBA, Chennai, 31 January 2014

Dr. G. Maheswarudu and **Dr. A. P. Dineshbabu** Meeting with delegates from High Commission of the Republic of Mozambique at New Delhi, 7 March 2014

Dr. K. G. Mini 4th Workshop-cum-Installation training programme under the NAIP Consortium on Strengthening Statistical Computing for NARS held at University of Agricultural Sciences, Bangalore, 15-16 November 2013

Dr. K. S. Mohamed 54th meeting of the TANUVAS Academic Council at Madras Veterinary College, Chennai, 5 April 2013

Brain storming session to 'Evolve a Research Policy for the University' at Kerala University of Fisheries and Ocean Studies, Panangad, Kochi, 20 May 2013

55th meeting of the TANUVAS Academic Council at Madras Veterinary College, Chennai, 24 August 2013

Meeting with Director and Secretary of Fisheries, Andaman & Nicobar Islands, at Marine Hill, Port Blair, 25-31 August 2013

Fourth meeting of the Committee to work out the revised fleet plan for the Indian EEZ at Krishi Bhavan, New Delhi, 11 September 2013

Ashtamudi Clam Fisheries Governing Council (ACFGC) meeting at Kollam, 1 October 2013

Served as member, UPSC interview Board for selection of Director General, FSI at New Delhi, 26 November 2013

Workshop on "Application of modelling approaches for management of inland open water fisheries management" at CIFRI, Barrackpore, 24 February 2014

Dr. K. S. Mohamed, Dr. P. U. Zacharia, Dr. Prathibha Rohit, Dr. K. K. Joshi, Dr. A. P. Dineshbabu, Dr. R. Jeyabaskaran and **Dr. Rekha J. Nair** BOBLME MFF Regional Symposium on "Ecosystem Approaches to the Management and conservation of Fisheries and Marine Biodiversity in the Asian Region" at Kochi, 25-30 October, 2013

Dr. T. M. Najmudeen Workshop on "User Acceptance Testing of ERP solutions for Implementation of Management Information System (MIS) including Financial Management System (FMS) in ICAR" at Indian Agricultural Statistics Research Institute, New Delhi, 8 -10 May 2013

Refresher course on Agricultural Research Management for Directly Recruited Senior/Principal Scientists at National Academy of Agricultural Research Management (NAARM), Hyderabad, 15-27 July 2013

Dr. R. Narayanakumar Mid-Term Evaluation of Performance of RFD of the Fisheries Research Institutes held at Fisheries Division, ICAR, New Delhi, 8 November 2013

International Training Programme on Fisheries Management, organised by the Ministry of External Affairs and Kerala University of Fisheries and Ocean Studies at Kochi and delivered a lecture on "Economics of fishing methods and fisheries management", 15 December 2013

Syllabus revision committee meeting in the Fisheries Economics and Extension Division, CIFE, Mumbai, 20-22 February 2014

Dr. R. Narayanakumar and **Dr. J. Jayasankar** Meeting convened by the DG (ICAR) on "Performance indicator" held at NCAP, New Delhi, 17 July 2013

General Management Programme for Scientists sponsored by Department of Science & Technology, Government of India held at ASCI, Hyderabad., 26 August to 6 September 2013

Dr. K. K. Philipose First meeting of the committee constituted for 'Revalidation of fish catch potential from inland and marine cages' convened by the DAHD, Ministry of Agriculture, Govt. of India at New Delhi, 6 September 2013

Open sea cage culture programme conducted by MFDC at Ratnagiri, 25 January 2014

Second meeting of the National Cage Revalidation Committee meeting organised by Ministry of Agriculture, 29 January 2014

NICRA TDC Review meeting at CRIDA, Hyderabad, 3 March 2014

Dr. K. K. Philipose and **Dr. T. Senthil Murugun** National symposium on "Taxonomy and Biogeography" organised by Department of Studies in Marine Biology, Karnataka University P. G. Centre, Karwar, 7 December 2013

Dr. M. A. Pradeep Short course on Recent Advances in Proteomics for Biomarker Discovery organised by Animal Biotechnology Centre, National Dairy Research Institute, 8-17 July 2013

