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CMFRI

Largest Fisheries Institute in the world

वार्षिक प्रतिवेदन
Annual Report
2012-13

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(Indian Council of Agricultural Research)
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Contents

Mandate

- To monitor the exploited and assess the under-exploited of the 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 data base
- To conduct transfer of technology, post-graduate and specialized training, education and extension-education programmes
- To provide consultancy services

Preface

Our journey towards bringing about a sustainable marine fisheries management regime coupled with sustained increase of bio-mass from the sea through mariculture witnessed many unprecedented challenges, which were met successfully, because of our missionary zeal and team work.

Being the largest marine fisheries research institute in the world, achieving a near precise assessment of the harvestable marine fishery resources potential in the Indian EEZ and a possible mechanism to forecast the future availability has been the most important challenge before us. To meet the challenge, CMFRI has initiated a collaborative research programme with Space Application Centre of Indian Space Research Organization (ISRO) to utilize the remote sensing data on chlorophyll availability in the Indian Ocean for developing models for this purpose. The concept was not new, as we are only rejuvenating the attempt made by our peers four decades ago

We have developed successfully two marine bio-molecules of neutraceutical value namely GMe and GAe, which were commercialized during this period. This will be an affordable and safe alternative in place of costly imported drugs.

As a prelude to usher in 'green auditing and accounting', which is about to be implemented by the Government, CMFRI estimated the value of the ecosystem services and natural capital. The health of the eco-system is also given due importance through periodical assessment of pollutants and the various hydrographical parameters. CMFRI is making all efforts to promote the concept of "Green Economy" in the coastal villages by strategising new forms of participatory collaboration with grassroots level institutions.

The establishment of National marine fish brood bank is complete along with state of the art Recirculation Aquaculture system (RAS), which is a landmark for encouraging quality seed production for increasing fish production through Mariculture.

The success of any research finding is deemed to have been realized only when the ultimate end user recognizes and gets benefit out of it. CMFRI's cage culture technologies and successful demonstration of farming of various marine fishes have motivated the coastal entrepreneurs to successfully undertake the venture on their own. The success stories include the pompano culture at Nagayalanka (Andhra Pradesh), small scale lobster farming at Vasai (Mumbai) & Veraval (Gujarat), cage farming of mullet in Kerala, lobster farming and many to follow. The "sidi" tribes of Somnath (Veraval) earned about Rs.15,000 per family per month through cage culture implemented under the Tribal sub plan (TSP). They are bound to earn more, when they go for the second crop next season.

The valuation of marine fish landings and analysis of price behaviour of marine fish varieties across the seasons provided the base for assessing the contribution of fisheries to the national income of the country. The guidelines for better implementation of the responsible fisheries management are also being formulated.

In addition to the above land mark achievements, CMFRI's visibility increased through the eprints@CMFRI, the open access repository of our staff members' publications. More than10,000 articles have been uploaded and our Institute ranks 2nd in Indian Open Access Repositories and 354 at global level. Our untiring efforts in the scientific publications has resulted in the improvement in the NAAS rating of Indian Journal of Fisheries, which increased from 4.9 to 6.2 and also we got the International Impact Factor of 0.195.

An institution is recognized not only by the visible infrastructure but also by the intangibile substructure of human capital that subsumes it. On this account, the "Team CMFRI" deserves full compliments for the achievements and progress made during the last year in all fields of marine fisheries research and management. I also wish to avail this opportunity to sincerely acknowledge the unstinted support received from the Director-General ICAR and all the members of CMFRI.

1st June 2013
Kochi

G.Syda Rao
Director

EXECUTIVE SUMMARY

CMFRI made significant contribution to marine fisheries and mariculture during 2012-13 through its systematically formulated research projects. The projects covered 11 themes chosen as the priority areas of research for the 12th Five Year Plan period.

Annual marine fish landings for India registered an all-time high of 3.94 million metric tonnes during the year 2012, compared to 3.82 million tonnes during 2011 showing 3.4% growth. Kerala is the highest contributor towards production with 8.4 lakh tonnes, crossing eight lakh tonnes for the first time. All maritime states and union territories except West Bengal and Odisha witnessed an increase in production during 2012 compared to the previous year. In region-wise landings, southwest region comprising Kerala, Karnataka and Goa contributed maximum with 13.9 lakh tonnes (35.1%) followed by northwest region with 11.5 lakh tonnes (29.2%), southeast region 10.1 lakh tonnes (25.5%) and northeast 4 lakh tonnes (10.2%). Sector wise contribution to all India marine fish landings indicated the dominance of mechanized vessels catching 30.8 lakh tonnes followed by motorized vessels with a catch contribution of 7.8 lakh tonnes and non-motorized vessels contributing a meager 0.8 lakh tonnes. In group-wise resources, pelagic finfishes contributed major share with 54%, demersal accounting 28%, crustaceans13% and molluscs 5%. *Sardinella longiceps* (Oil sardine), continued to be dominating species, as in the previous year with a contribution of 18.2% and registered an increase of 1.8% than 2011. Other important resources contributed to the total landings were perches (8.6%), penaeid prawns (6.4%), ribbonfishes (6.0%) and carangids (5.5%). Analysis of quarterly marine fish landings data indicated that fourth quarter witnessed peak fishing activity with nearly 13.3 lakh tonnes of harvest followed by first quarter with 10.6 lakh tonnes, third quarter producing nearly 9 lakh tonnes and second quarter the least with 6.5 lakh tonnes.

The total marine fish landings along the Kerala coast was 8.39 lakh tonnes recording an increase of 12.9% than 2011. The pelagic resources contributed 73.4% of the total landings and the overall increase recorded was due to the increased production by pelagic resources like oil sardine (+24.1%), *Stolephorus* (+ 49.1%), other sardines (+84.2%), scads (+57.4%), and other clupeids (+68.3%). In Lakshadweep, the estimated total fish landing in 2012 was 7,683 tonnes, recording an increase of 19.5% than 2011. The tunas contributed to the major share of fishery (71.5%) and the important species were *Katsuwonus pelamis, Thunnus albacares*, *Euthynnus affinis, Auxis thazard* and *Gymnosarda unicolor*. The annual estimates of marine fish catch in Karnataka and Goa during 2012 showed that the catch was increased by 21.7% and 23.7% respectively than the preceding year. The mechanized sector formed the major contributor of catch both in Karnataka and Goa; in Karnataka it was dominated by trawlers, while in Goa 82% of the catch was by purse-seines. The pelagic fishes comprised the bulk of the marine landings in Karnataka (56.3%) & Goa (86.1%) and oil sardine was the dominating species in both the states. The marine fish landings in Maharashtra during 2012 were estimated at 3.15 lakh tonnes recording only a marginal increase of 2.5% than in 2011. During the year, pelagic resources registered 13.4% decline while demersal finfishes, crustaceans and molluscan resources recorded 5.1%, 14.7% and 41.2% increase over the last year respectively. It is noteworthy to mention that oil sardine (*S. longiceps*) and Indian mackerel (*Rastrelliger kanagurta*) have emerged as the major species in Maharashtra like 2011, relegating traditional Bombayduck to 6th position. The estimated marine fish production from Gujarat was 6.90 lakh tonnes showing an increase of 9.14 % over 2011. Almost all the major resources recorded positive growth except the Elasmobranch resources.

The southeastern states of Tamil Nadu and Andhra Pradesh recorded an increase in the total estimated landings than in previous year and their contribution was 7.1 lakh tonnes and 2.83 lakh tonnes respectively in 2012. Pelagic finfishes contributed maximum share in the landings in both states. Oil sardines formed the major contributor in Tamil Nadu, while in Andhra Pradesh it was lesser sardines. The mechanized sector continued to be the major contributor to the landings in Tamil Nadu (69.9%) and Andra Pradesh (50%). The

estimated marine fish landings in states of West Bengal and Odisha experienced a drastic decline during 2012. The landings were 1.6 and 2.4 lakh tonnes respectively, compared to 3.7 and 3.2 lakhs tonnes during 2011. In Odisha, major share was contributed by carangids (26,318t) and in West Bengal it was by clupeids (10,358t).

Microsatellite markers were developed to study the population genetic structure of Indian oil sardine, *S. longiceps*, *R. kanagurta* and *Perna viridis* from the southern coast of India. Successful recombinant expression and purification GIH-GFP fusion protein (rPmGIH-GFP) of *Peneaus monodon* achieved. Molecular characterization of vitellogenin in the sand lobster *Thenus unimaculatus* initiated. Tissue culture experiments initiated with mantle tissue of green mussel (*Perna viridis*). Primary culture of embryonic stem cells from midblastula stage embryos of the orange clown fish *Amphiprion ocellaris* was attempted.

Nutritional evaluation of feed formulated with cassava leaf protein concentrate (LPC) indicated potential use of LPC as a cheap source of fishmeal replacement at 20% level, in ornamental formulated feeds.

Pathogen profiling in cage farmed finfish (cobia, pompano & red snapper), lobsters and marine ornamentals continued. Epidemiological studies on the host range of *Perkinsus* spp. infecting bivalves in India, indicated 2 more new bivalve hosts (*Villorita cyprinoides* and *Donax cuneatus*) taking the host range to 15 bivalve species.

Fifteen cell lines out of the 29 continuous cell lines established from 5 species of marine food fish (Cobia-*R. canadum*; honey comb grouper-*E. merra*; the rabbit fish-*S. canaliculatus*; Malabar grouper-*E. malabaricus* & Pompano-*T. blochii*) and 3 species of marine ornamental fishes (three spot damsel-*D. trimaculatus*; caerulean damsel-*P. caeruleus* & clown fish-*A. percula*) have been characterised. The cell lines will be deposited in the National Repository for Fish Cell Lines (NRFC) at NBFGR, Lucknow for distribution to end users.

Screening of sponge-associated bacterial isolates for antimicrobial activity indicated positive results. Secondary metabolites from the squid, *Loligo duvacelli* and the edible oyster *Crassostrea madrasensis* were characterized for bioactive principles. The presence of pro-inflammatory prostaglandins PGE2 and PGF2-α were identified in green mussel *P. viridis* and confirmed by co-chromatography with the PG standards.

Two nutraceutical products (Cadalmin™ Green Algal extract and Cadalmin™ Green Mussel extract) for use against arthritis/joint pain have been commercialized to the private partners under ITMU of CMFRI. Cadalmin™ Green Algal extract has been commercialized with Celestial Biolabs Limited, a Hyderabad based Pharmaceutical Company and Cadalmin™ Green Mussel extract (Cadalmin™ GMe) has been commercialized with Accelerated Freeze Drying Company Pvt. Ltd., a FDA, ISO 22000 FSSC 22000:2011 certified flag Ship Company of Amalgam Group of Companies. Detailed evaluation of toxicity studies of Cadalmin™ Green Algal extract (Cadalmin™ GAe) using laboratory animal models proved, GAe could be safely taken against joint pain and arthritis, without any side effects.

The hydrologic variations of the inshore waters were assessed as per the United States Environmental Protection Agency (USEPA-2004) guidelines and sea water quality index (SWQI) was worked out for selected areas along the Indian coast. This index can be used as a gauge for the health of the coastal environment. Habitat restoration protocol had been developed for clams in Dakshina Kannada in Karnataka. Successful participatory mangrove restoration experiments in relation to fishery were conducted in Kerala and in Karnataka.

Exploratory analyses on the persistent occurrence of Potential Fishing Zone (PFZ) in the SE Arabian sea clearly indicated that the nearshore regions of the Arabian Sea off Kerala with depths less than 50m recurred more in the PFZ advisory maps than the mid continental shelf region and the continental slope. Also, the northern regions of Kerala had persistent PFZ areas especially in the region between Calicut and Kannur. The relatively high river discharges in the area and presence of high nutrient content in the discharges due to high mangrove afforestation are likely causes for the persistent occurrence of PFZs in these regions.

The assessment of spawning behavior of major fish species in marine environments with a view to harness the beneficial effects of temperature showed that for *Nemipterus japonicas*, SST (Sea Surface Temperature) of >26°C was found to be the preferred temperature for the spawning and for thread fin breams, SST between 27.5-28°C was the optimum. Skipjack tuna abundance is more in the inshore areas of 50m depth zone during the winter months (November-January) whereas it is near 100m zone during summer

months (March-May). A historical environmental database(1960-2011) was developed, which would be useful for linking fishery production analysis.Vulnerability assessment was conducted based on demography, infrastructure, occupation, climate, fisheries for the selected coastal districts of Tamilnadu and Kerala.

CMFRI has designed and established artificial reefs at fifty places along Tamil Nadu coast to enhance the sustainability of artisanal fisheries and increasing the natural productivity. In all places there was increase in fish capture with catch rates even going up to 10 times. This also can be considered as an alternative rehabilitation option while allaying the fears of developmental activities like establishment of nuclear plants.

Attempts taken to explore the marine biodiversity of reef fishes off Kerala and Tamil Nadu coasts, accounted around 89 species under 19 families from various gears and recorded six new emerging species in the fishery. In *Ilha Grande*-Goa, coral fish abundance estimates were done using underwater visual census (UVC) technique using belt transect by SCUBA diving in three sites. A total of 202 species of coral reef fishes belonging to 53 families were recorded from Gulf of Mannar and 45 species belong to 23 families, along Visakhapatnam coast.

Experimental farming of finfishes in marine cages gave encouraging results at Karwar and Mandapam for Asian seabass-*Lates calcarifer*, Cobia-*Rachycentron canadum*, Pompano-*Trachinotus blochii*, Snappers-*Lutjanus argentimaculatus*, *L. russeli* & *L. johni* and Sea bream-*Acanthopa gruslatus.*

At Mariculture hatchery of Visakhapatnam sex reversal (female grouper to male) *Epinephelus tauvina* (Greasy grouper) was achieved with the hormonal & enzymatic manipulation. Also successful spawning, larval rearing, spat settlement and nursery rearing of green mussel *Perna viridis* was achieved at the centre. At Mandapam, Broodstock development and successful breeding of Fire clown fish, *Amphiprion ephippium* was achieved.

The estimated value of marine fish landings at landing centre level was worked out at ` 24,890 crores in 2012, showing an increase of 2.13% over 2011. At the retail level, the estimated value was ` 38,562 crores registering an increase of 1.07% over the year 2011. The unit price of fish was ` 74.17 per kg at first sales and `111.92 per kg at last sales in India for the year 2012. The fishermen's share in the consumer's rupee varied from 45.59% for Bombay duck to 84.12% for pomfrets.

CMFRI conducted 47 human resource development programmes in 2012 which were attended by 759 outside participants. About 110 staff of CMFRI attended 54 training programmes conducted by other organization.

Krishi Vigyan Kendra (KVK) attached to CMFRI conducted on farm trials on six various aspects and five front line demonstrations during 2012-13. Apart from the regular training programme and exhibitions, KVK initiatives included packages and tools to rejuvenate *pokkali* farming, campaign on safe curry leaf production, D-Cowl programme for waste land utilization, participatory vegetable seed production, market linkage for maize, soil health camps and soil fertility map, conservation of indigenous cattle breeds of Ernakulam district, rearing of indigenous poultry-*Kadaknath*, open precision farming unit at Thevara campus and low cost media for nursery raising of vegetable seedlings.

CMFRI bagged the highest award for Official Language Implementation the Indira Gandhi Rajbhasha Shield in Region 'C' for the year 2010-'11.

The institute executed 32 in-house, 15 externally funded and 13 consultancy projects during 2012-13. Collateral attainments of these research endeavours were amply reflected by 101 research papers in peer reviewed journals, 43 technical articles, 27 popular articles and 4 books.

About CMFRI

CMFRI, Kochi

The Central Marine Fisheries Research Institute (CMFRI), one of the eight national fisheries institutes under ICAR, through its research and developmental activities in marine fisheries during the last five decades has been able to sustain the marine fish production through development and implementation of resource management strategies and policy advisories to the Govt. of India for fisheries governance. The Institute has been responsible for developing time series database on marine fish production from the Exclusive Economic Zone (EEZ) of the country, their biology, distribution, abundance, fishery forecast, potential yield, stock assessment and in formulating management measures for sustainable production. The Institute has developed and commercialized two nutraceuticals, Cadalmin™ GMe and Cadalmin™ GAe

▲ Head Quarters, Kochi

Mandapam Regional Centre

The regional centre at Mandapam, true to its history of pre-eminence in mariculture research, achieved yet another major breakthrough in Cobia and Silver Pompano breeding with the achievement of seed production. Adoption of suitable broodstock feeding regimen resulted in the successful broodstock maturation of Cobia in sea cages for the first time in India. Methods for induced breeding were also developed and successful spawning and larval production were achieved. The hatchery production of Cobia fingerlings is bound to pave way for large-scale cage farming of Cobia in our country.

▲ Research and administrative block at Mandpam RC

Visakhapatnam Regional Centre

Amongst other activities successfully carried forward by this Centre, which is vested with the responsibility of studying the long and challenging north east coastal region of our country, a stand out achievement of breeding success in Greasy Grouper (*Epinephelus tauvina*) for the first time in the annals of Indian mariculture research was recorded this year.

▲ Mariculture Lab at Visakhapatnam RC


▲ Veraval Regional Centre


▲ Modular Biology Lab at Mumbai RC


▲ Karwar Research Centre


▲ Mangalore Research Centre


▲ Calicut Research Centre


▲ Vizhinjam Research Centre


▲ Tuticorin Recearch Centre


▲ Kovalam Field Centre

Veraval Regional Centre

The highlight of this bustling centre situated at the heart of Saurashtra region was the success realised by the Tribal Sub Plan (TSP) project on establishment of open sea cage farms for sidiadivasi tribes of Gujarat. On a pilot basis a sea cage farm was established off Somnath in the Arabian Sea with the full-fledged cooperation of the target group. The seasoned cage culture technology of CMFRI was comprehensively transferred to the target group, with their association graduating to partners/ owners level even while they were working in the cage sites. The harvest of the crop which took place after about 110 days resulted in an income equivalent to Rs. 15,000/- per month per family. This epoch making intervention resulted in the enhancement of the near penury livelihood of the tribal group to a healthy level of sustenance.

Mumbai Research Centre

The centre operates the m-Krishi® Fisheries Service in 13 villages of Raigad District of Maharashtra under the NAIP Scheme on Strategies to enhance adaptive capacity to climate change in vulnerable regions.

Karwar Research Centre

The National Consultation on Integrated Development of Uttara Kannada District was held at Karwar on 1st September 2012. This is the first time such an interactive meeting is held in the country. The meeting provided an excellent platform for the integration of scientific developments with traditional know-how and to identify ways and means for the holistic and efficient approaches to increase food production from agriculture, horticulture, floriculture, livestock, poultry and fisheries in Uttara Kannada District. As the outcome of the deliberations, a project 'Uthran' for the integrated agricultural development of Uttara Kannada was proposed, which will be coordinated by CMFRI.

Mangalore Research Centre

The Centre is making a good progress on GIS based resource mapping of distribution and abundance of fin fishes and shellfishes of Indian coast and will be focusing on resource mapping in this plan.

Calicut Research Centre

Studies on culture of *Etroplus suratensis* and red snappers were conducted.

Vizhinjam Research Centre

Survey and inventorying of bio-resources like corals and sponges are studied. Coral diversity and growth, fish assemblages and sponges associated with patchy coral reefs in South India are investigated using Line Intercept Transect (LIT) and visual census methods.

Tuticorin Research Centre

The Centre carries out studies on technology development for seed production of clams *Paphia malabarica* and pearl oyster *Pinctada fucata*. Fisher women got trained implantation in marine pearl culture. A new laboratory building was inaugurated.

Chennai Research Centre

The Chennai centre received a shot in its research arm with the inauguration of a new Marine Hatchery-cum- Research Complex at Kovalam Field Laboratory. The centre has bagged projects, which aim at installation of Artificial Reefs in the coastal waters of Tamil Nadu, which are aimed at boosting the fishermen income.

Fishery resource monitoring and forecasting

Marine fish landings, estimated based on the stratified multistage random sampling design developed by CMFRI, indicate a prospective growth in marine fish landings along the coastal waters of India. During this estimation, landing centres and fisheries harbours in 9 maritime states and 2 union territories were covered. The marine fish landings for Kutch district in Gujarat included in the data is provisional estimate.

During 2012, the sampling frame for the estimation of marine fish landings were updated by re-organizing the landing centres constituting different strata in a zone. The monthly gear-wise estimate for each species is generated for each fishing zone, which forms the basic geographic unit for generating state wise and all India estimates. The database, maintained at National Marine Fish Data Centre of CMFRI, was updated for 2012 with information on individual species level estimates of landings and gear-wise fishing effort, both in terms of number of units operated and hours of operation.

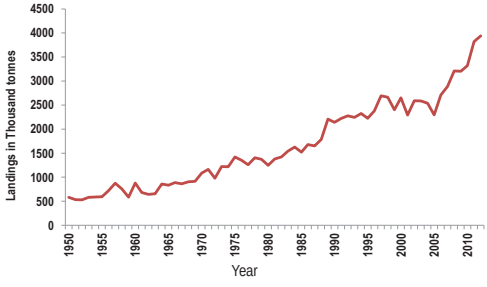
Marine fish landings of 2012 hits an all-time high

- Annual marine fish landings for India registered an all-time high of 3.94 million metric tonnes during the year 2012. Kerala is the highest contributor towards production with 8.4 lakh tonnes, crossing eight lakh tonnes for the first time.

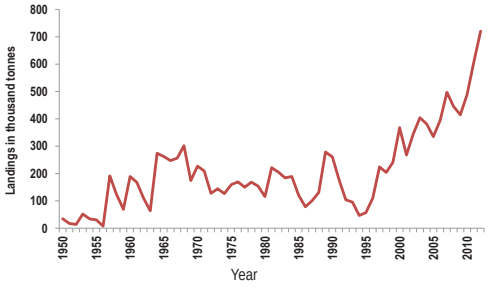
Other salient features

- Estimates of marine fish landings during 2012 for all India is 3.94 million tonnes compared to 3.82 million tonnes during 2011 showing 3.4% growth.
- Contribution from the four regions: northwest 11.5 lakh tonnes (29.2%), southwest 13.9 lakh tonnes (35.1%), southeast 10.1 lakh tonnes (25.5%) and northeast 4.0 lakh tonnes (10.2%)
- Important resources that contributed to the total landings are oilsardine (18.2%), perches (8.6%), penaeid prawns (6.4%), ribbonfishes (6.0%) and carangids (5.5%).
- Contributions from pelagic, demersal, crustacean and molluscan resources are 21.3, 11.2, 5.0 and 2.0 lakh tonnes respectively.
- Sector-wise contribution to all India marine fish landings indicate the dominance of mechanized vessels catching 30.8 lakh tonnes followed by motorized vessels with a catch contribution of 7.8 lakh tonnes and non-motorized vessels contributing a meager 0.8 lakh tonnes.

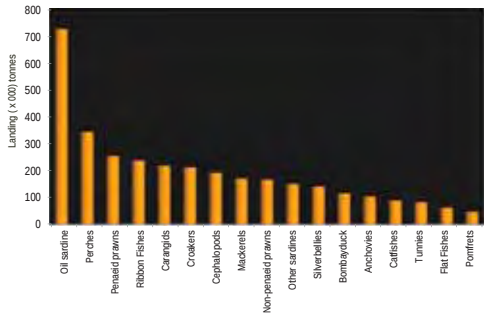
State-wise marine fish landings in India during 2012



Estimated marine fish landings in India from 1950 to 2012



Oilsardine landings in India from 1950 to 2012



Oilsardine landings in India from 1950 to 2012

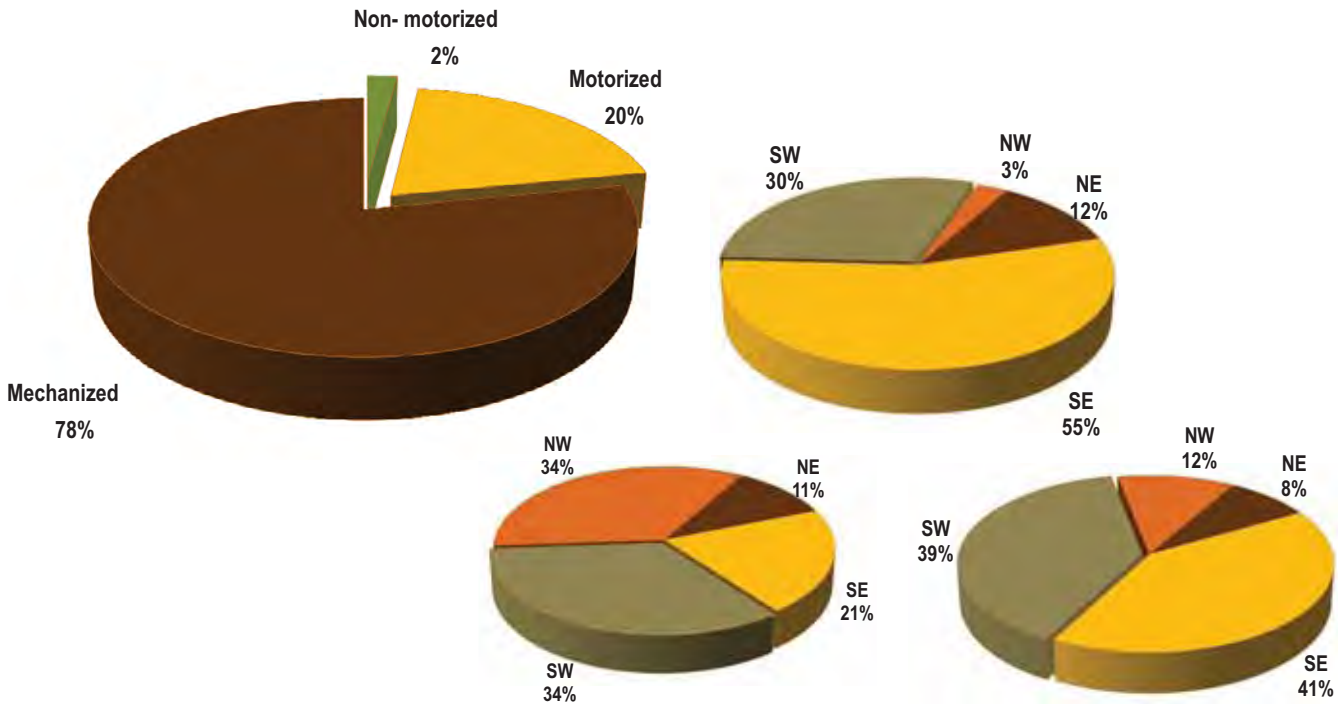
- Analysis of quarterly marine fish landings data indicate that fourth quarter witnessed peak fishing activity with nearly 13.3 lakh tonnes of harvest followed by first quarter with 10.6 lakh tonnes, third quarter producing nearly 9 lakh tonnes and second quarter the least with 6.5 lakh tonnes.

Resource abundance in marine fish landings

Indian oilsardine dominated the marine fish landings with a recorded new peak of 7.2 lakh tonnes. Other major drivers for the hike in production are the landings of threadfin breams (perches), penaeid prawns, ribbonfishes, carangids, croakers and cephalopods. Hilsa landings from West Bengal witnessed a heavy decline from 83,000 tonnes in 2010 to 20,000 tonnes in 2011. In 2012 also, the commercial fisheries landings of Hilsa along the Indian coast has dropped further to 9,981 tonnes. Indian mackerel also has shown a heavy decline from 2.8 lakh tonnes in 2011 to 1.7 lakh tonnes in 2012. Pelagic resources continued to be dominant with oilsardine contributing to the major chunk followed by carangids. The share of major contributors to the demersal, crustacean and molluscan fishery resources in 2012 is also depicted.

Sector-wise production pattern

Mechanized vessels were the major contributor to the fishery in comparison to their motorized and non-motorized counterparts. The effort expended in the fishery along the coast during 2012 indicates that the increased production is an outcome of a comparatively less effort than 2011. Northwest region is having a major share of fishing effort from mechanized vessels followed by southwest region. Motorized and non-motorized efforts in fishing are mainly from the southern coasts.



Contribution of various sectors to the marine fish landings of India during 2012

Region-wise landing patterns

All maritime states and union territories except West Bengal and Odisha witnessed an increase in production during 2012 compared to the previous year. The region-wise and resource wise significance are discussed below:

Northwest coast: Comprising the maritime states of Gujarat, Maharashtra and the UT of Daman & Diu, the marine fish landings for NW coast for the year 2012 is 11.5 lakh tonnes as against 10.3 lakh tonnes in 2011 recording 12.2 % growth. Gujarat with 66% of share in the landings is leading the region followed by Maharashtra with 27% and UT of Daman & Diu with 7%.

Southwest coast: The southwest region, consists of maritime states of Kerala, Karnataka and Goa, is the largest contributor to the total marine fish landings in India. The estimated landing during 2012 is 13.86 lakh tonnes, which forms about 35.1% of the all India landings. The maximum contribution was from Kerala (61%), followed by Karnataka (34%) and the remaining was from Goa. As compared to the estimates of 2011, an increase of about 1.75 lakh tonnes is noticed in this region.

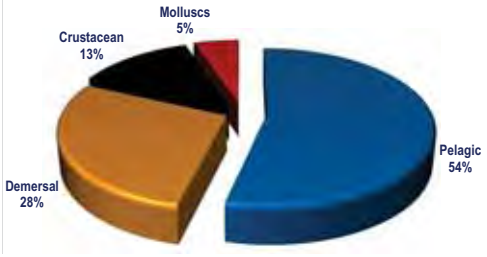
Southeast coast: Comprising the maritime states of Andhra Pradesh, Tamil Nadu and Puducherry, the marine fish landings for southeast coast for the year 2012 is 10.06 lakh tonnes as against the estimate of 9.12 lakh tonnes in 2011 recording 10% growth. State-wise contribution towards all India fish landings shows 8% share from Andhra Pradesh, 16% from Tamil Nadu and 1% from Puducherry.

Northeast coast: The maritime states of West Bengal and Odisha constitute the northeast region of India. The estimated marine fish landings in the region experienced a drastic decline from 6.9 lakh tonnes in 2011 to 4.0 lakh tonnes in 2012. The landings in West Bengal and Odisha are 1.6 and 2.4 lakh tonnes respectively, during 2012 compared to 3.7 and 3.2 lakhs during 2011.

Deep sea fishery resources of the continental slope of Indian EEZ and Central Indian Ocean

The taxonomically difficult complex of Plesionika 'narval' group comprising 14 species found in the deep sea (> 200 m depth) was studied using standard taxonomy as well as molecular DNA tools. The occurrence of *Plesionika quasigrandis* as the dominant species in the deepsea shrimp fishery along the southwest coast of India was confirmed (NCBI GenBank Accession number JF340436). Distribution pattern of deepsea fishes indicated three major clusters of distribution, namely upto 400 m, 401 – 1000 m and > 1000 m. Certain species like *Bathyuroconger vicinus* and *Alepocephalus bicolor* had wide distribution in terms of depth (200 - >1000 m), while species like *Anoplogaster cornuta* and *Aristaeopsis edwardsiana* were found only beyond 800 m depths. *Chlorophthalmus* spp. were predominant in the 200 – 400 m depths while the eel *Gavialiceps taeniola* was most abundant in the 400 -600 m depths.

Species like *Chlorophthalmus agassizi*, *Neoepinnula orientalis* and *Priacanthus hamrur* exploited a wide range of prey and most of the species in the 200-500 m depth zone fell in the trophic guild of macronekton foragers with a varied diet of planktonic crustaceans (mysids, euphausiids and decapods), cephalopods, chaetognaths, myctophids and other mid-water fishes. Piscivory was common among the large fishes of the 200 - 800 m depth zone while deepsea squids were comparatively rare in the diet of deepsea

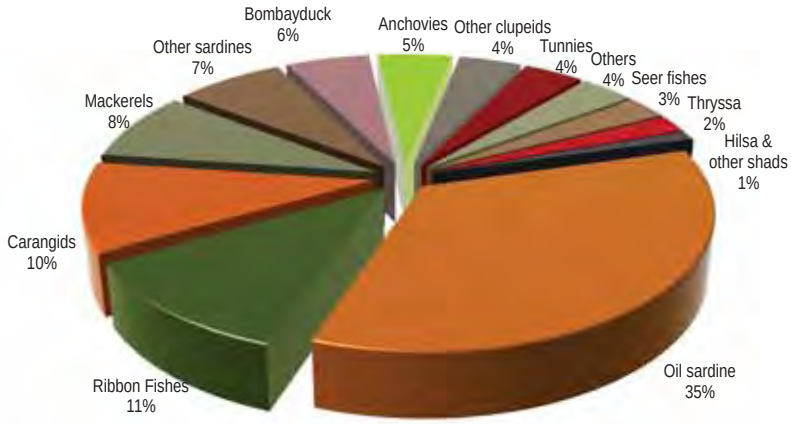


Contribution in landings by the four groups of fishery resources during 2012

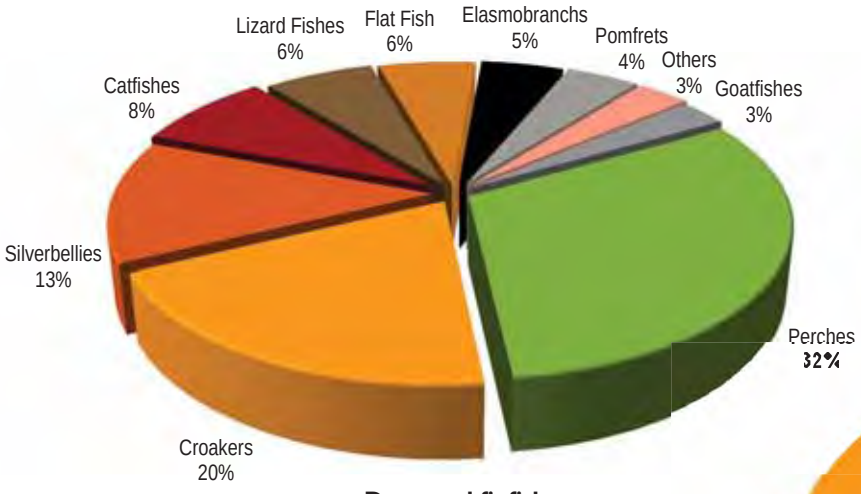
Northeast	• Penaeid prawns (17.45%) • Croakers (14.66%) • Ribbonfishes (6.5%) • Bombayduck (6.2%) • Non-penaeid prawns (4.7%)
Northwest	• Non- Penaeid prawns (11.9%) • Croakers (9.4%) • Bombayduck (7.7%) • Penaeid prawns (6.3%) • Threadfin breams (6.0%)
Southwest	• Oil sardine (40.5%) • Threadfin breams (8.8%) • Indian mackerel (5.8%) • Scads (5.3%) • Penaeid prawns (4.0%)
Southeast	• Oil sardine (12.2%) • Silverbellies (11.9%) • Lesse sardines (11.5%) • Penaeid prawns (5.5%) • Indian mackerel (5.1%)

Important marine fishery resources landed during 2012 in different regions

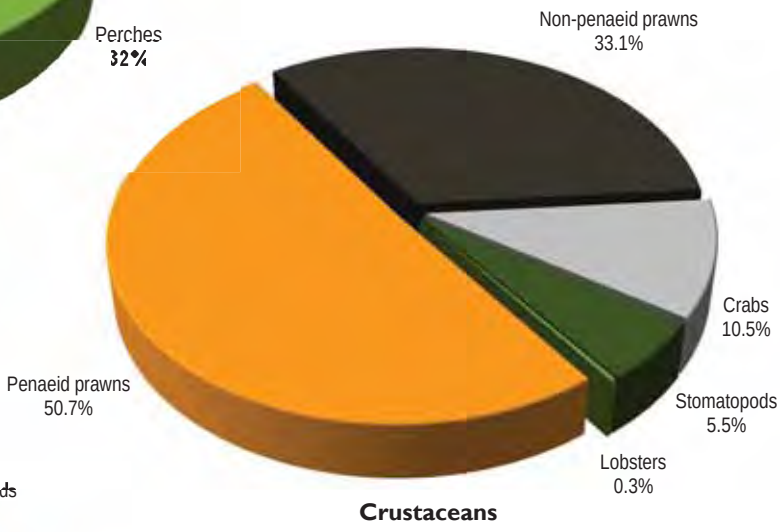
Nematocarcinus gracilis Bate, 1888, a new record from the Bay of Bengal



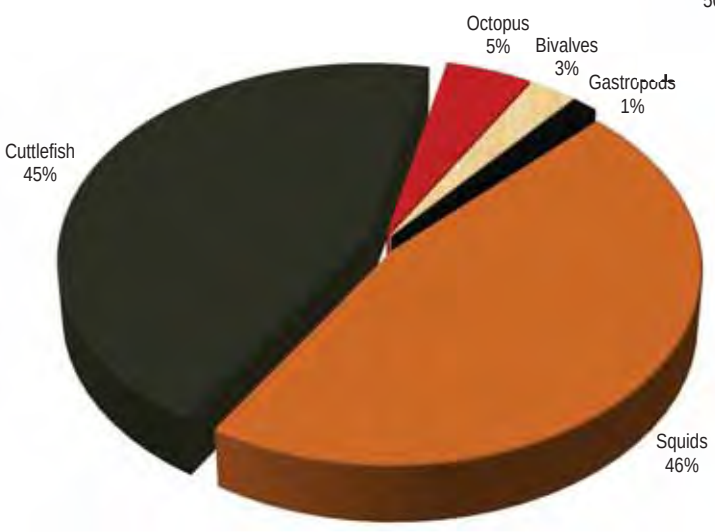
Pelagic finfishes



Demersal finfishes



Crustaceans

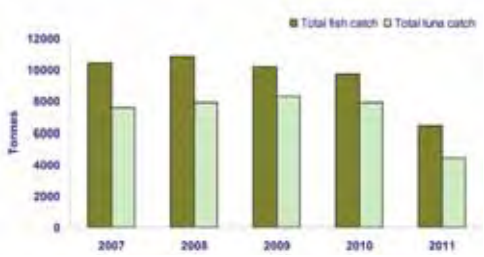


Molluscs

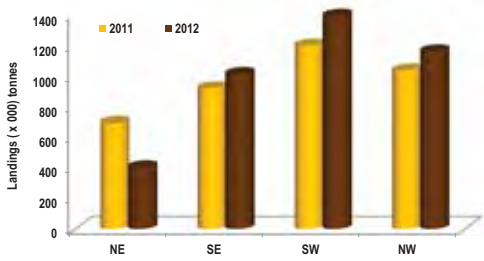
Components of various groups in the marine fish landings of India during 2012

Estimated Marine fish landings (t) during 2011 and 2012

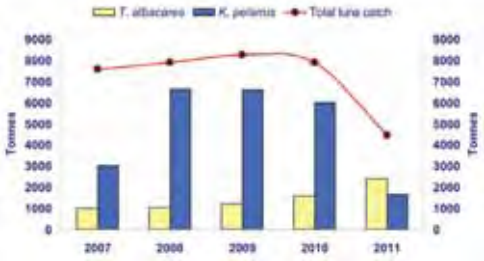
Pelagic finfish			Demersal finfish		
Name of fish	2011	2012	Name of fish	2011	2012
Clupeoids			Elasmobranchs		
Wolf herring	23985	20404	Sharks	26746	22537
Oil sardine	609111	720270	Skates	2706	2263
Other sardines	122935	149022	Rays	24017	27802
Hilsa shad	21901	9981	Elasmobranch Total	53470	52602
Other shads	14621	10769	Eels	10520	13819
Coilia	37629	26788	Catfishes	92678	89287
Setipinna	15239	8640	Lizard Fishes	55778	70004
Stolephorus	64603	68197	Perches		
Thryssa	36120	42246	Rock cods	25231	44602
Other clupeids	81240	85420	Snappers	7286	7828
Clupeoids Total	1027386	1141737	Pig-face breams	15546	17040
Bombayduck	115594	115296	Threadfin breams	174079	211618
Half Beaks & Full Beaks	5474	4096	Other perches	53860	60229
Flying Fishes	1239	2157	Perches Total	276002	341318
Ribbon Fishes	241978	236541	Goatfishes	30543	31014
Carangids			Threadfins	9764	12588
Horse Mackerel	37116	34056	Croakers	220120	214438
Scads	104903	91449	Silverbellies	82810	140843
Leather-jackets	12303	13085	Big - Jawed Jumper	9686	8298
Other carangids	76323	77857	Pomfrets		
Carangids Total	230646	216447	Black pomfret	20493	17798
Mackerels			Silver pomfret	34072	27515
Indian mackerel	278495	170297	Chinese pomfret	5420	1990
Other mackerels	8	113	Pomfrets Total	59985	47303
Seer Fishes			Flat Fishes		
S. commerson	31363	42607	Halibut	1154	1185
S. guttatus	17507	13493	Flounders	217	220
S. lineolatus	10	0	Soles	61298	61859
Acanthocybium spp.	46	70	Flat Fishes Total	62668	63264
Seer Fishes Total	48926	56170	Miscellaneous	27965	32448
Tunnies			Demersal Total	991988	1117226
E. affinis	32937	32763	**Shellfish**		
Auxis spp.	12494	9747	**Crustaceans**		
K. pelamis	8758	5780	Penaeid prawns	267932	253247
T. tonggol	11116	13926	Non-penaeid prawns	187061	164951
T. albacares	9396	14696	Lobsters	1761	1546
Other tunnies	1914	4462	Crabs	50847	52467
Tunnies Total	76615	81375	Stomatopods	25250	27613
Bill Fishes	10046	6216	Crustaceans Total	532850	499824
Barracudas	25602	33929	**Molluscs**		
Mullets	10699	5932	Cephalopods		
Unicorn Cod	422	1081	Squids	77241	92241
Miscellaneous	60139	61959	Cuttlefish	71922	88320
Pelagic Total	2133268	2133347	Octopus	7661	9761
			Miscellaneous	5277	8220
			Molluscs Total	162100	198542
			Shellfish Total	694950	698365
			Grand Total	3820207	3948938



Estimated total fish and tuna landings in Lakshadweep during 2007-11



Region-wise marine fish landings in 2011 and 2012



Estimated species-wise tuna landings in Lakshadweep during 2007-11

fishes found here. The deep sea caridean shrimp *Nematocarcinus gracilis* (Bate, 1888) (Nematocarcinidae) is reported from Bay of Bengal for the first time. The specimen was collected from the Bay of Bengal at depths of 520-700 m off Chennai during an exploratory survey on-board FORV Sagar Sampada (Cruise No: 291)

Oceanic tuna fisheries in Lakshadweep Sea

Production

The catch of yellowfin tuna in Lakshadweep sea maintained its uptrend during 2012 also. The declining trend in total marine fish and the skipjack tuna landings reversed during 2012 due to improvement in catches of skipjack tuna. Ever since the intervention of NAIP in Lakshadweep in 2007, local awareness on the importance and value of yellowfin tuna was increased and more and more attention was paid on their exploitation by administrators and enthused fishers. As a result, diversified fishing systems - monofilament pelagic longline introduced by NAIP and local innovations like double pole and line and handlines- were being largely employed for their exploitation. This transition was accelerated by decline in the abundance and catch of once abundant skipjack tuna along the region.

The introduction of monofilament longlines improved the efficacy of fishing system and catch of yellowfin tunas and like fishes were also increased. Tuna ageing through hard part reading and validation is in progress. Database on ecopath parameters of the component species of Lakshadweep pelagic ecosystem was developed. Ecosystem simulation and forecasting is in progress.

The estimated marine fish landings in Lakshadweep islands showed a decline of 38.7% from 10413.4 t during 2007 to 6428.5 t in 2011. The decline was due to decrease in targeted fishing of skipjack tuna, *Katsuwonus pelamis* by 45.1% (3018.2 t in 2007 to 1640.1 t in 2011). However, trend shows tremendous increase in targeted fishing of yellowfin tuna, *Thunnus albacares*, from deeper waters of the Lakshadweep sea during the same period. It was estimated that annual yellowfin tuna landing during 2007 was at 986.8t and it increased by 59.2% during the year 2011 and estimated landing was 2418.0t. Awareness on high value yellowfin tuna has also increased and diversified fishing systems are introduced for the yellowfin tuna catch. Targeted fishing of yellowfin tuna occur using monofilament pelagic longline in Pablo boats and also by handline.

The introduction of monofilament horizontal longlines in modified Pablo boats increased the efficacy of fishing system and catch of other tuna like fishes was also increased. Instead of the traditional pole and line gear, enthusiastic fishermen tried double pole and line method, in which single hook tied in two poles for fishing from deeper waters. Handlines were also used for the yellowfin tuna catch. This general trend was achieved through the awareness programme during the project period have made high impact on socio economic status of fishermen. Introduction of these new fishing practices have impact on optimal utilization of fishery resources in an island ecosystem.

Recommendations for management

Catch data reporting for monitoring sustainable harvest of stock, benefit on introducing monofilament longline fishery, ideal harvest and post harvest technologies, waste utilization strategies for protection of environment, introduction of ideal marketing channel and participation of stakeholders for better management of fishery resources in an island background.

Special zones may be developed to promote export oriented industries through transfer of technologies developed under the project. Some of the technologies developed require large investment for commercial level implementation, it can be achieved only through co-operative venture or self help group, through institutional assistance.

Tuna waste for the preparation of different feeds

Value addition

Processing technologies for the preparation of improved masmin has been developed. A new method for the development of ready to use *masmin* flakes from tuna has been developed which gives an improved product with convenience to use and have low benzopyrene content.

Light pulse treatment enhances the shelf life of tuna products. It was observed that maximum of 36 pulses were needed to extent the shelf life of tuna at acceptable level in chilled storage and further work is continued to standardize the method. Carbon monoxide treatment was done for colour retention of the red meat. Innovative value added products such as tuna kure, tuna burger, tuna roll, tuna *kebab*, tuna *pappad* etc. were developed. The smoked products currently available in our country are hard and easily prone to spoilage by fungus and mite attack and hence have a short shelf life. A ready to eat smoked product which is succulent and convenient to use, having high moisture content and extending shelf life of more than one year at ambient temperature storage has been developed. This technology can be transferred to entrepreneurs who are interested in production and marketing ready to eat convenience products and provide employment for 20 persons directly and 30 indirectly. Microbial and biochemical standards for raw meat and value added products were determined.

Fish feed from tuna waste

Waste utilization technologies through the preparation of various feed from tuna waste were developed. This innovative technology has impact on the health of island ecosystem as well as employment generation, women empowerment through SHGs and economic status of the islanders. The products are fish feed under the trade name SILO feed, pet feed and pig feed. During tuna processing, 8 -13% of red meat was removed during loin grade processing. To utilize this red meat, a pig feed was developed. Gelatin from tuna skin is a byproduct used as gelling agent. This technology can be utilized to generate wealth from the waste. This will minimize problems associated with waste disposal and pollution and at the same time generating income to the entrepreneurs. Fish oil rich in Poly Unsaturated Fatty Acid (PUFA) was extracted from tuna eyes for preparation of pharmaceutical products. PUFA was also extracted by Super Critical Fluid Extraction Method from tuna red meat at Synthetic Chemicals at Kolenchery, Ernakulam.

SILO - fish feed

Utilization strategy for oceanic squids (Cephalopoda) in Arabian Sea: A value chain approach

Oceanic squid production and marketing

Based on experience and trials in the previous years, a new mini purse seine was designed and fabricated for use on the squid jigger MV Titanic. Vessel modifcations and net fabrication has been completed. Fishing trials are underway. Light attraction resulted in good catches of the bigfin reef squid at Lakshadweep. Biological information of oceanic squids collected so far has been collated to determine vulnerability to fishing pressure. Qualitative differences in day and night plankton and night and night-light plankton has been studied. Biochemical properties of oceanic squid ink has been evaluated.

Red meat pig feed composition

Parameter	%
Moisture	7.3
Protein	22.8
Fat	22.4
Ash	8.8
Carbohydrate	38.7

Frozen products developed for oceanic squids under the brand name ARABIAN SEA MASTER SQUID

Mr. Anwar Hashim, former president, Seafood Exporters Association of India, releasing the products at NIFPHATT Fish Stall in the presence of Directors of CIFT, NIFPHATT and CMFRI.

Trial marketing of products developed from NIFPHATT Fish Stall, Kochi under the brand name - ARABIAN SEA MASTER SQUID. A revenue of `18,000 has been realized. Trial marketing of bigfin reef squid in fresh condition was done in Agatti Island.

Zooplankton phototaxis in oceanic squid fishing grounds in the Arabian Sea

Effects of night-illumination on zooplankton abundance were compared with day/night variations in oceanic squid fishing grounds in the central Arabian Sea. Zooplankton abundance showed significant variation in relation to three different light conditions with 52% of the total abundance happening during night and 25% during night with illumination. Siphonophores, chaetognaths, copepods and decapod larvae displayed significant negative phototaxis. Present results indicate that the response to light stimulus observed among the zooplankton groups were mostly due to the prey-seeking or predator avoidance behaviour.

Total zooplankton abundance in individuals m^{-3}, comparison of mean abundance in day (D), night (N) and night - illumination (NI) and estimated night: day (N:D) and night:night - illumination (N:NI) ratios.

Groups	D	N	NI	N:D	NI:N
Hydromedusae	15	8	10	0.5	1.3
Siphonophore	24[a]	101[b]	92[b]	4.2	0.9
Polychaetes	4	8	4	1.7	0.6
Chaetognaths	198[a]	999[b]	416[ab]	5.0	0.4
Copepods	13003[a]	34232[b]	17017[ab]	2.6	0.5
Ostracods	4242	4289	1573	1.0	0.4
Cladocerans	339	0	0	0.0	
Mysids	0	27	15	-	0.5
Amphipods	220	92	333	0.4	3.6
Lucifer	89	66	52	0.7	0.8
Euphausids	6	20	3	3.3	0.2
Salps	5	42	19	8.4	0.5
Doliolum	4	16	8	3.9	0.5
Appendicularians	181	370	241	2.0	0.7
Heteropods	3	4	7	1.5	1.7
Pteropods	13	34	35	2.6	1.0
Amphioxus	4	8	5	1.7	0.7
Decapod larvae	62[a]	229[b]	139[ab]	3.7	0.6
Cephalopod larvae	0	1	1	6.2	0.7
Gastropod larvae	87	1399	662	16.1	0.5
Fish Eggs	4	212	64	58.0	0.3
Fish larvae	2	14	7	8.6	0.5
Mean N±SE	529±133[a]	1205±262[b]	841±136[ab]	2.3	0.5

*Non-identical superscripts, row-wise, indicate significant differences at $p<0.05$ level.

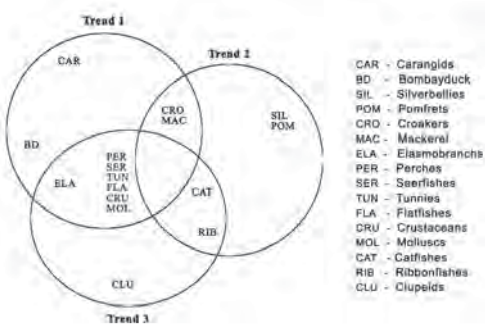
Fisheries and Ecosystem Modeling

Common trends in landings of prominent marine fishery resources extracted through dynamic factor analysis

Dynamic factor analysis (DFA), a multivariate time series technique used to identify common trends in a set of time series sequences, was applied to all India annual landings during 1980 – 2010 of prominent 16 marine

fishery resource groups to determine common trends in their landings. Three common trends were extracted from the multivariate time series data. The estimated first common trend initially showed an increasing trend, reaches a peak and then for few years it comes down slightly and remains steady thereafter. The second common trend showed an initial decline and continued in almost the same level for some years and at the end, it started increasing. The third common trend showed an increasing trend throughout the period with little fluctuations.

Based on the factor loadings of each of the resource groups corresponding to the three common trends, the groups were classified and represented using Venn diagram. Results revealed that carangids and Bombayduck contributed towards trend-1 only with positive and negative coefficients respectively. Both silverbellies and pomfrets contributed only towards trend-2 both with positive and almost equal factor loadings. Clupeids contributed only towards trend-3 with positive factor loadings. Croakers and mackerel contributed almost equally towards trend-1 and trend-2, whereas perches, seerfish, tunnies, flatfishes, crustaceans and molluscs formed a homogenous group contributing almost equally towards trend-1 and trend-3. Elasmobranchs also contributed towards trend-1 and trend-3 but with opposite sign. Catfishes and ribbonfishes contributed towards trend-2 and trend-3 but with opposite signs.



Venn diagram showing classification of groups corresponding to three common trends

Evaluating the effect of seasonal fishing ban on marine fish landings in Kerala through ARIMA intervention model

The Government of Kerala has constituted an expert committee with CMFRI scientists as members to evaluate the impact of seasonal fishing ban on fishing wealth along the Kerala coast. As a part of this task, the effect of seasonal fishing ban on marine fish landings in Kerala was evaluated using time series data on marine fish landings during 1961-2012 based on ARIMA intervention model. In Kerala, the seasonal fishing ban was introduced in 1988 and is in effect thereafter. Almost in the same period another intervention also took place by introducing crafts fitted with outboard engines and fishing gears especially the ring seines.

Suitable orders of ARIMA (p,d,q) models were determined based on Akaike's information criterion (AIC) and Schwarz's Bayesian Information criterion (SBC). Input time series used were the annual total marine fish landings, oilsardine landings and total landings excluding oilsardine. Based on the above criterion with the time series prior to the intervention (up to 1987, prior to seasonal fishing ban), the appropriate models determined are ARIMA(3,2,0) for total landings, ARIMA(2,2,0) for oilsardine landings and ARIMA(3,2,0) for the series with total landings excluding oilsardine. These models were then extended to the period up to 2012 by incorporating intervention terms in the model through auxiliary variables. For the total landings interventions were considered at 1988 and 2010, the later period being added to account for the boost in oilsardine landings, and for the other two series intervention at 1988 was only included in the model.


Intervention ARIMA (3, 2, 0) model for Kerala total landings

The ARIMA intervention models fitted explained 73.5% of the variability in the time series on total landings, 47.1% of the variability in oilsardine landings and 84.4% of the variability in the series with total excluding oilsardine. In the selected models, all the model parameters are significant except the intervention parameter in the case of oilsardine series. This shows that the intervention model does not suit the oilsardine landings and

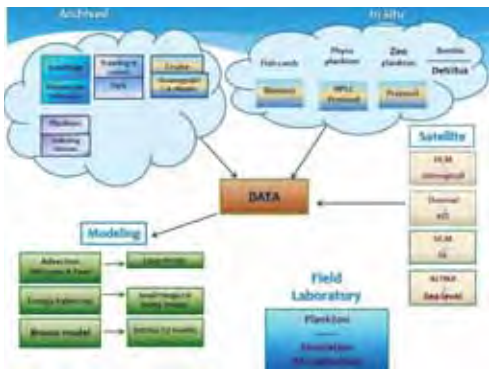
Intervention ARIMA (3, 2, 0) model for Kerala total landings (excluding oilsardine)

the effect of seasonal fishing ban on oilsardine landings is not significant. As per the estimated model, the increase in total landings in Kerala due to the interventions in 1988 is about 2,18,000 tonnes which is a confounded effect of both seasonal fishing ban and introduction of outboard engines with ring seines. The effect of outboard engines and ring seines were separated from the total by removing the oilsardine landings as ring seines mainly catch oilsardine. Thus the ARIMA intervention model applied to the time series data on total landings excluding oilsardine was used to estimate the effect of seasonal fishing ban introduced in the state from 1988 onwards. As per this model, the effect of seasonal fishing ban in Kerala was quantified to about 1,17,000 tonnes increase in landings per annum.

Chlorophyll based Remote Sensing Assisted Indian Fisheries Forecasting System (ChloRIFFS)

Towards establishing a scientifically deduced relationship between the marine environment and the resource availability on a realistic basis, there is a need for a focused application of established easy to surveil, oceanic, geophysical and physicochemical parameters and their direct or latent influence upon the planktons which happen to be the self-replenishing source of food and nutrition for the fishery resources spread in our EEZ. The spatio-temporal fluctuations of the plankton richness which can be remotely sensed have long been established as a major factor in predicting resource richness in general and congregation and catchable availability in particular.

Taking cue from these established models, paradigms can be designed to predict the resource availability from the easy to observe parameters after a thorough validation of the prediction scenarios juxtaposed with the estimated catch attributable to various fishing grounds. The change in the pattern of fishing, period of absence and the composition of fish caught per haul, when analyzed for a range of geo-spatial expanses would help refining and augmenting the existing paradigms resulting in a comprehensive prediction algorithm. Further such models would come in handy in the assessment of marine resource potentials and there periodic revalidation on a homogenous platform with a proper measure of confidence interval. Such exercises are of immense importance to the government and its policy pilots. CMFRI has a history of co-integrating plankton availability and resource landings since the early 1960's. Collaborative efforts have been in existence with reputed agencies like ISRO towards the identification of potential fishing zones (PFZ) in the 1980's and 90's.



Conceptual flow chart indicating the work design of ChloRIFFS

With the advancement of technologies like remote surveillance wherein more number of micro changes can be captured and quantified by the satellites, marine areas are more approachable en block than ever before for research prodding. Using the well-established linkages between the factors of primary productivity like the marine fauna whose exemplification is through the chlorophyll content of the marine expanse and the resource dynamics, prediction of the movement of shoals and location of potential fishing zones have been successfully carried out in recent past. There are established models linking resource dynamics and the habitat dynamics *vis-à-vis* finfishes. But a comprehensive model which would cover the entire gamut of physiological, habitation and climatic factors leading to a forecasting

paradigm is a new avenue especially under the tropical conditions in which Indian EEZ falls. Once fulfilled Chlorophyll based Remote Sensing Assisted Indian Fisheries Forecasting System (ChloRIFFS) of harvestable marine fisheries potential will be a great tool to capture the health and wealth of our waters to enable planners to intercede.

Flow of matter through trophic levels and biogeochemical cycles in marine and estuarine ecosystems

Monthly sampling was done from Mandovi, Zuari and coastal waters of Goa. The coast was divided into 8 equal sampling grids of 0.25° starting from south to north. Samples were collected from eight sampling stations fixed along the coast In Mandovi estuary samples were collected from 4 stations and in Zuari estuary from 6 stations. Data collection on primary production, zooplankton estimation, benthos and fishes of different ecological groups were completed from Mandovi and Zuari estuary and coastal waters of Goa. Data on L/F and other population parameters for biomass estimation for 85 species completed.

The diet data was analysed using index of preponderance, volume method and percentage of occurrence. Diet matrix of 70 species of finfishes studied. Preliminary non validated estimates of the biomass of six major groups completed for Mandovi estuary. Population parameters of major groups in Mandovi estuary done.

Preliminary non validated estimates of the biomass of nine major groups completed for Mandovi Estuary. Data analysis for Zuari and coastal waters of Goa is in progress. Model fitting and trial runs are in progress. Enumeration of bacterial load in sediments samples from Zuari and Mandovi estuaries and open sea in Goa. Preliminary biochemical tests revealed that the majority of the isolates belonged to Vibrioanaceae. Highest bacterial load was observed in April in Mandovi and October and November in Zuari and coastal waters respectively.

GIS based resource mapping of distribution and abundance of finfishes and shellfishes off Indian coast

The use of Geographic Information Systems (GIS) in decision-making and policy development is growing rapidly in many fields of resource management. While these applications are often limited to inventories and basic GIS techniques such as database query, the use of GIS is nevertheless making resource management more explicitly spatial. The use of GIS by managers themselves as an active aid for decision-making, scenario testing, site suitability analysis, or socio-economic analysis has yet to be established in marine fisheries. The present study attempts to make the fishery distribution and abundance to GIS platform.

Resource mapping and data analysis using GIS

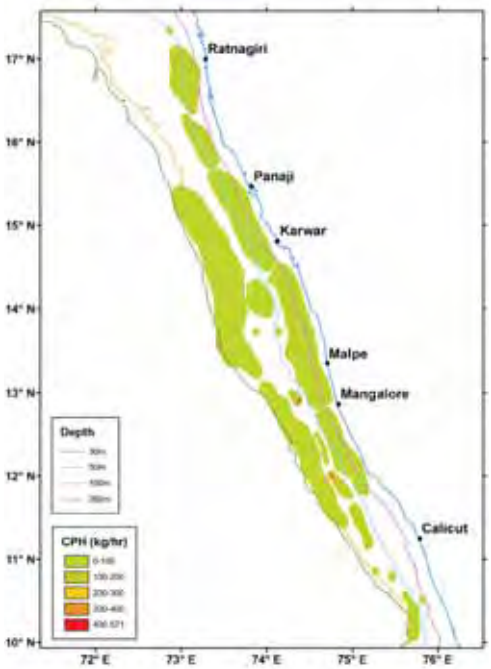
Data collection and analysis in GIS format aids in geospatial mapping and further for the analysis of the data by giving queries for the layers(maps) needed for the analysis. Since the project is new to the marine fisheries research in India, analysis of historical data collected in GIS format for 2007-2012 was carried out as a prerogative of the ongoing project and presented to show its utility. GIS maps prepared for monthly and annual basis is a

Population parameters of major groups in Mandovi estuary, Goa

Groups	M	F	Z	E
Large pelagics	0.70	1.33	2.04	0.65
Large benthic Carnivore	0.46	1.1	1.56	0.70
Medium benthic Carnivore	0.95	3.49	4.43	0.79
Small pelagics	2.04	1.54	3.59	0.43
Small benthopelagics	0.86	0.85	1.72	0.50
Shrimps	1.71	2.10	3.81	0.55
Crabs	1.79	3.57	5.36	0.69
Benthic omnivore	1.92	2.6	4.52	0.57
Small benthic carnivores	1.54	1.53	3.06	0.50

Biomass estimation of major groups in Mandovi estuary, Goa

Groups	Biomass (t km^{-2})
Large Pelagics	71.63
Large Benthic Carnivore	68.38
Medium Benthic Carnivore	408.88
Small pelagics	29.34
Small benthopelagics	722.41
Shrimps	227.72
Crabs	107.02
Benthic omnivore	74.13
Small Benthic Carnivores	118.79



Distribution and abundance of marine resources off Karnataka coast compiled for 2007-2012, which is the cluster of more than 32,000 layers of information, which and be retrieved and analysed individually.

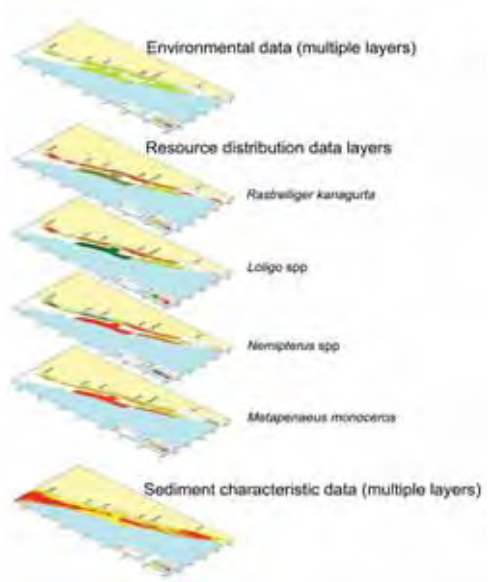


Illustration of different layers of GIS map of same geographical area in the same period in which can be retrieved individually for analysis.

congregation of many layers of information depending on the components in the map, like abundance, juvenile abundance, environmental parameters etc. The layers of information can be queried and retrieved according to the required scientific objectives. For example, in a sampling day in a haul if 100 species are recorded, the maps drawn will contain 100 layers of information. The number of layers again increases if juveniles data of the species also recorded in this case with each species data an additional layer of juvenile data also will be incorporated in the map. For the data analysis, each layer from this group can be retrieved separately and analysed for various research findings from the data. A collection of information of 1082 days of fishing with, an average of 20 number of species per day. At an average 10 of the species recorded have juvenile percentage data and commercial size data, which also can be depicted in separate layers. So the given GIS map is a congregation of 32,460 maps/layers on information (1082X20)+ (1082X10), and each layer of the maps can be retrieved and analyses.

The possibilities of the GIS maps (layers of information) are immense. Mapping is only the basic information in GIS application and the most important aspect of GIS based study is the data analysis. In marine fisheries scenario, most important priority is to understand the distribution and abundance of fishes in space and time. For fisheries management understanding the potential of fishery is most important criteria and the present fish landing based studies are not capable of giving the sea truth information on the distribution of fishes. It is approved fact that fishes are not distributed evenly in the sea and there is ground wise segregation of different species. The GIS based studies will help in identification of critical fishing grounds in terms of fishery and marine biodiversity. Based on the three years study and mapping, experimental trawling is planned in the selected critical fishing grounds off Indian coast to come out with policies for spatial restrictions and reallocation of fishing effort in these fishing grounds. Even though present project objectives are restricted to developing advisories for the operation based fishing regulations, the data collected during the period have immense potential in understanding the dynamics of the marine fisheries. Among many routines in GIS, mapping is one of the application which form basis for further routines like analysis. The analysis of information collected in layers will help in identifying, spawning period, spawning area, juvenile segregation, juvenile migration, *in situ* growth of different species, resident taxa of particular fishing ground, multi-group assemblages and the reasons for the multi-group assemblages and their dependencies, trophic structure of fishing grounds with "Ecospace" and "Ecotran" concepts, Identification of sites for installing FADs and marine cages; need for declaration of Critical ecosystems and MPAs etc, which remained mostly unknown in fisheries research.

Inventory of fish landing centres

For GIS mapping basic data requirement is the information regarding the fish landing centres around Indian coast. This information forms the basic layer of the resource mapping on which resource data layer will be stacked.

The data collected area, name of landing centre, district, its location with latitude and longitude (GPS reading), gears operated from the landing centre, Seasonality of each gear operation, distance covered for fishing from the centre, seasonal changes in direction of fishing activity, which will be incorporated in the Inventory of landing centres. Till December, 2012 the data collection on 596 landing centres along the Indian coast is completed from States most of the maritime states of India. The basic geospatial position of the landing centres are ascertained with physical verification of the GPS reading from the fish landing centres. Physical verification and mapping of 147 fish landing Centres of Maharashtra comprising five coastal districts, Sindudurg, Ratnagiri, Raigad, Greater Mumbai and Thane. The result of the study in 147 fish landing centres are depicted in the map and further information on fishing details and fishery details will be added to the basic map of these fish landing centres time to time.

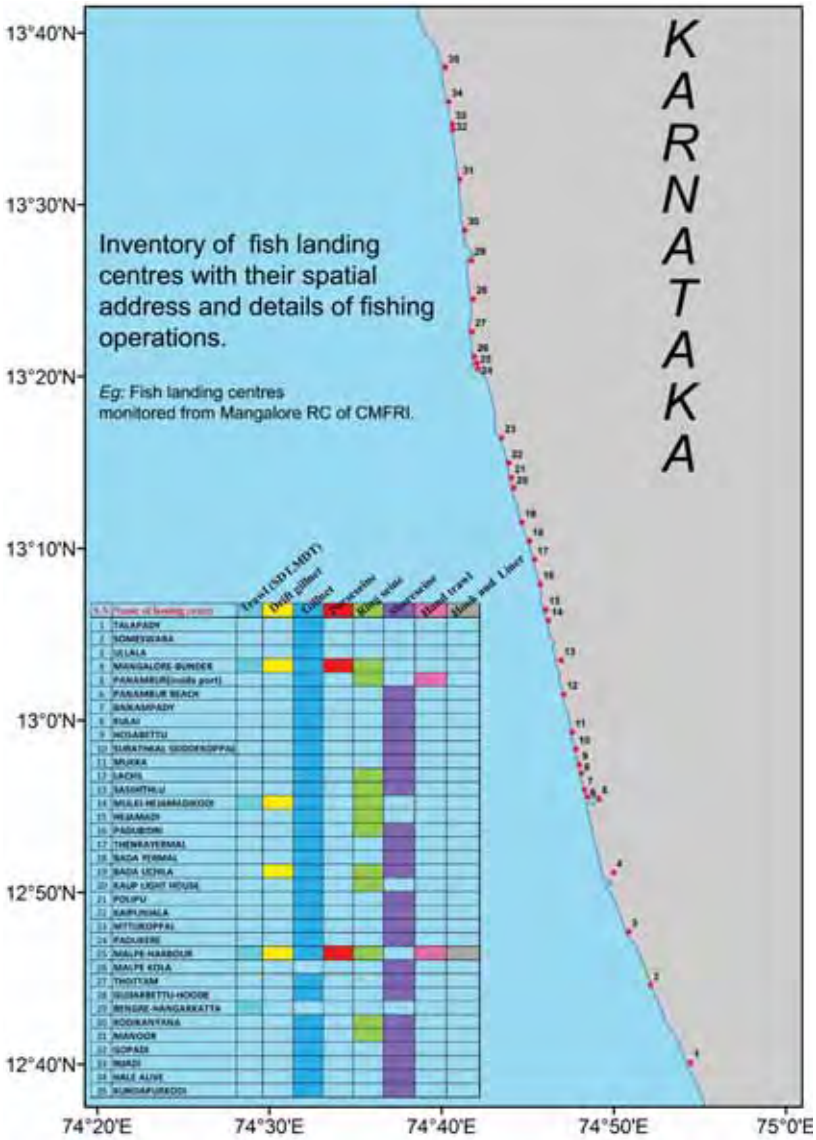
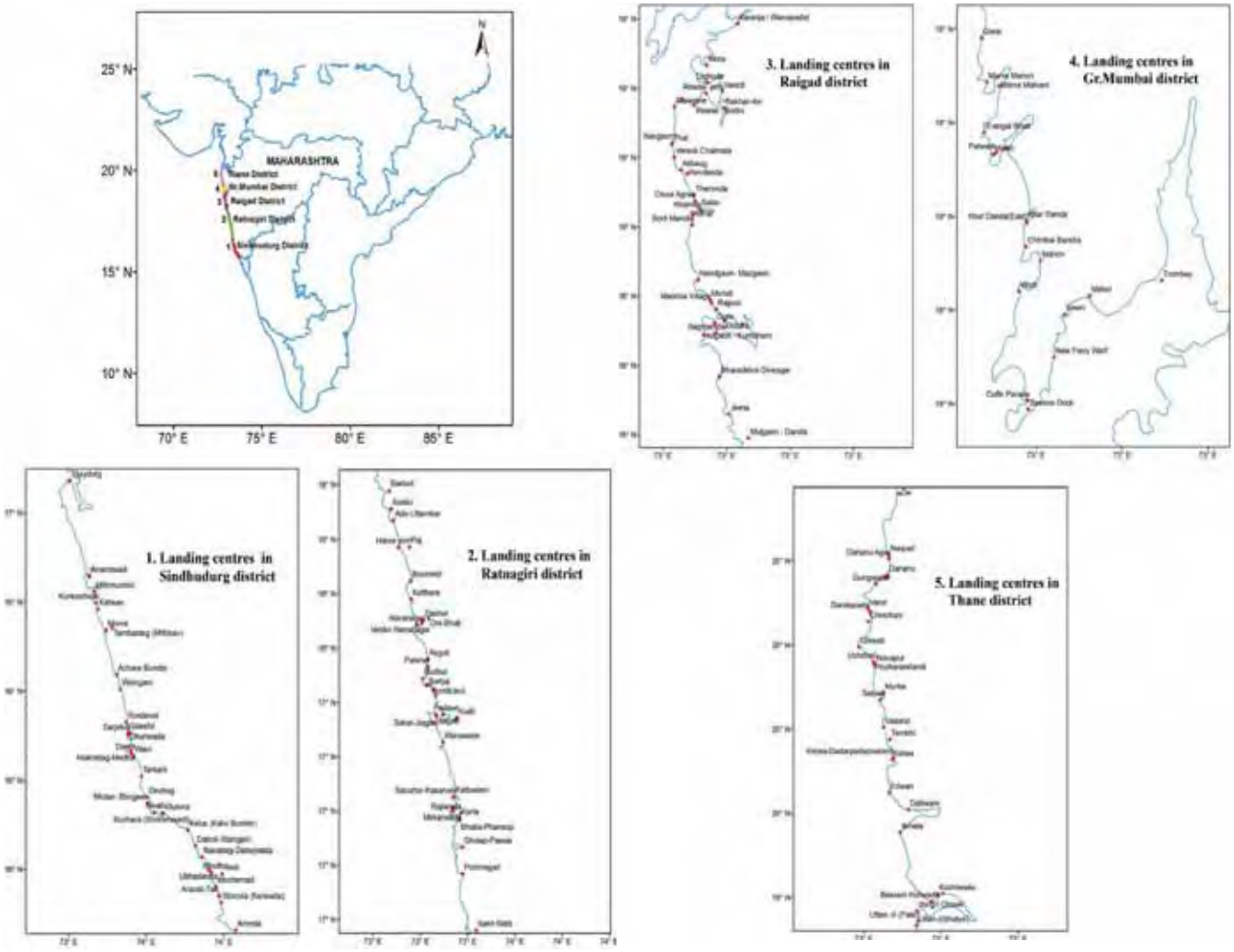


Illustration of a part of the inventory of marine fish landing centres of Indian coast



Base maps of spatial address of marine fish landing centres of Maharashtra.

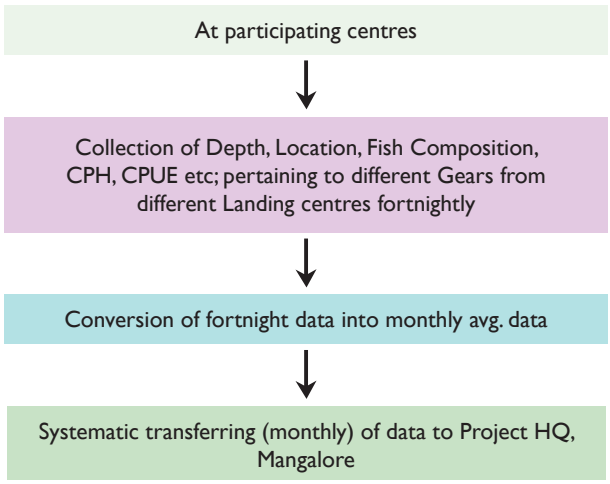
FRIM, software developed for interface data query for GIS mapping

From the database of fishing and fishery information, to derive GIS maps and to carry out GIS analysis, there is need for interface software, which can make queries on the data required to give the out put for GIS software. For the purpose, Mangalore Research Centre of CMFRI developed Fishery Resource Information and Management software, "FRIM". FRIM facilitates the analysis of the database by sending simple or complex queries. The determination of CPH, monthly averages, comparison of fish composition between fishing grounds, analyses of bycatch, juvenile species, species to species correlation, repetition of species in space and time etc., can be performed at great ease using FRIM. The output can be easily represented on a map using Arc GIS. FRIM-GIS outputs will be of great help for fishery resource mapping, planning, policy making and sustainable exploitation of fishery resources.

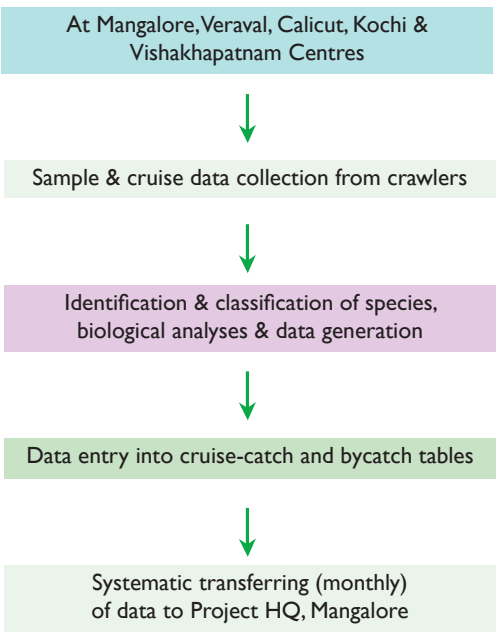
Data collection protocol at various centres

The data on the distribution of the marine fisheries resources are being collected from all the majour fish landing centers of the country. The technical programme of the project is mainly based on 1) data from multi day trawlers collecting at Veraval, Visakhapatnam, Calicut, Kochi and Mangalore centres 2) fortnightly collected data on different gears from different landing centres of the country and the work is in progress.

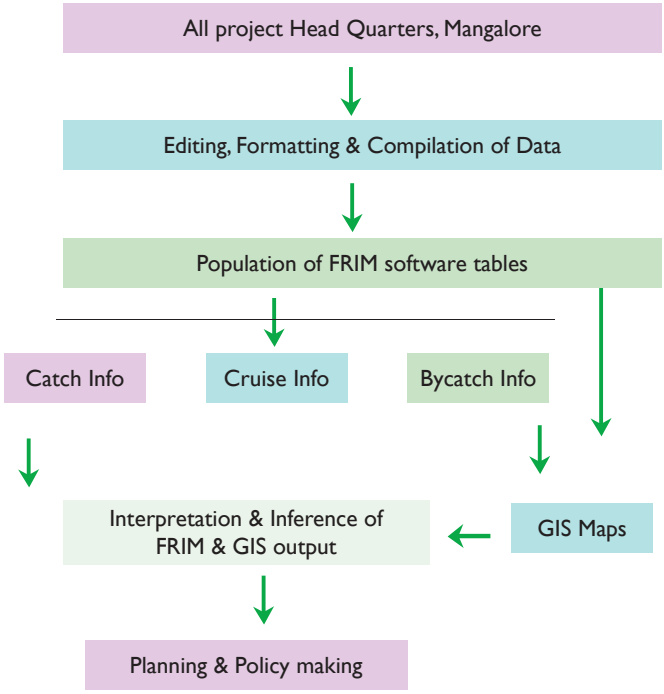
THE FLOW CHART FOR LANDING CENTRES' DATA ANALYSES



THE FLOW CHART FOR MULTI DAY TRAWLERS DATA



FLOW CHART FOR DATA ANALYSES AT PROJECT HQ. MANGALORE RC OF CMFRI



Satellite telemetry studies on migration patterns of tunas in Indian seas (SATTUNA)

The migration pattern of yellowfin tuna in oceanic waters of India still remains unknown. Large tunas are known for their long distance migrations to meet their biological needs or forced to either remain or move into certain water bodies due to their physiological needs. Studies conducted on the YFT collected from the coastal surface fishery indicate that younger fishes occur in the near shore areas and larger fishes in the oceanic waters. However, detailed information on their movement is not known. Vital information related to life history of yellowfin tuna remains unanswered. Iinformation gathered so far by conventional archival tagging methods has been limited and very little is still known on the migration behavior of the

Large sized yellowfin tuna being exploited by the modified double pole and line fishing at Lakshadweep

Tagging and deployment locations of yellowfin tuna off Lakshadweep and mainland coast of India during 2012-13

Tag ID	Serial no.	Date of tagging	Location	Time	Latitutde	Longitude	Fork length (cm)	Weather condition
111704	21700	07.12.12	Off Vskp	10.30	17015'53.6	"83026, 04.5"	91	Cloudy & windy
111712	21705	15.12.12	Off Agatti	17.28	10.55.002	72.18.324	96	Rough, Choppy, partially cloudy, and windy
111713	21706	15.12.12	Off Agatti	14.04	10.55.125	72.18.523	91	"
111714	21707	15.12.12	Off Agatti	14.30	10.55.248	72.15.726	119	"
111719	21712	15.12.12	Off Agatti	14.00	10055.129'	72018.541,	91	"
111723	21716	07.12.12	Off Vskp	11.00	17015'47.7"	83026'20.6"	93	Cloudy & windy
111716	21709	20.0..13	Off Manglaore	8.30	12050'06	73050"	142	Sunny & bright

Yellowfin tuna tagged with
PSAT ready for release into the sea

these fishes, the reasons for undertaking such long migrations if any, the dives they take during a day, and in the case of schooling fishes if the fish in a region belong to the same single stock or is shared. Further, conventional archival tags used have a number of disadvantages with very poor recovery rates and limited data on habitat and environment. The "Pop-up Satellite Archival Tags" (PSAT) have been developed to avoid such problems, track fish and reveal ocean-wide movements. These tags are attached externally and have a release mechanism that causes the tag to detach from the fish at a predetermined time and "pop-up" to the sea surface where the data can be recovered via the ARGOS system aboard polar-orbiting NOAA satellites. PSATs record temperature, depth and ambient daylight that can be reduced (e.g. as time-at-depth and time-at-temperature histograms and profile-depth temperature data). The tagging data could help in incorporating more parameters so as to enhance the accuracy levels for the prediction of the probable tuna fishing grounds.

Tagging large sized yellowfin tunas was continued during the year. Several cruises were made along the Indian coasts and off Lakshadweep but due to frequent bad weather conditions and unavailability of required size yellowfin tuna, this year (2012-2013) only seven tags could be deployed. Two tags were deployed off Visakhapatnam, four off Agatti and one off Mangalore

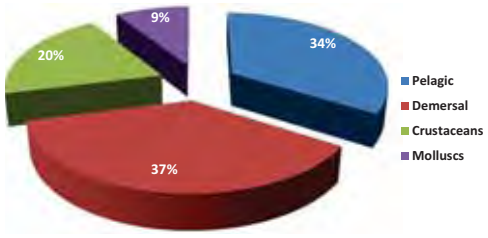
The tags deployed had a pop up time ranging from 6 months to 12 months. Fifteen PSATs deployed during the first phase of the project have popped up at different locations. Stored data recovered through the Argos have been decoded by Microsoft Telemetry Inc, and sent to INCOIS. Further analysis of the data will be done during this phase when we will be able to get a better understanding of movement of yellowfin tuna in the Indian waters. Preliminary data showed that tuna move into deeper waters but the tag pop up locations were within the Indian EEZ. Major problem identified is the premature popping up of the tags deployed.

Project funded by Indian National Centre for Ocean Information Services (INCOIS) Hyderabad

Sustainable management of fishery resources

Gujarat

The estimated marine fish production from Gujarat in 2012 was 6, 90, 396 t showing a marginal increase of 9.14 % from that of previous year. Almost all the major resources recorded positive growth except the Elasmobranch resources. The demersal landings were estimated as 2,46,257 t which formed 35.66 % of total production and registered an increase of 18.78% than the previous year. The pelagic resources contributed 2,29, 950 t (33.3%) followed by crustacean resources 1,36,849 t (19.82 %) and molluscs 58,807 t (8.51 %). The maximum landing was recorded by ribbon fish (91,729 t) followed by non-penaeid prawns (83,621 t), Bombay duck (65,496 t), Sciaenids (62,284 t), Thread fin breams (50,394 t) and catfishes (40,262 t).

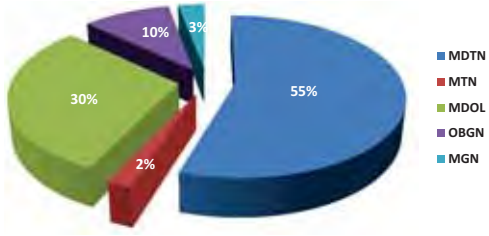


Catch composition of important fishery resources of Gujarat during 2012

Mechanised multiday trawlers contributed 55% of the total fish landing in Gujarat followed by mechanized dol netters (30%) and outboard gill netters (10%). The landing of both mechanized multi day trawlers and mechanized dol netters increased by 2 % each.

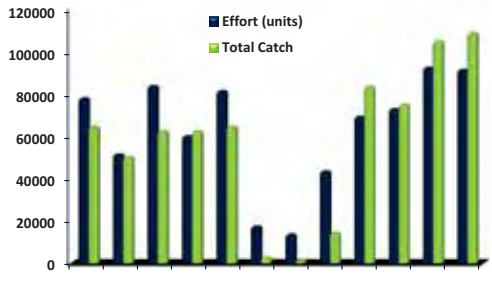
Pelagic Resources

Ribbon fish: Ribbon fish landing in Gujarat during 2012 was estimated to be 91,729 t registering nearly 12.5% increase over the previous year. *Trichurus lepturus* was the single species landed, which formed 13.3% of the total fish landing and 40% of the landing of all pelagic resources in Gujarat. Mechanised multi-day trawlers alone contributed for 82.5% of the total ribbon fish landing with a catch rate of 90 kg/unit and the remaining by single day trawlers, mechanized dolnetters and gillnetters. Size ranged between 320-1,119 mm with mean length 664 mm and sex ratio was 1:1.7. The fecundity of ribbon fish was observed to be 15,000. The gut content analysis of *T. lepturus* showed the dominance of *Acetes* spp., ribbon fish, cephalopods, Sciaenids, *Nemipterus* and *Squilla*.

