

**MADRAS RESEARCH CENTRE OF CMFRI  
CHENNAI**

## MAJOR ACHIEVEMENTS OF RESEARCH (2009-'14)

### MARINE CAPTURE FISHERIES

#### FISHERIES RESOURCE ASSESSMENT DIVISION

FRA/ASSESS/01 **Development of knowledge based information system for marine fisheries sustainability**

FRA/ASSESS/02 **Decision support system for marine fisheries management**

FISHCMFRISIL201200100001 **GIS based management advisory support information system for the marine fisheries sector.**

Assessment of landings and catch estimates of Chennai zone were carried out. Data collected from different fish landing centres along south Andhra Pradesh – north Tamil Nadu coast by technical staff of the FRA Division were processed and sent to Head, FRA Division, CMFRI Kochi.

FISHCMFRISIL201200200002 **Remote sensing assisted biodynamic forecasting paradigm for Indian marine fishery resources**

Inventory of species composition in commercial fishery of all the gears operated from Kasimedu Fishing Harbour, Chennai has been made.

#### PELAGIC FISHERIES DIVISION

PEL/IDP/03 **Strategies for sustaining tuna fishery along the coast of India**

FISHCMFRISIL201200700007 **Development of strategies to sustain the stock and fishery of large pelagics in Indian waters.**

Fishery & biology of tunas (2009-'14) and seer fish, barracudas, dolphin fish & cobia (2012-'14) were studied. All these fishes are exploited by trawl nets and mechanized gill nets. Biological data on dominant species were recorded for derivation of growth and stock indices.

DNA barcoding has been completed for 8 commercially and economically important species of tunas namely *Auxis rochei*, *Auxis thazard*, *Katsuwonus pelamis*, *Euthynnus affinis*, *Sarda orientalis*, *Gymnosarda unicolor*, *Thunnus albacares* and *Thunnus tonggol* (NCBI GenBank accession numbers GQ199626-GQ199630, GU190377 – GU190378, JQ617860).

FISHCMFRISIL201200800008 **Development of Fishery Management Plans for sustaining Marine Fisheries of Tamil Nadu and Puducherry. (2012-'14)**

Marine fishery along north Tamil Nadu & Puducherry coast by boats operating trawl nets, gill nets, hook & line and seines from Chennai, Puducherry & Cuddalore was monitored. Species composition, catch rates, length composition, feeding biology and reproductive biology was studied for major species - 3 sardines, 1 mackerel, 1 ribbonfish, 2 anchovies, 2 seer fish, 2 tunas, 2 rays, 2 sharks, 6 threadfin breams, 3 silverbellies, 3 pomfrets, 2 flatfishes, 2 lizardfishes, 3 goatfishes, 4 croakers, 3 perches, 3 shrimps, 2 lobsters, 2 crabs and 3 cephalopods. Hydrographic data were collected from 6 stations, from Ennore to Thiruvanimiyur. Eight new/rare records of finfish and shellfish species were documented.

## DEMERSAL FISHERIES DIVISION

### DEM/IDP/01 Management advisories for sustaining marine fisheries of Tamil Nadu & Puducherry

Monitoring and strengthening of data base on fishery and biology of major pelagic, demersal, crustacean and molluscan resources occurring in trawl net /gill net / hook & line landings along Tamil Nadu and Puducherry coast was continued (April '09-March '12) from Chennai, Tuticorin and Mandapam. The landings of important resources by different gears at major landing centres along the coast were studied for quantification, composition and biological profiles of dominant species. BRPs and stock status were assessed for 2 species of sardines, 2 of whitebaits, 1 seerfish, 1 ribbonfish, 1 carangid, 1 mackerel, 3 species of tunas, 2 species of rays, 1 shark, 6 of threadfin breams, 5 silverbellies, 4 sciaenids, 3 lizardfishes, 3 perches, 3 species of shrimps, 2 of lobsters, 2 crabs and 2 species of cephalopods. Population parameters of 7 pelagic fishes, 11 demersal fishes and 4 crustaceans were estimated. MSY and  $F_{msy}$  for 5 pelagic, 3 demersal, 2 crustacean and 1 molluscan resources were estimated.