Dr. Prathibha Rohit Technical Programme Discussion Meeting for review of the research projects as the invited Expert held under Board of Research in Nuclear Sciences (BRNS), Department of Atomic Energy BARC at Mumbai, 20 September 2013

Second meeting of the expert Committee for Comprehensive review of Deep sea fishing policy and guidelines at Chennai, 31 October 2013 and the third and fourth meetings at Krishi Bhavan, New Delhi, 22 November 2013 and 13 March 2014

Meeting of experts from fishery and marine biology and presented inputs for the proposed web based Karnataka biodiversity atlas at Malleshwaram, Bangalore, 6 December 2013

Annual Review meeting of SATTUNA Project at INCOIS, Hyderabad, 19 March 2014

Dr. Prathibha Rohit and **Dr. Shyam. S. Salim** Programme Advisory Committee meeting of the Department of Science and Technology for the project proposal presentation on 'Sustainable blue food security and carbon issues under a changing climate: Challenges in Australia and India' at New Delhi, 13 June 2013

Dr. D. Prema National Seminar on "Climate change scenario: Threats and Potential Impacts on Ecosystem" held at Morning Star Home Science College, Angamaly, 30 July 2013

Dr. G. B. Purushottama Training on "Communicating science through Mainstream Media" at National Academy of Agricultural Research Management (NAARM), Hyderabad, 17- 26 December 2013

Dr. K. Rajesh MDP Workshop on PME of Agricultural Research Projects at NAARM, Hyderabad, 19-23 November 2013

Dr. C. Ramachandran Meeting on 'Deep Sea Fishing Policies at CIBA, Chennai, 31 October 2013

Shri. L. Ranjith AusAID Ecotoxicology Training Workshop under Commonwealth Scientific and Industrial Research Organisation (CSIRO)-Indian Institute of Toxicology Research (IITR)-National Bureau of Fish Genetic Resources (NBFGR) project on "Safe Water for the Future" held at NBFGR, Lucknow, 2-6 December 2013

Dr. Rema Madhu and **Dr. Shoji Joseph** General Management Programme for Women Scientists sponsored by the Department of Science and Technology, Govt. of India, at ASCII Hyderabad, 21 October to 01 November 2013

Dr. Ritesh Ranjan Advisory Committee meeting of Hilsa project at Kolkata, 22 February 2014

Dr. Sandhya Sukumaran Expert consultation on "Fish Genomics Research in India: A Way Forward" organised by NBFGR, Lucknow, 2 August 2013

BOBLME/FAO/NBFGR International Harmonisation Workshop on Indian

Mackerel Genetics at NBFGR Kochi Unit, 20-27 August 2013

Shri. N. K. Sanil Orientation Training for the project on "National Surveillance Programme for Aquatic Animal Diseases" (NSPAAD) held at NBFGR, Lucknow, September 2013

Dr. B. Santhosh Training on DNA barcoding of aquatic organisms: a tool for molecular taxonomy at National Bureau of Fish Genetic Resources, Lucknow, 5 -14 February 2014

Dr. P. T. Sarada Training programme on Data analysis using SAS at CIFT, Kochi, 1-7 February 2014

Shri. R. Saravanan Refresher course on Integrated Coastal Management held at College of Fisheries, Mangalore, 28-31 October 2013

Comprehensive Management Action Plan Meeting for Gulf of Mannar Biosphere Reserve organised by Wildlife Warden, Ramanathapuram, 21 February .2014

Dr. T. V. Sathianandan Expert Committee meeting to study "Impact of trawl ban along Kerala coast" in the chamber of Hon. Minister for Fisheries, Government of Kerala at Trivandrum, 18 June 2013

Dr. T. V. Sathianandan and **Dr. K. G. Mini** 11th meeting of the Technical Monitoring Committee for the Central Sector Scheme on "Strengthening of Database and GIS for Fisheries Sector" of the Department of Animal Husbandry Dairying & Fisheries at The International Centre, Dona Paula, Goa and gave a presentation on Marine Fisheries Census 2015, 30 August 2013