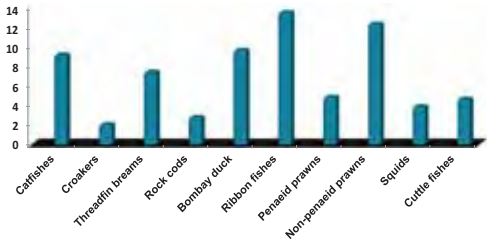


Contribution by different gears to the marine fish landing in Gujarat during 2012

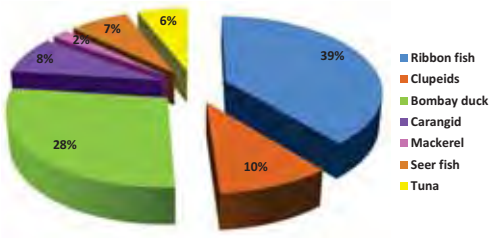
Bombay duck: The estimated total catch of Bombay duck in Gujarat during 2012 was 65,496 t recording an increase of nearly 33% over the previous year. Bombay duck landing formed 9.49% of the total marine fish production during 2012 and 28.5% of the pelagic resources. The landings by dol nets from the in-shore grounds of Nawabunder, Rajpara and Jaffrabad alone were 43,641 t, which is nearly 22% of the total dolnet catches with a catch rate of 652.6 kg/unit per month for an effort of 68,380 units. Landing of Bombay duck, *Harpadon nehereus* occurred throughout the year with peaks in April and December. The landed Bombay duck was in a length range of 75-359 mm with a mean length 185 mm. Sex ratio was found to be 0.85:1 showing the



Month-wise catch and effort (in units) of Gujarat during 2012



Percentage contribution of major groups of fishes in Gujarat



Major components of the Pelagic fishery during 2012

View of Longtail tuna landing in Veraval Fishing Harbour

Growth Parameters of Some important Pelagic Resources

Species	L∞ (mm)	K (yr^{-1})	Z (yr^{-1})	M (yr^{-1})	F (yr^{-1})	E
H. nehereus	369.0	0.56	2.45	1.13	1.32	0.53
T.lepturus	1218.0	0.26	1.22	0.49	0.73	0.59
R.kanagurta	294.0	0.59	3.0	1.24	1.76	0.58
M.cordyla	460.0	0.36	0.79	0.77	1.56	0.49

dominance of females in the fishery. 74.5 % mature females were observed during the year. The gut content analysis showed the dominance of *Acetes, Coilia, N.tenuipes, Bregmaceros, Solenocera* and Sciaenids in the gut.

Tuna: The annual catch was estimated to be 13,633t registering a slight decline over the previous year and formed 7% of the pelagic resources. Outboard gillnetters (74.8%) and mechanised multiday gillnetters (23.5%) were the major gears contributed to the fishery. The tuna landing in multiday trawlers were exclusively of *Euthynnus affinis*. The dominant species landed were *Thunnus tonggol* (66%), *E. affinis* (23.7%), *Auxis thazard* (4.9%), *Katsuwonus pelamis* (4.8%), and *Thunnus albacares* & *Sarda orientalis* (0.7%). The annual estimated landings of carangids in Gujarat during 2012 was 17,919t which is approximately 2.6% of the total marine fish landing in Gujarat and 7.8% of the total pelagic resources. The length recorded for *T. tonggol* was in a range of 400-739 mm with mean length of 573 mm. Similarly the length of *E. affinis* varied between 300-699 mm with a mean of 507.6 mm. The sex ratio of *T. tonggol* and *E. affinis* were found to be 1:1.3 and 1:1.96 respectively. 45.6 % and 46.4 % of mature females were observed for *T. tonggol* and *E. affinis* respectively. Fecundity of *E. affinis* was found to be 6,70,000. In Tuna, major food items in the gut were mackerel, cephalopods, juveniles of tuna, *Acetes*, and other shrimps. Similarly, *K. pelamis* landed in a size range of 540-679 mm with a mean length 593.85 mm. The sex ratio of the species was 1:2.5. 60 % of mature females were observed in the fishery. *Acetes*, cephalopods, ribbon fish and mackerel were found to be the principal food components of *K. pelamis*.

Indian mackerel: Recorded 2.4% of the total pelagic resources in the state with a landing of 5479 t. Nearly 80% of the mackerel landing was by the outboard gillnetter and 12% by the mechanized multiday trawlers. November to March is the major season for the mackerel landing and sizes ranged between 170-289 mm with a mean length of 232.6 mm. The sex ratio was found to be 1:1.27 and 55% of the females were mature with a fecundity of 20,509. *Acetes*, copepods, dinoflagellates, foraminifera and juvenile of fishes were found to be the major food components of Indian mackerel.

Seer fish: Estimated landing was 8515 t mainly constituted by *Scomberomorus commerson* (52%) and *S. guttatus* (48%). 68% of the catch was contributed by the outboard gillnetters and the other major gears were multiday gillneters (16%) and multiday trawlers (12%).

Carangids: Multiday trawlers (50%) and outboard gillnetters (40.5%) contributed maximum of the carangid landings in Gujarat and the landings showed a decline by11.5%. *Megalaspis cordyla* (49.9%) dominated the gill net catches while *Decapterus russelli* (50.5%) dominated the trawl landings. The size range recorded for *M. cordyla* was 160-419 mm with a mean length of 308.6 mm and sex ratio 1:1.35. 39% of mature females were present in the fishery and the fecundity was estimated as 3,15,000. Gut content analysis revealed that *Acetes*, *Solenocera*, ribbon fish, octopus and catfishes were the major food items of the species.

Clupeids: Clupeids formed nearly 10% of the total pelagic landing with a landing of 25,815 t. Major components of the fishery were *Thryssa* spp. (38%), *Coilia dussumieri* (19%), *Chirocentrus dorab* (18.4%), other cluepids (12.3%), other shads (8.5%) and *Hilsa ilisha* (3%). The mechanised multiday trawlers landed nearly 40% of the clupeid resources and the main resources were *Thryssa* spp, wolf herring and other clupeids. *C. dussumieri* was the main catch of mechanized dolnetters among the clupeids.

Demersal Fishery Resources

Thread fin breams: Estimated landing by multi-day trawlers was 50,372 t at a catch rate of 6.97 kg/hr registering an increase of 42.41% over 2011. The fishery was constituted predominantly by *Nemipterus randalli* (50.6 %) and *N.japonicus* (44.8 %) along with small quantities of *N. bipunctatus* (4.5%). Length of *N. randalli* was 120-250 mm with a mean of 176.97 and *N. japonicus* ranged between 90-380 mm with a mean 203.17 mm.The sex ratio for *N. japonicus* and *N. randalli* was found to be 1:1.43 and 1:1.27 respectively. Analysis of food components revealed that the major species were *Acetes, Solenocera, P. stylifera, Loligo, Squilla, Sepia*, Crabs, *Secutor* sp., *Apogon* and Flat heads. The fecundity of *N. japonicus* observed varied from 12,220 to 72,664.

Sail fish landed atVeraval fishing harbour

Sciaenids: The estimated landing of croakers by multi-day trawlers, gill netters and dol netters was 62,284 t which was 2.03 % higher than the landing of 2011, at a catch rate of 3.36 kg/hr. Trawlers, dol netters and gill netters contributed 48.23 %, 22.14 % and 18.89 % to the total sciaenid landings at Gujarat. The Sciaenid landings were relatively high during first six months of the year. *Otolithes cuvieri* (40.96%) was the dominant species in the trawl fishery, *Johnieops sina* (36.67 %) was dominant in dol nets and *O. cuvieri* (45.17 %) was dominant in gill net. Length of *O.cuvieri* was ranged from 100-300 mm with a mean length of 175.55 with a sex ratio of 1:0.90 and maturity 44.82 %.

Lizard fishes: The estimated landing was 17359 t which was 30.41 % higher than 2011 at a catch rate of 0.99 kg/h. The main species contributing to the fishery was *Saurida tumbil* (70.2 %) followed by *S. undosquamis* (30.25 %). The length range of *S. tumbil* and *S. undosquamis* were 160-420 (mean length 271.05) and 90-360 (mean length 157.69) mm respectively. More percentage of immature females was found for *S. tumbil* while 50 % of mature females were found for *S. undosquamis*. Gut content analysis of both the species represented by fishes like *Cynoglossus, Saurida, Leiognathus, Otolithes, Nemipterus* and shrimps & cephalopods.

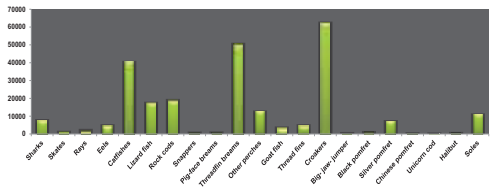
Bull's eye: Total landing by trawlers was 4280 t, recording 51.75% increase over 2011 with a catch rate of 1.46 kg/h. The length of *Priacanthus hamrur* ranged between 150-340 mm with a mean length of 227.69 mm and a sex ratio of 1:1.69.

Landing of juveniles of rays in Veraval

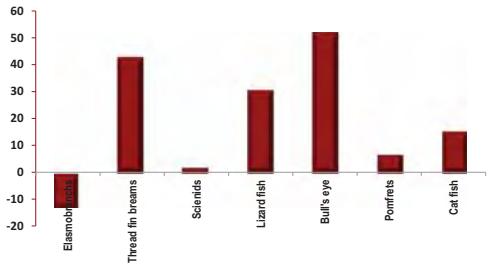
Eels: The production of eel during the year 2012 was 4673 and the length of *Muraenesox bagio* ranged from 176-1554 mm with a mean length of 803.52mm. The sex ratio was observed to be 1:1.4 and 60 % of mature females were observed in the fishery.The fecundity of *M. bagio* was observed between 39,834-1,95,120.

Pomfrets: The total pomfret production by trawls and gill netters was 7039 t recording a hike of 6.81% than 2011with a catch rate of 0.38 kg/hr. The catch was highest in multiday trawl (45.27 %) followed by multiday gill netter (33.52 %), outboard gill netter (13.49%) and multiday dol netter (6.26%). Major portion of the catch was contributed *Pampus argentius* (86.30 %) followed by *Parastromateus niger* (11.24 %) and *Pampus chinensis* (2.38 %). The length range of *P. argentius* varied from 90-320 mm with a mean length of 193.17 mm and sex ratio was 1:0.23. Fecundity of *P. argentius* ranged from 58,345 to 1, 31,523.

Cat fish: The cat fish landing of Gujarat was 40,262t (15.25 % higher than 2011) at a catch rate of 2.17 kg/hr. Maximum catch was by multiday dol netter (42.28 %) followed by multiday halter (33.08 %), outboard gill net



Components of demersal fishery of Gujarat



Percentage increase/decrease in landing of major demersal fishery resources over 2011

Landing of juveniles of black pomfret at Mangrol

Landings of cat fish at Veraval

(12.5 %), multiday gill net (6.9 %) and others (7 %). The length range of *Arius tenuispinis* was 280-670 mm with a mean length 408.22mm. The sex ratio 1:2.41 showed the dominance of females with 60% maturity. Fecundity ranged from 490-515. The gut content analysis showed a variety of food items like Shrimps, *Apogon, Nemipterus, Decapterus, Squilla, crabs*, clams and gastropods.

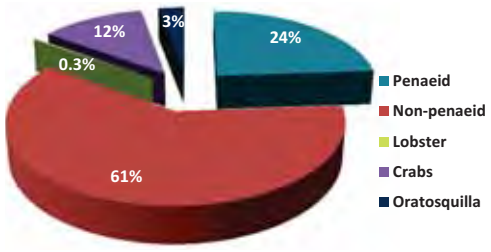
Perches: The total landing of Perches during the year 2012 was 20,166 t, where, the major catch was dominated by groupers (93.81%) followed by snappers (2.91 %) and pig- face breams (3.26 %). The catch of groupers was highest (95.68%) by multiday trawl in Gujarat. The length range of *Epinephelus diacanthus* was 60-500 mm with a mean length of 226.83 mm and sex ratio was 1:0.82. Gut content analysis showed the dominace of *Solenocera*, *Cynoglossus, Apogon, Loligo* and shrimps in the food. The length range of *Lethrinus nebulosus* was 240-480 mm with a mean length of 347.33 and sex ratio was 1:1. 62.5 % mature females were found in the fishery. The gut content analysis showed that *Loligo, Sepia*, Octopus and crabs were the major food items.

Elasmobranchs: The total elasmobranch landing of Gujarat was 10,755 t (13.14% decrease in catch than 2011), among which sharks were the major contributor (70.61%) followed by rays (19.44%) and skates (9.93 %). Major landing of sharks were from gill netters (55.20%) whereas, skates landed maximum in trawls (60.33%). The percentage of different elasmobranches to the total catch of trawl was *Scoliodon laticaudus* (39.49%), *Carcharhinus spp.* (7.84%), *Mustelus mosis* (1.34%), *Rhizoprionodon* sp(1%), *Sphyrna* lewini (0.44%), *Mobula* sp. (1.54%), *Rhinobatos* spp. (23.10%), *Dasyatis* spp. (24.9%) and *Rhina ancylostoma* (0.22%) at a catch rate of 0.31 kg/hr and 0.47% to the total trawl landing whereas, in gillnet fishery, *Carcharhinus* (51.5%), *Scoliodon* (28.6 %), *Mobula* (6.18%), *Sphyrna lewini* (5.60 %), *Mustelus mosis* (4.63 %) and *Rhizoprionodon* sp. (4.1%) were the important contributors. The catch rate was 13.09 kg/hr and 4.26 % to the total gill net landing. The length range of *S. laticaudus* was 260-620 mm with amean of 444.21 mm. The sex ratio was recorded to be 1: 2.94. The maturity percentage for the females was observed as 36.73%. *Acetes, P. stylifera, Solenocera, Loligo, Squilla,* Ribbon fish, *Coilia*, Bombay duck and *Sepia* were found to present in the stomach of this species. Similarly the length range observed for *Rhizoprionodon oligolinx* was 360-800 mm with a mean of 589 mm in the gill net.

Species	$L\infty$ (cm)	K (yr^{-1})	M (yr^{-1})	F (yr^{-1})	Z (yr^{-1})	E	L_r (cm)	L_c50 (cm)	L_m50 (cm)	Recruitment (peak)
N. japonicus	38.9	0.55	1.04	1.28	2.32	0.55	10.5	16.5	18.1	April-June
S. undosquamis	41.46	0.31	0.74	0.73	1.47	0.49	9.0	13.56	18.45	April-Aug
S. tumbil	44.1	0.84	1.40	1.31	2.71	0.48	15	26.5	29.5	June-Sept
O. cuvieri	36.70	0.51	1.06	1.12	2.18	0.51	10.0	14.86	24.5	March-June
J. glaucus	26.5	0.41	1.01	1.25	2.26	0.55	9.0	14.03	18.4	May-july
P. argenteus	31.97	0.99	1.71	1.62	3.33	0.49	9.0	16.8	26.5	Feb-July
A. tenuispinis	54.9	0.51	0.95	0.77	1.72	0.48	26.0	36.0	39.5	Dec- Feb
S. laticaudus	66.5	0.51	0.90	1.34	2.24	0.60	26.0	50.95	39	March-july
P. hamrur	38.2	0.51	1.05	0.68	1.73	0.39	17.75	16.90	22	April-july

Crustacean Fishery Resources

Crustacean resource landing was estimated to be about 1.37 Lakh t which constituted 20 % of the total fish production from Gujarat during 2012. Major groups in the crustacean landing were Non-penaied prawns (60.94%) followed by Penaied prawns (24.11%), Crabs (12.11%), Str omatopods (2.56 %) and Lobster (0.28 %). Major gears contributing to the crustacean landing were mechanised dol net (62.33 %) followed by multiday trawl net (31.86%), mechanised trawl net (5.29%) and others (0.52%).



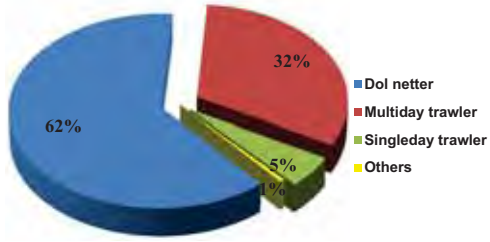
Catch composition of important crustacean resources of Gujarat

Crustacean resources of Gujarat during 2012

Species	Catch (t) Dol netter	Catch (t) Multiday trawl	Catch (t) Single day trawl	Catch rate (Kg/ h) Dol netter	Catch rate (Kg/ h) Multiday trawl	Catch rate (Kg/ h) Single day trawl
Non penaeid						
Acetes	54678.93	7118.02	3259.84	22.83	0.99	9.61
N. tenuipes	15929.18	22.29	68.17	6.65	0.003	0.20
E. ensirostris	1769.74	5.91	9.42	0.74	0.001	0.03
Penaied						
Solenocera						
S. crassicornis	4146.05	9192.15	412.32	1.74	1.27	1.22
Parapenaeopsis						
P. stylifera	3911.05	6090.43	1597.93	1.63	0.84	4.71
P. hardwickii	534.61	17.33	0.00	0.22	0.002	0.00
P. sculptilis	447.13	38.99	0.00	0.19	0.01	0.00
Metapenaeus						
M. affinis	621.37	1700.46	122.32	0.26	0.24	0.36
M. monoceros	250.23	2023.26	7.34	0.11	0.28	0.02
M. kutchensis	212.81	410.84	37.41	0.09	0.06	0.11
Penaeus						
P. semisulcatus	87.52	249.32	1.95	0.04	0.03	0.01
P. merguiensis	25.89	129.84	0.19	0.01	0.02	0.001
Metapenaeopsis						
M. stridulans	14.62	93.90	32.82	0.01	0.01	0.10
Crab						
P. sanguinolentus	6.67	678.00	0.11	0.003	0.09	0.00
C. feriatus	19.27	1652.52	27.90	0.01	0.97	0.02
Lobster						
P. polyphagus	101.35	150.24	10.02	0.04	0.02	0.03
Stomatopod						
Oratosquilla	815.17	1782.26	913.30	0.34	0.25	2.69

Growth and mortality parameters of important crustacean species in Gujarat during 2012

Prawns: Prawns contributed about 1.17 Lakh t forming about 85.05 % of the total crustacean landings of Gujarat during 2012. Non-penaeids contributed about 83,619 t forming 60.94 % of total prawn landing. Among the non-penaied prawns *Acetes* spp. dominated the catch (55.82 %) followed by *Nematopalaemon tenuipes* (13.73%), *Exhippolysmata ensirostris* (1.53%) and deep water prawn, *Heterocarpus* sp. (0.57%). Non-penaeid prawn resources



Gear wise contribution to the total crustacean landing in Gujarat during 2012

Women engaged in sorting of crabs at Mangrol

Landing of Solenocera spp.at Mangrol

Cephalopod landings at Veraval

Species	Sex	L∞ (mm)	K (yr^{-1})	M (yr^{-1})	F (yr^{-1})	Z (yr^{-1})	E
S. crassicornis	male	131.25	2.0	3.28	7.19	10.47	0.69
	female	140.50	1.7	2.79	4.59	7.38	0.62
P. stylifera	male	130.50	2.0	3.28	4.97	8.25	0.60
	female	152.25	1.8	2.95	4.95	7.90	0.63
M. affinis	male	183.75	1.7	2.79	4.04	6.83	0.59
	female	204.75	1.5	2.46	3.72	6.18	0.60
M. monoceros	male	203.50	1.7	2.79	4.02	6.81	0.59
	female	236.25	1.6	2.62	3.13	5.75	0.54
P. semisulcatus	male	214.50	1.8	2.95	3.55	6.50	0.53
	female	246.75	1.7	2.79	3.50	6.29	0.56

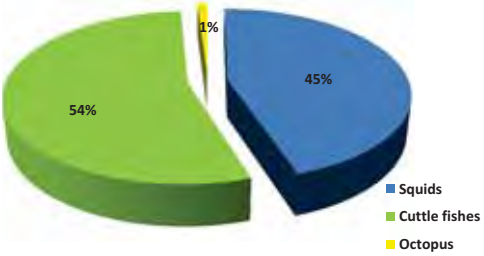
*Natural mortality was estimated using Alakraj (197) formula (M=1.64*K)

were mainly exploited by mechanised dol netter (87.35%) followed by multiday trawl netter (8.55%) and mechanised trawl netter (4%).

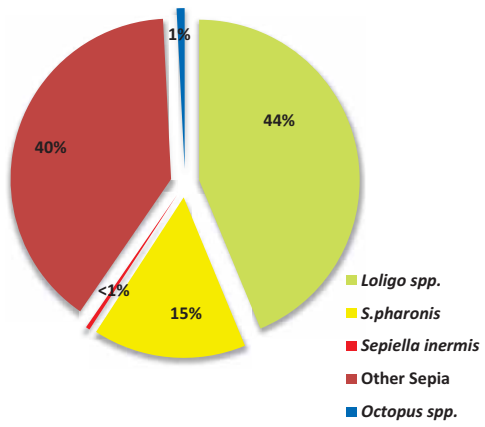
Penaeid prawns contributed about 33,080 t forming 24.11% of total prawn landing. Among the penaeid prawns, *Solenocera* sp. dominated the catch(11.91%) followed by *Parapenaeopsis* spp. (10.90 %), *Metapenaeus* spp. (4.74 %), *Penaeus* spp. (0.66 %). Penaeid prawn resources were mainly exploited by multiday trawl netter (61.95 %) followed by mechanised dol netter (31.16 %) and mechanised trawl netter (6.70 %).

Crabs: Crabs contributed about 16, 618 t forming about 12.11% of the crustacean landing. The major group in the crab landing was inedible crabs (by-catch) contributed about 14,1434 t forming 85.11% of total crab landing. *Charybdis feriatus* contributed about 1,700 t (10.23%) followed by *Portunus sanguinolentus* (4.13%), *Calappa* sp. (0.39%) and *Scylla* sp. (0.14%).Crabs were mainly exploited by multiday trawl netter (84.95%) followed by mechanised dolnetter (7.49 %), mechanised trawl netter (4.69%) and gill netters (2.74%).

Lobsters: Lobsters contributed about 382 t forming about 0.28% of the crustacean landing. The major groups in the lobster landing were *Panulirus polyphagus* (91.53%) followed by *Thenus unimaculatus* (8.36%) and *P. homarus* (0.11%).Lobsters were mainly exploited by multiday trawl netter (45.70 %) followed by mechanised dol netter (28.72%), gill netters (22.04%)and mechanised trawl netter (2.63 %).



Cephalopod catch composition from Gujarat of 2012



Cephalopod catch composition at Veraval

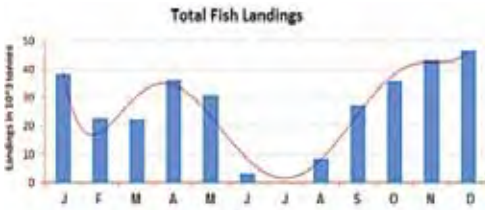
Stomatopods: Stomatopods contributed about 3,513 t forming about 2.56% of the total crustacean landing. and solely represented by *Oratosquilla* sp. Stomatopods were mainly exploited by multiday trawl netter (50.73%) followed by mechanised trawl netter (26%) and mechanised dol netter (23.20%).

Molluscan resources

Cephalopods: Total catch of Cephalopods in 2012 amounted to 58,807 t which formed 0.09 % of total marine landings from Gujarat. Cuttlefishes formed the major portion of the catch (54%) followed by squids (45%) and octopuses (1%). There was an increase of 14% of catch in 2012 as compared to the landings recorded in 2011. Major portion (98%) of cephalopods were landed by multiday trawlers.

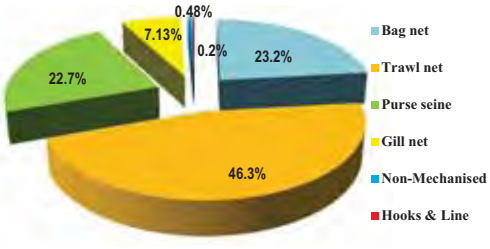
Maharashtra

The marine fish landings in Maharashtra during 2012 were estimated at 3.15 lakh t valued at ` 2,121 crores. The total fish landings recorded marginal increase of 2.5% over 3.07 lakh t in 2011 but the revenue remained almost the same. Monthwise total fish landings exhibited two peaks, first with increasing trend from August to peak in December and the second one in April after a lull during February-March. The pelagic finfishes contributed to the total landings 41.3%, demersals 23.4%, crustaceans 27.1 % and molluscs 7.4%. During the year, pelagic resources registered 13.4% decline while demersal finfishes, crustaceans and molluscan resources recorded 5.1%, 14.7% and 41.2% increase over the last year respectively. The major fishing gears that supported the fish landings in the State were trawl net (46.3%), bag net (23.2%), purse seine (22.7%)and gill net (7.1%), while traditional non-mechanized shore seines, bag nets and hooks & lines together contributed to 0.7% only. When compared to previous year, trawlers and bag nets recorded increase in catch by 14.3% and 5.8% while gill nets, purse seines, hooks & lines and non-mechanized gears registered decline by 20.3%, 10.5%, 14.8% and 16.1% respectively.



Monthwise total fish landings in Maharashtra during 2012.

The prominent species/groups that contributed to the fishery in the order of abundance weren on-penaeid prawns (16.8%), oil sardine (10.6%), penaeid prawns (9%), croakers (8%), squid & cuttlefish (7.3%), Indian mackerel (6.4%), Bombay duck (5.7%) and ribbonfishes (4.9%). It is noteworthy to mention that oil sardine (*S. longiceps*) and mackerel (*R. kanagurta*) have emerged as the major species in Maharashtra like 2011, relegating traditional Bombay duck to 6th position. During 2012 among the 28 commercially important resources, 14 recorded increase while the same number registered decline in catch when compared to 2011. The increase in catch was observed for barracuda (91.2%), squids (90.7%), catfishes (78.1%), eels (46.8%), cuttlefishes (34.5%), non-penaeid prawns (34.1%), bombay duck (31.4%), *Bregmaceros* (29.4%), polynemids (24.8%), perches (20%), lobster (15.9%), *Lactarius* (11.1%), nemipterids (10.6%) and penaeid prawns (4.1%) while decline in catch was observed for bill fishes (-93.8%), stomatopods (-38.6%), mackerel (-30%), flatfishes (-28.5%), oil sardine (-21%), tuna (-19.5%), pomfrets (-19.3%), clupeids (-11.6%), ribbonfishes (-8.2%), croakers (-7.9%), elasmobranchs (-7.7%), carangids (-2.9%)and seer fishes (-1.1%). The high abundance of oil sardine and mackerel did not last in 2012 and as a result purse seining was not as vigorous as in 2011. However, due to better marketing of oil sardine to the southern states, indigenous boats converted to mini pursers continued for ring seining in Raigad district of Maharashtra.

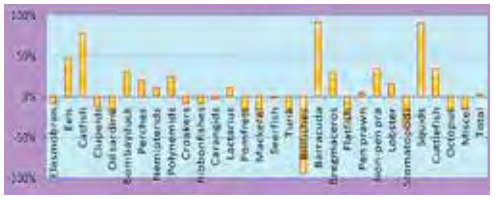


Gearwise landings during 2012

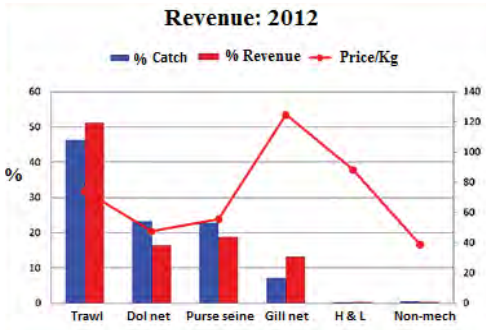
Some of the fishers in this district were supported by potential fishing zone (PFZ) advisories through NAIP assisted "m-Krishi" mobile service which enabled them to have better fish catch.

Comparison of landings of fishery resources during 2012 & 2011

Resources	2012	%	2011	%	Increase/ decrease
Pelagic	130133	41.3	147551	48.0	-13.4%
Demersal	73675	23.4	69918	22.8	5.1%
Crustaceans	85272	27.1	72756	23.7	14.7%
Molluscs	23157	7.4	13626	4.4	41.2%
Misc.	2177	0.7	2592	0.8	-19.0%
Total	**314414**	**100**	**306443**	**100**	**2.5%**



Percent increase/decrease in catch of important resources during 2012 in Maharashtra.



Gearwise catch, revenue and average price of fish.

The value of total fish landings in the state at first point of sell has been estimated as ` 2,121 crores and the weighted average price of fish was ` 67.4 per kg. Major share of revenue came from trawling (46.3%) followed by dol nets (23.2%), purse seines (22.7%), gill nets (7.1%), hooks and line (0.2%) and non-mechanised fishing (0.5%). Despite 2.5% increase in landings over 2011, neither the revenue (` 2,122 crores) nor the average price of fish (` 66.8/kg) has changed appreciably in 2012. One of the major reasons for stagnation of the revenue is attributed to 34% increase in landings of low value non-penaeid prawns (53,012 t) that has offset increase in total revenue and the average price of fish. Purse seining improved the performance in revenue share from 12.9%in 2011 to 22.7% due to better price offered for mackerel (` 94/kg) and sardine (` 21/kg) during the year. In addition, purse seiners operating from Sassoon docks could target shoals of high value croakers like 'Ghol' (*Protonibea diacanthus*) and 'koth' (*Otolithoides brunneus*) during February-March. It is possible that thermocline in post winter period off northwest coast pushes these fishes to subsurface waters which are easily located by fish-finders to be caught by purse seiners in shoals.

Pelagic resources

The pelagic finfishes contributed 1,30,133 t to the total fish landings (41.6%) but when compared to 2011 they recorded 13.4% decline.The major pelagics were sardines (29%), mackerel (16%), bombayduck(13.7%), carangids (9.3%) anchovies (5.8%) and tuna (3%).

Sardine: *Sardinella longiceps* contributed 33,389 t (10.6%) to the total fish landings in Maharashtra and ranked 2nd largest during 2012 but as compared to the previous year showed 21% decline in catch.Purse seine was the major gear that caught *S. longiceps* (43.3%) followed by non mechanised gill nets (40%). In order to harvest oil sardine that was abundant in shallow coastal waters (<5 m) along Raigad district, many indigenous crafts were converted in to mini purse seiners (ring seiner). Among clupeids, other sardines and *Thryssa* contributed 8.7% and 2.3% respectively followed by wolf herrings (2%) and shads (1.1%). The size range of *S. longiceps* was 140-194 mm with mature and gravid sardines during August and November. Copepods, *Navicula*, tintinnids, *Coscinodiscus, Biddulphia,* Decapoda, *Fragilaria* and *Nitzschia* were the major planktonic food items. Biology of *Ilisha filigera* collected from 'Karli dol nets' revealed length range between 163 to 385 mm and gut contents of 180 specimens showed dominance of *Acetes indicus* and crustaceans in food. Sex ratio was 0.8:1.

Golden anchovy: Golden anchovy, *Coilia dussumieri* contributed 2.4 % (7,500 t) to the total marine fish landings but recorded 9% decline over the last year. Trawlers contributed 59% while bag nets 29% and gill nets 11.7 % to the total catch of the species. The size range of *C. dussumieri* was 40-205 mm and gravid specimens were seen from February to April and October to December. The major food consisted of Copepods, Decapoda, *Acetes* spp, and *Lucifer.*

Indian mackerel: With 20,111 t catch it contributed to 6.4% forming the fifth largest resource in Maharashtra. Major catch of the mackerel landing in Maharashtra was contributed by purse seine (83.5%) followed by 10.5%

by trawl and 5.8% by gill nets. The size range was 170-240 mm and almost all the females were in mature and gravid condition during September to December. Gut analysis showed dominance of *Coscinodiscus*, copepods, amphipods, *Ceratium*, *Peridinium*, and *Nitzschia*.

Bombay duck: It formed 5.7% (17,821 t) of the total fish catch of the state; 59.8 % landed by dol nets and rest by trawlers, registering and increase of 31.4% than 2011. The size of the species ranged from 45 to 384 mm. Mature and gravid females were noticed during October and November and food consisted of *Nematopalaemon tenuipes* as the most favourite food followed by *Acetes* spp, *Coilia dussumieri* and juveniles of Bombay duck.

Ribbonfish: Ribbonfish contributed 15,514 t (4.9%) to the total fish landings of Maharashtra. The catch decreased by 8.22% when compared to 2011. Trawl net contributed to 90.7% of the resource followed by dol net (4.7%) and gill net (4.5%). *Trichiurus lepturus* was the most dominant species with size range of 410-1210 mm. The occurrence of mature and gravid females was noticed from January to March and September to October. Major food items in the gut were *Acetes* spp, *N. tenuipes*, *Loligo* spp, young ones of *T.lepturus, Bregmaceros* and *Metapenaeopsis stridulans*.

Seer fishes: Seer fishes contributed 5,121 t (1.6%) to the total fish landings in which *Scomberomorus commerson* (63%) and *S.guttatus* (37%) were the only two species contributing to the fishery. About (58.6%) of the *S.guttatus* was landed by gill nets followed by trawl (29.9%), purse seine (10.3%) and dol net (1.1 %). Size of *S. guttatus* ranged between 210-709 mm and females in mature and gravid stages were noticed in October and November. Gut analysis showed *Acetes* spp, *N.tenuipes*, *Loligo* spp, *S. inermis, Stolephorus, Decapterus russelli* as the major food.

Tuna: The estimated catch of tuna in 2012 was 4,070 t that declined by 19% over the last year. During the year 79% of tuna were caught by purse seine 11% by multi-day trawlers, and 10% by gill nets. Among the species *Euthynnus affinis* was the most dominant (63%), followed by *Thunnus tonggol* (24%), *Auxis* spp. (5%) and others (7%). The contribution of *Auxis* spp. to the total tuna landings reduced from 26% during 2011 to 5%. However, contribution of *T. tonggol* to the tuna fishery increased from 16% to 24%. Biology of *E.affinis, A.thazard* and *A.rochei* was investigated for size, sex and maturity. Size range of *T. tonggol* was 389-700 mm and food content was mainly constituted by fish, *Acetes* and cephalopods. Cent percent males of *A. thazard* were observed in September and their stomachs were empty with traces of digested *Acetes* sp. In the case of E. *affinis* sex-ratio was in 1:2.74 and the females were in spent stage. The stomach contained mainly the digested and semi-digested Bombay duck, golden anchovy, prawns and cephalopods. Gut content analysis of 51 specimens of *A. rochei* showed that the digested matter of fish was dominant in food content. Total length ranged between 213 to 308 mm. The sex ratio was 1.22:1.

Barracuda: With 1,862 t catch it contributed to 0.6% to the total landings in Maharashtra. Almost 95% of the barracuda landing was contributed by a single species saw-tooth barracuda, *Sphyraena putnamae*. Other species that contributed to the catch were *S. jello* and *S. barracuda*. The catch was mainly contributed by purse seine (43.6%) followed by trawl (42.1%) and gill nets (13.5%). The maximum catch was recorded in October and November. The range was 195-928 mm with a mean size at 564 mm.

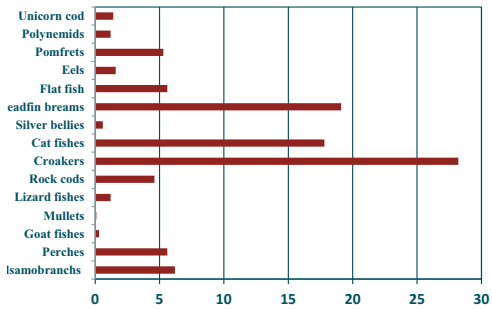
Bill Fishes: The estimated catch of bill fishes in 2012 was 126 t. *Istiophorus*

Purse seining for oil sardine in Maharashtra.

platypterus was the only contributor to the bill fish landings in Maharashtra. Gut analysis of 14 specimens revealed that food mainly comprised cuttlefish, squids, ribbon fish, anchovy, mackerel and oil sardine. Size range of *I. platypterus* was 115-292 cm.

Dolphin fish: At Sassoon Docks 158 t of dolphin fish, *Coryphaena hippurus* was landed in purse seine (79%) and gill nets (21%) with a size range of was 441-695 mm. Of the observed population, females were dominating (52.5%) and food mainly comprised of digested fish, prawn and cephalopods.

Wolf herring: The estimated catch of *Chirocentrus nuduswas* 1,069 t which showed 18% decline over the last year. During the year, 48% catch landed by trawl nets, 46% landed by gill nets, 0.6% by purse seines and 5.6% landed by dol nets.The length ranged from 320-735mm. The food mainly consisted digested matter of fish, cephalopods, ribbon fish, and *Acetes*. Of the observed population, males were 33.68% while females contributed 66.3%.



Composition of demersal finfishes in Maharashtra.

Demersal Resources

The estimated total catch of demersal resources during 2012 was 89,151 t that comprised of 23.4% of the total fish landings in the state; 71% of demersal fishes were landed by the trawlers. When compared to 2011 the catch recorded 5.1% increase.The catch was mainly contributed by croakers (28.2%), threadfin breams (15.7%) and catfishes (14.7%) of which the former two resources were targeted by using fish trawl in more than 40 m depth.

Elasmobranchs: Elasmobranch catch (4,529 t) along Maharashtra coast in 2012 exploited by trawlers, gill netters, dol netters, purse seiners and hooks & lines was 2208 t, 1700 t, 200 t, 411 t and 10 t with contribution of 1.5%, 7.6%, 0.3%, 0.6% and 1.8% respectively. Nearly 49% of Elasmobranchs were mainly exploited by trawlers and compared to 2011, the catch decreased by about 8%. Sharks was the dominant group (86%) followed by rays (11%) and skates (3%). Among the sharks *Scoliodon laticaudus* was predominant with 90% contribution in trawl, 77% in gill and 91% in dol. *Himantura alcockii* (41%) and *Rhynchobatus djeddensis* (92%) were the most dominant among rays and skates respectively.

Biology of *S. laticaudus* showed size range between 220-520 mm. Mature and gravid females were noticed in November and December. The species fed mainly on *T.lepturus, Cynoglossus arel,* cephalopods and prawns. *Rhizoprionodon oligolinx* ranged in size between 580-690 mm and pregnant females were found in September with maximum of 6 embryos (L-3,R-3). Size of *H. imbricata* ranged between 187-340 mm and pregnant females were noticed in November and December with single pup.

Pomfrets: An estimated catch of pomfrets in trawl, gill, dol net and purse seine in Maharashtra was 975 t, 1777 t, 872 t and 279 t respectively. Nearly, 46% of pomfret catch was exploited by gill nets. The catch registered 13% decline compared to the previous year. In the total fish catch, pomfrets contributed (0.7%) in trawl, 7.9% in gill, 1.2 % in dol nets and 0.4% in purse seine. *Pampus argentius* was most dominant species in gill net (95%) and dol net (97%) while *P.niger* was the dominant species in trawl net (47%) and purse seine. The size range of silver pomfret in dol net was 50-330 mm (mean size 169 mm), in gill nets 110-300 mm (202.6 mm) and in trawl 80-310 mm (154.2 mm). Thus, trawlers mostly landed undersized pomfrets but by virtue of landings dol nets caught far greater number of silver pomfrets juveniles that is damaging the stock due to growth overfishing. Biology of black pomfret *P. niger* showed size range between 190-355 mm with annual

mean size at 273 mm. Mature and gravid females were noticed in March. The species showed mainly *Acetes* spp and *Myctophum* sp in the stomach. Biology of *P.argentius* showed that females were dominant and maximum number of mature females were noticed in November (77%) and December (70%). Gut analysis revealed that they mainly feed on *Acetes* spp, *Myctophum* spp. and *Bregmaceros mcclellandi*. The fecundity of the species ranged between 12,558 and 79,200 ova.

Lizard fish: Lizard fishes contributed 877 t in total fish catch of Maharashtra landed exclusively by bottom trawlers. They constituted 0.6 % of the total fish at the catch rate of 0.12 kg/hr. Compared to 2011, the catch showed declined by 8%. *Saurida tumbil* (90%) was the dominant species followed by *S. undosquamis* (10%).

Polynemids: An estimated catch of polynemids in trawl, gill and dol nets in Maharashtra was 417 t, 437 t, and 5 t with a contribution of 0.3%, 1.95% and 0.1% respectively. The catch recorded 25% increase when compared to the last year. Polynemid catch was mainly contributed by *Polynemus heptadactylus* (92%) in trawl, *P.indicus* (78%) in gill net and *E.tetradactylum* (80%) in dol net. Size of *P. heptadactylus* ranged between 81-228 mm and nearly 70% females were found in mature condition during study period. The species fed mainly on *Acetes* spp, *Solenocera crassicornis* and *N.tenuipes* in the stomach.

Catfishes: The estimated catch of catfishes was 13,000 t which contributed 4.1% to the total fish landings and 14.1% to the demersal finfishes. When compared to 2011 the catfish catch increased by 78%. The catch of catfishes in trawlers, gill netters, dol netters and purse seiners was 2,782 t, 2,929 t, 360 t and 6,917 t in which the contribution was 1.91%, 4.01%, 1.6% and 9.67% respectively. Annual catch rate in trawl net was 0.39 kg/hr, in gill net 1.48 k/hr, in dol net 0.24 kg/hr and in purse seiner 54.79c/h kg. In comparison to last year, catfish catch increased in trawl net, gill net and purse seine by 36%, 75% and 156% respectively but declined in dol net, hook & line by 53% and 33% respectively.

The catfish catch mainly comprised *Osteogeneiosus militaris* (32.1%), *Tachysurus dussumieri* (19.1%), *T. tenuispinis* (27%) and *T. caelatus* (18%). The spawning period for *T. tenuispinis* was March, May and November and for *O. militaris* September and October. The sex ratio of *T. tenuispinis* and *O. militaris* was 1:.09 and 1:1.02 respecively. *T. tenuispinis* and *O. militaris* mainly fed on *Solenocera* spp, *Acetes* spp,, *N. tenuipes*, squilla, squids, crabs and bivalves. The size range of *T. tenuispinis* was 150-500 mm with mean at 284.8 mm, *T. caelatus* 150-670 with mean at 308.3, *T. dussumier*i 190-530 mm with mean at 272.1 and *O. militaris* 150-510 mm with a mean size of 301.6 mm.

Nemipterids: Nemipterids exploited exclusively by trawlers amounted to 13,974 t and contributed 4.4% to the total fish landings with annual catch rate of 1.95 kg/hr. Compared to last year, Nemipterid catch increased by 10.6%. The major species landed in 2012 were *Nemipterus japonicus* (55%), *N. randali* (30%) and *N. dealoge* (15%). The size ranged of *N. japonicus* was 60-320 mm with mean of 157.2 mm and *N. randali* 70-190mm with a mean size of 127.2mm. The spawning period for both *N.japonicus* and *N. randali* was from October to December; sex ratio was 1:0.47 and 1:0.4 for the two species respectively. Both the species mainly fed on *Solenocera* spp, *Acetes* spp, *N. tenuipes*, squilla, squids, crabs, juveniles of *N.randali*, *Bregamaceros mcclellandi* etc.

Groupers: Groupers were mainly landed by the trawlers (3,145 t) forming

about 2.2% of the total catch at the rate of 0.44 kg/hr. The catch and effort increased by 42.6% and 31.9% whereas contribution of groupers declined by 10% and 27% in comparison to last year. The relative species abundance showed the dominance of *Epinephelus diacanthus* (82.9%) followed by *E. tauvina* (14.2%) and *E. latifasciatus* (2.9%). Length range of *E.diacanthus* was 80-509 mm but the catch was dominated by the juveniles which accounted for 72% by numbers.

Croakers: Bulk of their catch was landed by trawlers (21,917t), which formed 87% of the total croakers landing with a catch rate of 3.1 kg/hr. During January-March, large shoals of 'ghol'and koth' were targeted by purse seiner in 30-40 m depth resulting in unusual landings of them amounting to 2.7-3 t and 0.4-0.6 t respectively and fetching ` 1-3 crores in each operation. 'Ghol' (*Protonibea diacanthus*) commanded the highest price of ` 20,000-25,000 per fish weighing 10-12 kg. In trawlers the catch of sciaenids increased by 22% as compared to previous year. Relative abundance showed dominance of *Johnius vogleri* (32.3%) followed by *J. macrorhynus* (29.3%), *Otolithes cuvieri* (21.4%) and *O. biauritus* (16.4%). Appearance of *Pennahia macrophthalmus* (0.48%) and *J. macropterus* (0.12%) in the catch was significant during the period.

Goat fish: Goat fishes were mainly landed by the trawlers (218.7 t) forming 0.15% of the total catch at the catch rate of 0.03 kg/hr. The catch increased by 68% and percentage contribution of goat fishes increased by 10% and 27.05% in comparison to last year. The relative species abundance showed dominance of *Upeneus molluccensis* (96.9%) followed by *U. sulphureus* (3.1%).

Sole fish: Sole fishes were mainly landed by the trawlers with catch of 3,916 t and catch rate of 0.55 kg/hr. The relative species abundance showed dominance of *Cynoglossus arel* (88.6%) followed by *Cynoglossus macrostomus* (11.4%).

White fish : *Lactarius lactarius* was mainly exploited by trawlers along the Maharashtra coast, gill netters, dol netters, and purse seiners with attributed catches of 900 t, 156 t, 4 t and 3 t in the respective gears. It formed nearly 0.33% of the total fish catch. The contribution of this resource dominated in trawl (84%) and gill nets (14%). The size range was 110-290 mm. The major spawning period for the species was October-November. The sex ratio was 1:0.7. *Lactarius lactarius* mainly fed on *N. tenuipes, Acetes* spp, prawns and squids.

Crustacean resources

The estimated total landings of crustacean were 85,272 t which contributed 27.1% to the total marine fish landings of the state. The crustaceans showed 17.2% increase in landings over 72,756 t in 2011. Among the crustaceans, major contributors were non-penaeid prawns (54.3%), penaeid prawns (37.5%), stomatopods (6.9%), crabs (1%) and lobsters (0.2%). The crustaceans were mainly landed by dol nets (61.8%) and trawlers (37.8%).

Prawns: Prawns formed 95.5% of the crustaceans, of which non-penaeids constituted two third and penaeids one third of the landings. During the year catch rate of prawns improved from 2.98 kg/h to 5.55 kg/hr, yet shrimp trawling was not profitable due to stagnating shrimp price and rising fuel cost. Nevertheless trawling continued owing to demand for croakers (lesser sciaenids), nemipterids and groupers.

It is interesting to note that in 2012 *Metapenaeus affinis* has emerged as the dominant species (27.9%) despite 8% decline in catch rate. Catch of *P.stylifera* showed 17% improvement but its contribution slipped to 21%, *M.monoceros* improved to 20.6% and *S.crassicornis* to 20.4%. *Fenneropenaeus indicus* and *Metapenaeus dobsoni* occurred in most of the months and appear to have established in the state. Similarly, *S.choprai* is a regular species in multi-day trawl landings with catch of 223 t that formed 1.8% of annual total landing of prawns in 2012 at New Ferry Wharf.

Non-penaeid prawns: Estimated landing of non-penaeid prawns was 53,021 t that contributed 16.8% to the total marine fish landings in the state and ranked on the top of all the marine fish resources in 2012. The catch was mainly landed by 'dol' nets (92.1%) followed by trawlers (7.6%) and non-mechanized bag nets (0.3%). Among the non-penaeid prawns *Acetes* was the dominant species (78%) followed by *N.tenuipes* (19%) and *Exhippolysmata ensirostris* (3%).

Lobsters: The estimated catch of lobsters was 199 t,which formed only 0.2% of the total fish landings but earned maximum average price of ` 900/kg. The catch recorded 13.5% increase over 172 t of last year. Trawl was the principal gear that accounted for 87.2% of lobster catch followed by gill nets (11.8%) and in bag nets (0.9%).Overall recruitment of young lobsters (<1 year class) in the fishery was very low as a result gill net fishery suffered. *Panulirus polyphagus* was the only species in the catch. The catch was maximum in September, December and April in trawl. The size of *P. polyphagus* ranged between 85-355 mm in TL but those in 165-205 mm (+2 year class) formed the mainstay of trawl catch. In trawls, the juveniles abundance was low (<260mm TL) indicating poor recruitment. Berried females were observed mainly during August-October (34-42%).

Crabs: Crabs with 561 t of landings formed 1% of the crustacean landings. The crab landings recorded 25% decline as compared to 748 t in 2011. Pelagic crabs were mostly landed by trawlers (82.5%) and the rest by other gears (17.5%) and their landings were maximum during January-May. *Charybdis feriatus* accounted for the bulk followed by *Portunus sanguinolentus* (22.3%), others (10.7%) and *P. pelagicus* (0.8%). The size ranges of the three species were between 63-158 mm for *C. feriatus*, 83-178 mm for *P. sanguinolentus* and 98-173 mm for *P. pelagicus.* The sex-ratio showed dominance of males in *C. feriatus* (1: 0.68) and *P. pelagicus* (1: 0.7) but that of females in *P. sanguinolentus* (1:1.6). The ovigerous females were maximum during August-December (80-100%) for *C. feriatus* and in April (84.6%) and June to September (66%) for *P. sanguinolentus*.

Cephalopods: The annual catch of cephalopods by trawlers in Maharashtra state was 15,658t with catch rate of 2.28 kg/hr forming 11.1% of the total fish landings in the state. *Loligo duvauceli* with 60% dominated trawl landings of cephalopods at New Ferry Wharf. The other major cephalopod species comprised of cuttlefishes *Sepiella inermis* (10.9%), *Sepia aculeata* (12.1%), *S. pharonis* (16%) and *Cistopus indicus* (1%).The annual cephalopods catch in the state of Maharashtra by trawlers increased by 16.7%.

The dorsal mantle length of *L. duvauceli* ranged between 30-319 mm, *S. aculeata* 20-159 mm, *S. inermis* 20-94 mm and *S. pharonis* ranged between 60-349 mm. The dorsal mantle length of octopus *C. indicus* ranged between 30-189 mm. A total of 800 specimens of *L. duvaucelli* ranging in length from 50-155 mm was analysed for the gut contents which indicated that they mainly fed on fish (72.2%) followed by prawns (25.8%) and squid (2%). The

sex-ratio was 1:0.9. Among the specimens observed for stages for maturity, indeterminate were 0.7%, immature 7.6%, mature 73.2% and gravid/spent 18.5%. The fecundity ranged between 1,080 and 15,570; the ova diameter ranged between 0.5-1 mm. About 130 specimens of *S. pharonis* ranging in length from 66-330 mm were analysed for the gut contents. It was observed that they mainly fed on fish (63.5%) followed by prawns (1.8%) and crabs (34.7%). The sex-ratio was 1:0.88. Among the specimens observed for maturity stages, indeterminate were 2.2%, immature 41.5%, mature 27.4% and gravid/spent 28.9%. The fecundity ranged between 1,550-9,570 and the ova diameter ranged between 2-6 mm. About 170 specimensof *C. indicus* ranging in length from 50 to 155 mm were analysed for the gut contents. It was observed that they mainly fed on fish (67.7%) followed by prawn (15.5%) and digested matter (16.7%). The sex-ratio was 1:0.31. Out of the specimens observed for maturity stages immature were 12.2%, mature 58.6% and gravid/spent 29.3%. The fecundity ranged between 1,170-22,530 and the ova diameter ranged between 1-6 mm.

Bivalves: A preliminary estimate of bivalve resources of Maharashtra indicated that 70-80% came from Ratnagiri district. Bivalves are harvested mainly from Shirgoan, Sakhartar and Bhatye creekswith estimated production of 3 t, 1.4 t and 2.7 t respectively.Bivalve landings were dominated by *Katelysia opima* (23.5%) followed by *Paphia malabarica* (22.5%), *Meretrix* spp. (15.9 %), *Polymesoda erosa* (8.5%) and other bivalves (15%). Mussels, *Perna viridis* also contributed 6.9% and oyster *Crassostrea* spp. contributed 7.8%. The shell length of the dominant commercial species *Katelysia opima* was 5-45 mm followed by *Paphia malabarica* 6-40 mm, *Meretrix* spp. 6-89 mm, *Polymesoda erosa* 30-70 mm, *Perna viridis* 30-130 mm and *Crassostrea* spp. 30-90 mm. On an average 12 people are engaged in hand picking of bivalves along Shirgoan creek and about six hand operated dredges are operated for harvesting bivalves.

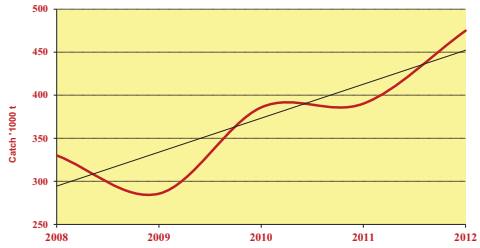
Fishery environment: Annual seawater parameters recorded at various points in and around Mumbai, their range and mean values are as given below.

Parameters	Versova creek	Mahim creek	Gorai creek	Mahim (nearshore)	Juhu (reference)
AT ° C	30.3 (26.5-35.0)	30.0 (26.0-33.5)	31.6 (27.5-35.5)	29.5 (26.0-33.0)	30.7 (26.5-34.0)
SST ° C	27.8 (24.8-31.0)	28.6 (23.0-35.6)	28.3 (26.0-31.4)	27.5 (22.7-30.9)	28.6 (23.0-31.7)
pH	7.5 (7.2-7.8)	7.4 (7.1-7.9)	7.5 (7.3-7.7)	7.5 (7.1-7.9)	7.7 (7.2-8.0)
Salinity (ppt.)	23.6 (2.8-33.1)	19.1 (4.7-30.6)	25.6 (9.2-32.8)	30.6 (23.5-34.1)	30.9 (22.5-34.7)
TSS (mg/l)	0.27 (0.17-0.48)	0.52 (0.23-0.98)	0.33 (0.14-0.81)	0.55 (0.07-1.05)	0.23 (0.15-0.36)
TDS (mg/l)	30.40 (23.40-38.60)	30.09 (24.60-35.48)	32.14 (20.80-41.80)	34.20 (23.60-41.75)	33.58 (28.60-43.98)
Turbidity (NTU)	48.10 (16.80-65.60)	28.31 (15.0-48.20)	43.26 (19.84-74.30)	35.40 (18.40-66.50)	48.13 (20.14-100)
Chl a (mg/l)	7.76 (2.20-15.79)	9.49 (1.73-16.26)	11.23 (3.89-18.04)	9.80 (1.11-14.69)	11.34 (0.82-19.35)
BOD (mg/l)	5.8 (2.0-10.0)	5.2 (2.0-10.0)	6.8 (4.0-12.0)	4.7 (2.0-8.0)	4.7 (2.0-12.0)

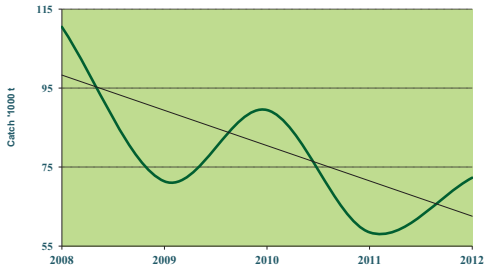
D O (mg/l)	1.2	1.3	1.8	2.4	2.7
	(0.1-2.5)	(0.5-3.4)	(0.9-3.5)	(1.2-3.4)	(1.5-3.5)
T.V.C (c.f.u/ml)	104-106	103-106	103-105	104-105	102-105
T.C.F (c.f.u/ml)	102-105	102-104	Nil-104	Nil-104	Nil-102
E.C (c.f.u/ml) *	Nil-102	102-103	Nil-102	Nil	Nil
Phosphate (mg/l)	6.91	5.93	2.60	2.38	1.17
	(4.0-9.86)	(1.10-8.70)	(1.60-3.90)	(1.30-4.40)	(0.30-2.10)
Nitrate (mg/l)	9.47	7.50	12.09	7.32	7.76
	(5.50-14.60)	(4.30-10.40)	(9.60-23.40)	(5.20-9.40)	(6.40-9.10)
Nitrite (mg/l)	2.07	1.03	1.57	0.53	0.35
	(0.15-3.28)	(0.17-1.96)	(0.15-3.28)	(0.18-1.00)	(0.21-0.52)
Silicate (mg/l)	8.37	4.97	6.22	2.91	1.29
	(5.68-10.70)	(1.96-9.42)	(4.98-7.26)	(2.14-3.42)	(0.85-2.14)

Stock assessment

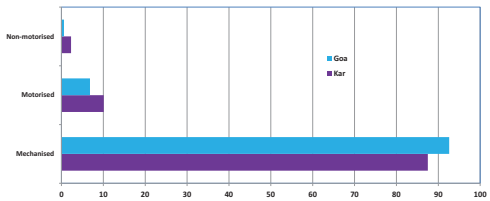
- Rapid assessment (Mohamed *et al*., 2010) of 25 stocks in Maharashtra during 2007-2011 showed that 8% were abundant, 28% less abundant, 56% declining, 4% depleted and 4% in collapsed state and their contribution to the maximum landings in the state were 9.6%, 56.5%, 30.5%, 0.16% and 0.08% respectively.
- Stock assessment by analytical length based model for 36 species of commercially important finfishes, elasmobranchs, crustaceans and cephalopods during 2007-11 showed that 25 (70%) are over-exploited ($E>E_{max}$).
- MSY and F_{msy} for shrimps targeted by trawlers were estimated by using 22 years of time series data using catch and catch rate with standardized trawling hours. Based on MSY (44,647 t) and F_{msy} (7.75 million trawling hours) the optimum number of trawlers in the state was computed 2,778 as against present fleet of 5,613 (CMFRI, 2010). This indicates that the state has overcapacity in the trawling fleet.
- Decadal compounded growth rate (CGR) of marine fish landings in Maharashtra increased at the rate of 3.2% annually from 1961 to 1990, but slowed down to 0.41% during 1991-2000 and showed negative growth rate (-4.7%) during the past decade (2001-2010). The contribution of the State to total marine fish landings of India also declined from 19.6% in 1971-80 to 12.6% during 2001-10.
- Among the 25 resources investigated by CGR only 5 recorded positive growth rates (increasing trends) while the rest showed negative growth rates during 2001-2010 when compared to the previous decade (1991-2000). Half-beaks and full beaks (1.5%), tuna (1.2%), mullets (0.9%), mackerel (0.2%) and whitefish (0.3%) showed increasing growth rates (CGR) while following showed negative growth rates: Ribbonfish (-16.4%), goatfish (-12%), eels (-9.5%), elasmobranch (-8.7%), seer fish (-8.3%), pomfrets (-7.7%), unicorn cod (-6.4%), perches (-5.9%), flatfish (-2.8%), lizardfish (-2.8%), threadfins (-2.4%), cephalopods (-1.9%), catfish (-1.2%) and carangids (-0.1%).
- Analysis of Indian mackerel landings in Maharashtra also showed 7-9 year cycles of abundance. Considering the lowest biomass during the lean years of the cycles, the MSY and Fmsy were estimated at 29,547 t and 5,46,875 fishing hours by purse seiners. The estimated optimum fleet size for regulation of purse seine fishery in the state is 182 against the present fleet of over 500 in 2011.



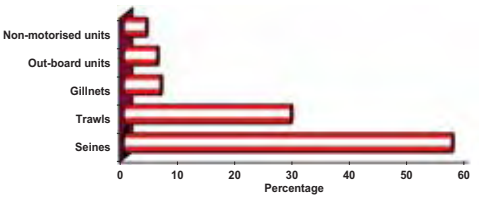
Catch trend in Karnataka during 2008-2012



Catch trend in Goa during 2008-2012



Contribution of mechanized, motorized and non-motorized sectors to the marine fishery production at Karnataka and Goa



Contribution of different types of gears to the total marine fish production at Karnataka

Karnataka & Goa

The annual marine fish catch in Karnataka and Goa during 2012 was estimated at 4,74,981 t and 72,307 t respectively. The catch during the year is 21.7% and 23.7% respectively more than the catch estimated the same period the preceding year (2011). The total catch over the years has registered an increasing trend in Karnataka. In Goa the total fish catch fluctuated with a declining trend but, registered an increase this year. The major resources that contributed to the catch at Karnataka were: oil sardine (25.2%), threadfin breams (12.8%), mackerel (7.1%), scads (6.5%), ribbonfish (6.2%), lizardfish (5%), squids (3.2%), stomatopods (3%), rock cods (2.8%) and penaeid prawns (2.7%). In Goa a similar trend was observed with oil sardine forming the major catch (58.%) followed by Indian mackerel (8.8%), lesser sardines (6.2%), carangids (5.8%), tunas (4.8), and penaeid prawns (3.3%).

The mechanized, motorized and the non-mechanized sectors contributed 87.6%, 10% and 2.4% respectively of the total catch at Karnataka and 92.6%, 6.8% and 0.6% in Goa. The mechanized sector at Karnataka was dominated by the trawlers (multi-day and the single day) which contributed to 72.3 % of the total fish catch. The purse seines were the next dominant gear contributing to 20.3 % of the total catch. The contribution of mechanized gillnets, hooks and line were negligible. The motorized sector mainly operated the ring seines and gill nets and these gears contributed 6.6% and 3.4% respectively to the total catch. The indigenous non mechanized gears comprised a variety of small gears mostly the shore seines and small gill nets/trammel nets and the catch by these gears comprised 2.4% of the total catch.

Increase/decrease (%) in catch, effort and catch per unit effort of major gears operating off Karnataka coast as compared to 2011

Gear	Catch (t)	Effort*	Catch/ Effort	Pelagic fishes	Demersal fishes	Crusta-ceans	Mol-luscs
Trawls	+36.9	+14.2	+19.9	+22.3	+57.1	+10.1	+58.3
Purse seines	-8.5	-18.0	+11.6	-7.7	+67.1	-14.8	+100
Ring seines	+73.5	+44.6	+20.2	+36.2	+461.8	+21.7	+100
Other motorised	-44.6			-34.8	-6.3	-78.2	
Non-motorised	+169.1			+224.1	+64.2	+139.7	
All gears	+21.7			+8.2	+54.7	+6.3	58.3

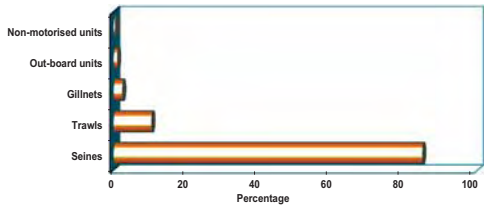
*Effort in hours for trawls and in units for all other gears

Increase/decrease (%) in catch, effort and catch per unit effort of major gears operating off Goa coast as compared to 2011

Gear	Catch (t)	Effort*	Catch/ Effort	Pelagic fishes	Demersal fishes	Crusta-ceans	Mol-luscs
Trawls	-7.0	+13.4	-18.0	-73.0	+37.2	-19.3	+43.8
Purse seines	+32.4	-7.7	43.4	+37.7	-59.8	-77.2	+2300
Other motorised	+25.0			+5.8	+53.7	+251.9	-100
Non-motorised	-71.4			-86.8	-37.6	+487.5	-85.7
All gears	+23.7			+29.3	-7.0	-2.4	+43.7

*Effort in hours for trawls and in units for all other gears

The mechanized sector formed the major group at Goa too. The catch by purse seines dominated, forming 82.0% of the catch. The catch by trawlers comprised 10.5%, the catch by gill netters 2.5% the remaining catch (4.9%) made by the other motorized and non-mechanized sector. As in Karnataka, the motorized sector was mainly represented by the small seines (ring seines) and the gill nets; the non-motorized gears comprised of shore seines and other smaller traditional gears.



Contribution of different types of gears to the total marine fish production at Goa

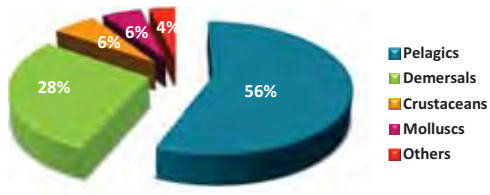
In-situ data collection of operation area and catch obtained by selected crafts/gears types registered at Mangalore was initiated for the first time in this project. Log sheets were prepared in local language and provided to the boat crew for details of operation area, catch composition of each haul, duration of each haul, etc. In addition, fortnightly *in situ* sampling of catch as well as water samples were initiated from September 2012. One such log sheet is shown below:

Monthwise details of *in situ* sampling of selected craft types operating from Mangalore Fishing Harbour

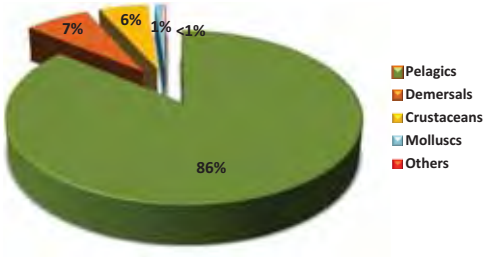
Month	Single day trawler			Multi-day trawler			Purse seine		
	Lat	Lon	Depth (m)	Lat	Lon	Depth (m)	Lat	Lon	Depth (m)
July	-	-	-	-	-	-	-	-	-
Aug	-	-	-	-	-	-	-	-	-
Sep	-	-	-	13°35'600" - 14°18'900"	73°46, 200" - 73°46'500"	63-69	-	-	-
Oct	12°51'507"	74°48'429	6.6-11.5	11°53'500" - 15°30'900"	74°36'400" - 72°54'200"	58 - 140	-	-	-
Nov	12°01'525" - 12°59'912"	74°01.267 - 74°58'897	5.5–10.0	13°03'150" - 14°51'800"	73°30'600" - 73°16'200"	86 - 130	12°00'417" - 12°59.289	74°39.901" - 74°44'916"	12 - 34
Dec	12°43'726" - 12°48.968	74°45.935 - 74°47.740	5.0 - 12.0	12°13"000" - 13°20'000"	73°29'000" - 73°40'000"		12°00'860" - 12°59'680"	74°41'430" - 74°40'590"	11 - 34

The pelagic fishes comprised the bulk (56.3%) of the marine landings in Karnataka. The demersal fishes, crustaceans and the molluscs comprised 28.5%, 6.1, and 5.5% respectively. The contribution of pelagics to the total catch increased by 8.21% as compared to the previous year. The catch of demersals increased by 54.7% and molluscs by 58.3% and crustaceans by 6.3% at Karnataka. At Goa the pelagic fishes contributed 86.1%, demersal fishes 7.2%, crustaceans 5.5% and molluscs 1%. Pelagic fishes have always been the mainstay of the marine fisheries of Goa and during the year their contribution increased by 29.3 % as compared to the previous year. The landings of molluscs too increased by 43.7% but the demersal and crustacean catch declined by 7% and 2.4 % respectively.

The oil sardine continued to dominate the catch this year also with a total landing of 1,19,611 t contributing 25.2% of the total catch at Karnataka and 41,973 t comprising 58.1% of the total catch at Goa. Other groups that contributed significantly to the catch at Karnataka include threadfin breams (12.8%), mackerel (7.1%), ribbonfish (6.2%), scads (6.5%), lizardfish (5%), squids (3.2%), stomatopods (3%), penaeid prawns (2.7%) and cuttlefish (2.2%). Of these, the catch of tunas, other clupeids, rockcods, white



Contribution of different groups to the marine fish landing of Karnataka

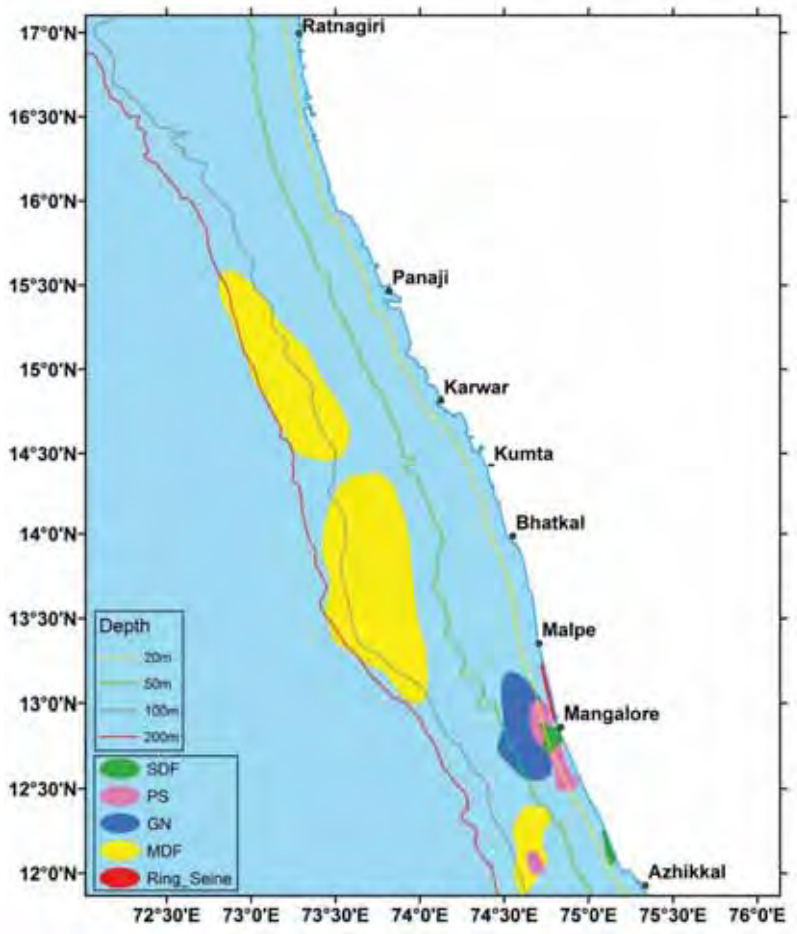


Contribution of different groups to the marine fish landings of Goa

Oil sardine being bailed into the purse seiner

Pufferfish being processed at Mangalore fish landing centre

S.pharaonis females with ripe gonads exploited from FADs using hand-jigs



Map showing the operation area of Multi-day trawl, Single day trawl, Purse seine, motorized gill net units and ring seine based on log data collected from sampled commercial crafts operating from Mangalore Fishing Harbour.

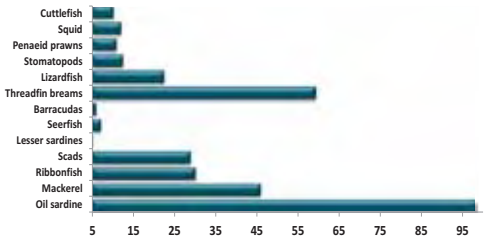
pomfrets and cuttlefish increased steeply by several folds. The cuttlefish had registered a steady declining trend since 2009. CMFRI had reported the destructive nature of fishing for adult mature cuttlefish using coconut fronds as FAD's. The trawl boat owners also had started an agitation against fishing for cuttlefish using FAD's during 2011. Based on the scientific study report of CMFRI and the discussions with all parties concerned with cuttlefish fishing, the Govt. of Karnataka banned fishing for cuttlefish using any kind of attracting devices. This will go a long way to protect the cuttlefish spawners and conserve the stock.

Major groups other than oil sardine contributing to the fishery at Goa include mackerel 8.8%, lesser sardine (5.8%), tunas (4.6%), other perches, penaeid prawns (3.2%), stomatopods (2.3%) and threadfin breams (2%). The catch of tunas, silverbellies, anchovies and cuttlefish increased by several folds.

Length frequency distribution and biological characteristics of dominant species under major groups 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.

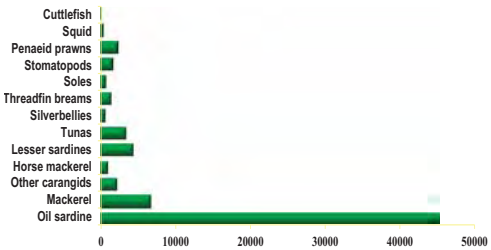
Species	Catch (t)	Period of abundance	Length range (cm)	Mean (cm)	Lm	Sex ratio (M:F)	Major food items
R.kanagurta	17763	Dec-Jan	11.5-28	21.1	17.5	1:0.97	*Trichodesmium, Coscinodiscus, Fragilaria, Pleurosigma, Biddulphia, Nitzchia, Skeletonema, Navicula, Triceratium, Ceratium, Peridinium, Foraminifera,* Tintinids, polychaetes, copepods, amphipods, Prawn larvae, Lucifer, bivalves, fish eggs, fish scales, mussel spats, Bacteriastrum, *Thallassiosira, Melosira, Ornithoceros*, copepod eggs.
S.longiceps	35158	Dec.	10-21	16.5	15	1:0.8	*Triceratium, Coscinodiscus, Pleurosigma, Chaetoceros, Biddulphia, Ceratium, Peridinuim, Protoperidinium*, diatoms, copepods, amphipoda.
S.gibbosa	1051	Dec-Jan	13-18.5	16.3	-	1:0.8	Copepods, amphipods, *pleurosigma, Fragilaria, Protoperidinium*, fish eggs, *Coccinidiscus, Nitzschia*, Calanoids, *Skeletonema*, Nauplii.
S.fimbriata	1141	Dec-Jan	11.5-20	16.2	-	1:1.6	Cladocera, amphipoda, *Peridinium, Ceratium, Triceratiium, Prorocentrum, Fragilaria, Coscinidiscus*, Foraminifera, crustacean remains, mesodinium.
S.albella	988	Dec-Jan	11.5-15	14.2	-	1:0.8	Ceratium, Peridinium, Amphipoda, Copepod, Pleurosigma, fish eggs, crustacean larvae.
E.devisi	2652	Mar.	5-10.4	8.3	6.8	1:0.93	Cladocerans, amphipods, megalopa, bivalves.
S.waitei	1685	Mar.	5-11.5	8.4	8	1:0.62	*Ceratium, Fragilaria,* Cladocera, Amphipods, polychaeta, Peridinium, Criustacean remains, *Coscinodiscus, Skeletonema, Thallasiocera, Pyrophacus.*
Trichiurus lepturus	28860	Sep-Oct	22-112	67	60	1:1.17	Acetes sp, prawns, crabs, squids, cuttlefish, octopus, *S.longiceps, Thryssa* sp, whitebaits, *Decapterus* sp., *M.cordyla*, *R.kanagurta, Nemipterus* spp., *Platycephalus* sp., *Saurida* sp., *Psenus* sp., *Lagocephalus* sp., eel, *Bregmaceros* sp., *Sphyraena*, digested fish, digested matter.
S. nigrofasciata	19.5	Oct	18-50	34	-	1:0.76	*D.russelli*, *Loligo* sp., *T.lepturus, T.myops*, digested fish.
S. commerson	2519	Sep, Apr.	12-88	41	70	1:0.94	*S.longiceps, Decapterus* sp, *M.cordyla, Saurida* sp, *Scomberoides* sp, *R.kanagurta, E.diacanthus,* Whitebait, digested fish.
R. canadum	404	Dec.	20-138	59	-	1:1.5	Pufferfish, Decapterus, *D.acuta, Parascolopsis* sp, crabs, squids, squilla, cuttlefish, octopus, *S.longiceps, E.diacanthus*, whitebaits, flatheads, *M.cordyla, R.kanagurta,* flatfish, threadfin breams, belone, *Callionemus* sp, *silverbellies, Saurida* sp, *L.lactarius, Priacanthus, sciaenids, Trichiurus* spp., *Fistularia* sp., *Sphyraena*, eel, shark, digested fish.
P. niger	1161	Sep.	10-46	20.2	-	-	Copepods, polychaetes, salps, shrimp larvae, *Lucifer*.
P. argenteus	909	Sep.	8.5-32.5	12.3	-	1:1.64	Fish, prawn, copepods.
N. japonicus	20454	Aug-Oct	6.0-34.0	14.9	18.8	1:0.6	Fish, crustaceans, polychaetes.
N. randali	40447	Aug.-Oct.	5.0-24.0	14.0	17.2	1:0.4	Fish, crustaceans, polychaetes.
S. undosquamis	2391	Sep.	10.0-40.0	22	-	-	
S. tumbil	21277	Sep	10-50	23.3			

L. lactarius	2218	Jan-Mar	6.0-31.0	15.2	13.2	1:0.9	Fishes, crustaceans.
I. omanensis	105.8	Feb.	17.0-69.0		-	1:0.9	prawns, other fish remains, crabs, octopus.
L. inermis	1213	Mar.	10.0-42.0	28.3	-	1:1.1	*Saurida* spp., squids, prawns, crabs.
P. hamrur	168	Oct.	10-39	22	-		
M. dobsoni	3488	Mar.	Male- 4.8-9.3 Female- 4.8-11.3	7.23 7.64	7.1	1:0.65	Copepods, cladocerans and amphipod.
P. stylifera	1064.1	Mar-May	Male-7.9-10.8 Female-8.3-11.8	76.8 91.1	8.4	1:0.7	Shrimps, mysids and amphipods.
M. affinis	2565	Mar-May					
M. monoceros	3403.9	Feb-Mar	Male-8.3-16.3 Female-9.3-18.8	11.1 12.6	11.6	1:1.10	
S. choprai	541.1	Mar	Male-5.3-9.8 Female-5.3-11.3	7.2 8.3	6.5	1: 1.33	Polychaetes, molluscs and fish remains.
P. pelagicus	576.3	Jan-Mar	Male -5.8-15.3 Female-5.8-13.8	93.5 91.4	9.6	1:0.72	Shrimps, crabs and stomatopods.
P. sanguinolentus	511.4	Feb-Mar	Male- 5.8-14.8 Female-5.8-14.3	98.7 99.5	9.0	1:2.01	Shrimps, crabs and stomatopods.
C. feriatus	814.3	Jan-Mar	Male- 4.8-13.3 Female- 48-108	8.47 7.64	6.0	1:0.85	Shrimps, crabs, stomatopods.
L. duvauceli	8578	Oct-Mar	4-29	10.8	13.3	1:0.72	Fish, cepahalopods, shrimps.
S. pharaonis	8829	Aug-Nov	4-34	11	17.1	1:1.05	Fish, crab, shrimp, cephalopods, *Squilla*, dig. matter
O. membranaceus	497	Aug-Oct	2-10	4.7	4.9	1:0.69	Crustacean, molluscs and fish remains.



Major resources in Karnataka

S.pharaonis catch from FADs



Major resources in Goa

Tuna landed by gillnets at Manglaore

Data on Operating cost of multiday trawlers, single day trawlers and purse seiners at Mangalore Fisheries Harbour was collected to estimate the cost-benefit ratio. The socio-economic profile and work pattern of 100 fisherwomen at Malpe Fisheries harbor was studied. Fish marketing was the predominant occupation labourer/work was the second most important area. Fisherwomen constituted 36.77% of the total fisher folk population of the district and fisherwomen laborers constitute 33.47. Fisherwomen were involved as labourers in works such as loading of fish, unloading, manual transporting from boats to fish vehicles, sorting of fishes according to sizes, and peeling of shrimps at the harbor. The fisherwomen sorters worked for almost 7 hours during the peak season of fishing (September to December) from 5 am to 12 noon, earning on an average ` 400-500 and in the case of loading/unloading workers, they worked for 13 hours a day (5am to 7pm) and earn ` 600- 1000/day. During the medium season of fishing, (March to May), they worked for almost 6 hours from 6 am to 12 noon and earned from `300-400/day. During the lean fishing months (June to first week of August), they earned on an average `50-100. A large number of women migrate from neighboring districts of Bijapur and Davanagare to Malpe in search of employment. The physical dexterity and heavy manual labour undertaken by these fisherwomen are on par with that of fishermen and hence they are a commendable labour force to reckon with and form a visible work force contributing to the marine fishery economy of Karnataka.

Women carrying oil sardine from canoe to waiting trucks at Alevekodi

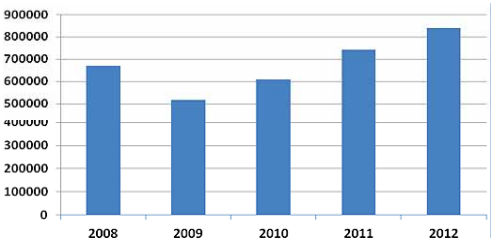
Women workforce in full swing at Malpe fishing harbour

Kerala & Lakshadweep

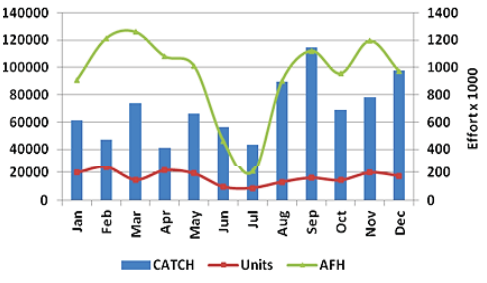
The total marine fish landings along the Kerala coast was 8,39,185 t against 7,43,123t during 2011. An increase of 96,062 t (12.9%) compared to previous year. The overall increase recorded was due to the increased production recorded by pelagic resources. Pelagic fin fishes constituted 73.4%, demersal 15.4%, crustacean 6.2% and molluscs 5.0% of the total landings. The contributions of mechanised, motorised and artisanal sectors were 68.2 %, 30.3 % and 1.5% respectively. Yield of 39 out of 60 important groups monitored has increased and 21 groups declined during 2012. The production of pelagic resources like oil sardine (+24.1 %), *Stolephorus* (+ 49.1%), other sardines (+ 84.2 %), scads (+57.4%), and other clupeids (+68.3%) recorded significant increase. The major groups contributed to the fishery were oil sardine (47.6 %), Indian mackerel (4.8 %) *Stolephorus* (4.6 %), penaeid prawns (4.9 %), threadfin breams (7.1 %), carangids (7.0 %), cephalopods (4.9 %), flatfishes (2.6 %), tunas (2.0 %) ribbonfishes (1.5 %) etc. The major gears that supported the fishery were ring seines (55.7 %), trawlers (29.6%) gill nets (6.2 %), non mechanised 1.47%) and other mechansied units 4.9%. The highest landings were recorded during the third quarter (29.5 %) followed by last quarter (29.2%), first quarter (21.7%) and second quarter (19.6 %). The highest catch was recorded in September (13.7%) and least in April (4.9%). District-wise production showed that Calicut ranked first with 22.4 % followed by Malappuram (15.1%), Ernakulam (14.6 %), Kollam (14.0 %), Trichur (10.7%), Kannur (10.0%), Alleppey (6.7 %), Trivandrum (4.2 %), and Kasaragod (2.2 %). The production of demersal resources like soles (+54.9%), croakers (+59.7%), lizardishes (+12.7%), elasmobranchs (+4.7%) silver bellies (+23.0%) catfishes (+31.6%) etc. registered an increase in the catch. Increase registered by the squids (+ 5.0 %) and cuttlefishes (+21.9 %) had also helped to improve the overall landings.

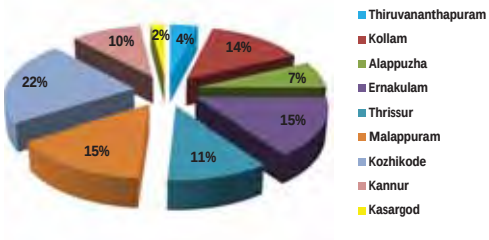
Landings of all major crustacean resources like penaeid prawns (+16.1%), crabs (+100.0%), stomatopods (+93.8%) have increased. Non-penaeid

Yearwise marine landings in Kerala during 2008-12



Monthwise catch (t) and effort in Kerala 2012





Districtwise landings in Kerala 2012

prawns (-34.7%), lobsters (-61.2 %) and pelagic resources like ribbon fishes (-54.0%), leather jackets (-62.5%), Indian mackerel (-44.6%) etc. registered a negative growth.

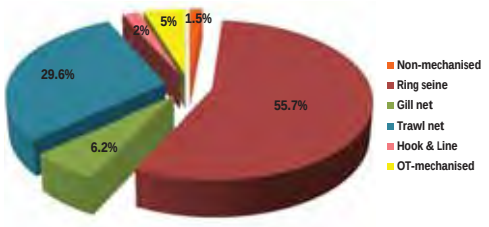
Ring seine was the most important gear which helped to increase the production 1909 kg/unit followed by mechanized purse seine (190 kg/unit) and other gears (863 kg/unit). In trawl net the catch rate was 48.7 kg/h while in gill net and hooks and line the catch rate was 77.6 kg/unit and 84.8 kg/unit respectively. The total fishing hours expended by trawlers during the year was 5.1 million fishing hours, which was 17.7% more compared to 2011. In gill net, hooks and lines, and other gears the effort was declined by 9.7%, 16.8% and 48.2% respectively. In non mechanised gears the effort increased by 33.1% more compared to 2011.

Pelagic Resources

The pelagic resources constituted 6,15,966 (73.4%) of the total Kerala landings which was 13.8 % more compared to 2011. The major resources were oil sardines (64.9%), Indian mackerel (6.5 %), white baits (6.3 %), carangids (9.5%), tunas (2.7%), ribbon fishes (2.0 %), lesser sardines (1.3 %) and seer fishes (1.9 %).

Oil sardine

The oil sardine, *Sardinella longiceps* with 3,99,786 t (47.6%) contribution was the most important resource in Kerala landings and formed 64.9 % of the pelagic landings. Oil sardine landings during the year recorded an increase of 24.1%. The peak landings were recorded in the months of September and December. Ring seine with a production rate of 1,529.8 kg/unit was the most efficient gear that contributed 93.7% of the sardine landings. Trawlers and gillnets contributed 2.2% (1.7 kg/hr) and 2.18% (12.9 kg/unit) respectively. Although, the exploited size ranged from 55 - 210 mm in TL the fishery dominant group was 120-190 mm. The mean size of the species and the length at capture (L_c) are larger than the size at maturity (L_{mat}) and optimum size for exploitation (L_{opt}). This indicates that the exploitation of stock is at biologically safer level.