### DEM/IDP/03 Carbon sequestration potential of Indian seaweeds

Carbon-fixing efficiency & emission rates of brown alga *Padina* sp. & red alga *Kappaphycus alvarezii* were estimated.

### FISHCMFRISIL201200500005 Assessment of Elasmobranch Resources in the Indian waters

Elasmobranch landings along the Indian coast were monitored at 4 centres in Gujarat, 3 in Maharashtra, 2 in Karnataka, 7 in Kerala, 8 in Tamil Nadu and 1 centre in Andhra Pradesh. Data on catch statistics, enumeration of large elasmobranchs landed, cataloguing of available species in the Indian waters, confirmation of taxonomic status, biology and population characteristics, assessment of vulnerability status and awareness generation among fishermen communities on the need to conserve this resource were the focal areas.

## MOLLUSCAN FISHERIES DIVISION

### FISHCMFRISIL201201200012 Development of Fishery Management Plans (FMPS) for the bivalve fisheries of India.

The Pranangada water bodies near Pulicat Lake and the Palar estuary were surveyed for clam and oyster beds.

### FISHCMFRISIL201201300013 Evaluation of ornamental gastropod fisheries in India and assessment of shellcraft industry.

Data were documented on fishery and trade of the sacred chank, *Turbinella (Xancus) pyrum* caught by trawlers and entangled in small numbers in indigenous boat seines operated from FRP boats/catamarans in shallow coastal areas of Tranquebar, Pudupattinam, Sinnangudi, Kaveripatinam, Melamookkarai and Tirumulaivasal.

## CRUSTACEAN FISHERIES DIVISION

### CF/IDP/02 Resource damage assessment in marine fisheries: impact of selective fishing of juveniles and by-catch and discards in trawl fisheries

Quantitative and qualitative analysis of the low-value by-catch (LVB) of trawl operations from Chennai was done, with special emphasis on the extent of removal of juveniles of commercially important finfishes and shellfishes. Marketing and utilization pattern of the LVB was also evaluated.

### FISHCMFRISIL201200900009 GIS based resource mapping of distribution and abundance of finfishes and shellfishes off Indian coast for suggesting operational based strategies for fisheries management

Major and minor fish landing centers from Ongole district to Puducherry were surveyed. Data on GPS readings of fishing grounds and reefs, their area and extent, information on wind and current pattern, species caught, craft and gear operated, gearwise catch & effort and seasonal variations in operations were collected for trawl operations from Chennai and for gill net operations from Kovalam. Juvenile composition and occurrence of spawners of 20 finfish & shellfish species of commercial importance were monitored. Coastal fishing grounds for seerfish off Kovalam were mapped through fishermen participation.

## FISHERY ENVIRONMENT MANAGEMENT DIVISION

### FEM/01 Impact of anthropogenic activities on coastal marine environment and fisheries.

The seasonal variation in important hydrographic variables (temperature, salinity, pH, dissolved oxygen, total dissolved solids, chlorophylls a, b, & c, gross and net primary productivity, nitrate, ammonia and phosphate) were monitored from Ennore, Periakuppam and Chennai fisheries harbour. Hydrology and beach litter were monitored from Marina, Besant Nagar and Thiruvanmiyur. Samples of water, sediment and fish tissue (*Rastrelliger kanagartha*, *Nemipterus* spp, *Parapenaeopsis maxillipedo*, *Metapenaeus dobsoni*, *Perna* sp., *Sepia* sp., and *Loligo* sp.,) were analysed for heavy metals mercury and arsenic using Induction Couple Plasma Technique.