Dr. T. V. Sathianandan and **Shri. S. Haja Najeemudeen** Pre-Census Workshop under the Central Sector Scheme on "Strengthening of Database and Geographical Information System for fisheries sector-Marine Fisheries Census" funded by DAHDF, Ministry of Agriculture, New Delhi at Mumbai Research Centre of CMFRI, 2-4 January 2014

Dr. T. V. Sathianandan, Dr. J. Jayasankar and **Dr. Somy Kuriakose** Meeting with the Joint Secretary (Fy), Department of Animal Husbandary, Dairying & Fisheries, Ministry of Agriculture at Krishi Bhawan, New Delhi, 6 March 2014

Dr. T. V. Sathianandan, Shri. Wilson T. Mathew, Smt. K. Ramani and **Shri. K. P. George** Pre-Census Workshop under the Central Sector Scheme on "Strengthening of Database and Geographical Information System for fisheries sector-Marine Fisheries Census" funded by DAHDF, Ministry of Agriculture, New Delhi at Madras Research Centre of CMFRI, 7-9 January 2014

Dr. Sekar Megarajan Training on "Development and Nano-sizing of Biotechnological Products for Fisheries and Aquaculture" at Central Institute of Fisheries Education, Mumbai, 5-25 February 2014

Dr. S. N. Sethi, Smt. M. Muktha and **Mr. S. Ramkumar** Awareness Workshop on "Challenges and Opportunities in Intellectual Property Management and Commercialisation of Technologies in Fisheries and Agriculture Sectors" held at NBFGR, Lucknow, 20 March 2014

Shri. K. R. Sreenath Hands-on training on "DNA barcoding and molecular taxonomy" at NBFGR Koch unit, 16-21 December 2013

Dr Shoba Joe Kizhakudan Interactive Trainer's training workshop on "Moving towards sustainability" organised by the Fishery survey of India at Chennai, 1-3 August 2013

Dr. Shubhadeep Ghosh Third Annual Review Workshop of the NFBSFARA at A. P. Shinde Symposium Hall, NASC Complex, Pusa, New Delhi, 21-23 July 2013

Meeting regarding the project "Stock characterisation, captive breeding, seed production and culture of Hilsa (Tenualosa ilisha)" funded by NFBSFARA, ICAR at CIFRI, Barrackpore, 27 July 2013

Dr. Subhadeep Ghosh and **Dr. Biswajit Dash** Second Advisory Committee meeting and inauguration at CIFRI, Barrackpore, 13 -14 April 2013

Dr. Shubhadeep Ghosh, Smt. M. Muktha, Shri. Loveson Edward and **Shri. N. Rajendra Naik** Interactive meeting with the President and the Executive Director, Scientific Committee on Oceanic Research (SCOR) at the Centre for studies on Bay of Bengal, Andhra University, 17 May 2013

Dr. Shyam. S. Salim 120th Meeting of the Academic Council at the Kerala Agricultural University, Vellanikkara, 3 April 2013

Delivered an interactive lecture on "Trade Agreements and Impacts in the Indian Fisheries Sector: Constraints and Prospects for the Graduate Students of Michigan State University as part of ongoing MSU-CMFRI partnership via Skype, 24 April 2013

Dr. Somy Kuriakose, Dr. K. G. Mini, Shri. J. Srinivasan and **Smt. Sindhu K. Augustine** Pre-Census Workshop under the Central Sector Scheme on "Strengthening of Database and Geographical Information System for fisheries sector-Marine Fisheries Census" funded by DAHDF, Ministry of Agriculture, New Delhi at Mangalore Research Centre of CMFRI, 16 -18 January 2014

Dr. Sujitha Thomas Workshop for Northern Indian Ocean under the auspices of UN at Chennai, 25-27 November 2013

International workshop under auspices of U.K. in support of regular process for global reporting and assessment at ESSO-NIOT, under MoES, Govt. of India, 27-28 January 2014

Dr. Sujitha Thomas and **Dr. Bindu Sulochanan** Refresher course on "Integrated coastal zone Management" at College of Fisheries, Mangalore, 28-31 October 2013

Dr. Sujitha Thomas and **Dr. Geetha Sasikumar** Training programme on "Finfish cage culture and bivalve farming" at the ICAR Research Complex for Goa and made presentations on "Estuarine cage culture and mussel farming" during11-12 February 2014