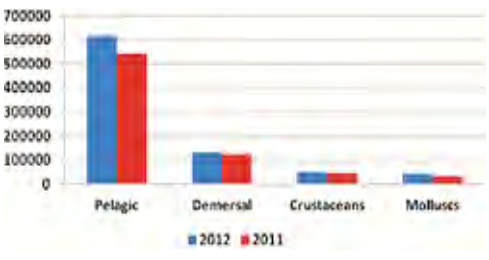


Gearwise distribution during 2012

Indian mackerel

The Indian mackerel, *Rastrelliger kanagurta* with 4.8 % contribution (39,914 t) formed the fifth largest resource in the Kerala landings which showed a decline of 44.6% against the previous year. The peak landing was recorded in the month of June. The ring seine with a production rate of 68.2 kg/unit contributed 41.8% and the trawls 15.6 % (1.2 kg/hr) to the mackerel landings. The exploited sizes ranged from 80-295 mm in TL, with 120-240 mm as the fishery dominant group. The mean size of the species is larger than the size at maturity (L_{mat}) and same as optimum size for exploitation (L_{opt}). But L_c is slightly lower, necessitating a cautious approach.

Groupwise Marine fish landings (t) in Kerala



White baits

The white baits, *Stolephorus* spp., with 4.6 % (38,697 t) contribution was the sixth most important resource that supported the Kerala landings which formed 6.3% of pelagic catch. December was found to be the most productive month. The gears and their percentage contributions that supported the fishery were trawlers (12.9%) at the catch rate of 0.9 kg/hr, ring seines 82.2% (129.9 kg/unit), gill nets 0.01 % (0.1 kg/unit), non mechansied units 1.8% (1.5kg/unit) and other mechanised units (3.0%) and the catch rate was

24.5 kg/unit. Four species were observed with the dominance of S. devisi 28.3 % (size range 70-95 mm) followed by *S. commerson* 27.0 % (size range 75-155 mm), *S. waitei* 25.3 % (size range 70-100 mm) and *S. insularis* 12.3% (size range 64-85 mm). Entire catch was by mature fishes.The mean size and the length at capture (L_c) of dominant species; *S. devisi* and *S. commerson* are larger than the size at maturity (L_{mat}) and optimum size for exploitation (L_{opt}). This indicates that the exploitation of stock is at biologically safer level.

Stolephorus spp. landed at Puthiyappa (Calicut)

Carangids

They contributed about 6.9% to the total marine fish landings of Kerala by registering an increase in their contribution to total marine fish production of the state. Their landings fluctuated widely over the year along the coast, with an annual yield of 58,463 t. Their yield registered more than 38 % increase over the last year (42,257 t). Highest production was recorded during March-May and August-November. Several gears exploit this resource, with trawls being the major gearing landing 64.2% of the resource catch, followed by ring seine (13.3%), gill net (8.8%) and the rest by other gears. Large species exploited mainly by hooks and line and drift gill nets and small species by trawl, purse seines, ring seines and other non mechanized gears. The fishery was supported by scads (71.6%), horse mackerel (7.2 %), black pomfret (1.8%), trevallies (3.9%), rainbow runners, pompanos, jacks and leather jackets. Scads were caught by trawls and trevallies by hand lines/ long lines/gill nets.

Biological indicators of important species of carangids

Species	L_r	L_{max}	Mean	L_c	L_{mat}
D.russelli	13.5	22.0	16.4	15.8**	13.9
S.crumeno-phthalmus	17.3	29.6	20.8	17.4**	17.3
M.cordyla	19.6	39.7	27.4	24.7**	25.4

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

32 species were seen in the fishery, with nearly 13 species at commercial level. Scads represented by *Decapterus* sp., *Alepes* sp., *Selar* sp., *Atule* sp. and *Selaroides* sp. constituted 71.6 % of the carangid. *Decapterus* spp.is the most dominant group and *D.russelli* the dominant species in the catch. Contribution of different scads are *Decapterus* Spp (86.5%), *Alepes* sp. (2.6%), *Selar* sp. (9.7 %) and other scads (1.2%). Young ones of almost all species encountered in the catch. Peak abundance of juveniles were observed during south west monsoon period. Mean size and length at capture (L_c) of *Decapterus russelli*, *Selar crumenophthalmus* and *Megalaspis cordyla* are larger than the size at maturity (L_{mat}) and optimum size for exploitation (L_{opt}). This indicates that the exploitation of stock is at biologically safer level. Stock assessment further showed that small carangids (*D. russelli* and *S.crumenophthalmus*) remain under-exploited and had scope for improved production. *M.cordyla* was exploited at optimum level and needed caution in increasing fishing pressure over the resource. In the case of small carangids, the stock is in good health and need no management interference. Mean size and length at capture (L_c) are either larger or close to size at maturity (L_{mat}), indicating healthy fishing conditions. The major observation is that for all species more than 50% of the catch was by matured or spent individuals, indicating that large proportion of the stock get a chance to spawn before being caught.

Decapterus macrosoma landed at Cochin fisheries harbor

Ribbonfishes

Ribbonfish production declined over the previous year by 54.0 % 12,504 t. Fishery was intermittent along the coast with peak during September. Catch was supported exclusively by *T. lepturus*. Trawlers with 67.2% contributed the bulk of the catch followed by gill nets (6.1%) and hooks and lines (4.9%) and the rest by other gears. Fishery was supported by 20-91 cm along the Malabar region with 62 to 80 cm size group as fishery dominant group. Along the central Kerala it was by 63-112 cm with 72-87 cm as fishery dominant group. Targeted fishery for juveniles are observed at places like

Catch of giant trevallies at Cochin fisheries harbor

A view of *Trichiurus lepturus* landed at Beypore

Kollam region, especially for bait purpose for tuna longliners and handliners. Mean size of the species in the catch is larger than the size at maturity (L_{mat}) and optimum size for exploitation (L_{opt}); whereas length at capture (L_c) is much smaller, necessitating cautious approach. Stock assessment on the other hand shows that the resource is under-exploited indicating scope for improved production. Overall stock is exploited at biologically safer level and no specific management is needed for time being. However, large scale exploitation of small one will be detrimental in the long run and so need cautious approach.

Seerfishes

The uptrend observed in production during 2011 (6,489t) continued during the year also with a production of 11,493 t. Major share (55%) was contributed by hooks and line, followed by gill nets (29%) and the rest (16%) by ring seine and trawls. Fishery occurred round the year with peak during October-November and February. Fishery was supported by three species dominated by *Scomberomorus commerson* (96.2%), *S. guttatus* (3.7%) and *Acanthocybium solandri* (0.1%). Landings of *A. solandri* showed wide fluctuation over the season. Catch of *S. commerson* was supported by small fishes (13-35 cm) in trawl and ring seines almost round the year, with peak during June to September. In hooks and line and gill nets catch supported by large fishes of 58-162 cm. Catch of *A.solandri* was supported by 74-138 cm fishes in hooks and line and gill nets. Mean size and length at capture (L_c) of *S.commerson* in gill net-hooks and line combination is much higher than the size at maturity (L_{mat}). This shows that large meshed gill nets and hooks and lines are ideal for exploiting the resource as they exploit mainly large and adult fishes. Trawls on the other hand catch small fishes in their nursery grounds. However, since catch by trawls remain very low and there is no need of any concern as on now.

Biological indicators of the seer fishes

Species	L_r	L_{max}	Mean	L_c	L_{mat}
S.commerson	13.6	162.0	82.3	75.6*	70.1
A.solandri	74.0	138.0	97.6	92.2*	-

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

Tuna

Tuna landings along the coast registered a marginal decline of 3.4 % from 17,373 t of 2011 to16,782t during the current year. They were landed mainly by drift gill nets and hooks and line and to some extend by ring seines. Fishery occurred round the year without any seasonal pattern in landings. However, young one of coastal tunas landed round the year with peak in June-September period by ring seines and trawls.

Seerfish catch at Munambam Fisheries harbour

Fishery was supported by eight species, six at commercial level. Coastal and neritic tunas represented by five species together constitute 80.9 % of the tuna catch and was dominated by *Euthynnus affinis* (46% of the total tuna catch). Catch of coastal/neritic tuna marginally declined, whereas that of oceanic tunas improved. Coastal/neritic tuna fishery was supported by *E.affinis, Auxis thazard, Auxis rochei, Sarda orientalis* and *Thunnus tonggol*. The length at capture (L_c) and mean size of coastal tunas are almost equal or larger than size at maturity (L_{mat}) and optimum size for exploitation (L_{opt}). The presence of large SSB also indicated that stock along the coast is very robust and healthy. Stock assessment of coastal tunas for Kerala coast based on past data showed that they are exploited either optimally or slightly above the optimum level. This necessitates cautious approach to maintain the stock and yield at optimum level or slightly below it. At the same time scope for increased production from less exploited area like sea-ridges, mounts and knolls needed to be explored.

Biological indicators of tuna species

Species	L_r	L_{max}	Mean	L_c	L_{mat}	E	F	Z	M	Remarks
E.affinis	18.4	68	41.2	37.6**	39.4	0.68	2.68	3.97	1.29	Slightly over-exploited
A.thazard	16.7	47.8	33.7	29.4 **	29.7	0.51	1.36	2.68	1.32	Optimally exploited
A.rochei	17.8	36.4	24.2	23.8**	20.7	0.53	1.62	3.07	1.45	Over-exploited

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

Estimates of exploitation and mortality rates

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

Billfishes

Production registered decline during the year from 2,533 t of 2011 to 2,170 t during 2012 by registering 14.4 % decline. They were exploited mainly by hooks and line (12.9 %), gill nets (13.3 %) and others (73.8%). Fishery occurred round the year with peak during March and October. Billfish fishery was supported by *Istiophorus platypterus* (90.3 %), *Makaira* spp. (8.9%) and *Xiphias* spp. (0.8 %). Length at capture(L_c) is small compared to L_{mat} and L_{opt} indicating stress on the stock. Stock assessment also shows that species is over-exploited, necessitating cautious approach in the exploitation of the resource.

Demersal Resources

The total demersal fish landings 1,28,783 t (15.4 %) increased by 5.6% compared to 2011. The major contributors were threadfin breams with 59,326 t (46.1 %) flatfishes 21,790 t (16.9%), lizard fishes 1,2731 t (9.9%), croakers 9,240 t (7.2%), elasmobranchs 4,040 t (3.1 %) and groupers 2,231t (1.7%). Among them sharks (+5.2 %) flatfishes (+54.9%), croakers (+59.7%), silver bellies (+23.0%), catfishes (+31.6%), lizardfishes (12.7%) exhibited an increase in the production. But, resources like groupers (-22.4%), snappers (-9.0%), threadfin breams (-10.8%), skates (-29.5%), pigface breams (-12.8%) declined over the previous year.

Elasmobranchs

An estimated total of 4,040 t of elasmobranchs were landed in Kerala during 2012 as compared to 3,858 t landed in 2011 registering an increase of 4.7%. Elasmobranchs formed 3.1 % of the total demersal finfish landings and 0.5% of the total marine landings of the state. Sharks contributed 63.0 % (2,543 t) of the elasmobranch landings of the state followed by rays contributing 30.7% (1,242 t) and skates 6.3 % (256 t). Mechanised drift net hook & line units (MDNHL) contributed major share (55.9 %) in elasmobranch landings followed by mechanized drift net units (MDN) with 19.7%. MDNHL was the major gear contributing to shark (67.0 %) as well as ray (42%) landings, whereas multiday trawl nets (MDTN) contributed major share (85.0 %) of skate landings. The catch rate was less than 1 kg in most of the gears.

A view of sharks landed at Calicut

A variety of species (>25 species) were observed in the shark landings by H&L units at Cochin Fisheries Harbour with major share by *Carcharhinus falciformis* (34.2%), *Alopias superciliosus* (17%), *Sphyrna lewini* (9%), *Carcharhinus longimanus* (7%), *Carcharhinus limbatus* (6%) and *Isurus oxyrinchus* (4%). The major species landed in trawls at Cochin and Neendakara were *Rhizoprionodon acutus, Scoliodon laticaudus, Iago* sp. and *Mustelu*s sp.Five species were observed in the fishery of sharks in Calicut region. Among sharks, *C. limbatus* (45.7%), *C. sorrah* (19.9%), *S. lewini*(10.0 %), *S. zygaena* (14.0%) and *Alopias vulpinus* (6.0%) were present in the catch. *C. limbatus* was the dominant species found in all the gears.

In the case of rays *Dasyatis uarnak* (25.28%), *Aetobatus narinari* (24.27%), *D. bleekeri* (19.3%), *D. sephen* (18.5%), *Mobula* spp (4.4%) and *R. javanica* (3.8%) were the species found in the catches. *R. djeddensis* was the only species of skate found in the fishery.14 species of rays belonging to 9 genera *Manta, Mobula, Himantura, Rhinoptera, Neotrygon, Pterygotrygon, Taeniura, Aetobatus, Myliobatis* were landed at Cochin. Of these *Mobula japonica* was the most dominant contributing 64.53 %.The length of *C. limbatus* observed in the fishery was 498-2296 mm with the commercial size range was 1200-1800 mm and annual means size was1271.8 mm.The sex ratio of *C. limbatus* in the fishery was 1:0.9.

Threadfin breams

Catch during the year was 59,325 t, it showed a decline of 10.8%. They formed 46.1 % of the demersal landings. Bulk of the catch (89.3%) were landed by trawlers. The catch rate was 10.4 kg/h in trawlers. *Nemipterus randalli* (53.5%.), *N. japonicus* (44%) and *N. bupunctatus* (2.5%) were the species landed with *N. randalli* being the dominant species landed at Cochin. Dominance of juveniles (ranging in size from 50 – 110 mm TL) of *N. randalli* in the landings was noticed only during January and November, as compared to the previous year, during which dominance of juveniles were pronounced during January, February as well as December. *N. randalli* (58.3%) dominated the fishery followed by *N. japonicus* (39.3%), *N.tolu* (2.0%) and *Parascolopsis aspionasa* (0.4%) were the species landed in the Calicut region.The exploitation ratio is currently above the optimum level in *N. randalli* (E=0.71) and *N. japonicus* (E=0.67), but the spawning stock biomass estimated in both species is more than 32 % of the stock at its unexploited level.This shows that these resources are having sufficient regeneration capacity for the revival of the fishery.

Fishery related parameters of some important demersal finfish resources

Species	Length range (mm)	Mean size (mm)	Fishery dominant size group (mm)	Exploitation ratio (E)	Spawning stock biomass (t)	Standing stock biomass (t)	Yield (t)
C. limbatus	498-2358	1241.9	1200-1800	0.78	768	1138	1094
N. mesoprion	22-258	143.9	120-210	0.71	9238	14406	33376
N. japonicas	42-308	151.4	120-240	0.67	7499	10513	23810
C. macrostomus	42-177	116.2	90-140	0.52	9506	16549	15377
J. sina	32-198	129.1	120-180	0.70	1792	4203	3134
O. ruber	72-298	175.3	160-240	0.73	249	370	935

Flatfishes

Flatfish catch during the year (21,790 t) increased by 54.9% over 2011.They formed 16.9% of the demersal landings. Bulk of the catch was landed by trawls (94.5%), followed by ring seine (2.7%) and non mechanised gears.The

catch rate was highest in trawls (4.1 kg/h), while in other gears the catch rate was negligible. *Cynoglossus macrostomus* was the dominant species both along the Malabar (73.1%) and Central Kerala (78.2%). Other important species were *C. dubius* (13.9%), *C. arel* (9.9%) *C. bilineatus* (1.8%) and others (1.7%).Virtual population analysis carried out on *C. macrostomus* shows that the spawning stock biomass estimated is more than 35 % of the annual stock at its unexploited level. This indicates that the resource is having sufficient regeneration capacity.

Sciaenids

Catch during the year was 9240 t, which was increased by 59.7 % over 2011. They formed 7.2 % of the demersal landings. 27.6% of the catch was contributed by trawlers followed by ring seine (57.2%) gill net (8.1%), non mechanised gears (4.2 %), H& L (0.2%) and others (2.8%). Highest catch rate was recorded in ring seine (2.5 kg/unit), followed by other mechansied units (5.4 kg/unit) and in all other gears the catch rate was less than 2 kg/u. The fishery was supported by 10 species belonging to four genera in Calicut region. *Johnieops sina* (56.2%) was the dominant species followed by *Otolithes ruber* (13.5%), *J. macropterus* (7.2%), *J. glaucus* (11.2%), *J. caruta* (1.1%), *O.cuvieri* (2.7%), *J. belangerii* (6.5%), *J. dussumieri* (1.3%), *J. caroutta* (1.1%) and *J.elongatus* (0.2%). Although the sciaenid resources especially *J. sina* and *O. ruber* were 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 its capacity to revive the future fishery.

Lizard fishes

Catch of this resource was 12,731t (9.9%),the catch was increased by 12.7% compared to 2011. Major share of the catch was landed by trawlers (86.2%) followed by other mechanized units (12.8%), ring seines (0.4%), non mechanized gears (0.4%) and gillnetters (0.2%). The catch rate in trawl was 2.2 kg/h, while in other gears it was34.3 kg/units. *Saurida tumbil* (65.3%), *S. undosquamis* (23.1%), *Trachynocephalus myops* (0.7%), *S. gracilis* (5.3%) and others(1.1%) were the species supported the fishery at Calicut region during the year. At Cochin, *S. undosquamis* dominated with a contribution of 49% followed by *S. tumbil* (44%) and *T. myops* (7%).

Groupers

The grouper catches during the year was 2230 t (0.3 %), the catch declined by 22.4 % compared to 2011. The grows formed 1.7 % of the demersal landings. They were landed by trawlers (33.9 %), gill nets (24.9%), hooks and line (17.3%), ring seine (0.5%), non mechanised gears (0.2%) and others (23.1%). The catch rate of groupers was high in hooks and line (1.9 kg/ unit) and other mechanised units (10.8 kg/unit). In other gears the catch rate was less than 1 kg/unit. 18 species of groupers contributed to the hooks & line fishery at Cochin harbour. *Epinephelus diacanthus* was the most dominant species. Other important species. were *E.epistictus*, *E.chlorostigma* and *E. longispinis*.

Snappers

An estimated 1,217 t of snappers i.e., 0.2 % of the total landings was constituted by snappers in Kerala. Gearwise contribution showed that 59.2% was contributed by gill net followed by mechanised other units (20.6%), hooks and line (16.5%) and trawl (3.3%) and rest by non mechanised units (0.3%). Except the month of May, landings of snappers were scanty. The

catch rate of snappers were negligible in most of the gears. nine species of snappers belonging to five genera contributed to the hook and line fishery at Cochin. They are *Lutjanus gibbus, L.bohar, L.kasmira, L.lutjanus, L.rivulatus, Pristipomoides typus, Aprion virescens, Aphareus rutilans,* and *Pinjalo pinjalo*.

Silverbellies

An estimated 4,662 t of silver bellies was landed in Kerala, which has shown an increase of 23.0% compared to 2011. The catch rate was highest in mechanised other units (8.1kg/unit), followed by ring seine (4.6kg/unit), gill net (0.8kg/unit), trawl net (0.3kg/h) and non-mechanised 2.0kg/unit).

Pomfrets

Pomfret catches were 1,587 t, (1.2%) of demersal resources, the catch increased by 7.6 % compared to 2011. The major gears that contributed to the fishery of silver pomfret was trawlers (71.6%) and non mechanised gears for Chinese pomfret. The catch rate of pomfrets were negligible in most of the gears. *Pampus argentius* was the dominant species found in the catch.

Catfish

The catfish catches during the year, 316 t, the catch increased by 31.6 % compared to 2011. They formed just 0.2% of the total demersal landings. The major gears that supported the fishery were trawl nets (40.2%) followed by hook and lines (11.4%), gill net (8.3%), ring sine (7.4%), other mechanised units (26.9%) and non mechanised units (5.8 %).

Pigface breams

The landings of pigface breams (Emperor breams) were dominated by *Lethrinus mahsena*. Pigface breams formed 691 t of the total landings in Kerala, the catch declined by 12.7%. The gears that contributed the fishery were gill nets (57.3%), hooks and lines (25.5%) and trawls (4.5%). The highest landings was recorded in February (107 t). In trawl and gill net, the catch rate was less than 1 kg.

Crustacean resources

The total crustacean landing during the year, 51,755 t, increased by 15.0 % compared to 2011. The major contributors were penaeid prawns 40,885 t (79.0%), non-penaeid prawns (4,088 t), crabs (4,384 t), stomatopods (2,141 t) and lobsters (38 t). 85.5 % of the crustaceans were landed by trawlers followed by ring seines (11.5 %) and other gears (3.0%). Trawlers contributed 82.9% of the penaied prawns, followed by ring seine (14.5%), other mechanised units (2.0%) and the rest by other gears. Trawlers contributed 96.1% of non-penaeid catch and rest by others (3.9%). Penaeid prawn catches during the year was 40,884 t, which was increased by 16.0% over 2011. Trawlers (75.4%) and non mechanised gears (24.6 %) were the major contributors of lobster. Non-penaeid prawn catches during the year, 4,085 t declined by 35.0 % over 2011. Lobster catches during the year was 38 t which declined by 61.0% over 2011. Crab catches during the year was 4,384 t which doubled during 2012. Stomatopod landings during the year was 2,141 t which increased by 94.0 % over 2011.

Shrimps

Total penaeid prawn landing in 2012 was 40,884 t, which increased by 16.0 %

Prawn landings at Neendakara harbour

Fishery related parameters of important prawns

Species	Length range (mm)	Mean size (mm)	Dominant size group (mm)
M. monoceros	96-170	123.0	110-150
F. indicus	91-180	144.0	120-150
M. affinis	41-150	128.0	120-150
P. stylifera	45-120	84.0	80-120
M. dobsoni	46-120	91.0	80-120
S. choprai	56-100	77.0	70-80

over 2011. They formed 79.3 % of the crustacean landings. 93.6 % of the shrimp landings were constituted by penaeid prawns and 6.4% by non-penaeid prawns. The catch rate of penaeid prawns was highest in ring seine (24.1kg/unit), followed by others (17.2kg/unit) and trawl net (6.6 kg/h).Among the inshore penaeid prawns, *Parapenaopsis stylifera* dominated with 61.9% in south Kerala landings whereas, *Metapenaeus dobsoni* was the dominant species in the Malabar (46.9%) and central Kerala (84.0%).The other important species were *Fenneropenaeus indicus*, *Metapenaeus monoceros*, *M. affinis*, *Trachysalambria curvirostris* etc.The total non-penaeid prawn catch was 4,085 t (7.9%) of the crustacean catch and it has shown a decline of 35.0 % (2,174 t) of previous year.The catch rate of non-penaeid prawn was negligible in trawl net (0.8kg/h), while in other mechansied units it was 3.2 kg/unit.The deep sea penaeid prawns catch was dominated by *Metapenaeopsis andamanensis* (62.4%) followed by *Aristeus alcocki* (37.6%).Among the deep-sea non-penaeid prawns, *Plesionika spinipes* contributed 56.0% in south Kerala and 54.2% in central Kerala landings. Other important species were *Heterocarpus gibbossus* (21.0 %) and *H. woodmasoni* (18.0 %).

Prawn landings at Beypore in Calicut

Crabs

The crab landing during the year was 4,384t which was doubled compared to 2011.They formed 8.5 % of the crustacean landing. 92.0% were landed by trawlers and the remaining portion by gill netters (1.1%), non-mechansied units (6.1%) and others (0.8%).The catch rate of crabs was less than 1 kg in all the gears.While *Portunus pelagicus* (69.4%) was the dominant species in the Malabar crab landings and *P. sanguinolentus* accounted for the bulk of the landing in south and central Kerala (47.0%). Other important species were *Charybdis feriatus, Charybdis lucifera* and *Podophthalmus vigil*.

Podophthalmus vigil landed at Cochin fisheries harbour

Lobsters

Lobster landings during the year was 38 t which declined by 61.0 % compared to 2011.They formed 0.07 % of the crustacean landing. 75.4% were landed by trawlers and 24.6 % by non mechanised gears. In lobsters also the catch rate was less than 1 kg. Slipper lobster, *Thenus unimaculatus* and spiny lobster, *Panulirus homarus* were the most important species landed during the year.

Fishery related parameters of important crabs

Species	Carapace width (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

Molluscan resources

The molluscan landing was 42,679 t and this was 22.0 % more compared to 2011. 80.3 % of the resource catch was by trawlers followed by hooks and lines (11.7%), gill nets (0.9%) and others (7.1%).The major contributors were cuttlefishes (47.7%), squids (33.7%), octopus (15.2%) and gastropods (2.8%).Among the molluscs, squid (+ 5.0 %) and cuttlefish (+22.0 %), octopus (+61.0 %) and gastropods (+205.0 %) catch increased compared to 2011.

Cuttlefishes

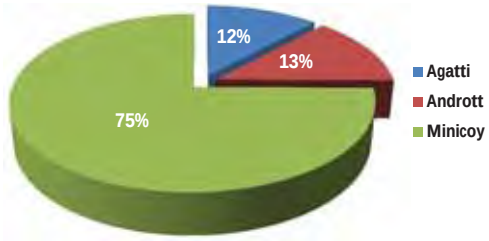
Cuttlefish landing (20,385 t) formed 47.8 % of the total molluscan landing. 75.1% of the catch was by trawlers followed by hooks and lines (20.1%) and others (4.8%). 90.9% of the cuttlefish catch was represented by *Sepia pharaonis* alone. Other species were *Sepiella inermis*, (3.3%). *Sepia elliptica* (3.1%) and others (1.8%).The catch rate was highest in hooks and line (20.3 kg/unit), while in trawlers the catch rate was 2.9 kg/h.

Loligo duvauceli landed at Beypore in Calicut

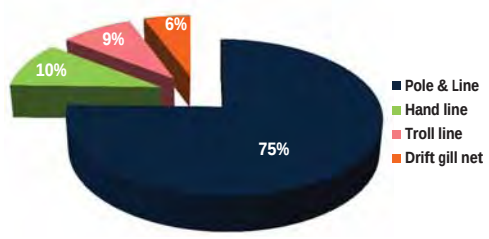
Squids

Squid landings formed 14,389t (37.7%) of the total molluscan landings. 80.3%

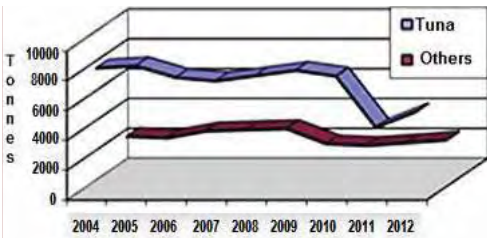
Octopus spp. landed at Beypore in Calicut



Island wise Tuna landing in 2012



Gearwise Tuna landingin 2012



Estimated Tuna and other fishes during 2004-12

Estimated species composition in 2012

of squids catch was by trawlers, followed by gillnets (6.7%), ring seine (0.6%) and others (12.0 %). The catch rate of squid was high in hooks and line (4.8kg/unit), but in trawl net it was 2.38 /h.Catch was represented mainly by *Loligo duvauceli* (59.8%). Other species were *L. singhalensis* (23.5%), *L. edulis* (20.2%), *Sepioteuthis lessoniana* (14.4%) and others (2.3%).

BRP and VPA of dominant cephalopods of Central Kerala

Species	(L_∞) mm	Growth Rate (K) (yr^{-1})	Optimum Length of capture (L_{opt}) mm	Mean Generation time (tg) (yr)	Reproductive Load	Mean size (mm)	SSB (t)	ST (t)*
L. duvauceli	374	1.4	247.0	0.77	0.33	204	12934	14470
S. pharaonis	387	0.63	240.0	1.54	0.52	164	6339	7437
A.neglectus	107	0.81	63.5	1.11	0.30*	56	1835	2276

Octopus

Octopus landing 6,515 t which formed 15.3% of molluscan landing. The catch increased by 61.0% over 2011. Almost 95.4% of the catch was by trawlers. The catch rate was higher in other mechanised units (6.2 kg/unit), while in trawlers it was 1.2 kg/h. Fishery was supported by *Amphioctopus neglectus* (51.4%), *A. marginatus* (25.4%), *Cistopus indicus* (18.6%) and others (18.6%).

Lakshadweep tuna fishery

The estimated total fish catches in 2012 by pole & line, troll line, drift gill net, encircling gill nets, hand lines & long line was 7,683 t against 6,428t in 2011. The total catch during the year increased by 19.5 % compared to the previous year. Tunas formed 71.5 % (5,493 t) and other fishes and elasmobranchs formed 28.5 % (2,189t). The tuna landings during the year increased by 19.8 % and other fishes and elasmobranchs increased by 17.7 %. Apart from these, about 20-22 t of octopus also were caught during the year. The contributions by 3 observation centres viz Minicoy, Andrott and Agatti were 24.2%, 4.25% and 3.87 % respectively to the total Lakshadweep tuna landings. The contributions by Agatti was found to be gradually declining from 2009 onwards and has reached the lowest in 2012. But, the contributions by Andrott, due to the diversified fishing practices including the adoption of pole & lining, has been steadily increasing during the last five years. The tuna landings in general (4,437t to 5,493t) and skip jack landings in particular (1,640t to 2,484t) recorded comparatively considerable increase throughout Lakshadweep. This was mainly due to the comparatively better aggregations of skip jack shoals at islands like Minicoy, Andrott, Kalpeni etc, and due to the targeted fishing using double pole method of P&L for deep swimming larger yellow fins tunas.

The species which supported the tuna fishery in 2012 & 2011 were *Katsuwonus pelamis* (45.2 % & 36.9 %), *Thunnus albacares* (47.1 % & 54.49 %), *Euthynnus affinis* (5.36 % & 5.53 %), *Auxis thazard* (2.1 % & 2.7 %) and *Gymnosarda unicolor* (0.3 % & 0.3 %). In spite of the improvement (+ 40.2 %) in the skip jack landings (2,484 t) during the year, the yellow fin catches retained the top position with 2587t landings in 2012 also. Five gears supported the tuna fishery during the year. As usual, pole & line landed more than 67% of the catches and long line the least (0.02 %). The double pole P&L method practiced for larger yellow fin tunas has greatly helped to improve (75.44 % vs 68.7 % in 2011) the contribution by the P& L gear during the year. The most productive and the least productive months were

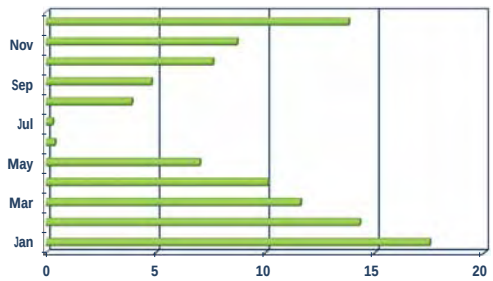
January & July with the percentage shares of 17.52 % and 0.33 % respectively. The 1st quarter (43.4%) was the most productive period followed by 4th quarter (30.07%), 2nd quarter (17.45%) and lastly the 3rd quarter (9.07%). The fresh tuna prices during the year varied from `100 to 400 /kg and that of cooked, smoked and dried *Mas* price was ` 650 to 900 /kg .The prices for fresh octopus ranged from ` 200 to 300 /kg and that of dried octopus was ` 900 to 1100 /kg.

Pole & line catch

Troll line catch

Hand line catch

Drift Gill Net catch



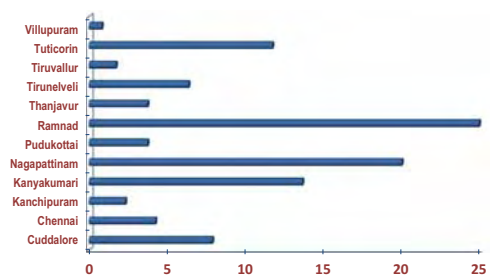
Mothwise tuna catch in 2012

Tamil Nadu

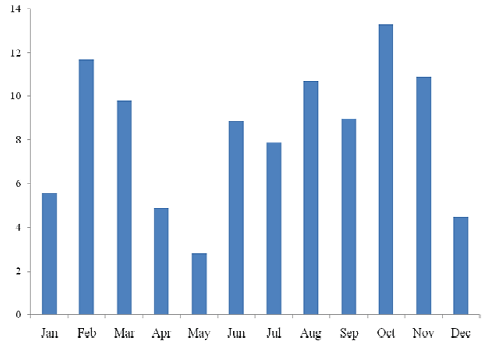
The total marine fish landing along Tamil Nadu coast during 2012 was 7.1 lakh t which showed an increase of 13 % compared to that of 2011. The highest contributor was from Ramanathapuram district contributing 24.7% followed by Nagapattinam(19.8%), Kanyakumari(13.5%) and Tuticorin(11.6%). Average seasonal abundance shows that the peak period was June to November with a minor peak in February to March. Pelagic finfishes contributed 51.4%, demersal 34.1%, crustaceans 8.7% and molluscs 5.9% to the total landings. The mechanized, motorized and the non-motorized sectors contributed 69.9%, 29.1% and 1.0 % respectively. Single day Trawlers were the major unit contributing 44.1% followed by gill nets operated by motorized boats (16.2%), and multiday trawlers (MDTN) (14.9%). The multiday trawlers (MDTN) catch showed an increase of 96 % compared to previous year. Out board motor driven ring net (OBRS) catch also showed an increase of 73 % compared to previous year. In Tirunelveli and Tuticorin, the use of ring net gear was rampant this year.

Pelagic resources

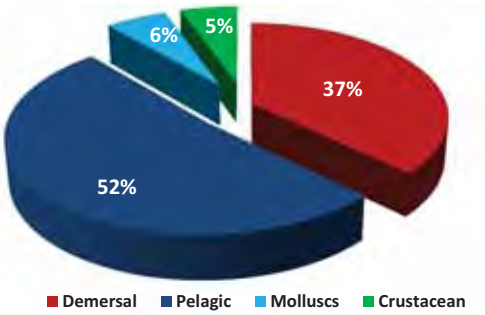
Sardines: The sardines formed 46 % of the total pelagic resources and the contribution of oil sardine alone was 22 %. Ring seine contributed 67 %



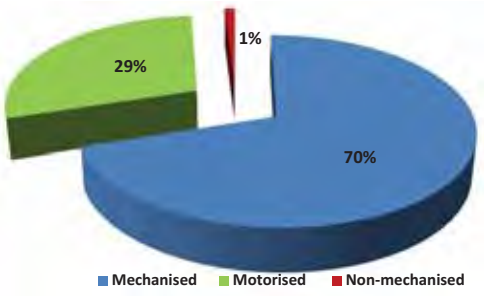
Districtwise contribution of landings (%) in Tamil Nadu



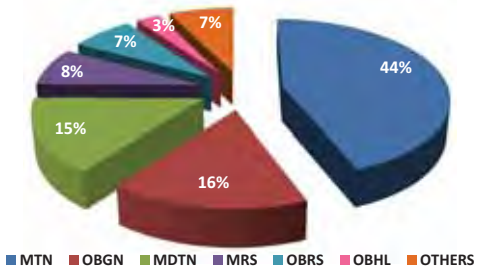
Monthly variation (%) of landing



Resource wise distribution of landings



Sector wise landing



Gear wise contribution

of the total landing of oil sardine followed by outboard driven gill net (OBGN) of 12.6 %. Three species have been found to support the sardine fishery in Chennai among which *Sardinella gibbosa* formed 80% followed by *S. longiceps* (18%) and *Amblygasters* irm (2%). In Mandapam, the overall percentage contribution was 42 % by *S. longiceps*, 39 % by *S. albella* and 18 % by *S. gibbosa*. But here the oil sardine formed a fishery only during October to December whereas the other two species were found to form the fishery throughout the year.In Tuticorin, the fishery comprised *S. gibbosa*, *S. albella, S. longiceps, A.sirm* and *A. clupeoides* mainly among which *S. gibbosa* was present throughout the year and formed 89.3 % in trawl net and 72.4 % in gill net. In Chennai *S.gibbosa* ranged in size from 80-178 mm TL and that of *S.longiceps* from 75-198 mm. In Tuticorrin, the size of *S.gibbosa* ranged from 110-180 mm with a mode of 135 mm and a mean of 141 mm.In Mandapam, *S. albella* ranged in size from 100-145 mm with a mode of 120 mm and that of *S.gibbosa* from 95 to 155 mm with a mode at 130 mm.

Mackerel: Mackerel fishery comprised a single species, *Rastrelliger kanagurta*. It formed 5.9 % of the total landing of pelagic resources. Of the total mackerel landing, 46% was contributed by OBGN and 28 % by single day mechanized trawl netters(MTN). Mackerel size range at Chennai was 75-258 mm whereas at Mandapam, it ranged from 110-270 mm. In Tuticorin, it varied from 125-300mm.

White baits : White bait landing was 10,409 t which was 2.8 % of the total pelagic resource landing. It comprised mainly *Stolephorus indicus* and its size ranged from 40-150 mm in Mandapam and from 90-165 mm in Tuticorin.

Ribbon fish: Ribbon fish landing was 19,933 t forming 5.4 % of the pelagic fish landing. It comprised a single species *Trichiurus lepturus* and its size varied from 125-850 mm.

Seer fishes: Total seer fish landing was only 9,642t with a percentage contribution of 2.6% to the total pelagic fish landing.The fishery comprised *Scomberomorus commerson* and *S.guttaus* in Chennai whereas at Tuticorin, it was mainly by *S.commerson* and *Acanthocybium solandri.* Size range of *S. commerson* varied between 25.2-67.0 cm at Chennai whereas it was from 26.0 to 152.0 cm at Tuticorin. At Chennai *S.guttaus* varied from 33.6-57.3 cm and *A.solandri* from 86.0-138.0 cm.

Tunas: Total tuna landing was 18,795 t contributing 5.1 % to the total pelagic fish landing. The tuna landing comprised *Euthynnus affinis* forming 37.1% followed by *Auxis* sp. (13.2%), *Katsuwonus pelamis* (4.8%) and other tunnies (44.9%). The fishery comprised four species at Chennai whereas at Tuticorin it was constituted by 8 species. The most dominant species at Chennai were *Thunnus albacares* (36.6%) followed by *K. pelamis* and *E. affinis*. In Tuticorin, the species composition was *T. albacares* (34 %), *K. pelamis* (27.8%) *E. affinis* (31.7%), *Auxis thazard* (5.7%), *A. rochei* (0.1%), *T. tonggol* (0.27%), *Sarda orientalis* (0.4%) and *G. unicolor* (0.03%). *G. unicolor* observed in the fishery for the first time from Tuticorin.

Carangids: The total carangid landing was 28,728 t forming 7.8 % to the total pelagic fish landing.The carangid fishery was constituted by scads (21.2 %), leather-jackets (7.2 %), Horse mackerel (1.5 %) and others by 70.1 %.

Bill fishes : The total landing was 664 t contributing 0.2 % to the total pelagic fish landing. In Tuticorin, the fishery comprised *Istiophorus platypterus, Tetrapterus* sp., *Makaira indica* and *Xiphius gladius*.

Population characteristics of some important pelagic resources

Species	Length range (cm)	Mode (cm)	Mean (cm)
S.gibbosa	11-18	13.5	14.1
S.indicus	9-16.5	12.0	12.5
R.kanagurta	12.5-30.0	24.0	23.9
T.albacares	30-186	52&74	72
K.pelamis	28-78	58&60	54
E.affinis	20-66	48	45
A.thazard	28-54	36	37
A.rochei	20-30	26	26
T.tonggol	48-88	60	60
S.orientalis	28-60	32&40	41
G.unicolor	36-48	44	43
S.commerson	26-152	84	88
A.solandri	86-138	100&102	109
X.gladius	72-84	114	114
M.indica	180-280	230&232	236
I.platypterus	110-218	160	165

Demersal resources

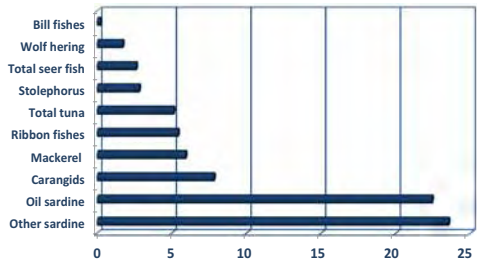
Elasmobranchs: The total elasmobranch landing was 11,888 t contributing 4.5% of the total demersal landing in Tamil Nadu. Among elasmobranchs, rays formed 93.3 % sharks 3.9 % and skates 2.8 %. *Himantura jenkinsii* was the dominant species in rays whereas sharks were comprised by *Scoliodon laticaudus, Rhizopri onodonacututs, Carcharhinus sorrah* and *C.leucas* in Chennai.

Silverbellies: This was the most dominant resource contributing 48.3 % of the total demersal fish landing. At Chennai the dominant species were *Leiognathus splendens* (32.6%), *L. dussumieri* (30.8%) and *L. bindus* (20.4%). The landing of silverbellies declined by 18.4% than the previous year. In Mandapam, it was comprised by nine species, *L. jonesi,* L. brevirostris, *L. daura, L. bindus, L. dussumierri, Secutor reconius, S. insidiator* and *Gazz aminuta*. In Palk bay, *L. jonesi* dominated forming 53% followed by L. brevirostris whereas in Gulf of Mannar, *L. dussumierri* dominated forming 75% followed by *L. bindus*. The size of *L. jonesi* varied from 30-130 mm with a mode at 80 mm and that of *L. dussumierri* varied from 50-145 mm with a mode at 90 mm.

Threadfin breams: Total landing of threadfin breams was 11,424t forming 4.3% to the total demersal fish landing. The major species were *Nemipterus japonicus, N. randalli* and *N. peroni*.

Sciaenids: The total sciaenid catch was 15,741t with a percentage contribution of 6.0% to the total demersal landing. The group was represented by 14 species of which *Otolithes* ruber (30.4%), *Nibea maculata* (21.7%) and *Johnius carutta* (26%) were dominant at Chennai. The fishery at Mandapam was comprised by eight species of which *Pennahia macrophthalmus* (44.2%) followed by *J.dussumieri* (18.9) dominated the fishery. The size of *P. macrophthalmus* varied from 80-210 mm and that of *N. maculata* from 90-240 mm.

Snappers: Snappers formed 1.6 % to the total demersal fish landing. The major species was *Lutjanus rivulatus*

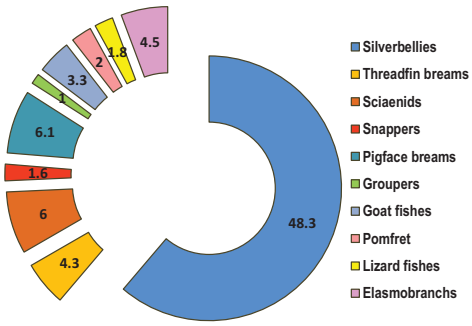


Contribution by major pelagic groups

Optimum length of exploitation of some of the pelagic resources

Resource	L_{max} (cm)	L_{inf} (cm)	L_{opt} (cm)	L_{opt}/L_{inf}
*R.kanagurta**	30	31	19	0.61
*S.commerson***	152	155	102	0.66
*A.solandri***	138	141	92	0.66
*T.albacares***	186	189	125	0.66
*K.pelamis***	78	81	52	0.64
*E.affinis***	68	70	45	0.64
*T.tonggol***	88	91	59	0.64
*X.gladius****	184	187	124	0.66
*M.indica****	280	283	191	0.67
*I.platypterus****	218	221	148	0.67

*TL, **FL, ***LFL (Lower jaw fork length)



Contribution of major demersal groups

Pigface breams: Its landing was 15,995 t with a percentage contribution of 6.1 to the total demersal fish landings. The major species was *Lethrinus lentjan* at Tuticorin.

Groupers: Grouper landing was 2,574 t contributing to 1% of the total demersal fish catch. *Epinephelus tauvina* and *E. malabaricus* were the main species in Chennai.

Goat fishes: The landing of goat fishes was 8,655 t forming 3.3 % to the total demersal fish landing. *Upeneus taeniopterus* (32.6%) and *U. vittatus* (24.2%) were the dominant species while *U. sundaicus* and *U. sulphureus* formed only 8% and 9.4%, respectively at Chennai. The fishery was comprised by 8 species of which *Upeneus sundaicus* (44.6%) followed by *U. taenuipterus* (23.6%) and *U.tragula* (22.1%) dominated the fishery at Mandapam. *U. sundaicus* varied from 80-190 mm with a mode at 110 mm and *U. tragula* varied from 80-190 mm with a mode at 130 mm.

Pomfrets: The total landing of pomfrets in Tamil Nadu was 5,177t, which formed 2% of the total demersal fish landings. Silver pomfret dominated forming 84.1% followed by black pomfret (15.3%) and Chinese pomfret (0.6%). But in Chennai, *Parastromateus niger* (84.6%) dominated followed by *Pampus argenteus* (12.2%) and *P. chinensis* (3.2%).

Lizard fishes: The total exploited lizard fish in Tamil Nadu was 4,886t, forming 2% of total demersal fish landing in Tamil Nadu. *Saurida tumbil* (48%) and *S.undosquamis* (40%) were dominant in the catch in Chennai.

Crustacean resources

Total crustacean landing was 62,121 t comprising 36.5% penaeid prawns, 2.2% non-penaenid prawns, 24% crabs, 8.5% lobsters and 28.8% stomtopod.

Prawns: At Tuticorin, 26 species were recorded in mechanized trawl. Out of this, 10 species were caught from deep sea. *Penaeus semisulcatus* (91%) and *Fenneropenaeus indicus* (7%) were the dominant inshore prawns whereas the dominant deep sea prawns were *Plesionika spinipes* (58%), *Solenocera hextii* (21%) and *Heterocarpus gibbosus* (14%). *P. semisulcatus* formed 94% of the catch of indigenous trawlers which consisted of 11 species. The estuarine gill nets were operated mainly for *F. indicus* which formed 77%. *P. semisulcatus* formed 21 % of this catch and the remaining portion was formed by 5 species. At Chennai the length range of *Metapenaeus dobsoni* was 41-125 mm, *Parapenaeopsis maxillipedo* was from 51-120 mm and *Metapenaeopsis stridulans* was from 46-115 mm.

Crabs: At Tuticorin, nine species were recorded in the commercial fishery of mechanized trawlers out of which *Portunus sanguinolentus* (41%) dominated followed by *Charybdis natator* (39%) and *P. haani* (19%). In indigenous trawlers 11 species were landed and among those *P. pelagicus* dominated (50%) followed by *C. natator* (32%) and *P. sanguinolentus* (17%).In estuarine gill nets seven species were landed and the dominant species was *P. sanguinolentus* (60%). The other species were *C. natator* (17%), *P. pelagicus* (16%), *P. haani* (7%), *Thalamita* spp., *Scylla* spp., and *C. feriatus*. In marine gill nets 12 species were landed. Among those *P. sanguinolentus* (37%) dominated followed by *C. natator* (26%), *P. haani* (19%) and *P. pelagicus* (13%). The length range observed at Chennai was 41-160 mm for *P. sanguinolentus* and 46-145 mm for *Podophthalamus vigil*.

Biological details of Prawns and crabs from Tuticorin

Gear	Species	Size range (mm)	Sex ratio (%) (M/F)	Immature (%)	Mature (%)	Main food
Prawns						
Mech. trawl	*P. semisulcatus*	96-250	57:43	29	71	Crustacea, Mollusca
	F. indicus	96-195	55:45	46	54	Mollusca, Crustacea
Ind. trawl	*P. semisulcatus*	56-200	52:48	95	5	Mollusca, Crustacea
Gill net	*F. indicus*	31-125	49:50	100		Crustacea
Crabs						
Mech. trawl	*P. sanguinolentus*	56-160	28:72	39	61	Fish, crab
	C. natator	41-135	47:53	44	56	Fish, crab
	P. haani	31-110	63:37	40	60	Fish, crab
Ind. trawl	*P. sanguinolentus*	41-160	43:57	70	30	Crab, fish
	C. natator	36-135	42:58	90	10	Crab, fish
	P. pelagicus	41-160	45:55	85	15	Crab, mollusca
Gill net (estuary)	*P. sanguinolentus*	56-175	58:42	48	52	Crab, fish
	C. natator	61-140	62:38	39	61	Crab, mollusca
Gill net (marine)	*P. sanguinolentus*	56-160	71:29	26	74	Mollusca, Crab
	C. natator	41-130	68:32	36	64	Crab, mollusca

Lobsters: At Tuticorin,the catch constituted by three species. Among those *Panulirus homarus* (58%) dominated followed by *P. ornatus* (37%) and *P. versicolor* (5%). At Chennai, the species observed to be occurring in the catch were *Thenus unimaculatus*, *P. homarus, P. polyphagus, P. versicolor, P. ornatus* and *P. penicillatus*. *P. homarus* from Kanyakumari varied from 102-190mm with a mean of 129 mm for male and 113-210 mm with a mode at 139 mm for female whereas from Colachel, the male had a size range of 125-250 mm with a mode at 173 mm and that of female had a size range of 138-270 mm with a mode at 182 mm.

Biological details of lobsters from Tuticorin

	P. homarus		*P. ornatus*		*P. versicolor*	
Size range	Male	Female	Male	Female	Male	Female
TL mm	120-290	120-300	140-335	130-395	190-235	170-235
CLmm	48-120	55-120	55-133	65-160	90-125	80-95
Weight g	70-550	100-930	100-1300	120-2020	300-550	175-550
Mean TL	166	187	196	217	215	202
Mean CL	70	75	82	85	108	88
Mean wt.	185	271	347	456	402	342
Sex ratio	56	44	56	44	50	50

Cephalopod resources

The cephalopod catch was 22,639t. The catch was comprised by squids (25%), cuttle fishes (25%) and octopus (3%) which together formed 53% of the total molluscs. Cephalopod catches in Mandapam were comprised by cuttlefishes (66.7%), squids (15.7%) and Octopus (17.6%).

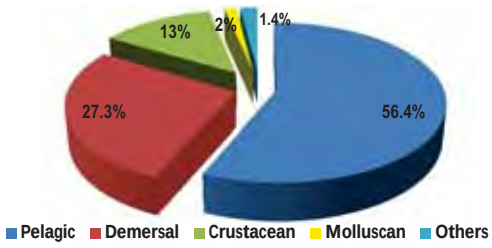
Cuttlefish: *Sepia aculeata* (43.3%) followed by *S. pharaonis* (27%) dominated in Palk Bay whereas, *S. pharaonis* (21.3%) followed by *S. aculeata* (11.1%) at Gulf of Mannar. The size of *S. aculeata* was 40-180 mm with a mode at 90 & 110 mm. *S. pharaonis* varied from 100-360 mm with a mode at 190 and 260 mm. *S. pharaonis* from Tuticorin ranged from 77-345 mm with a mode at 218 mm.

Squids: *Sepioteuthis lessoniana* was dominant (64.9%) followed by *Loligo singhalensis* (55.1%). *S. lessoniana* was 70-340 mm with a mode at 190 mm.

New Distributional record

Cuttlefish *Sepia arabica* (Massy, 1916) is reported for the first time from Chennai in the east coast of India.

Dorsal view of *Sepia arabica* (Massy, 1916) collected from Bay of Bengal off Chennai Coast.



Resource-wise contribution to marine landings

Andhra Pradesh

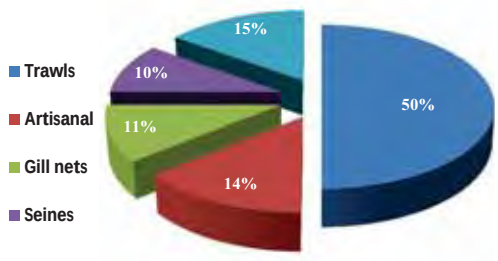
The total marine fish production of Andhra Pradesh during 2012 was 2.83 lakh t. The mechanized trawls contributed nearly 50% of the landings, artisanal gears 14 %, gill nets 11%, seines 10% and others (including hooks and lines) 15%. Pelagic resources accounted for 1.6 lakh t (56.4%), followed by demersal resources with 0.77 lakh t (27.3%), crustacean resources with 0.36 lakh t (12.9%) and cephalopods with 0.04 lakh t (1.4%) of the total fish landings. The dominant pelagic groups landed were clupeids (0.68 lakh t and 40.4%), mackerels (0.25 lakh t and 15.1%), tunas and billfishes (0.22 lakh t and 12.8%), carangids (0.20 lakh t and 11.7%), ribbon fishes (0.19 lakh t and 11.4%) and seer fishes (0.06 lakh t and 3.5%). The major groups that contributed to demersal landings were perches (0.136 lakh t, 17.64%), sciaenids (0.130 lakh t, 16.9%), pomfrets (0.122 lakh t, 10.46%), elasmobranchs (0.086 lakh t 11.16%), silverbellies (0.070 lakh t, 9.07%), goatfish (0.068 lakh t, 8.8%) and catfish (0.050 lakh t, 6.5%).

The estimated penaeid prawn catch was 29,570 t and it contributed 10.4% to total marine fish landings. Mechanized trawlers contributed high (81.7%) with CPUE of 4.9 kg, followed by drift nets and others operated by in built motorised boats (10.3%) with 27.8 kg, non motorized gill nets (2.6%) with 19.41kg, and motorized gill nets (2.4%) with 22.82 kg. The estimated crab catch was 5,946 t. Mechanized trawlers contributed maximum (73.9%) with 0.896 kg CPH, followed by motorized gill nets (10.0%) with CPUE of 0.7 kg drift nets and others operated by in built motorised boats (8.3%) with 4.56 kg and non-motorised gill nets (5.7%) with 0.65 kg. Cuttlefish landings were estimated at 2,365 t and squid at 1,475 t.

Species Composition

Among clupeids, the major contributors were lesser sardines contributing 0.34 lakh t, oil sardine contributing 0.12 lakh t and *Stolephorus* contributing 0.05 lakh t. Carangids landed were contributed by horse mackerel (21.8%), scads (22.4%), leatherjackets (8.8%) and other carangids (47.1%). The mackerel landings were contributed solely by *Rastrelliger kanagurta*. Seer fish catch was dominated by *Scomberomorus commerson* (59.4%) and *S. guttatus* (40.6%). Among tuna, the dominant species landed were *Thunnus albacares* (34.1%), followed by *Euthynnus affinis* (28.8%), *Katsuwonus pelamis* (28%) and *Auxis thazard* (9.1%). The landings of billfishes and barracudas for the year were 0.04 lakh t and 0.04 lakh t, respectively.

Carangids landed were contributed by horse mackerel (20.1%), scads (28.1%), leatherjackets (6.9%) and other carangids (45.0%). The catch rate of horse mackerel, scads and other carangids in trawl nets were 0.37 kg/h, 1.11 kg/h and 0.92 kg/h. The mackerel landings were contributed solely by *Rastrelliger kanagurta*. The catch rate in trawlers was 1.77 kg/h. Seer fish catch was dominated by *S. commerson* (63.9%) and *S. guttatus* (36.1%). Among tuna, the dominant species landed were *T. albacares* (40.1%), followed by *E. affinis* (26.7%), *K. pelamis* (24.2%) and *A. thazard* (9.1%).



Gear-wise contribution to marine landings of Andhra Pradesh

The landings of billfishes and barracudas for the year were 0.035 lakh t and 0.04 lakh t, respectively. The catch rate of barracudas in trawlers was 0.56 kg/h. Threadfin breams were almost exclusively caught by mechanized trawlers which contributed to 97.5% of the threadfin bream landings in the state. The average catch rate for threadfin breams was 1.01 kg/hr during the year which was similar to that of the previous year. The major species of threadfin breams landed by mechanized trawls were *Nemipterus japonicus* (51.1%), *N. mesoprion* (36.5%), *N. luteus* (5.9%), *N. delagoae* (4.4%) and *N. tolu* (2.2%).

Sciaenids were landed mainly by mechanized trawlers (63.5%), non-mechanized gears (13.6%) and gill nets (both mechanized and motorized) (10.5%). The catch rate of sciaenids in mechanized trawls was 1.69 kg/hr for the state in 2012 which was the same asthe previous year.

An estimated 12,255 t of pomfrets were landed in the state during 2012. The landings of *Parastromateus niger* was 8,086 t (65.98%), *Pampus argenteus* was 3,554 t and that of *P. chinensis* was 615t. Mechanized trawls landed 7,592t (61.95%) of pomfrets with a catch rate of 1.5 kg/hr. Pomfret catch rate in 2012 declined by 25% from the previous year's catch rate of 2 kg/hr.

An estimated 8,622 t of elasmobranchs were landed in Andhra Pradesh of which 1,382t (17.05%) were sharks, 130t (1.6%) were skates and 7,110 t (81.4%) were rays. Sharks were mainly landed by mechanized gear (trawls, gill nets and hook and lines) which contributed to 80.0% of total shark landings. Mechanized trawls contributed 90.8% of the skate landings of the state. Mechanized gear (trawls, gill nets and hook and lines) contributed 80.6% of ray landings in the state during 2012. The main sharks species landed are *Iago omanensis*, *Mustelus mosis*, *Sphyrna lewini*, *Chiloscyllium griseum* and *Carcharhinus sorrah*. The main species of rays landed are *Gymnura poecilura, Himantura jenkinsii*, *Dasyatis kuhlii* and *Aetobatus narinari*.

An estimated 7,005 t of silverbellies were landed with 4,702 t (67.12%) being landed by mechanized trawls alone. The catch rate of silverbellies in mechanized trawls was 0.96 kg/hr. Catch rate in 2012 declined by 24% from the previous year's catch rate of 1.27 kg/hr.

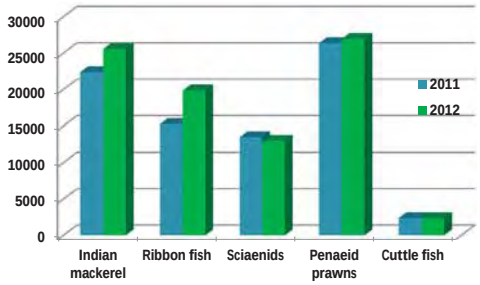
An estimated 6,785 t of goatfish was landed in the state of which 5,951 t (87.7%) were landed by mechanized trawls alone. The catch rate of goatfish in trawls was 1.2 kg/hr. Goatfish catch rate also declined by 14% from the previous year's catch rate of 1.39 kg/hr. An estimated 5,019 t of catfish were landed in the state with 2,998 t (59.7%) being landed by mechanized trawls. The major species of catfish landed were *Netuma thalassina* and *Plicofollis tenuispinis*.

The catch of small mechanized trawlers was represented by 25 species of penaeid prawns, dominated by *Metapenaeus monoceros* (29.52%), followed by *Solenocera crassicornis* (15.41%) *Trachysalmbria curvirostris* (8.99%) *M. dobsoni* (6.93%), *Parapenaeopsis stylifera* (5.47%), and *Penaeus semisulcatus* (3.23%). The catch landed by sona boats was constituted of 15 general species of penaeid prawns, dominated by *M. monoceros* (38.44%), followed by *Solenocera* spp. (13.91%), *Metapenaeiopsis* spp. (10.89%), *M. dobsoni* (10.18%), and *Parapenaeopsis* spp. The crab catch by trawlers was constituted with commercial crabs (49.38%) and other crabs (50.62%). The catch of commercial crabs supported by *Portunus sanguinolentus* (83.61%), *P pelagicus* (10.35%) and *Charybdis* spp. (6.02%).

The mechanized trawlers (MDSOTN + MDTN + MSOTN + MTN) contributed almost entirely (99.1%) to the cephalopod landings. At Visakhapatnam, cuttlefish landings were estimated at 1,047t and squid at 1,051t. Among Cuttlefish, *Sepia pharaonis* (450t) 21.5%. *S. aculeata* landed (477t) 22.73% and *Sepiella inermis* (74t) 3.5%. Among squids, *Loligo duvauceli* was the only species landed. Maximum landings of cephalopods occurred during July-August. The catch rate of cephalopods in mechanized trawls was 0.78 kg, which was higher compared to the catch rate of 0.61 kg in 2011.

Biology of key stocks

***Sardinella longiceps*:** The length of oil sardine, *Sardinella longiceps* at Visakhapatnam ranged from 80 mm to 219 mm with an annual mean of 166.85 mm. The highest mean length of 206.13 mm was recorded in the



Landings (t) of dominant species along Andhra Pradesh

Catch (t) of major finfish and shell fish resources of Andhra Pradesh

Group	2012	2011	Increase %	Decrease %
Clupeids	68108	67697	0.6	
Mackerel	25377	22401	13.3	
Ribbon fish	19193	15252	25.8	
Carangids	19732	16873	16.9	
Tunas	17945	18614		-3.6
Seer fishes	5824	5559	4.8	
Barracudas	3954	4332		-8.7
Bill fishes	3590	3624		
Threadfin breams	5092	5027	1.3	
Sciaenids	13021	13488		-3.5
Lizardfish	4422	4539		-2.6
Goatfish	6785	6735	0.70	
Sharks	1382	2054		-32.7
Rays	7110	5872	21.1	
Penaeid Prawns	29570	26368	12.4	
Crabs	5946	5703	4.26	
Cuttlefish	2365	1734	26.7	
Squid	1475	1074	27.2	

month of May and the lowest mean length of 106.26 mm was recorded in January. The annual sex ratio was 1.55. Males dominated the catch in February and March while females dominated the catch in rest of the months. May - August is the peak breeding season of oil sardine. This is substantiated by the presence of high proportion of spawners (66.11%) and by high gonadosomatic index (6.55) in these months. Their fecundity ranged from 12,253 to 91,992 with ova diameter varying from 0.24 to 0.68 mm. Food component analysis in gut revealed an abundance of planktonic matter.

Rastrelliger kanagurta: The length of Indian mackerel, *Rastrelliger kanagurta* at Visakhapatnam ranged from 110 mm to 249 mm with an annual mean of 186.97 mm. Maximum mean length of 221.28 mm was recorded in March and minimum mean length of 143.19 mm was recorded in October. Annual sex ratio was 1.54. Males dominated the catch in January - March and July while females dominated the catch in rest of the months. June appears to be the peak breeding month with two third of the females in mature condition and high gonadosomatic index value of 4.6. Their fecundity ranged from 37,714 to 2,98,953 with ova diameter varying from 0.16 to 0.64 mm. The analysis of food components revealed an abundance of copepods, decapods, ostracods, *Coscinodiscus, Foraminifera* along with minute quantities of cladocerans, fish eggs and larvae, zoea, tintinnids and nematods.

Trichiurus lepturus: was the sole species with size ranging from 360 to 1099 mm and having mean length of 590.71 mm. There was a preponderance of females in the catch with mature females encountered only in August, November and December. Fecundity varied from 22,533 to 1,86,667 with ova diameter ranging from 0.35 to 0.85 mm. The high IRI values of nonpenaeids, cephalopods, penaeids, clupeids, juveniles of sciaenids, ribbon fishes, scombrids and carangids and other teleosts and digested fish imply that they were the principal food constituents of *Trichiurus lepturus.*

Katsuwonus pelamis: The length of skipjack tuna, *Katsuwonus pelamis* at Visakhapatnam ranged from 380 mm to 679 mm with an annual mean of 519.5 mm. The highest mean length of 600.16 mm was recorded in the month of October and the lowest mean length of 489.2 mm was recorded in March. Annual sex ratio was 1.35 with significant dominance by males in September and by females in February – March and November - December. More than 80% of the females were mature in March indicating it to be the peak breeding season. Average gonadosomatic index was 1.47. Their fecundity ranged from 20,5947 to 1,75,8204 with ova diameter varying from 0.18 to 0.7 mm. The high IRI values of cephalopod, penaeid prawn, carangids, sardines and anchovies along with digested food imply them to be the principal food constituents.

Thunnus albacares: The length of yellow fin tuna, *Thunnus albacares* at Visakhapatnam ranged from 120 to 1719 mm with an annual mean of 783.05 mm. Maximum mean length of 1,182.4 mm was recorded in April and minimum mean length of 434.62 mm was recorded in December. Annual sex ratio was 2.82. Males dominated the catch in January and October while females dominated the catch in January, September and December. High percentage (83.33%) of mature females was observed in October. Their fecundity ranged from 23,06,062 to 38,15,101 with ova diameter varying from 0.2 to 0.56 mm. Cephalopods are their preferred prey, followed by mackerel, crab, *Squilla*, coastal tunas, carangids and other scombrids.

Sepia aculeata: The size range of males contributing to the fishery was 8.9 to 21.1 cm. The modal class represented was 10 and 10.9 cm. The mean size was 11.05 cm. The size range of females contributing to the fishery was 9.0 to 27.8 cm. The modal classes were 16 and 16.9 cm. The mean size was 13

cm. The annual sex ratio was 1:1.63. Females dominated throughout the year except during March-April. 53.2% of the females were in mature condition and 46.8 % in immature condition. The diet of *S. aculeata* comprised of mostly digested shrimp (*Acetes* sp.), digested fish, such as scales and bones. Juveniles of *S aculeata* occurred throughout the year. 49.7% of the total landings were juveniles. Maximum percentage of juveniles occurred during March (75.9%), February (75%), April (71.1%)

Sepia pharaonis: The size range of males contributing to the fishery was 8.7-29.6 cm. The modal class represented was 12 and 18.9 cm respectively. The mean size was 16.9 cm. The size range of females contributing to the fishery was 9.8 to 29.5 cm. The modal class was 16.9 cm. The mean size was 17.6 cm. The annual sex ratio was 1:1.04. Females dominate throughout the year. 77.4 % of the females were in mature condition and 14.3% in immature condition. The diet of *S pharaonis* comprised of mostly digested shrimp (*Acetes* sp.), digested fish, such as scales and bones. Juveniles of *Sepia pharaonis* occurred throughout the year. 19.6% of the total landings were juveniles. Maximum percentage of juveniles occurred during April (45.9%) and March (32.6%).

Loligo duvauceli: The size range of males contributing to the fishery was 3.1 to 13.7cm. The modal class represented was 10 and 10.9 cm respectively. The mean size was 7.99 cm. The size range of females contributing to the fishery was 5.5 to 16 cm. The modal class represented was 8 and 8.9 cm respectively. The mean size was 8.82 cm. The sex ratio was 1:0.75. 29.5% of the females were in mature condition and 62.2% in immature condition. The diet of *L duvaucelii* comprised mostly digested shrimp (*Acetes* sp.), digested fish, such as scales and bones. Juveniles of *Loligo duvauceli* occurred throughout the year. 49.9 % of the total landings were juveniles. Maximum percentage of juveniles occurred during February (64.7%), October (58.7%), December (57.9 %), and July (57.7 %).

Crustaceans: 0.06 % of juveniles of *M. monoceros* (males) and 1.26 % (females) occurred in the fishery. 12.95 % (females) juveniles of *M. dobsoni* occurred in the fishery. 0.33 % of juveniles of *P. sanguinolentus* (males) and 0.59 % (females) occurred in the fishery. 42.1% of *M. monoceros* females were in stage 2 and 36.1 % were in stage 4 of maturity. 74.7 % of *M. dobsoni* females were in stage 2 and 3.9 % were in stage 4 of maturity. 63.7% of *P. sanguinolentus* females were in stage 2,19.45 in stage 3 (berried- orange) and 15.6 % stage 4 (berried-black) of maturity.

Length measurements and sex ratio of major finfish and shellfish species of Andhra Pradesh

Species	Length range (mm)	Mean length (mm)	Annual Sex ratio
S. longiceps	80-219	166.9	1:1.55
R. kanagurta	110-249	187.0	1:1.54
T. lepturus	360-1099	590.7	1:1
K. pelamis	380-679	519.5	1:1.35
T. albacares	120-1719	783.1	1:2.82
N. japonicus	105-275	171.0	1:0.7
N. mesoprion	91-164	120.0	1:0.8
O. ruber	146-352	212.0	1:4.0
N. thalassina	207-418	282.0	1:1.75
M. monoceros (♂)	91-185	130.7	1:1.72
M. monoceros (♀)	96-215	148.3	
M. dobsoni (♂)	66-105	86.6	1:1.45
M. dobsoni (♀)	51-110	86.4	
P. sanguinolentus (♂)	61-180	121.8	1:1.39
P. sanguinolentus (♀)	81-170	114.1	
S. aculeata (♂)	89-211	110.5	1:1.63
S. aculeata (♀)	90-278	130.0	
S. pharaonis (♂)	87-296	169.0	1:1.04
S. pharaonis (♀)	98-295	169.0	
L. duvaucelli (♂)	31-137	80.0	1:0.75
L. duvaucelli (♀)	55-160	88.0	

Environment

Monthly samples of seawater collected from 10 m and 20 m depth were analyzed for different environmental variables to study the impact on fisheries. Temperature ranged from minimum of 27°C during October to maximum of 31.3°C in April. Salinity ranged from a low of 24.3 ppt in August to a high of 34 ppt in April. Dissolved oxygen values peaked during January and August-September and declined in April-June. Dissolved oxygen ranged from 3.78 mg/l in June to 5.07 mg/l in January. Hydrogen ion concentration (pH) exhibited a direct relationship with temperature and ranged from 8.1 during April- May and low of 7.7 in July. The nutrient salts (Nitrate, nitrite and phosphate) 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 run offs. After the cessation of the north-east monsoon the concentration decreased. The high concentration of all the three salts from March to May has been attributed to the subsurface water coming to the surface.

Trawl fishery of the north east coast of India

Trawl landings and catch rate

The total production by trawlers during 2012 along the north east coast of India (Andhra Pradesh, Odisha and West Bengal) was 4.72 lakh t. The catch rate was 50.79 kg/h. Trawl landings in Andhra Pradesh was 1.43 lakh t forming 50.5% of the total marine landings. The overall catch rate was 29.2 kg/h for the state. The contribution of sona boats to the trawl landings of Andhra Pradesh was 65.7% and the contribution of small mechanized trawlers was 34.3%. The catch rate in sona boats was 30.3 kg/h and in small mechanized trawlers was 27.2 kg/h. In Odisha, the trawl catch was 2.46 lakh t forming 88.1% of the annual marine catches. The overall catch rate in Odisha was 88.6 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 86.8 kg/h and in singleday trawlers was 164.1 kg/h. In West Bengal, 0.83 lakh t was landed by trawlers forming 58.6% of the total marine landings.

Trawl catch composition (%) of dominant groups and species along the north east coast of India

Andhra Pradesh	Odisha	West Bengal
Penaeid prawns (15.7)	Penaeid prawns (28.2)	Penaeid prawns (17.2)
Ribbonfishes (9.0)	Croakers (18.7)	Croakers (13.3)
Rastrelliger kanagurta (6.4)	Ribbonfishes (7.7)	*Coilia dussumieri* (5.9)
Croakers (5.8)	Scads (4.4)	*Harpadon nehereus* (4.4)
Goatfishes (4.2)	Non-penaeid prawns (4.3)	Catfishes (4.2)
Black pomfret (3.6)	Goatfishes (4.1)	Scads (4.2)
Scads (3.5)	Soles (2.4)	Silverbellies (4.1)
Threadfin breams (3.5)	*Rastrelliger kanagurta* (1.9)	*Setipinna* spp (3.8)
Rays (3.4)	Catfishes (1.9)	Ribbon fishes (3.6)
Silverbellies (3.3)		Soles (3.2)
Crabs (3.1)		Threadfin breams (2.9)

Catch composition

Andhra Pradesh

The landings of ribbonfishes, mackerel, croakers, goat fishes, threadfin breams and lizardfishes were 12,920t, 9,160t, 8,270t, 5,951t, 4,963t and 4,111t at catch rates of 2.64 kg/h, 1.87 kg/h, 1.69 kg/h, 1.21 kg/h, 1.01 kg/h and 0.84 kg/h. Croakers landed were contributed chiefly by *Otolithes ruber* (22.8%), *Protonibea diacanthus* (24.2%), *Pennahia macrophthalmus* (12.3%), *Nibea maculata* (10.2%) and *Johnius carutta* (7.9%). *Upeneus vittatus* (47.1%) dominated the goatfish landings followed by *U. sulphureus* (24.6%) and *U. moluccensis* (27.3%). Threadfin bream and lizardfish landings were composed chiefly of *Nemipterus japonicus* (51.1%) and *N. mesoprion* (36.5%) and *Saurida undosquamis* (60%), *S. micropectoralis* (24.4%) and *S. tumbil* (12.7%), respectively. The catch of carangids was 11,328t with almost half of the catches being supported by scads. Pomfret landing was 7592t with black pomfret (68.5%) dominating the landings. Elasmobranch landing amounted to 5,581t of which rays contributed 86.8%. The catch rate of scads, black pomfret and rays were 1.02 kg/h, 1.06 kg/h and 0.99 kg/h. Around 11,905t of clupeids were landed and *Stolephorus* spp. accounted for more than a quarter of the total landings at a catch rate of 0.66 kg/h. The other major groups of fin fishes landed were barracudas (2,616t) and flat fishes (1,471t). The total crustacean landing was 29,345t of which the

contribution of penaeid prawns, non penaeid prawns and crabs were 22,419t, 1,744t and 4,397t. Their catch rates were 4.57 kg/h, 0.36 kg/h and 0.90 kg / h, respectively. *Metapenaeus monoceros* dominated (49.6%) the penaeid prawn catches in sona boats followed by *Solenocera* spp. (17.3%), *Metapenaeopsis* spp. (15.1%) and *Penaeus monodon* (5.2%). In the catches of small mechanised trawls, *Metapenaeus monoceros* (31.8%), *Solenocera* spp. (29.4%) and *Trachysalambria curvirostris* (9.5%) were the chief contributors. More than 80% of the edible crabs landed by sona boats and small mechanised trawls were constituted by *Portunus sanguinolentus*. Among cephalopods, the catch of cuttlefish was 2,339t at a catch rate of 0.48 kg/h and the catch of squid was 1,467t at a catch rate of 0.30 kg/h. Cuttlefish landing was contributed by *Sepia aculeata* (47.6%), *S. pharaonis* (45%) and *Sepiella inermis* (7.3%) while squid landing was contributed entirely by *Loligo duvaucelli*.

Odisha

The landings of croakers, ribbon fishes, goat fishes, soles, mackerel and catfishes were 46,336t, 19,078t, 10,172t, 6,005t, 4,748t and 4,694t at catch rates of 16.59 kg/h, 6.83 kg/h, 3.64 kg/h, 2.15 kg/h, 1.7 kg/h and 1.68 kg/h. Carangids landed amounted to 26,318t with scads (41.5%) being the dominant species. The catch rate of scads was 3.91 kg/h. The catch of clupeids was 21,438t with *Stolephorus* spp. (16.74%) and *Setipinna* spp. (14.0%) being the dominant species. Pomfret landing (3,861t) was shared more or less equally by black pomfret and silver pomfret. Similarly, elasmobranch catch (1,327t) was shared between rays and sharks. Crustacean landing was 83,004t, of which contribution of penaeid prawns was 69,847 t, non penaeid prawns 10,531t and crabs 2,192t. Their catch rates were 25.0 kg/h, 3.77 kg/h and 0.78 kg/h, respectively. Around 2,640t of cephalopods were caught in which the contribution of squid was 55.8% and cuttlefish was 44.2%. The catch rate for squids was 0.53 kg/h and for cuttlefish was 0.42 kg/h.

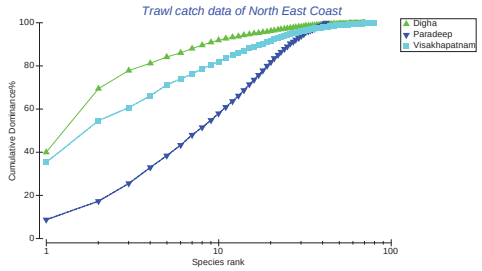
West Bengal

The landings of croakers, Bombay duck, catfishes, silverbellies, ribbon fishes, soles and threadfin breams were 5,160t, 1,699t, 1,610t, 1,591t, 1,380t, 1,244t and 1,126t. The catch of clupeids was 10,358t in which dominated *Coilia dussumieri* (35.4%) and *Setipinna* spp. (22.7%). Carangids landing amounted to 1,810t of which more than 90% were represented by scads. Similarly, elasmobranch catch (470t) was dominated by sharks. Around 7,654t of crustacean resources were landed in which the share of penaeid prawns was 87.1%, non penaeid prawns 7.3% and crabs 4.1%. The catch of cephalopods was 745t in which cuttlefish landing was 50 t and squid 695t.

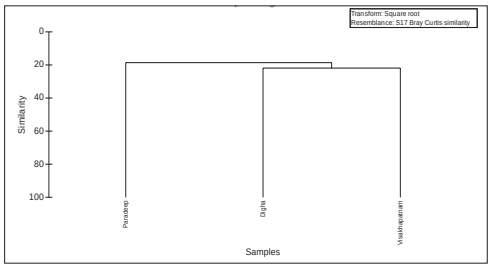
Biology of dominant species

Andhra Pradesh

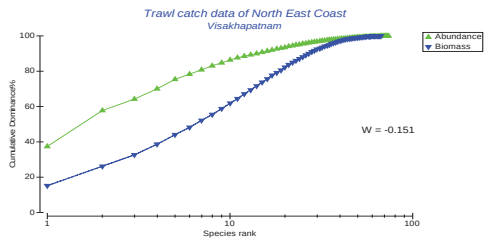
The length of *Trichiurus lepturus* ranged from 360 to 1099 mm with peak spawning activity in August and average fecundity of 87,753 and ova diameter varying from 0.35 to 0.85 mm. For *Rastrelliger kanagurta*, the length range was 110 – 249 mm, spawning season was from February to June with average fecundity of 96,980 and ova diameter of 0.16 – 0.64 mm. The length ranges recorded for *Otolithes ruber*, *Upeneus vittatus*, *Nemipterus japonicus* and *Saurida undosquamis* were 190 – 399 mm, 110 – 199 mm, 120 – 249 mm and 110 – 399 mm respectively. Spawning season for *Upeneus vittatus*, *Nemipterus japonicus* and *Saurida undosquamis* was during July – August, December – February and November – December. Their average fecundity



Dominance plot showing higher diversityin Paradeep as compared to Visakhapatnam and Digha



Species composition and abundance similarity in trawl catches at Visakhapatnam, Paradeep and Digha



Species abundance biomass curve for Visakhapatnam

Diversity indices of trawl catches at Visakhapatnam, Digha and Paradeep

Stations/ Indices	Species richness (d)	Pielou's evenness (J')	Shannon H' (log2)	Simpson's 1-Lambda'	Hill abundances (N1)
Digha	7.99	0.46	2.82	0.74	7.07
Paradeep	7.53	0.89	4.82	0.95	28.43
Visakhapatnam	9.32	0.57	3.63	0.82	12.45

was 99,759; 38,487; 44,004 and 72,747 and their ova diameter ranged from 0.28 to 0.59 mm, 0.23 to 0.47 mm, 0.15 to 0.58 mm and 0.24 to 1.35 mm. The mean length of *Sphyraena obtusata* was 265.5 mm with gonado somatic index of 3.4. The average fecundity was 75,901 with ova diameter varying from 0.35 to 0.48 mm. About half of the fishes possessed empty stomachs. The lengths for *Penaeus monodon* and *Fenneropenaeus indicus* ranged from 168 – 278 mm and 132 – 203 mm with peak spawning during February – March and ova diameter varying from 0.03 – 0.1 mm and 0.03 – 0.06 mm. Mean length for *Metapenaeus dobsoni* was 75.1 mm for males and 83.5 mm for females with sex ratio dominating with males and majority (80%) of the females in immature state. In *Portunus sanguinolentus*, the mean length was 126.9 mm for males and 126.1 mm for females with dominance of mature females in the catches. Length range for *Sepia aculeata* varied from 89 to 278 mm with preponderance of females in the catch. More than half of the females were found to be mature. For *Loligo duvaucelli*, the size varied from 65 to 159 mm with mature females encountered in most months of the year and ova diameter ranging from 0.78 to 1.3 mm. Juveniles of *S. aculeata* and *L. duvaucelli* were encountered in the fishery throughout the year in high numbers.

Odisha

Length recorded varied from 260 to 349 mm for *Otolithes ruber*, 540 to 719 mm for *Trichiurus lepturus*, 120 to 179 mm for *Upeneus vittatus*, 160 to 209 mm for *Rastrelliger kanagurta*, 200 to 309 mm for *Nemipterus japonicus* and 280 to 439 mm for *Saurida undosquamis*. Peak spawning months for *R. kanagurta*, *N. japonicus* and *S. undosquamis* was August, July – August and November – December. Mature females of *Penaeus monodon* and *Fenneropenaeus indicus* were recorded in most months with peak during August – December. *L. duvaucelli* ranged in length from 65 to 169 mm and high proportion of mature females was recorded in all months of the year.

West Bengal

Lengths for *Otolithes ruber, Johnius dussumieri, T. lepturus, N. japonicus, R. kanagurta, S. tumbil, U. sulphureus* and *S. undosquamis* varied from 200 to 329 mm, 160 to 259 mm, 440 to 659 mm, 130 to 319 mm, 140 to 229 mm, 170 to 369 mm, 110 to 189 mm and 210 to 279 mm respectively. Peak spawning was observed during September – December for *J. dussumieri,* December for *T. lepturus* and *S. undosquamis*, April for *N. japonicus*, April and July – September for *R. kanagurta*, October – December for *S. tumbil* and July for *U. sulphureus*. Mean length of *Cynoglossus arel* was 248 mm with length ranging from 200 to 289 mm and preponderance of males in the catch. For *P. monodon* and *F. indicus,* the length ranged from 155 to 247 mm and 119 to 175 mm. Breeding season was February – July for *P. monodon* and March – August for *F. indicus*. The length for *L. duvaucelli* varied from 60 to 189 mm with peak spawning observed in July.

Biodiversity analysis

Trawl samples were collected from trawlers operating off Visakhapatnam in Andhra Pradesh, Paradeep in Odisha and Digha in West Bengal and the data was analyzed with respect to diversity indices, dominance plot, Bray–Curtis similarity and abundance and biomass comparison plot.

Diversity Indices - In line with the higher number of species, Shannon diversity {H'(log 2)} was more in Paradeep (4.82) as compared to Digha (2.82)and Visakhapatnam (3.63) reflecting the diverse nature of these

centres. The Simpson species richness index for Paradeep (0.95) was also found to be more than that of Digha (0.74) and Visakhapatnam (0.82).

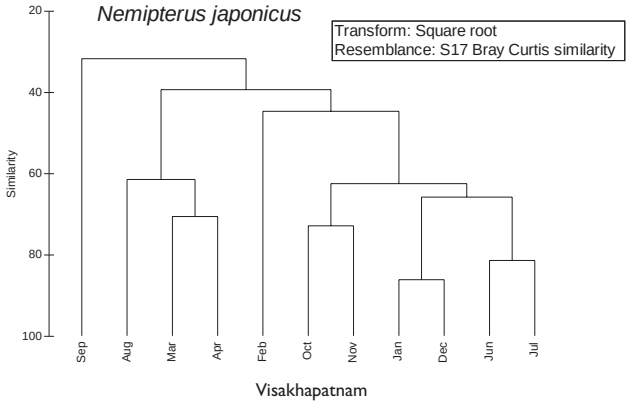
Abundance/biomass comparison plots - The abundance/biomass comparison (ABC) plot for Paradeep showed the K dominance curve for biomass to be above the curve for abundance. W statistics value was highest in Paradeep (0.063). These indicate higher degree of evenness and lower degree of disturbance at Paradeep. The ABC plot for Digha and Visakhapatnam showed the K dominance curve for abundance to be above the curve for biomass. W statistics values for Digha and Visakhapatnam were -0.193 and -0.151. These indicate lower degree of evenness with higher disturbance level at Digha and Visakhapatnam. The species dominance plot indicates the rich diversity of trawl catches in Paradeep as compared to Digha and Visakhapatnam with respect to the number of species. The Bray–Curtis similarity in species composition and abundance among Digha, Paradeep and Visakhapatnam was 16.67-21.87%.