Dr. P. S. Swathi Lekshmi Short course on "Communicating science for the main stream media" at NAARM, Hyderabad, 17- 26 December 2013

Dr. V. Venkatesan NAIP Preparatory Cross Learning Evaluation Workshop held at ISI, Kolkata, 3-4 December 2013

Workshop on "Fisheries and Human Well Being at Gulf of Mannar" held at National Centre for Sustainable Coastal Management, Chennai, 30 September 2013

Dr. Veerendra Veer Singh Workshop on "Mud crab fishery management" organised by Marine Products Export Development Authority and delivered Key note address at Ulva, Moha Village, 21 June 2013

Raigad District Fisheries Council Meeting at Alibaug, 30 July 2013

TCE, NAIP and NFBSFARA project planning meetings at Delhi, with the DG, ICAR, Chairperson Empowered committee, Co-ordinators, project leaders and other project investigators, 8-9 January 2014

Appraisal meeting with World-Bank TTTL (Technical Team Task Leader) along with NAIP Project Team, 24 January 2014

Stakeholders' Workshop of NAIP Comp-III, Sub project "Strategies to enhance adaptive capacity to climate change in vulnerable regions" (World Bank -GEF) at IARI, New Delhi, 7-8 March 2014.

Dr. Vidya Jayasankar Workshop on 'Climate Change Studies: An Organismal Approach' conducted by Sathyabama University, Chennai and served as resource person, 27-28 March 2014

Dr. M. Vijayakumaran International Conference on "Small- Scale Fisheries Governance: Development for Wellbeing and Sustainability" at CESS, Hyderabad, 10-13 December 2013

Stakeholder consultation meeting at Regional Centre of CMFRI, Visakhapatnam in connection with the requirement of the Technical Committee (TC) to review the duration of the ban period and to suggest further measures to strengthen the conservation and management aspects, 6 January 2014

Stakeholder consultation meeting at the Fisheries Department, Government of Tamil Nadu, 10 January 2014

Inception Workshop of the Technical Cooperation Programme on Support to the Implementation of the Strategy for Fisheries Management for Sustainable Livelihoods (FIMSUL) at Chennai, 29 -30 January 2014

Integrating BIMSTEC 2014 "Focusing Fourteen Pillars of Cooperation" at Imphal, Manipur organised by Indian Chamber of Commerce (ICC) and delivered a lecture on "Evolving Ecosystem Based Fisheries Management in the Bay of Bengal-Opportunities and Challenges", 8 February 2014

Second meeting of the National Marine Fisheries Management Code (MFMC) Committee at CMFRI, Kochi, 18-19 February 2014

Stakeholder consultation meeting at Puducherry organised by the Fisheries Departments, Government of Puducherry and Tamil Nadu, 27 February 2014

Norman Borlaug Birth Centenary Dialogue "Take it to the Farmer" organised by the M. S. Swaminathan Research Foundation at Chennai, 13 March 2014

Dr. K. K. Vijayan "Pre-RMP programme" held at NAARM, Hyderabad, 26 November to 7 December 2013

Chaired the session on 'Marine Biotechnology and its Applications in Aquariculture' at 'International Seminar on Ornamental Fish Breeding, Farming and Trade' organised by Department of Fisheries, Govt. of Kerala at Cochin, 26-27 January 2014

Dr. K. K Vijayan and **Shri. N. K. Sanil** Launch workshop of the "National Surveillance programme for Aquatic Animal Diseases" held at NBFGR, Lucknow, 27-28 May 2013

Dr. Vinay D. Deshmukh Raigad District Fisheries Council meeting at Alibaug, 30 July 2013

Invited by Hon. Chief Minister of Maharashtra State to find out possible reasons of jelly fish and sting rays attack at Girgaon Beach during Ganapati immersion, 13 September 2013

Visited Ganapati immersion venue at Girgaon Beach on request of Commissioner Municipal Corporation of Greater Mumbai and Commissioner of Police, Mumbai to survey and create awareness about sting ray attack, 18 September 2013