Mean length, sex ratio, gonado somatic index and maturity % of major species caught in trawlers at Visakhapatnam, Paradeep and Digha

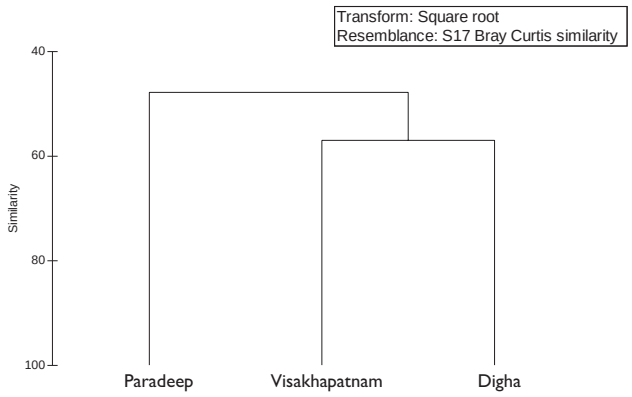
Species Name	Mean length (mm)			Sex ratio			Gonado somatic index			% Maturity		
	Vizag	Paradip	Digha	Vizag	Paradip	Digha	Vizag	Paradip	Digha	Vizag	Paradip	Digha
Rastrelliger kanagurta	186.9	181.2	195.2	1.5	0.8	0.9	2.71		5.7	19.3		25.7
Nemipterus japonicus	183.6	235.2	193.9	4.4	1.3		2.98		3	35.1		6.46
Trichiurus lepturus	186.9	181.2	195.6	1.5	0.8	0.9	2.71		5.6	19.3		25.7
Upeneus vittatus	148.1	140.7		1.6	1.1		3.24	0.5		40.6	2.2	
Upeneus sulphureus			143.6			2.5			5.9			14.5
Otolithes ruber	263.8	310.7	255.1	2.7	1.1	2.4	1.41			8.3		
Saurida tumbil			250.6			1.6			3.08			13.6
Saurida undosquamis	271.3	330.3	233.3	2.6	1.5	5.7	2.4	2.94	4.86	33.7	17.4	12.7
Johnius dussumieri			194.7			1.2			5.39			38.0
Penaeus monodon	218.2		193.7	0.5		1.8	7.2		9.73	43.6		19.1
Fenneropenaeus indicus	173.7		152.6	2.9		1	8.1		11.1	33.0		12.7
Metapenaeus monoceros	146.8			17			7.85			17.7		
Loligo duvaucelli	98.2	92.4	104.3	1.7	1.3	2.1	9.4		12.28	57.6	87.9	17.9

Feeding intensity of major species caught in trawlers at Visakhapatnam, Paradip and Digha

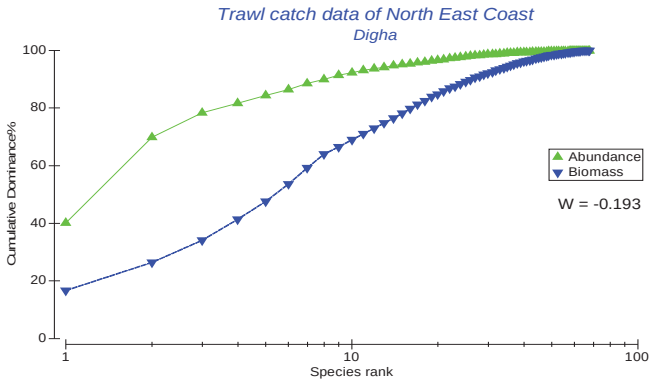
Feeding Intensity (%)	Empty-Trace			Quarter Full-Half Full			Three fourth-Full		
Species Name	Vizag	Paradip	Digha	Vizag	Paradip	Digha	Vizag	Paradip	Digha
Rastrelliger kanagurta	30.04	53.74	53.79	58.64	36.61	35.60	25.22	9.64	12.72
Nemipterus japonicus	55.9	49.6	54.08	28.69	37.34	20.95	16.63	13.04	24.95
Trichiurus lepturus	40.77	59.49	75.42	37.88	14.82	10.18	21.33	5.43	14.39
Upeneus vittatus	61.3	39.08		32.07	33.18		6.59	1.04	
Upeneus sulphureus			87.67			9.11			3.2
Otolithes ruber	56.02	29.4	55.05	25.67	16.66	19.19	16.66	3.88	25.75
Saurida tumbil			78.25			5.85			14.3
Saurida undosquamis	49.04	65.87	79.28	31.41	13.18	2.5	19.04	3.87	18.21
Johnius dussumieri			88.98			4.92			8.19
Penaeus monodon	44.56		76.88	38.69		24.75	16.74		10.66
Fenneropenaeus indicus	26.27		73.85	41.35		22.81	32.37		3.33
Metapenaeus monoceros	19.61			44.69			40.59		
Loligo duvaucelli	78.54	77.07		14.03	20.77		8.16	2.15	



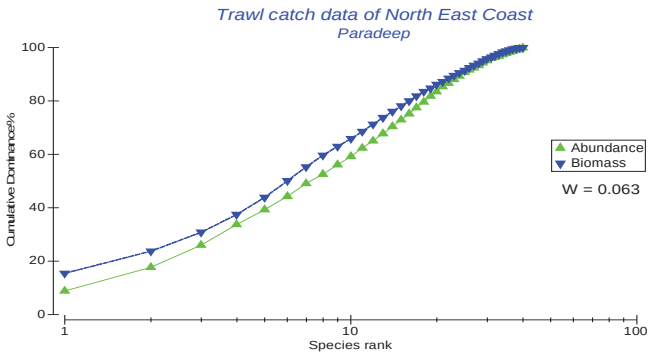
Dendrogram showing similarity of diet of *Nemipterus japonicus* for different months at Visakhapatnam



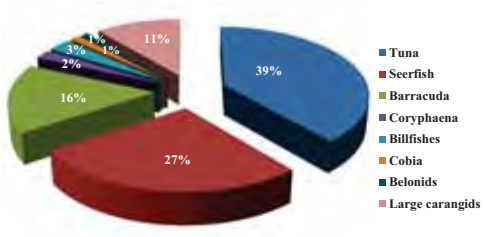
Dendrogram reflecting the regional differences in the pooled diet contents of five major finfishes (*N. japonicus*, *U. vittatus*, *S. undosquamis*, *O. ruber* and *T. lepturus*) caught in trawls



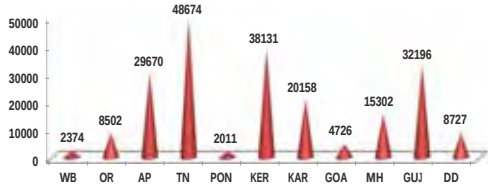
Species abundance biomass curve for Digha



Species abundance biomass curve for Paradeep



Composition of large pelagics in the catch



State-wise contribution of large pelagics in the catch (t)

Fishery of Large Pelagics

The fishery was supported by fast moving large oceanic resources. Their catch during the year was 2,10,472t accounting 5.4% of the total marine fish production (39,41,365t) of the country. Major share of the catch was supported by tunas (81,751t) followed by seerfishes (56,174t), barracudas (33,910t) and large carangids (23,175t). Contribution of other components are billfishes 6,385t, dolphin fishes 4,281t, cobias 2,838 t and belonids 1,958t. Major share of the catch was from southern states; Tamil Nadu 23.1%, Kerala 18.1%, Andhra Pradesh 14.1% and Karnataka 9.6%. southeast coast contribute 38.2% of the catch, followed by southwest (29.9%) and northwest coast (26.7%). Contribution by northeast is 5.2%. Contributions from different states to each resource catch also vary considerably.

Tuna: Fishery was supported by eight species representing neritic and oceanic species. Kawakawa (*Euthynnus affinis*), frigate tuna (*Auxis thazard*), bullet tunas (*A. rochei*), longtail tuna (*Thunnus tonggol*) and bonito (*Sarda orientalis*) represent the neritic species. They support 70.3% of the total tuna catch. Oceanic species, which represent 29.7% was represented by yellowfin tuna (*T. albacares*), skipjack tuna (*Katsuwonus pelamis*) and dogtooth tuna (*Gymnosarda unicolor*). They were being exploited from the entire Indian

coast except from West Bengal. Major contributors to the national catch were Tamilnadu, Kerala, Gujarat and Andhra Pradesh in that order.

Seerfish: Fishery was supported by four species; *Scomberomorus commerson*, *S. guttatus, S. lineolatus* and *Acanthocybium solandri*. *S. lineolatus* supported fishery mainly along the southern coast of Tamil Nadu in small quantities. Others were exploited all along the coast with major contributions from Kerala, Gujarat, Karnataka, Tamil Nadu and Andhra Pradesh.

Barracuda: Fishery was supported by seven species; *Sphyraena barracuda, S. jello*, *S. putnamiae*, *S. forsteri*, *S. obtusata*, *S. picuda* and a previously non-described species *S. nova*. They were landed all along the coast except from West-Bengal. Tamilnadu followed by Karnataka are the major contributors to their fishery. Other minor contributors are Andhra Pradesh, Kerala and Gujarat.

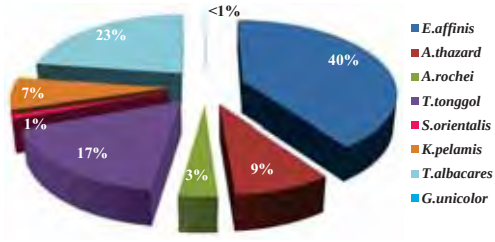
Billfish: Fishery was by five species; three marlins and one species each of sail fish and sword fishes. Marlins (Family: Istiophoridae) were represented by two genera; *Makaira* and *Tetrapturus* in the catch. Common in the catches are *M. indica*, *M. mazara*, and one species under the genus *Tetrapturus*. Sail fish (Family: Istiophoridae) in the catch was represented by *Istiophorus platypterus* and Swordfish (Family: Xiphidae) by *Xiphias gladius*. Major share of their catch was landed along the Andhra Pradesh and Kerala coast. Contribution from northeast coast (West Bengal and Odisha) was negligible.

Dolphin fish: Fishery was supported by two species; *Coryphaena hippurus* and *C. equiselis*. Gujarat followed by Kerala were the major contributors to dolphin fish fishery.

Cobia: Fisheries comprised the single species *Rachycentron canadum*. Cobia was exploited mainly from west coast, with Maharashtra and Gujarat as the major contributor. Appreciable quantity was also being landed along the coasts of Kerala and Karnataka.

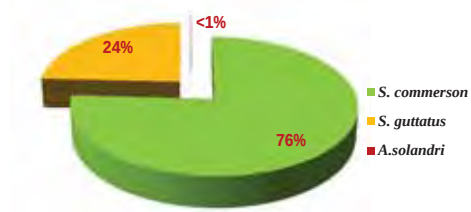
Belonids: Fishery was by several species belonging to the genera *Ablennes, Stronglyura* and *Tylosurus*. *Tylosurus crocodilus*, *T. acus melanotus* and *Ablennes hians* are the major species supporting the fishery. Belonids enjoy wide spatial distribution and fishery with large contribution from the coast of Tamil Nadu, followed by the coasts of Kerala and Maharashtra.

Carangids: Carangid component in the large pelagic catch was supported by rainbow runner and leather jackets. Rainbow runner in the catch was supported by single species, *Elagatis bipinnulata*; leather jackets comprised



Species composition of tuna


Landing of yellowfin tuna at Kochi fisheries harbour

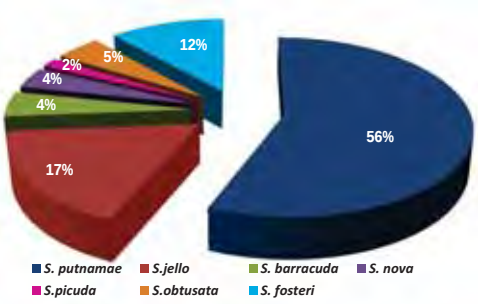


Species composition of seerfishes

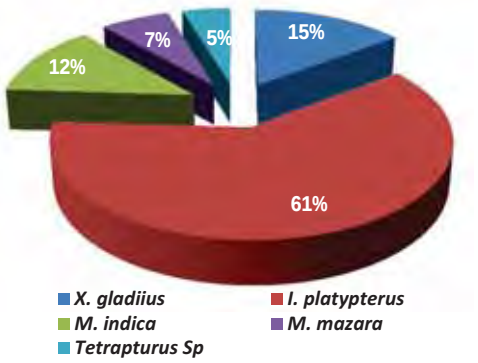

Landing of King seer, *S. commerson* at Kochi fisheries harbour

State-wise production (t) of different large pelagic groups during 2012

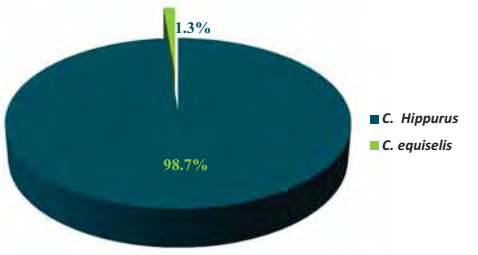
Resource	WB	OR	AP	TN	PON	KER	KAR	GOA	MH	GUJ	D&D	Total
Belonids	0	31	160	848	0	325	96	133	251	104	10	1958
Carangids	560	4163	2284	4564	135	1823	1558	551	2640	4152	744	23175
Seerfishes	1769	2357	7152	8361	544	11520	8647	348	5133	8774	1569	56174
Tunas	25	1240	12947	22096	565	16859	2421	3510	4088	13242	4758	81751
Billfishes	0	4	2532	772	22	2229	12	0	130	533	150	6385
Barracudas	0	584	4009	11567	668	3690	6963	183	1871	3447	929	33910
Cobia	20	120	48	175	0	450	363	0	798	690	176	2838
Coryphaena	0	3	538	291	77	1237	98	0	391	1255	391	4281
Total	**2374**	**8502**	**29670**	**48674**	**2011**	**38131**	**20158**	**4726**	**15302**	**32196**	**8727**	**210472**



Species composition of barracuda



Species composition of billfishes



Species composition of dolphin fishes

Landings of dolphin fishes at Kochi fisheries harbour

Landing of sailfishes at Kochi fisheries harbour

four species; *Scomberoides commersonianus*, *S. lysan*, *S. tala* and *S.tol*. Large carangids are being exploited from the entire Indian waters with large catches from waters of Andhra Pradesh, Odisha and Gujarat coast.

Temporal pattern in landings

Their fishery occurred round the year along the Indian coast with peak landings of most resources during August-December and in March. Tuna fishery occurred round the year.

Mode of exploitation

Commercial fisheries for large pelagics involve different craft and gear combination. Most fishing units carry variety of fishing gears and operation of each depends on the resource targeted and ground conditions. Large pelagics form targetted catch in some of the gears and bye catch in others. Major share of the catch was by hooks and lines and gill nets. Drift gill nets are generally used to capture fishes moves in the upper water column and hooks and lines in deeper layers.

Tunas as a whole were exploited by gill nets, hooks and line, purse seines, ring seines and trawls. Neritic tunas were exploited mainly by gill nets, purse seines, ring seines and trawls. Their contribution by hooks and line is limited. Oceanic tunas on the other hand was harvested mainly by hooks and line and contribution from other gears were limited.

Seer fishes were exploited mainly by gill nets, trawls and hooks and line. Catch in gill nets were constituted by sub-adults and in hooks and line by large adults. However, trawl catch was supported by juveniles and sub-adults.

Trawls were the main gear exploiting barracudas. They land mainly smaller species and young ones of the large species. Gill nets and hooks and lines land mainly adult of larger species.

Gillnets, trawls and hooks and lines were the major gears exploiting dolphinfishes. Trawls land mainly young ones of the species. Gill nets and hooks and lines land mainly adults of both species.

Billfishes were landed mainly by gill nets and hooks and line. Catch in gill nets were mainly due to entangling. Trawls, especially deep sea trawls, occasionally land small ones of different species.

Cobias were landed by several gears. Gill nets contribute major share of the catch, followed by it trawls and hooks and lines. 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. The study showed presence of some species in the fishery which are not described previously.

Biology of species.

Length range in the catch, food and feeding, sex ratio, gonadal development, maturity, spawning and fecundity of major species were monitored.

Large numbers of small ones of the sword fish, *X. gladius*, were landed occasionally at major landing points. Small ones predominated the catch in number on occasions when fishing occurred over and around sea-mounts and oceanic ridges. The size composition of other species indicated that major share of the catch of most species were represented by adult population

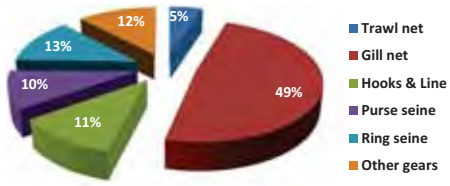
Food & feeding

All species are highly predatory and carnivores in feeding habit. Major share of the food was supported by pelagic finfishes, crabs and oceanic squids/ octopus. The details are given in the following table.

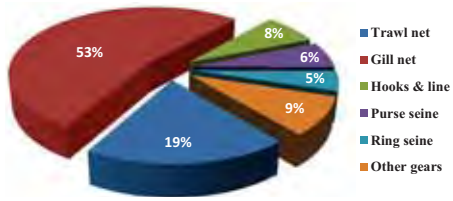
Species	Food content
T. albacares	*Decapterus*, Tunas-*A. rochei*, *A. thazard*, *K. pelamis*, flying fishes, halfbeaks, big-eye scad pelagic crab - *Portunus* spp, squid, octopus.
K. pelamis	*Decapterus*, halfbeaks, flying fishes, big-eye scad, pelagic crab- *Portunus* spp, octopus.
G. unicolor	*A. rochei*, squid, pelgic crab
T. tonggol	*Decapterus*, flying fish, halfbeaks squid, octopus
E. affinis	Sardines, anchovies, scads-*Alepes*, Selaraoides, ribbonfishes, penaeid prawns, crabs
S. orientalis	Sardines, anchovies, scads-*Decapterus*, penaeid prawns, crabs, barracudas
A. thazard	*Decapterus*, flying fish, squid, octopus
A. rochei	*Decapterus*, flying fish,half beak, squid, octopus
S. commerson	*S. longiceps*, anchovies scads, horse mackerel, *Saurida* sp., *Chorynemus*, mackerel, *E. diacanthus*, whitebaits, digested fish.
S. guttatus	Sardines, anchovies, penaeid prawns,
A. solandri	*Decapterus*, small tunas flying fishes, halfbeaks, big-eye scad pelagic crab- *Portunus* spp, squid, octopus.
S. putnamae	*Decapterus*, mackerel, squid
S. barracuda	*Decapterus*, flying fishes, hemiramphids, full beaks, big-eye scads, squids
S. obtusata	Sardines, anchovies, penaeids, squid
S. nova	*Decapterus*, Crab, squid
M. indica	Tunas-*A. rochei*, *A. thazard*, *T. albaceres*, *K. pelamis*, flying fishes, halfbeaks, sharks, rays, perches, big-eye scad, pelagic crab- *Portunus* spp, squid, octopus.
I. platypterus	Tunas-*A. rochei*, *A. thazard*, *T. albaceres*, *K. pelamis*, flying fishes, halfbeaks, Sciaenids sharks, rays, big-eye scad, pelagic crab- *Portunus* spp, squid, octopus.
X. gladius	Tunas-*A. rochei*, *A. thazard*, *T.albaceres*, *K. pelamis*, flying fishes, halfbeaks, big-eyescad, rays, small sharks, pelagic crab- *Portunus* spp, squid, octopus.
C. hippurus	Ribbonfish, *Decapterus*, ballistids, Sciaenids, squid, octopus, *M.cordyla*, flyingfish, pufferfish, digested fish
C. equisilis	Ballistids, squid, octopus, *M.cordyla*, flyingfish, pufferfish, digested fish
R. canadum	Pufferfish, *Decapterus*, *D. acuta*, *Parascolopsis* sp, crabs, squids, squilla, cuttlefish, octopus, *S.longiceps*, *E.diacanthus*, whitebaits, flatheads, *M. cordyla*, *R.kanagurta*, flatfish, threadfin breams, belone, *Callionemus* sp, silverbellies, *Saurida* sp, *L. lactarius*, *Priacanthus*, sciaenids, *Trichiurus* spp., *Fistularia* sp., *Sphyraena*, eel, shark, digested fish

Landing of marlins at Kochi fisheries harbour

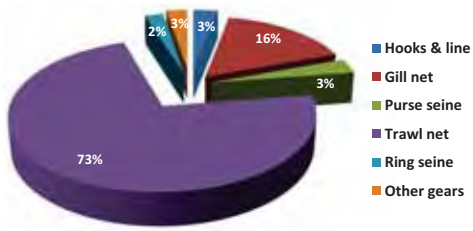
Landing of leatherjackets at Tharuvaikkulam fish landing centre



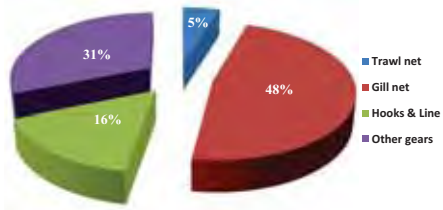
Gear by contribution of total tunas



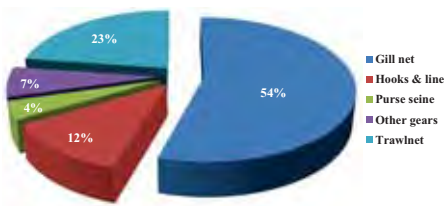
Gear by contribution of seer fishes



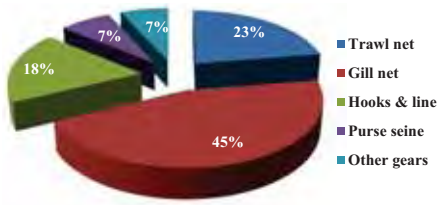
Gear by contribution of barracuda



Gear by contribution of billfishes



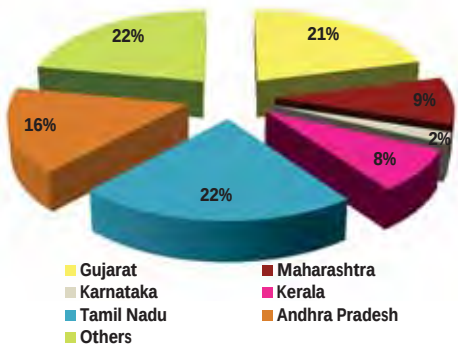
Gear by contribution of cobias



Gear by contribution of dolphin fishes

Biological parameters of important species

Species	L_r	L_{max}	Mean	Mode	L_c
T.albacares	30	176	136.4	52, 74, 127	127
K.pelamis	28	98	53.7	45, 53,59	38.3
G.unicolor	36	148	76.4	41, 77	38.3
T.tonggol	24	88	56.3	33, 55, 73	41.2
E.affinis	32	78	47.3	35, 43, 63	34.8
S.orientalis	24	60	39.2	33, 41	
A.thazard	22	54	35.7	29, 33	31.2
A.rochei	18	42	27.1	25, 29	25.3
S. commerson	33	158	77.8	43, 84, 118	71.4
S. guttatus	33	105			
A. solandri	73	138	92.1	101	82.3
S. putnamae	17	72	77.5	43, 47, 63	44.7
S. barracuda	48	132	89.7		
S. jello	26	128	83.7		
S. obtusata	20	68	39		
S. nova	44	121	72.2		
M. indica	98	280	198	198, 231	
I. platypterus	105	220	164.6	160	
X. gladius	72	148	97.6	114	
C. hippurus	32	150	78.8	38, 72	66.4
C. equisilis	24	55	47.8		
R. canadom	56	78			



Contribution of states to elasmobranch landings in India in 2012

Chiloscyllium arabicum recorded from Veraval and Mumbai, with egg cases

Summary

- Distribution of large pelagics are mainly towards oceanic waters. However, the fishery is generally restricted to outer continental shelf, adjacent oceanic waters knolls and seamounts, where these fishes frequented in large numbers for feeding, thus leaving large areas of oceanic waters and its resources un-exploited by the nation.
- Major issue in the development of their fishery are lack of sufficient skilled crew and lack of scientific awareness on the spatio-temporal distribution, abundance and migration pattern of the species.
- Present coastal based oceanic fishing fleets have operational limitation for fishing in oceanic waters.
- Skill of the fishers for oceanic fishing must be enhanced through scientific awareness on the distribution pattern of the resource and by providing proper training on long lining.
- Spatio-temporal movement and abundance charts of the resource may be developed through exploratory surveys.
- Large longliners with deep-sea going facilities, long endurasnce 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 on board or transported to onshore facilities.

Elasmobranch fishery

The production of elasmobranchs in India in 2012 was to the tune of about 5,2261 t, with trawl nets accounting for 55.6%, gill nets 29.4% and hooks & line and longline units 10.5%. The catch showed a slight reduction of 2.3% from the catch in the previous year. Sharks formed 44.6% of the total elasmobranch landings, skates, 3.9% and rays, 51.5%. The quantum of sharks landed has seen a fall of 13% from the landings in the previous year, while skates have fallen by 25%. Rays however registered an increase in the quantity landed, being about 12% more than the landings in 2011.

Gujarat: The elasmobranch landing of Gujarat was 10,755 t (13.14% decrease from 2011), among which sharks were the major contributors (70.61%) followed by rays (19.44%) and skates (9.93%). Major landing of sharks were from gill netters (55.20%) followed by trawl net (24.51%) and dol net (9.4%). The landings of rays and skates were highest by trawl net (60.33%). The catch of sharks was highest in December (1,633 t) whereas, the landing of skates (212 t) and rays (282 t) was highest in March along the Gujarat coast.

Maharashtra: The annual production of elasmobranchs in Maharashtra was 4,476 t during the year 2012, contributing 1.42% to the total marine landings in the state. The elasmobranch landings have decreased by 8.7% from the previous year. Trawl nets landed 36.9% of the total elasmobranchs, gill nets, 28.4% and dol nets, 3.3%. Sharks dominated the elasmobranch catch in all gears, forming 85.7% of the total elasmobranch landings, rays formed 11% and skates, 3.3%.

Karnataka & Goa: An estimated catch of 1,314t of elasmobranchs landed in Karnataka which formed about 0.27% of the total catch. At Goa 155t of elasmobranchs landed during the period of which 89% was contributed by sharks and remaining by rays. Sharks formed 56%, rays 29% and skates formed 15% of the elasmobranch catch in Karnataka. There was 1.2% increase in catch of elasmobranchs when compared to the previous year.

Kerala: An estimated total of 4,075t of elasmobranchs were landed in Kerala during 2012 which formed only 0.5% of the total marine landings of the state. Sharks contributed 64% (2,585t) of the elasmobranch landings in the state, followed by rays contributing 30% (1,213t) and skates formed 6% (257t). Mechanized driftnet hook & line units contributed major share (50%) in elasmobranch landings followed by mechanized driftnet units with 27%. The drift gill net hook & line units were the major contributors to shark (65%) as well as ray (42%) landings, whereas multiday trawl nets contributed major share (74%) of skate landings.

Tamil Nadu: Elasmobranch landings along Tamil Nadu coast in 2012 were estimated to be about 11,351.3 t. Trawlers and hooks & lines accounted for 73% of the landings. Single-day trawlers landed 35% (3,972.5 t) of the total elasmobranch landings with catch rate 0.9kg/h. Multiday trawlers landed 2,299 t with catch rate of 1.5 kg/h, forming 20% of the total elasmobranch landings. The landing by mechanized hook & line units was estimated to be 1748 t, which formed 15.4% of the total. Gillnetters contributed to about 20% of the elasmobranch landings in the state. The non-mechanized sector landed 479.4 t, contributing to 4.2% of the total elasmobranch production in the state in 2012. Rays dominated the elasmobranch landings from all the gears (10,489 t; 92.4 % of total elasmobranchs). The landing of sharks was to the tune of 531 t, forming 4.7% of the total. Skates were a minor group, forming 3% (331.5 t) of the elasmobranch landings.

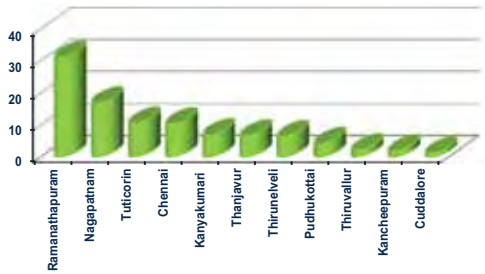
Andhra Pradesh: During 2012, an estimated 8,619 t of elasmobranchs were landed in Andhra Pradesh, forming 11.2% of demersal finfish landings and 3.04% of total marine landings in the state. Contribution of elasmobranchs to the demersal landings has decreased from 18.8% in 1,985 to 11.2% in 2012. Mechanized trawls landed 5,581 t of elasmobranchs contributing to 64.8% of total elasmobranch landings in the state. Motorized and mechanized crafts operating hook & line and long line units along with other gear landed 1,556 t (18.1%) and 1,042 t (12.1%) respectively, while gillnets landed 327 t contributing to 3.8% and artisanal gear landed 113 t contributing to 1.3% of total elasmobranch landings in 2012. Landings of sharks were 1,382 t (16.03%), skates 127 t (1.47%) and rays 7110 t (82.49%). Shark landings in the state decreased by 32.7% while landings of skates and rays increased by 24.5% and 21.1% respectively, from 2011.

Species diversity

The species profile of elasmobranch landings from different landing centres along the Indian coast revealed high species richness in Indian waters. 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 families Rhinidae and Rhinobatidae.

Rays landed at Colachel

Alopias superciliosus landed at Cochin



Contribution of different districts to elasmobranch landings (%) in Tamil Nadu during 2012

Manta alfredi (pup)
collected from Cochin Fisheries Harbour

Iago sp. at Madras Fisheries Harbour

Functional female (with claspers) with embryos

Heptranchias perlo

Isurus paucus

Inception Workshop (Chennai 11-12 Dec 2012)

Mobula sp.

Rare and new occurrences

The short fin mako shark *Isurus oxyrhynchus* and the long fin mako shark, *Isurus paucus* have been recorded for the first time from the waters off north Tamil Nadu. The occurrence of *I. paucus* has not hitherto been documented from the Bay of Bengal along the Indian coast. The silky shark, *Carcharhinus falciformis* was also recorded for the first time in the commercial landings at Madras Fisheries Harbour. The porcupine ray *Urogymnusa sperrimus*, the sharp nose seven gill shark *Heptranchia sperlo* and the slit-eye shark *Loxodon macrorhinus* were recorded for the first time at Cochin Fisheries Harbour.

Protected species

A single individual of the large tooth sawfish *Pristis microdon*, declared protected under Schedule-1 of the Wildlife (Protection) Act, India, was accidentally caught in a trawl net and brought ashore to Malpe in Udupi district, Karnataka. The fish weighed about 800 kg. To counter recurrence of such accidental catches, pamphlets in all local languages are being prepared to spread awareness on the protected elasmobranch species, their biology and vulnerability, so as to encourage fishermen to remain watchful and release any such individual back into the sea.

Stakeholder Participation

A major initiative under the project has been the involvement of the shark fishermen from Thuthoor, a fishing village in Tamil Nadu known for targeted shark fishing along the Indian coast. Representatives of the Association of Deep-Sea Going Artisanal Fishermen (ADSGAF), Thuthoor, participated in the Inception Workshop of the project held at Chennai during 11-13 December 2012, and their constant inputs on shark fishing activities along the coast are of help in understanding seasonal availability of different species, location of shark fishing grounds and market trends.

Trade in devil ray gill rakers

Of late, trade in devil ray gill rakers has seen an upward trend at Chennai. The devil rays are auctioned at the rate of 30-40/kg. The flesh is salted, sun-dried and sold in the dry fish market. The gill rakers are removed carefully, cleaned in seawater and dried at room temperature for about 4-5 days. Processed gill rakers are sold at prices ranging between ` 2500 and 10,000/ kg, depending on the size of the ray and the species. The gill rakers of *Mobula tarapacana*, commonly called "white" is being sold by traders from Kochi to buyers in Chennai, at high prices of ` 9000/kg dry weight, and the meat at ` 200/kg wet weight. The gill rakers of *M. japonica*, locally called "black" fetch only ` 4000/kg dry weight. The gill rakers are exported from Chennai to foreign countries for soup and medicine preparation.

Population studies

Growth and stock parameters were assessed for Scoliodon laticaudus exploited from the north-west coast. With a size range of 190-590 mm TL and mean size of 367 mm represented in fishery, L_∞ was estimated to be 610 mm, annual K, 0.52y^{-1} and exploitation ratio E, 0.46. About 59% and 67% of the landings of *S. laticaudus* in the states of Maharashtra and Gujarat comprised juveniles. Growth and stock parameters estimated for the scaly whip ray *Himanturaim bricata* were L_∞ = 260.6 mm K = 0.64 y^{-1}, E = 0.35.

Classification of Stock Status

Analysis of the elasmobranch landing data of Karnataka for the period 1961-2012 for rapid classification of stock has revealed the stocks to be "Declining." While the status of sharks is "Declining" rays are "Less abundant" and skates are "Abundant."

Bivalve fisheries

Annual production of bivalves in different estuaries and important landing centres along the States of Maharashtra, Karnataka, Kerala, Tamil Nadu, Andhra Pradesh and Odisha were estimated by species. The annual landing of bivalves from Ratnagiri, Karwar, Mangalore, Calicut, Kochi, Vizhinjam, Tuticorin, Chennai, Visakhapatnam, Kakinada and Puri was estimated at 89,897t. Clams, oysters and mussels contributed 82.1%, 2.6% and 15.3% respectively.

Maharashtra

Creeks of Ratnagiri District contributed to more than 70% of the bivalve production from the State. Annual bivalve production from three major creeks, Shirgoan, Sakhartar and Bhatye creeks in Ratnagiri were 3t, 1.4 t and 2.7 t respectively. Bivalve landings was dominated by *Marcia opima* (23.5%) followed by *Paphia malabarica* (22.5%), *Meretrix* spp. (15.9%), *Perna viridis* (6.9%) *Crassostrea* spp. (7.8%) and others (23.5%). Hand-picking for bivalves was not regular in creeks along the other four coastal Districts of Maharashtra.

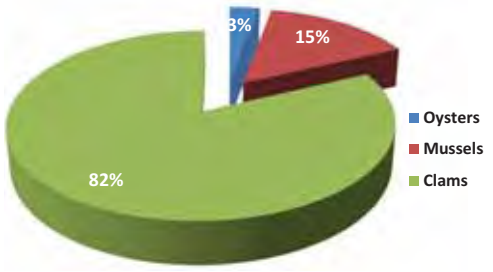
Karnataka

Clam production (9,619 t) in Karnataka recorded an increasing trend by 49%, while green mussel landings (2,519 t) showed a decreasing by 11% compared to 2011. *Meretrix casta* and *P. malabarica* contributed 96% to the total clam production. Clam production from Nethravathi, Aghanashini, Gangavali and Kalinadi decreased during the period. 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 Chettuva estuary in Kerala and transplanted in Coondapur estuary prior to retailing. Preliminary surveys in Mulki, Gurupur, Sita, Swarna and Coondapur estuaries of Dakshina Kannada and & Udupi District of Karnataka was carried out. Peak recruitment of *P. malabarica* and *M. casta* in Swarna and Sita estuaries was observed in November, when 3-20 mm size groups formed 71% (*P. malabarica*) and 49% (*M.casta*) of the clam stock.

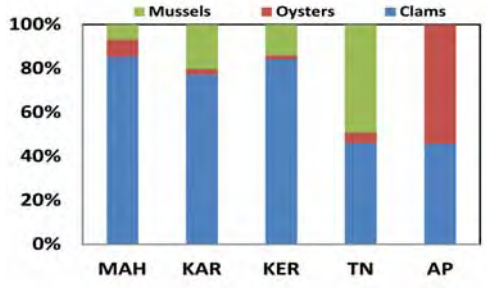
Kerala

Clams formed 84% of bivalve production in Kerala followed by mussels (14%) and edible oysters (2%). Bivalve production along the Malabar Coast was estimated at 25,880 t contributing 35% to the State production. Clams, *M. casta*, *V. cyprinoides* and *P. malabarica* dominated the fishery (59%). Green mussel *Perna viridis* constituted 9,205 t forming 36% of the bivalve landings. Mussel fishery of Malabar area has of late seen a shift in the resource management by local self-governance. Daily catch quota per person is fixed based on the rough assessment of the mussel stock availability in different beds. Removal of mussel seeds for farming was also not permitted from mussel beds to avoid stock reduction. Estuarine waters of Central Kerala contributed 75% to the clam production of the State. Production of *P. malabarica* in Ashtamudi Lake during March to November 2012 (11,174 t)

Cleaned and partially dried gill rakers



Contribution of clams, oysters and mussels to bivalve landings



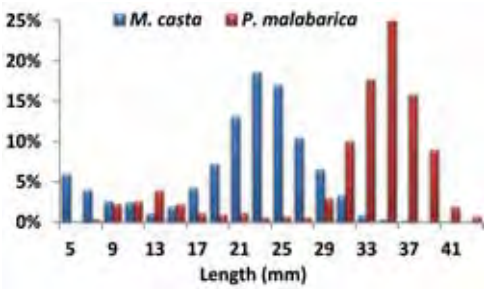
Contribution of bivalve groups to the total landings by States

Bivalve fishers of Maharashtra

Clam fishery at Coondapur estuary

Estimated bivalve landings during 2012

Groups	Species	Maharashtra	Karnataka	Kerala	Tamil Nadu	Andhra Pradesh	Odisha	Total (t)
Clams	*Paphia malabarica*	1.8	4199	11745	11	29		15986
	Meretrix meretrix	1.2	138			123		262
	M. casta		5034	8816	745	10		14604
	Marcia opima	1.8	165		10	21		197
	Villorita cyprinoides		83	42371				42454
	Anadara granosa					236		236
	A. rhombea					15		15
	Gafrarium tumidum				0.3			0.3
	Others	1.8				27		29
	Total	**6.6**	**9619**	**62932**	**765**	**460**		**73783**
Oysters	*Crassostrea madrasensis*	0.6	227	1303	82	82		1694
	Saccostrea cucullata		97					97
	Placuna placenta					447		447
	Others					15		15
	Total	**0.6**	**324**	**1303**	**82**	**544**		**2253**
Mussels	*Perna viridis*	0.5	2519	9205	818			12542
	P. indica			1181				1181
	Total	**0.5**	**2519**	**10387**	**818**	**0**		**13724**
	Total bivalves	**7.7**	**12462**	**74622**	**1664**	**1004**	**138**	**89897**



Length composition in Swarna-Sita clam beds in Karnataka (July-Nov 2012)

Bivalve shell exploitation for lime

Meretrix casta grading

recorded 4.5% decrease compared to 2011. Self-imposed ban on fishing during December 2011-February 2012 for *P. malabarica* continued in region. Black clam production in Vembanad during 2012 was estimated at 36,006 t. Proportion of juvenile clams showed a steady decrease, attributable to the usage of larger mesh size and increased awareness among fishers on the consequences of juvenile exploitation. In Chettuva estuary *M. casta* and *V. Cyprinoides* formed the major fishery. Total estimated bivalve production was 380 t of which black clam contributed 79%. Brown mussel fishery was observed only along the Vizhinjam coast in the tune of 1,181 t.

In Ashtamudi Lake, the estimated biomasses of seed clams (*P. malabarica*) were projected to the fishing season based on growth and mortality parameters, and used to derive an estimate of the Total Allowable Catch (TAC). In subsequent years, after fine tuning and validation exercises, this TAC will be allocated as individual quotas to clam fishers. The Clam Fishery Management Plan (CFMP) for Ashtamudi Lake was passed on to the Kerala Principal Secretary (Fisheries), Director of Fisheries, the Kollam District Collector and the District Panchayat for implementation. Agreement has been reached for the formation of the Village and District Clam Fishery Council (CFC). This also forms part of the process for getting the short-neck clam fishery eco-labeled and certified as per the norms of the MSC.

Tamil Nadu

Exploitation of live and dead clams comprising of *P. malabarica*, *M. opima* and *Meretrix* spp. from Karapad Bay, Tuticorin was primarily for lime industry. Total annual production was estimated at 29.5 t for a period of 207 fishing days. Mussel (*P. viridis*), clam (*M. casta*) and oyster (*C.madrasensis*) production from Palar estuary, Pranangada waters near Pulicate lake, Ennore Estuary and Kovalam Backwater was estimated at 1,635 t.

Andhra Pradesh

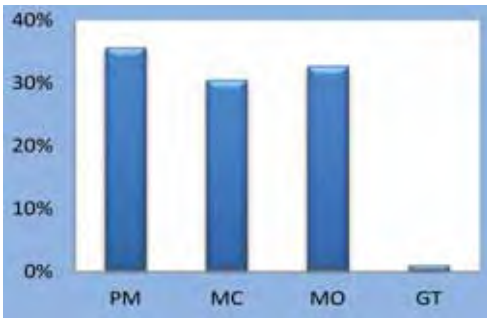
Total bivalve landings from Chollangi and Peddavalsala landing centres of Kakinada bay was estimated at 1,004 t. The landings increased by 5.6%

compared to previous year. Windowpane oyster, *Placuna placenta* contributed 45% and *Anadara granosa* 23% to the bivalve landings followed by *M. meretrix* 12% and *C. madrasensis* 8%. Landings of *M. meretrix* increased by 39.5%, *P. malabarica* by 51.6%, *M. opima* by 78.4% while, *Anadara* sp. declined by 9.4%, *M. casta* by 87.5%, *Geloina* sp. by 91.9%. Bivalve catch and effort in the Bhimili estuary continued to decline drastically due to inclement weather, with frequent cyclones and thunderstorms. Bivalve production estimated at 49.2 t declined by 44.5% compared to 2011. Landing of *M. casta* declined by 56.1%, *M. meretrix* by 79.8%, *Anadara* sp. by 74.1% and *C. madrasensis* decreased by 32.8%.

Perna viridis fishery at Mahe

Odisha

Bivalve collection is done regularly near Puri and Berhampur districts of Odisha in and around Chilika lake. Many local farmers are collecting dead and live bivalves from coastal and estuarine areas near Baidhar, Charchari, Lunapani, Bhagavanpur, Gambhari, Sipakuda and Arakuda areas for poultry, pharamaceutical, lime and fertilizer companies. Live bivalves are being collected during lowtide near Bhagavanpur. About 125-150t of bivalves are traded annually from Arakuda, Sipakuda, Baidhar and Charchadi village for lime production. Regular mining of bivalve is being carried out at Bahuda estuaries at Berhampur district and trade is being done @ 30 t per month. Along with dead, live bivalves were also collected in small canoes and dumped in an area near to estuaries.



Species composition of clams exploited at Karapad Bay, Tuticorin
PM: *Perna malabarica*, MC: *Meretrix casta*, MO: *Marcia opima* and GT: *Gafrarium tumidum*

Marcia opima landed at Kakinada

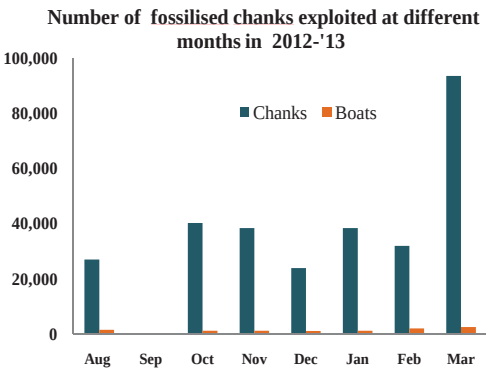
Black clam marketing in Kerala

Bivalve shell exploitation at Odisha

Ornamental gastropods

Tuticorin

Fishery of sacred chank from Kalavasal and Kayalpattinam centres of Tuticorin was monitored. Estimated exploited chanks at Kalavasal 51,878 numbers by 5,339 boats with a catch/unit effort of 10 chanks and at Kayalpatnam, 70,265 nos by 6,544 with a CPUE of 11 chanks. The size/weight of chanks are 111-213 mm (171mm)/150-1,050g (627g) and 91-208mm (161mm)/140-1,900 (420g) respectively.Live fishery for *Chicoreus ramosus* was monitored (Oct-December 2012) and total estimated landing was 68,590 nos. by 1200 boats with a CPUE of 57 nos. The size/ weight range observed was 147-207 (189mm)/200-1,410 (915g) at Kalavasal and 21,187nos by 1,801 boats with a CPUE of 12 nos. The size/weight ranged from 99-199(166mm)/ 50-750 (355g) at Kayalpattinam respectively. Fossilised chank exploitation at Kalavasal between August to December 2012 was estimated to be 1,29,590



A heap of processed ornamental gastropods

Processed *Architechtoniums* spp.

nos. by 4,900 boats with a CPUE of 26 chanks. The size/weight range was 113-212 (171mm)/180-1,700 (804g).

Kollam

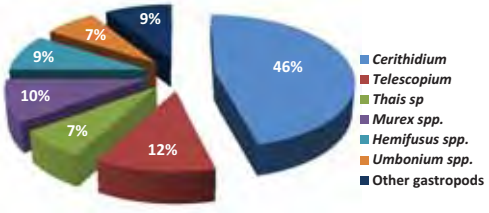
During the period, January - December, 2012, an estimated quantity of 1,193.4 tonnes of cephalopods was landed by trawlers expending approximately 31,628 units of fishing effort from this district. The catch rate (Kg/unit) was 38. The maximum catch was observed during April and May, while maximum catch rate was observed in May. The highest landings were recorded during the II quarter (Apr - Jun); percentage contribution being 96.3 % followed by III quarter (1.8 %), I quarter (1.1 %) and IV quarter (0.7 %). Trawl nets operating up to 100m depth accounted for 99.9 % followed by other gears (0.1 %). *Turritella* sp., *Tibia curta*, *Bursa* sp., *Murex* sp., *Turbinella pyrum*, *Dentalium* sp., *Tonna* sp., formed the major fishery.

Ernakulam

During the period, the trawlers operated off this district brought estimated ornamental gastropods' catch of 1.7 tonnes with avg. catch rate (kg/unit) of 0.04 kg. The shell length (SL) and wet weight of *Bursa spinosa* ranged from 35.1 – 74.3 mm and 1.2 – 9.3g. Sex ratio (M: F) was 1: 0.32.

Estimated gastropod landings by trawl at Kollam and Ernakulam districts in Kerala

	Centre : Kollam			Centre : Ernakulam		
Month	Gastropods (kg)	Effort (Units)	CPUE	Gastropods (kg)	Effort (Units)	CPUE
Jan	1527	2366	0.64	0	4265	0
Feb	9115	3194	2.85	1383	6550	0.21
Mar	2686	3589	0.75	0	5458	0
Apr	646584	3580	180.62	0	4686	0
May	451124	4554	99.06	0	5308	0
Jun	51701	1660	31.15	108	2046	0.05
Jul	0	0	0	0	0	0
Aug	15658	6521	2.40	162	5552	0.03
Sep	6101	3261	1.87	0	3125	0
Oct	8948	2903	3.08	0	2901	0
Nov	0	0	0	0	0	0
Dec	0	0	0	0	0	0
Total	1193444	31628	37.73	1653	39891	0.04



Landings of different gastropods at Kakinada Bay during 2012-13

Kakinada Bay

The estimated total gastropod landing from Kakinada Bay was 217t with average monthly landings of 18.1t. The total effort was 5,565 units with average CPUE of 37.9. Species landed were *Cerithidium* sp. (99.5t), *Telescopium* sp. (26.3t), *Thais* sp. (15.2t), *Murex* sp. (20.8t), *Hemifusus* sp. (20.7t), *Umbonium* sp. (14.24t) and other gastropods (20.2t). Maximum landings were during March and August-October and the price ranged between from `6-12/ Kg. Total gastropod landings declined by 31% (96t) as against previous year and the effort declined by 10%, however, the catch per unit effort increased by 21% (10.2kg). *Certithidium* sp. registered an increase of 141.4t (58.7%) and all other species recorded a decline viz., *Umbonium* sp. 11.1t (78.2%), *Hemifusus* sp. 10.9t (52.7%), *Murex* sp. 10.5t (50.5%), *Telescopium* sp. 3.3t (12.5%) and *Thais* sp. 1.3t (8.6%).

Fish genetics and genomics

Biotechnological applications in mariculture and fishery resources management

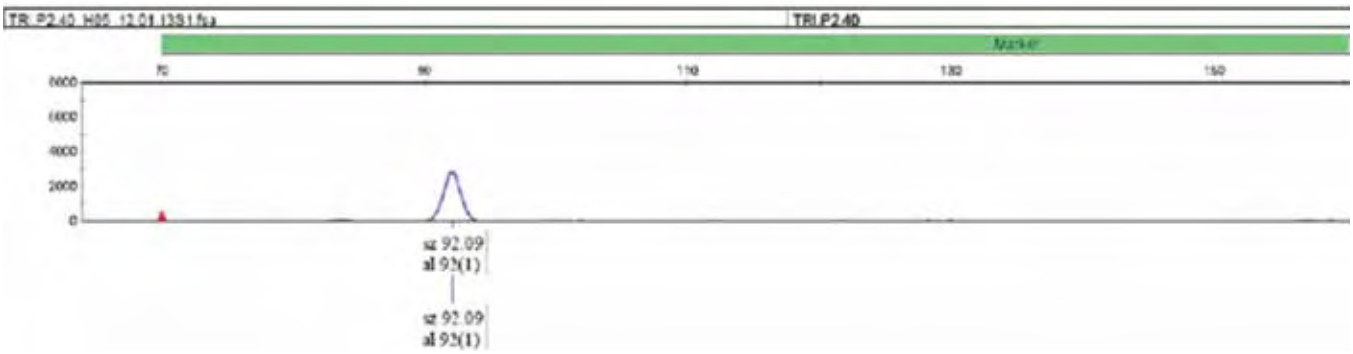
Development of microsatellite markers for population genetic analysis of Indian oilsardine and mackerel

Microsatellite markers were developed to study the population genetic structure of Indian oilsardine, *Sardinella longiceps* from the southern coast of India. Primers from closely related species (*Sardina pilchardus* and *Sardinops sagax*) were tried for cross species amplification in *S. longiceps*. Out of the 19 primers screened, 6 of them gave clear bands (at specific combinations of annealing temperature and magnesium chloride). They were selected for labeling with 6 FAM flourescein, microsatellite primers selected for screening of a commonly used fluorescent dye for attaching to oligonucleotides.

Microsatellite primer selected for screening of *Sardinella longiceps*

Locus name	Primer sequence 5'-3'	Product size
SAR B-D09	5'GGT CAT CTG CTT CAA CAA CAC-3' 5'GCA GCC TGT CTG AAA CTC TG-3'	300-350 bp
SAR B-H04 (F)	5'CTC TCG GTG CTT GGA GAG GAA-3' 5'GGA GGA GGG GAG GAA AAG ATG-3'	180-200 bp
SAR B-G09	5'GGT GGA AAG AAC ACT GGT CA-3' 5'GGT TCA CTA TGC AGG CTA TG-3'	700-800 bp
SAR B-H04	5'CGA GTT TGT CCC ACA CCT GGA G-3' 5'CTC CAA GCA CCG AGA GCA TC-3'	450-500 bp
SAR B-A08	5' GTG ATA CTC TCT GCC TTG GA-3' 5' GCA CTT TGT CCT AGT AAA TAG C-3'	400-450 bp
SAR 9	5' AGG ATG TGA TGT CCA TGA AGA AG-3' 5' GTT CTT ATT GCC TGC ACT GAA CA -3'	600-700 bp

Indian oilsardine samples (100 nos.) were collected from Kochi and Chennai coasts. DNA was extracted from all the collected specimens and 60 of these samples were used for microsatellite analysis. The samples were analysed with the fluorescently labeled (6 FAM) primers. Automated genotyping was done on the ABI Prism genetic analyser and alleles were identified using allele calls in GENEMAPPER software. A high degree of allelic variation was observed in samples from Kochi as compared to Chennai samples Indicating samples from Kochi to be more heterogeneous with a greater degree of genetic differentiation. This shows the presence of a well established population. Studies using more loci are in progress to thoroughly understand the genetic variation.



Alleles expressed as peaks in automated genotyping using ABI Prism genetic analyser (oil sardine).

Micorsatellite markers were also developed to study the population genetic structure of Indian mackerel, *Rastrelliger kanagurta*. Preliminary screening was done with the following primers.

Microsatellite primers selected for screening *Rastrelliger kanagurta*

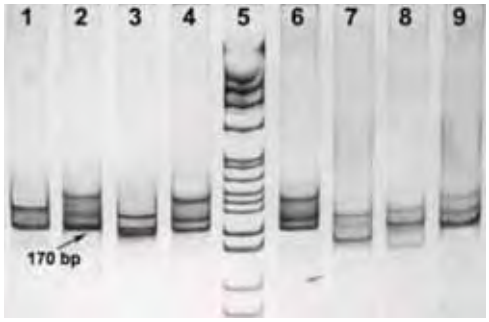
Locus name	Primer sequence 5'-3'	Product size
Mac 1	5'ACG CAG CAA TGC ACC GTG G-3'	
	5'AAG AAT CAA CAC AAA CAG CAC C-3'	350-400 bp
Mac 2	5'AAA GAA TGG AAA TTC AGA TCA C-3'	
	5'TAA AAT GAC ATC ATC CCA TGG-3'	300-400 bp
Mac 3	5'TGA TCT AAT CAA TGG GAG AGG-3'	
	5'TGC TCA CAT GTG CAA GCA AT-3'	300-400 bp
Mac 4	5'TGA TGA GGC TGA AAG ACT GAC-3'	
	5'AGG TAG TGA CCA ACG CTC C-3'	280-300 bp
Mac 5	5' ATG GCA ACG GCG AGA TTA AGG-3'	
	5' TCC AGA ACA GCA GCA GTT TCC-3'	180-200 bp

Development of microsatellite markers for population genetic analysis of the green mussel, *Perna viridis*

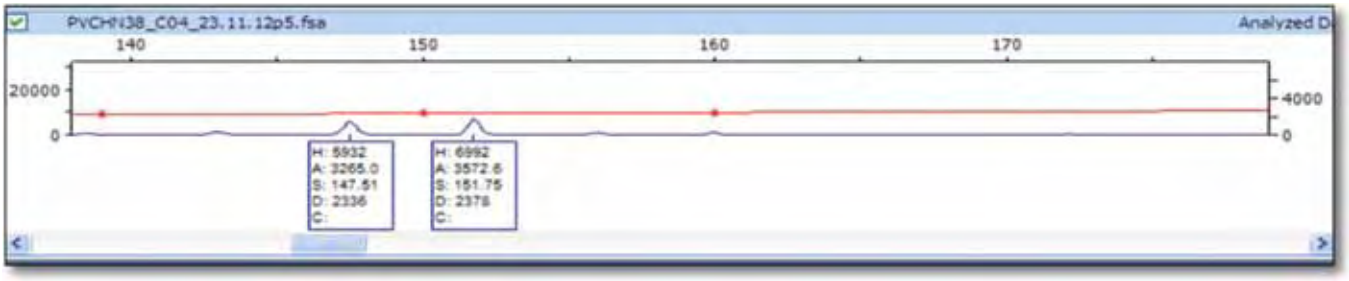
Microsatellite markers were developed to study the population genetic structure of the green mussel *Perna viridis* from the southern coast (Kerala, Karnataka and Tamil Nadu) of India. Eighteen pairs of microsatellite primers previously tested by Ong *et al.* (2009) in *P. viridis* were selected and screened for polymorphism and consistency. Out of the eighteen pairs of microsatellite primers, six pairs which gave clear, reproducible and polymorphic bands were selected for fluorescent labeling using 6 FAM flourescein.

Microsatellite primers selected for population analysis of *P. viridis*

Primer name	Sequence 5'- 3'	Tm (°C)
BP14-7-1 F	TGAGGCGATAGATAGATAG	58
BP14-7-1 R	GATCAACTGTTAAGCGATAG	
BP2-35-2 F	CTCTTTCATCTTTCACCTC	48
BP2-35-2 R	CGTCAGGTACTCCATATCC	
BP2-17-2 F	ATACACTGGGCTATTCTCTT	42
BP2-17-2 R	TATTCTCTCTCTCTCTCTC	
BP10-16-1 F	TGTGTGTTCTCTCTCTCTC	52
BP10-16-1 R	CTGTCTTTGCTAGTTCCTC	
VJ1-18-1 F	GTAGCGGCTCTCTCTCTCT	46
VJ1-18-1 R	GCGTGACACTCTTTTTCTTT	
VJ1-9-1 F	TGCGTGTGGAGGCTCTCT	50
VJ1-9-1 R	TCACCTCTTGGTTGAGGACA	



Poly-Acrylamide gel with the profile of microsatellite locus amplified by the primer BP14-7-1 showing multiple alleles of *Perna viridis* population collected from Pulicat lake and pBR322 MSPII digested DNA ladder (lane 5)



Alleles expressed as peaks in automated genotyping using ABI Prism genetic analyzer (green mussel)

Fifty numbers of green mussel samples were collected from Kerala, Karnataka and Tamil Nadu coasts. DNA was extracted from all the collected specimens and the samples were analysed with the fluorescently labeled (6 FAM) primers. Automated genotyping was done on the ABI Prism genetic analyser and alleles were identified using allele calls in GENEMAPPER software. The populations were found to be heterogeneous with high allelic diversity. Studies are in progress to deduce the pattern of genetic differentiation and variation between the 3 populations of green mussel.

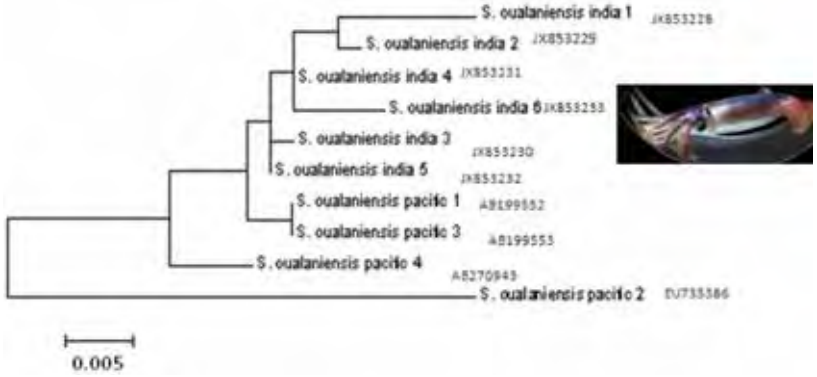
DNA barcoding using species specific molecular markers

Bar coding of commercially important Indian mackerel *Rastrelliger kanagurta*, and purple black flying squid *Sthenoteuthis oulaniensis* collected from Arabian sea (southwest coast of India) was carried out using mitochondrial cytochrome c oxidase I gene. Partial sequence of cytochrome c oxidase gene to be used as bar code resolved from *S. oulaniensis* and Indian mackerel were submitted to Gen Bank and the following accession numbers were obtained.

Details of DNA sequence submissions

JX853228	*S. oualaniensis*	mitochondrial	cytochrome	c oxidase	gene	partial	sequence
JX853229	*S. oualaniensis*	mitochondrial	cytochrome	c oxidase	gene	partial	sequence
JX853230	*S. oualaniensis*	mitochondrial	cytochrome	c oxidase	gene	partial	sequence
JX853231	*S. oualaniensis*	mitochondrial	cytochrome	c oxidase	gene	partial	sequence
JX853232	*S. oualaniensis*	mitochondrial	cytochrome	c oxidase	gene	partial	sequence
JX853233	*S. oualaniensis*	mitochondrial	cytochrome	c oxidase	gene	partial	sequence
JX866767	*Rastrelliger kanagurta*	mitochondrial	cytochrome	c oxidase	gene	partial	sequence
JX866768	*Rastrelliger kanagurta*	mitochondrial	cytochrome	c oxidase	gene	partial	sequence

A preliminary comparison was made using the barcode data of 6 haplotypes of *S. oualaniensis* from Indian ocean (collected by CMFRI) with 4 haplotypes of *S. oualaniensis* from the Pacific ocean (data from Gen Bank). Pacific ocean



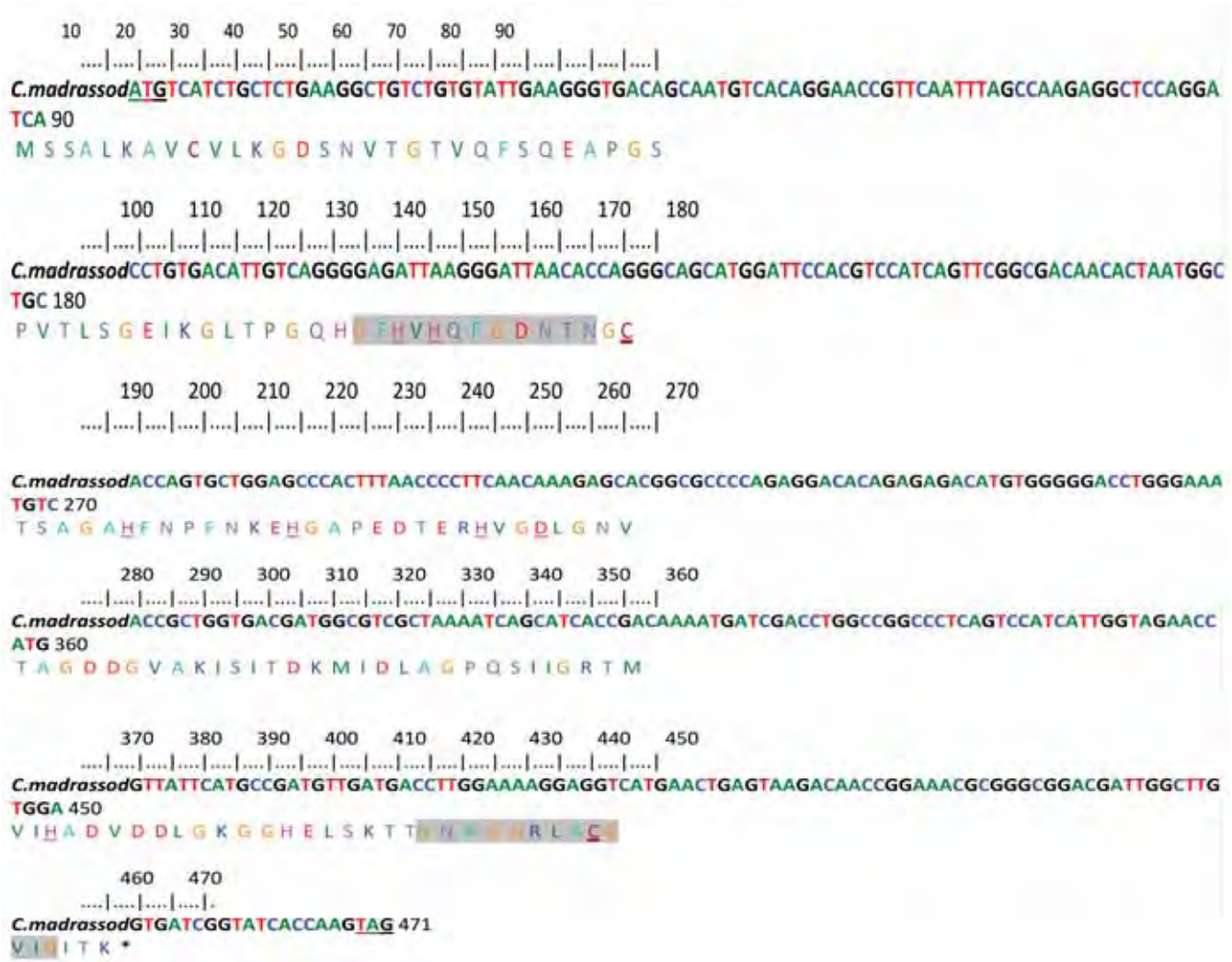
Maximum likelihood tree generated using the mitochondrial cytochrome c oxidase gene sequences of *S. oulaniensis* from Indian and Pacific coasts

haplotypes were genetically more distant from Indian ocean haploypes in maximum likelihood analysis using MEGA 5.1. *S. oulaniensis* pacific 1, 3 and 4 are from Northern Hawaiian waters and Pacific 2 is from tropical Pacific waters.

Functional gene characterisation

Molecular characterisation of the antioxidant gene, superoxide dismutase in *Crassostrea madrasensis* was continued to develop full length gene sequence through 3' and 5' RACE-PCR, as it is a functional gene involved in stress tolerance and disease resistance. Sequencing of the RACE products revealed the complete coding region of 471 bp .

BLAST search of SOD (Cm CU/Zn SOD) gene sequence of *C. madrasensis* of the present study with that of the sequences in the GEN BANK have shown 98% identity with that of *Pinctada fucata* from Indian ocean, 93% each with *Crassostrea hongkongensis* and *Crassostrea ariakensis* and 91% with *Crassostrea gigas*.



Nucleotide and deduced amino acid sequences of the complete coding region of Cm Cu/Zn SOD. The start codon (ATG) and the stop codon (TAA) are underlined. Two Cm Cu/Zn SOD family signatures predicted by Inter Pro Scan Program are shaded gray. The amino acids required for copper (His-49,-51,- 66,and -123) and zinc (His-66,-74,and -83 and Asp-86) binding are bold and underlined. Two cysteines (Cys-60 and Cys-149) that form a disulphide bond are bold and double underlined. GenBank accession number is NCBI(JX532084)

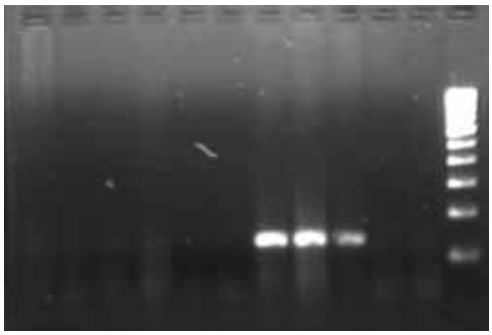
Deduction of amino acid sequence from the complete coding region using online software Transeq of European Molecular Biology Laboratory (EMBL) revealed that 156 amino acids are encoded by it .The analysis of amino acid sequences using the InterProScan online software to find out specific domains have revealed four copper/zinc binding domains within the superoxide dismutase sequences. They were between amino acid positions 47-69, 83-92, 102-124 and 127-153. Further, copper/zinc binding sites referred to as signature 1 and 2 were detected in amino acid positions between 47-57 and 141-152. The representative sequence pattern of signatures 1 and 2 were : [GA]-[IMFAT]-H-[LIVF]-H-{S}-x-[GP]-[SDG]-x-[STAGDE] and G-[GNHD]-[SGA]-[GR]-x-R-x-[SGAWRV]-C-(2)-[IV]. The signal peptide analysis showed that SOD lacked the signal peptide thereby confirming its intracellular nature.

The amino acid sequence of Cm Cu/ZnSOD have shown identity of 98% with *Pinctada fucata* from Indian Ocean, 97% with *Crassostrea gigas* from Chinese coast, 94% with *Crassostrea gigas* from French coast, 96% with *Crassostrea hongkongensis*, 94% with *Crassostrea ariakensis*, 88% with *Ostrea edulis*, 74% with *Mytilus chilensis* and 73% with *Mytilus galloprovincialis*. The sequences of *C. gigas* from Chinese coast used for homology search is based on the results of whole oyster genome and trascriptome sequencing published in Nature (Guofan *et al*., 2012). This sequence of Cu/Zn SOD of *C. gigas* is showing 3% difference with the sequence of the same species from French coast (Boutet *et al*., 2004).

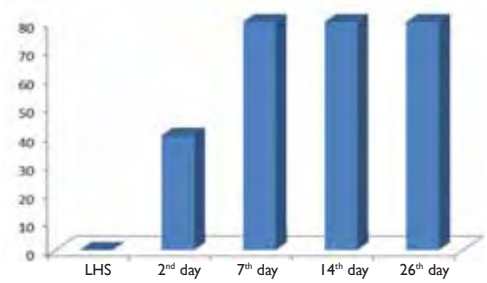
In order to understand the genetic relatedness of the candidate species with the oyster and mussel species distributed in different geographical locations, phylogenetic analysis was conducted with the software MEGA along with totally unrelated species like *Gallus gallus* as an out group. The phylogenetic analysis brought some exciting results. The candidate species *C. madrasensis* and *P. indica*, though belong to different genera were clustered in the same group. Pearl oyster *Pinctada fucata*, which belong to different genera was also in the same cluster along with *C. madrasensis* and *P. indica*. It is worthwhile to note that Cu/Zn SOD sequences of *P. fucata* used in phylogenetic analysis was reported from oysters along the Indian coast.

Sequence divergence analysis at inter domain junction of HSP70 gene

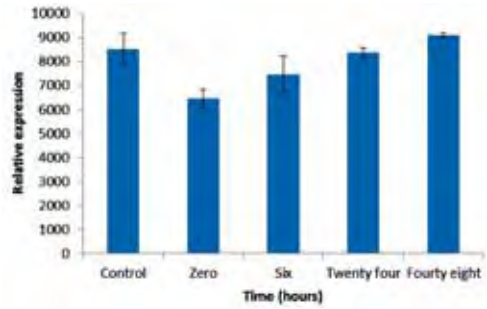
Studies were undertaken to analyse the sequence divergence within the HSP gene sequence of the oyster, *Crassostrea madrasensis* as they are exposed to diverse environmental conditions. The sequence data were analysed using Bio Edit software. The inter domain junction between peptide binding domain and C- terminal domain are found to be more diverse. Species specific PCR primers were designed from the highly conserved region of Original Reading Frame (ORF) located towards C-terminal region using the software, Beacon designer. The amplification trials using c-DNA reverse transcribed from the total RNA of gill tissues resulted in expected amplicons. The specific primers designed for *C. madrasensis* resulted in single bands of 155 bp. As the primers were designed from within the exon sequences, PCR resulted in the expected products with genomic DNA as well, when used as a template, making the entire process fast and cost effective. The initial trials of cross amplification of this specific primer pairs in other related and common bivalves of Indian coast resulted in ensuring the specificity of primers. PCR with the above *C. madrasensis* specifc primer failed to give amplicons with *Perna indica*, *Perna virids* and *Saccostrea cucculata*.



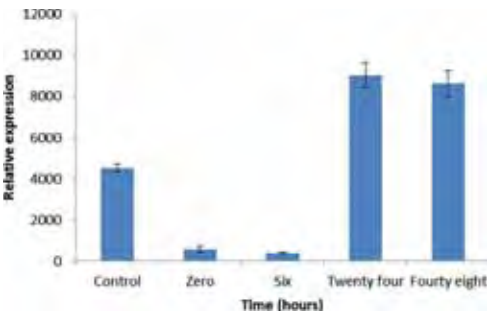
PCR Amplification of HSP70 fragment restricted to *C. madrasensis* (155bp) showing the specificity of primer designed.



Induction of thermal tolerance in the Indian edible oyster. LHS : Lethal heat shocked. 2,7,14 and 26 refer to days on which oysters recovering from SHS were exposed to LHS. Each bar represents % survival of one group of 10 animals



Elevated levels of Hsp 70 gene in *C. madrasensis* exposed to thermal stress



Elevated levels of SOD gene in *C. madrasensis* exposed to thermal stress

Transgenic zebra fish larvae expressing GFP

PCR confirmation of the presence of transgene in *E. maculatus* embryo. Lanes 2, 3, 5-confirmed; Lanes 1, 4, 6 and 7-negative; M-marker

These alterations within a gene playing vital role in the normal physiology of animal is an important evidence of soft inheritance that is taking place in bivalves in tune with environmental pressures. Experiments with more number of samples covering different geographic locations are going on to check the level of diversity within the HSP gene among the oyster and mussel as they are exposed to different environmental pressures in different locations and habitats.

Thermo tolerance

The thermal limits of *C. madrasensis* were experimentally determined by exposing the oysters to different temperature regimes. The sublethal temperature (SLT), the maximum temperature an animal can withstand, is determined to be 44^{0}C in *C. madrasensis*. This is the maximum tolerable temperature reported from bivalves. *C. madrasensis* survives 7^{0}C more than the Pacific oyster *C. gigas* which could withstand only up to 37^{0}C. These findings prove the potential of Indian edible oyster to survive harsh environmental challenges and make it as a suitable species for bivalve mariculture even in stressful ambience.

Prolonged thermo-tolerance following gene activation

The ability to survive beyond the lethal temperatures following an initial exposure to a sublethal shock and thereby increasing the upper limit of thermal tolerance in organisms is known as induced tolerance. This phenomenon was first reported in *C. gigas* (Clegg *et al*., 1998). The initial exposure of Indian edible oyster *C. madrasensis* to 44^{0}C (sublethal temperature) have made the oyster to survive the lethal temperature (47^{0}C) and this ability was retained up to 26 days after the initial sublethal shock. This is a record duration compared to the longest period ever reported in any animals. Oysters surviving lethal temperatures through induced tolerance can be effectively used for selective breeding to raise better genetic stock to be used in mariculture. The molecular basis of such induced tolerance was deciphered through screening the expressions of functional genes related to stress and defense.

Ornamental transgenics

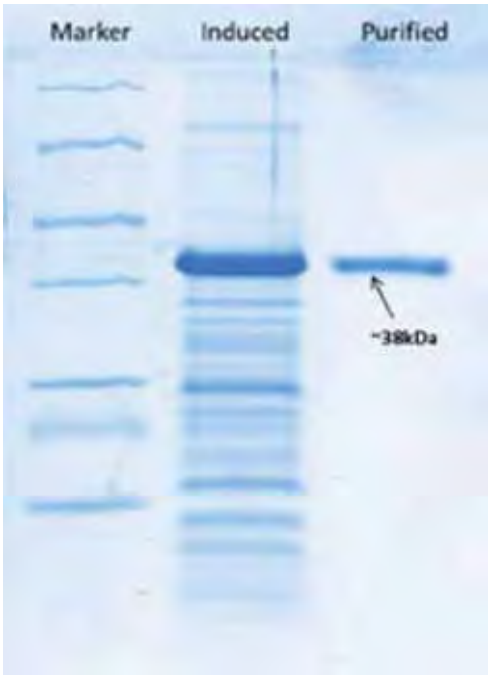
Trials were continued for the development of a transgenic fish expressing fluorescent proteins in their muscles. Transgenic larvae of *Danio rerio* expressing Green fluorescent protein was produced using electroporation. The integration of the gene was confirmed by PCR using specific primers. Green fluorescence expression was also visualised under fluorescent microscope. The transgenic larvae could survive only 1dph.

Transgenic *Etroplus maculatus* embryo expressing Red fluorescent protein was also produced using electroporation, the integration of the gene was confirmed using PCR with specific primers. The transgenic embryos were viable for 72 h.

Recombinant expression and purification of rGIH of *Peneaus monodon* fused at C terminal with GFP

A T7 promoter based expression vector was engineered in the lab for expression of recombinant proteins with C-terminal fused with Green fluorescent protein (GFP) gene and 6xHIS tag. Gonad inhibiting hormone (GIH) gene from *Penaeus monodon* was cloned into this engineered vector and the recombinant expression plasmid was used to transform BL21

E. coli strain and induced with IPTG to express the recombinant fusion protein. Recombinant GIH-GFP fusion protein (rPmGIH-GFP) was purified using IMAC system under native condition. The PmGIH-GFP showed fluorescent green colour, an indication of the presence of functionally active recombinant fusion protein. The elute was subjected to 15% SDS PAGE analysis to confirm the presence of recombinant protein with expected molecular weight of ~38kDa. The purified recombinant PmGIH-GFP can find applications in developing subcellular localisation assays to localise the binding partner for GIH.

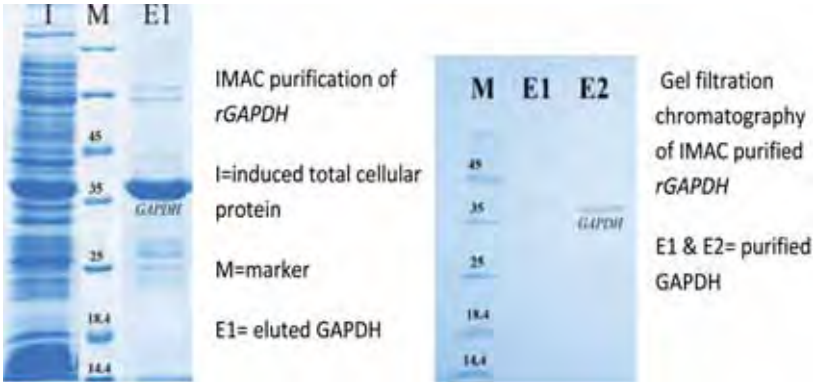


SDS-PAGE (15%) analysis of the rPmGIH-GFP

Recombinant expression of *Vibrio anguillarum* (O1) antigenic protein GAPDH and its purification for development of subunit vaccine

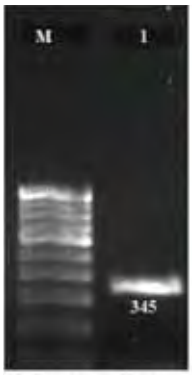
GAPDH gene of *Vibrio anguillarum* was cloned into pET28 expression system and recombinant GAPDH expressed using BL21 strain of *E.coli*. The rGAPDH was purified using IMAC system followed by gel filtration. The purified protein can now be used for preparation of subunit vaccine, and also for monoclonal/polyclonal production of antibodies in suitable host.

Characterisation of FKBP-type peptidyl-prolyl cis–trans isomerase from microalgae, *Scenedesmus* sp.



FKBP binding protein is a family of proteins that are expressed in all organisms and are involved in several biochemical processes including signal transduction, protein folding, and development. The FKBP family consists of multiple members that are distinguished by their molecular weights ranging from 12 kDa (FKBP12) to over 77 kDa (FKBP77).

Temperature tolerant microalgae *Scenedesmus* sp. was isolated from the Manikaran hot springs at Himachal Pradesh. Water samples collected were enriched with 'D' medium and kept at 42 °C in an air incubator with 30 µE m^{-2} s^{-1} white fluorescent light. Isolation was carried out through serial dilution, followed by further purification by agar plating. Single colony was picked and cultured under sterile conditions. Strain identification was done by morphology and confirmed with 18S rDNA sequencing.



cDNA amplification of FKBP 12 gene (complete CDS) in *Scenedesmus* sp.

Expression profile of FKBP 12 gene on 15% SDS-PAGE
UI - Uninduced total cellular protein
I - Induced total cellular protein
E - Purified FKBP 12
M - Marker

Scenedesmus FKBP12 gene sequence was obtained as part of the Suppressive Subtractive Hybridisation (SSH) for the characterisation of differentially expressed genes under temperature stress. The coding sequence of the FKBP gene obtained was 345 bp, and have shown high similarity with FKBP 12 gene. The complete coding sequence of FKBP 12 gene was cloned into pET28 expression vector and transformed to BL21 competent cells for recombinant expression of FKBP 12 in fusion with 6X His tag. Transformed

cells were cultured, induced with IPTG. These cells were harvested, lysed and purified using IMAC columns. The rFKBP12 was visualised on SDS-PAGE as a single prominent band of ~ 14Kd.

Vitellogenesis in the sand lobster, *Thenus unimaculatus*

Studies on the characterisation of vitellogenin in the sand lobster *Thenus unimaculatus* was initiated. Adult female sand lobsters of the maturation facility of the Kovalam Field laboratory were used for the study. The reproductive stages assessed on the basis of colour and size of ovaries, included stages II, III, IV (early) and VI (spent recovery). The vitellogenin (Vg) gene total RNA was extracted from ovary and hepatopancreas of a reproductively mature female. The RNA was reverse transcribed and the cDNA obtained was subjected to PCR using a pair of primers designed from the Vg gene sequence of other crustacean species. An amplification product of ~ 200 bp was generated from both hepatopancreas and ovary samples.

Tissue culture experiments using bivalve tissues

Proliferated cells of *P. viridis*

Tissue culture experiment was conducted with the mantle tissue of green mussel (*Perna viridis*) with two media (M199 and L15) and three supplements in different combinations (10% fetal calf serum, 0.1% lipid mixture 10 µl ml^{-1}, 0.1% yeast extract, 100µl ml^{-1} and a combination of lipid mixture and yeast extract) in three replicates. Cell numbers were counted and size was measured on eighth day to find out the difference in proliferation in different combinations of media. More cell proliferation was noticed in L15 media than in M199. Maximum cell proliferation (5.19x104 cells ml^{-1} compared to 1.5 x 104 cells ml^{-1} in control) and bigger cells (13.15 µ compared to 9.1 µ in control) were noticed in L15 media with yeast extract supplement. Experiments are being continued to confirm the results and to standardise the optimum combination.

Primary culture of fish embryonic stem cells

Midblastula stage embryo of *A. ocellaris*

Isolated blastomeres in culture

Primary culture of embryonic stem cells from embryos of the orange clown fish *Amphiprion ocellaris* was attempted. Formulated tissue culture media with various additives and supplements for the initiation of primary culture. Successfully isolated blastomeres from midblastula stage (128 - 256 cells stage) embryos of *A. ocellaris* and *in vitro* culture trials of isolated blastomeres were attempted in six well dishes using different media combinations. Multiplication of blastomeres observed only in selected trials. Effects of various growth factors and supplements as well as feeder layers are being tested for obtaining stem cell colonies from the blastomeres without differentiation.

Fish nutrition, fish health and bioprospecting

Fish nutrition

Continuing the evaluation of tapioca leaf protein concentrate (LPC), in collaboration with Central Tuber Crops Research Institute (CTCRI) Thiruvananthapuram, a 120 days of feeding experiment in black molly (*Poecilia sphenops*) was completed and nutritional analysis of the newly formulated feed with LPC was conducted. The data indicates that, up to 20% inclusion of LPC replacing fish meal, there is significant ($P<0.05$) increase in growth and other nutritional parameters assessed. This feed treatment was found to be higher when compared with the feed containing 50% fish meal and 0% LPC and a commercial feed with more than 50% protein. The proximate composition of the experimental feeds is given in the Table below.

Study indicated the potential use of tapioca leaf as a cheap source of fishmeal replacement at 20% level, in ornamental formulated feeds. This will lead to the development of a cost effective formulated feed with an indigenous fish meal alternative.

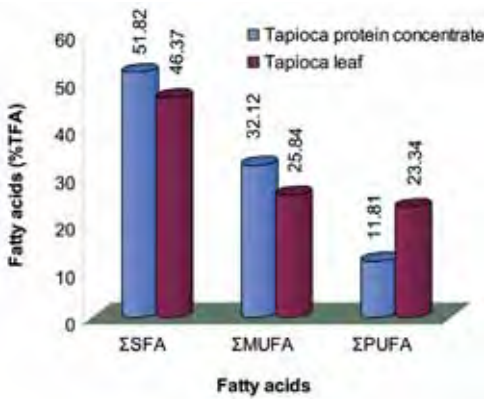
Proximate composition and Gross energy (GE MJ kg^{-1}) of the experimental feeds (% dry matter basis),

Feed identity	CP	EE	NFE	CF	Ash	AIA	GE	Cyanide mg 100^{-1}	Total phenols g $100g^{-1}$
LPC 0	39.17	9.78	31.37	0.73	18.95	1.07	17.60	nd	0.3
LPC 10	38.85	9.91	32.99	0.95	17.30	1.11	17.87	nd	0.35
LPC 20	38.57	10.72	34.82	1.00	14.90	0.84	18.44	nd	0.38
LPC 30	38.90	10.97	37.01	0.49	12.63	0.55	18.99	nd	0.40
LPC 40	38.16	11.87	38.36	1.63	9.98	0.46	19.41	0.15	0.45
LPC 50	38.85	12.69	39.60	1.13	7.73	0.46	20.10	0.20	0.50
Control	53.97	7.09	1.30	24.28	13.36	0.53	14.52	ne	ne

CP : Crude Protein, EE : Ether Extract, NFE : Nitrogen Free Extract, AIA : Acid Insoluble Ash, GE : Gross Energy, calculated based on Cuzon & Guillaume (1997): 21.3, 17.2 and 39.5 MJ kg^{-1} of protein, carbohydrate and lipid, respectively; .nd : not detected, ne: not estimated

Fatty acid composition of tapioca leaf protein concentrate

Tapioca leaf protein concentrate (LPC) was analysed for the fatty acid profile. Lipids from LPC were extracted quantitatively with chloroform-methanol mixture. Total lipids were purified and saponified, followed by transesterification to yield fatty acid methyl esters (FAMEs).



Fatty acid composition of tapioca leaf and LPC

Dry cassava leaves were also analysed for comparison. The gross fatty acid compositions are illustrated in the figure. Saturated fatty acids (SFA) and monounsaturated fatty acids (MUFA) were found to concentrate in the LPC. Polyunsaturated fatty acids (PUFA) content decreased during the processing of whole leaf to LPC. Palmitic acid (16:0) and stearic acid (18:0) are the predominant saturates. 18:1n9 (oleic acid) is the predominant MUFA. 18:2 n6 (linoleic acid) is the major PUFA present. EPA and DHA were present only in trace amounts.

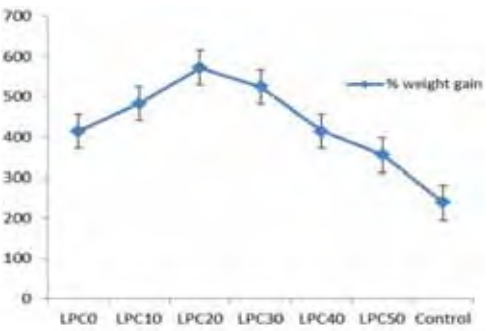
Feeds for cage farmed finfish

An experiment to compare the growth of sea cage cultured cobia (*Rachycentron canadum*) fed on oilsardine (fresh feed) and formulated pellet feed was conducted. As the fat coating technology for the manufacture of marine fish feed requiring above 6% fat in a floating pellet is not yet adopted by extruded fish feed manufacturers in India, a custom made floating marine fish feed was procured from a commercial scale extruded fish feed manufacturer and used for the experiment. The feed formulation was with 43% protein, 7.5 % fat, 33 % carbohydrates and 9% minerals (Ash).

Nutritional evaluation of leaf protein concentrate incorporated feeds in black molly for 120 days

	LPC0	LPC10	LPC20	LPC30	LPC40	LPC50	Control
Weight gain mg	944.44±21.11^{a}	966.67±23.57^{a}	1144.44±21.11^{b}	1050.00±26.35^{c}	827.78±23.31^{d}	711.11±17.37^{e}	477.78±21.60^{f}
% weight gain	413.69±10.56^{a}	483.33±11.79^{a}	572.22±10.56^{b}	525.00±13.18^{c}	413.69±11.66^{d}	355.56±8.69^{e}	238.89±10.80^{f}
SGR % day^{-1}	1.45±0.02^{a}	1.47±0.02^{a}	1.59±0.01^{b}	1.52±0.02^{c}	1.36±0.02^{d}	1.26±0.02^{e}	1.01±0.01^{f}
Feed Intake	4.13±0.15^{a}	2.43±0.05^{b}	3.10±0.31^{ab}	4.57±0.28^{c}	4.10±0.05^{a}	3.53±0.30^{a}	3.70±0.16^{a}
FCR	3.76±0.06^{ab}	3.48±0.08^{ab}	1.62±0.08^{c}	2.32±0.07^{ac}	3.97±0.42^{ab}	4.23±0.76^{b}	4.82±0.04^{b}
Survival %	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Means with the same superscripts do not differ significantly (P<0.05)



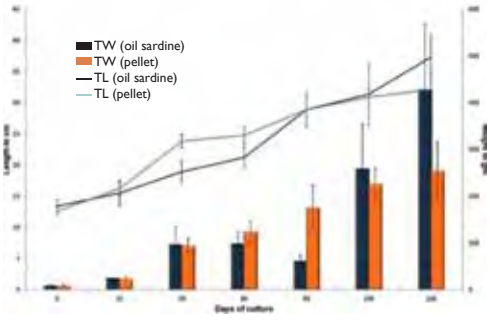
Percentage weight gain in black molly fed with feeds containing tapioca leaf protein concentrate (LPC)

It was observed that till 90 days of culture, the growth in pellet fed group was better than oilsardine fed group with significantly higher weight gain in pellet fed group., while after 90 days of culture, the weight gain was significantly better in oilsardine fed group. However, the variation in weight gain was more in oilsardine fed group when compared to pellet fed group as depicted in the figure. Experiments with varying levels of protein, fat, and other components need to be conducted, for further refinement of feeding regimes and requirements.

Lobster nutrition

Identification of chemical cues and feed attractants, and chemosensory capacities in the sand lobster, *Thenus unimaculatus*.

Growout experiments conducted at Kovalam Field Laboratory, Chennai, revealed that the juvenile and adult sand lobsters have a natural tendency to feed on clams (marine wedge clams and estuarine *Meretrix* sp.), when provided live. Gastropods and worms were only scarcely preferred, and cut trash fish (sardine and silverbelly) in starvation feeding trials alone. The responses to artificial (wet/semi-moist gel/dry) feeds developed and tested in spiny lobsters have also been very poor. The possible cues available in the clam mantle fluids/tissue are being studied to determine the factor(s) responsible for the feed preference of lobsters. The available and so far



Growth rate of cobia fed with oil sardine and pellet feed

accepted raw diets (even at low levels) are being tested for the release of volatile compounds/free amino acids, and the relation to the animal's feeding responses. The information obtained from these trials can be incorporated into developing a diet with improved acceptance by the sand lobsters.

Evaluation of livefeed enrichment emulsions

Continuing the evaluation of enrichment emulsions developed by CMFRI, further testing was carried out in a commercial hatchery. The algae for the rotifer culture used in the commercial hatchery is *Chaetoceros* spp. Feeding this at a rotifer density of 1000 to 1500 per ml was obtained compared with *Nanocloropsis* sp. in the same hatchery. Rotifers enriched with *Chaetoceros* and *Isochrysis* were also sampled for fatty acid profiling. Enrichment of rotifer with DHA rich oil was also repeated in the hatchery at time intervals of 3 h for 24 h. Results of the fatty acid profile of the microalga *Chaetoceros* species indicated that it is an EPA rich alga.

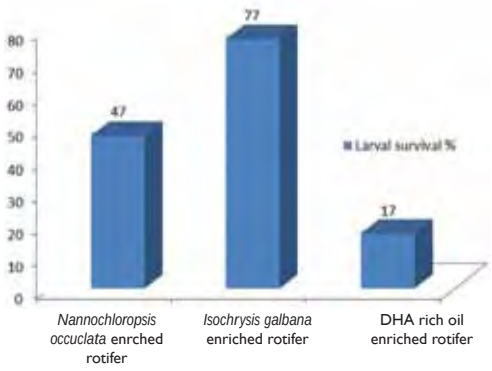
Experiments with rotifers

Rotifers enriched with *Cyclotella*, *Isochrysis* and DHA rich oils emulsions were sampled at three hourly intervals for 24 h and analysed for fatty acids. The DHA rich oil emulsion was photo documented for measuring the size of the oil globules. The photographs indicated that the size of the globules were below 10 µm which is the appropriate size.

Size of oil globules in seawater

Larval nutrition experiments

Due to inconsistencies noticed in survival of larval clownfish *Amphiprion ocellaris* in the previous experiments, another trial of 10 days was conducted again at the Vizhinjam Research Centre of CMFRI using rotifers enricjhed with eicosapentaenoic acid (EPA) rich *Nannochloropsis oculata* (20-30 x 10^6 Cells ml^{-1}), docosahexaenoic acid (DHA; 22:6n-3) rich *Isochrysis galbana* (15-20 x 10^6 ml^{-1}) and DHA rich oil (0.1 ml l^{-1}). Rotifers enriched with *Isochrysis galbana* showed the highest rate of survival followed by *Nannochloropsis oculata* fed rotifers as shown in the figure. The oil enriched rotifers registered the least survival. These experiments were repeated with the oil emulsions, modified and improved with carotenoids.



Larval survival of *Amphiprion ocellaris* supplemented with different live feed enrichments

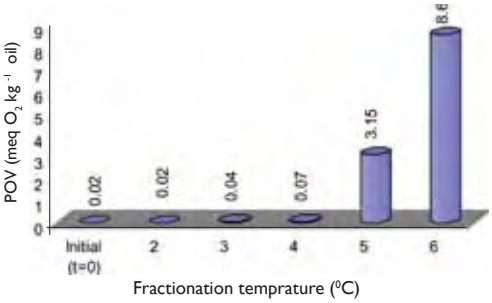
Nutritional biochemistry

Stability studies of PUFA enriched sardine oil

The olefinic moieties of PUFA (EPA and DHA) are the most susceptible to oxidation. Oxidative stability of sardine oil and fatty acid concentrates purified at different temperatures were studied. PUFA, derived from sardine oil was concentrated by urea-fractionation at different temperatures (2-60°C) to recover concentrated PUFAs. The initial peroxide value of sardine oil was 0.02 meq O_2 kg^{-1} oil, which rose to 8.6 meq O_2 kg^{-1} oil when temperature was relatively higher (60°C).

No significant changes in peroxide values were found during urea fractionation at lower temperatures (2-40°C). The peroxide value was recorded to be within safe limit up to a temperature of 40°C (0.07 meq O_2 kg^{-1} oil), and thereafter an accelerated increase in peroxide value was noticed (3.15 meq O_2 kg^{-1} oil at 50°C and 8.60 meq O_2 kg^{-1} oil at 60°C).

The lipid oxidation at higher crystallisation temperature was probably due to the release of Fe and other pro-oxidants from the oil. Peroxide values were found to be very marginal in sardine oil and during solvent extraction process, indicating a higher stability and shelf life for the product.

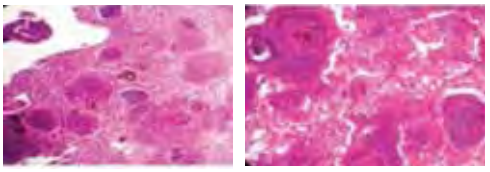


Peroxide values of sardine oil and fatty acid concentrates purified at different temperatures

Haemorrhagic gastritis due to *V. alginolyticus* in cobia

Congestion and necrosis of the liver and spleen in pompano

Multiple necrosis of the spleen and kideny in pompano



Extensive necrosis and squamous metaplasia of kideny parenchyma in pompano

Vibrio harveyi infections in red snapper

Market potential of ornamental fish feeds (Chennai market)

An all India market survey of ornamental fish feeds, their availability, indigenous capability in production and market potential was initiated. At Chennai market approximately 2500 t of ornamental fish feeds are sold per annum. In this about 50% *i.e.*, 1250 t are produced indigenously by three companies who also import and sell ornamental fish feeds. The imported feeds are of premium quality and a range not manufactured in India. The indigenously produced feeds are of an economical range in terms of cost. Samples of all products and data collected are compiled and analysed.

Fish health

Bacterial diseases in finfishes

Investigations on the sudden mass mortality in cobia brood stock revealed severe hemorrhagic gastritis in majority of the dead fishes. Severe haemorrhage and congestion was observed in the entire gastric mucosal folds. A presumptive diagnosis of *Vibrio alginolyticus* was identified based on the results of biochemical test, which was further confirmed by PCR methods.

Investigations on the acute mortality in pompano (*Trachinotus blochii*) revealed presence of multiple necrosis/white nodules in the entire spleen and kidney with severe congestion in liver. Histopathology of spleen and kidney revealed fibrinous inflammation and necrosis in the parenchyma. The putative organism *Bacillus cereus* was isolated and identified from the moribund fishes, which was confirmed through sequencing.

Infection with *Vibrio harveyi* causing up to 50% mortality in cage reared red snapper, *Lutjanus argentimaculatus* was reported from Karwar. External symptoms included hemorrhagic lesions and histopathological studies revealed extensive vacuolation of hepatic parenchyma as well as hemorrhage and infiltration by inflammatory cells in kidneys. The disease was associated with stress caused by shifting of snappers from one cage to another. *V. harveyi* was confirmed by nested PCR.

Mortality in cage reared cobia (*Rachycentron canadum*) at Karwar was found to be caused by *Photobacterium damselae* sub sp. *damselae*. The gross lesions included hemorrhages at the base of the fin. The causative organism was confirmed by biochemical and molecular characterisation.

Health monitoring of cage cultured finfishes at Karwar has been initiated and the cage cultured fishes were screened for the presence of bacterial pathogens at regular intervals. The fish were found to be free of any bacterial pathogens and were healthy during the sampling period. Total bacterial loads of water and sediment in cobia cages were also monitored at fortnightly intervals. The total bacterial loads of water varied between 0.3×10^4 cfu ml^{-1} to 1.1×10^6 cfu ml^{-1} and total vibrio loads varied between

0.8×102 to 0.7×10^3 cfu ml^{-1}. Total bacterial counts of sediment at cage site ranged between 0.5×10^3 to 1.4×10^6 cfu g^{-1}. Total vibrio loads of sediment were 0.4×10^2 cfu g^{-1} to 0.8×10^4 cfu g^{-1}.

At Vizhinjam Research Centre of CMFRI, tail rot associated with infections on the caudal peduncle, gill infections and erythemia associated with morbidity was investigated in clown fishes *viz.*, *Amphiprion nigripes* and *Premnas biaculeatus* in the marine ornamental fish hatchery/aquaria. Bacteriological studies revealed seven different bacterial colonies. The total microbial load

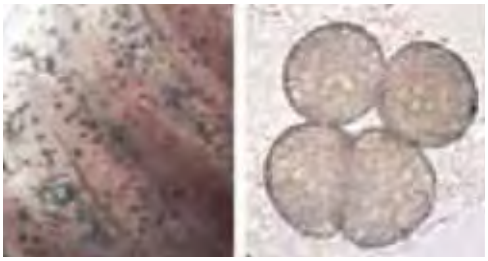
in the infected tissue and gills was $2.7X10^7$ and $2.2X10^7$ CFU g^{-1} respectively while the microbial load in the rearing water appeared very high with more than $1X10^6$ CFU ml^{-1}. Histologically, severe necrotic areas and disarray of muscle fibres associated with infiltration of cells in liver parenchyma was observed. Antibiotic sensitivity studies showed that the bacteria were susceptible to tetracycline, an approved antibiotic for aquaculture.

Bacterial infection in clown fish

Parasitic diseases in finfishes

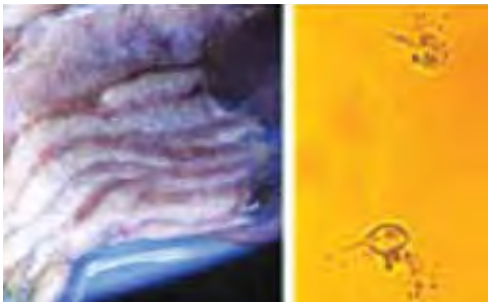
At Manadapam RC of CMFRI, *Amyloodinium ocellatum* infestations leading to mortalities were recorded in pompano *Trachinotus blochii*. The infection was brought under control through dip treatment using freshwater and 5-10 ppm of formalin.

Infections with the myxosporean parasite *Henneguya* spp. was recorded from wild collected pompano brood stock. The small whitish nodules of the parasite were observed covering the entire surface of the gastrointestinal tract. Histopathological, the entire lumen of the pyloric caeca was occluded with the nodules.



Stages of *Amyloodinium ocellatum*

Investigations on the mortalities in various species of clown fishes (*Amphiprion ocellaris*, *A. nigripes*, *A. percula*, *A. frenatus*, *A. perideraion*, *A. clarkii* and *Premnas biaculeaus*) in the hatchery at Vizhinjam revealed infestations with a monogenean parasite which was identified as *Benedenia* sp. Normal bath treatment in freshwater did not yield a complete recovery but repeated treatment using Praziquantel 100 mg l^{-1} for 3-5 min followed by a complete overhauling of tanks proved successful in eliminating this infection.



Cyst and spores of *Henneguya* spp. from pompano

Fluke infestation of the gills was recorded from cage reared Asian seabass at Karwar. The monogenean was identified as *Pseudo rhabdosynochus* sp. by histopathological and molecular characterisation. Monogeneans were attached with their opisthaptors to the adjacent lamellae. Lamellar oedema with the presence of epithelial residue in close proximity to the bodies of worms was evident. The prevalence of infection was 90%.

Pathogen profiling in bivalves

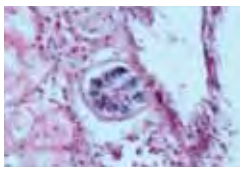
As a continuation of the epidemiological studies on the host range of *Perkinsus* spp. infecting bivalves in India, 2 more new bivalve hosts (*Villorita cyprinoides* and *Donax cuneatus*) were found to harbor *Perkinsus* spp. infection taking the host range to 15 bivalve species. The *Perkinsus* sp. diagnosed through PCR in the green mussel, *Perna viridis* was sequenced for confirming its identity at species level. The amplified PCR products revealed that the parasite is *Perkinsus olseni*, an OIE listed parasite of bivalves.

Benedenia sp. infecting clown fish

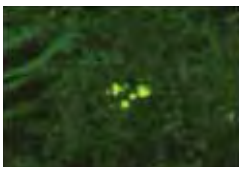
Sporocyst of the gregarine *Nematopsis* sp. were found in the connective tissue of mantle and digestive tubules of oyster collected from Kollam. Gregarines of genus *Nematopsis* use bivalves as their intermediate host.

Fluorescent in situ hybridisation (FISH) technique was used to confirm the presence of *Perkinsus* spp. in *C. madrasensis* and *Geloina bengalensis*. Fluorescent Probe template was synthesised and labeled with Alexa Fluor (R) 488 dye, followed by hybridisation. Binding of the *Perkinsus* sp. specific probes resulted in the appearance of green regions, confirming the presence of parasite in tissues. The no-probe control did not show any green fluorescent signal.

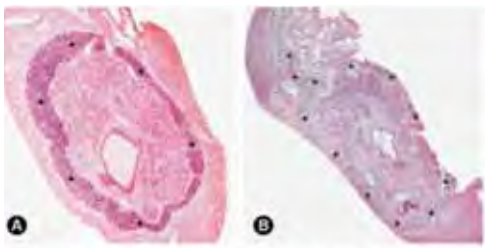
Histology of gill showing monogenean attached to the gill filaments



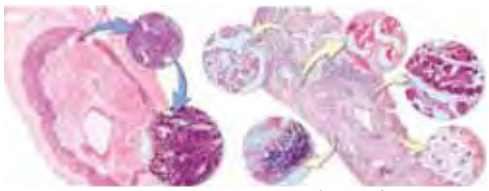
Sporocyst of *Nematopsis* sp. in the connective tissue of oyster



Stages of *Perkinsus* spp. in the tissues of *Gelonia bengalensis*

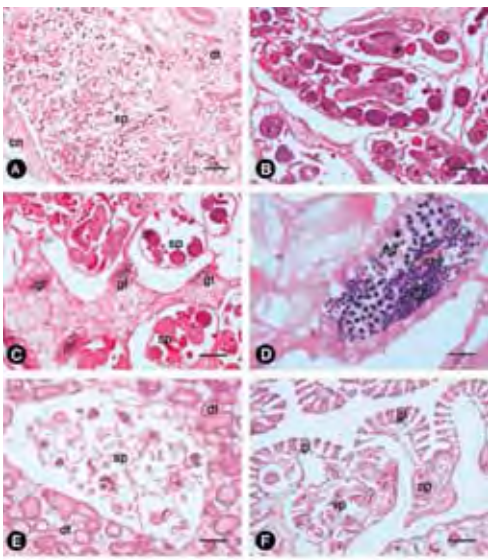


Reconstructed image of the transverse sections of *C. madrasensis*. **A.** Unparasitised male with darkly stained mature gonads; B. Parasitised male with *Bucephalus* sp., developmental stages completely replacing the gonadal tissues.



Uninfected *C. madrasensis*

C. madrasensis infected with larval *Bucephalus* sp.



A. Developing sporocyst mass in the gonadal region; B. Detailed view of sporocyst with developing germballs; C. Gametogenic acinar architecture altered and reduced to small patches interspersed within the developing sporocyst mass; D. Magnified view of a patch of infected gonadal tissue showing reduced number of early and advanced germ cell lines and spermatids; E. Larval *Bucephalus* sp. infection within the digestive tubules; F. Larval *Bucephalus* sp. infection in the gills.

C. madrasensis samples collected from Tuticorin revealed the presence of larval Bucephalid infection in the gonads with a prevalence of 3.3%. The infected animal did not exhibit any apparent external manifestations but squash preparation indicated the presence of developmental stages of trematode infection in the gonadal tissues.

Histopathological evaluation of the infected specimen showed severe tissue level changes and the intensity of infection was rated as 2 on the semi-quantitative scale. Normally, uninfected *C. madrasensis* had fully mature gonads surrounding the digestive system. In infected *C. madrasensis*, intra-molluscan larval stages have invaded the gonadal, digestive and gill tissues and the region between the mantle and digestive tubules were found packed with slender, branching sporocysts. Each sporocyst contained many germballs and cerecariae at different stages of maturity indicating the developmental potential of the infection which is in an active stage and has started spreading over to the digestive gland and gills. The multi-branched, filamentous structure of the sporocyst and the presence of pear-shaped, gasterostome cercariae having a short tail with two characteristic long, slender furcae indicated the affiliation of the parasite to the genus *Bucephalus*.

In uninfected animals, the gonadal tissues consisted of large number of well-organised, developing gametogenic acini with follicles full of densely packed spermatozoa. The outer or the basal region of the acini consisted of early germ cell line which includes spermatogonia, spermatocytes and undifferentiated round spermatids and the central or lumen of the acini contained elongated spermatids with tails toward lumen. In infected *C. madrasensis*, the characteristic acinar architecture was altered when compared to unparasitised oysters. The number and area of gametogenic acini has been reduced drastically and the remnants of the gonads were represented by small, irregular patches of gonadal tissues lying along the edges or interspersed within the developing sporocyst mass). Even though the gonadal tissues were seen only as small patches, within these, the process of gametogenesis appears to be continuing as evidenced by the presence of spermatogonial cells, spermatocytes and spermatids, though very less in number. A well-defined lumen and gonoducts were absent.

Immune response against the parasite stage was almost absent except for very low levels of hemocytic infiltration observed in the connective tissues adjacent to sporocysts in some regions. Other immune responses like inflammation and encapsulation of the parasite/stages by the hemocytes were totally absent. The lack of any effective immune response indicates that the bivalve host never gets rid of the infection, thus contributing to the successful completion of the trematode life-cycle. The massive replacement of gonadal tissues with sporocyst mass leaving only the remnants of gonadal tissues in small patches in the present study indicates the level of damage caused by the parasite. The altered tissue architecture as evidenced by the absence of typical acinar lumen and gonoducts and the drastic reduction in the number and volume of the gonadal acini appears to be insufficient to support any gametic release, resulting in gonadal dysfunction leading to parasitic castration of the host. An increase in the prevalence of *Bucephalus* infection in the region can seriously hamper the reproductive potential of the wild stocks and thereby limit the availability of the spat, affecting the viability of oyster farming in the region.

Pathogen profiling in lobsters

Instances of mortality in lobster holding facility in Kanyakumari with necrosis, tail erosions, lesions as well as loss of walking legs and blackening of joints and cephalothorax region were recorded. The microbial load in the rearing tanks varied from 1.1 $X10^7$ to 5.9$X10^7$ (cfu ml^{-1}). Swelling and fluid accumulation in the joining area just below the carapace was recorded in some lobsters. Four distinct types of bacterial colonies were isolated from the infected animals. The colonies were subjected to biochemical investigations and antibiotics sensitivity pattern studied. The bacteria isolated are being characterised.

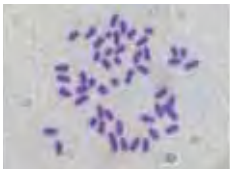
Establishment and characterisation of marine fish cell lines

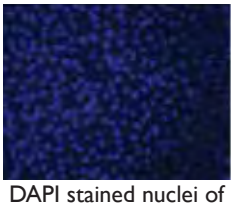
A total of 29 continuous cell lines have been established from 5 species of marine food fish (Cobia *Rachycentron canadum*; Honey comb grouper *Epinephelus merra*; rabbit fish *Siganus canaliculatus*; Malabar grouper *Epinephelus malabaricus*; Pompano *Trachinotus blochii*); and 3 species of marine ornamental fish (three spot damsel *Dascyllus trimaculatus* ; Caerulean damsel *Pomacentrus caeruleus* and the Clown fish *Amphiprion percula*). All the cell lines have been successfully stored by cryopreservation in liquid nitrogen at various levels of passages and are also being maintained and passaged in the Cell culture Laboratory of CMFRI. Out of the 29 cell lines developed, 15 have been completely characterised by chromosome analysis, immunoflourscence staining for fibroblast/epithelial markers, ultrastructural analysis by transmission electron microscopy as well as by mitochondrial CO-1 gene sequencing to confirm the species of origin. One copy each of all the characterised cell lines will be deposited in the recently established National Repository for Fish Cell Lines (NRFC) at NBFGR, Lucknow for distribution to end users.

Details of marine fish cell lines developed at CMFRI

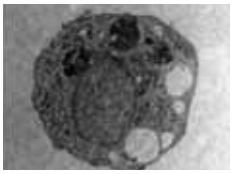
Species	Cell line	Tissue of origin	Latest passage no:
Cobia *R. canadum*	RC4H1 Tr	Trypsinised heart	157
	RC4F1 Tr	Trypsinised fin	138
	RC4F2 Tr	Trypsinised fin	159
	RC4Cp Tr	Trypsinised caudal peduncle	118
	RC3Br1 Tr	Trypsinised brain	75
Honeycomb grouper *E. merra*	HC1H1Ex	Heart explant	157
	HC2H2Ex	Heart explant	146
	HC2CpTr	Trypsinised caudal peduncle	107
	HC2BrTr	Trypsinised brain	110
	HC2G1Tr	Trypsinised gill	138
	HC2SpEx	Spleen explant	124
	HC2F2Ex	Fin explant	126
	HC2F3Ex	Fin explant	110
Rabbit fish *S. canaliculatus*	SC12Br1Ex	Brain explant	57
Malabar grouper *E. malabaricus*	EM2HTr	Trypsinised heart	151
	EM3GEx	Gill explant	272
	EM2GEx	Gill explant	206
	EM4SPEx	Spleen explant	241
Silver pompano *T. blochii*	TB1F1Tr	Trypsinised fin	104
	TB1F1Ex	Fin explant	81

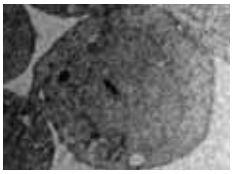

Metaphase spread of DT1F4Ex


Metaphase spread of EM3GEx

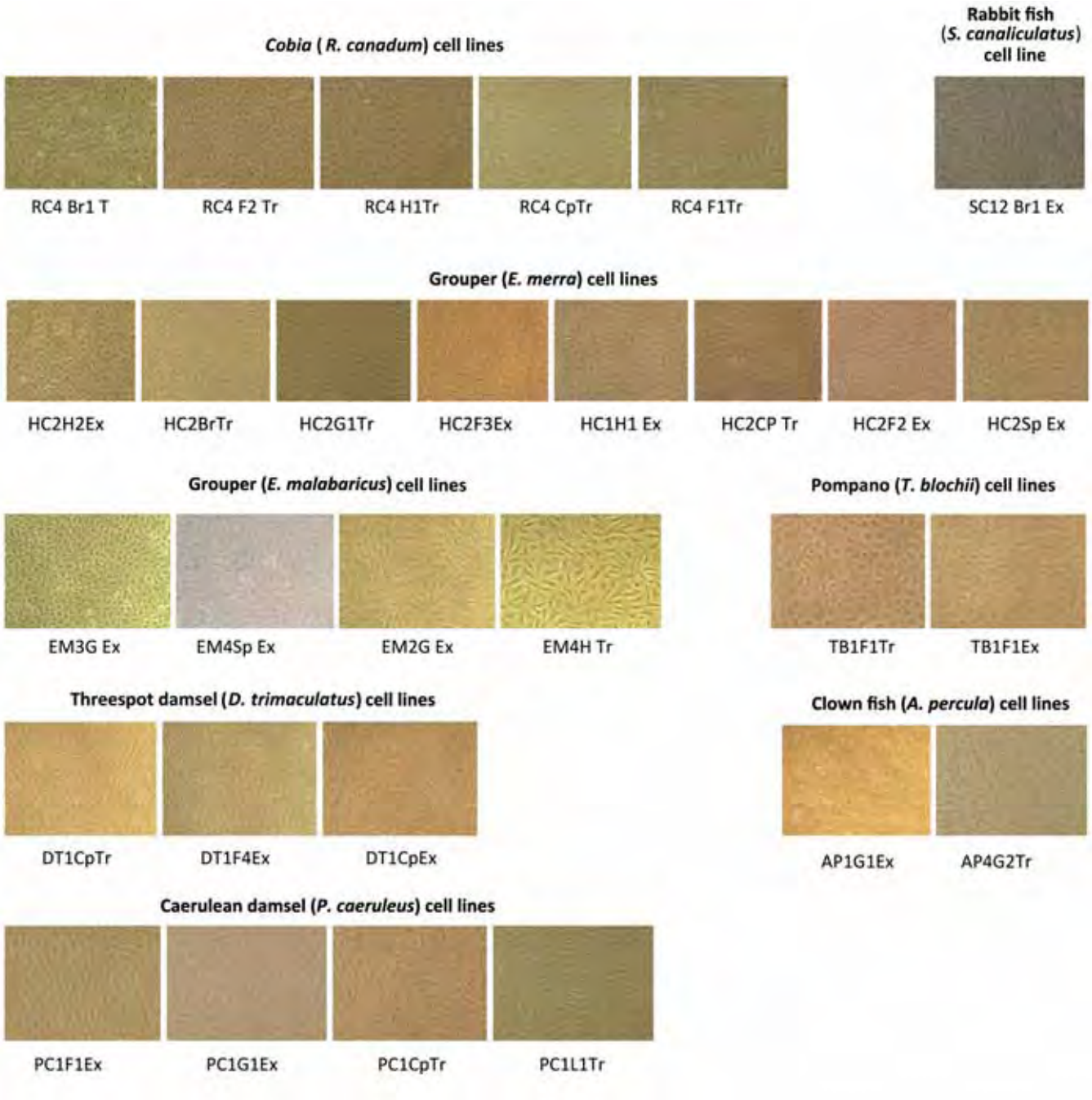

DAPI stained nuclei of grouper cell line (EM3GEx)


Pancytokeratin positive cells detected using antimouse IgG FITC in EM3GEx


TEM micrograph of cobia cell line (RC4CpTr)


TEM micrograph of grouper cell line (HC2F2Ex)

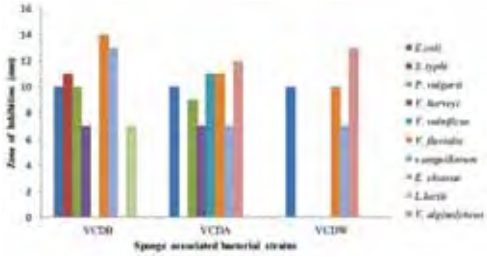
Threespot damsel *D. trimaculatus*	DT1F4Ex	Fin explant	189
	DT1CPTr	Trypsinised caudal peduncle	158
	DT1CPEx	Caudal peduncle explant	186
Caerulean damsel *P. caeruleus*	PC1CPTr	Trypsinised caudal peduncle	139
	PC1F1Ex	Fin explant	128
	PC1L1Tr	Trypsinised liver	114
	PC1G2EX	Gill explant	126
Percula clown fish *A. percula*	AP1G1Ex	Gill explant	118
	AP4G2Tr	Trypsinised gill	78



Bioprospecting

Isolation of sponge-associated microbes from the sponge *Callyspongia diffusa*

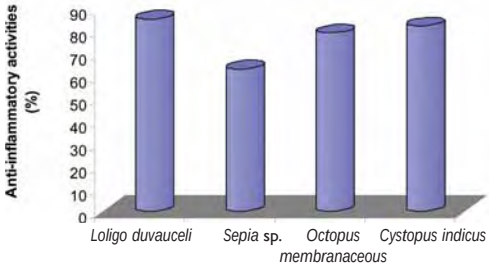
Seven morphologically and culturally distinct bacterial isolates designated as: VCDB, VCDA, VCDW, VCDI, VCDY, VCDP and VCDPS were isolated from the marine sponge *Callyspongia diffusa*. The total number of bacterial colonies from the sponge internal surface was recorded to be 50% higher than the bacterial load from the ambient seawater and among these isolates, VCDB was a true sponge-associated bacteria as it was not recorded from the ambient seawater.



Antimicrobial activity of bacteria associated with *Callyspongia diffusa*

Screening of sponge-associated bacterial isolates for antimicrobial activity

Studies on the cell free supernatant of the associated bacteria showed that all the bacterial isolates except VCDI showed a significant antibacterial activity against all the tested human and fish pathogens. The VCDB isolate showed significant activity against *Salmonella typhi* (MTCC 92), *Vibrio fluvialis* and *Enterococcus cloacae*. VCDA exhibited significant antibacterial activity with an inhibition zone of 12 mm against *Enterococcus cloacae* and 11 mm inhibition against *V. fluvialis* and *V. anguillarum* and mild activity of 7 mm against *V. harveyi* and 9 mm against *Proteus vulgaris*. The VCDB strain of bacteria was characterised as *Shewanella algae* (new isolate) which exhibited effective biocontrol potential against *Aspergillus niger*, *Aspergillus fumigatus*, *Saccharomyces cerviceae* and *Colletotrichum gloeosporiodes*.

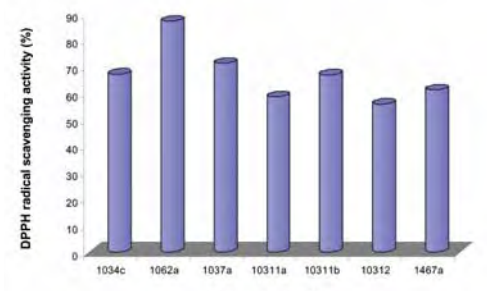


Anti-inflammatory activities of different cephalopod species

Bioactive compounds from bivalve and cephalopod species

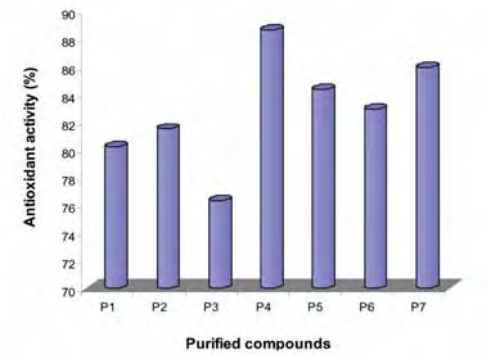
Secondary metabolites from various cephalopod species were characterised for bioactive principles. Preliminary purification yielded the fractions as: LD (yield 4.34%)> OM (1.97%)> S (1.9%)> CI (1.11%). The anti-inflammatory activity of fractions (2 mg ml^{-1}) were found to be in the order: LD (85%)>CI (82%)>OM (79%)>S (63%). A significantly lower formation of malondialdehyde equivalent compounds was observed for S (3.68 mMMDAEC kg^{-1}).

The crude extract of *Loligo duvaucelli* was purified to get 12 fractions (1031 – 10312). Of these fractions 1034, 1035 separated as 1034a, 1034b, 1034c and 1035a, 1035b, 1035c. Also, 10311 was separated as 10311a and 10311b. 1039 was further purified using column chromatography to furnish 12 fractions (1461 - 14612). Among the various fractions, 1034c, 1062, 1037, 10311a, 10311b, 10312 and 1467 (67.2%, 87.3%, 71.25%, 58.64%, 66.98%, 55.91% and 61.34%, respectively) showed greater than 60% activity against DPPH free radical. Comparatively higher antibacterial activities were detected for the metabolites at 1468 - 14610 (IZD >12 mm). These compounds were identified to possess polyols with multiple olefinic groups, terpenoids, and chalcone derivatives.

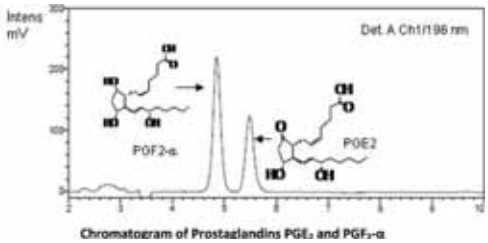


Antioxidative activities of purified bioactive fraction from *Loligo duvaucelli*

Studies on the antioxidant composition of *Crassostrea madrasensis* revealed that among different purified components of this species CEM 1-7 showed 76-88% activity against DPPH free radical. The non-polar fractions too exhibited high DPPH activity (73-88%, 1 mg ml^{-1}) and they are potentially active to deter lipid peroxidation in a model system (TBARS value <2 mMMDAEC kg^{-1}, 2 mg ml^{-1}).



Antioxidative activities of the purified bioactive fractions from *Crassostrea madrasensis*

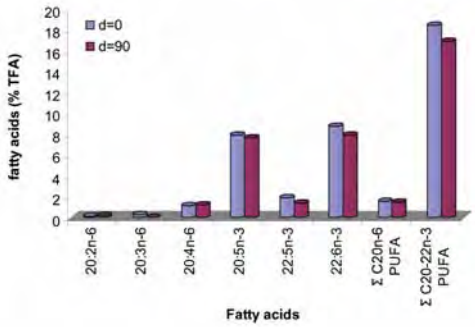


Chromatogram of Prostaglandins PGE2 and PGF2-α

Response of pro-inflammatory prostaglandin contents in anti-inflammatory concentrate from green mussel *Perna viridis*

Prostaglandins PGE2 and PGF2-α have been identified in green mussel *Perna viridis*. The presence of these compounds was confirmed by co-chromatography with the PG standards. An isocratic reversed-phase HPLC separation of the PG derivatives in green mussel extract in a time course accelerated shelf-life study was conducted. The concentrations of PGE2 and PGF2-α after shelf-life study of 90 days were significantly higher in the control green mussel (MSL, 122.18 and 810.6 ppm respectively) than the anti-inflammatory concentrate from green mussel (189.72 and 292.21 ppm, respectively).

An inverse correlation between antioxidative effects of the additives and PGE2 concentrations in green mussel extract at baseline (day 0, d=0) and at the end of the study (day 90, d=90) was apparent. The relative increases and time-courses of formation of AA and PGE2/ PGF2-α were highly correlated. The levels of PGE2 registered an approximately 24.35 times increase at the end of the study (day 90, d=90) than at baseline (day 0, d=0) compared with the anti-inflammatory concentrate from green mussel, realised a meager increase of 2.5 times (at d=90). The results of this study highlight the greater utility of measuring PGE2 and PGF2-α as an index of antioxidant status and lipid peroxidation.

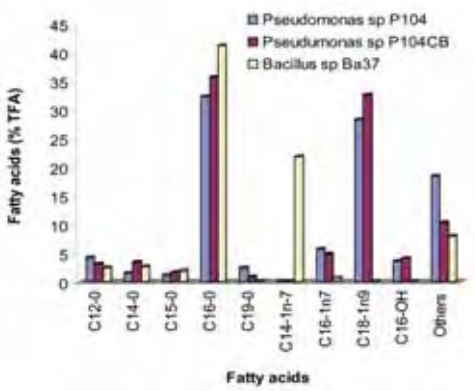


Polyunsaturated fatty acid profile of an anti-inflomatory concentrate from green mussel during shelf life study

Fatty acid profile of green mussel (MSL) and an anti-inflammatory concentrate from green mussel during shelf life study

The C20 n-6 and C22 n-6 fatty acid profiling of control green mussel (MSL) and an anti-inflammatory concentrate from green mussel in a time series stability study showed that PUFAs with more than 20 carbon atoms were found to represent more than 18% of the total fatty acids for MSL and green mussel extract. However, the C20:n-6 PUFAs in MSL experienced an increase in terms of their total content from the initial composition during the shelf life study for 90 days as compared to the anti-inflammatory concentrate from green mussel.

In the present study, total C20-22n-3 PUFA content in MSL was found to be lesser (16.46%) than recorded in the anti-inflammatory concentrate from green mussel (>18%) at d=0. The content of C22n-3 PUFA, C22:6n-3 in the anti-inflammatory concentrate from green mussel (8.7%) were found to be higher than in MSL at d=0. The anti-inflammatory concentrate from green mussel was able to effectively protect C22:6n-3 from oxidative degradation even after 90 days (d=90) of accelerated storage (7.84%). The PUFAs with C20-22n-3 PUFAs in MSL were found to be significantly reduced (d=90, 10.37%; 37% reduction with respect to initial value) after shelf life study. However, no significant reduction of this group of fatty acids was noticeable for green mussel extract (8.5%). The C20n-6/C20-22n-3 fatty acid ratio is directly proportional to the anti-inflammatory activities due to the fact that C20:5n-3 is a precursor to anti-inflammatory lipid mediators (RvE1), whereas docosanoids C22:6n-3 to RvD1 and protectins (NPD1).



Fatty acid profile of three candidate antagonistic bacteria

Fatty acid profile of three potential antagonistic bacterial species belonging to *Bacillus* and *Pseudomonas*

Three potential antagonistic bacterial species belonging to *Bacillus* (*Bacillus subtilis* Ba37) and *Pseudomonas* (*Pseudomonas* sp. P104CB and *Pseudomonas* sp. P104) isolated from the coastal ecosystems have been evaluated for fatty acid profile. The fatty acid C14:1n-7 is predominant in *Bacillus 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 *Bacillus 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 acids (32-41%) in these species, although *Bacillus subtilis* Ba37 recorded higher C16:0 (~41%) than in *Pseudomonas* sp. (32-35%).

Toxicity studies of CadalminTM Green Algal extract (CadalminTM GAe) for use against joint pain and arthritis

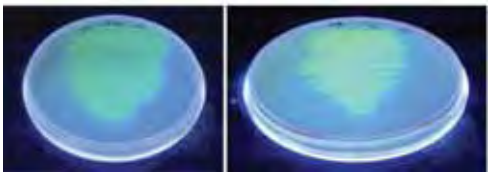
Detailed evaluation using laboratory animal models proved that the Green Algal Extract, CadalminTM GAe could be safely taken without any side effects. The acute toxicity studies and lethal dose of CadalminTM GAe using Wistar rats was carried out to understand its effect on various parameters like mortality, weight change, food consumption, haematological function, liver function, renal function, serum electrolytes and lipid profile. All the organs were examined for any gross abnormalities in the structure. The results indicated that CadalminTM GAe (1.5, 2.5 and 4.0 g kg body weight^{-1}) given to experimental subjects (male and female) did not produce any clinical or behavioural changes, change in food consumption, water consumption and body weights in rats, indicating that it has no toxicity to these animals. It did not produce any biochemical changes related to hepatic and renal function, in haematological parameters such as WBC, RBC, platelet, haemoglobin and differential count. This indicates that Cadalmin^{TM} GAe even at very high concentrations was not lethal to the mammalian subjects. Necropsy of the animals after sacrifice did not show any morphological changes in the tissues or any gross pathological abnormalities.

Marine fish microbial diversity

Bacterial diversity in 21 marine fish, 4 prawn and 2 crab species collected from eight locations in Kerala, Goa and Puducherry were studied. About 116 bacterial isolates associated with the skin, gills and viscera of these species were subjected to phenotypic characterisation. Completed characterisation of 59 strains. The major genera identified were *Pseudomonas*, *Acinetobacter* and *Vibrio*.

Starch and cellulose hydrolysing bacteria

Symbiotic bacterial strains from marine fishes offer a large scope for marine microbiological studies and biotechnology applications. Some of them help in digestion of complex molecules by converting into simpler ones inside the digestive tract. The following starch and cellulose hydrolysing bacteria were isolated from marine fishes: *Bacillus nealsonii* (GenBank Accession No. JN710379); *Bacillus atrophaeus* (GenBank Accession No. JN712298), *Aeromonas hydrophila* (GenBank Accession No. 712299) and *Bacillus* sp. (GenBank Accession No. JN712300) (starch hydrolysing isolates). *Bacillus subtilis* (GenBank Accession No. N710380), *Klebsiella oxytoca* (GenBank Accession No. JN712301) (cellulose hydrolysing isolates).



Fluorescent bacterial isolates from marine finfishes

Broodstock development and Seed production

Cobia broodstock

Cobia fingerlings stocked in the cage

Pompano brooder

Food fishes

Cobia (*Rachycentron canadum*)

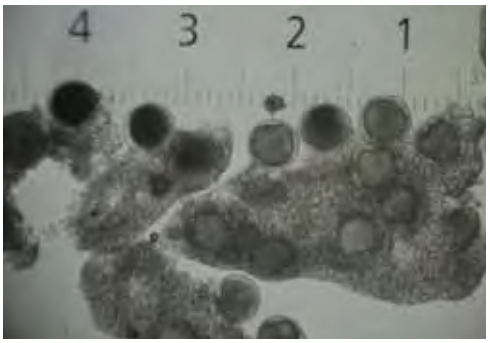
Successful broodstock development of cobia and induction of spawning produced a total of 5.55 million fertilized eggs during 2012 at Mandapam Regional Centre of CMFRI. During this period, a production of 22,800 cobia fingerlings were achieved at the Centre. Through Larviculture and fingerlings production protocols, fingerlings were supplied to the CMFRI Centres at Karwar,Veraval and fishermen/ farmers in Tamil Nadu and Andhra Pradesh. A part of the fingerlings were used for broodstock development at Mandapam. Less than 1% of the newly hatched larvae were used for fingerling production. The remaining number was sea ranched in open sea on 3rd day of post hatch. It was found that at water temperature of 26.5°C or less, the embryonic development of eggs was arrested. The optimal temperature required for hatching of cobia eggs (90% hatching) could be at 31°C. Optimal salinity for hatching of cobia eggs was found to be 31 ppt and the highest survival rate of cobia larvae was achieved at 29°C. Studies on effect of tank colour on prey catching, survival and growth of cobia larvae revealed that the maximum growth of cobia larvae can be achieved in yellow and blue colour tanks. The study on the effect of larval density per litre showed that best survival could be achieved at 5 nos/l followed by 10 nos/l. The survival was very poor at densities of 15 and 20 nos./l. Further, it was also experienced that early grading of larvae i.e., from 7th day onwards resulted in good larval survival.

Silver Pompano (*Trachinotus blochii*)

About 3,000 nos. of sliver pompano fingerlings produced at the Mandapam Regional Centre of CMFRI were reared in the open sea cages by feeding with extruded floating pellet with crude protein of 36% and crude fat 6%. The fish of 1.0 kg and above were segregated and reared in a separate cage for broodstock development. These fishes were fed with squid/ trash fish/INVE fish broodstock feed supplemented with required minerals and vitamins.

Four numbers of 10 tonne capacity tanks, each containing pompano brooders at the sex ratio of 1 female: 3 males are being maintained in finfish hatchery. The photoperiod regime of 15L:10D is being maintained in each tank. After assessing the stage of gonadal development, the fishes were given supplementary dose of GnRh hormone @ 75 µg/ kg body weight to accelerate the ovarian development. Cannulation biopsy was carried out at

regular intervals to monitor the ovarian development. The broodstock are being fed once daily @ 5% of their body weight with fresh squid, crab and shrimp meat mixed with mineral and vitamin pre-mix.



Advanced stage of pompano intra ovarian oocytes

Snappers and breams

Broodstock development of snappers (*Lutjanus argentimaculatus*, *L. russelli*, and *L. johni*) was carried out at Karwar. The fishes collected from wild with more than 1kg weight was PIT tagged and maintained in separate cages and were fed with crabs and squids. Fishes weighing more than 1kg were cannulated and the gonadal maturity were assessed and recorded. The red snapper *L. argentimaculatus* weighing 1.5 to 2.5 kg reared in sea cages at Kochi were found to have maturing gonads.

Cannulation of sea breams, *Acanthopagrus latus*, at Karwar confirmed that sex reversal had taken place and the oocytes were in developing stages. When the weight of the fish reached more than 450 g, through monthly canulation process the gonadal development was monitored. Up to a size group of 850 g, all the individuals were found to be potential males and they oozed milt by gentle pressure over the belly area. The fishes which crossed 850 g size started showing ovarian developments. Freshly chopped oil sardine (*Sardinella longiceps*) was fed to the fishes @ 5% body weight per day. Feeding was done twice a day. It was observed that the diets rich in fatty acids accelerates growth and maturity in seabreams.

Broodstock development of *Rhabdosargus sarba* was initiated at Vizhinjam. Fish less than 1 kg or below 30cm in total length (TL) were observed as males. Those measuring above 30 cm TL, showed ovarian development.


Rhabdosarus sarba

Groupers

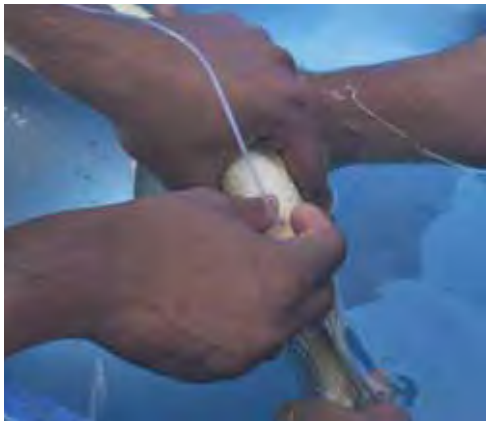
At Visakhapatnam, maturity stages of female broodstock *Epinephelus tauvina* (Greasy grouper) were examined every month by intra ovarian biopsy (IOB) and individual gonad development history of fishes were maintained. Female fish with intra ovarian ova of diameter 450 µ was used for induced spawning.

Successful sex reversal (female grouper to male) was achieved with the hormonal and enzymatic manipulation. Twenty fishes were implanted with 17 α methyl testosterone and aromatase inhibitor enzymes. 60% of the implanted fishes were sex reversed after 4 months. Implantation of hormone and aromatase inhibitor enzyme was being carried out once in two months to maintain the sex of male broodstock. These brooders were cannulated once in a month to assess the milt production. These males were used for induced spawning.

Sl.No.	Date of induction	Hormone	No. of spawned eggs (lakhs)	Remarks
1	09/04/2012	HCG	1.50	Fertilization rate 45%
2	12/06/2012	HCG	5.00	Fertilization rate 80%
3	09/09/2012	HCG	6.00	Fertilization rate 87 %
4	18/11/2012	HCG	0.00	No response
5	12/12/2012	HCG	5.00	Unfertilized egg
6	17/12/2012	HCG	4.00	Unfertilized eggs


Female broodstock of *Epinephelus tauvina* in cage

Induced spawning of grouper was carried out in happa (2 m diameter and 3 m depth) of mesh size 500 µ installed inside the brood stock cage. Six



Cannulation of Sea bream

spawning induction trials were conducted during the reporting period. The females were 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. The fishes spawned at about 12-14 hrs after the last dose of injection. The details of spawning are as follows;

Mullet and Indian halibut

The broodstock development of *Mugil cephalus* (Flathead Grey Mullet) is underway at Kochi in indoor tanks. The broodstock development of the Indian halibut, *Psettodes erumei*, was initiated at Kovalam, Chennai.

Reproductive biolog y of the species was studied and the sexes were found to be separate. Observations on adult fishes sampled from the fish landings at Kovalam indicated size range of 225-545 mm (females) with fecundity ranging from 19740 to 300699. The GSI was found to range from 2.27% (in fish of 427 mm TL) to 8.22 (in fish of 225 mm TL). Depending on the ovarian maturation stage, the number of eggs per gram ranged from 1420 to 3850.

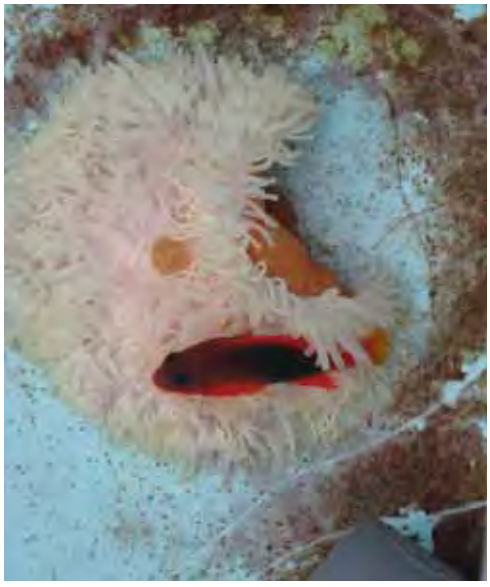
Marine ornamental fish

Halibuts in holding tank

Fire clown *Amphiprion ephippium*

Broodstock development and successful breeding of clown fish viz. *Amphiprion ephippium* was achieved at Mandapam. The broodstock of *A. ephippium* were maintained in the aquarium glass tanks and fed twice a day with chopped squid and shrimp meat, and once with artificial fish feeds. PVC pipes/ earthen pots were provided in the tanks to serve as substratum for laying of eggs. The tanks were also provided with a sea anemone. After incubation of 8-9 days hatching of the eggs occurred. The total length of the newly hatched larvae was around 5 mm and the mouth gape was 200µ. Larviculture was carried out mainly with rotifers and followed by larval inert diets. The metamorphosis was completed during 14-16 days. From 21days onwards, the juveniles start epibenthic life.

Amphiprion frenatus



Fire clown brooder

Studies on influence of temperature on somatic and sexual growth of *A. frenatus* conducted at Kochi showed no significant somatic growth difference in both male and female at different temperatures. However, the gonadosomatic index (GSI) varied between 1.46 to 2.52 in the females and 0.51 to 1.02 in males at different temperatures. It was noted that the GSI was highest at 29^{0}C.

Newly hatched larvae of *A. frenatus* were reared in 6 h light:18 h dark, 12 h light:12 h dark, 18 h light: 6 h dark and 24 h light: 0 h dark up to 15 days of post hatch (DPH) for studying the effect of duration of photoperiod on larval survival. It was observed that 24 h light: 0 h dark yielded the best survival rate of 80-85%.

Juveniles of *A. frenatus*, *A. nigripes* and *A. ocellaris* reared in sea cages showed better growth and colouration when compared with the same grown in indoor tanks.

Ecsenius bicolor

The broodstock development of bicolor blenny *E. bicolor* is progressing at Kochi.

Shell fishes

Sand lobster

Successful cycles were obtained in the seed production of sand lobsters at the Kovalam Field Lab of CMFRI. Phyllosoma I hatched from two wild brooder clutches were stocked in 4 different raceways @ stocking densities of 5-7 larvae per litre, progressed to nisto settlement and seed formation in a period of 29-32 days of culture (DOC). About 400 nos. of phyllosoma IV progressed to nisto stage and the survival at seed formation was 50%.

Diseases and health management

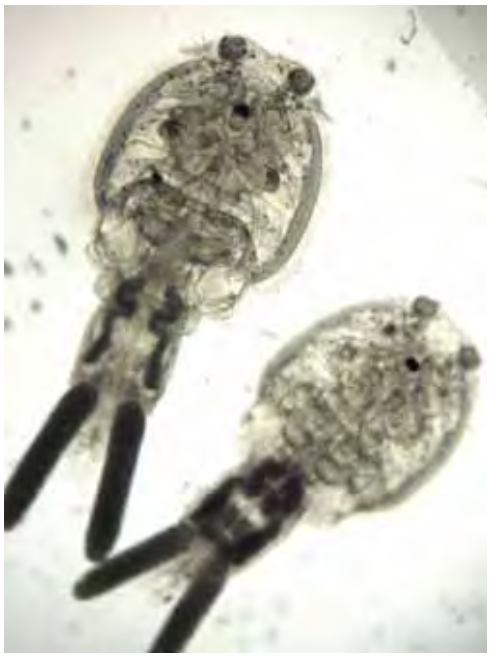
Bacterial disease of cobia broodstock

Sudden mass mortality of cobia broodstock was observed during May 2012. Haemorrhagic gastritis was the only lesion recorded in majority of the dead fishes. The causative agent was identified as *V. alginolyticus* based on TCBS culture studies and biochemical tests. It was further confirmed through molecular methods. Antibiotic, Oxytetracycline was mixed with feed and fed to the broodstock twice daily to control the mortality.

Parasitic infection of pompano broodstock

Mortality of silver pompano, *Trachinotus blochii* was recorded due to *Amyloodinium ocellatum* infection. Microscopic examination of the fresh gill filaments showed heavy infestation. The fishes were treated with fresh water and 5-10 ppm of formalin dip for 5-10 min, which resulted in dropping off of cysts and improvement in survival rate.

Frequent infestation with the parasitic copepod, *Caligus* spp., was noted in *T. blochii*. The infested fish were given freshwater treatment for 5-10 minutes for three consecutive days to control the infestation.



Caligus elongatus from pompano

Monogenean infestation in ornamental fishes

Mass mortality occurred in all species (*Amphiprion ocellaris*, *A. nigripes*, *A. percula*, *A. frenatus*, *A. perideraion*, *A. clarkii* and *Premnas biaculeaus*) and stages of clownfish at Vizhinjam. This was caused by a monogenean parasite *Benedenia* sp. which infected almost all species in the hatchery. Normal bath treatment did not yield a complete recovery. Repeated treatment using Praziquantel 100mg/l for 3-5 minutes followed by a complete overhauling of tanks could eliminate this infection.

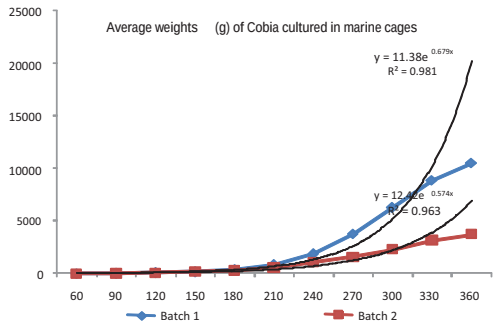
Benedenia sp.

Live feeds

Mass culture of copepod *Acrocalanus gibber*

A protocol for mass culture of copepod, *Acrocalanus gibber* was developed at Vizhinjam. The culture can be initiated in larger tanks with introduction of 1-2 l of culture slowly increasing the water level and a full tank culture can be made within 30 days. Daily feeding is necessary using a mixture of *Nannochloropsis* and *Isochrysis*. On alternate days the bottom settled faecal matter and moults can be siphoned out and collected using sieves of 20 micron size into a separate container. This will have lot of eggs which can be kept in aeration for 2 days and filtered and washed through 40 μ sieve and added back to the culture. Every 30 days tanks should be changed. A combination with a benthic harpacticoid copepod (*Microsetella norvegica*) also yielded better survival of *A. gibber* than monoculture. Ciliate and other infestations also were noticed. In normal cases filtration using a flow through system is ideal and if the contamination is severe, it is better to discard the stock and restart the culture.

Grow-out technologies



Growth rate of cobia cultured in marine cage at Karwar

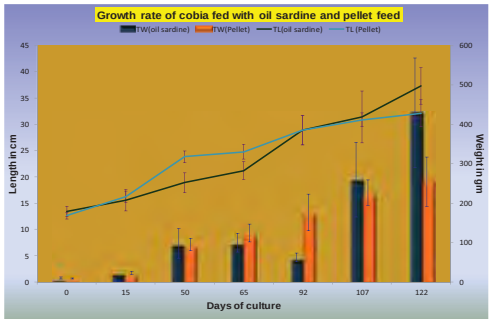
Marine finfishes

Karwar

At Karwar, five groups of marine finfishes *viz*., Asian seabass, cobia, pompano, snappers and sea breams were cultured in 6 m diameter cages with varying stocking densities. Asian seabass, *Lates calcarifer,* seeds were brought from RGCA, Sirkhazhi reared in a private hatchery for one month till they reach 15g size and stocked at a density of 14 nos/m^3 in 6 m diameter marine cages and were cultured for an year. Average weight obtained for Asian seabass during 360 days of culture was 2.5 kg

Stocking density experiments for cobia and pompano were conducted in 6 m diameter cages at Karwar. Two thousand numbers of cobia, *Rachycentron canadum* and pompano, *Trachinotus blochii*, seeds were transported from Mandapam Regional Centre of CMFRI. Cobia were stocked in two 6 m diameter cages with a density of 4 nos/ m^3 and 14 nos/m^3 and were fed with fresh oil sardines @ 5% biomass. Pompano species were stocked with a density of 14 nos/m^3 and the growth parameters were monitored at fortnightly intervals. Cobia attained an average weight of 3.5 kg and 10.5 kg which were stocked with densities of 4 nos/m^3 and 14 nos/m^3 after 360 days of culture. Average weight of Pampano was 500 g at 360 days of culture.

Feed experiments using pellet feeds and fresh feeds were conducted at Karwar. Cobia seeds (2800 Nos.) were brought from Mandapam Regional Centre of CMFRI during August 2012 and were stocked at a density of 6 nos/m^3 in three 6 m diameter cages. One batch of cobia was fed with oil sardines @ 10% biomass and another batch with pellet feed @ 4 % biomass. Regular sampling was made at fortnightly intervals for growth rate analyses of fish.

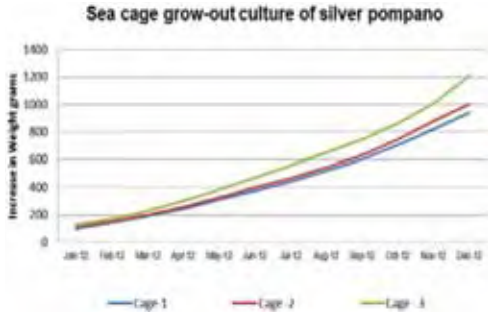


Growth rate of experimental cobia fed with different feeds

Mandapam

Experiments were carried out to assess the growth performance of hatchery produced Silver Pompano *Trachinotus blochii*, in the sea cages, at different stocking densities at Mandapam. Pompano fingerlings of average initial length and weight 6.52±0.4 cm and 5.34±0.2 g respectively were stocked in circular HDPE cages of 6 m diameter and 3.5 m depth. The stocking densities are 15 nos./m^3 (Cage 1), 10 nos./m^3 (Cage 2) and 5 nos./m^3 (Cage 3) in each cage. The fingerlings were fed with formulated floating pellet feed containing 38% crude protein and 6% crude fat once in a day @ 5% of body weight. Grading and growth monitoring of the fingerlings in terms of length and weight was

carried out at every 30 days interval. After a culture period of 16 months, the fishes stocked at the lowest density attained an average weight of 1210 g compared to the higher density group, which attained an average weight of 941 g. The growth performance of Silver pompano grow-out details are given in.



Trachinotus blochii cultured in cages at Mandapam

Kochi

A cage farming demonstration was conducted in Public Private Partnership mode, led by a group of four local artisanal fishermen families at Pooyappilly, Chittatukara Panchayat, Kerala. Mullet fry collected from the wild were nursery reared in hapas erected in earthen ponds till it reached 25 g and above. After nursery rearing 5500 fingerlings were stocked in a 6 m diameter cage during January-February 2012. The total operational expenditure including cage maintenance and feed was Rs.1.1 lakh. The mullet production was 1650 kg worth Rs.5 lakhs. The farm gate price obtained was Rs.300/kg. The mean weight of the fish had ranged between 385 g and 450 g.

Harvest of cage farmed mullets at Kochi

The fabrication of 2 nos. of 3 m dia cages and one number of 6 m dia cages were made with G.I. pipe. Plastic barrels of 200 lit. capacity, filled with 30 lb air were tied to the frame for flotation. Cages were launched at Chellanam sea for farming experiments. Out of this one 3 m cage was used for stocking collected seeds and the other cage were launched in the open sea for rearing of juveniles.

Calicut

The low cost cage design was used for culture of pearl spot in the less saline waters of Moorad and Thiruvangoor in Calicut district. These two sites are ideal due to very good tidal flow of water and good salinity of 20-25 ppt after monsoon season. Ten cages each were installed at Moorad and Thiruvangoor estuarine areas. Each cage in Moorad is stocked with 150 young ones of Pearl spot of 25 mm in November. Feeding was done twice in a day during morning and evening at the rate of 10% biomass with formulated feed made of Coconut oil cake, Rice bran, Tapioca powder, Maida and common salt. The ingredients were mixed with boiled water and made into small balls and mixed with growth enhancers, and placed in the feeding tray. The salinity in the site ranged from 20 to 25 ppt (October-December). The DO ranged between 5.2 and 6.8 ml/L in these sites. Presence of ammonia and nitrates in the cage farming areas was almost negligible. Flow of water in the site was very good, which provided healthy environmental conditions for the growth of food fishes stocked in the cages which also helped to reduce the risk of occurrence of disease in the farming area.

Pearl Spot cultured in the small cages at Moorad, Calicut

One 5 m GI frame cage has been designed and fabricated for installation in the open sea off Kovalam, Chennai for lobster fattening in open sea conditions. One 3 m GI frame cage has been designed and fabricated for installation in the identified creek at Pulicat for cage rearing of selected species of finfish.

Capture Based Aquaculture

Snappers and sea breams collected from wild were stocked in 3m and 6 m diameter cages at Karwar and were fed with oil sardine @ 10 % biomass. The average weight of *Lutjanus argentimaculatus* was 2.3 kg after 360 days of culture. The average weight of the other two species i.e., *L. russeli* and *L. johni* were 1.2 kg and 1.8 kg, respectively. Sea breams, *Acanthopagrus latus,* attained an average weight of 1.2 kg.

Pearl Spot cultured in the small cages at Thiruvangoor, Calicut

Cage cultured snappers, *Lutjanus argentimaculatus*

At Uppunda, Byndoor, Mangalore, 14 cages were installed in coastal waters. The cages were stocked with wild seeds of *L. argentimaculatus*, *Alepes* spp. and *Lates calcarifer*. Fishes of size 80-140g were stocked and stocking density ranged from 500-700 numbers per cage. The fishes attained a size of 650-900 g and it was marketed locally at ` 280/kg. After a culture period of about 240 to 250 days, the Shrimp scad, *A. djedaba,* reached an average size of 640 g with an average survival of 86.6% which was almost equivalent to the growth of red snapper (average weight 760 g and survival 92%). Initiation of integration of finfish cage culture with mussel farming was done at Saligrama near Udupi.

The rearing of red snappers under captivity in concrete ponds was carried out at Calicut. Red snappers were collected from the Malabar region. The size of the fish in the concrete ponds varied from 150 to 310 mm in length and 200 to 1300 g weight. The salinity in the pond was around 35 ppt by pumping sea water. The water depth in the pond was always maintained above 2.5 inches. The fishes were daily fed live Tilapia and also oil sardine at the rate of 10% of their body weight.

Physico-chemical and biological parameters of water and sediment of cage and reference sites were undertaken at Karwar to assess the influence of these factors on fish growth.

Cage cultured seabream, *Acanthopagrus latus*

The temperature ranged between 25^{0}C and 30^{0}C and the salinity varied between 15 and 36 ppt, the Dissolved Oxygen 3.4 to 4.9 mg/l and pH ranged from 7.0 to 8.1. There is no significant difference in the water quality parameters of cage and reference site. Ammonia, nitrate and nitrites were found to be within the optimum range. Plankton analysis revealed presence of eleven genera at cage site, *Chaetoceros* and *Rhizosolenia* were the dominant genera.

Total bacterial loads of water from cage site recorded during the sampling period were found to be high in both cage and reference site whereas total *Vibrio* loads varied between 0.5 x 10^2 cfu/ml and 0.2 x 10^4 cfu/ml at cage site.

Benthic studies near cage culture site also revealed the presence of molluscs, polychaete worms, echinoderms and sponges with polychaete worms as dominant population.

Development of Low cost farming technologies

Existing GI cage design was submitted for patent (No. 5196/CHE/2012). Improvement of existing GI cage design was done to reduce the transport cost by manufacturing as dismantilable pieces

Natural finfish seed resources

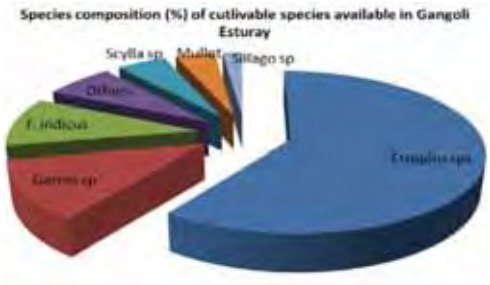
Low cost cage design (patented)

Survey on the availability of cultivable fish seed was carried out in Gangoli estuary at Udupi district of Karnataka. Species composition of cultivable species available in Gangoli estuary was estimated.

Survey of seed resources in and around Chellanam area, Kochi, Kerala was carried out. The seeds of *Liza tade* of size 7 to 8 cm were available during the period June to October. *Mugil cephalus* and *L. tade* of total length 3 to 5 cm were available during January to February in two locations at Chellanum. Juveniles of *L. tade* and *M. cephalus* (10 to 12 cm) were available during the month of December and January. Seeds of different sizes (3 to 12 cm) of *Valamugil cunnensis* and *Therapon* sp. were recorded from these coasts throughout the year. Survey of seeds and juveniles of *L. argentimaculatus*

were also carried out at Alappuzha, Brahmamangalam to Chellanam area. However, availability of seeds was limited. For collection of wild seeds, a rectangular cage frame was fabricated with GI pipes and tied with hapa net partially (one side) immersed in water, in which hiding materials and plant materials were tied. Once in three days the structure was lifted and the seeds collected in the structure was sorted out and stocked in separate cages. The collected seeds were stocked in hapa (1.5x2x2.5m) net and fed with pelleted feeds.

Survey on selection of site suitable for marine cage farming was carried out at three states *viz*., Karnataka, Goa and Maharashtra states. Other than Karwar, two places were selected for cage culture operations at Uttar Kannada District, *viz*., Kumta (Vanahalli Bay) and Amdalli (Kodar Bay). Polem Bay and Canacona Bay are selected at Goa state whereas, in Maharashtra state Ratnagiri outer harbour I and II are selected for cage farming of marine finfish and shellfish. Site surveys were also carried out at Thiruvallur, Kancheepuram, Arangankuppam, Nettukuppam, Kovlam, Cuddalore, Chinnakuppam and Oyyalikuppam along Tamilnadu coast for selecting suitable sites for cage farming. Site surveys were conducted at Calicut area for finding out suitable culture site for food fishes in cage in less saline water for coastal mariculture



Seed survey at Percentage Composition of cultivable species at Gangoli estuary

Clams

The clam farming protocols developed last year were developed into a public fundable project suitable for clam fisher societies to undertake clam relaying and farming. The Vembanad Lake Clam Societies Council has agreed to put up 600 units in 15 hectare area using 60 tonnes of clam seed with an expected return of 480 tonnes after 6 months of grow-out. The input cost per unit was worked out as ` 3222 per unit.

List of Black Clam fisher societies in Vembanad Lake who are proposing to do clam farming/ conservation

Name of the Society	No. of members (fishers)	Area of farming (Hectares)	Amount of seed (Kg.)	Projected harvest (tonnes)
Aryad Clam Lime Shell Industrial Co-operative Society, Komalapuram, Alappuzha.	749	2.5 Ha (100 units)	10,000 kg	80
Muhamma Black Clam Lime Shell Industrial Co-operative Society, Muhamma, Alappuzha.	1640	2.5 Ha (100 units)	10,000 kg	80
Kavalam Black Clam Lime Shell Industrial Co-operative Society, Kavalam P.O., Kuttanad, Alappuzha.	251	2.5 Ha (100 units)	10,000 kg	80
Thaikkattusseri Black Clam Lime Shell Industrial Co-operative Society, Cherthala, Alappuzha.	1640	1.25 Ha (50 units)	5,000 kg	40
Kuthiathodu Clam Lime Shell Industrial Co-operative Society, Kuthiathodu, Alappuzha.	714	2.5 Ha (100 units)	10,000 kg	80
Vechoor Black Clam Lime Shell Industrial Co-operative Society, Kudavechoor, Kottayam.	250	1.25 Ha (50 units)	5,000 kg	40
Vaikom Lime Shell Industrial Co-operative Society, Vaikom, Kottayam.	582	2.5 Ha. (100 units)	10,000 kg	80
TOTAL	**5826**	**15 Ha (600 units)**	**60 tonnes**	**480 t**

Mussels

Mussel farming demonstration at Goa: Areas suitable for the development of mussel farming in South Goa were identified at 1.6 km from the bar mouth in Sal estuary. Resident shrimp farmers and entrepreneurs

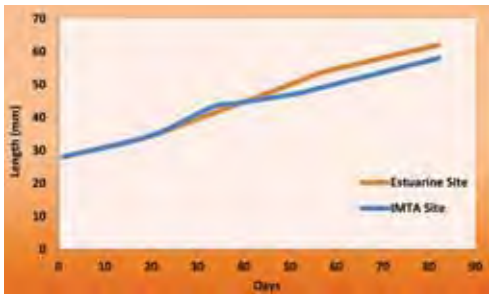
Training on seeding operation at Madgoan

were identified with the support of B.F.F.D.A., Madgaon and KVK, South Goa. Environmental conditions favoring mussel farming prevails in the selected site from October to May. Mussel and oyster culture demonstration was jointly organized with B.F.F.D.A., Goa, for the identified groups of farmers and entrepreneurs in Sal estuary. Demonstration racks were fabricated using bamboo poles and fixed at 2 m water depth for suspend mussel grow-out ropes.

Mussel farming training were also conducted to farmers for popularising farming techniques at Coondapura, Karnataka, Calicut, Kerala and Sindudurg, Maharashtra. One raft of 5X5 m size was installed in the coastal waters of Arakuda at Odisha with 61 ropes. Adult size green mussels were introduced for seeding in mosquito net tied at the bottom of the raft. The famers were trained on the importance of green mussel and its farming. Farmers themselves have introduced another raft near to the existing raft.

Mussel farming as part of Integrated Multi-tropic aquaculture (IMTA)

In Multi-trophic approach, aquaculture of organisms that extract either dissolved inorganic nutrients (seaweeds) or particulate organic matter, such as bivalves (mussel) are combined with farming of fed organisms, (finfish/ shellfish), for balancing the biological and chemical processes in the farm site. Besides environmental sustainability, it provides economic diversification and reduces the economic risk when appropriate species are chosen for farming.150 seeded ropes from Saligrama (Sita estuary, Udupi District) and 200 meters of seeded ropes from Padanna (Kasargod District) were transported to Karwar for farming in open-sea rafts near marine finfish cages. Mussel growth in IMTA site (Karwar) was compared with the growth rate of farmed mussel in estuarine sites at Saligrama. The mussel growth rate and environmental parameters in the farming site were monitored.



Growth rate of green mussel in estuarine and open seasites.

Green Mussel spat production and nursery rearing

Tenth successful spawning of the green mussel *P. viridis* in the Mariculture hatchery of Visakhapatnam Regional Centre produced 10.3 million larvae and over 2.5 lakh spat were settled after 21days. The spat were reared and further used for nursery rearing experiment.

An upwelling system was set up for rearing the green mussel spat to develop a nursery technique for faster growth of spat to the seeding size for further farming in the estuaries and sea. The spat of initial average shell length of 6.8 mm and average weight of 0.04 g were stocked in the PVC tubes set in the upwelling tank, provided with continuous aeration and feed (*Isochrysis galbana* and *Chaetoceros calcitrans*). The spat attained an average shell length of 12.15 mm, average width of 6.8 mm and weight of 0.34 g in 50 days. Preliminary results indicate faster growth in the upwelling system compared to growth in tanks.

Mabe Pearl Oyster

Image pearl ornaments

Six hundred image nuclei were produced and were implanted in 390 oysters of 50 to 75 mm DVM. The implanted oysters were stocked in cages at the rate of 50 numbers per cage. Oysters were harvested 52 days after implantation. The rate of 'A' quality image pearls ranged from 10-15 %. Sale of image pearl generated a revenue of Rs. 6000/-. Five day training programme sponsored by NFDB on 'Techniques in designer pearl production' was conducted at CMFRI, Vizhinjam.

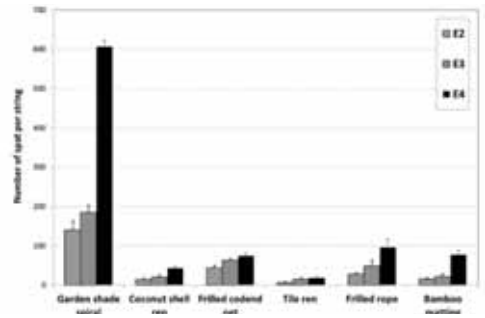
Carrying Capacity of Estuaries for Mussel Farming

Diurnal observation on the dissolved oxygen levels in the bivalve farming areas on three hourly interval was carried out at Padanna estuary before stocking mussels and 20 days after stocking the seeds in the raft. This observation revealed autotrophic condition of the estuary. Monitoring the oxygen budget during the active culture period will be continued monthly or bimonthly. Chlorophyll-a minimum and oxygen minimum levels were observed during early morning hours. Water quality parameters of mussel growing sites and mussel farming water bodies were monitored monthly.

Comparison of number of spat settled after 48 DOC when settlers were introduced after spat formation (E1) and during pediveliger stage (E2).

Black pearl - *Pinctada margaritifera*

The settlement of spat of the blacklip pearl oyster *Pinctada margaritifera* in the hatchery was investigated with respect to time of introduction of settlers, type of cultch material and the larval (pediveliger) densities. The study clearly indicated that the ideal time for deployment of spat collectors in the hatchery is when the pediveligers are beginning to appear in the larval rearing tank. In similar larval stocking densities, the settlement was more on the spat collectors which were deployed when the larvae had not metamorphosed to spat. The spat counts were almost doubled when settlers were introduced at pediveliger stage in the case of cultch substrates such as garden shade spiral, coconut shell ren, frilled cod-end net and tile ren. While in frilled rope treatment the difference between E1 and E2 was small, in the case of bamboo matting treatment, the introduction of settlers after spat formation proved to be better. Six different types of cultch materials were tested for their efficiency in three larval densities. The study showed that more spat collection of *P. margaritifera* can be achieved in hatcheries by providing darkness, dark coloured, rough-surfaced, corrugated and conditioned spat collectors such as the garden shade spiral at higher larval densities of 1.0 larvae/ml.



Comparison of number of spat settled after 48 DOC using different cultch substrates under different pediveliger densities, 0.2 pediveliger/ml (E2); 0.6 pediveliger/ml (E3) and 1.0 pediveliger/ml (E4). Vertical bars indicate standard deviation.

Edible oysters

At the oyster hatchery at Narakkal, 75,060 numbers of spat were produced through settlement of spat on the polyethylene sheet and clam shell grits provided in the tanks. 11,000 nos of cultchless spat along with cultch spat of edible oysters were also produced in the hatchery at Narakkal through spat settled on the polyethylene sheet and the clam shell grits provided in the tanks.

The farmed oysters were harvested from May 14th onwards upto 29th June 2012. The estimated production was 3500 tonnes during this season, indicating an increase of 9.4% over that of 2011 (3200 tonnes) and 28% over that of 2010 (2500 tonnes).

Depuration of oysters in the village depuration unit

Farmers used the common depuration unit set up in the village developed under the NAIP for depurating the farmed oyster. The depurated oysters were heat shucked in the automatic steam unit developed under the NAIP thereby ensuring high quality/ purity of the product.

Algal production systems for new phytoflagellate, *Pavlova lutheri* and diatom *Chaetoceros* sp. were developed and standardized at the oyster hatchery and the oyster larvae were fed with these phytoflagellates. Oyster spat produced in the hatchery were transferred to the farm.

Oyster products such as ready-to-cook, *viz*. Individually Quick Frozen (IQF)

Depuration of oysters in the village depuration unit

Smoked oyster wrapped with shrink film

oysters and ready-to-serve product such as oyster curry under the brand name 'MUZURIS' were marketed through the retail outlets of NIFPHATT, Cochin.

New innovative product *i.e.* "Cold smoked oyster-shell on" which was developed in last year had very good demand in high-end restaurants so the production of this product was also intensified.

A patent for a device and process to separate oyster meat from shell using pressurized steam, such that there is a steam generator, which supplies pressurized steam to a pressured chamber where live oysters are loaded, was prepared and submitted.

Marine Biodiversity

Reef fishes

During the year, around 89 species under 19 families, of fishes were recorded from hooks and lines, gill nets and trawlers operated off Kerala and Tamil Nadu coasts. Other than the new records, many rare, threatened, vulnerable and ornamental fish species from different families like Serranidae, Labridae, Acanthuridae, Lutjanidae and Siganidae was also collected during the year. It was noticed that *Epinephelus areolatus, Aphaereus rutilans* landings have declined during the study period whereas landings of certain species like *Epinephelus epistictus* has increased. New emerging species in the fishery were *Naso reticulatus*, *Parascolopsis capitinis*, *Liopoproma* sp, *Pristigenys refulgens*, *Acanthurus tennetti* and *Acanthurus barienne*.

In Grande Island-Goa, coral fish abundance estimates were done using underwater visual census (UVC) technique using belt transect by SCUBA diving in three sites. *Chaetodon lunula*, *C. collare, Bodianus* sp, *Heniochus* spp, *Sargonentron* sp, *Gymnothorax* sp, *Epinephelus* sp, *Acanthurus* spp, *Plectorhyncus lineatus, Thalassoma lunare, Bodianus* sp, *Labroides dimidatus, Aballistes stellatus* etc were dominated in the first site. The *Lutjanus* spp. was observed more in the second site followed by *Heniochus* spp., *Chaetodon collare*, *Sargocentron* sp., *Chlorurus sordidus*, *Siganus canaliculatus*. *Acanthurus* spp. was abundant in third site followed by *Ballistids*, *Wrasses*, *Sargocentron* sp, *Lutjanus* sp, *Scorpaenopsis* sp, etc. Holothurians and beautifully coloured nudibranchs, were also observed in this site.

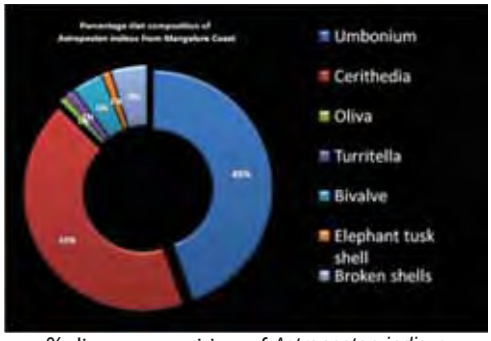
Coral reef fishes landed at Pamban therkuvady, Pamban light house, Mandapam and Keelakarai by trawl nets, bottom set gill nets, hooks & lines and traps respectively were collected, identified and recorded. A total of 202 species belonging to 53 families were recorded of which, the maximum numbers were contributed by trawl, followed by traps, gillnets and the least number of species was contributed by hooks & lines from this region. One endangered species *Cheilinus undulates* was observed in the area.

The fish samples collected from fishing harbour, Lawson's Bay, and Bheemunipatnam along Visakhapatnam showed the presence of 45 species belongs to 23 families. Lutjanidae dominated the collection with six species followed by Mullidae, Holocentridae and Apogonidae. Other familes recorded were Acanthuridae, Ambassidae, Antennaridae, Balistidae, Chaetodontidae Haemulidae, Nemipteridae, Pempheridae, Platacidae, Plotosidae, Pomacanthidae, Scaridae, Scatophagidae, Scorpaenidae, Serranidae, Siganidae, Sparidae, Terapontidae and Uranoscopidae.

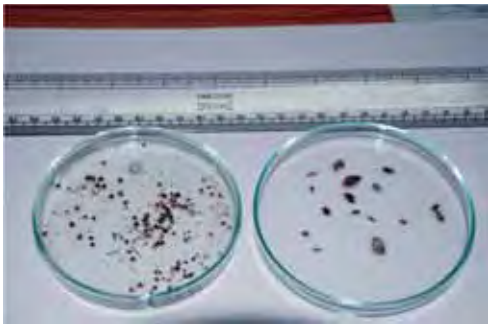
Damsels

Epinephelus lanceolatus

Cheilinus undulatus from Gulf of Mannar



% diet composition of *Astropecten indicus*



Gut content of *Astropecten indicus*

Mastigias cf. *papua*

Other resources

Sand star species *Astropecten indicus* Doderlein, 1888 was found in good numbers in the single day trawl catches in Mangalore waters. The gut content analysis of 180 sand stars revealed diverse benthic organisms' *viz*., *Umbonium* sp, *Cerithedia* sp, *Oliva* sp, *Turritella* sp, bivalves, elephant tusk shell etc., in their gut content. *Umbonium* sp and *Cerithedia* sp was the dominant food item.

The jellyfish survey was conducted in Netravti-Gurupur Estuary (9.8 Km2) and Sambavi-mulki estuary (0.9 Km2) revealed that the species *Acromitus flagellates* was dominant. At Kamini river bar mouth the successive breeding of *Acromitus flagellates* was observed in 2011 and 2012. The Scyphomedusae diversity along the southwest coast was at 8 species, in which two species have been collected from Karnataka coast this year. In Palk Bay and Gulf of Mannar, four species of scyphozoan jellyfishes were recorded. The species *Cassiopea* cf. *andromeda* was recorded from Tuticorin coast and the remaining three species *Chrysaora caliparea* (Reynaud, 1830), *Mastigias* cf. *papua* (Lesson) and *Rhopilema* cf. *hispidum* was recorded from Mandapam and Thiruppalaikudi coast of Palk bay.

Field surveys carried out along Visakhapatnam coast revealed the presence of spiny sea urchins, gastropods and zoanthids on the rocky shores during low tide period from VUDA Park to Lawson Bay of Visakhapatnam.

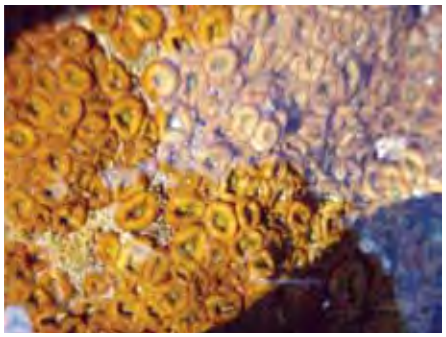
Hard corals

Survey was carried out at two stations in the Gulf of Kutch region viz., Mithapur and Poshitra. At Mithapur, the intertidal rock pool region was with 2% coral cover and 35% coral coverage was recorded in the subtidal region. Macro-vegetation *viz*., *Sargassum* sp. coverage in intertidal pool was 40% which impacted the hard corals growth. Corals belong to the genus *Favia* showed higher coverage followed by *Porites* and *Favites*. Patchy distribution of *Acanthastrea* sp. and *Montipora* sp. was also recorded from the region. Patchy colonies of hard corals were observed along the southern margin at Laku Point of Poshitra. Intertidal region coral coverage was 40% and 35% was recorded in subtidal region upto 1.5 metre depth. The genera, *Porites* and *Favia* showed maximum coverage followed by the genera *Symphyllia*, *Platygyra*, *Turbinaria, Siderastrea*, and *Pseudosiderastrea.*

Malvan

Preliminary study carried out at Malvan revealed the presence of patchy coral growth dominated by *Porites lutea* and *P. lichen* followed by *Goniastrea*

Sea urchin



Exposed zoanthids at Lawsons Bay, Visakhapatnam

Acanthastrea sp.