Dr. K. Vinod National Stakeholder's meeting held at BOBP-IGO, Chennai under the IUCN–MFF Gulf of Mannar Regional Project entitled "Living Resources of the Gulf of Mannar: assessment of key species and habitats for enhancing awareness and for conservation policy formulation between Sri Lanka and India", 2 September 2013

Meeting of the National Task Force (NTF) of the BOBLME project held at Chennai, 3 October 2013

Pre-qualification Bid Evaluation meeting held at O/o Tamil Nadu Urban Infrastructure Financial Service (TNUIFSL), Chennai for evaluating bid and project reports in setting up of World Class Oceanarium at Mammallapuram under PPP mode through TNTDC and Department of Fisheries, Govt. Tamil Nadu, 17 December 2013

Third meeting of Task Force for the conservation of dugongs held at Ministry of Environment and Forests, New Delhi, 25 March 2014

Dr. K. Vinod, Dr. Joe K. Kizhakudan, Dr. Vidya Jayasankar, Smt. Hemasankari, Dr. R. Geetha, and **Ms. Indira Divipala** National Seminar on "Development of fisheries in water deficient regions" organised by Fisheries Technocrats Forum at Central Institute of Brackishwater Aquaculture, Chennai, 25-26 February 2014

Dr. V. P. Vipinkumar Management Development Workshop on Technology Management for Researchers at NAARM, Hyderabad, 28 February to 6 March 2013

Consultative Workshop at MANAGE, Hyderabad, 20-21 June 2013

Dr. P. U. Zachariah First meeting of the committee to review the duration of the fishing ban period, 12 July 2013

Dr. P. U. Zacharia and **Dr. Rekha J. Nair** NCRA Annual Review Workshop held at IARI, New Delhi, 17-19 June 2013

Dr. P. U. Zachariah, Dr. R. Narayanakumar, Dr. T. V. Sathianandan, Dr. J. Jayasankar, Dr. V. V. Singh, Dr. Prathibha Rohit, Dr. I. Rajendran, Dr. Grinson George, Dr. B. Johnson, Shri. Gyanaranjan Dash, Shri. K. R. Sreenath, Dr. Amir Kumar Samal, Smt. Anulekshmi Chellappan, Ms. Karthireddy Syamala, Shri. Vinay Kumar Vase, Shri. L. Renjith, and **Shri. N. Rajendra Naik** Preparatory Workshop on the project on "Remote Sensing Assisted Biodynamic Forecasting Paradigm for Indian Marine Fishery Resources (ChloRIFFS)" at Space Application Centre, Ahmedabad, 8-9 July 2013

Dr. P. U. Zacharia, Dr. V. Kripa, Dr. K. K. Vijayan, Dr. T. V. Sathianandan, Dr. A. P. Dineshbabu, Dr. Sujitha Thomas, Dr. P. S. Asha, Dr. Somy Kuriakose, Dr. V. P. Vipinkumar, Dr. C. P. Suja, Dr. Shyam S. Salim, Dr. T. M. Najmudeen, Dr. Rekha J. Nair, Dr. K. G. Mini, Dr. N. Aswathy, Dr. Shubhadeep Ghosh, Dr. Rekha Devi Chakraborty, Dr. Sandhya Sukumaran, and **Shri. K. R. Sreenath** Second International Conference on "Ecosystem Conservation, Climate change and sustainable development (ECOCASD-2013)" organised by the Department of Aquatic Biology and Fisheries, University of Kerala and Ambo University, Ethiopia at Thiruvanathapuram, 3-5 October 2013

Deputation abroad

Dr. E. M. Abdussamad Workshop on "Fish Otolith-based ageing and stock assessment 2013" organised by the Fisheries Support Unit (FSU) of "Indian Ocean Rim Association for Regional Co-operation (IOR-ARc)"

at Marine science and Fisheries Centre (MSFC), Muscat, Oman, 23-31 October 2013

Dr. A. P. Dineshbabu Workshop on 'Tropical Trawl Fishery Management" conducted by Asia Pacific Fisheries Commission and FAO at Phuket, Thailand, 30 September to 4 October 2013

Dr. Divu Damodaran Training under the HRD programme of NAIP, ICAR at University of Stirling, U. K., October 2013 to January 2014