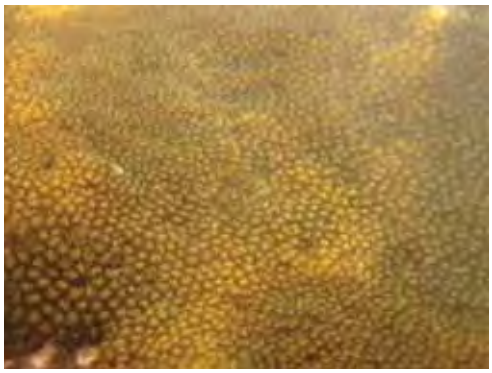
Favia sp.

Favites sp.

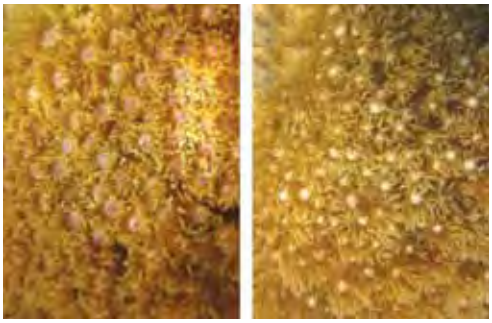
sp. *Siderastrea* sp, *Cyphastrea* sp. and *Turbinaria* sp. Few colonies of *Favites* spp. were observed in areas where depth was more than 1m.

The patchy coral cover and diversity was assessed using line intercept transect method in Grande Island, Goa. The survey was carried out in three locations: 1. Lobster Avenue 2. Chow Point and 3. Jetty. In the Lobster avenue, the coral cover was dominated by *Turbinaria* spp. *Psammocora profundacella*, *Goniastrea retiformis*, *Plesiastrea versipora*, *Favites pentagona*, *P. lobata*, *Cyphastrea serailia*, *Porites lutea*, *Favia pallid*, *Favites complanata*, *Favia speciosa*, *Alveopora fenestrata* and *Dendrophyllia* sp. In this area, the coral coverage was 54.2% followed by sponges 8.55%, dead corals covered with encrusting algae 1.8% and the 34.45% area was dominated by rocks and seaweeds, especially by *Padina* sp. and *Chaetomorpha* sp. The Chow point in coral cover was 43.77% followed by sponges contributing 10.84% and the green algae forming 1.23% of the area. *Turbinaria* spp. dominated the coral fauna followed by *Goniastrea retiformis*, *Porites lobata*, *Psammocora profundacella*, *Favia speciosa*, *Favites pentagona*, *Favia pallida*, *Porites lutea*, *Cyphastrea serailia*, *Pocillopora verrucosa* and *Pavona minuta*. The Jetty area was having comparatively less coral cover 29.98 % and 3.0 % of sponge cover. *Favites pentagona* was the dominant coral followed by *Goniastrea retiformis*, *Favia speciosa*, *Turbinaria mesenterina*, *Porites lutea* and *Porites lobata*.

Regular monitoring was done in the Tuticorin Port Trust Jetty, where corals were found mostly on the stones/concrete blocks. The live corals cover was mainly by corals belonging to the family Faviidae and Dendrophyllidae. Dead corals were mostly dominated by Acroporids and dead corals with encrusting algae were dominated by Faviids. Different types of corals, mainly Acroporids, Pocilloporids, Faviids and Dendrophyllidswere encountered in the bottom set gill net from Sippikulam, Vipar and Vellapatti.



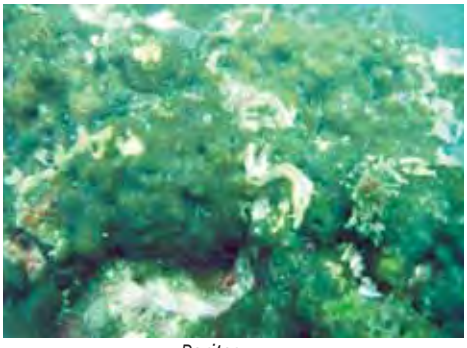
Hydnophora sp.



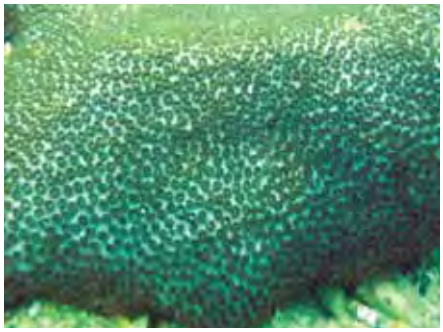
Goniopora sp.

Turbinaria sp.

Goniastrea retiformis

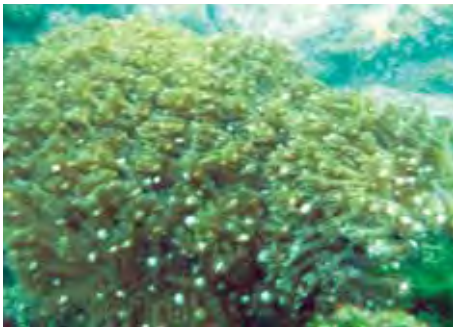


Porites spp.



Plesiastrea versipora

Tubastrea sp.



Alveopora fenestrata

Lobophytum sarcophytoides Moser, 1919

Culture of *Lobophytum sarcophytoides* at Cochin

A view of healed portion of the cut region of parent colony

Soft corals

Fragmentation culture of the soft coral, *Lobophytum sarcophytoides* was initiated and the experiment in triplicate was set up using feed and light as variables.

Feeds selected were *Nannochloropsis occulata* and an invertebrate feed available in the market. In the case of light, different combinations of actinic blue and white tubes were used in culture tanks. Along with these, a control was also run simultaneously. The weight and volume of the fragments were taken on monthly intervals. The water quality parameters like temperature, pH, Dissolved oxygen, salinity and Total dissolved solids were also recorded. After cutting, the fragments were found to attach firmly to the substratum on 12th day. But, in another experiment conducted earlier with *Lobophytum pauciflorum*, the fragments were found to attach firmly to thesubstratum by 20th day of cutting. Hence, attachment of fragments to the substratum is faster in the case of *Lobophytum sarcophytoides* when compared to that of *Lobophytum pauciflorum*.

Studies on the propagation of soft coral *Dampia pocilloporaeformis*

Experiments were initiated to study the substrate preference, attachment and growth of a soft coral *Dampia pocilloporaeformis*. Three types of substratum were used for the study viz., coral rubble, black stone and tiles. There was no difference between the substrates with regard to the time taken for attachment. The cut fragments were found to attach on to the substratum in about 20 days and the cut area of the fragment was found to start healing in about 2 weeks' time.

Assessment of fishing impacts on biodiversity loss, with special reference to the threatened species, to formulate management options for their protection

At Mumbai, the trawl net was found to have a cod end mesh size of 25mm (for shrimp) and 35mm (for fish); fish at an average of four trawls per day at depth range between 25m and 55m. The average total catch per haul was found to be 333 kg with maximum of 500 kg/haul and minimum of 150 kg/haul and the average total discard was found to be 188 kgwith maximum of 250 kg/haul and minimum of 100 kg/haul i.e. 56% of the total trawl catch per trawl was found to be discarded.

In Cochin, two types of trawl are operated *viz*., Single day trawler and Multiday trawlers. The trawl catches include juveniles and sub adults of a variety of fishes like sharks, rays, skates, catfishes, sciaenids, flatfishes, silverbellies,

perches, groupers, snappers, breams, saurids, whitefish, threadfin breams and pomfrets. The landings of cat fish and white fish (*Lactarius lactarius*) showed a decline over the years. Recent studies indicated that the fishes like *Nemipterus* (Threadfin breams), *Sphyraena* (Barracuda), *Trichiurus* (Ribbon fish), *Euthynnus affinis* (Little Tuna), *Stolephorus* (Anchovies), *Chirocentrus dorab* (Wolf herring), *Hemiramphus* (Halfbeaks), *Leiognathus* (Silver bellies), *Carcharhinus* (Grey sharks), *Arius* (Catfishes) and *Pampus argenteus* (Pomfrets) were also showing a declining trend.

At Neendakara and Sakthikulangara, trawl nets and ring seines are mainly operated and juveniles of nemipterids, flat fishes and *Saurida* spp. are landed along with the main catch.

Newly developed colonies of *Dampia pocilloporaeformis* on different types of substratum

Colachel is mainly a trawl net operating centre which is cephalopod oriented. Heavy landing of sharks and rays, especially *Rhyncobatus djiddensis* and honeycomb stingray, *Himantura uarnak* were also observed in the trawl landings.

On 27th November 2012, two Olive ridley turtles were caught as by-catch on trawl net at a depth of 40m while undergoing experimental trawling along Visakhapatnam coast. The curve carapace length and weight of the turtle were 68 cm and 40 - 45 kg respectively. After taking morphometric measurements, the turtles were released back into the sea.

At Muttom, chain of rocks found on the shore as well as on the sea bottom harbour a very rich sponge fauna along with gorgonids and good concentration of rock dwelling fishes mainly perches and lobsters. The different types of bottom set gill nets along with the fish catch, remove the sponges, gorgonids, antipatharians, star fishes and other echinoderms, sea weeds etc. in large quantities.

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 which include the live rocks (about 10 kg per net), gorgonids, gastropods (*Bursa spinosa, Hemifusus* sp., *Xancus pyrum, Murex* spp., *Chicoreus* spp., *Pteria* sp.) and many species of non-edible crabs. The targeted lobsters are caught only in very few numbers.

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 *Turbinella pyrum*. The non-target resources destroyed include the gastropods (*Murex virgineus, Hemifusus* sp., *Conus* spp. and *Chicoreus* sp.), sponges, starfish and different species of non-edible crabs.

The mini trawls locally called *thallu valai* are operated in the sea grass beds off Devipattinam and Thiruppalaikudi in the Palk Bay. These gears target the juveniles of *Penaeus semisulcatus* which are found to inhabit in the sea grass beds. About 10 to 15 kg of sea grass are removed during a single operation while the targeted *P. semisulcatus* constituted about 3 kg.

Elasmobranch landing in Coachal

Incidence of *Rhyncobatus djiddensis* in the catch

The list of threatened species of Elasmobranchs landed at Cochin

Species	IUCN Red list status, 2012
Alopias pelagicus	Vulnerable
Alopias superciliosus	Vulnerable
Alopias vulpinus	Vulnerable
Hemipristis elongatus	Vulnerable
Carcharhinus macloti	Near threatened
C. mealnopterus	Near threatened
C. falciformis	Near threatened
C. longimanus	Near threatened
C. dussumieri	Near threatened
C. albimarginatus	Near threatened
C.amboinensis	Vulnerable
Galeocerdo cuvier	Near threatened
Negaprion acutidens	Near threatened
Prionace glauca	Near threatened
Eusphyra blochii	Near threatened
Sphyrna mokarran	Endangered
S. zygaena	Vulnerable
Chiloscyllium griseum	Near threatened
C. arabicum	Near threatened
Nebrius ferrugineus	Vulnerable
Rhincodon typus	Vulnerable
Odontaspis ferox	Vulnerable
Isurus oxyrinchus	Vulnerable
Lamna nasus	Vulnerable
Aetobatus nari nari	Near threatened
Rhinoptera javanica	Vulnerable
Manta birostris	Near threatened
Mobula japanica	Endangered

Olive Ridley turtle (*Lepidochelys olivacea*) as by-catch in trawl net

A view of the bottom set crab gill net

Sea grass removed by mini trawl

Holothuria spinifera observed in mini trawl

Star fish (*Pentaceraster* spp.), gastropods, large numbers of juvenile crabs (*Portunus pelagicus*) are also very common. Highly endangered animals like sea cucumber and pipe fish are also caught in this gear.

Bioinventorying and biodiversity valuation of marine organisms in selected marine ecosystems along the Indian coast

Seven species of fishes namely *Apogon queketti*, *Cheilodipterus macrodon*, *Pristiapogon kallopterus*, *Acanthacepola limbata*, *Sirembo jerdoni, Sirembo jerdoni* and *Acropoma hanedai* collected from Tuticorin area were recorded for the first time and deposited into the Marine Biodiversity Referral Museum. Seven species of fishes collected from Cochin area were new records and deposited into the Marine Biodiversity Referral Museum. The species deposited are *Pogonoperca punctata* (Valenciennes, 1830); *Priacanthus blochii* Bleeker, 1853; *Scarus rubroviolaceus* Bleeker, 1847; *Chelidoperca investigatoris* (Alcock, 1890); *Naucrates doctor* (Linnaeus, 1758) *Caesio xanthonotus* Bleeker, 1853 and *Stegostoma fasciatum* (Hermann, 1783).

Total fish landings from the area were about 1.187 million tones (31% of all India landings). Marine fish landings from Kerala was 7.43 lakh t of which more than 50% was contributed by oil sardine, mackerel, threadfin breams, carangids and penaeid prawns. The value estimated for the ecosystem services and natural capital of Kerala coast is of US $ 1660-1930 billion per year from an area of 260101 Km^2 which includes brackish water, estuaries and open Ocean. The Ecosystem Based Fisheries Management (EBFM) approach develops models of fisheries dynamics, trophic relations and ecosystem interactions.

A view of the bottom set crab gill net

Place	Gear	Vulnerable / Threatened species encountered	Indian Wildlife (Protection) Act, 1972
Colachel	Trawl	*Rhyncobatus djiddensis*	Schedule I, part II-A
Vishakapatnam	Expt. trawl	Olive Ridley turtle *Lepidochelys olivacea*	Schedule I, part II
Vembar	Trawl	Sponges	Schedule III
Tuticorin	Trawl	Sponges	Schedule III
	Bottom set gill net	Corals	Schedule I, part IV-A
		Sponges	Schedule III
		Sea cucumbers	Schedule I, part IV-C
Thiruppalaikudi, Devipattinam (Palk Bay)	Mini trawl, *Thallu valai*	Sea cucumber	Schedule I, part IV-C
		Pipe fish	Schedule I, part II-A
	Bottom set gill net, *Nandu valai*	Sponges	Schedule III
		Sea cucumber	Schedule I, part IV-C
Muttom	Bottom set gill net, *Thathu valai*	Gorgonids	Schedule I, part IV-A
		Sponges	Schedule III
	Bottom set gill net, *Kelaichu valai*	Gorgonids	Schedule I, part IV-A
		Sponges	Schedule III
Vethalai, GOM	Bottom set gill net, *Singhi valai*	Gorgonids	Schedule I, part IV-A
		Sponges	Schedule III
	Bottom set gill net, *Nandu valai*	Sponges	Schedule III

Marine Habitats

During the recent years the impacts of the coastal ecosystem due to anthropogenic activities have increased and several new issues have become more relevant now than in the past. The occurrence of marine litter, degradation of critical habitats, deteriorated water quality; high concentrations of heavy metals which can be bio-accumulated and magnified in the trophic chain are some of the common problems. Encountering these adversities are the main fauna whose sustainability has been challenged. During the period 2012-13, the ecological aspects of the coastal habitats as well as the avian fauna were studied.

Water Quality Grading of Coastal Waters

Grading of important coastal areas of different maritime states based on water quality

The hydrologic variations of the inshore waters have been studied during the period under report. Based on the USEPA (2004) guidelines, the sea water quality index (SWQI) was worked out for selected coastal areas.

Kerala: In the Vembanad lake, five locations were selected for detailed investigations, two in the estuarine region (Edayar and Irumpanam), a control site for these (Aluva) and two in the fishing area, off Kochi at 10 and 20m depths respectively. The SWQI was poor in the Irumpanam area but was found to be fair in Edayar and IFP harbour while it was graded as good in the fishing area and Aluva.

Water Quality index of surface waters, off Cochin and Vembanad Lake

Location	DO mg l^{-1}	DIP mg l^{-1}	DIN mg l^{-1}	Chl a, µg l^{-1}	WQI
Aluva	6.724	0.002	0.153	0.350	Good
Edayar	4.853	0.011	0.332	1.000	Fair
Irumpanam	2.474	0.250	0.920	3.196	Poor
IFP Harbour	5.470	0.027	0.209	1.344	Fair
Barmouth	5.268	0.012	0.076	1.520	Good
10m Depth	7.013	0.006	0.011	0.777	Good
20m Depth	7.203	0.009	0.035	0.268	Good

Karnataka: In the inshore waters of Karnataka, water quality grading was done at six sites. Among these, though the dissolved oxygen levels were good/fair, the sites were graded as fair and one site, Kulur was graded poor. The area at Kasba Bengare was graded as good.

Water quality index of different coastal areas of Karnataka

	DO, mg l^{-1}	Chl a, $\mu g l^{-1}$	DIP, mg l^{-1}	DIN, mg l^{-1}	WQI
Thaneerbhavi	5.7	7.6	0.03	0.06	FAIR
Panambur	5.8	6.7	0.03	0.067	FAIR
Chitrapur	5.71	6.65	0.03	0.07	FAIR
Kulur	4.25	21.34	0.10	0.17	POOR
Kasba Bengare	6.03	4.42	0.02	0.08	GOOD
Bunder	5.13	5.17	0.05	0.10	FAIR

Maharashtra : In three creeks and four other near-shore coastal areas, the water quality was tested continuously. Unlike other states, where coastal waters adjacent to areas of high anthropogenic activities had one or more parameters graded as good, in the Mumbai region there was not even a parameter which was graded as good. The WQI was poor in all the sites. An urgent need is evident to rectify this problem.

Water quality index of different coastal areas of Maharashtra

	DO mg l^{-1}	DIP mg l^{-1}	DIN, mg l^{-1}	Chl a, μg l^{-1}	WQI
Versova Creek	1.165	5.935	11.509	7.757	Poor
Mahim Creek	1.338	4.813	9.275	9.491	Poor
Gorai Creek	1.833	2.450	13.234	11.227	Poor
Mahim Nearshore	2.396	1.908	7.401	9.803	Poor
Juhu	2.694	1.044	7.120	11.344	Poor
Apollobunder	2.867	0.659	2.067	6.899	Poor
Versova	1.994	2.067	2.210	7.967	Poor

Andhra Pradesh: The coastal waters especially the Fishing harbour area and sewage outfall area was monitored and the SWQI was rated as poor. The chlorophyll content was good in all sites, while levels of dissolved oxygen were fair except at sewage outfall area where it was anoxic. With regard to DIP and DIN, the grades were poor except at Mangamaripeta where it was graded as fair.

Water quality index of different coastal areas of Vishakapatnam

	DO, mg l^{-1}	Chl a, µg l^{-1}	DIP, mg l^{-1}	DIN, mg l^{-1}	WQI
Fishing harbour Surface	3.17	0.23	0.89	0.89	POOR
Fishing harbour Bottom	3.43	0.81	0.49	0.49	POOR
Sewage Outfall	0.00	0.56	4.21	4.21	POOR
Mangamaripeta	4.42	0.50	0.25	0.25	FAIR

Effect of thermal effluents and fly ash discharge

From Tuticorin Centre, the effect of thermal effluents and fly ash discharged from the coal fired thermal power plant was monitored during the period under report. The mean values of water quality parameters indicated very high levels of productivity, ammonia, CO_2 and dissolved nutrients but very low dissolved oxygen.

Sedimentation Rate in Vembanad Lake

An experiment was initiated to study the sedimentation rate in Vembanad Lake. Sediment traps were installed in the open channel and samples analyzed after a period of 5 to 10 days. The sedimentation rate was found to be 228 g day $^{-1}m^{-2}$ during November 2012 and increased to 1187 g day $^{-1}m^{-2}$ in January.

Assessment of Marine Litter and its Impacts on Habitats and Fauna

The impacts of human activities especially those related to non-biodegradable wastes (NBW) were studied in different locations. The quantity of marine litter and other main observations made on marine litter and its impacts on the ecosystem and fauna are given below.

Occurrence of micro plastics in surface waters

It is understood that micro plastics of size less than 5mm and 5 to 10mm which occur along with the plankton can easily enter the food chain. An attempt was made to record the occurrence of micro plastics in plankton. Among the 21 zooplankton samples analysed, micro plastics of size less than 5mm were observed in 10% of samples while plastics of size 5 to 10mm were observed in 14% of samples in the coastal waters up to 30m depth off Kochi.

Region- wise quantification of non-biodegradable waste in coastal regions

- Karnataka: As an impact of monitoring and awareness campaign conducted in and around Mangalore by CMFRI and other organizations, positive changes in the management of beaches of Mangalore as well as the adjoining estuarine areas have been brought out. Beach cleaning activities have been taken up at Thanneerbhavi and Panambur beaches. Thus there was a reduction in quantity of marine litter in 2012 compared to that in 2011. In Chitrapur beach where there was not much cleaning activity, the total weight $m^{-2}yr^{-1}$ of marine litter was 2632 g and 2913 g for 2011 and 2012 respectively.

Gut of Common dolphin fish (*Coryphaena hippurus*) with partially digested fish and plastic bits

- Calicut : Quantity (gm^{-2}) of Non Biodegradable waste observed in the beaches near Calicut was estimated as 7.43; Konnad, 3.85 and 0.56 while in the fishing ground it was comparatively higher 39.5 g per trawl.
- Kochi : In the beaches of Central Kerala (Mararikulam, Puthuvypin and Cherai), the quantity of plastics showed monthly variation and ranged between 0.6 to 38 gm^{-2}
- Mumbai : The quantity of plastic materials and other debris in four selected beach areas were assessed. The average plastic in Mumbai beaches was estimated as 258 g and ranged between 60 to 867 gm^{-2}
- In the beaches of Vishakhapatnam, the quantity of plastics ranged between 5 to 1612 gm^{-2} .

Plastics in food chain and impacts on fishes

In the gut of common Dolphin fish *Coryphaena hippurus*, a surface-dwelling fish caught off Mangalore was found to contain pieces of plastic milk cover and other unidentified plastic bits. Identifying the bits of plastic is an important step towards management of waste.

Incidence of ghost fishing in south-eastern Arabian Sea

'Ghost nets' in coastal waters of Kerala – Is the fishing area becoming a dumping ground?

Ghost net which was washed ashore in Vypin Island

On 25th of February 2013 a huge abandoned fishing net in the fishing area was washed ashore on the beach of a fishing village, Edavanakadu in Vypin Island, Kerala. Discarded fishing nets or "Ghost nets" are damaged nets which cannot be used for fishing operations which are thrown by fishermen in fishing area. Sometimes these partly torn nets drift on the surface or column waters and at times they get entangled on submerged objects or rocks and sway in the aquatic environment.

This is the first report of a ghost net being washed ashore in the coastal area of southwest coast of India. This indicates that the threat to marine fauna due to uncontrolled anthropogenic activities is on the rise and that there is an urgent need to create awareness among fishers to be more responsible in discarding damaged nets.

Entangled in the 32.5 m long net was a small piece of skeletal remains of a whale. The net had entangled ropes, plastic bottles, buoys, cans and also jigs with steel hooks. The ghost net consisted of nets with different mesh sizes and approximately twenty four different types of nets were present.

Skeletal remains of the whale in the ghost net

Details of non-biodegradable items entangled in the ghost net

Non Biodegradable Litter items	Number
Plastic bottle	13
Plastic jug	4
Plasti bouy	5
Plastic cover	9
Thermocol	7
Jigs	1
Total Number	**39**

Disposing such nets is a problem for coastal villagers and in this instance they had decided to dry the net and sell it to the scrap yard where it will be melted and reused for other purposes.

Potential Impacts :This incident exposes the fact that danger is lurking in the coastal waters of Kerala which has resident populations of several dophins. Also there are chances of such ghost nets getting entangled in the propeller of boats.

Observations on impacts of plastics and discarded fishing net in oceanic regions

Through observations in the oceanic ecosystem when cruises were undertaken for studying other oceanic resources, the impacts by ghost nets were recorded.

Incidence of entanglement of turtles in ghost nets in central Arabian Sea

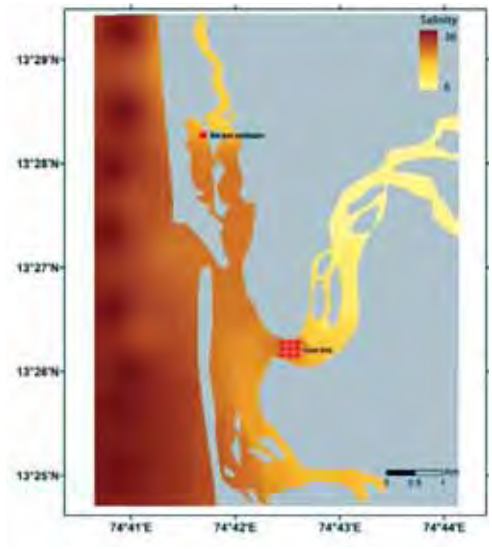
Habitat Restoration Programmes

Assessment of impacts of sand mining on bivalves especially clams

Mining of sand in Dakshina Kannada (DK) District has occurred on a large scale since 2007-08. Prior to this period in time, sand mining activities in the District were considerably smaller in scale.

The year-round removal of the sandy substratum from estuarine areas within the CRZ can significantly impact the benthic infauna including bivalves. Experiment for developing clam restoration protocols were carried out at Swarna-Sita estuary, Udupi.

Areas suitable for clam restoration experiments were selected based on the salinity and sediment characteristics in natural beds of Meretrix casta and three pens of 2x2m were erected. Clams were stocked in the pens at 4 different stocking densities with 3 replicates in each stocking density @500, 1000, 1500 and 2500 Nos. m^{-2}. The growth rate and survival of clam in the estuarine net pen were monitored.



Map showing the salinity profile and clam transplantation site in Sita-Swarna estuary, Karnataka

Grazing pressure in the seagrass beds of some coral atolls

Density and composition of seagrass species from Laccadive coral reefs were monitored. Minicoy atoll showed an average biomass of 500 gm^{-2} wet weight of underground parts of seagrass plants including rhizomes and roots but had only 96 gm^{-2} of leaves indicating the canopy loss (leaf biomass) owing to herbivory. Distribution of Cymodocea and Syringodium in Minicoy lagoon once dominant was only negligible.

Seagrass bed near Kadalundi

Large extensive seagrass bed of *Halophila beccarii* (Ashers) was observed from Kadalundi community reserve area close to the bird sanctuary measuring 2 hactares. Wet biomass of seagrass *Halophila beccarii* along with the associated flora and fauna were collected bimonthly to study the ecosystem kinetics.

Wet biomass of *Halophila beccarii* harvested from Kadalundi

	July 2012	Sept 2012	Nov 2012	Jan 2013
Total weight (gm^{-2})	210	150	720	270
Halophila (gm^{-2})	90	40	200	100
Other algae and animals(gm^{-2})				
(Tibia, Neeris, fish and crab juveniles)	120	110	520	170

Involving children in mangrove restoration programmes –propagules being planted in bio pouches

Installation of coastal bird experimental unit (CBEU)

View of birds perching on CBEU

Migratory birds in the paddy cum shrimp farm at Chellam, Kerala

Progress of Experiments on Mangrove Restoration

Karnataka : Three sites, (i) Kudroli where mangroves are planted after partial degradation of natural ecosystem (ii) Thaneerbhavi – non mangrove site (iii) Mulki – natural mangrove site, were monitored for water quality on a monthly basis during the period. The growth of the planted mangroves was also monitored on a monthly basis.

Kerala (North) : Vertical growth rate studied monthly from Kadalundi mangrove areas showed a value of 7 cm month^{-1} for Soneratia caseolaris plants and that of Rhizophora mucronata plants at Dharmadom was determined to be 2.8 cm month^{-1} during the reporting period.

Kerala (Central zone) : Bio-pouches made of leaves were used for nursery rearing of propagules. This year also students were involved in preparing mangrove nursery. The saplings of *R.mucronata* planted in September 2010 had growm to nearly 150 cm and had developed 5 to 7 prop roots. The occurrence of fish and shrimp juveniles in the mangrove area was also assessed.

Observations On Sea /Coastal Birds

Karnataka

Along Mangalore 36 species of coastal birds were identified and photographed from 12 surveys conducted in coastal region. The main groups were egrets, herons, cormorants, kites, shanks, sandpipers, lapwings and plovers.

Among seabirds, the major birds observed were the gulls, brown headed *Larus brunnicephalus* and black headed *Larus ridibundus* followed by the terns. Oceanic birds Pomarine Skua (*Stercorarius pomarinus*) were observed off Mangalore in November 2012.

Andhra Pradesh

Avian fauna associated with the marine habitats of Visakhapatnam were noted. About 46 different types of coastal and sea birds were observed. The soft-plumaged petrel, Pterodromamollis was found to be associated with anchovy fishery.

Coastal birds of Gulf of Mannar

The coastal birds of Tuticorin were studied. Egrets, herons and sand pipers were the most frequently sighted groups. The main birds were spot billed pelican, painted stork, gray heron, white little egret, white bellied egret, terk sand piper, curlew sand piper, great egret, Eurasia oyster catcher and little cormorant.

Investigations on biology of coastal birds

Little is known about the feeding biology of coastal and sea birds of India. A Coastal Bird Experiment Unit (CBEU) to study the feeding behaviour and links between environment and coastal birds was set up in Cochin backwaters in December 2012. The structure is a modified floating hapa with a double layered frame lower made of PVC pipe and upper with wooden pole.

Observations on migratory coastal birds

In the traditional shrimp farms of Chellanam, the water duck, were seen during January 2013 to March 2013. These were found to feed on the fruits of weeds and other fauna. They were also found to use the mangrove habitats.

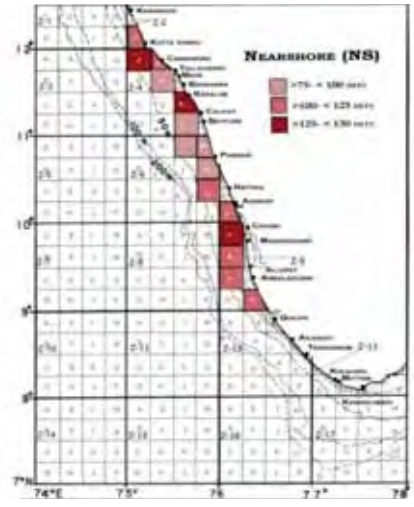
Investigation on Persistent Occurrence of PFZs along SE Arabian Sea

A targetted study to understand the potential fishing areas and their ecological relavence was carried out. For this anaysis, the fishing area off Kerala within (Latitude 7° to 13°N; longitude 74° to 77°30'E) was divided into 18 Zones (one degree grid) starting from Zone 1 in the region off Kasargod and concluding in Zone 17 in the southern part of Kerala.

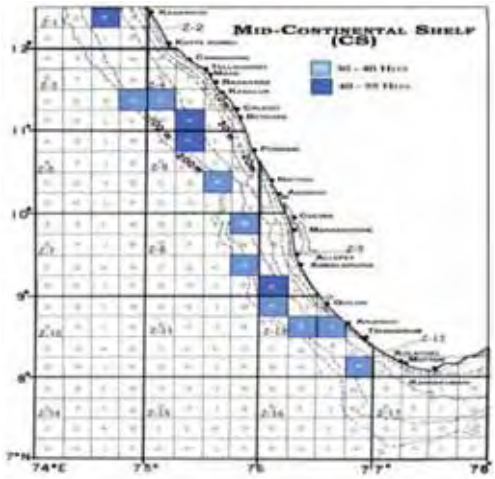
Each Zone was further divided to 16 sub-grids (area of each grid 225 nm^2;). Further, based on depth, the grids were classified into three categories namely nearshore (NS; less than 50m); mid continental shelf (MS; 50 to 200m depth) and continental slope (CS; greater than 200m depth).

169 advisories released by INCOIS during the period 2003 to 2007 (5 years) were used. The curved lines marking on the PFZ advisory chart are locations where the productivity is high due to Special Oceanic Processes (SOPs) such as cyclonic eddies, rings, meanders and fronts which are made based on the satellite imageries

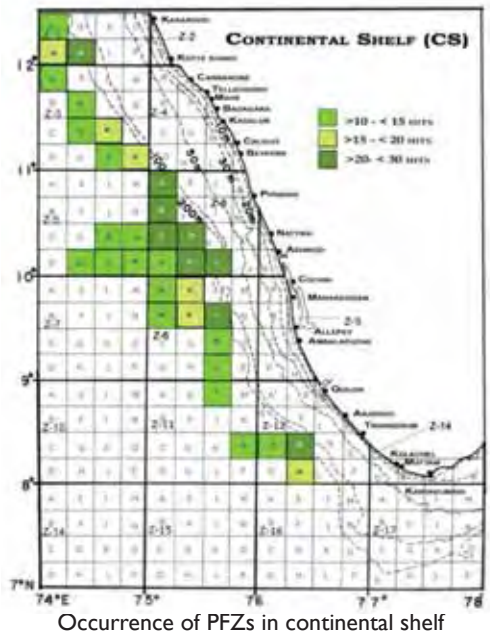
- This analyses clearly indicated that the nearshore (NS) regions of the Arabian Sea off Kerala with depths less than 50m occurred more (51% of the total observations) in the PFZ advisory maps than the mid continental shelf (MCS) region and the continental slope (CS).
- Also, the northen regions of Kerala had persistent PFZ areas especially in the region between Calicut and Kannur.
- The relatively high river discharges in the area and presence of high nutrient content in the discharges because of high mangrove afforestation are likely causes for the persistent occurrence of PFZs in these regions.
- The coastal area between Beypore and Kannur (Lat 11° to 12°N; Long 75° to 75°50'E), was the most productive followed by Zone 9 (off Kochi-Alleppey)
- One common feature of these three grids is that all the three depth contours namely 10, 20 and 30m pass through these grids. Moreover, in the northern grids, rivers like Korapuzha, Kuttiyadi, Kallayi, Kavvayi, Kuppam and Valapattam flow to the Arabian Sea in these areas.
- The region off Kochi-Alleppey is also known for the formation of "mud banks" which has unique features and these regions also support good fisheries.
- In the MS area, grids 4H (Lat 11°00' to 11°15') and 6E (Lat 10°45' to 11°00') lying between the same Long 75°30' to 75°45' (between Ponnani and Calicut) were the most frequent.
- In the CS grids lying in the region north off Kochi and south off Beypore were most frequent.
- PFZs rarely occurred in the grids away from the 200m depth contour.



Occurrence of PFZs in the near-shore areas



Occurrence of PFZs in the Mid continental Shelf



Occurrence of PFZs in continental shelf

Out Reach Activities

World Environment Day Celebrations:

The CMFRI, Kochi supported by science promoters like Marine Biological Association of India (MBAI) and the World Wide Fund for Nature (WWF,

India), and a private green energy company, the Petronet LNG, organized a mega event to promote eco-friendly activities to motive everyone to be a partner in Green Economy drive on June 05, 2012 at CheraiVillage in Vypin Island of Kerala, India. The UNEP theme, WED 2012 - GREEN ECONOMY: DOES IT INCLUDE YOU? was popularized. Of the 9000 participants in the competition, CMFRI was one among the 32 short listed for finalists. The activities lead by FEM Division carried out in a coastal village are given below.

Cherai is a coastal village where the marine ecosystem supports the livelihood of the majority of villagers through a multitude of activities like fishing, aquaculture and tourism. It is important that the negative impacts of these anthropogenic activities are made known through public awareness and participation. The Cherai beach is one of the major tourist spots in the district.

Children taking the pledge prepared by CMFRI on World Environment Day;

Following 10 activities were carried out on June 05, 2012 at Cherai Village:

1. Motivating children to be Builders of Green Village

- On June 5th school children of nearly 50,000 schools of Vypin Island pledged to conserve and protect nature at 9.30 am in their own schools led by their peers. This is the first mass event in the nation where school children pledge for the environment. The pledge was prepared by CMFRI.

2. Citizens Pledge for a clean, green, healthy and sustained environment

- Citizens vowed to adopt a responsible life style for promoting green economy. The ceremony lead by celebrities was held at Cherai Beach. Nearly 400 people participated in the pledge.

3. Beach installation art to promote awareness on proper waste disposal

- An installation art was created on the beach by sculptor Mr. Pramod who along with the public collected plastic bottles and waste from the beach to create a monstrous plastic octopus.
- The impressive 3 m tall sculpture created in 4-days using 125 kg of plastic bottles and carry bags depicted a terrifying octopus getting a stranglehold on our lives. The waste that we throw away so casually will become life threatening to us in future was the message conveyed.


An installation art using plastic bottles and other non biodegraded items collected from Cherai beach on WED-2012

4. Developing a Bio-shield

- Mangroves are nature's gift. They protect the coasts and provide a multitude of services to the ecosystem. On WED-2012, 5000 propagules of local mangrove were collected and planted in weed bio-pouches nursery by children and local residents for eventual mangrove restoration.

5. Thematic live painting by famous artist and painting competition for children

- Renowned artist and national award winner Mr. T. Kaladharan did a live painting on the theme of green economy in front of children and the public. Hundreds of children participated in a painting competition and prizes were distributed to the best.

6. Live poem on the theme green economy

- Renowned poet and national award winning litterateur Mr. Sippi Pallipuram wrote a poem on green economy village and made everybody recite it.

7. Empowering women for taking up zero-carbon budget aquaculture activity

- Women-folk of the village were empowered to take up farming of oysters. Oyster farming is a zero carbon aquaculture technology developed by CMFRI.
- Oysters are also very rich in minerals and essential amino acids and are considered as a "Health Food".

8. Awareness on eco-friendly fishing techniques and green technologies

- An exhibition of live fish and eco-friendly fishing implements was organized to build up awareness among the villagers and fishers.
- The exhibition also included eco-friendly technologies for rainwater harvesting, vermicomposting, terrace farming, organic manures and weed based products.

9. Social forestry

- Nearly 1000 seedlings of common trees and bushes were distributed to villagers by the social forestry department.

10. Spreading awareness on WED 2012 concepts through an 800 km cycle expedition

- One of the villagers, Mr. Dipani, started on a cycling expedition to Goa, nearly 800 km to the north of Cherai Village, spreading the message of green economy to thousands of people *enroute*.

Climate Change

Data Repository and Analysis system developed under NICRA

National Initiative on Climate Resilient Agriculture of ICAR (NICRA)

The major theme of work by CMFRI was the assessment of spawning behavior of major fish species in marine environments with a view to harness the beneficial effects of temperature.

As part of development of database, length frequency, maturity, ova-diameter, food, fecundity, ovary weight, gut condition, spawning characteristics of 9 species of marine finfish/shellfish from south east Chennai, (1990-2012) and all the commercial species of crustaceans, cephalopods and finfishes from southwest (Mangalore) coast was digitised.

A Data Repository and Analysis system was developed at Madras RC of CMFRI for easy data entry, quick retrieval and analysis.

Under capture fisheries, studied the phenological changes especially on spawning of wild fish populations and assessed the changes in distribution and abundance of fish populations in relation to climate change. Catches of oil sardine and lesser sardines show increasing trend over past 20 years, corresponding with the increasing trend in SST along Tamilnadu coast and south west coast.

Significant changes were noticed in the spawning months of *Sardinella longiceps* from January - March during 1977-78 to June - July in 2011-12 along South east coast.

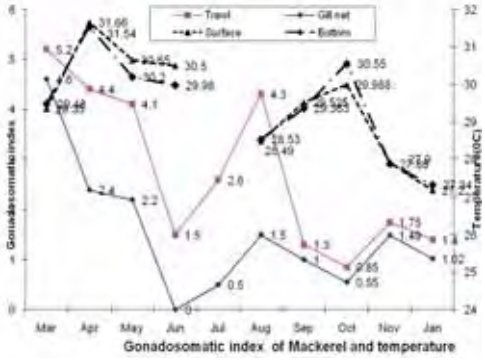
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1977-'78												
1980-'81												
1993-'94												
1996-98												
2002-'05												
2007-'10												
2011-'12												

	90-100% of females in stages 4 and above
	60-80% of females in stages 4 and above
	>60% of females in stages 4 and above

An SST of > 26^{0}C was found to be the preferred temperature for the spawning of Nemipterus japonicus. SST between 27.5 - 28.0°C may be the optimum for thread fin breams and when the SST exceeds 28.0°C, the fish shift the spawning activity to seasons when the temperature is around the preferred optima. Spawning season has shifted from September –October during 1990-99 to November –December during 2002-10.

Catches of mackerel showed increasing trend over past 20 years, corresponding with the increasing trend in SST along Tamilnadu coast. The mackerel, being a tropical fish, is expanding the boundary of distribution to depths as they are able to advantageously make use of increasing temperature in the sub-surface waters. Hence catches in the bottom trawl are increasing.

Relationship between SST and biological parameters of mackerel was studied at Tuticorin. Females dominated in all the months except in July and August. Correlation of gonado-somatic index and relative fecundity with temperature using SPSS showed that the correlation was not significant at 5 % level.



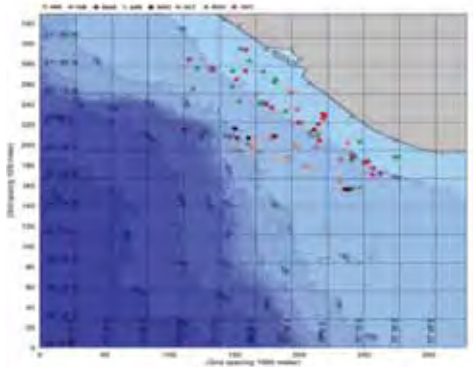
Gonadosomatic index of Mackerel and temperature

Adaptation of species with greater mobility was noted by extension/shift in distribution of fish horizontally and vertically. In general, low value, small sized, short-lived species with quick turnover of generations such as oil sardine and mackerel are able to adapt to seawater warming by extending their distributional boundaries to northern latitudes and deeper depths.

Skipjack tuna abundance is more in the inshore areas of 50m depth zone along Veraval coast during the winter months of November, December and January where as it is near the 100m zone during the summer months of March to May.

A historical environmental database (1960 - 2011) was developed. Analysis of SST of the last 105 years (1906-2010) indicates that rate of increase in minimum SST is pronounced at Kanyakumari.

Studies on the Ocean acidification showed that near shore areas are more vulnerable. An analysis of the instances of low pH values of surface waters in three depth zones viz 10m, 20m and 30m during the period 2005 to 2012 has indicated that in the year 2012, ph of surface water at 10m depth zone was low for a considerably longer period (21% of the total recorded observations) than in the previous years. Among the three depth zones, low pH values were recorded only in the surface waters at 10m depth zone indicating the influence of coastal landmass and anthropogenic activities. pH was always greater than 7 in the regions away from the shore.


Skipjack tuna abundance during various seasons

Details of instances when pH was less than 6 in the surface waters in the region off Kochi

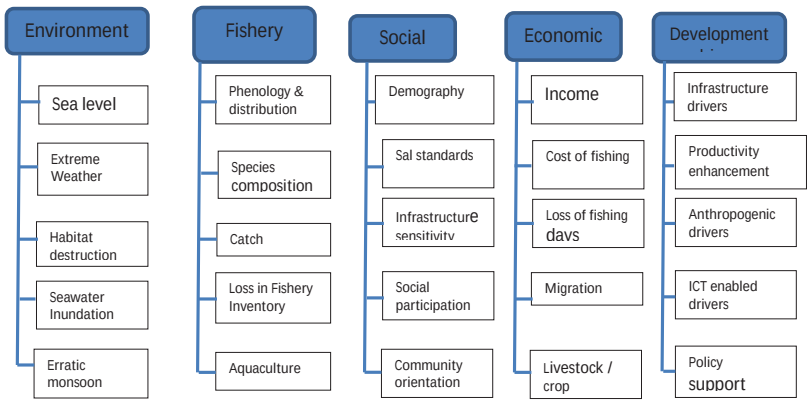
Year	No. of real time observations	No. of instances when pH was less than 6			Months when pH was less than 6
		10m	20m	30m	
2005	7	1	0	0	June
2006	7	1	0	0	September
2007	3	0	0	0	nil
2008	4	1	0	0	September
2009	4	1	0	0	September
2010	6	1	0	0	September
2011	8	1	0	0	December
2012	10	3	0	0	May, September, November

Mapping of carbon dioxide consumption and emission from boat building, net fabrication, fish catch, processing, ice plants, transportation to final fish consumption from various fishing harbours were carried out. Carbon sequestration studies were conducted. Green algae was found to have better CO_2 sequestering ability than the red and brown algae. The carbon sequestering efficiency was found unaltered even in high levels of dissolved CO_2.

Vulnerability Assessment studies along Cuddalore coast showed that of the nine villages selected and ranked for vulnerabiity index using the five variables (Environment, fishery, social, economic and development drivers) Pettodai and Reddiarpettai were ranked the most vulnerable. Pettodai and Reddiarpettai are situated within 100 metre from the seashore and habitat destruction and sea water inundation are visibly observed in these two villages.

Based on parameters like cyclones/winds, earthquakes, coastal/inland erosion and flooding, mangrove extinction, pollution, sea level rise and socio-economics of the fishermen; the coastal districts of Krishna and East Godavari were selected as the two most vulnerable ones of Andhra Pradesh.

In Kerala, of the nine coastal districts, Alapuzha was found to be the most vulnerable. Vulnerability of the fishing villages in Alappuzha district was done using PARS methodology. Of the three taluks assessed, Karthikappally (69.94), Ambalappuzha (64.31) and Cherthala (75.91) were found to be most vulnerable.



The level of awareness of fisherfolk to climate change is low which indicate that the fishers couldn't correlate environmental changes consequent to climate change to their livelihood. The 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.

Empowerment initiative of the coastal fishermen to harness positive impact of climate change was done at Karnataka. In Karnataka, invasion of saltwater in estuarine areas due to sea level rise and limited freshwater availability caused livelihood issues for fishermen due to non availability of estuarine fishes. Red snapper was identified as the most suitable and fast growing


Red snapper cage at Karnataka

species for Karnataka waters (under Capture Based Aquaculture) and a cage of 5m x 2.5m x 2m cage produced 500 kg of red snapper in 10 months with an average weight of 900g (range 650-1.200g) in 2013.

Under mariculture the response, especially of spawning, hatching success and larval survival of cultivable species of 1 species each of shrimp and sand lobster, 5 species of ornamental fish and 2 species of food fish and live feed organisms (3 species of microalgae, 1 species of copepod) to different seawater temperature and salinity was studied.

In *Trachinotus blochii*, 34^{0}C was favourable for reducing hatching duration and success, larval metamorphosis and growth, and juvenile growth. However, larval and juvenile success was very low at 34^{0}C. In Amphiprion nigripes and Amphiprion frenatus, the rate of hatching increased when water temperature was increased from 29^{0}C to 30^{0}C. However, mortality of eggs was noticed after 30^{0}C.

Highest hatching percentage of hatching of cobia eggs was obtained at 31^{0}C, while the lowest hatching percentage was in 34^{0}C. Faster growth of 6.47 mm was noticed in larva maintained at 32^{0}C at 40 dph whereas at 34oC all larvae shown retarded growth. Ambient temperature was 29-30.5oC.

Under technology demonstration, conducted 20 training programmes involving fishermen and officials on sea cage farming, *Etroplus* breeding and farming, high density fresh water fish culture at abandoned quarries, open sea cage farming and mussel farming.

Most of the Pokkali fields in Kerala are kept fallow due to less profitability. To demonstrate that farming can be done profitably in pokkali fields in Kerala, paddy farming was integrated with fish culture in four farms from Pizhala, Ezhikkara and Kadamakkudy. Farming was initiated in June, seeding done in July; Mullet (@ 3000 per farm) and pearl spot fingerlings (@ 250 no.s per cages-2x2x1.5 m cage) were stocked; Pokkkali was harvested in October; fingerlings were released into farms in November. Harvesting mela was conducted on 10th April 2013. A profit of ` 83,000/- was obtained per hectare after the first year.

Participatory approach of artisanal cage farming of pompano with a fishermen group of Marakayarpatinam gave good results. In 5 months, weight of fish increased from 62 g to 433 grams; farm gate price was 120 Rs/kg.

Results of pond culture of Pompano in a one acre pond having salinity of 8 ppt gave good results. After 240 days of culture about 1305 kg of fishes were harvested with a survival rate of 91.32% and FCR of 1:1.83 During the culture period, salinity gradually increased to 24 ppt.

Major facilities developed are procurement of 19.75 m Fishery Oceanographic research vessel FV Silver Pompano which can be used for real time studies on oceanographic parameters, chlorophyll abundance, variation etc., and trawl fishing to assess the abundance and behaviour of fish in relation to climatic variables. Other facilities developed are fish phenology lab and environmental chamber.

Pokkali field and harvest of Pearl Spot

FV Silver Pompano

Resource management, economic sustainability and socio economics

The estimated value of marine fish landings at landing centre level was worked out at ` 24,890 crores in 2012 an increase of 2.13 per cent over the year 2011. The unit price per kg of fish at landing centre was ` 74.17 an increase of 10.57 per cent. At the retail level, the estimated value was ` 38,562 crores registering an increase of 1.07 per cent over the year 2011. The unit price at the retail market level was `111.92 an increase of 6.88 per cent compared to last year.

The economic performance of various fishing methods were worked out. The state-wise analysis is given below.

Economics of fishing operations in West coast Kerala

The average operating cost per trip of a single day trawl operation in Puthiyappa worked out to ` 18,504 per unit with an average gross return of ` 34,648. The average capital productivity ratio worked out to 0.53.

For a multi-day trawl operation (less than six days) in Beypore, the average operating cost worked out to ` 1,16,963per unit with an average gross return of ` 1,90,307. The average capital productivity ratio worked out to 0.61. For a multi-day trawl operation (less than six days) in Puthiayappa, the average operating cost worked out to ` 1,18,133 per unit with an average gross return of ` 1,76,318. The average capital productivity ratio worked out to 0.67.

The multi-day trawl (> 6 days) operation in Munambam Fisheries Harbour, incurred an average operating cost of ` 1,16,963 per unit with an average gross return of ` 1,90,307. The average capital productivity ratio worked out to 0.61.

For a multi-day trawl operation of 2-5 days in Cochin Fisheries Harbour, the average operating cost worked out to ` 75,009 per unit with an average gross return of ` 1,05,225. The average capital productivity ratio worked out to 0.71. For a multi-day trawl operation of 2-5 days in Cochin Fisheries Harbour, the average operating cost worked out to ` 84,598 per unit with an average gross return of ` 1,36,080. The average capital productivity ratio worked out to 0.62.

For multi day gill netter operations in Munambam fishing harbour the average operating cost worked out to ` 2,69,462 per unit with an average gross return of ` 4,20,000. The average capital productivity ratio worked out to 0.61.

Economic indicators for mechanized trawlers in Kerala

Economic indicators	Single day trawling	Multi-day trawling (< 6days)	Multi-day trawling (> 6 days)
Total Operating Cost	18,504	95,986	1,06,565
Gross Revenue	34,648	1,47,766	1,67,568
Net income	16,144	51,780	61,004
Operating ratio	0.53	0.66	0.64

Karnataka

The total operating cost per trip of single day trawling was ` 5,320 and gross revenue was ` 6,180 and operating ratio was 0.86. For singleday purse seiners, the average fuel consumed per trip was 181 litre /trip. Fuel cost accounted 44.93 and crew wages accounted 44.90 percent of the total cost. The total operating cost was ` 15, 875 and the revenue was ` 16, 528 and the operating ratio was 0.96.

In Mangalore Fisheries Harbour, the average operating cost of Multi Day Trawler (8-10 days)per trip worked out to ` 2,68,660.The average operating cost of a purse seiner per trip was ` 1,24,750. The average operating cost of Single day trawler per trip was ` 7,800.The average operating cost of gill netter (2-3 days) was ` 19,500.

Goa

The total operating cost per trip of multi day purseiners (>6days) was ` 1.32 lakh and gross revenue was ` 2.24 lakh with operating ratio of 0.59. The average diesel consumption was 1,732 liters/trip. Both boat drivers and other crew were paid monthly salary in addition to food and bata given for each trip.

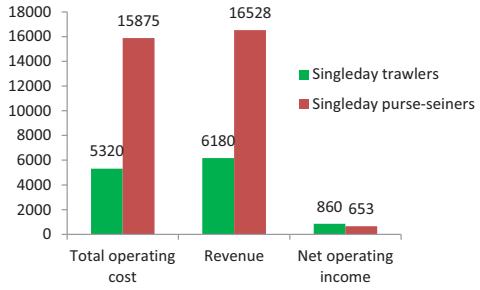
The multiday purse seiners in Goa undertook voyage fishing up to 15 days duration. The total operating cost was ` 1.91 lakh and gross revenue was

` 3.84 lakh with operating ratio of 0.50.

In the case of singleday trawlers operating in North Goa, the overall length was 30ft with engine horsepower of 40hp.The average diesel consumption was 130 litres per trip.The gross revenue was ` 9,061 and the total operating cost was ` 7,324 with operating ratio of 0.81. The main resources caught were flat fishes, crabs and non-penaeid prawns.

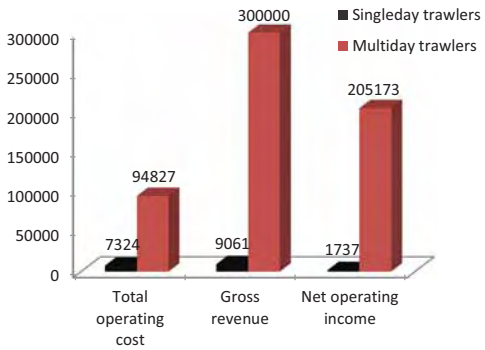
The multiday trawlers operating in Malim undertook fishing trips of 7 to 12 days duration. The horsepower of the engine was 180 hp with an average overall length of 42ft. The average diesel consumption was 1,514 litres. The average operating cost was ` 94,827 and gross revenue was ` 3 lakh. The operating ratio was 0.32. The major resources caught were penaeid prawns and squids.

In the case of motorized gillnetters operating in Donapaula, the OAL of boat was 38 ft with 10hp outboard engine. The average kerosene used was six liters costing ` 354/trip. The total operating cost was ` 7025 and gross revenue was ` 16,267 with operating ratio of 0.46.



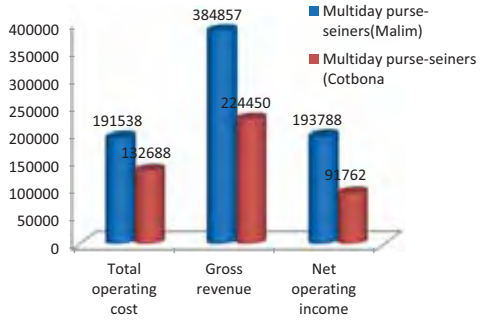
Economic performance of mechanized fishing units in Karwar (in `)

Trawlers landed at Malpe fishing harbour in Karnataka



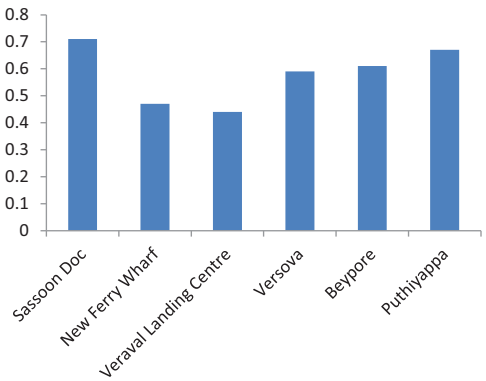
Economic performance of mechanized trawlers in Malim, North Goa (in `)

Multiday Purse seiner landed at Cotbona (South Goa) fishing harbour



Economic performance of multiday purseiners (>6 days) in Goa (in `)

Crushed ice stored in a trawler in Malim fishing harbour (North Goa)



Capital productivity ratios of multi day trawl operations in selected locations in India 2012-2013 (less than six days)

Economic indicators for different fishing units in Goa

Economic indicators	Single day trawling	Multi-day trawling (<6days)	Multi-day purse seine (> 6 days)
Total Operating Cost	7,175	94,827	1,32,688
Gross Revenue	12,664	3,00,000	2,24,450
Net income	5,490	2,05,173	91,762
Operating ratio	0.62	0.32	0.59

Maharashtra

Trawl

For a multi day trawl operation of 2-5 days in Sasoon Docks landing centre in the average operating cost worked out to ` 1,13,452 per unit with an average gross return of ` 1,58,678. The average capital productivity ratio worked out to 0.71.In New Ferry Wharf the average operating cost for the same type of trawlers worked out to ` 89,318 per unit with an average gross return of ` 1,88,356. The average capital productivity ratio worked out to 0.47. In Versova landing centre the average operating cost worked out to ` 84,443 per unit with an average gross return of ` 1,43,125 during the post monsoon. The average capital productivity ratio worked out to 0.59.

The average operating cost per trip of a multi day trawl (> 6 days) in Versova worked out to ` 91,368 per unit with an average gross return of ` 1,47,367 during the post monsoon period. The average capital productivity ratio worked out to 0.62. In New Ferry Wharf for a multi day trawl operation of more than six days, the average operating cost worked out to ` 1,50,715 per unit with an average gross return of ` 2,52,192. The average capital productivity ratio worked out to 0.58. In Naigaon, for the multi day trawl operation of more than six days the average operating cost worked out to ` 68,397per unit with an average gross return of ` 1,39,242. The average capital productivity ratio worked out to 0.53. In Sasoon Docks landing centre for the multi day trawl operation of more than six days in the coastal district of Greater Mumbai, the average operating cost worked out to ` 1,58,461 per unit with an average gross return of ` 3,80,408. The average capital productivity ratio worked out to 0.42.

Dolnetter

For a single day dol netter operation in the Naigaon average operating cost worked out to ` 1,512 per unit with an average gross return of ` 2,182 during the pre-monsoon. The average capital productivity ratio worked out to 0.59. For a single day dol netter operation, the average operating cost worked out to ` 2,415 per unit with an average gross return of ` 5,842 during the pre-monsoon. The average capital productivity ratio worked out to 0.41 whereas in thepost -monsoon season, the average operating cost worked out to ` 1,216 per unit with an average gross return of ` 4,554. The average capital productivity ratio worked out to 0.28.

For a multi day dol netter operation of 2- 5 days in the Naigaon, the average operating cost worked out to ` 1,61,251 per unit with an average gross return of ` 3,46,218 during the post monsoon. The average capital productivity ratio worked out to 0.46. In the pre- monsoon season, the average operating cost worked out to ` 83,621 per unit with an average gross return of ` 1,31,921. The average capital productivity ratio worked out to 0.63.

Gujarat

The operating cost of single day trawl operation in Veraval landing centre in the coastal district of Junagadh, worked out to ` 14,198 per unit with an average gross return of ` 30,358 during the post monsoon. The average capital productivity ratio worked out 0.47.

For a multi day trawl operation of less than six days in Veraval landing centre (Old light house), the average operating cost worked out to ` 44,465 per unit with an average gross return of ` 1,01,500. The average capital productivity ratio worked out to 0.43.

For a multi day trawl operation of more than 15 days in Veraval landing centre (light house), the average operating cost worked out to ` 1,84,600 per unit with an average gross return of ` 3,24,100. The average capital productivity ratio worked out to 0.57.

Economics of fishing operations in East coast

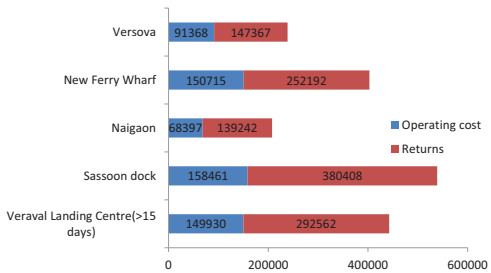
Andhra Pradesh

The capital productivity of single day trawling at Kakinada was found to be more efficient with an operating ratio of 0.25 than Bhariavapalem (B.V.Palem) at 0.31. The labour productivity was also comparatively higher at Kakinada at 124 kg per crew compared to 97 kg in BV Palem.

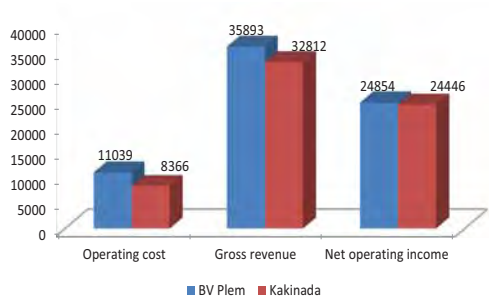
In multi-day trawling of 2-5 days duration, the economic performance was better in Kakinada compared to BVPalem with an operating ratio of 0.29 (0.33 in BV Palem) and labour productivity of 245 kg per crew (202 kg per crew at BV Palem.). However in multi-day trawling of more than six days duration the capital productivity was same in both the centres and the labour productivity was higher in Kakinada (313 kg per crew) compared to 303 kg per crew in BV Palem.

Economic indicators for multiday trawlers in Maharashtra

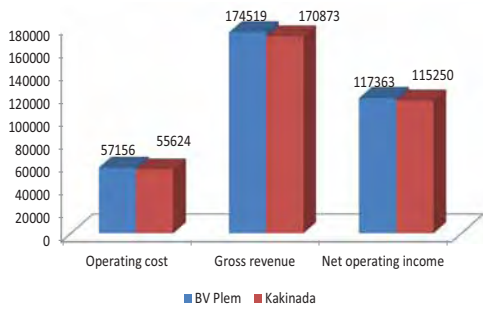
Economic indicators	Multi-day trawling (< 6days)	Multi-day trawling (> 6 days)
Total Operating Cost	95,738	1,17,235
Gross Revenue	1,63,386	2,29,802
Net income	67,649	1,12,567
Operating ratio	0.59	0.53



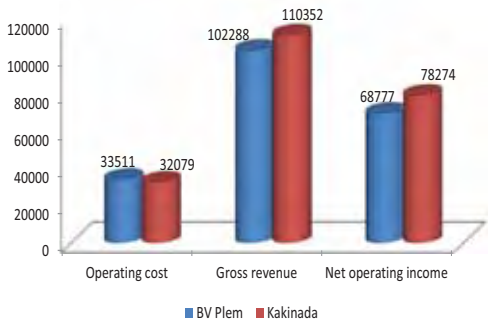
Capital productivity ratios of multi day trawl operations in selected locations in India 2012-2013 (more than six days)



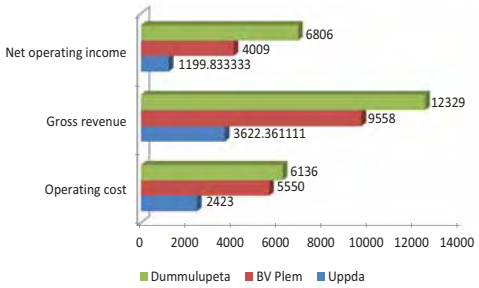
Economic performance of single day trawling Andhra Pradesh, 2012-2013



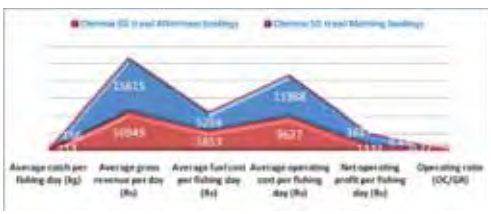
Economic performance of multi-day trawling (> 6days), Andhra Pradesh



Economic performance of multi-day trawling (2-5 days)



Economic performance of motorized gillnets, Andhra Pradesh



Comparison of morning and afternoon landings of singleday trawlers in Chennai

In Nizampatinam, the average OAL of the boat was15 meters with an engine capacity of 98 hp and 108 hp. The average crew size of less than 6 days operation was 7 and more than 6 days operation was 11. The fuel consumption varied from 850 liters per trip (<6 days) to 1200 liters per trip (>6days). Crew members realized an average of 20 per cent of total fishing income. Drivers get an additional share in addition to crew wage. The fuel cost accounted for 52 to 54 per cent of the total operating cost of mechanized trawlers. Labour cost constituted 29 to 32 per cent of the total operating cost.

Non-mechanized sector

Economic performance of non-mechanized fishing units in Andhra Pradesh

Centre	Operating cost (`)	Gross revenue (`)	Net operating income	Capital productivity	Catch per trip	Crew size	Labour Productivity
Uppda (gillnet)	377	753	377	0.50	33	3	11
BV Plem (trawl net)	1388	2484	1096	0.56	60	2	30
Dummulupeta (gillnet)	1170	1774	1000	0.66	58	3	19

Tamil Nadu

In Chennai, the average overall length (OAL) of the boat was 15 mts with an engine capacity of 120 hp. The average crew size of multiday trawler was 8. The fuel consumption was 1,100 liters per trip. Crew members realize an average of 20 per cent of total fishing income. Drivers get an additional share in addition to crew wage. The fuel cost accounted 58 per cent of the total operating cost of mechanized trawlers.

In Nagapattinam, the overall length (OAL) of the boat varied from 12-14 m with an engine capacity of 90 to120 hp. The average crew size of less than 6 days operation and more than 6 days operation was 5 & 7 respectively. The fuel consumption varied from 475 liters per trip (<6 days) to 1000 liters per trip (>6days). The fuel cost accounted 46 to 48.5 per cent of the total operating cost of mechanized trawlers. Labour cost constituted 25 to 31 per cent of the total operating cost. In mechanized fishing, crew members realized an average of 22 per cent of total fishing income whereas in motorized fishing crew & owner get 60 & 40 per cent share after deducting all the expenses from gross fishing income.

In Ramanathapuram, the average OAL of mechanized unit boat was found to be 14 to 18 metre. In majority of the mechanized boats Ashok Leyland engine (188 to 210 hp) and Innova engine (120 to 240 hp) are used with the mileage of 13 km per hour. The average operational cost incurred for fishing was ` 28,000, with the revenue generated was 47,500. The average motorized unit boat length was found 10 to 13 metre. In majority of the motorized boats Kirolskar engine (10 to 20 hp) are used with the mileage of 10 km per hour. The average operational cost incurred for fishing was ` 4,000, with the revenue generated was ` 10,000.

In Threspuram landing centre in Tuticorin the recorded average fish catch per boat was 672kg valued at ` 81,781 in 2012. After deducting all operational expenditures involved, the net income for the owner was ` 35,945 while the earnings for the crew was ` 32,712.

Operating ratios of different fishing units in Tamil Nadu

Fishing Method	Operating ratio
Single day trawling	0.78
Multi-day trawl (2-5 days)	0.73
Multi-day Gill Net (2-5 days)	0.55

Input-output analysis of Marine Fisheries at Tuticorin Fishing Harbour

One time survey was conducted to collect the information on the private/ public participants/institutions involvement in development and management of Tuticorin Fishing Harbour (TFH). Profile of the fishing harbor and selected sample trawl owners representing various size group was prepared.

Presently, there are 307 mechanized fishing boats registered/re-registered with State fisheries department/Marine Product Export Development Authority (MPEDA). The number of boats added into operational fleet has gone up from mere two in 1998 to a maximum of 49 in 2010.The length and breadth of the boat along with the engine power has increased tremendously over the period. In order to reach the distant fishing grounds, engine power is being increased every year with the present maximum level of more than 600hp.

Data collected for the period from 2010 to 2012 indicated that on an average 197 fishing days per annum with 16 days per month was recorded. The estimated efforts per month varied from 595 units in April to a maximum of 3,084 units in June, i.e. immediately after the annual fishing ban period. Though there were 307 registered trawlers at TFH, on an average 100 out of 244 berthed boats went for the recorded minimum fishing units (24) in the month of December, while the maximum of 156 units was registered during the month of July.

The estimated total catch at TFH during 2012 was 23,958 tons. Nearly 67% of the total catch was *Leiognathussp*., followed by unspecified by-catches. Highly priced fish species accounted for less than 15% of the total catch. The estimated value of the total landings was ` 1,265 million during 2012.

Regular monitoring and data collection from selected mechanized trawlers of different size groups is being carried out to generate bio-economic data for the input-output economic model being developed for TFH.

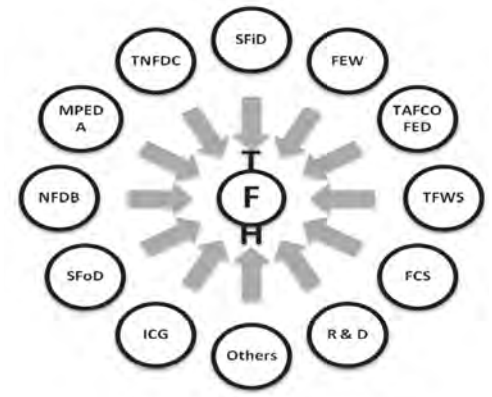
Fishery governance, livelihood, gender and welfare

Capacity development for responsible fisheries management in India

An orientation cum methodology workshop was conducted for the project team on responsible fisheries during 22-25 September 2013 at SEETTD, CMFRI headquarters, Kochi. The need for capturing the multidimensionality of capacity deficiency was identified to explore beyond behavioral and infrastructural dimensions.The protocols were developed after diagnostically scouting location specific instances of induced as well as sui generis fisheries management constellations. These protocols were pretested in different identified locations along the study states namely Kerala, Karnataka, and Tamil Nadu. After evaluation of the results of the pre-testing specificdata collection tools meant for different

Landings at Dhanuskodi

Landing centre at Rameswaram



Various participants involved in Tuticorin Fishing harbour (TFH)

Details of boats at Tuticorin Fishing Harbour

Year	Nos. regstd./ re-reg-std.	Length (m)	Breadth (m)	Engine power (HP)	Draft (feet)
1998	2	14.4	4.9	123	2.5
1999	20	15.0	5.1	123	2.6
2000	16	14.9	5.0	112	2.6
2001	48	15.5	5.2	117	2.8
2002	46	16.0	5.1	125	2.8
2003	44	16.5	5.3	136	3.2
2004	4	15.4	5.1	152	3.1
2005	6	15.3	5.2	160	2.3
2006	11	16.6	5.6	163	2.2
2007	4	17.5	5.7	207	2.8
2009	15	19.2	6.6	178	2.9
2010	49	18.3	6.0	241	3.2
2011	28	19.3	6.3	312	3.4
2012	14	19.8	6.4	366	3.4

Fishing effort at Tuticorin Fishing Harbour

Fishing Months	Nos. berthed at TFH	Fishing Days/ Month	Fishing units engaged per month		
			Total	Min	Max
January	238	16	1454	55	134
February	236	19	1565	48	116
March	234	23	1930	50	119
April	233	9	595	38	101
May	236	2	245	91	101
June	246	23	3084	85	152
July	250	21	2479	59	156
August	252	16	1984	79	150
September	252	14	1615	57	150
October	252	22	1957	31	136
November	251	19	1587	28	546
December	251	13	1010	24	129
Total	-	197	19505	644	1990
Average	244	16	1625	54	166

stakeholders like fisher folk, line departments, policy makers were designed to identify not only Capacity Deficiency but also Information Needs. The various research dimensions that delineate capacity include conservation orientation , skill and knowledge gaps, gender gaps, HRD gaps, epistemological divide, digital divide, need hierarchy, perceived attributes of governance regimes , community dynamics, linkage mechanisms, media support and determinants of institutionalization as well as the research –policy interface.

As a test case a preliminary study was conducted on the three-four day rule, which is a unique management mechanism initiated as part of district administrative orders that allows mechanizedfishing vessels tofish for three days a week while small-scale fishers couldfish on the remaining four days, being implemented in the Palk Bay and Gulf of Mannar (GoM) region of Ramanathapuram District since 1993. It was found that the regulations were formulated by fishermen organizations and boat owners' associations themselves, to avoid conflicts in thefishing grounds. The Assistant Directors at the district levels are responsible for issuing tokens to mechanizedfishing vessels on a daily basis, before they venture into the sea. These tokens are also used to distribute subsidized fuel, to maintain law and order, and implement the three-four day rule. Mechanized fishing vessels are not allowed to venture into the sea without a token.

The tools to assess Capacity deficiency for Ecosystem Based Responsible Fisheries Management were administered on stakeholders representing Fisheries Department, NGOs, SHGs, private organization and fishermen organizations. Fisheries Department expressed the need for training on stock assessment methodology to the officials involved in Fisheries Management. Almost all agencies expressed the need for training on know-how about Ecosystem Based Responsible Fisheries Management.

Another case study to track the variables along a historical trajectory that influence capacity development was initiated by revisiting the fishing villages which enacted the first-ever internationally aided fisheries modernization experiment called the Indo Norwegian Project 1951-62. The imperative of Technological change is found to have caused varied impact on capacity development dimensions across the three major harvest sectors and the allied value chain subsector.

Markets trade and environment

Supply chain management in marine fisheries sector

Average Fishermen's Share of the Consumer's Rupee for the major species in India

Species	Per cent to total landings	Average Retail prices (/kg)	Fishermen Share in Consumers Rupee
Oil sardine	18.28	48	64.58
Penaeid prawns	6.42	350	69.14
Ribbon Fishes	6	89	53.93
Croakers	5.43	89	58.43
Threadfin breams	5.36	56	57.14
Indian mackerel	4.32	74	67.57
Non-penaeid prawns	4.19	140	64.29
Other sardines	3.72	36	72.22

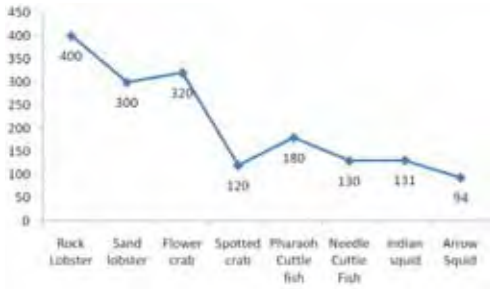
Silver Bellies	3.49	38	65.79
Bombay Duck	2.93	68	45.59
Squids	2.34	143	65.73
Scads	2.32	82	58.54
Catfishes	2.26	78	62.82
Cuttlefishes	2.24	138	66.67
Other clupeids	2.15	42	64.29
Other carangids	1.97	84	59.52
Lizard Fishes	1.78	41	63.41
Anchovies	1.73	61	50.82
Soles	1.57	60	70

Price integrations and marketing efficiency

The price integrations and marketing efficiency of the major markets across the coastal states are given below.

(a) Tamil Nadu

Analysis of fish price behavior at Chennai landing centre showed that the average minimum price was recorded for oilsardine at ` 44 per kg at landing centre and ` 59 per kg in retail market followed by Malabar anchovy (` 44 and ` 58 per kg in landing centre and retail market respectively) and the maximum for narrow barred seer fishes at ` 403 per kg in landing centre and ` 442 per kg in retail market followed by Black pomfrets and Giant sea perch (` 386 and ` 430 per kg in landing centre and retail market respectively).



Average marine fish prices in Chennai landing centre

Varieties like silver pomfret (93%), Cobia (92%) and giant sea perch (91%) and black pomfret (92% of the consumer rupee) gave more than 90% of the consumer rupee to the fishermen indicating very efficient marketing system existing for these premium varieties in Chennai markets. Fishermen earned nearly 70 per cent of the consumer rupee for Indo pacific seer fish, snappers, groupers, tuna, mullets, milk shark, cat fish and croakers.

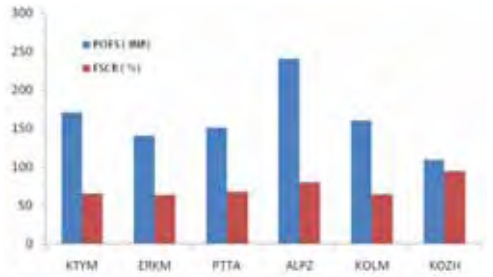
The price spread between landing centre and retail price in Ramanathapuram district worked out to be ` 90 for seerfish and milk shark, which is the highest. In Ramanathapuram district of Tamil Nadu the price of one kg size of lobster (*Panulirus ornatus*) locally called as manisinghi is ` 2,700 during january 2013, whereas the price of 500 size of lobster is ` 2,000 per kg. Hence there is a price difference of ` 700 between 500 g and one kg size of lobster

(b) Karnataka

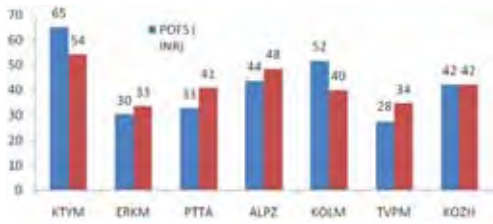
In Mangalore the fish prices varied from ` 14 /kg for oilsardines (small) to ` 625/kg for silver pomfrets (large) at the landing centre. At retail level the lowest prices were for oilsardines and White sardine (` 40/kg) and highest price was for Silver pomfret (large) at ` 700/kg. The highest price spread was for Silver pomfret (medium) at ` 125 /kg followed by Chinese pomfrets (medium) at ` 115/kg. The lowest price spread were for silver bellies (` 8/Kg) redfilament threadfin bream (medium) at ` 12/kg and Ribbon fish (small) at ` 10/kg. The fishermen's share in the consumer's rupee varied from 35% for oil sardines to 92.7 per cent for large sized Seer fishes. The highest price spread was for silver pomfret (medium) at ` 125 /kg and the lowest was for silver bellies at ` 8/kg.

Transportation of seer fishes in Rameswaram

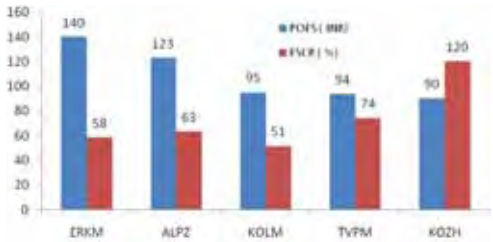
Wholesale fish market at Margao(Goa)



Comparison of prices at the point of First Sales and fishermen's share of Consumers' Rupee across different districts for Black Pomfrets



Comparison of prices at the point of First Sales and Fishermen share of Consumers' Rupee across different districts for Oil Sardine



Comparison of prices at the point of First Sales and Fishermen share of Consumers' Rupee across different districts for Indian squids

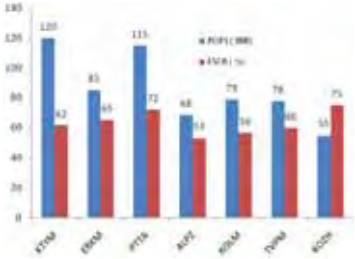
(c) Goa

In Goa at landing centre level, the lowest price was recorded for Malabar anchovy (small) at ` 13 /kg followed by oilsardines at ` 15/kg. The highest price was recorded for medium sized tiger prawn (` 358/kg) followed by Indo-pacific seer fish at `300/kg. At wholesale level the lowest prices werefor Malabar anchovy (small) at ` 16 /kg followed by oil sardines at ` 21 /kg. The highest prices were Tiger prawn (` 425/kg) followed by Silver pomfrets (` 315/kg). At retail and terminal markets also the lowest was for Malabar anchovy (small) at ` 25 /kg followed by oil sardines at ` 41 /kg. The highest prices at retail and terminal market were for tiger prawns at `538 and ` 550/kg respectively. The highest price spread was for narrow barred seer fish at ` 207/kg and the lowest was for Malabar anchovy at ` 13/kg. The fishermen's share in the consumer's rupee varied from 37% for oil sardines to 77.78% for False trevally.

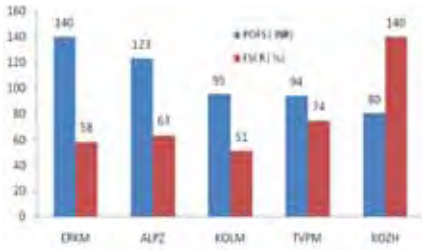
(d) Kerala

The comparison of prices at the point of first sales (landing centre prices) and the point of Last Sales (retail prices) and the Fishermen share of Consumers' Rupee for the major commercially important traded species across the different districts of Thiruvananthapuram (TVPM), Kollam (KOLM), Pathanamthitta (PTTA), Alappuzha (ALPZ), Ernakulam (ERKM) and Kozhikode (KOZH) are given below in following figures.

(i) Pelagics - Oilsardines
(ii) Pelagics - Indian mackerels
(iii) Demersals - Black pomfrets
(iv) Crustaceans - Indian white shrimps
(v) Molluscans - Indian squids



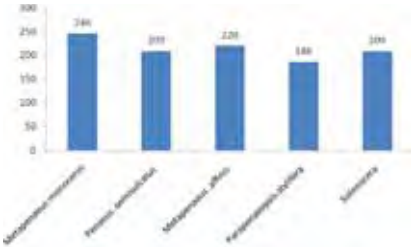
Comparison of prices at the point of First Sales and fishermen's share of Consumers' Rupee across different districts for Indian Mackerel



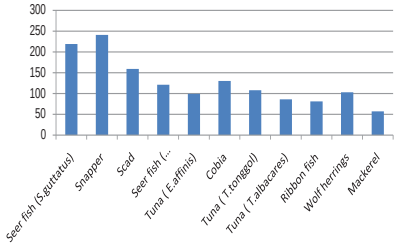
Comparison of prices at the point of First Sales and Fishermen's share of Consumers' Rupee across different districts for Indian white shrimp

(e) Gujarat

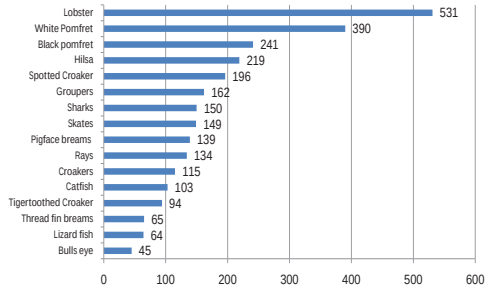
Analysis of the average retail market prices of crustacean resources in Junagadh district of Gujarat showed that the average price of the five crustacean species viz., *Metapenaeus monoceros*, *Penaeus semisulcatus*, *Metapenaeus affinis*, *Parapenaeopsis stylifera* and *Solenocera crassicornis* was ` 214 ranging from ` 246 for *Metapenaeus monoceros* to ` 186 for *Parapenaeopsis stylifera*.



Average retail market prices of Crustacean resources in Junagadh district, Gujarat



Average retail market prices of pelagic resources in Junagadh district,Gujarat

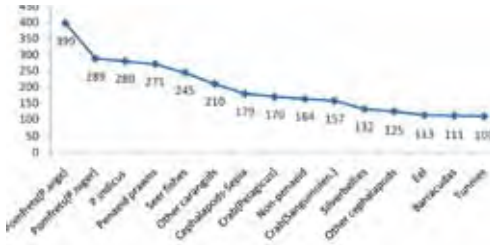


Average retail market prices of demersal resources in Junagadh district, Gujarat

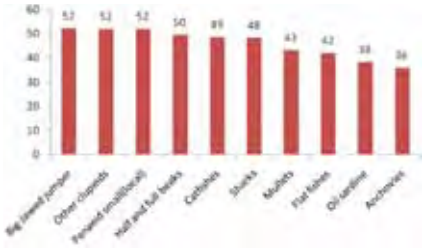
(f) Maharashtra

The fishermen's share of consumers' rupee of the major species traded in Maharashtra showed that pomfret registered a higher fishermen's share of 84 per cent followed by cephalopods and croakers.

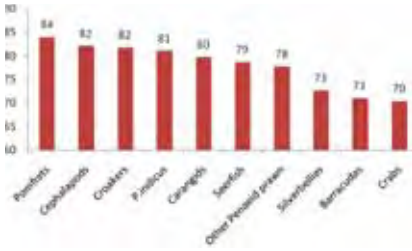
On the other hand anchovies, oilsardines and flatfishes registered a fishermen's share of consumer's rupees of less than 40 per cent.



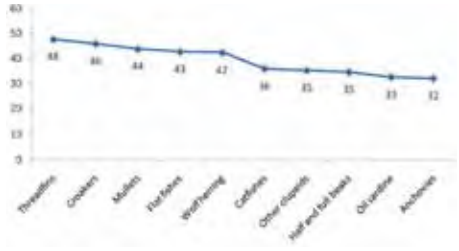
Average landing center prices of commercially important fish species in Maharashtra



Fishermen share of consumer's rupee for lowvalue fishes in Maharashtra



Fishermen share of consumer's rupee for higher value fishes in Maharashtra



Average landing center prices of commercially important fish species in Maharashtra

Artificial reefs

Triangular fish module

Deployment of triangular grouper module

Triangular grouper module

Artificial reefs are a kind of artificial facility to flourish biological resource in the sea. It defined as submerged structures placed on the seabed deliberately, to mimic some characteristics of natural reefs'. The design, shape and material of artificial reefs are very important which enhance the fishery resources. Artificial reef provide place for macro algal attachment and build into sea forest. It acts as spawning, feeding and hiding grounds for fishes and other organisms and refuges for many fish species. When artificial reef modules are provided with complexity of holes and crevices, in course of time some of the visitors become residents and start living in the artificial reef itself. The artificial reef gradually matures into a full-fledged ecosystem supporting these residents by providing feeding, breeding and nursery grounds, all in one place. This naturally leads to the enhancement of the biological resources in area where the artificial reef is deployed. Artificial reefs are the most common habitat modifying tools, especially in USA and Japan.