Dr. G. Gopakumar Sub-committee on Marine Science and Technology (SCMSAT) in the 65th meeting of the ASEAN Committee on Science & Technology at Philippines, 20-21 May 2013

Dr. Grinson George Training in the area of Carbon Sequestration (Fisheries Sciences) under the HRD programme of NAIP, ICAR at Plymouth Marine Laboratory, U. K., 17 October 2013 to 15 January 2014

Dr. Jayasree Loka Training under the HRD programme of NAIP, ICAR at NOVA University, Florida, USA, October 2013 to January 2014

Dr. K. S. Mohamed Developing World Working Group (DWWG) meeting of the Marine Stewardship Council (MSC) at Lisbon, Portugal, 8-9 December 2013

Meeting of Technical Advisory Board (TAB) of the Marine Stewardship Council (MSC) in London, 8-12 April 2013

Ecosystem characterisation meeting organised by BOBLME Project of Food and Agriculture Organization (FAO) in Phuket, Thailand, 10-12 February 2014

Dr. T. M. Najmudeen Short training course on "Climate change governance. Adaptation and mitigation as institutional change processes" organised by Wageningen University, Netherlands, 2-13 September 2013

Dr. M. A. Pradeep Training in the area of Transgenic Animals (Fisheries Science) under the HRD programme of NAIP, ICAR at University of Alabama, Birmingham, USA, 11 November 2013 to 8 February 2014

Dr. Prathibha Rohit and **Dr. E. M. Abdussamad** Third Working Party on Neritic Tunas (3WPNT) organised by the Indian Ocean Tuna Commission (IOTC) at Bali, Indonesia, 2-5 July 2013

Dr. Shyam S. Salim visited Michigan State University (MSU), Michigan, USA as a visiting faculty member under the Visiting Scholars to Advance Science Grants (VISTAS) programme, 6 -13 January 2014

Dr. K. S. Sobhana BBSRC-DBT Panel meeting on Farmed Animal Health and Disease at London, U. K., 5-6 September 2013

Dr. Somy Kuriakose and **Dr. K. G. Mini** BOBLME-IOTC Fisheries Stock Assessment Training Workshop organised by the Bay of Bengal Large Marine Ecosystem Project and the Indian Ocean Tuna Commission at Bangkok, Thailand, 20-24 May 2013

Dr. P. Vijayagopal Department of Biotechnology (DBT), Govt. of India, Cutting Edge Research and Training (CREST) Fellowship Award at Temasek Polytechnic, Singapore, 23 December 2012 to 22 December 2013. Also attended The Aquaculture Roundtable Series (TARS) 2013 and the Trade Show Aqauarama 2013 at Singapore, the period

Dr. P. U. Zacharia BOBLME Marine Protected Area (MPA) working Group Meeting at Penang, Malaysia and presented the status and updates on "MPA and fish refugia after 2012 in India", 11-12 February 2014

Krishi Vigyan Kendra, Narakkal

Dr. Shoji Joy Edison Training on "Technology transfer of vegetable micronutrient mixture" at IIHR Bangalore, May 2013

Smt. P. Sreeletha Entrepreneurship development programme at MSME, Ettumanur, Kottayam Distirct, November to December 2013

Training on Technology for Neem soap preparation at IIHR, Bangalore, May 2013

Dr. Vijendra Kumar Meena Training on "Technology transfer of banana micronutrient mixture" at IIHR Bangalore, May 2013

Dr. P. A. Vikas CMFRI-SAARC International Workshop on "Status of good practices and lessons learnt in aquaculture in the SAARC region" at CMFRI, Kochi, 5-7 June 2013

Winter School on "ICT-oriented Strategic extension for responsible fisheries management" organised by Socio-economic evaluation and technology transfer Division of CMFRI at Kochi, 5-25 November 2013

Zonal level sensitisation Workshop on "Foot and Mouth Disease and its management" organised by IVRI Regional Station, Hebbal, Bangalore, 1 February 2014

Training on "Environmental Impact assessment" organised by Cochin Municipal Corporation and SCMS at SCMS Cochin School of Business campus, Aluva, Ernakulam, 21- 22 February 2014

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