Role of CMRI in installing artificial reefs

CMFRI initiated the artificial reef programme in 1980's and deployed in Tamilnadu, Kerala and Minicoy coast. Deployment of artificial reefs at eleven sites along the coasts of six maritime districts of Tamil Nadu and monitoring those habitats was entrusted with CMFRI during 2006-2009 by the Fisheries Department of the Government of Tamil Nadu. CMFRI has successfully implemented the project with active participation of the fishermen and the impact of the artificial reefs on various aspects such as the maturation process of the reefs by underwater videography, the improvement in the fish catch for the reef areas, socio-economic betterment etc., were also studied in detail for the first time in India. On an average 206.9 t of fish were caught from a single artificial reef out of the 11 artificial reef deployed in addition to an estimated annual average catch of 1548.1 t from the non-artificial reef areas of Sathankuppam fishing village of Chennai. The hooks & line contribution was 70.65 t and the rest 136.25 t by gillnets from the reef area. Annual average gross income was Rs.110.45 lakhs and the net income was Rs. 98.9 lakh after deducting the operational cost, opportunistic cost, depreciation of craft, gear and the artificial reef structures (11.55 lakhs per annum) from the gross income. A total of 50 reefs were deployed/in process in Tamilnadu which make it a model state in Fisheries management. In all places there was increased catch rates up to even 10 times. This also may be considered as alternative rehabilitation option while allaying the fears of developmental activities like establishment of nuclear plants etc.

The Process of Deployment

Three types of artificial reef modules, the triangular fish module, the triangular grouper module and the circular ring shaped sea horse module are to be fabricated. Initially a bacterial biofilm will form over all the reef structures, followed by the settlement of algae. Later the biofoulers such as the barnacles, ascidians, gorgonids, sponges, coralline algae, sea fans, sea anemones etc. start settling on the reef structures and the adjacent areas will be invaded by sea urchins, sea cucumbers, star fishes, chanks and clams. A large variety of small coloured ornamental fishes will also occupy the reefs. The payback period is estimated to be 0.23 year which shows that the fishers can easily repay loan if they wish to avail for the erection of an artificial reef off their village on their own. In total, the artificial reefs help not only to improve the fishery resources but the socio-economic status of the traditional fishermen also.

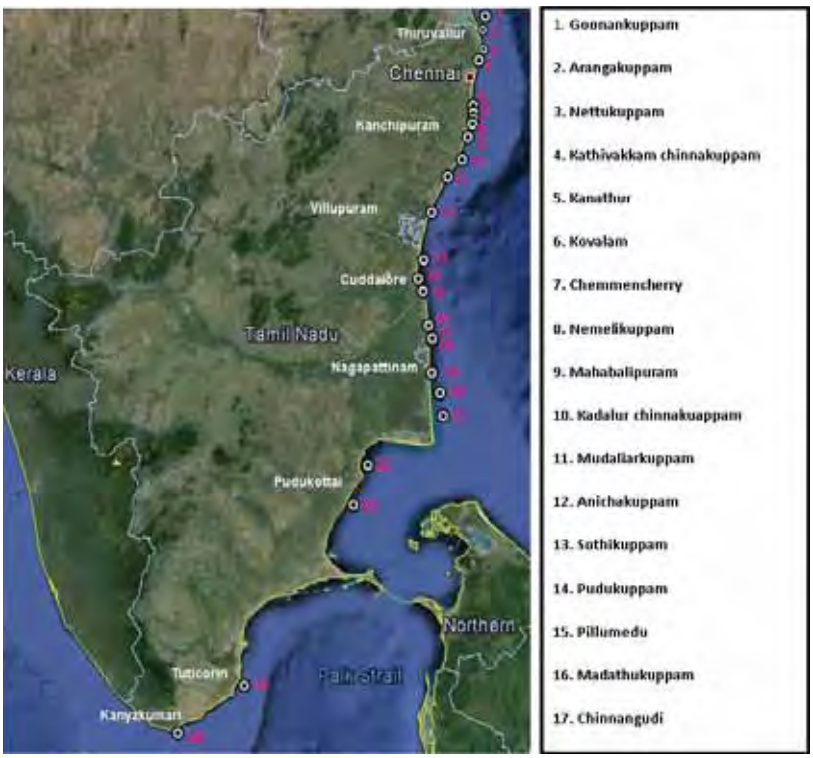
Benefits of Artificial Reefs

- Fishermen's catch, and thus income, increases by 50-150%.
- Reduces fuel-consumption of mechanized fishing boats.
- Increases variety of catch since different species of fish (including predatory fish and those from deeper waters) converge at the artificial reefs.
- Minimizes drudgery, searching time and hazards for fishermen.
- Provides excellent environment and substratum for marine plant life and other organisms to proliferate thus producing further links in the food chain.
- Artificial reefs are meant to serve as fish attracting or aggregating devices, in some cases they have been installed to prevent trawling and destruction of bottom habitat.

Fishes aggregating at artificial reef

Circular ring shaped sea horse module

Deployment of triangular module



Sites for deployment of artificial reefs during 2013

Partnerships

Dr. G. Syda Rao, Director CMFRI discussing with 'Sidi' adivasi tribal society president and members

1. Initiation of Tribal Sub Plan (TSP) for *Sidi* tribes

The Tribal Sub Plan (TSP) project on establishment of open sea cage farms for Sidi Adivasi Tribes of Gujarat was initiated from the Veraval Regional Centre of CMFRI. In the first phase a batch of 12 *adivasi* tribes were identified and given training in different aspects of cage culture. They we taken around the research centres of CMFRI wherever cage farming demonstrations were going on.

A sea cage farm was established for their benefit under TSP off Somnath in the Arabian sea with their whole hearted participation. The CMFRI's cage culture technology was totally transferred to them while they were working in the farm as partners/owners. Twenty cages of 5m dia were installed in the sea at a depth of about 7m facing Somnath temple. The lobster seed collected from the wild, weighing about 50-80 g were stocked during december 2012/Jan 2013 and fed well with trash fish. The tribes were well trained in fabrication of cages, mooring, net handling, feeding and all other requirement for the cage farm management.

After about 110 days the crop was ready for sale as an item of high valued live export. The total estimated production was about 2,500 kg which was being sold at a price of ` 1200/kg valued about ` 26 lakhs. They will have the opportunity of raising one more crop after September 2013 and can get equal production in this year. Thus CMFRI/ICAR has empowered their permanent livelihood from hunger to an income of about ` 15,000/ month / family, for 20 families in this phase. Hon.DG, Dr S. Ayyappan had graced the occasion by witnessing and launching the harvest in presence of officials of ICAR, Fisheries College, Veraval member of fishing community of that area.

2. Cadalmin™ Green Mussel extract (Cadalmin™ GMe) goes commercial

The Cadalmin™ Green Mussel extract (Cadalmin™ GMe) developed by CMFRI during 2010 has been commercialized. A MoU was signed with Accelerated Freeze Drying Company Pvt. Ltd., a FDA, ISO 22000 FSSC 22000:2011 certified flag Ship Company of Amalgam Group of Companies.

The MoU is valid for a period of ten years, and as per ICAR guidelines. This is the first nutraceutical produced by an ICAR institute. Cadalmin™ GMe contains 100% natural marine bioactive anti-inflammatory ingredients extracted from green mussel *Perna viridis*. The product is effective to combat arthritic pain and inflammatory diseases in human beings. Animal model experiments proved the efficiency and safety of this nutraceutical.

This product will be commercially produced and marketed by Accelerated Freeze Drying Company Pvt. Ltd. under their own brand name. The commercialization of Cadalmin™ GMe is significant to the mariculture industry and fishermen as this will enhance the demand to produce more green mussels, particularly along the west coast of India. The company plans to produce about 100 million capsules for domestic as well as for export purposes.

Cadalmin™ GMe was invented by Dr. Kajal Chakraborty, Scientist, Marine Biotechnology Division. All the members gathered on this occasion congratulated the Division and Scientist.

The MoU was signed by Dr. A. J. Tharakan, Chairman, Accelerated Freeze Drying Company Pvt. Ltd. and Dr. G. Syda Rao, Director, Central Marine Fisheries Research Institute on behalf of Indian Council of Agricultural Research (ICAR).

Cadalmin™ GMe

3. Cadalmin™ GAe is commercialized

A Memorandum of Understanding (MoU) was signed with Celestial Biolabs limited, Hyderabad for for commercial production and marketing of Cadalmin™ Green Algal extract (Cadalmin™ GAe). The MoU was signed by Dr. G. Syda Rao, Director, Central Marine Fisheries Research Institute (CMFRI) and and Dr. A.N. Singh, Managing Director, Celestial Biolabs limited, Hyderabad in the gracious presence of Dr. S. Ayyappan, Secretary, DARE and Hon'ble Director General, ICAR.


Cadalmin™ GAe

4. Collaborative Research Projects

(a) University of Tasmania, Hobart

CMFRI in collaboration with the University of Tasmania had completed a AISRF funded research workshop on Preparing for climate change for the marine systems for India and Australia under the Round Five (2009-11) .The back to back workshops in Hobart ,Australia and Cochin, India focussed on developing strategic research plan for climate change under which 10-12 collaborative research projects were developed. Consequently numerous novel initiatives were proposed and international linkages were developed with submission of collaborative research projects for were submitted for international funding.


Deligates of CMFRI and University of Tasmania, Australia

AISRF Research Project - A research project proposal on 'Sustainable marine food security and carbon challenges under a changing climate in Australia and India' was submitted under Australia-India Strategic Research Fund (AISRF) – Round Seven , 2013/15 (Indo-Australia Fund for Scientific and Technological Cooperation). The proposal is seeking research grant on the theme area of marine sciences .The project's expected cost is Rs. 67.47 Lakhs with duration of two years.The project was short listed and invited for presentation in the Programme Advisory Committee meeting of the Earth Sciences , Department of Science and Engineering Board on 13th June 2013 held at New Delhi. Dr.Stewart Frusher , University of Tasmania, Austarlia is the theme leader of the project and Dr.G.Syda Rao, ,Director,CMFRI leads the Indian side

(b) Michigan State University

Coastal SEES Research Project - A project proposal on Cascading Globalization and Resilient Marine Socio-Ecological Systems: Multi-scale Responses to Global Market Shifts in Indian Fishing Communities" for funding by US National Science Foundation's new program entitled Coastal Science, Engineering and Education for Sustainability (Coastal SEES) with collaboration from Michigan State University, USA and Dr.Mark Axelrod, Assistant professor, MSU as the team leader. SEETT Division of CMFRI represented the Indian partner.

MSU Research Project - A project proposal on "Resilient and sustainable communities and ecosystems that can adapt to external shocks brought on by global market forces and environmental changes" based on the discussions held between MSU and CMFRI faculties under the funding of US National Science Foundation Program on Dynamics of Coupled Natural and Human Systems. SEETTD Division of CMFRI represented the Indian partner.

(c) Belmont Forum and G8 Research Councils Initiative Research Project

Under the "Belmont Forum and G8 Research Councils Initiative on Multilateral Research Funding International Opportunities Fund CMFRI submitted a project titled titled "Global learning for local solutions: Reducing vulnerability of marine-dependent coastal communities" (GULLS) on the Theme section Coastal Vulnerability with Rhodes University, Grahamstown, CSIRO Marine and Atmospheric Research, Hobart, Central Marine Fisheries Research Institute, Cochin, University of São Paulo, São Paulo, National Oceanography Centre, Southampton, University of California Santa Cruz, Santa Cruz, University of Otago, Dunedin, University of Victoria, Victoria and Eduardo Mondlane University, Maputo. Belmont Forum Research Project - on 13th March, 2013. The duration of the project is three years with an expected funding of `165.60 lakhs and is under review . Dr. Kevern Cochrane, Rhodes University, South Africa is the theme leader of the project and Dr.G.Syda Rao, Director, CMFRI leads the Indian side. Dr. Shyam. S. Salim, Senior Scientist, SEETTD is the research programme co-ordinator of these initiative and institutional linkages developed

5. ChloRIFFS

Indian marine fisheries have all along remained buoyant to vagaries of fishing effort and other factors with the past decades recording consistently increasing trends despite the disaggregated analysis throw up new scenarios. The most imposing challenge before the planners and hence in the realms

of research feeding to policy designing is the real time assessment of harvestable potential and possible mechanism to forecast the near future availability.

Taking cue from the recent technological advances and dwelling deeply on the seminal research carried in the past, CMFRI has rededicated itself to forge the best of remotely sensed information and its physical infrastructure existing at various centres across the Indian coast towards construction of a paradigm aimed at assessing and forecasting marine fishery resources and harvestable potential. The green data supplied through the OCM sensed information and the brown data on the benthic studies involving detritus along side the derived data on secondary producers and higher level animals are planned to be modeled on a spatio-seasonal basis over a period of five years with a sound sea-truthing rigour planned at various regions of the EEZ.

CMFRI has planned to undertake this venture, through joint research with mandated organizations like Space Application Centre of Indian Space Organization (ISRO) and FSI towards achieving better results. The initiative is likely to herald the finalization of a hybrid modeling modules by the end of the first phase in three years starting from 2012-'13. After revalidating the output of these models, bio economic subsidiary models based on the market scenarios existing for different resources at different parts of the country would be developed alongside the fleet capacity availability on a dynamic basis, which would result in the realistic prediction of harvested catches for different of the year.

Major Events

Chlorophyll based assessment of Indian Marine Fishery Resources-CMFRI's research initiative meeting

Inauguration of renovated laboratory cum office building of Karwar RC

Cadalmin™ GMe has been commercialized on 5th October 2012 with Accelerated Freeze Drying Company Pvt. Ltd., a FDA, ISO 22000 FSSC 22000:2011 certified flag Ship Company of Amalgam Group of Companies.

Release of book "Marine Mammal Species of India" by Dr. S. Ayyappan, Director General ICAR New Delhi on 01.09.2012 at Karwar

The First e-book of CMFRI, "Herbarium of Common Seaweeds and Seagrasses of India" released on 30.04.2012 at New Delhi

National Consultation programme on 'Integrated Development of Uttara Kannada District on 01.09.2012. at Karwar

GAe goes commercial; MoU signed with Celestial Biolabs, Hyderabad on 14.02.2013 at New Delhi

Patents and ITMU

Intellectual property rights, which connote the rights available for the protection and exploitation of technology for the benefit of patentee, society, and government, occupy an important place in today's world. Intellectual property safeguards the rights of an inventor in his invention, and at the same time facilitates social and economic growth by providing an impetus to the advancement of science and technology. Central Marine Fisheries Research Institute pioneered in shaping a number of IP protected technologies and their commercialization, which are of direct or indirect benefits to the society and mankind.

Functions of ITMU in the Institute

The ITMU of CMFRI functions according to the ICAR IP guidelines

- IP protection, maintenance and management.
- To carry out internal examination before filing patents.
- Patent filing; invite expert opinion from patent attorney/ IPR expert.
- ITMC duly records the reasons for acceptance/rejection of each patent proposal.
- Correction/ rectification/ updation of primary information.
- Technology transfer/ commercialization.

Key Considerations Given by ITMU of CMFRI to Prioritize the Cutting-Edge Technologies

- Sustainable use of marine natural resources.
- Protection of public sector research can be used as defense mechanism to keep innovations in the public domain.
- IPR enabled technologies from marine resources could be utilized to negotiate/ bargain access to strategic research tools and technology from the private sector.
- Technology transfer of the IP protected technologies for greater benefits to society and mankind

The primary objectives of IP management in CMFRI are to protect the intellectual wealth generated through our research and commercialization of IPR enabled technologies through public private partnership leading to their efficient transfer. The salient achievements under ITMU of CMFRI during 2012-2013 are as follows.

(1) Transfer of IP-protected Technologies:

Two nutraceutical products (Cadalmin™ Green Algal extract and Cadalmin™ Green Mussel extract) for use against arthritis/joint pain have been commercialized to the private partners under ITMU of CMFRI. The details are as follows:

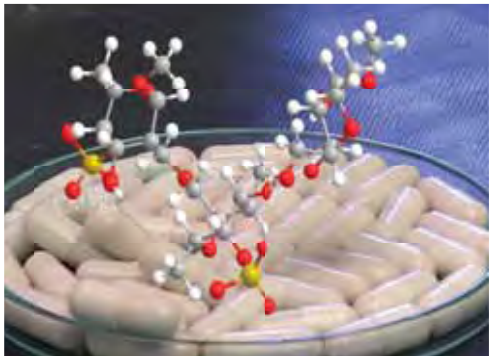
Dr. G. Syda Rao and Dr. A. N. Singh signing MoU for commercialization of CadalminTM GAe in the gracious presence of Dr. S. Ayyappan, Secretary, DARE and Hon'ble Director General, ICAR

Cadalmin™ Green Algal extract has been commercialized with Celestial Biolabs Limited, a Hyderabad based Pharmaceutical Company

Cadalmin™ GAe developed by CMFRI has been commercialised with Celestial Biolabs Limited on 14th February, 2013 at NASC Conference Hall in Delhi. The Memorandum of Understanding (MoU) was signed by Dr. G. Syda Rao, Director, Central Marine Fisheries Research Institute (CMFRI) and Dr.A.N. Singh, Managing Director, Celestial Biolabs limited, Hyderabad in the gracious presence of Dr. S. Ayyappan, Secretary, DARE and Hon'ble Director General, ICAR for commercial production and marketing of Cadalmin™ Green Algal extract (Cadalmin™ GAe).

Salient features of the technology

Cadalmin™ Green Algal extract (Cadalmin™ GAe) contains a unique blend of 100% natural marine bioactive anti-inflammatory ingredients extracted from selected seaweeds or marine macroalgae with a patented ecofriendly "green" technology (Indian Patent Application Nos. 2064/CHE/2010, 5199/CHE/2012). The product is effective to combat arthritic pain and inflammatory diseases in human beings. The active principles in Cadalmin™ GAe competitively inhibit pro-inflammatory mediators, resulting in decreased production of inflammatory prostaglandins and leukotrienes, and its activity was found to be superior to some of the synthetic non steroidal anti-inflammatory drugs available in the market. The mean lethal dose (LD_{50}) of Cadalmin™ GAe was found to be greater than 4000 mg/kg body weight of the mammalian subjects that indicate the safety of the product. As part of the further safety assessment of the extract, feeding of Cadalmin™ GAe even at a dose upto 2500 mg/kg body weight did not induce significant change in body weights, hematological indices, histopathological, and serum biochemical parameters between the control and treated groups indicating that it has no toxicity to the experimental animals. Cadalmin™ GAe was distributed to more than 400 patients suffering with chronic joint pain and arthritis, and questionnaire and clinical trial-based studies revealed that more than 98% of the respondents were satisfied with the product with about 70-85% relief in joint pain and arthritis. None of the respondents reported any side effects. The diagnostically useful autoantibody termed as Rheumatoid Factors (RFs), which are the most useful prognostic marker for rheumatoid arthritis, significantly reduced from more than 300 IU/mL to less than 20-35 IU/mL within a period of two months of consuming the product.



Cadalmin™ GAe developed from the seaweeds that are natural bounty of sea, possess valuable anti-inflammatory compounds that can offer relief to the millions of patients suffering from arthritis and associated joint pain

Cadalmin™ Green Mussel extract (Cadalmin™ GMe) has been commercialized with Accelerated Freeze Drying Company Pvt. Ltd., a FDA, ISO 22000 FSSC 22000:2011 certified flag Ship Company of Amalgam Group of Companies

Cadalmin™ Green Mussel extract (Cadalmin™GMe) developed by Central Marine Fisheries Research Institute during 2010 (Indian Patent Application

Cadalmin™ GMe goes commercial

Cadalmin™ GMe: A nutraceutical product from Green Mussel for use against arthritis

No. 2065-2066/CHE/2010, 5198/CHE/2012) has been commercialized on 5th October 2012 with Accelerated Freeze Drying Company Pvt. Ltd., a FDA, ISO 22000 FSSC 22000:2011 certified flag Ship Company of Amalgam Group of Companies. This is the first nutraceutical produced by an ICAR institute. The MoU was signed by Dr. A. J. Tharakan, Chairman, Accelerated Freeze Drying Company Pvt. Ltd. and Dr. G. Syda Rao, Director, Central Marine Fisheries Research Institute on behalf of Indian Council of Agricultural Research (ICAR).

Salient features of the technology

Cadalmin™ Green Mussel extract (Cadalmin™ GMe) contains 100% natural marine bioactive anti-inflammatory ingredients extracted from green mussel *Perna viridis*. The product is effective to combat arthritic pain and inflammatory diseases in human beings, and is an effective green alternative to synthetic non steroidal anti-inflammatory drugs and other products available in the market. Consuming Cadalmin™ GMe will avoid unfortunate side effect of these synthetic non steroidal anti- inflammatory drugs. The active principles in Cadalmin™ GMe isolated from P. viridis were competitively inhibit inflammatory cycloxygenases and lipoxygenase in an inflammation and oxidative stress reaction, resulting in decreased production of pro-inflammatory prostaglandins and leukotrienes, and its activity was found to be superior to the synthetic non steroidal anti-inflammatory drugs available in the market. *In vivo* animal model studies revealed that the active principles effectively suppressed the edema produced by the histamine, which indicates that they exhibit its anti-inflammatory action by means of either inhibiting the synthesis, release or action of anti-inflammatory mediators. The product is free from deleterious carcinogenic trans fatty acids, free radicals/ free radical adducts, low molecular weight carbonyl compounds, and long term study on animal model proved the efficiency and safety of this nutraceutical.

Cadalmin™ GMe from *Perna viridis*

(2) Application and maintenance of the IP assets of CMFRI

The following patents have been either submitted for complete application in the patent office (Chennai) and/or requested for examination:

Patent Title	Status of Application
Development of galvanized iron cage for finfish culture in open sea (Appl. No. 5196/CHE/2012)	Complete patent filed
Cement & concrete moulded artificial reef apparatus to aggregate marine fish (Appl. No. 5197/CHE/2012)	Complete patent filed
A Process to isolate anti-inflammatory principles from Green Mussel *Perna viridis* L. to prepare a stabilized nutraceutical supplement against inflammatory disorders and a product thereof (Appl. No. 5198/CHE/2012)	Examination request filed
A product containing anti-inflammatory principles from brown seaweeds and a process therof (Appl. No. 5199/CHE/2012)	Examination request filed
Growout pellet feed for silver pompano *Trachinotus blotchii* Lacépède) and a process therefore to incorporate essential nutritional elements in fish	Complete patent filed
A device and process to separate oyster meat from shell using pressurized steam	Complete patent filed

(3) Publication under Institute Technology Management Unit of CMFRI:

The ITMU unit of CMFRI handles matters related to create awareness (by publications) of IP issues and commercialization of viable technologies. The publications under ITMU are as follows:

- Intellectual Property Rights: A Perspective in Marine Fisheries and Mariculture. 2013. Kajal Chakraborty. CMFRI Special Publication No. 108, ISSN: 0972 – 2351. A contribution from the ICAR IP&TM funded project XI Plan scheme Intellectual Property Management and Transfer/ Commercialisation of Agricultural Technology, 153 pp.
- Publication of pamphlet on Open sea cage farming in high density polyethylene and galvanized iron cage (CMFRI pamphlet no. 16/2013)

(4) Participation in seminar/symposia/conferences/ technology promotion events /exhibitions / IPR workshops

- Participated and presented CMFRI Annual Progress report under ICAR IP & TM Cell funded project entitled "Intellectual property management and transfer/commercialisation of Agricultural technology scheme and up-scaling of existing components i.e., Intellectual Property Right (IPR)" in DOR Hyderabad, Annual Meeting-cum-Workshop organised by Zonal Technology Management - Business Planning and Development (ZTM-BPD) Unit, South Zone during 4th March 2013 at DOR, Hyderabad.

- Participated in the DST sponsored National training programme on "Entrepreneurship Development & Management" during 10th to 14th December, 2012 at Entrepreneurship Development Institute of India, at Ahmedabad.
- Participated in the NAIP sponsored Training Programme on "Intellectual Property Rights and Biotechnology" from September 21-25, 2012 held in NAARM, Hyderabad.
- Participated in the Society for Technology Management workshop held at Chennai.

(5) Other activities

- Executing the committed objectives under the IP & TM project entitled "Intellectual property management and transfer/commercialisation of Agricultural technology scheme" for augmenting facilities at the disposal of the IPR Cell of the Institute.
- Submission of proposal of Regional Incubation Centre/Business Incubation Units at CMFRI under ZTM-BPD, South Zone to ICAR IP & TM unit for incubating entrepreneurs to facilitate them starting business ventures, by providing infrastructures and technology based services.
- Submission of inputs with respect to the technologies of CMFRI for presentation in the various conference-cum-exhibitions listed below:

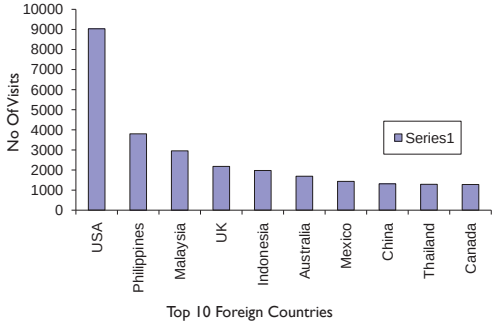
1) National Convention –The Next Frontier of Agri-Business and Technology held at Gandhinagar, Gujarat during 3-5th September, 2012
2) Emerging Kerala -2012 held at Hotel Le-Meridian, Kochi during the period from 12-14th September, 2012
3) Exhibition in connection with the international meeting for the 'Expert Consultation on Managing Trans-boundary Diseases of Agricultural Importance In Asia & Pacific" during 10-12th October, 2012 at NASC Complex, New Delhi
4) PORSEC International seminar during 05-09 November, 2012 at IMA House, Kochi, Exhibition
5) Aqua Aquaria India 2013 at Vijayawada of Andhra Pradesh organized my MPEDA during 2nd to 5th February, 2013
6) Kerala Agri Food Pro Meet 2013 at Jawaharlal Nehru International Stadium, Kaloor, Kochi during 18th to 21st February, 2013,
7) India-International Food and Agri Expo - 2013 at Jawaharlal Nehru International Stadium, Kaloor, Kochi during 22nd to 25th, February, 2013.

Library and Documentation

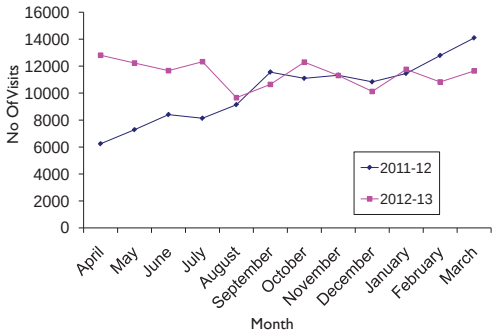
Global visibility of CMFRI publications through eprints@cmfri

The Library & Documentation Centre has developed it's open access Institutional Repository eprints@cmfri for Institutional publications and now recognized worldwide as a leading research information centre. The Institutional repository facilitates browsing by year of publication, author, department, subject category and document type. Advanced search is possible by author, title, subject and with many options. More than 350 full text articles contributed by the scientists and staff of CMFRI were uploaded during the period 2012-13, and are available in 'eprints@cmfri'. We have uploaded more than 9600 scientific papers. Now CMFRI Open Access IR places as

- 1st ICAR Institute reaching this stage
- 1st at National level & 3rd at Global level among the OA Institutional Repositories on Marine Science
- 304th place in Ranking of Web of World Repositories
- 90th place in Google Scholar



Usage of eprints@cmfri during 2012-13: Top 10 Foreign Countries



Usage of eprints@cmfri during 2011-12 and 2012-13

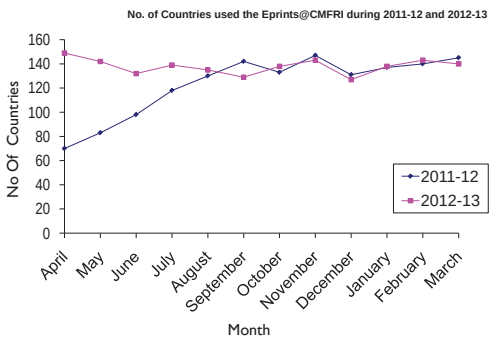
The usage of eprints@cmfri for the period April, 2012 to 31st March 2013 has been recorded. More than 198 countries used the repository and 137303 times visited and downloaded full text of scientific papers. Notably, visits from India are highest with 80,563 times followed by USA 9030, Philippines 3801, Malaysia 2953, UK 2181, Indonesia 1975, Australia 1692, Mexico 1431, China 1311, Thailand 1286 times and so on. The trend of usage of Institutional Repository is appended in graphs.

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. Now Indian Journal of Fisheries has got an increased International Impact Factor for 2013 from 0.04 to 0.195. NAAS Rating of Indian Journal of Fisheries has also been increased from 4.5 to 6.2.

OPAC and Online Journals

CMFRI library provides access to print and electronic resources in most user friendly manner. The Online Public Access Catalogue (OPAC) hosted in the Institute website provides details of all the documents available in the library which includes books, journals, current periodicals, reports, proceedings, theses & other publications. OPAC is open to all and can be searched from anywhere. During the year 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 subscribed covers records from 1971 onwards and Wiley online journals from Vol.1 onwards. Access to more than 3500 electronic journals on agriculture and allied subjects including Springer and Elsevier journals is made available to CMFRI HQs and RCs through Consortium for e-Resources in Agriculture under the NAIP, ICAR project.



No. of Countries used the Eprints@CMFRI during 2011-12 and 2012-13

Computerized circulation of books & journals continued to the members of library. Reference facility and reprographic services provided to the users. The library maintains an exchange relationship with various National and International Research Institutes, Universities and other organizations for Institute publications and receives 400 titles in exchange/complementary. The library maintains a free mailing list for free distribution of Institute publications. CMFRI Digital Library Information Service provides the latest information in the field of marine research and fisheries to all the scientists individually by email.

'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 released during 2012-13

1. Indian Journal of Fisheries: Vol. 59 Nos. 1-4, 2012
2. Marine Fisheries Information Service: Nos. 209 to 214
3. Cadalmin: CMFRI Newsletter Nos. 132-135
4. Special Publication: Nos. 107, 108, 109 & 111
5. Annual Report: 2011-12
6. Marine Mammal Species of India
7. Hand book of Prawns

Budget and Expenditure Statement 2012-13

The Budget & Expenditure under Non-Plan & Plan for the financial year 2012-13 in respect of CMFRI, Kochi (Figures in lakhs)

Budget Head	Non-Plan		Plan	
	Budget	Expenditure	Budget	Expenditure
Revenue				
Estt. Charges	3520.00	3520.00	0.00	0.00
OTA	0.25	0.25	0.00	0.00
TA	21.00	21.00	120.00	120.00
Other Charges	373.39	373.39	675.00	675.00
Works Repair & Maintenance				
Office Buildings	318.68	318.68	0.00	0.00
Residential Buildings	19.11	19.11	0.00	0.00
Minor work	3.87	3.87	0.00	0.00
Miscellaneous Expenses (including HRD)	21.70	21.70	30.00	30.00
Capital				
Equipments	8.20	8.20	108.23	108.23
Information Technology	5.00	5.00	49.70	49.70
Library	0.00	0.00	50.00	50.00
Vessel	0.00	0.00	104.00	104.00
Furniture & Fixtures	1.80	1.80	90.29	90.29
Works	35.00	35.00	316.00	316.00
Minor work	0.00	0.00	0.00	0.00
Tribal Sub Plan			35.00	35.00
TOTAL	**4328.00**	**4328.00**	**1578.22**	**1578.22**

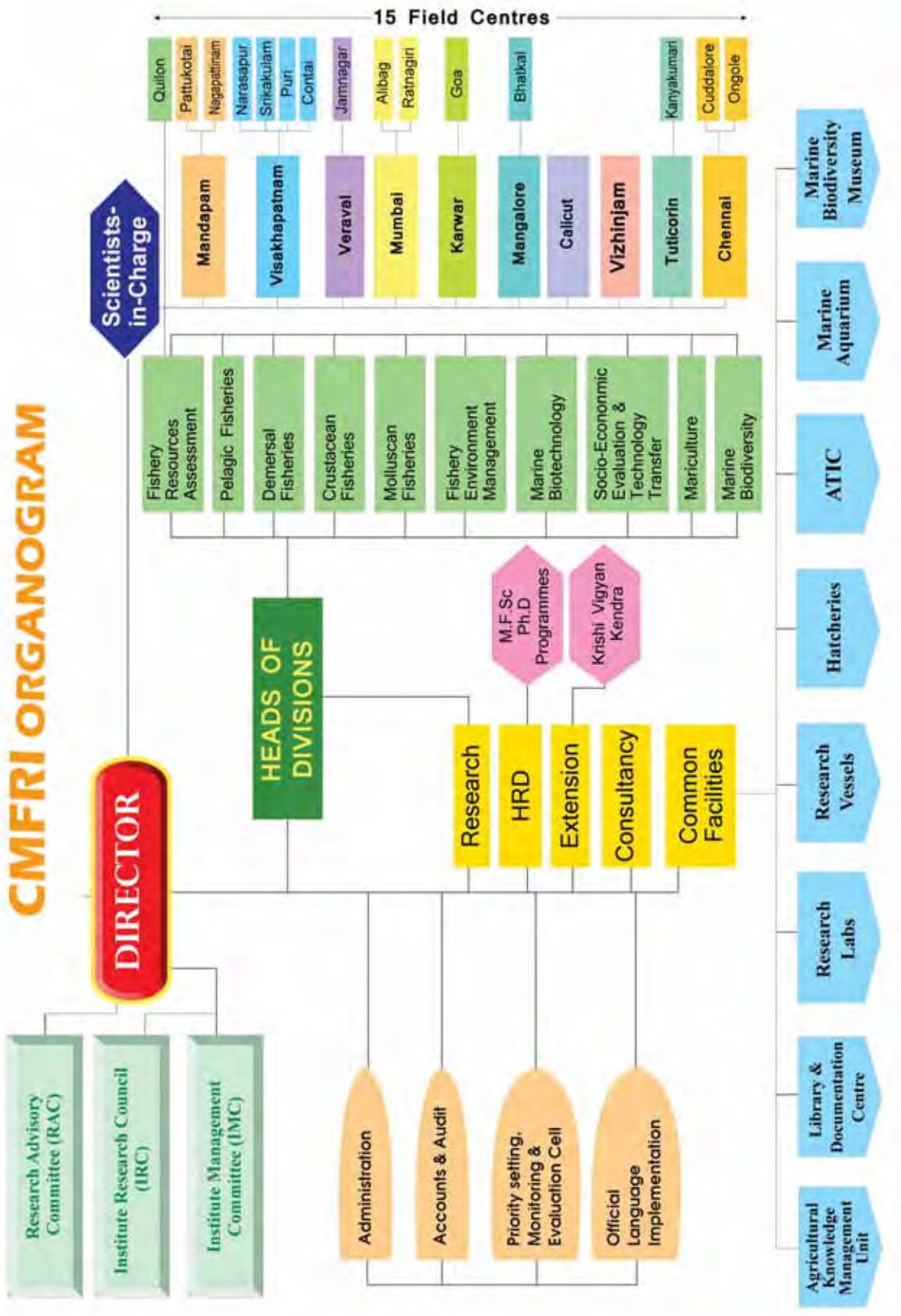
	Budget	Expenditure
Pension	2880.00	2880.00
Loans & Advances	30.00	9.19

Other Projects

Non-Plan Schemes	13.69
NAIP	167.56
NICRA	479.79
National Fund Schemes	11.05
Other Plan Schemes	26.93
Deposit Schemes	122.22
A.P. Cess Schemes	0.04
KVK, Narakkal	93.57
Consultancies	81.78

Revenue Receipts

Head	Target	Achievements
Revenue Receipts	70.00	130.39
Sale of Asset		1.12
Interest on Short Term Deposit		75.19
Recovery of Loans & Advances		44.10
TOTAL		**250.80**


CMFRI ORGANOGRAM
DIRECTOR
Research Advisory Committee (RAC)
Institute Research Council (IRC)
Institute Management Committee (IMC)
HEADS OF DIVISIONS
Research
HRD
Extension
Consultancy
Common Facilities
M.F.Sc Ph.D Programmes
Krishi Vigyan Kendra
Administration
Accounts & Audit
Priority setting, Monitoring & Evaluation Cell
Official Language Implementation
Scientists-in-Charge
15 Field Centres
Quilon
Pattukotai
Nagapattinam
Narasapur
Srikakulam
Puri
Contai
Jamnagar
Alibag
Ratnagiri
Goa
Bhatkal
Kanyakumari
Cuddalore
Ongole
Mandapam
Visakhapatnam
Veraval
Mumbai
Karwar
Mangalore
Calicut
Vizhinjam
Tuticorin
Chennai
Fishery Resources Assessment
Pelagic Fisheries
Demersal Fisheries
Crustacean Fisheries
Molluscan Fisheries
Fishery Environment Management
Marine Biotechnology
Socio-Economic Evaluation & Technology Transfer
Mariculture
Marine Biodiversity
Marine Biodiversity Museum
Marine Aquarium
ATIC
Hatcheries
Research Vessels
Research Labs
Library & Documentation Centre
Agricultural Knowledge Management Unit

Personnel

(Not a gradation list)

Scientific

Sl No	Name of Employee	Designation
	CMFRI, Kochi	
1.	Dr. G. Syda Rao	Director & Principal Scientist
2.	Dr. K.K. Vijayan	Principal Scientist & Head, MBTD
3.	Dr. K. Sunilkumar Mohammed	Principal Scientist & Head, MFD
4.	Dr. (Mrs.) V. Kripa	Principal Scientist & Head, FEMD
5.	Dr. P.U. Zachariah	Principal Scientist & Head, DFD
6.	Dr. G. Maheswarudu	Principal Scientist & Head, CFD
7.	Dr. P.C. Thomas	Principal Scientist & Head-in-charge, PFD
8.	Dr. T.V. Sathianandan	Principal Scientist & Head-in-charge, FRAD
9.	Dr. R. Narayanakumar	Senior Scientist Head, SEETTD
10.	Dr. (Mrs.) Josileen Jose	Principal Scientist
11.	Dr. (Mrs.) Imelda Joseph	Principal Scientist
12.	Dr. K. Madhu	Principal Scientist
13.	Dr. (Mrs.) K.S. Sobhana	Principal Scientist
14.	Dr. (Mrs.) Shoji Joseph	Principal Scientist
15.	Dr. E.M. Abdussamad	Principal Scientist
16.	Dr. P. Vijayagopal	Principal Scientist
17.	Dr. J. Jayasankar	Principal Scientist
18.	Dr. Boby Ignatius	Principal Scientist
19.	Dr. (Mrs.) Rema Madhu	Principal Scientist
20.	Dr. K.K. Joshi	Principal Scientist
21.	Dr. P. Laxmilatha	Principal Scientist
22.	Dr. (Mrs.) D. Prema	Senior Scientist
23.	Dr. C. Ramachandran	Senior Scientist
24.	Dr. (Mrs.) Molly Varghese	Senior Scientist
25.	Dr. (Mrs.) Somy Kuriakose	Senior Scientist
26.	Dr. V.P. Vipin Kumar	Senior Scientist
27.	Dr. T.M. Najmudeen	Senior Scientist
28.	Dr. Shyam S. Salim	Senior Scientist
29.	Dr. R. Jeyabaskaran	Senior Scientist
30.	Dr. Mini. K.G.	Senior Scientist
31.	Dr. Grinson George	Senior Scientist
32.	Dr. U. Ganga	Senior Scientist
33.	Dr. Rekha J. Nair	Senior Scientist
34.	Dr. Kajal Chakraborty	Senior Scientist
35.	Dr. S. Lakshmi Pillai	Senior Scientist
36.	Dr. N. Aswathy	Scientist
37.	Shri. N.K. Sanil	Scientist (Selection Grade)
38.	Smt. Rekhadevi Chakraborty	Scientist
39.	Shri. Wilson T. Mathew	Scientist
40.	Dr. V. Venkatesan	Scientist
41.	Dr. Pradeep M.A	Scientist
42.	Mrs. Sandhya Sukumaran	Scientist
43.	Dr. Amir Kumar Samal	Scientist (on probation)
44.	Shri. Vinay Kumar Vase	Scientist (on probation)
45.	Dr. Sekar Megarajan	Scientist (on probation)
46.	Smt. Karhireddy Shyamala	Scientist (on probation)
	Mandapam R.C	
47.	Dr. G. Gopakumar	Principal Scientist, Head-In-Charge, Mariculture Division & SIC
48.	Dr. I. Rajendran	Senior Scientist
49.	Dr. A.K. Abdul Nazar	Senior Scientist
50.	Dr. Rengarajan Jayakumar	Senior Scientist
51.	Shri C Kalidas	Scientist
52.	Dr. G. Tamilmani	Scientist
53.	Dr. M. Sakthivel	Scientist
54.	Shri Johnson B.	Scientist
55.	Dr. P. Rameshkumar	Scientist
56.	Shri Saravanan R.	Scientist
	Visakhapatnam R.C	
57.	Shri Shubhadeep Ghosh	Senior Scientist & SIC
58.	Shri Ritesh Ranjan	Scientist
59.	Smt. Biji Xavier	Scientist
60.	Smt. Muktha M.	Scientist
61.	Shri Loveson Edward L.	Scientist
62.	Shri Nenavath Rajendra Naik	Scientist
63.	Shri Pralaya Ranjan Behera	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	Scientist
	Madras R.C	
68.	Dr. K. Vinod	Principal Scientist & SIC
69.	Dr. A. Margaret Muthu Rathinam	Principal Scientist
70.	Dr. Joe K. Kizhakudan	Senior Scientist
71.	Dr. Vidya Jayasankar	Senior Scientist
72.	Dr. Sobha Joe Kizhakudan	Scientist
73.	Dr. P. Hemasankari	Scientist (Senior Scale)
74.	Dr. Satyanarayan Sethi	Scientist
75.	Dr. (Mrs.) R. Geetha	Scientist
76.	Dr. Srinivasa Raghavan V	Scientist
77.	Ms. Indira Divipala	Scientist
	Mangalore R.C	
78.	Dr. A.P. Dinesh Babu	Principal Scientist & SIC
79.	Dr. K. Vijayakumaran	(on Deputation) Senior Scientist
80.	Dr. Sujitha Thomas	Senior Scientist
81.	Dr. K.M. Rajesh	Senior Scientist
82.	Dr. Prathibha Rohit	Principal Scientist
83.	Smt. Bindu Sulochanan	Scientist (Senior Scale)
84.	Smt. Geetha Sasikumar	Senior Scientist
85.	Dr. P.S. Swathilekshmi	Senior Scientist
	Calicut R.C	
86.	Dr. P. Kaladharan	Principal Scientist & SIC
87.	Dr. Gulshad Mohamed	Principal Scientist
88.	Dr. P.P. Manoj Kumar	Principal Scientist
89.	Dr. P.K. Asokan	Principal Scientist
90.	Shri. K.P. Said Koya	Scientist (Selection Grade)
	Karwar R.C	
91.	Dr. K.K. Philipose	Principal Scientist & SIC
92.	Dr. Jayasree Loka	Senior Scientist
93.	Dr. S.R. Krupesa Sharma	Senior Scientist
94.	Dr. Senthil Murugan	Senior Scientist
95.	Dr. Divu Damodaran	Scientist
	Mumbai R.C	
96.	Dr. V.D. Deshmukh	Principal Scientist & SIC
97.	Dr. Veerendra Veer Singh	Principal Scientist
98.	Kum. Anulekshmi Chellappan	Scientist
99.	Shri. Purushottama G.B.	Scientist
100.	Shri. S. Ramkumar	Scientist
	Tuticorin R.C	
101.	Dr. M.S. Madan	Principal Scientist & SIC
102.	Dr. I. Jagadis	Principal Scientist
103.	Dr. M. Sivadas	Senior Scientist
104.	Smt. 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. R. Sathiadhas	Principal Scientist
110.	Dr. A.P. Lipton	Principal Scientist
111.	Dr. N. Ramachandran	Principal Scientist
112.	Dr. M.K. Anil	Principal Scientist
113.	Dr. B. Santhosh	Senior Scientist
114.	Smt. K.N. Saleela	Scientist (Senior Scale)
115.	Smt. S. Jasmine	Senior Scientist
	Puri FC	
116.	Dr. (Mrs.) Reeta Jayasankar	Principal Scientist
	KVK, Narakkal	
117.	Dr. Shinoj Subramannian	Programme Co-Ordinator

Technical

Sl.No	Name of Employee	Designation
	CMFRI, Kochi	
1.	Shri. N.Venugopal	T-9 (Technical Officer)
2.	Shri. P.K. Harikumar	T-7-8 (Technical Officer)
3.	Shri.V. Edwin Joseph	T-7-8 (Technical Officer-Library)
4.	Shri. J. Sreenivasan	T-7-8(Technical Officer)
5.	Shri. N.Viswanathan	T-7-8(Technical Officer-Civil)
6.	Smt. E.K. Uma	T-7-8 (TO - Hindi Translator)
7.	Shri. S. Haja Najeemudeen	T-6 (Technical Officer)
8.	Smt. K. Ramani	T-6 (Technical Officer)
9.	Dr.(Mrs.) S. Girijakumari	T-6 (Technical Officer-Library)
10.	Shri. P.S. Anilkumar	T-6 (Technical Officer)
11.	Shri. Mathew Joseph	T-6 (Technical Officer)
12.	Shri. C.K. Sajeev	T-6 (Technical Officer)
13.	Dr.V. Mohan	T-6 (Technical Officer-Library)
14.	Smt. P. Geetha	T-6 (Technical Officer-Library)
15.	Smt. G. Shylaja	T-6 (Technical Officer)
16.	Smt. E. Sasikala	T-6 (Tech. Officer - Hindi Translator)
17.	Shri. M.G. Sivadasan	T-5 (Technical Officer-Electrical)
18.	Shri. S.Yadavayya	T-5 (T.O. - Motor Driver)
19.	Shri. R. Ramachandran Nair	T-5 (T.O. - Motor Driver)
20.	Shri. K.K. Sankaran	T-5 (Technical Officer - Artist)
21.	Shri. M.P. Paulton	T-5 (Technical Officer -Training)
22.	Shri. L.R. Khambadkar	T-5 (Technical Officer)
23.	Smt. K.V. Rema	T-5 (Technical Officer)
24.	Smt. P.M. Geetha	T-5 (Technical Officer - Museum)
25.	Smt. Jenni. B	T-5 (Technical Officer)
26.	Smt. K.P. Salini	T-5 (Technical Officer)
27.	Shri. K.M.Venugopalan	T-5 (Technical Officer)
28.	Shri. K.K. Surendran	T-5 (Technical Officer)
29.	Shri.V.J. Thomas	T-5 (Technical Officer)
30.	Smt. P.K. Seetha	T-5 (Technical Officer)
31.	Shri. A. Padmanabha	T-5 (Technical Officer- Electrical)
32.	Shri. K.P. George	T-5 (Technical Officer)
33.	Smt. M.R. Beena	T-5 (Technical Officer)
34.	Shri. M.B. Seynudeen	T-5 (Technical Officer)
35.	Smt. Lata L. Khambadkar	T-5 (Technical Officer)
36.	Shri Sijo Paul	T-5 (Technical Officer)
37.	Shri. K.N. Pushkaran	T-4 (Senior Technical Assistant)
38.	Shri. P.K. Baby	T-4 (Senior Technical Assistant)
39.	Shri. A.Y. Jacob	T-4 (Senior Technical Assistant)
40.	Shri. K.G. Baby	T-4 (Senior Technical Assistant)
41.	Smt. Sindhu K. Augustine	T-4 (Senior Technical Assistant)
42.	Shri.V.K. Suresh	T-4 (Senior Technical Assistant)
43.	Shri. K.G. Radhakrishnan Nair	T-4 (Motor Driver)
44.	Shri. S. Nandakumar Rao	T-3 (Technical Assistant)
45.	Shri. D. Prakasan	T-3 (Technical Assistant)
46.	Shri. P.S. Alloycious	T-3 (Technical Assistant)
47.	Shri. K.C. Hezhakiel	T-3 (Technical Assistant)
48.	Shri. N.K. Harshan	T-3 (Technical Assistant)
49.	Shri. Baby Mathew	T-3 (Motor Driver)
50.	Shri Arun Surendran	T-3 (Technical Assistant)
51.	Shri Retheesh T.	T-3 (Technical Assistant)
52.	Shri. K.M. David	T-2 (Artist)
53.	Shri. C.V. Jayakumar	T-2 (Press & Editorial)
54.	Shri. Manjeesh .R	T-2 (Computer Application)
55.	Shri. P.R. Abhilash	T-2 (Exhibition Assistant)
56.	Shri David Babu	T-2 (Junior Technical Assistant)
57.	Shri M. Radhakrishnan	T-1 (Field Assistant)
58.	Shri M.P. Mohandas	T-1 (Field Assistant)
59.	Shri V.H.Venu	T-1 (Field Assistant)
60.	Smt. J. Sudhadevi	T-1 (Field Assistant)
61.	Shri K. Murugan	T-1 (Field Assistant)
62.	Smt. Sheela. P.P.	T-1 (Field Assistant)
63.	Shri P.V. Sunil	T-1 (Field Assistant)
64.	Smt. Shyamala. M.P.	T-1 (Field Assistant)
65.	Shri Shaji. A.K.	T-1 (Field Assistant)
	Quilon F.C	
66.	Shri Thomas Kuruvila	T-4 (Senior Technical Assistant)
	Mandapam R.C	
67.	Shri P. Chithamparam	T-6 (Technical Officer - Library)
68.	Shri N. Ramamurthy	T-6(Technical Officer - Museum)
69.	Shri I. Mendonza Xavier	T-5 (Technical Officer - Draughtsman)
70.	Shri P.M.A. Muheedu	T-5 (Technical Officer - Deckhand)
71.	Shri D. Anandan	T-5 (Technical Officer - Deckhand)
72.	Shri G. Subbaraman	T-5 (Technical Officer)
73.	Shri P. Muthukrishnan	T-5 (Technical Officer - Skin Diver)
74.	Shri A. Gandhi	T-4 (Senior Technical Assistant)
75.	Shri V. Sethuraman	T-4 (Senior Technical Assistant)
76.	Shri V. Sathyanesan	T-4 (Senior Library Assistant)
77.	Shri A.Vairamani	T-4 (Senior Technical Assistant)
78.	Shri A. Shanmughavel	T-4 (Senior Technical Assistant)
79.	Shri P.Villan	T-3 (Technical Assistant)
80.	Shri N. Boominathan	T-3 (Technical Assistant)
81.	Shri M. Asokan	T-3(Painter-cum-Polisher)
82.	Shri G. Hanumantha Rao	T-3 (Technical Assistant)\
83.	Shri M. Anbarasu	T-3 (Technical Assistant)
84.	Shri A. Palanichamy	T-I-3 (Technical Assistant)
85.	Shri K.U. Raman	T-I-3 (Motor Driver)
86.	Shri Vijaya Karthikeyan	T-2 (Electrician)
87.	Shri M. Palanichamy	T-2 (Electrician)
88.	Shri K. Shanmughanathan	T-1 (Field Assistant)
89.	Shri R. Selvakumar	T-1 (Field Assistant)
90.	Shri S. Murugaboopathy	T-1 (Field Assistant)
91.	Shri N. Ramakrishnan	T-1 (Field Assistant)
92.	Shri P. Rajendran	T-1 (Field Assistant)
93.	Shri S.M. Sikkender Batcha	T-1 (Field Assistant)
94.	Shri I. Syed Sadiq	T-1 (Field Assistant)
95.	Shri V. Muniasamy	T-1 (Field Assistant)
	Pattukottai F.C	
96.	Shri A. Kumar	T-6 (Technical Officer)
97.	Shri A. Ramakrishnan	T-5 (Technical Officer)
	Visakhapatnam R.C	
98.	Shri K. Ram Mohan	T-6 (Technical Officer)
99.	Shri Sailada Satya Rao	T-6 (Technical Officer)
100.	Dr. Biswajit Dash	T-6 (Technical Officer)
101.	Shri K. Narayana Rao	T-5 (Technical Officer)
102.	Shri R.V.D. Prabhakar	T-5 (Technical Officer)
103.	Shri J. Bhuvaneswara Verma	T-5 (Technical Officer)
104.	Shri M. Samuel Sumithrudu	T-5 (Technical Officer)
105.	Shri M. Prasada Rao	T-5 (Technical Officer)
106.	Shri C. H. Ellithathayya	T-5 (Technical Officer)
	Visakhapatnam R.C	
107.	Dr. Madhumita Das	T-6 (Technical Officer)
108.	Dr. Phalguni Pattnaik	T-6 (Technical Officer)
109.	Shri S. Nageswara Rao	T-4 (Senior Technical Assistant)
110.	Shri P.Venkataramana	T-4 (Senior Technical Assistant)
111.	Ms.Veena Shettigar	T-4 (Senior Technical Assistant)
112.	Shri Mamidi Satishkumar	T-3 (Technical Assistant)
113.	Shri K. Lakshminarayana	T-3 (Motor Driver)
114.	Shri Y.V.S. Suryanarayana	T-3 (Technical Assistant)
115.	Shri S. Tatabhai	T-2 (Junior Technical Assistant)
116.	Shri R.P.Venkatesh	T-2 (Fitter)
117.	Shri Sangaru Padmaja Rani	T-1 (Field Assistant)
118.	Shri Durga Suresh Relangi	T-1 (Field Assistant)
119.	Shri D. Bhaskara Rao	T-1 (Field Assistant)
120.	Shri D. Jaganna	T-1 (Field Assistant)
	Narsapur F.C	
121.	Shri N. Burayya	T-4 (Senior Technical Assistant)
	Contai F.C	
122.	Shri Pulin Behari Dey	T-5 (Technical Officer)
123.	Shri Swapan Kumar Kar	T-4 (Senior Technical Assistant)
124.	Shri Bijoy Krishna Burman	T-4 (Senior Technical Assistant)
	Puri F.C	
125.	Shri Sukhdev Bar	T-5 (Technical Officer)
	Veraval R.C	
126.	Shri Suresh Kumar Mojjada	T-6 (Technical Officer)
127.	Shri H.K. Dhokia	T-5 (Technical Officer)
128.	Shri Govindnath Chudasama	T-5 (T.O. - Motor Driver)
129.	Shri Mangalsingh Surajsingh Zala	T-5 (Technical Officer)
130.	Shri Vanvi Jayaanthilal Dayabhai	T-4(Senior Technical Assistant)
131.	Shri Ladani Amrutlal Arjunbhai	T-4 (Senior Technical Assistant)
132.	Shri Polara Jamnadas Premji	T-4 (Senior Technical Assistant)
133.	Shri Chudasama Ramji Raja	T-3 (Technical Assistant)
134.	Ms. Bharadiya Sangita Aravindkumar	T-3 (Technical Assistant)
135.	Shri H.M. Bhint	T-2 (Junior Technical Assistant)
136.	Shri Shiju P.	T-1 (Field Assistant)
137.	Shri S. Pradeep	T-1 (Field Assistant)
138.	Shri Makwana Somapitha	T-1 (Field Assistant)

	Jamnagar F.C	
139.	Shri Makadia B.V.	T-5 (Technical Officer)
	Madras R.C	
140.	Shri D. Pugazhendi	T-6 (Technical Officer)
141.	Shri S. Subramani	T-6 (Technical Officer)
142.	Shri P.Thirumilu	T-6 (Technical Officer)
143.	Shri S. Mohan	T-6 (Technical Officer)
144.	Shri S. Chandrasekhar	T-6 (Technical Officer)
145.	Shri S. Seetharaman	T-5 (Technical Officer)
146.	Shri Ahmed Kamal Basha	T-5 (Technical Officer)
147.	Smt. S. Gomathy	T-5 (Technical Officer)
148.	Shri N. Rudhramurthy	T-5 (Technical Officer)
149.	Shri C. Manibal	T-5 (Technical Officer-Deckhand)
150.	Shri S. Ganesan	T-5 (Technical Officer-Deckhand)
151.	Shri V.S. Gopal	T-5 (Technical Officer)
152.	Shri S. Rajan	T-3 (Technical Assistant)
153.	Shri K.S. Shaik Mohamed Yousuf	T-3 (Technical Assistant)
154.	Shri S. Selvanidhi	T-2 (Junior Technical Assistant)
155.	Shri M. Ravindran	T-2 (Junior Technical Assistant)
156.	Smt. I. Santhosi	T-2 (Junior Technical Assistant)
157.	Shri R. Sunder	T-1 (Field Assistant)
158.	Shri R.Vasu	T-1 (Field Assistant)
159.	Shri V. Joseph Xavier	T-1 (Field Assistant)
160.	Shri Bareen Mohamed	T-1 (Field Assistant)
	Kovalam F.L.	
161.	Shri R. Ponniah	T-4(Sr.T A -Electrician)
	Ongole F.C	
162.	Shri G. Sudhakar	T-4 (Senior Technical Assistant)
163.	Shri S.V. Subba Rao	T-3 (Technical Assistant)
	Cuddalore F.C	
164.	Shri M. Manivasagam	T-6 (Technical Officer)
165.	Shri P. Jaiganesh	T-3 (Technical Assistant)
166.	Shri T. Nagalingam	T-2 (Field Assistant)
	Tuticorin R.C	
167.	Shri K. Diwakar	T-6 (Technical Officer)
168.	Shri M. Bose	T-5 (Technical Officer)
169.	Shri R. Sekhar	T-5(Technical Officer -Deckhand)
170.	Shri S. Enasteen	T-5(Technical Officer -Deckhand)
171.	Shri S. Mohamed Sathakathullah	T-4 (Senior Technical Assistant)
172.	Shri U. Jeyaram	T-4 (Senior Technical Assistant)
173.	Shri N. Jesuraj	T-4(Skin Diver)
174.	Shri S. Sekar V. Rayer	T-4 (Skin Diver)
175.	Shri J. Padmanathan	T-3 (Technical Assistant)
176.	Shri K. Muthuvel	T-3 (Motor Driver)
177.	Shri Ashok Maharshi	T-3 (Technical Assistant)
178.	Shri B.Thangaraj	T-I-3 (Junior Technical Assistant)
179.	Shri S.K. Gurusamy	T-I-3 (Motor Driver)
180.	Shri K.P. Kanthan	T-2 (Junior Technical Assistant)
181.	Shri K. John James	T-1 (Field Assistant)
	Kanyakumari F.C	
182.	Shri A. Prosper	T-5 (Technical Officer)
	Srikakulam F.C	
183.	Shri V.Achuta Rao	T-5 (Technical Officer)
	Mumbai R.C	
184.	Shri Nilesh Anil Pawar	T-6 (Technical Officer)
185.	Shri A.D. Sawant	T-5 (Technical Officer)
186.	Shri R. Dias Johny	T-5 (Technical Officer)
187.	Shri B.B. Chavan	T-5 (Technical Officer)
188.	Shri J.D. Sarang	T-5 (Technical Officer)
189.	Shri Baban N. Katkar	T-5 (Technical Officer)
190.	Shri S.D. Kamble	T-5 (Technical Officer)
191.	Shri A.Y. Mestry	T-4 (Senior Technical Assistant)
192.	Shri Sujit S.K.	T-4 (Senior Technical Assistant)
193.	Shri D.G. Jadhav	T-4 (Senior Technical Assistant)
194.	Shri Jayadev S. Hotagi	T-4 (Sr.Technical Assistant)
195.	Shri Thakurdas	T-4 (Sr.Technical Assistant)
196.	Shri Punam Ashok Khandagle	T-3 (Technical Assistant)
197.	Shri Suresh Krishnaro Kamble	T-3 (Technical Assistant)
198.	Shri Sashikant R.Yadav	T-3 (Motor Driver)
199.	Shri Vaibhav Dinkar Mhatre	T-3 (Technical Assistant)
200.	Shri Umesh Hari Rane	T-2 (Jr.Technical Assistant)
201.	Shri Prabhakar Sankar Salvi	T-2 (Jr.Technical Assistant)
202.	Shri M.P. Jadhav	T-1 (Field Assistant)
	Ratnagiri F.C	
203.	Shri Bashir Ahmed Adam Shilodar	T-4 (Senior Technical Assistant)
204.	Shri D.D. Sawant	T-4 (Senior Technical Assistant)
205.	Shri Kishor Raghunath Mainkar	T-4 (Senior Technical Assistant)
	Aligbag F.C	
206.	Shri Ramesh B. Rao	T-4 (Senior Technical Assistant)
	Karwar R.C	
207.	Shri K.C. Pandurangachar	T-5(Technical Officer)
	Mandapam R.C	
208.	Shri C.K. Dinesh	T-5(Technical Officer)
	Karwar R.C	
209.	Shri Narayan G Vaidya	T-5 (Technical Officer)
210.	Shri S. Satyanarayan V. Pai	T-5 (Technical Officer)
211.	Shri C.G. Ulvekar	T-3 (Technical Assistant)
212.	Shri Narsimhulu Sadhu	T-3 (Technical Assistant)
213.	Ms. Sonali S.Mhaddolkar	T-3 (Technical Assistant)
214.	Shri Kodi Srinivasa Rao	T-3 (Technical Assistant)
215.	Shri Laxman Shanker Korabu	T-2 (Skin Diver)
216.	Ms. Dhanya G.	T-1 (Technical Assistant)
217.	Shri N. Selvakumar	T-1 (Field Assistant)
218.	Shri Rajendra D. Hulswar	T-1 (Field Assistant)
219.	Smt. Pramila Harish Borkar	T-1 (Field Assistant)
	Veraval R.C	
220.	Shri Fofandi Mahendrakumar	T-6 (Technical Officer)
	Goa F.C	
221.	Shri Prakash C. Shetty	T-4 (Senior Technical Assistant)
222.	Shri M.E. Durgekar	T-3 (Technical Assistant)
	Mangalore R.C	
223.	Shri S. Kemparaju	T-6 (Technical Officer)
224.	Shri B. Sridhara	T-5 (Technical Officer)
225.	Shri N. Chennappa Gowda	T-5 (Technical Officer)
226.	Shri Y. Muniyappa	T-5 (Technical Officer)
227.	Shri V. Lingappa	T-4 (Senior Technical Assistant)
228.	Shri M. Chaniappa	T-4 (Senior Technical Assistant)
229.	Shri R. Appayya Naik	T-4 (Senior Technical Assistant)
230.	Shri G. Sampathkumar	T-3 (Technical Assistant)
231.	Shri G.D. Nataraja	T-3 (Technical Assistant)
232.	Shri P. Harshakumar	T-3(Motor Driver)
233.	Ms. Lavanya S.	T-3 (Technical Assistant)
234.	Shri Kamarathullah Sahib. P	T-1 (Field Assistant)
	Bhatkal F.C	
235.	Shri Udaya V. Arghekar	T-5 (Technical Officer)
236.	Shri Ganesh Bhatkal	T-5 (Technical Officer)
	Calicut R.C	
237.	Shri V.A. Kunhikoya	T-6 (Technical Officer)
238.	Smt.V.K. Janaki	T-5 (Technical Officer)
239.	Shri M.P. Sivadasan	T-5 (Technical Officer)
240.	Shri K. Chandran	T-5 (Technical Officer)
241.	Shri P.P. Pavithran	T-5 (Technical Officer)
242.	Shri M.M. Bhaskaran	T-4 (Senior Technical Assistant)
243.	Shri K.C. Pradeep Kumar	T-4 (Senior Technical Assistant)
244.	Shri A. Anasukoya	T-4 (Senior Technical Assistant)
245.	Smt. M.V.Valsala	T-3 (Technical Assistant)
246.	Shri N.P. Ramachandran	T-3 (Technical Assistant)
247.	Shri C. Chandran	T-3 (Technical Assistant)
248.	Shri M.N. Sathyan	T-2 (Motor Driver)
249.	Smt. P. Renuka	T-1 (Field Assistant)
	Vizhinjam R.C	
250.	Shri S. Ramachandran Nair	T-5 (TO-Motor Driver)
251.	Shri K.K. Suresh	T-5 (Technical Officer)
252.	Shri K.T.Thomas	T-5 (Technical Officer)
253.	Smt.T.A. Omana	T-5 (Technical Officer)
254.	Shri Jose Kingsly	T-5(Technical Officer)
255.	Shri V.P. Benziger	T-5 (Technical Officer)
256.	Shri A. Udayakumar	T-5 (Technical Officer)
257.	Shri V.A. Leslie	T-5 (Technical Officer)
258.	Shri P. Hillary	T-4 (Deckhand)
259.	Shri C. Unnikrishnan	T-4 (Senior Technical Assistant)
260.	Shri B. Raju	T-3 (Technical Assistant)
261.	Shri K. Solaman	T-I-3 (Technical Assistant)
	KVK, Narakkal	
262.	Smt. P. Sreelatha	T-7-8 (Technical Officer)
263.	Shri B. Suresh Kumar	T-6 (Technical Officer - Training)
264.	Shri Shoji Joy Edison	T-6 (SMS)
265.	Shri Vijendra Kumar Meena	T-6 (SMS)
266.	Shri F. Pushparaj Anjelo	T-6 (SMS)
267.	Dr. Karikkathil Smitha Sivadasan	T-6 (SMS)
268.	Shri Vikas P.A	T-6 (SMS)
269.	Shri V.K. Manu	T-4 (Programme Assistant - Computer)
270.	Ms. Dipti N.V	T-4 (Programme Assistant - Laborator 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.	Smt. Christina Joseph	Assistant Administrative Officer
5.	Shri P. Krishnakumaran	Assistant Finance & Accounts Officer
6.	Shri Thomas Joy	Assistant Finance & Accounts Officer
7.	Shri P.V. Devassy	Assistant Administrative Officer
8.	Smt. C.M. Jenny	Assistant Administrative Officer
9.	Smt.V.K. Sobha	Assistant Administrative Officer
10.	Smt. Meera. K.N.	Assistant Administrative Officer
11.	Smt. Ponnamma Radhakrishnan	Assistant Administrative Officer
12.	Shri K. Ramadasan	Assistant
13.	Shri V.C. Subhash	Assistant
14.	Smt. M.G.Chandramathy	Assistant
15.	Smt. M. Safiyabi	Assistant
16.	Shri C. Jayakanthan	Assistant
17.	Shri P.P. Chandrasekharan Nair	Assistant
18.	Smt. Moly Lazer	Assistant
19.	Shri C.N. Chandrasekharan	Private Secretary
20.	Smt. N.R. Lethadevi	Private Secretary
21.	Smt. K.V. Sajitha	Personal Assistant
22.	Shri R. Chandrakesa Shenoi	Personal Assistant
23.	Smt. P.K. Anitha	Personal Assistant
24.	Shri C.D. Manoharan	Personal Assistant
25.	Smt. P.Vineetha	Personal Assistant
26.	Shri K.N. Murali	Personal Assistant
27.	Smt. Bindu Sanjeev	Personal Assistant
28.	Smt. K. Smitha	Stenographer Grade III
29.	Smt. Saritha L.	Stenographer Grade III
30.	Smt. Dhanya M.B	Stenographer Grade III
31.	Smt. G. Ambika	Assistant
32.	Smt. N.K. Suseela	Assistant
33.	Shri K. Baburajan	Assistant
34.	Smt. K.K. Kousallia	Assistant
35.	Smt.V. Jayalakshmi	Assistant
36.	Smt. C.A. Leela	Assistant
37.	Smt. Manjusha G. Menon	Assistant
38.	Smt. Radhika Krishnan	Assistant
39.	Ms. Soumya Surendran	Assistant
40.	Ms. Ramya M	Assistant
41.	Shri C.K. Sivadas	Assistant
42.	Shri Tomy Prince. M.J.	Assistant
43.	Smt. P.K. Mary	Upper Division Clerk
44.	Smt. Binny Cherian	Upper Division Clerk
45.	Smt. Gouri Hareendran	Upper Division Clerk
46.	Smt. D. Lalithambika Amma	Upper Division Clerk
47.	Smt.T.C. Chandrika	Upper Division Clerk
48.	Shri A.K. Kunjipalu	Upper Division Clerk
49.	Smt. C. Devaki	Upper Division Clerk
50.	Shri K.S. Ajith	Upper Division Clerk
51.	Shri K. Jerald Raja	Upper Division Clerk
52.	Shri K.P. John	Upper Division Clerk
53.	Smt Annies Mary Paulose	Upper Division Clerk
54.	Shri T.K. Sumesh	Upper Division Clerk
55.	Shri K.S. Sunil Raj	Upper Division Clerk
56.	Shri Sunil A.T	Upper Division Clerk
57.	Shri Joseph Mathew	Upper Division Clerk
58.	Smt. Deepa P.N.	Upper Division Clerk
59.	Smt. Febeena P.A.	Upper Division Clerk
60.	Smt. Manju Jose	Upper Division Clerk
61.	Shri E.A. Roopesh	Lower Division Clerk
62.	Smt. Sujatha K.K	Lower Division Clerk
63.	Shri S. Sreekumar	Lower Division Clerk
64.	Shri C.P. Umasankar	Lower Division Clerk

Sl No	Name of Employee	Designation
	KVK of CMFRI	
65.	Shri Augustus Julin Raj	Assistant
66.	Smt. Rincy K.R.	Stenographer Grade III
	Mandapam R.C	
67.	Shri M. Radha Krishnan	Assistant Finance & Accounts Officer
68.	Smt. P.S. Sumathy	Assistant Administrative Officer
69.	Smt. N. Gomathi	Private Secretary
70.	Smt. S. Parisa	Assistant
71.	Smt. M. Rameswari	Assistant
72.	Ms. Sumeena	Assistant
73.	Ms. Priyankakumari	Assistant
74.	Shri G.K. Rajan	Lower Division Clerk
75.	Shri M. Shahul Hameed	Lower Division Clerk
76.	Shri B. Balasubramanian alias James	Lower Division Clerk
	Visakhapatnam R.C	
77.	Shri Ashish Chobey	Assistant Administrative Officer
78.	Smt. G. Hemlata	Assistant Finance & Accounts Officer
79.	Smt. B. Gauri	Assistant
80.	Shri Rajarshi Chakma	Assistant
81.	Smt. D. Madhavi Latha	Upper Division Clerk
82.	Shri P. Krishna Rao	Upper Division Clerk
83.	Smt. N.C. Saroja	Upper Division Clerk
84.	Shri L. Pydi Raju	Lower Division Clerk
	Veraval R.C	
85.	Shri Chandra Mauli Sharma	Assistant Administrative Officer
86.	Shri J.N. Jambudiya	Assistant
87.	Shri Upendar Kumar	Assistant
	Mangalore R.C	
88.	Smt. Martha R. Mascarenhas	Assistant
89.	Shri Rishikesh Aandi	Assistant
90.	Shri U. Purandhara Shetty	Assistant
	Mumbai R.C	
91.	Shri M.R. Wadadekar	Assistant Administrative Officer
92.	Smt. Ashlesha Ashok Sawant	Assistant
93.	Shri Vanvi Mansukhlal Madhavji	Assistant
94.	Shri Vinod P. Bhagayatkar	Upper Division Clerk
	Tuticorin R.C	
95.	Smt. S. Sarada	Assistant
96.	Smt. C. Rajeswari	Assistant
97.	Shri M. Samuthiram	Assistant
98.	Smt.T. Mahalakshmi	Upper Division Clerk
99.	Shri J.Vinoth Prabhu Vaz	Upper Division Clerk
100.	Smt. C. Pushparani	Upper Division Clerk
101.	Shri A. Dickson Jebaraj	Upper Division Clerk
102.	Shri W. Sathyavan Neelraj	Upper Division Clerk
103.	Smt. R. Anantharani	Lower Division Clerk
	Madras R.C	
104.	Smt. G. Abitha	Assistant Administrative Officer
105.	Smt. Leelavathi	Personal Assistant
106.	Smt. P.Thankaleelal	Assistant
107.	Shri S.Yuvarajan	Upper Division Clerk
108.	Smt. S. Anjalidevi	Lower Division Clerk
	Karwar R.C	
109.	Shri Haris N.K	Assistant
110.	Shri Ratan P. Naik	Lower Division Clerk
	Vizhinjam R.C	
111.	Smt. K. Latha	Assistant
112.	Shri A. Yesudhas	Lower Division Clerk
113.	Shri R. Balakrishnan	Lower Division Clerk
114.	Smt. M.P. Kaladevi	Lower Division Clerk
	Calicut R.C	
115.	Shri R. Sreenivasan	Assistant
116.	Smt. K.P. Shylaja	Assistant
117.	Smt. K. Balamani	Assistant
118.	Smt. N.G. Supriya	Assistant

Skilled Support Staff

Sl No	Name of Employee
	CMFRI, Kochi
1	Shri T. Sreedharan
2	Shri T.I. Soman
3	Shri N.P. Mohanan
4	Shri K.C. Rajappan
5	Shri V.T. Ravi
6	Smt. A. Latha
7	Shri K.G. Jayaprasad
8	Shri E.J. James
9	Shri T.K. Antony
10	Smt. K.T. Prakasin
11	Smt. P.K. Usha
12	Shri K. Thankappan
13	Shri M.D. Suresh
14	Smt. Usha. S.
18	Shri Sreekumar. K.M.
19	Shri Vijayan. M.T.
20	Shri V. Rajendran
21	Shri Jestin Joy. K.M.
22	Smt. P.K. Sujatha
23	Shri M.J. Joseph
24	Smt. Subaida. K.S.
25	Smt. S. Prasannakumari
26	Smt. K.S. Jeeji
27	Shri C.R. Mohanan
28	Smt. K. Parukutty
29	Shri Biju George
30	Shri T. Rajesh Babu
32	Shri R. Pydi Raju
33	Shri P.M. Gireesh
34	Smt. T.R. Kumari
35	Shri Rajesh P.A
	Mandapam R.C.
37	Shri R. Sonaimuthu
38	Shri S. Murugan
39	Shri V. Narasimhabharathi
40	Shri P. Ramu
41	Shri J. Hameed Sultan
42	Shri K. Thangavelu
43	Shri U. Rajendran
44	Shri K. Jeevanandam
45	Shri N. Nagamuthu
46	Smt. Subbulakshmi
47	Shri M. Saravana Kumar
48	Shri K. Anandan
49	Shri K. Ganesan
50	Shri K. Chandran
51	Shri N. Ramamoorthy
52	Shri B. Kathiresan
53	Shri K. Muniyasamy
54	Shri M. Ganesan
55	Shri M. Thayalan
56	Shri M. Saravanan
57	Shri K. Senthil Kumar
58	Smt. M. Saraswathi
59	Shri N. Thirupathi
60	Shri M. Jayasingh
61	Shri A. Bose
62	Shri K. Narayanan
63	Shri K. Krishnan
	Visakhapatnam R.C
64	Shri R. Kanaka Raju
65	Shri C.H. Moshe
66	Shri D. Lingaraju
67	Shri Oggu China Venkateswarlu
68	Shri S. Srinivasulu
	Veraval R.C
69	Shri A. Abubin Mehsam
70	Shri Haridas Khimdas Makwana
71	Shri Ladani Dhirajlal Jamnadas
72	Shri Chudasama Karsan Punja
73	Shri Sangabhai Lakhabhai Paredi
74	Smt. Santok A. Bharada
75	Smt. Bhanuben L. Waghela
	KVK, Narakkal
36	Shri M.K. Anilkumar
	Mumbai R.C
76	Shri S.M. Tandel
77	Shri K.K. Baikar
78	Shri D.D. Jangam
79	Smt. Urmila S. Balmiki
80	Shri Bhangare Sunil Ramachandra
	Bhatkal F.C
81	Shri Somayya S. Gonda
	Karwar R.C
82	Shri Subhash K. Naik
83	Shri Gopi X. Chodenkar
84	Smt. Somi M. Harijan
86	Shri Ramakant Shankar Harikantra
87	Shri Suresh Rumo Majalikar
88	Smt. Vijayalakshmi Y. Gamanagatti
89	Smt. Nandini Mayekar
	Calicut R.C
90	Shri A. Sivadasan
91	Shri P. Dassan
92	Shri M.K. Chandran
93	Shri T.P. Renilkumar
94	Shri K.T. Mohanan
95	Shri K. Sankaran
96	Shri P. Satheeshkumar
97	Shri M.P. Devadasan
98	Shri P.V. Gopalan
99	Shri P.B. Jeevaraj
	Mangalore R.C
100	Shri U.B. Sadasiva
101	Shri A. Keshava
102	Shri L.K. Suvarna
103	Shri D. Gangadhara Gowda
104	Shri S. Mahalinga Naik
	Tuticorin R.C
105	Shri K. Thankaraj
106	Shri V. Samayamuthu
107	Shri S. Balakrishnan
108	Shri S. Alagesan
109	Shri I. Ravindran
110	Shri S. Mariappan
111	Shri M. Soundrapandian
112	Shri M. Kalimuthu
113	Shri K. Subramanian
114	Smt. B. Koncies Mary
115	Shri S. Willington
116	Shri M. Joseph Sahayaraj
117	Shri N. Ramaswamy
118	Shri A. Paul Pondi
119	Smt. A. Usha Rani
120	Shri C.S. Santhanakumar
	Vizhinjam R.C
121	Shri V. Viswanathan
122	Shri B. Babu
123	Shri S. Mohanan
124	Shri A. Anukumar
125	Smt. T. Jayakumari
126	Shri S. Satheesh Kumar
	Chennai R.C
127	Shri D. Pakkiri
128	Shri A. Janakiraman
129	Shri G. Chakrapani
130	Shri P. Selvaraj
131	Shri S. Imbamani
132	Shri M.P. Chandrasekharan
133	Shri V. Sitaramacharyulu
134	Shri S. Chandrasekharan
135	Smt. R. Kalaiselvi
136	Shri R. Kumaran
137	Smt. R. Sarojini
138	Smt. M. Sundari
139	Smt. R. Eswari

Canteen Attendant

Sl No	Name of Employee
	CMFRI, KOCHI
1	Shri P.V. George
2	Shri M.V. Devassyjkutty
3	Shri P.K. Purushan

12th Plan Research Projects (2012-17): In-house

Sl. No	Project Code	Title of the Project	PI of the project & Div.	Co-PI
1.	FISHCM-FRISIL201200100001	GIS based management advisory support information system for the marine fisheries sector	Dr.T.V. Sathianandan FRAD	J. Jayasankar, Somy Kuriakose, K.G. Mini, Wilson T Mathew, Grinson George
2.	FISHCM-FRISIL201200200002	Remote sensing assisted biodynamic forecasting paradigm for Indian marine fishery resources	Dr. J. Jayasankar FRAD	T.V. Sathianandan, Somy Kuriakose, K.G. Mini, Wilson T Mathew, Prathibha Rohit, Sreenath.K.R, Beena Kumari, Gyanaranjan Dash, Anulakshmi chellappan, Ranjith F, Johnson B, Indira Divipala, N.R. Nair
3.	FISHCM-FRISIL201200300003	Development of Fishery Management Plans for Sustaining Marine Fisheries of Kerala and Lakshadweep	Dr. P.P Manojkumar FRAD	Rekha. J. Nair, P. U. Zacharia, K. S. Shobana, T. M. Najmudeen, V. Venkatesan Head, CFD, Josileen Jose, S. Lakshmi Pillai, Rekha Devi, Chakraborty, Head, PFD, E. M. Abdusammad, U. Ganga, K. P. Said Koya, P. K. Asokan, N. Ramachandran, K.N. Saleela, B. Santosh
4.	FISHCM-FRISIL201200400004	Development of Fishery Management Plans for Sustaining Marine Fisheries of Gujarat	Shri. K. Mohammed Koya PFD	Swatipriyanka Sen, Gyanaranjan Dash, Sreenath K.R
5.	FISHCM-FRISIL201200500005	Assessment Of Elasmobranch Resources In The Indian Seas	Dr. Shoba Joe Kizhakudan DFD	K. S. Shobana, P. U. Zacharia, T. M. Najmudeen, Rekha. J. Nair, P.P. Manojkumar, Sujitha Thomas, Ms. Muktha Menon, G. B. Purushottama, Ms. Swaipriyanka Sen, B. Santosh Shri. R. Saravanan, Shri. L. Ranjith
6.	FISHCM-FRISIL201200600006	Development of fishery management plans for sustaining marine fisheries of Karnataka and Goa	Dr. Prathibha Rohit PFD	A. P. Dineshbabu, Sujitha Thomas, Rajesh K.M, Geetha Sasikumar, Swatilekshmi P.S, Bindu Sulochanan
7.	FISHCM-FRISIL201200700007	Development of strategies to sustain the stock and fishery of large pelagics in Indian waters	Dr. E.M. Abdussamad PFD	K.P. Said Koya, Mohammed Koya, C. Anulekshmi Prathibha Rohit, Rajesh K. M., U. Ganga, S. Jasmin, M. Sivadas, A. Margaret Muthu Rathinam, Shubhadeep Ghosh
8.	FISHCM-FRISIL201200800008	Development of Fishery Management Plans for sustaining Marine Fisheries of Tamil Nadu and Puducherry	Dr.M.Sivadas PFD	I. Jagdis, P.T. Sarada, Sobha Joe Kizhakkudan Margaret Muthu Rathinam, S. N. Sethi, Indira Divibala, K. N. Saleela, R. Saravanan
9.	FISHCM-FRISIL201200900009	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. Gyanranjan Dash, Smt. Swatipriyanka Sen, V. D. Deshmukh, Kum. Anulekshmi, Prathibha Rohit, Sujitha Thomas, K. M. Rajesh, Senthil Murugan T P. P. Manojkumar, Josileen Jose, Lekshmi Pillai, Rekha Devi, Najmudeen T.M, Saleela K. N, P.T. Sarada, Sivadas M., Shobha Joe Kizhakudan Kum. Indira Divipala, Shubhadeep Ghosh, Muktha. M, Shri. N. Rajendra Naik
10.	FISHCM-FRISIL201201000010	Development of fishery management plans for sustaining marine fisheries of Maharashtra	Dr.V.D.Deshmukh CFD	Veerendra Veer Singh, Anulekshmi Purushottama G. B., Ramkumar. S

11.	FISHCM-FRISIL201201100011	Development of Fisheries Management Plans (FMPs) for Sustaining marine fisheries of Andhra Pradesh	Dr.P.Laxmilatha MFD	G. Maheswarurdu, Shubhadeep Ghosh, Muktha. M, Loveson Edward, Shri. N. Rajendra Naik
12.	FISHCM-FRISIL201201200012	Development of Fishery Management Plans (FMPs) for the bivalve fisheries of India.	Dr. Geetha Sasikumar MFD	P. Laxmilatha, Sathyanarayan Sethi I. Jagdis, N. Ramachandran, K. S. Mohamed Shri. V. Venkateshan, P. K. Ashokan Reeta Jayasankar
13.	FISHCM-FRISIL201201300013	Evaluation of ornamental gastropod fisheries in India and assessment of shell craft industry	Dr. I. Jagadis MFD	Laxmilatha, S. N. Sethi, Shri. V. Venkatesan Shyam. S. Salim, Shri. C. Kalidas
14.	FISHCM-FRISIL201201400014	Sustainable molluscan mariculture practices	Dr.P.K. Asokan MFD	K. S. Mohammed, P. Laxmilatha, I. Jagdis, Geetha Sasikumar, M. K. Anil, V. Kripa P. Kaladharan, Vipinkumar. V. P
15.	FISHCM-FRISIL201201500015	Bioinventorying and biodiversity valuation of marine organisms in selected marine ecosystems along the Indian coast	Dr. K. K. Joshi MBD	Molly Varghese, S. Jasmine, R. Narayanakumar Shri. K. R. Sreenath, Shri. R. Saravanan Shri. Renjith. L, Shri. Pralaya Ranjan Behera Shri. Ramkumar. R FRAD
16.	FISHCM-FRISIL201201600016	Investigations on vulnerable coral reef ecosystems of Indian waters with special emphasis on formulation of management measures for conservation	Dr. Rani Mary George MBD	S. Jasmine, K. Vinod, Molly Varghese, K. S. Sobhana, Shri. K. R. Sreenath Shri. R. Saravanan, Shri. Ranjith. L Shri. Pralaya Ranjan Behera Shri. Ramkumar. S
17.	FISHCM-FRISIL201201700017	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	K. K. Joshi, Molly Varghese, S. Jasmine Shri. K. R. Sreenath, Shri. Saravanan Shri. Ranjith. L, Shri. Pralaya Ranjan Behara Shri. Ramkumar. R, R. Geetha
18.	FISHCM-FRISIL201201800018	Ecosystem process of critical marine habitats and development of protocols for restoration	Dr.V.Kripa FEMD	D. Prema, R. Jayabhaskaran, P. Kaladharan Bindhu Sulochanan, V.V. Singh, P. S. Asha P. Hemasankari, Loveson Edward Geetha Sasikumar
19.	FISHCM-FRISIL201201900019	Pollution and litter in the coastal and marine ecosystem and their impact	Dr.P.Kaladharan FEMD	V. Kripa, D. Prema, R. Jayabaskaran Dr. Bindhu Sulochanan, V.V. Singh P. S. Asha, Hemasankari, Loveson Edward
20.	FISHCM-FRISIL201202000020	Economics of marine fisheries and sustainable management: Policy Issues and Interventions	Dr.R.Narayanakumar SEETTD	R. Sathiadhas, M. S. Madan, C. Ramachandran Shyam. S. Salim, P. S. Swathilekshmi, N. Aswathy R. Geetha, B. Johnson
21.	FISHCM-FRISIL201202100021	An Input Output Economic Optimization Model for Marine Fisheries at Tuticorin Fishing Harbour	Dr. M.S. Madan SEETTD	N. Aswathy, M. Sivadas, Mr. L. Ranjit
22.	FISHCM-FRISIL201202200022	Capacity Development for Ecosystem Based Responsible Fisheries Management in India - A Co-Learning action research	Dr.C.Ramachandran SEETTD	Vipinkumar V. P, Swathilakshmi. P. S, Johnson. B Sathiadhas. R.

23.	FISHCM-FRISIL201202300023	Supply chain management of marine fisheries sector In India	Dr.Shyam.S.Salim	R. Narayanakumar, R. Sathiadhas, M. S. Madan, T.V. Sathianandan, Vipinkumar, N. Aswathy R. Geetha, B. Johnson
24.	FISHCM-FRISIL201202400024	Development and standardization of seed production technologies for selected high value finfishes and shellfishes	Dr. G.Gopakumar MD	A. K. Abdul Nazar, R. Jayakumar, G. Tamilmani M. Sakthivel, P. Rameshkumar, Shri. C. Kalidas K. Madhu, Dr. Rema Madhu, Boby Ignatitius Imelda Joseph, Shoji Joseph, C. P. Suja, Ritesh Ranjan, Smt. Biji Xavier, B. Santhosh K. K. Philipose, Jayashree Loka, T. Senthil Murugan, Krupesha Sarma, D. Divu Joe. K. Kizhakudan, Gulshad Mohammed Shri. Loveson Edward
25.	FISHCM-FRISIL201202500025	Innovations in Sea cage farming & Coastal mariculture	Dr.K.K.Philipose MD	Jayasree Loka, Senthil Murugan, Krupesha Sarma D. Divu, G. Gopakumar, Abdul Nazar Jayakumar, G. Tamilmani, Ramesh Kumar M. Saktivel, Sri. Kalidas, C. Johnson, Ritesh Ranjan, Biji Xavier, Rema Madhu K. Madhu, Boby Ignatitius, Imelda Joseph Shoji Joseph, Aswathi, Dinesh Babu Sujitha Thomas, Joe Kizhakudan Mohammed Koya, Gulshad Mohammed P. P. Manoj Kumar, Reeta Jayasankar
26.	FISHCM-FRISIL201202600026	Health management in selected finfish and shellfish for mariculture and aquariculture & bioprospecting from marine resources	Dr. K.K. Vijayan MBTD	A. P. Lipton, P. Vijayagopal, Shri. N. K. Sanil Kajal Chakraborty, Pradeep M. A Sandhya Sukumaran, P. K. Asokan, I. Rajendran Krupesha Sharma, Jayasree Loka, M. K. Anil, Joe. K. Kizhakudan, Vidya Jayasankar Srinivasa Raghavan. V, Rithesh Ranjan Ramesh Kumar. P.
27.	FISHCM-FRISIL201202700027	Aquatic feed biotechnology for mariculture and aquariculture	Dr. P.Vijayagopal MBTD	I. Rajendran, K. K. Vijayan, Pradeep. M. A M. K. Anil, Joe K. Kizhakudan, Boby Ignatius Krupesha Sharma, Vidya Jayasankar Kajal Chakraborty, Kalidas. C, Bala Nambisan
28.	FISHCM-FRISIL201202800028	Genetics, genomics and biotechnological applications in mariculture and fishery resources management	Dr.P.C. Thomas MBTD	K. K. Vijayan, Vidya Jayasankar Sandhya Sukumaran, Srinivasa Raghavan. V Pradeep M. A, Joe. K. Kizhakudan
29.	FISHCM-FRISIL201202900029	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	Vidya Jayasankar, C. P. Suja, Srinivasa Raghavan. V Indira Divipala
30.	FISHCM-FRISIL201203000030	Integrated approaches for improving the reproductive performance of selected marine food fishes	Dr. Divu. D MD	Senthil Murugan, Jayasree Loka Krupesh Sharma
31.	FISHCM-FRISIL201203100031	Derivation and characterization of embryonic (ES) and induced pluripotent (iPS) stem cell lines from selected marine fish species aimed at mariculture/conservation	Dr. K. S. Sobhana DFD	K. Madhu, Reema Madhu, C. Kalidas, M. Sakthivel
32.	FISHCM-FRISIL201203200032	Trawl fishery of the North east coast of India: An appraisal	Dr. Shubhadeep Ghosh PFD	G. Maheswarudu, Reeta Jayasankar P. Laxmilatha, Muktha. M, Pralaya Ranjan Behera N. Rajendra Naik

Research Projects (Externally Funded)

Sl.No	Title of the Project	Name of PI	Name of the 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 (CMLRE)
2	Impact, Adaptation and Vulnerability of Indian Agriculture to Climate Change-Marine Fisheries	Dr.V. Kripa	ICAR (Net) II Phase
3	Flow of matter through trophic levels and biogeochemical cycles in marine and estuarine ecosystems	Dr. Sujitha Thomas	MoES (Siber)
4	Microbial Diversity and Identification - Fish Microbes which are of application in aquaculture and/or allied industries	Dr. Imelda Joseph	ICAR (AMAAS)
5	Establishment and characterization of cell lines from selected marine food fish and ornamental fish	Dr. K.S Sobhana	DBT
6	Bioinventorisation of coral fishes of South India with special reference to threats and conservation measures	Dr. Rekha J. Nair	MoEF
8	Seed Production of Marine Food Fishes and Ornamental Fishes	Dr. K. Madhu	ICAR (Revolving fund)
9	Satellite telemetry studies for understanding environmental preferences and migratory patterns of yellowfin tuna, Thunnus albacares in the Indian Ocean	Dr. Prathibha Rohit	INCOIS
10	State of diversity of commercially important seaweeds along the West Coast of India	Dr.V.V. Singh (CC-PI)	ICAR (NFBSFARA)
11	Towards developing models for prediction of recruitment success in major Indian marine fish stocks	Dr.V. Kripa	MoES (CMLRE)
12	Assessment of Deep-Sea Fishery Resources of the Continental slope of the Indian EEZ	Dr. U. Ganga	MoES (CMLRE)
13	Assessment of Myctophid resources in the Arabian Sea	Dr.Rajesh K.M.	MoES (CMLRE)
14	Eco-biological investigations on major pelagic fishes ad eco biological modelling of the epipelagic habitat off Kerala and Lakshadweep	Dr.V. Kripa	INCOIS
15	Integrative taxonomy of Deep Sea Shrimp Resources among the Southern Coast of India	Dr. Rekhadevi Chakraborty	DST
16	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)
17	Stock characterization, captive breeding, seed production and culture of hilsa (Tenualosa ilisha)	Dr.Subhadeep Gosh	ICAR (NFBSFARA)
18	Mapping and Resource Assessment of Pearl Oyster tanks of Tuticorin(Central)Division of Gulf of Mannar.	Dr. J. Jagadis	MoEF
19	Utilization strategy for oceanic squids (Cephalopoda) in Arabian Sea: A value chain approach	Dr. K.S. Mohammed	NAIP
20	Export oriented marine value chain for farmed sea food production using Cobia through rural entrepreneurship	Dr. G. Gopakumar	NAIP
21	Bio-prospecting of genes and allele mining for abiotic stress tolerance	Dr. K. K.Vijayan	NAIP
22	Strategies to enhance adaptive capacity to climate change in vulnerable regions	Dr.V.V. Singh	NAIP
23	A value chain on high value shell fishes from mariculture systems	Dr.V.Venkatesan	NAIP
24	A value chain on oceanic tuna fisheries in Lakshadweep Sea	Dr. E.M. Abdussamad	NAIP

Consultancy Projects 2012-13

1	The Director, Dept. of Tourism, Park Avenue, Thiruvananthapuram.	Impact assessment of multipurpose reef at Howa Beach, Kovalam, Thiruvananthapuram on fishery resources of the area	July 2010-June 2011	6,97,000
2	M/s.MRPL,Mangalore	Monitoring chemical parameters of effluent and the hydrrobiological conditions in the Arabian sea off Chitrapur ….(Phase-11)	Aug2010-Aug 2011	10,43,438 +1,68,891
3	Project Director, RGCA, Sirkali, TN	Setting up of modern library at RGCA, Sirkali	Feb 2011	13,05,070
4	Deputy manager (AUD), NTPC, Simhadri Thermal Power Plant, Visakhapatnam	Study on the use of Fly ash for manufacture of Artificial Reefs	Dec.10'-May 11	9,19,471
5	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	April 2011	29,67,200
6	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	16 Months From 22-6-2011.	7,93,000
7	M/s Alpha Marine Emergency Response Service Pvt.Ltd., 13, 2nd Floor, 1st Main Road , SBM Colony, Anand Nagar, Bangalore	Marine EIA study for Kudankulam Nuclear Power Plant	4 July 2011- 17 Aug 2011	9,65,685
8	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	Dec.2011-17 months	19,90,000
9	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	Dec 2011-mar 2013	30,00,000
10	NIO, Mumbai Regional Centre, 4 Bungalow, Versova, Andheri- (W) MUMBAI	Rapid assessment of fishery resources of Vasishty river esturine system and possible impact of intake and discharge of water from thermal power plant on it	Feb2012-July 2012	14,64,630
11	Vice President (Proj), Sindya Power Generating Company Private Ltd., 5th Floor, Pottipati Plaza, 77, Nungambakkam High Road, CHENNAI – 600 034.	Consultancy project on Marine Rapid EIA study and preparation of MEIA report for Sindya Power Generating Company Private Ltd.'s coastal thermal power project at Sirkazhi, TN	16th Feb 2012 – March 2012.	24,55,000
		Total		**1,77,69385**

Human Resource Development Cell

Summary	
No of HRD Programmes attended by CMFRI Staff:	54
No. of CMFRI staff who attended the programmes:	110
No of HRD Programmes conducted by CMFRI:	47
No. of participants for the CMFRI programmes :	759

Ph.D Programme

Total No. of scholars undergoing Ph.D at CMFRI :	59
under Mangalore University :	34
CUSAT :	25

CMFRI is conducting Ph.D. Course work in addition to the research guidance under both universities .

Scholars admitted during the year	15
Students undergoing Course work	15
Thesis submitted during the year	5
Degree awarded during the year	3

ICAR UG Entrance Examination

No. of candidates	4310
No. of venues	8
No. of Exam halls	157
No. of staff on duty	406

ARS Examination

No. of disciplines	35
No. candidates	996
No.of Exam Halls	25
No. of staff on duty	81

NET Examination

No. of disciplines	55
No. candidates	878
No.of Exam Halls	23
No. of staff on duty	71

Women's Cell

Major Activities

The women's Cell, CMFRI organized a special lecture on "Women at Work Place and in Public Administration" by Mrs. B. Bhadra, Hon. Deputy Mayor, Corporation of Cochin on 11th May, 2012 at 3 pm at CMFRI, Kochi. Dr. G. Syda Rao, Director CMFRI, presided over the function. The lecture by Hon. Deputy Mayor was followed by an interactive session with active participation from the staff of CMFRI.

The Women's Cell CMFRI and KVK, CMFRI had jointly organized a training programme on various aspects of "Kitchen Gardening" on 2nd March, 2013 at Thevara Campus of KVK, CMFRI. Selected items of organic agro products and planting materials were supplied to the participants. The programme had benefitted around 80 participants consisting of CMFRI, CIFRI and NBFGR staff members, their family, students and retired staff of CMFRI.

As a part of Women's Day observation, the Women's Cell, CMFRI organized a special talk on "Women and Society" by Dr (Mrs.) Geetha Suraj, Principal (Retd.), S.N.M. College, Maliyankara on 8th March, 2013 at CMFRI Cochin. The talk touched upon the e function.

There was no complaint of women harassment or impaired treatment of women at CMFRI during the report period.

Programmes organised

1. Institute Management Committee (IMC)

The 73rd meeting of the Institute Management Committee of CMFRI was held on 23.07.2012 at CMFRI Hqrs., Cochin. Review of the action taken on the items considered during the previous meeting held on 24.11.2011 at CMFRI was done. On the basis of the recommendation of the IMC, the Council has approved the expenditure incurred on security service of CMFRI and its Regional/Research Centres. As per the approval of the IMC, a proposal for appointment of 5 Authorized Medical Attendants at Visakhapatnam for treatment of staff and their family members at Visakhapatnam Regional Centre of CMFRI was sent to the Council and the same has been approved by the Council. As proposed by the IMC, a proposal for appointing Dr. Benny Paul, MBBS, Dewar Road, Perumannor, Ernakulam as Authorized Medical Attendant at Cochin for the medical treatment of Staff and family members of CMFRI Hqrs., Cochin and KVK of CMFRI was sent to the Council and the same has been approved by the Council. As approved by the IMC of CMFRI the Institute Grievance Committee of CMFRI has been re-constituted. The IMC placed on record the recommendation for procurement of minor equipments/furniture &fixtures during the year 2012-13. Expenditure of the amount allotted under Plan and Non-Plan 'Works' for the financial year 2011-12 was reviewed. Expenditure on various maintenance works at Hqrs. and Regional/Research Centre under Plan and Non-Plan 'Works' for the financial year 2012-13 was also reviewed.

2. Institute Research Council (IRC)

The 19th Institute Research Council (IRC) meeting was held in Institute Headquarters at Kochi from 26th June to 30th June under the chairmanship of the Director, Dr. G. SydaRao. The Heads of Divisions, Scientists-in-Charge of all Regional and Research Centres, KVK, all Principal Investigators (PI) and Co-PIs from Headquarters, all Regional and Research Centres attended the meeting. The progress under the various in-house and sponsored projects was critically evaluated. The new projects for the 12th Plan were presented and were evaluated and recommended for implementation from 2012-13.

CMFRI Marine Biodiversity Museum

The Designated National Repository Museum of CMFRI, recognized by the Government of India is authorised to keep in safe custody specimens of different categories of biological material. Currently the museum houses 1640 specimens belonging to different groups of marine organisms.

New additions to the Museum during 2012

Shrimps

1. *Nematocarcinus gracilis* Bate,1888

Crabs

1. *Lophozozymous incisus* (H. Milne Edwards,1834)

Fishes

1. *Carcharhinus longimanus* (Poey, 1861)
2. *Scolopsis igcarensis* sp.nov.
3. *Iniistius twistii* (Bleeker, 1856)
4. *Opistognathus pardus* Smith-Vaniz,Bineesh & Akhilesh,2012
5. *Liopropoma randalli* Akhilesh, Bineesh & White, 2012
6. *Chlorophthalmus corniger* Alcock, 1894
7. *Glyphocrangon investigatoris* (Woodmason & Alcock,1891)
8. *Neobythites stefanovi* (Nielson & Uiblin,1993)
9. *Neobythites multistriatus* (Nielson &Quero,1991)
10. *Grammonus ater* (Risso,1810)
11. *Gadella imberbis* (Vaillant, 1888)
12. *Coloconger raniceps* (Alcock,1889)
13. *Neoscopelus microchir* (Matsubara,1943)
14. *Zameus squamulosus* Gunther, 1877
15. *Parapercis clathrata* Ogilby,1919
16. *Ctenochaetus binotatus* Randall, 1955
17. *Scarus rubroviolaceus* Bleeker, 1847
18. *Pogonoperca punctata* (Valenciennes, 1830)
19. *Priacanthus blochii* Bleeker, 1853
20. *Chelidoperca investigatoris* (Alcock,1890)
21. *Naucrates ductor* (Linnaeus,1758)
22. *Liopropoma lunulatum* (Guichenot,1863)
23. *Parascolopsis capitinis* Russell,1996
24. *Caesio xanthonotus Bleeker,1853*
25. *Stegostoma fasciatum* (Hermann,1783)
26. *Psudocarcharias kamoharai* (Matsubara,1936)

Visitors to the Marine Biodiversity Museum, Kochi during Jan. - Dec. 2012

- Total number of visitors : A total of 7,700 people from 20 States and Union Territories of the country visited the Museum during the period under report.
- Students: Students constituted 77 % of the total visitors indicating the significant role the Museum plays in education.
- Students were from 14 States and Union Territories of the country: 90 educational institutions from Kerala, 19 from Tamil Nadu, 5 from Karnataka, 2 each from Punjab, Bihar, Andhra Pradesh, Gujarat, Lakshadweep, one each from Jammu&Kashmir, Assam, Uttarakhand, Maharashtra, W.Bengal, and Andaman & Nicobar Islands.
- Visitors also included 1,100 personnel belonging to 81 organisations from 14 States and Union Territories of the country and delegates from 5 foreign countries.

Members of 'Sidi' Adivasi Tribal Society of Gujarat Visiting the Museum on 31-07-2012

Krishi Vigyana Kendra

On Farm Testings

KVK has conducted on farm testing of cage culture of fin fishes in brackish water in a traditional shrimp farm pond at Pallipuram, Cherai. Small floating cages of 2m×2m×1.3m size were fabricated using HDPE nets, PVC material and stocked Pearl spot (*Etroplus suratensis*) fingerlings 300 Nos. in each cage. The fishes stocked in the cages were initially fed with slow sinking pellet feed (1mm) using feed tray. For juveniles, floating pellet feed of 2mm and 3mm size were used. Cage reared fishes attained marketable size (150 to 200 gm) after nine months culture with 90% survival rate.

Another on farm testing (OFT) was conducted to test the best possible locally available and low cost media to raise vegetable seedlings in protrays. Composted coir pith was found better than cocopeat: vermiculite: perlite mixure, which is the commercially available media. The Seedlings raised in *in-situ* composted coir pith have shown faster germination, better growth and lesser seedling mortality.

The suitability of *Palak* cultivation in Ernakulam district was assessed in another on farm testing conducted in four farmer fields at Kumbalangi, Edavanakad, and Chottanikkara. The variety Harith Shobha contributed 35kg percent total yield.

Tomato varieties resistant to bacterial wilt disease was another OFT conducted in five farmers fields at Kumbalanghi, Puthuvyppu and Edavanakkad. *Arka Samrat* – IIHR released high yielding F1 hybrid with triple disease resistance to tomato leaf curl virus, bacterial wilt, early blight was compared with KAU released bacterial wilt resistant variety *Anagha*. Average yield of Arka Samrat was found to be 75 t/ha in comparison to 28 t/ha for *Anagha*.

Plant Growth Promoting *Rhizobacterium* (PGPR) mix I and II were tested on cowpea variety *Anaswara* at 5 farmers fields in Kumbalanghi, Puthuvyppu and Edavanakkad panchayats. PGPR mix I, a consortium of plant growth promoting *Rhizobacteria*, reduced the fertilizer requirement by enhancing soil nutrient availability and PGPR mix II controlled or inhibited the activity of plant pathogen.

Effect of both *Trichoderma* and *Pseudomonas* against the fruit rot disease in nutmeg was studied in 3 farmers fields at Mookanoor panchayat. Fruit rot is a common disease in Ernakulam area which result in low yield. Preliminary results indicate reduction of the fruit rot disease. The programme would be replicated for 2013-14 also.

Frontline Demonstrations

A front line demonstration (FLD) on culture of potential marine finfishes in low saline water bodies was implemented in a farmer's field at Kumbalangi. As part of the programme, high density Mullet farming was initiated in a low saline water at Kumbalangi, Ernakulam district. Nursery rearing of the wild caught frys was done in rectangular pens of 2m×2m×1.5 m size, made of velon screen material. Ninty percent survival was achieved with slow sinking formulated pellet feed having 40% protein.

Another FLD on high density cage culture of pearlspot (*Etroplus suratensis*) was conducted in abandoned fresh water resources in Kothamangalam. This cage aquaculture model was initiated since harvesting, predation and feeding

Athulya layer poultry in cage system for urban households.

Bailer in operation in paddy field

Brackish water cage culture of Pearlspot

Cage culture sites in pokkali field

Director visiting the cage culture in granite quarries

Dr.Gurbachan singh, Chairman (ASRB) seeing the operation of Chineese fish net mode

Dr.S.Prabhukumar, Zonal Project Director Inaugurates the SAC meeting 2012

Fish harvested from Pokkali fields

are the main problems for doing any aquaculture activity in granite quarries due to its depth. Pearl spot (*Etroplus suratensis*) and fast growing Tilapia (*Tilapia nilotica*) were selected as candidate species for testing the suitability of species. Hatchery produced Pearl spot frys of 2 cm length and 2 g size were stocked in cages at the rate of 250 per cage.

Micronutrient deficiencies are a major problem for banana and vegetable growers in Ernakulam district leading to many physiological disorders and deficiency symptoms. The micronutrients like Zinc, Boron, Iron, Manganese etc are combined in the required specific concentration as a single product specifically for banana and vegetables which is produced and marketed by IIHR, Bangalore. Demonstration of these technologies are undergoing in selected fields of vegetable and banana farmers in the district.

A Front Line Demonstration on System of Rice Intensification (SRI) method in paddy was conducted in 3 farmer field at Ayoor village. An increase in production by 27 per cent was observed in this method.

A front line demonstration aimed at rejuvenation of the coconut gardens in the district is being carried out at 3 progressive farmer's fields at the Kottapady village of Kothamangalam block. A detailed soil test was conducted on the plots on NPK status and the micronutrient level and based on that, chemical fertilizers along with bio fertilizers were applied. Applied *Pseudomonas* and *Trichoderma* to prevent damage from diseases. Diancha, a nitrogen fixing green manure crop was also grown in the basin to supplement neem cake was also applied in the basins as well as in the crown.

In order to promote production of organic eggs in households in Kochi Corporation area, KVK popularized cage rearing of *Athulya* poultry. Each unit comprising of 5 birds and a cage were distributed free of cost to the urban housewives and regularly monitored the performance, acceptability and spread of the technology. The unit is getting wide popularity among urban housewives. The factors which popularized this programme are less space requirement and high rate of egg production, i.e 1500 eggs per year from the unit. In order to ensure supply of organic feed to these units, KVK has formulated an organic layer poultry feed and marketed under the brand name CADALMIN™.

Karimeen Seed sale at Narakkal campus

KVK has initiated *Karimeen* (Pearl spot) seed production through modified hatchery method at its Narakkal campus. KVK sell *Karimeen* seeds acclimatized in both fresh water and brackish water environments. The seeds are supplied in oxygen filled packets that are capable of withstanding 18 hours transportation stress. Printed instruction slip also supplied. Prize is ` 5/- for 3 cm size and ` 10/- for 6 cm and above size fingerlings.

Package to rejuvenate Pokkali farming

Pokkali is a conventional farming system in Kerala where paddy and shrimp are alternatively farmed in the same field. The biomass residues of the paddy crop form the feed for the shrimps and the residues of the shrimp culture form the fertilizer for the paddy. The paddy culture is generally done during June to October followed by shrimp farming during November to April. The *Pokkali* farming is purely organic and the paddy and prawn possess good taste since there is no chemical inputs are used. During the year 2009, pokkali farming system received Geographical Indication (GI) certificate

and an approved logo for its products. The *pokkali* farming community also received Plant Genome Community saviour Award during 2010-11.

The area under *pokkali* farming is getting declined due to climate change, high labour cost and widespread attack of White Spot Syndrome (WSS), viral infection to the shrimps. The barren *pokkali* lands submerged in water results un-balanced eco-system in the area.

KVK (Ernakulam) of CMFRI has successfully demonstrated a new method for revival of *pokkali* farming system wherein cage culture of fin fish was integrated with traditional paddy and shrimp farming. The programme was implemented with the funding from National Initiative on Climate Resilient Agriculture (NICRA) Project, functioning at Central Marine Fisheries Research Institute (CMFRI). A package of practice for integrated paddy, shrimp and fin fish culture in *pokkali* fields was developed. Mullet (*Thirutha*) and Pearlspot (*Karimeen*) were the candidate fish selected for the cage culture.

The fixed cost required per year for the cage culture in 1 ha *pokkali* fields is `18,000/-. The operational cost per year is `90,000/-. The gross income per year would be `1,90,000/- and the profit per year would be `83,000/-. The present profit from paddy alone is only `15,000/- and that from paddy-shrimp field is `50,000/-. In order to revive pokkali farming in the district, this new method which fetch the farmer additional income of `83,000/- per ha need to be promoted. The initial investment can be provided on loan to the farmers through financial institutions. KVK and CMFRI can provide technical assistance to the farmers. The KVK is also planning to demonstrate the technology to more farmers in the coming years.

Entrepreurship development programme of broiler rabbit rearing

Campaign on safe curry leaf production

The curry leaf consignments coming from nearby state are contaminated with pesticide residues many folds than the allowable limit. KVK (Ernakulam) has initiated a campaign on safe curry leaf production at homsteads. Good quality curry leaf seedlings are being supplied to public from KVK. A demonstration on "High Density commercial Planting" of curry leaf was set up at Thevara campus of the KVK after learning similar models from the curry leaf villages at Pedavedlapudi, Vijayawada and Mettuppalayam, Tamil Nadu.

high density curry leaf planting demonstration at Thevara

D-Cowl Programme for waste land utilization

In an effort to demonstrate the efficient utilization of public wasteland, KVK has initiated a D-Cowl (Development of Community Orchards in Waste Lands) programme. In this series, high density planting demonstration of curry leaf and a fruit orchard are being maintained in the waste land in association with Kasthurba Nagar Residents association, Thevara, Ernakulam.

Participatory vegetable seed production

Farmer participatory seed production programme has been initiated by KVK Ernakulam, initially for selected crops viz., cowpea, *Amaranthus* and *okra*. Participating farmers signed MoU with KVK and follow the package of practices for seed production recommended by KVK. It is envisaged to treat the seeds at KVK and sell through its salescounter. A seed storage facility is also created at KVK.

In-situ composted coirpith as medium for growing vegetable seedlings

Packed, labelled and trade mark protected tuna pickle marketed by KVK trainee

Soil fertility map of Ernakulam district

KVK team visiting Kuttampuzha to identify native cattle breeds

Kadaknath chicks being grown at Thevara

Market linkage for Maize

A Special programme on maize was initiated to test the possibility of continuous marketing the maize cobs year round. The crops are raised continuously by staggered planting in weekly intervals in selected locations at Mookkannoor and Ayoor villages. Staggered sowing is done in such a way to harvest 500 cobs/ day in a continuous manner. Farmer-buyer linkages established towards sustainable production round the year.

Soil health camps and soil fertility map of Ernakulam district

In order to analyse soil samples from various parts of the district towards preparing a district soil map, KVK associated with district kudumbashree mission for collecting soil samples from farmers fields. KVK trained members of the selected Kudumbashree SHG groups in Ernakulam district on soil sample collection methods and subsequently organized soil health camps at various locations. KVK has prepared soil fertility map of Ernakulam district wherein all the macro nutrient viz., Nitrogen (N), Phospherous (P) and Potassium (K) status of soils in all the panchayaths, municipalities and corporation was documented. The nutrient status was classified into low, medium and high. This will facilitate farmers, agriculture officials and policy makers to understand the general fertility status of each region without analyzing the soil. Accordingly region specific general fertilizer recommendations can be made. In addition, certain crops can be recommended to particular regions to improve the fertility status in deficient area. For e.g., pulse crops can be recommended to improve the Nitrogen status in deficient area to improve the nitrogen fertility.

Conservation of Indigenous Cattle Breeds of Ernakulam District

An awareness campaign on Conservation of indigenous cattle breeds was conducted in Kuttampuzha Grama Panchayat near Kothamangalam on 24.09.2012. The programme was inaugurated by Sri. C.J. Eldhose, President, Kuttampuzha Grama Panachayat and attended by standing committee chairman, ward members and 26 farmers. After the campaign, people rearing the indigenous cattle expressed their desire and willingness to conserve the indigenous cattle and formation of society for the purpose. It was decided to collect data on indigenous cattle breeds during the cattle census to know the status of indigenous cattle population as well as to identify all farmers rearing such cattle.

Rearing of Indigenous Poultry - Kadaknath

Kadaknath, *Karinkozhi* in malayalam is used for the traditional treatment of many diseases in human beings and is also considered an aphrodisiac. The *Kadaknath* birds are comparatively expensive and much aspired for. The meat and eggs are also reckoned to be a rich source of protein. It was observed that the population of this bird is declining rapidly and it is under threat of extinction and genetic erosion. So KVK conserve *kadaknath* brood stock and supply day old chicks through KVK hatchery to popularize and promote the rearing and conservation of these birds and with future plans to start egger nursery as per availability of pure chicks.

Open Precision Farming Unit at Thevara campus

KVK set up an open precision farming at Thevara campus to demonstrate the technology to farmers. Precision farming is an integrated approach wherein the inputs viz., water, fertilizer and pesticides are applied in a controlled manner. Hence soil test based fertilizer recommendation was done. The fertilizer was applied directly to the root zone through drip irrigation system so that wastage was minimized. The measured quantity of liquid fertilizers was mixed with irrigation water by using a venturi system. The crop specific production algorithm was prepared and the input application schedule followed accordingly. Cabbage, cauliflower, brinjal, *Amaranthus*. *Bhindi*, Cowpea and chilly were grown under precision farming mode.

SRI method of rice cultivation

Low cost media for Nursery Raising of Vegetable Seedlings

An experiment was conducted at KVK farm, Thevara and also at participating Self Help Group's nursery units to identify a cheaper and locally available medium for growing vegetable seedlings in protrays. Four combination of cocopeat based media in the ratio 1:1:1 , 3:1:1, 5:1:1 (cocopeat from cocopeat blocks, vermiculite and perlite) and one medium consisting only of insitu composted coir pith was used for the experiment. The *in-situ* composting was done using *Pleurotus* spawn, *Trichoderma* culture, urea, *Panchagavya* and *Gliricidia* leaves. It was observed that the germination percentage for all crops was maximum in case of *in-situ* composted coir pith medium. The survival rate and days to marketable maturity values were maximum for insitu composted cocopeat. Incidence of disease, like damping off and seedling blight was least in insitu composted cocopeat. Hence *in-situ* composted coirpith is recommended as a cheap and locally available medium for protected growing of vegetable seedlings.

The precision farming unit at KVK Thevara campus

Training and Entrepreneurship development programmes

To empower the progressive traditional shrimp fish farmers for large scale fin fish farming, one day training programme entitled "Seed Production and farming of pearl spot" was conducted at KVK Narakkal Campus on 23-4-12. Around 40 farmers from Kannur, Calicut, Trichur, Ernakulam, Alappuzha, Kollam and Trivandrum districts were participated in the training programme. Hands on training on Pearl spot larval rearing, small floating cage fabrication and feed management were provided during the programme. In association with Mariculture division of CMFRI, two Training cum demonstration programmes on Pearl spot farming was conducted on 9th August 2012 and 5th October 2012 at KVK Narakkal campus for 80 farmers from Idukki district. They were trained on backyard fish culture and high density fish farming in abandoned granite quarries. Theory cum practical session on Pearl spot breeding, seed production and farming was conducted at NFIAM, Kadungallur and also at KVK Narakkal campus for newly joined extension functionaries of the Kerala state fisheries department. Two days hands on training programme for five extension functionaries was conducted on *Artemia* cyst decapsulation and hatching" at KVK, Narakkal Campus during 25-6-12 to 26-6-12. Training programme was conducted on 21-1-13 on "Farming of Mud Crabs in Backwater Ponds" at KVK, Narakkal Campus for six entrepreneurs. Pond preparation methods, seedling procurement and stocking, feeding and other management methods were demonstrated in

Palak harvest mela inaugurated by Kumbalanghi Panchayath President

OFT of tomato varieties resistant to bacterial wilt disease at kumbalanghi farmers field

the training. Subsequently, one group initiated a mud crab pond farming at Chendmangalam and another group initiated mud crab fattening in open creeks using small FRP cages at Chellanam.

Total six trainings on 18-09-2012, 5-11-2012, 04-01-2013, 18-01-2013, 19-01-2013 and 7-03-2013 were conducted in the series- Entrepreneurship development in broiler rabbit farming. Around 222 farmers, farm women and rural youth benefited from the programme. The training module consisted of hands on training, preparation of project proposals, low cost cage fabrication, identification of common diseases and their preventive measures etc. The training aimed at encouraging more entrepreneurs to take up Broiler rabbit farming as a remunerative enterprise.

Two one day training programme on Scientific cultivation of nutmeg were conducted on 16th April 2012 & 10th December 2012 at Kothamangalam. Dr. P.A. Mathew, Principal Scientist from IISR, Kozhikkode lead the classes. 140 farmers from various parts of the district and adjoining district participated in the training programme.

Enterpreneurship development training programmes in value addition on fish products were conducted at Narakkal campus. The integrated training module consisted of procurement of raw materials, product preparation, packing, labeling, branding and test marketing. 375 entrepreneurs from various parts of the district attended the programme. One young entre preuner from Narakkal has started a small scale industry making sea food products and branded the products as Malayali foods.

Shri. Anvar Sadath M.L.A and others taking pledge on conserving paddy lands

Three training programmes on mushroom cultivation were conducted on 06-11-2012, 22-01-2013 and 28-03-2013. Another three programmes were conducted on mushroom spawn production also. 177 farmers and youths participated the programmes. The trainees were given hands on training on bed preparation, spawn inoculation and spawn production technologies.

Programme for the Students

On the Job training for VHSE students from St Peters Higher Secondary School, Kolenchery was conducted at Thevara campus from 27th to 29th November, 2012 on Horticultural Nursery Management and Ornamental Gardening. A six days Science camp was conducted at Narakkal campus for the Higher Secondary students from Govt. Vocational Higher Secondary School, Narakkal during the period from 15th to 20th October 2012. A total of 53 students and 3 Instructors participated in the Training programme.

KVK Sales Counter

KVK opened a sales counter at Thevara campus. As part of the programmes to promote organic agriculture, selling of farming inputs and products initiated at the sales counter. KVKs insect repellents like Enriched neem cake and Neem oil are getting wide popularity among farmers of the district. *Panchagavya* an organic growth promoting hormone prepared at KVK by fermenting dairy products and by-products is being sold in one litre and 200 ml bottles. This product has proven to improve fruiting, flowering and overall yield in plants. The vegetable seed packets supplied from KVK contains a small write up on "how to grow" in local language which is appreciated by urban consumers. The protray grown seedlings are preferred to seeds by farmers as it is ready to grow at home and devoid of germination problems. The poultry and quail eggs produced and supplied from KVK demonstration

Pearl spot seeds packed for transportation

units are free from hormone/antibiotic residues or other contaminations as the birds are grown in purely organic environment. The rabbit kits supplied from the breeding unit are ensured as pure lines. The organically grown fresh vegetables supplied from KVK sales counter are getting wide preference among the local households. In addition, the Layer poultry feed formulated without any hormones is being sold at a premium price in 5 kg bags in order to meet the demands of the backyard poultry growers of the district.

Farmers field school on mechanization of Paddy fields

KVK Conducted Farmers Field School (FFS) on paddy mechanization at Kanjoor near Kalady. Three sessions were held. Training on laying mat nursery for mechanized seedling transplantation was done in the first lesson held on 31 October 2012. The training was given by renowned expert in rice mechanization in Kerala, Dr. Shaji James, Programme Co-Ordinator, Palakkad KVK. The second session held on 16-11-2012 was on mechanized transplanting. The session was inaugurated by Shri. Anwar Sadath, M.L.A. followed by oath taking on conserving paddy lands. Dr. Shaji James and Dr. Shinoj Subramannian lead the class wherein 2 acre paddy field was transplanted using rice transplanter. There was a demonstration on the usage of dry seeder machine also. The third session held on 06-12-2012 was on the usage of power weeder in paddy fields. Dr.Shinoj Subramannian demonstrated the power weeder for weed removal in paddy fields. The fourth session on harvesting paddy using combine harvester was held on 26 February 2013 Shri. Anwar Sadath, M.L.A inaugurated the harvest mela. The farmers were trained on the operation of combine harvester. The fifth session on bailing was held on 28 February 2013. Er.Anu Ray Mathew, Asst. Engineer (Agri), Ernakulam trained the farmers.

Paddy transplanter in operation

Power weeder operation in Paddy field

Exhibition during National Conference-2012 at PAU, Ludhiana

KVK (Ernakulum) set up a stall in the exhibition organized in connection with the National conference of KVKs at Punjab Agricultural University, Ludhiana during 20th, 21st and 22nd November 2012. Hundreds of students from various universities in and around Ludhiana and general public of Ludhiana city visited the stall in addition to officials and delegates from Indian Council of Agricultural Research, Various agricultural universities, KVKs from various parts of the country and other organizations. Live pearlspot (*Karimeen*), the state fish of Kerala was the centre of attraction in the exhibition. In addition, various fishing gears, fixed specimen of lobsters, prawn, tuna, clam, mussel and squid, marine fish cage, rabbit waste composting unit, model of pokkali farm, bush pepper plant, VARNA fish feed, packed sea food products of KVK, Green Algal Extract, Green Mussel extract, *Pokkali* rice and paddy, seeds, seedlings and posters showcasing various technology interventions of KVK in Ernakulam district were exhibited. The Green Algal extract samples were distributed to dignitaries free of cost along with the feedback form for data collection. The sea food products, fish feed, posters and books were sold during the exhibition.

KVK Scientific Advisory Committee Meeting

The Scientific Advisory Committee (SAC) meeting of KVK for the year 2012-13 held at Narakkal campus on 29th October 2012. Dr. S. Prabhukumar, Zonal Project Director, Zone VIII inaugurated the meeting in the presence

Spraying of banana special in banana field

Pearl spot seeds packed for transportation

of Dr.P.V. Balachandran, Director of Extension, Kerala Agricultural University. The meeting was chaired by Dr.G.Syda Rao, Director CMFRI.

Recognition

Dr. Shinoj Subramannian, Programme Co-ordinator receives JN Award

Dr.Shinoj Subramannian, Programme Coordinator received the prestigious Jawaharlal Nehru Award of Indian Council of Agricultural Research (ICAR) for Outstanding Doctoral Thesis Research in Agricultural and Allied Sciences-2011. He received the award from Shri. Sharad Pawar, Union Minister for Agriculture and Food Processing Industries during the 84th foundation day of ICAR at New Delhi on 16th of July 2012. The award consists of a gold medal, citation and Rs.50,000 in cash. He has done his research work at Tamil Nadu Agricultural University (TNAU), Coimbatore and University of Saskatchewan, Canada availing the Commonwealth student exchange programme fellowship of Canadian Bureau of International Education (CBIE), Ottawa, Canada. The work was done under the guidance of Dr. R. Visvanathan, Professor of TNAU.

Best poster award in National conference

The Poster entitled Testing the suitability of different cocopeat based media for protected growing of vegetable seedlings by Shoji Joy Edison and Shinoj Subramannian won the first price and best poster award during the National Seminar on Advances in Protected Cultivation organised by Indian Society for Protected Cultivation (ISPC), Centre For Protected Cultivation Technology (CPCT), Indian Agriculture Research Institute, New Delhi held on 21st March, 2013.

Radio talks:

1. Vikas, P.A. Subject Matter Specialist (Fisheries) delivered a radio talk on "Fin fish farming" on 24/09/12, broadcasted by AIR Trichur.
2. Shoji Joy Edison, Subject Matter Specialist (Horticulture) delivered a radio talk on Cultivational aspects of Cauliflower and Cabbage, broadcasted on 16.10-2012

Trainings attended by KVK staff

1. Shoji Joy Edison SMS, Horticulture, attended 3 days training on "Hi-tech farming" at Central Training Institute, Mannuthy from 4-6th December, 2013.
2. F. Pushparaj Anjelo, SMS, Agril. Extn., attended the 5 days "Trainers training programme on Entrepreneurship development" held at ni-MSME, Hyderabad during 8-12th September 2012.
3. F. Pushparaj Anjelo, SMS, Agril. Extn., attended the 6 days training on "Participatory Impact Management and Assessment" held at KVK, Erode during 28th January-2nd February 2013.
4. Dr. K. Smita Sivadasan, SMS, Animal Husbandry and Dipti N.V., Programme Assistant, attended 5 days training programme held at MANAGE, Hyderabad during 25-29th June 2012.

Official Language Implementation Activities

Shri Rakesh Kumar CAO inaugurating the Translation Training programme

Ensurance of bilingualisation and targets of correspondence

During the year Cent percent bilingual issue of Section 3(3) documents (1235), reply of letters received in Hindi (724) and target of Hindi correspondence (65%) against the target of 55% were ensured.

Under bilingualization of stationery items during the year 28 name plates, 31 rubber stamps, 43 Museum labels and labels of Hatchery, 1 Plaque; 46 Identity cards of staff members, Pensioners and Research Fellows were renewed; 8 charts; 17 Certificates of Hindi Chethana Mas.

Official Language Implementation Committee meetings organized / attended

- Official Language Implementation Committee meetings
  The 91st , 92nd , 93rd and 94th meetings of Official Language Implementation Committee of the Institute were held on 23.06.2012, 29.09.2012, 21.12.2012 and 30.03.2013 respectively.

- Town Official Language Implementation Committee meetings
  Attended meetings of Town Official Language Implementation Committee meetings at Kochi and Outstations. Attended TOLIC meeting at Income Tax Office, Kochi on 06.12.2012 and 21.03.2013.

Review of OL activities of Regional/Research Centres

The Official Language implementation activities of 10 Regional and Research Centres were reviewed and suggestions were given for improvement.

Translation Training programme members of the training

Inspection of Centres

Director, CMFRI inspected the Official Language implementation activities of Mumbai Research Centre on 05.05.2012 and 15.11.2012, Karwar Research Centre on 07.12.2012, Vizhinjam Research Centre on December, 2012, Visakhapatnam Regional Centre on 18.03.2013 and Mangalore Research Centre on 29.01.2013.

HRD programmes

(i) Hindi Workshops: With a view to encourage the staff to work in Hindi with out hesitation, eight Hindi Workshops were conducted as follows:

- 4 Hindi workshops were conducted at Headquarters, Cochin (1) on 5-7.06.2012 on functional Hindi and (2) on 01.09.2012 on Bolchal ki Hindi, (3) on 15.12.2012 Technical Talk in Hindi and (4) on 04-08 March, 2013 Translation Training course.
- One Day Hindi workshop at Mangalore Research Centre on 12.12.2012 on Unicode.
- One Day Hindi workshop at Tuticorin Research Centre on 25.07.2012.
- One Day Hindi workshop at Madras Research Centre on 24.08.2012. and
- One Day Hindi workshop at Karwar Research Centre on 28.09.2012. Altogether 157 Officers and staff were benefitted.

(ii) Condensed Translation Training Course: Under the quinquennial programme of encouraging the proficient Hindi users of the Institute and to promote the functional use of Hindi a 5 day Condensed

Chief Guest Shri R.C.Sinha, Director, CIFNET Addressing the staff

Release of poster

Translation Course was conducted at CMFRI Headquarters during 04-08 March, 2013 with the faculty support of Central Translation Bureau, New Delhi. Certificates were issued to 23 participants.

(iii) Obligatory Hindi training: Two Stenographers passed Hindi Stenography course under Hindi Teaching Scheme and one Stenographer is undergoing the training. At Mandapam Regional Centre 12 staff members and 14 staff members of Visakhapatnam Regional passed various Hindi courses during the year.

(iv) A word a day: Under A word a day programme around 267 Hindi words with English equivalents were displayed on display board and circulated among staff members of Headquarters and Outstations.

(v) Special incentive scheme

- Under special incentive scheme total 17 Officers / Staff won cash awards.
- Special incentive scheme cash incentives were also granted to Mangalore, Calicut Research Centres and Veraval Regional Centre.

Extension programmes

(i) Hindi Chethana Mas Celebration: Hindi Chethana Mas was observed at CMFRI Headquarters, Cochin from 1 to 28 September, 2012 with various competitions / programmes. The programme was inaugurated on 1st September, 2012 by Prof. U. Muraleedharan Pillai. Dr. G. Syda Rao, Director, CMFRI presided over the valedictory function held on 28th September, 2012. Shri R.C Sinha, Director, CIFNET, Cochin was the Chief Guest. Winners of competitions and overall contributors for the year were felicitated during the function. With the conduct of cultural programme the spirit of nationality and cultural magnanimity was kindled.

A glimpse of cultural programme

- Hindi Day/ week/ Fortnight was observed in all Regional and Research Centres of CMFRI.

(ii) Technical Talk in Hindi: A Technical Talk in Hindi on the subject Fishing techniques and aquatic environment was held at CMFRI Headquarters on 15.12.2012 for the Scientists and Technical personnel of the Institute.

(iii) The Joint Official Language Celebration – 2012: CMFRI organised Joint Official Language celebration 2012 of Kochi TOLIC during 21-25 February, 2013. In the various events organized over 100 employees from 32 member organizations participated.

Hindi Publications

Quarterly bilingual periodicals released

- ❖ MFIS - Issue Nos. 209 & 210
- ❖ CMFRI Newsletter Cadalmin – Issue Nos. 133, 134, 135 & 136

Special Publication

- ❖ Matsyagandha 2011-12

Book

- ❖ Jalvaayu parivartan aur maatsyiki.

Hindi Week celebration at Mandapam RC

E-governance programmes continued

(i) Web display of Tender Notice / Advertisement of Posts
(ii) Use of bilingual software for fishing data collection
(iii) E- Prints of Institute's Hindi publication
(iv) The Terminology Bank on fisheries with addition of new terms made available at Internet.
(v) Installation of phonetic software UNICODE on all computers.

Recognition

a. Indira Gandhi Rajbhasha Shield

CMFRI bagged the highest Award for Official Language implementation the Indira Gandhi Rajbhasha Shield under the category Boards / Autonomous Bodies / Societies etc. in Region 'C' for the year 2010-2011. On the occasion of Hindi Day on 14.09.2012. Dr. G. Syda Rao, Director, CMFRI received the Shield from the President of India Shri Pranab Mukherji in the programme organized at Vigyan Bhavan, New Delhi. Shri Sushil Kumar Shinde, Hon'ble Union Cabinet Minister of Home Affairs presided over the function. Shri Jitendra Singh, Minister of State for Home Affairs graced the occasion. CMFRI is receiving this award for the last two consecutive years.

b. Rajarshi Tandon Award

CMFRI bagged the Rajarshi Tandon Award for the year 2011 for the outstanding Official Language Implementation activities among the Institutes situated in Region 'C'. Dr. M.S.Swaminathan distributed the award in the Directors' Conference held at NASC Complex, New Delhi on 19.03.2013.

Dr.G.Syda Rao, Director, CMFRI receiving Rajarshi Tandon Award from Dr. M. S. Swaminathan

c. TOLIC Performance Award

CMFRI bagged the Award for the best performance in Kochi Town Official Language Joint Hindi Week celebration – 2012. In the TOLIC meeting held on 21.03.2013 Income Tax Commissioner, Kochi distributed awards.

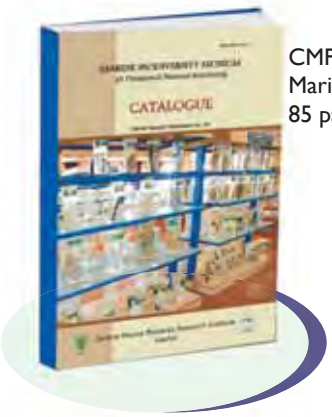
Shri Rakesh Kumar, Chief Administrative Officer receiving Trophy from Shri.V.K.Mishra, Income Tax Commissioner

Dr.G.Syda Rao, Director, CMFRI receiving the Award from Hon'ble President of India Shri Pranab Mukherji

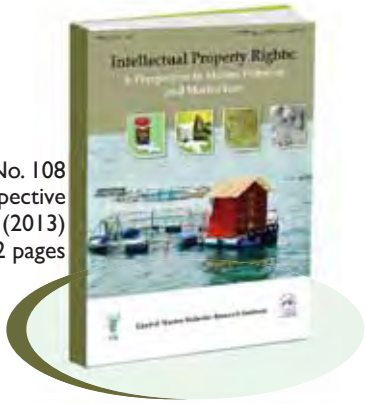
CMFRI Publication

Marine Mammal Species of India
Vivekanandan, E and Jeyabaskaran, R (2012)
Hard bound, 228 pages

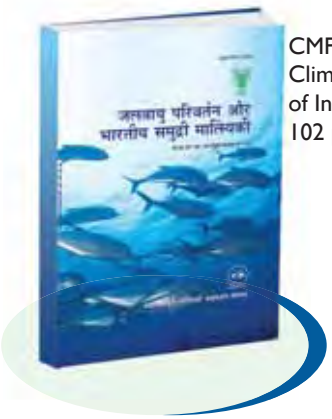
Handbook of Prawns.
Radhakrishnan, E.V., Josileen Jose
and Pillai, S. Lakshmi, (2012)
Spiral bound, 125 pages



CMFRI Special Publication No. 107
Marine Biodiversity Museum Catalogue (2012)
85 pages



CMFRI Special Publication No. 108
Intellectual Property Rights: A perspective
in marine fisheries and mariculture (2013)
152 pages



CMFRI Special Publication No. 111
Climate Change and Marine Fisheries
of India (Hindi) (2012)
102 pages

CMFRI Special Publication No. 109
Pelagic Fishery Resources of India (Hindi) (2012)
92 pages

Posters

Poster on Soft corals and seafans of India

Poster on Reef Associated Perches of India

Poster on Marine Penaeid Prawn Fishery Resources of India

Journal (Peer reviewed)

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Abdussamad, E.M., Prathibha Rohit, Said Koya, K.P., and Sivadas, M., 2012. Status and potential of neritic tunas exploited from Indian waters. *IOTC-2012.-WPNT02-15 Rev.1.*

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- Radhakrishnan, E.V., Josileen Jose and Lakshmi Pillai, S. 2011. *Handbook of Prawns*, Central Marine Fisheries Research Institute, Kochi, 125p.
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Book Chapters

- Chakraborty, Rekha D. and Nandakumar, G. 2011. Deepsea prawns. *In:* E.V. Radhakrishnan, Josleen Jose and S. Lakshmi Pillai (*Eds.*). *Handbook of Prawns*. Central Marine Fisheries Research Institute, Kochi, pp. 67-82.
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- Ramkumar, S., Purushottama, G.B., Sujith Sundaram and Nilesh V. Kudupkar. 2013. Status and Exploitation of Molluscan Fishery Resources of Maharashtra. *In*: S.K. Chakraborthy and W.S. Lakra, (*Eds.*) *Fisheries Resources of Konkan Region - Utilization and Management*, Central Institute of Fisheries Education, Mumbai, pp. 65-72.
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- Abdussamad, E.M. and Prathibha Rohit. 2012. Diversity of Carangids (Family carangidae) of Indian seas and description of genera and species. *In*: T*raining manual Capacity building workshop on Taxonomy and identification of pelagic finfishes*, pp. 134-145.
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- Dineshbabu, A.P., Prathibha Rohit and Sujitha Thomas, 2012. *Manual for the workshop GIS based resource mapping and abundance of finfish and shellfishes off Indian coast*, Central Marine Fisheries Research Institute, 17-18 August, 2012. p 36.
- Lipton, A.P., Jose Kingsly, H. and Udayakumar, A. 2012. *Training Manual on Sea Farming Avenues and cage Aquaculture to cope up with climate variability*. CMFRI-NICRA HRD Compilation. Central Marine Fisheries Research Institute, Vizhinjam. 71 p.
- Shyam, S. Salim and Narayanakumar, R. 2012. *Manual on World Trade Agreement and Indian Fisheries Paradigms: A Policy Outlook.* Central Marine Fisheries Research Institute, Kochi. 456p.
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vulnerability in India. *In*: Kaladharan, P. and Asokan, P.K., (*Eds.*), *Lecture notes on Capacity building workshop on Vulnerable/Threatened Marine Ecosystem*, Calicut Research Centre of CMFRI, pp.18-23.

- Zacharia, P.U., 2012. Effect of bottom trawling on physic-chemical parameters, benthos and fish fauna off Mangalore coast, Karnataka state. *In:* Kaladharan, P. and Asokan, P.K., (*Eds.*), *Lecture notes on Capacity building workshop on Vulnerable/Threatened Marine Ecosystem*, Calicut Research Centre of CMFRI, pp.15-17.

DVD/CD Roms

- Narayanakumar, R., Aswathy, N., Vipinkumar, V.P., Shyam, S. Salim, and Ramachandran, C. 2012. Marine fisheries in India-at a glance (compilation)
- Syda Rao, G., Gopakumar, G. and Vipinkumar, V.P. 2012. A CD on Pompano Breeding Success story of CMFRI
- Vipinkumar, V.P., Shyam S. Salim, Narayanakumar, R., Sahtiadhas, R., Madan, S., Ramachandran, C., Swathilekshmi, P.S., Johnson, B. and Aswathy, N. 2012. Interactive multimedia on Impact of Microfinance on Coastal Indebtedness: An ICT module (in DVD), Central Marine Fisheries Research Institute, Kochi.

Thesis/Dissertations

Doctor of Philosophy (Ph.D.) in Aquaculture was awarded by Central Institute of Fisheries Education, University under section 3 of UGC Act, Indian Council of Agricultural Research Versova, Mumbai – 400 061, to Shri Nilesh Anil Pawar, (Technical Officer) on the topic entitled *Evaluation of dietary pre- and pro-biotics for improving growth and immunocompetence of Labeo fimbriatus* (Bloch, 1795) *fingerlings*, under the guidance of Dr. M.P.S. Kohli, Principal Scientist (Retd.) CIFE, Mumbai.

Reports

- Somvanshi, V.S., Deshmukh, V.D., Chakaborty, S.K., Shirdhankar, M.M., Patil, R., Naik, V.V., Gandage, S.N. and Kulkarni, S.S. 2012. Report of the study committee on the status of purse seine fishing and its impact on traditional fishing and ecology along Maharashtra coast. Submitted to Govt. of Maharashtra Department of Animal Husbandry, Dairy Development and Fisheries, Mumbai.
- Meryl Williams, Miriam Balgos, Ramachandran, C., John Hambrey, Carlos Alberto, Lima dos Santos and Victor Pouomogne 2012. Evaluation of FAO's support to the implementation of the Code of Conduct for Responsible Fisheries, Technical report, Office of Evaluation, FAO, Rome, 176p. (Available in electronic format at: http://www.fao.org/evaluation)
- Frusher, S., Syda Rao, G., Haward, M., Hobday, A., Holbrook, N., Jennings, S., Vivekanandan, E., Menon, M., Nursey-Bray. M., Pecl, G., Radhakrishnan, E., Ramachandran, C., Shyam S. Salim, Sathianandan, T.V., Van Puttenl, 2012. Preparing for climate change on marine systems in Australia and India. Report to the Australia-India Strategic Research Fund, Department of Industry, Innovation, Science, Research and Tertiary Education, Australia.

Posters

- Meenakumari B., Prathibha Rohit, Geetha Sasikumar and Swathi Lekshmi, P.S. 2012. Presented a poster on Gender Roles in marine fisheries: A case study of trawl fisheries in southern coastal Karnataka, India. *Global Conference on Women in Agriculture*, Organized by the ICAR and Asia-Pacific Association of Agricultural Research Institutions (APAARI) held at NASC Complex, New Delhi from 13-15 March, 2012.
- Nair, Rekha J. and Dinesh Kumar, S. and Zacharia, P.U. and Somy Kuriakose, 2012. Poster on *Reef Associated Perches of India*. Central Marine Fisheries Research Institute, Kochi.
- Rani Mary George, Naomi, T.S., Mary K. Manisseri, Sanil, N.K., Joshi, K.K., Vinod, K., Molly Varghese, Sandhya Sukumaran and Thomas, V.J. 2012. Poster on *Soft corals and horny corals of India.* Central Marine Fisheries Research Institute, Kochi, India.

- Swathilekshmi, P.S. 2012. Presented a poster on the *Socio-Economic Status of Fisherwomen in dry fish trading along Coastal Karnataka- an Empirical Analysis Global Conference on Women in Agriculture*, Organized by the ICAR and Asia-Pacific Association of Agricultural Research Institutions (APAARI) held at NASC Complex, New Delhi from 13-15 March, 2012.

Recognitions and Awards

Best CIO Award-APAC Award

TATA Consultancy Services (TCS) Innovation Lab (NAIP Project partner of MRC of CMFRI) received the Best CIO Award 2012 (APAC Award) on 20.07.2012 in 'Use of IT for Social cause' at Park Royal Hotel, Singapore. The award recognizes mKRISHI® Innovation which is a mobile based Integrated Rural Service Delivery Platform addressing rural development issues in the areas such as Agriculture, Rural Governance, Primary health care, Rural Banks & Finance, Fisheries, Farmer's social network and Livestock.

Certificate of Appreciation

'Certificate of Appreciation' received from NAIP on 09.11.2012 for demonstration of public-private partnership with development of mobile application (m-KRISHI®) for potential fishing zones and wind direction advisories under GEF-SLEM-NAIP sub-project *Strategies to enhance adaptive capacity to climate change in vulnerable regions* in presence of dignitaries such as Shri. Bharat Vir Wanchoo, Hon. Governor of Goa, Dr. Ramkrishna Kusmaria, Hon. Minister of Farmer Welfare and Agriculture Development, M.P., Dr. S. Ayyappan, Hon. Secretary, DARE and DG, ICAR.

Best presentation award

Best presentation award (First prize) Mhatre, V.D. Pawar, N.A, Chavan B.B and Deshmukh V.D. Export Trade of Dried Marine Products with special reference to Fish Maws from India. 2012. National seminar on *Horticulture and Marine Export in India*, Maharshi Dayanand College of Arts, Science and Commerce, Parel, Mumbai.

Best Thesis (Ph.D. – Indian category) Award

Dr. Grinson George, Senior Scientist Selected for the Dr. I. Karunasagar Best Post-Graduate Thesis (Ph.D. – Indian category) Award for the year 2012 for his thesis entitled "Fish Larval transport in the coastal waters through ecological modelling" instituted by PFGF, Mumbai.

Norwegian Agency for Development Co-operation (NORAD) fellowship

Shyam, S. Salim and Aswathy, N. were awarded with Norwegian Agency for Development Co-operation (NORAD) fellowship for attending the International Institute for Fisheries Economics and Trade conference at University of Dar-E-Salam during 16-20 July 2012.

Academic Council Member of Kerala Agricultural University

Shyam, S. Salim was nominated as the Academic Council member by the Chancellor of Kerala Agricultural University, K.A.U., Vellanikkara, Thrissur.

Participation of Scientists in Conferences / Meetings / Workshops / Symposia / Training etc.

Dr. Syda Rao, G., Director

Inauguration of Mangalore Office-cum-Laboratory building of CMFRI on 13th April 2012

Inauguration of maiden harvest of farm grown silver pompano at Antarvedi, Godavari, Andhra Pradesh on 17th April 2012

Meeting convened by DG, ICAR and DDG (Fy.), at ICAR, New Delhi during 28th - 30th April 2012

All India Coordinated Research Project (AICRP) Stakeholder meeting at Veraval during 5th - 8th May 2012

Visited Karwar Research Centre of CMFRI during 23rd - 24th May 2012

Meeting convened to discuss the All India Coordinated Research Project (AICRP) on Mariculture with the Director, CARI, Port Blair on 9th July 2012

Cage harvest function at Nagayalanka, Andhra Pradesh on 10th August 2012

'Knowledge Meet' convened by DG, ICAR, New Delhi during 21st - 22nd August 2012

National Consultation on the 'Integrated development of Uttara Kannada District of Karnataka' at Karwar on 1st September 2012

Visited Veraval Regional Centre of CMFRI on 9th September 2012

Received the Indira Gandhi Rajbhasha Puraskar 2010-11 from the Hon'ble President of India in the programme held at Vigyan Bhavan, New Delhi on 14th September 2012

Meeting convened by DG, ICAR at ICAR, New Delhi on 8th October 2012

225th meeting of the Governing Body of ICAR at New Delhi on 6th November 2012

Research review meeting at Mumbai Research Centre of CMFRI during15th - 17th November 2012

Meeting convened by DG, ICAR at New Delhi on during 5th - 6th December 2012

Visited Goa Shipyard and attended the review meeting of research at Karwar Research Centre on 7th December 2012

Research review meeting at Vizhinjam Research Centre and review of progress of research in cage farming at Kanyakumari during 14th - 15th December 2012

38th meeting of the Board of Management at CIFE, Mumbai on 2nd January 2013

2nd meeting of the 12th IJSC meeting at Mangalore Research Centre on 29th January 2013

Pillay Aquaculture Foundation Congress on Public-Private Partnership in Aquaculture and Culture based Fisheries - 2013 at Barrackpore, Kolkata on 9th February 2013

226th Meeting of the Governing Body of ICAR Society at NASC Complex, Pusa, New Delhi on 14th February 2013

84th Annual General Meeting of the ICAR Society at NASC Complex, Pusa, New Delhi on 18th February 2013

Dr. Abdul Nazar, A.K., participated in the '7th meeting of Fish, Fisheries and Aquaculture sectional committee, FAD12' at Bureau of Indian Standards, Manak Bhawan, New Delhi on 31st October 2012

Dr.Asokan, P.K., served as resource person for the training programme on Mussel Farming organized by the BFFDA, Goa for the Entrepreneurs of South Goa

Meeting under the UNDP collaborative project on Mussel mariculture at Ratnagiri, Sinddurg District, Maharashtra on 2nd February 2013

Dr. Biswajit Dash, attended meeting in connection with installation of cage in the Experimental tank at IIT, Kharagpur, West Bengal on 11th May 2012

Dr. Deshmukh, V.D., attended the Meeting with Shri. Madhukar Chavan, Hon. Minister (DAHD & Fisheries) in Mantralaya and had discussions on the regulation of marine fisheries in the state, on 14th May 2012

Served as member of the study committee on the status of purse seine fishing and its impact on traditional fishing and ecology along Maharashtra coast in May 2012

Dr. Dineshbabu, A.P., attended the talk on 'Molecular Evolutionary approaches to understanding Biology, delivered by Dr. Sudhindra R .Gadagkar,Alumnus College of Fishereis, Mangalore at Prof. HPC Shetty Seminar Hall, Mangalore, on 6th June 2012

MDP workshop on 'PME of Agricultural Research Projects-Learning and Capacity Building' at NAARM, Hyderabad during 21st - 25th January 2013

Shri. Edwin Joseph, V., attended Data digitisation workshop at IASRI, New Delhi on 12th September 2012

Served as a resource person i the Workshop on Digital Libraries using Dspace at Manonmanian Sundaranar University, Tirunelveli, Tamil Nadu, on 14th March 2013

Smt. Geetha, R., attended fishermen meet on Artificial Reefs at Pillumedu and Pudhupuppam, Cuddalore District on 7th November 2012

Dr. Gopakumar, G., attended the meeting convened to discuss the All India Coordinated Research Project (AICRP) on Mariculture with the Director, CARI, Port Blair on 9th July 2012

Participated in the 'Technical discussions on Mariculture programme' at Visakhapatanam Regional Centre during 23rd - 25th September 2012

Participated in the 'Governing Council meeting of KUFOS' at Kochi on 17th November 2012

Dr. Grinson George, attended Training Course on Field Trial and QTL analysis using R & R/QTL at ICRISAT, Patancheru during 2nd - 6th December 2012

Shri. Gyanaranjan Dash, attended Krishi Mahotsav at Porbandar on 28th May 2012

Smt. Indira Divipala, attended fishermen meet on Artificial Reefs at Pillumedu and Pudhupuppam, Cuddalore District on 7th November 2012

Dr. Jayasankar, J., served as Resource person in the workshop entitled 'Biometrical Analysis using SAS' at IGKV Raipur, Chhattisgarh, during 23rd January - 25th Janunary 2013

10th 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 and Fisheries, Ministry of Agriculture, New Delhi held at Bhubaneswar on 29th January 2013

Interaction meeting with Oceanography Group of NRSC, Hyderabad on 1st February 2013

Resource person in the training programme entitled "SAS for data reduction and Multivariate Analysis" conducted by CIFE, Mumbai on 14th February 2013

Delivered an invited lecture entitled "GIS applications in Marine Resource Management" at the Workshop on GIS applications in Natural Resource Management, held under the aegis of NAARM, Hyderabad during 19th - 22nd February 2013

Served as resource person in the NAIP consortium training programme on "Strengthening of Statistical computing for NARS" sponsored by IASRI, New Delhi, held at Swamy Keshavanand Rajasthan Agricultural University, Bikaner, Rajasthan on 6th March 2013

Second meeting to work out the fleet plan for oceanic and deep sea resources of Indian EEZ held under the aegis of DADF, New Delhi at BoBP, Chennai on 19th March 2013

Dr. Jeyabaskaran, R., participated and presented a paper in the National Consultation Workshop on "Coastal and Marine Biodiversity: Gaps, Challenges and Opportunities" jointly organised by Ministry of Environment & Forests, Government of India and GIZ at Gandhi Nagar, Gujarat during 12th - 13th April 2012

Meeting regarding "Marine EIA study for Kudankulam Nuclear Power Plant" in New Delhi on 10th May 2012

23rd Meeting of ICAR Regional Meeting No. VIII held at Tamil Nadu Agricultural University (TNAU), Coimbatore during 15th - 16th June 2012

Dr. Joe K., Kizhakudan, attended the fishermen meet on Artificial Reefs held at Cuddalore chinnakuppam on 21st November 2012

Dr. Johnson, B., participated in the Awareness programme on small scale mariculture for fishermen club at Olaikuda Village, Ramanathapuram District on 19th January 2013

Dr. Josleen Jose, attended the MDP workshop on 'PME of Agricultural Research Projects-Learning and Capacity Building' at NAARM, Hyderabad during 21st-25th January 2013

Dr. Kajal Chakraborty, participated and presented CMFRI Component on "High value compounds/ phytochemicals" in the platform group meeting on "High value compounds" in Directorate of Medicinal and Aromatic Plant Research, Anand, Gujrat during 3rd - 4th May 2012

Participated in the ICAR Chemists' Conclave at Division of Agricultural Chemicals, IARI, New Delhi during 14th - 15th January 2013.

Dr. Kaladharan, P., attended the MDP workshop on 'PME of Agricultural Research Projects-Learning and Capacity Building' at NAARM, Hyderabad during 21st-25th January 2013

Shri. Kalidas, C., attended CAFT training programme on 'Research strategies for mitigation and impact of climate change on fisheries' at CIFE, Mumbai during 15th November - 5th December 2012

Dr. Kripa, V., atended the PME meeting of open sea mussel farming project funded and organized by NABARD at Kasaragod on 17th April 2012

Served as Chief Guest at Vimala Public School, Thodupuzha during the occasion of Science exhibition 'Science Expo 2012' on 22nd October 2012

Served as member of the Institute Management Committee, Central Institute of Freshwater Aquaculture, Bhubaneswar, Odisha on 30th October 2012

Attended the 22nd Swadeshi Science Congress at CPCRI, Kasaragod and delivered a special lecture on 'Marine Habitats' during 5th - 7th November 2012

Attended meeting with District Collector, Alappuzha

as member of Expert Committee constituted to study permanent opening of Andhakararanezhi shutter

Dr. Krupesha Sharma, S. R., attended the NFDB sponsored National brain storming on mariculture development in India at NAAS complex, New Delhi on 3rd August 2012

NICRA Technology demonstration review workshop at IIHR, Bangalore during 7th - 8th August 2012

Field day at the Asian seabass pond culture site of CIBA at Harwada on 1st November 2012

Cage culture review meeting at the College of Fisheries, Ratnagiri on 19th January 2013

Dr. Lakshmi Pillai, S., attended the Training workshop on Taxonomy of Brachyuran crabs at the Department of Aquatic Biology and Fisheries, University of Kerala, Trivandrum during 9th - 11th January 2013

Dr. Laxmilatha, P., attended the annual review meeting of INCOIS, Hyderabad, at International Centre, Goa and presented the project proposal on "Development of an ecosystem based pelagic fishery forecast system" on 21st March 2012

MDP workshop on 'PME of Agricultural Research Projects-Learning and Capacity Building' at NAARM, Hyderabad during 21st - 25th January 2013

Dr. Mahendra D. Fofandi, attended the workshop on "Cage Culture - A New Direction" organized by the College of Fisheries, Ratnagiri on 24th January 2013

Dr. Maheswarudu, G., participated the interface meeting inviting technology developed by ICAR Institutes and stake holder departments pertaining to Andhra Pradesh for production enhancement, at CRIDA, Hyderabad on 21st April 2012

Meeting on 'identification of areas for skill upgradation in fishery sector and development of model curriculum' at NFDB conference hall at Secunderabad on 9th October 2012

Served as resource person in the one day workshop on "Aquaculture, new possibilities, constraints" organised by SPICAM at Kakinada on 29th October 2012

The Institute Management Committee Meeting at Central Institute of Brackishwater Aquaculture, Chennai on 14th December 2012

Participated in the 8th Aquatech Expo - 2013 at Eluru, Andhra Pradesh during 7th - 8th January 2013

Served as resource person in the one day programme on "Recent Trends in Aquaculture" at Fisheries Research Station, Sri Venkateswara Vetenary University, Kakinada, Andhra Pradesh on 6th March 2013

Shri. Mohammed Koya, K., attended Krishi Mahotsav at Porbandar on 28th May 2012

State level seminar on "Aquaculture development of Gujarat" organised by College of Fisheries, Veraval on 31st May 2012

XXII Meeting of the ICAR Regional Committee No. VI held at Central Arid Zone Research Institute (CAZRI), Jodhpur, Rajasthan during 16th - 17th November 2012

Fifth Scientific Advisory Committee Meeting of the Krishi Vigyan Kendra, Kodinar, Junagadh on 22nd February 2013

Dr. Narayanakumar, R., attended the Fisheries Division Meeting convened by the Secretary, DARE and DG ICAR to discuss regarding EFC preparation for the 12th Five Year Plan at New Delhi on 30th April 2012

TSP meeting held at Veraval Regional Centre of CMFRI during 6th - 8th May 2012

XXIII meeting of the Regional Committee No. VIII held at Tamil Nadu Agricultural University, Coimbatore on 16th June 2012

Participated in the inauguration of the Business Incubation Meet of ZTMBPDU by the DG, ICAR at CIFT, Kochi on 5th April 2012

Meeting in connection with the proposed AICRP on Mariculture held at Central Agricultural Research Institute (CARI), Port Blair during 8th - 9th July 2012

Meeting of RFD Nodal Officers of the Fisheries Research Institutes at Central Institute of Brackish Water Aquaculture (CIBA) at Chennai during 24th - 25th August 2012

Management Development Programme on Leadership Development (a pre-RMP programme) held at NAARM, Hyderabad, during 8th - 19th October 2012

Meeting of RFD Nodal Officers of Fisheries Research Institutes' held at ICAR, New Delhi during 4th-5th December 2012

Review Workshop and Sensitization Meeting of the PME Cells of the ICAR Institutes held at NDRI Karnal, on 8th December 2012

Meeting of the Directors of Fisheires Research Institutes and RFD Nodal Officers at New Delhi on 9th January 2013

Dr. Philipose, K. K., attended the NFDB sponsored National brain storming on mariculture development in India at NAAS complex, New Delhi on 3rd August 2012

NICRA Technology demonstration review workshop at IIHR, Bangalore during 7th - 8th August 2012

vsited Mundra and attended a meeting convened by TATA power to explain the possibilities of developing alternate livelihood for the fishermen displaced by the

thermal power project, on 3rd September 2012

Field day at the Asian seabass pond culture site of CIBA at Harwada on 1st November 2012

Cage culture review meeting at the College of Fisheries, Ratnagiri on 19th January 2013

Dr. Prathibha Rohit, attended the Board of Research in Nuclear Sciences (BRNS) as an Expert Faculty of the Review Committee to help in assessing the progress of the projects pertaining to marine fisheries at BARC, Mumbai, on 14th February 2013

Regional Workshop on 'Fisheries in Areas Beyond National Jurisdiction (ABNJ): Realising Sustainable Benefits through Appropriate Regional Fisheries Management' organized by the Bay of Bengal Programme Inter- Governmental Organization in Collaboration with the World Bank, during 4th - 5th March 2013

Third User Interaction Workshop at INCOIS Hyderabad on 8th March 2013

Dr. Rajendran, I., attended the ICAR Chemists' Conclave at Division of Agricultural Chemicals, IARI, New Delhi during 14th - 15th January 2013

Dr. Rajesh, K. M., attended the talk on 'Molecular Evolutionary approaches to understanding Biology, delivered by Dr. Sudhindra R .Gadagkar, Alumnus College of Fishereis, Mangalore at Prof. HPC Shetty Seminar Hall, Mangalore, on 6th June 2012

Dr. Ramachandran, C., attended the meeting convened by the Joint Director (Fy) at Krishi Bhavan, New Delhi to discuss the agenda for FAO - COFI, 2012, on 26th June 2012

"FAO/BOBP National Result Sharing and Scoping Workshop on Outcomes of the FIMSUL Project" at Chennai during 22nd - 23rd November 2012

Shri. Ranjith, L., attended the training programme on "SAS for Data Reduction and Multivariate Analysis" at CIFE, Mumbai during 11th - 16th February 2013

Smt. Salini, K. P., took a session on "Science through Communication" for the UG and PG students at Gregorius College, Kottarakkara, on 27th September 2012

Shri. Sanil, N. K., attended the National consultation on "Development of surveillance programme for Aquatic Animal Diseases" at NBFGR, Lucknow during 17th - 18th April 2012

Dr. Sathianandan, T.V., attended the 10th Meeting of the Technical Monitoring Committee for the Central Sector Scheme "Strengthening of Database and GIS for Fisheries Sector" of the Department of Animal Husbandry Dairing and Fisheries, Ministry of Agriculture, New Delhi held at Bhubaneswar on 29th January 2013

Dr. Sethi, S. N., attended fishermen meet on Artificial Reefs at Pillumedu and Pudhupuppam, Cuddalore District on 7th November 2012

Meeting with Deputy Director and Assistant Director, Tamil Nadu State Fisheries Department, Cuddalore for identification of fishing villages for IDLAM data collection on 7th November 2012

Dr. Shoba Joe Kizhakudan, attended fishermen meet on Artificial Reefs at Pillumedu and Pudhupuppam, Cuddalore District on 7th November 2012

Meeting with Deputy Director and Assistant Director, Tamil Nadu State Fisheries Department, Cuddalore for identification of fishing villages for IDLAM data collection on 7th November 2012

Participated as resource person in the Fifth Regional Training Programme on Code of conduct for Responsible Fisheries (RTCCCRF) organised by the Bay of Bengal Programme Inter-Governmental Organisation (BOBPIGO) and delivered a lecture on "Data processing and its application in Fisheries Management" during 19th January - 2nd February 2013

Dr. Shubhadeep Ghosh, participated in an interface meeting inviting technology developed by ICAR Institutes and stake holder departments pertaining to Andhra Pradesh for production enhancement, at CRIDA, Hyderabad on 21st April 2012

Participated in the '21st meeting of the Regional Committee of Zone II' at NAARM, Hyderabad organised by CIFRI, Barrakpore, Kolkata during 19th - 20th July, 2012

Dr. Shyam Salim, served as the Session panelist for the panel on Overcoming Gender Inequalities in Fish Supply Chains to Inform Policy and Action with Hillary Egna, AquaFish CRSP (Collaborative Research), and Meryl Williams (FAO) during 16th - 20th July 2012

MDP workshop on Supply Chain management in Agriculture at National Academy of Agriculture Research Management, (NAARM) Hyderabad during 15th - 19th October 2012

Academic Council meeting of Kerala Agricultural University at Vellanikkara, Trichur on 14th November 2012

Dr. Sivadas, M., attended the National strategic workshop on small scale fisheries, India organized by BOBP at Chennai during 1st - 11th January 2013

Dr. Sobhana, K. S., participated in the National Workshop on Fish Cell line development and storage at NBFGR, Lucknow on 19th April 2012

Attended the Department of Biotechnology (DBT) Task Force Meeting at New Delhi during 3rd - 4th December 2012

MDP workshop on 'PME of Agricultural Research Projects- Learning and Capacity Building' at NAARM, Hyderabad during 21st - 25th January 2013

Shri. Sreenath, K. R., attended Krishi Mahotsav at Porbandar on 28th May 2012

Dr. Srinivasa Raghavan, V., attended National workshop on "Foresight and future pathways of Agricultural research through youth in India at NASC complex, New Delhi during 1st - 2nd March 2013

Dr. Swathilekshmi, P. S., participated as faculty for the summer school on Gender Mainstreaming for Resilient Agriculture at the Directorate of Research on Women in Agriculture, Bhubaneswar Odisha, and delivered lectures on Gender Dimensions on Marine Fisheries Sector in India and on ITK's and Climate Change on 1st August 2012

Smt. Swatipriyanka Sen, attended Krishi Mahotsav at Porbandar on 28th May 2012

Attended the state level seminar on "Aquaculture development of Gujarat" arranged by College of Fisheries, Veraval and presented on the topic "Role of Research Institutes in Aquaculture development of Gujarat" on 31st May 2012

Dr. Veerendra Veer Singh, attended CIC meeting and Review Workshop of GEF funded subprojects at NASC Complex, New Delhi during 14th - 17th May 2012

Meting number 7 of the JNPP Committee at Bombay Natural History Society on 4th June 2012

Participated as nominated member in the ballast water committee meeting at DG Shipping Office on 7th June 2012

Final Consultation Workshop on GEF India Country Portfolio Evaluation in New Delhi on 8th November 2012

Received Certificate of Appreciation from NAIP during 22nd Regional Committee meeting at ICAR, Research Centre, Goa during 9th - 10th November 2012

Participation in meeting at CESCRA, New Delhi on m-KRISHI® and m-KRISHI® Fisheries with CPI and others for finalising roadmap for the m-KRISHI® Fisheries programme for Ganjam and Raigad districts, during 13th - 14th December 2012

Dr. Vijayan, K.K., attended and presented an invited paper in the "National Conference on Aquaculture: Fish for Billion" organised by CIFA, Bhubaneswar during 15th - 16th March 2012

Attended and made a presentation on 'Current status of marine finfish and shellfish diseases in India' in the National consultation on "Development of surveillance programme for Aquatic Animal Diseases" at NBFGR, Lucknow during 17th - 18th April 2012

Dr. Vinod, K., Attended fishermen meet held at Chemmencherry for artificial reef project on 23rd November 2012

Fishermen meet held at ten villages of Cuddalore District in connection with NICRA project, on 19th December 2012

Training on "Advanced Techno Management Programme" at ASCI, Hyderabad during 25th February - 29th March 2013

Dr. Vipinkumar. V. P., participated in the inauguration of the Business Incubation Meet of ZTMBPDU by the Director General, ICAR at CIFT, Cochin on 5th April 2012

Training programme on "ICTs for Agricultural Information management and Networking" at MANAGE, Hyderabad during 16th - 20th July 2012

National Convention and Exposition in the Next Frontier of Agri-Business and Technology being organized by the Industrial Organisation Bureau, Govt. of Gujarat, Mahatma Mandir, Gandhinagar' during 3rd - 6th September 2012

Participated in the international meeting for the 'Expert Consultation on Managing Trans-boundary Diseases of Agricultural Importance In Asia & Pacific" at NASC Complex, New Delhi during 10th -12th October 2012

Dr. Zacharia, P. U., attended the Annual Review Meeting of the NICRA at CRIDA, Hyderabad during 12th - 14th June 2012

National Task Force (NTF) of the Bay of Bengal Large Marine Ecosystem (BOBLME) Project at Visakhapatnam on 21st December 2012

Pre-SAP Consultative meeting of BOBLME at Pondicherry on 21st January 2013

Deputation Abroad

Dr. Syda Rao, G., Director, participated and presented a paper on "Collaborative efforts on conservation and management of charismatic species - considerations for India" in the second Bi-National Stakeholder Consultation on Sustaining the Gulf of Mannar Ecosystem and its Resources organized by the Bay of Bengal Programme Inter-Governmental Organization (BOBP-IGO) along with the Bay of Bengal Large Marine Ecosystem (BOBLME) Project at Jaffna, Sri Lanka during 18th - 22nd June 2012

Dr. Abdussamad, E. M., attended the Second Working Party on Neritic Tunas (2WPNT) organised by Indian Ocean Tuna Commission (IOTC) and presented a paper entitled 'Status and potential of neritic tunas exploited along the Indian EEZ' at Penang, Malaysia during 19th - 21st November 2012

Dr. Asha, P. S., attended and presented a paper on "The status of sea cucumber fisheries and management in India" in the workshop on "Sea Cucumber Fisheries an Ecosystem Approach to management in the Indian Ocean" organized by Food and Agricultural Organization (FAO) and Western Indian Ocean Marine Science Association (WIOMSA) at Zanzibar, Tanzania during 12th - 16th November 2012

Dr. Geetha Sasikumar, attended the Training on "Age estimation of squid and fish" under the NAIP project "Utilization strategy for oceanic squids (Cephalopoda) in Arabian Sea: A value chain approach" at the Department of Primary Industries (DPI), Fisheries Victoria, Queenscliff, Australia during 23rd March - 1st April 2012

Dr. Gopakumar, G., participated and presented a paper on "Collaborative efforts on conservation and management of charismatic species - considerations for India" in the second Bi-National Stakeholder Consultation on Sustaining the Gulf of Mannar Ecosystem and its Resources organized by The Bay of Bengal Programme Inter-Governmental Organization (BOBP-IGO) along with the Bay of Bengal Large Marine Ecosystem (BOBLME) Project at Jaffna, Sri Lanka during 18th - 22nd June 2012

Dr. Jagadis, I., attended the workshop on "Nutraceuticals from Muricidae Molluscs in Australia during 1st -16th November 2012

Dr. Jeyabaskaran, R., participated in the BOBLME SAP Indicators workshop on 'Marine living Resources' held at Phuket, Thailand during 30th - 31st May 2012

Dr. Kajal Chakraborty, attended the workshop on "Nutraceuticals from Muricidae Molluscs in Australia during 1st - 16th November 2012

Dr. Laxmilatha, P., attended the Mussel Standards Committee Meeting organized by the Global Aquaculture Alliance USA, as a member of the 12 member Mussel Standards Technical Committee to consolidate the document on Best Aquaculture Practices (BAP) for mussel farming, at Manchester, United Kingdom during 18th - 19th June 2012

Dr. Prathibha Rohit, attended the 'MTI 2012 Avian and Marine Tracking Conference' at Columbia, Maryland organized by Microwave Telemetry, Inc., during 27th - 30th March 2012

Attended and presented a paper entitled 'Status and potential of neritic tunas exploited along the Indian EEZ' in the Second Working Party on Neritic Tunas (2WPNT) organized by Indian Ocean Tuna Commission (IOTC) at Penang, Malaysia during 19th - 21st November 2012

Dr. Ramachandran, C., deputed to work as Small Scale Fisheries and Human dimension expert for the FAO evaluation team assessing the support of FAO in implementing CCRF and specific studies were conducted three phases in Ghana, Thailand, Indonesia and Bengladesh during October 2011 - May 2012

Shri. Sanil, N.K., attended the Workshop on 'Regional Proficiency Testing Programme for Aquatic Animal Disease Labortaories in Asia-Pacific' funded by NACA held at Bangkok, Thailand during 25th - 26th July 2012

Dr. Shyam Salim, attended the 16th biennial conference of IIFET 2012 Tanzania, on "Visible Possibilities: The Economics of Sustainable Fisheries, Aquaculture and Seafood Trade" organized by University of Dar E Salam and International Institute for Fisheries Economics and Trade held at Grand Hyatt, Kilimanjaro and University of Dar E Salam, Dar- E Salaam, Tanzania during 16th - 20th July 2012

Dr. Vijayan, K.K., atended presented country report on 'Population Genetics and Lab capabilities' at the Eight Nation Bay of Bengal Large Marine Ecosystem (BOBLME) governing Working Group Meeting on 'Assessing Genetic Stock Structure of Indian Mackerel (Rastrelliger kanagurta) for Fisheries Assessment' in Colombo, Srilanka during 28th - 29th May 2012

Workshop on "Nutraceuticals from Muricidae Molluscs in Australia during 1st - 16th November 2012

Dr. Zacharia, P.U., attended the Regional Fisheries Management Advisory Committee meeting of BOBLME at Bangkok, Thailand during 25th - 26th June 2012

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Hon'ble Union Agriculture Minister Shri. Sharad Pawar visits marine cages at Karwar

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