### FEM/02 Impact and yield study of environmental changes on distribution shifts in small pelagics along the Indian coast

The hydrographic variables at Marina were monitored. Seasonal variations in phytoplankton and zooplankton were studied. Morphometry, gut content analysis of Indian mackerel and oil sardine was carried out. Otoliths of the two species was extracted and sent to HQ for chemical study (strontium and calcium content). Altogether 1797 numbers of oil sardine and 1891 numbers of Indian mackerel were analysed. Tissue samples of the two species was collected and sent to HQ for genetic studies.

### FEM/03 Development of fisheries ecosystem restoration plans for critical marine habitats

The coastal areas around Chennai were surveyed for locating habitats such as mangroves, sea grass and coral reefs, and the information documented was strengthened from a historic perspective through fishermen interaction.

**FISHCMFRISIL201201800018 Pollution and litter in the coastal and marine ecosystem and its impact**

Water samples and sediment samples from six stations were collected on a quarterly basis and fish tissue samples on a monthly basis. Marine litter was collected from locations near Chennai, Marina, Besant Nagar and Thiruvanmiyur. An extensive survey for beach litter was conducted from Point Calimere to Pulicat during February 2014 covering 32 locations. The 32 locations were spread along north-south in Nagapattinum, Karaikal (UT), Cuddalore, Puducherry (UT), Villupuram, Kancheepuram, Chennai and Thiruvallur.

**FISHCMFRISIL201201900019 Investigation on the ecosystem process of critical marine habitat and development of protocols for restoration**

Hydrographic data including temperature, salinity, pH, dissolved oxygen, gross and net PP were collected from 6 stations, viz. Ennore, Periakullam, Marina, CFH, Besant Nagar and Thiruvanmiyur.

**MARICULTURE DIVISION**

**MD/IDP/01 Technology development for seed production of shellfish**

**MD/IDP/02 Development of diversified mariculture systems**

**FISHCMFRISIL201202400024 Development and standardization of seed production technologies for selected high value finfishes and shellfishes**

**LOBSTERS**

Hatchery raised seed of *Thenus unimaculatus* raised in 340 days and wild collected seed of *T. unimaculatus* and *Petrarctus rugosus* matured in captivity, mated and spawned. Different recirculatory systems were tried out (with *in situ* sand substrate and with external biofilters) successfully. Breeders of *Panulirus versicolor* and *P. polyphagus* were also raised in captivity from wild juveniles and sub-adults. *P. ornatus* juveniles collected from the wild matured and spawned twice in captivity.

Trials on live transportation of sand lobster broodstock and seed of 15-20 g size showed that broodstock can be transported under wet conditions (semi-moist) without any problem in 2-3 hours while the seed can endure wet condition for up to 12 hours.

Improved larval survival in mass rearing of *T. unimaculatus* & *P. rugosus*, and early larval rearing of *P. ornatus* and *P. versicolor* were achieved. Seed formation of *T. unimaculatus* was achieved in three cycles with survival rates of 10%, 40% and 16%. Protocols were developed for stocking density at various stages of larval development in spiny and sand lobsters.

Improvisations in sand lobster larval rearing system were carried out in seawater treatment methods, rearing system design and environmental manipulation, feed interventions, particularly feed enrichment & manipulation of nutritive quality of bivalves using microalgae for use as larval feed, and microbial interventions, particularly phage therapy and ozone treatment to control luminescent bacterial infections.

Biochemical analysis of eggs and larval stages at starvation / feeding/ moulting / infection etc., were carried out to study variations in lipid and amino acid profile. Embryonic development in sand and spiny lobsters was studied on a daily basis and the impact of temperature and salinity was examined.

**INDIAN HALIBUT *PSETTODES ERUMEI***

Preliminary studies on live collection, quarantine and holding was carried out from 2012. Volitional spawning was observed in one female in August 2013, releasing approximately 60,000 eggs, with the male in the tank responding simultaneously. While early cell division was noticed, beyond 16 hours, the eggs turned opaque and settled at the bottom of the tank.

**MD/CBA/01 Innovations in sea cage farming and development of sustainable Capture Based Aquaculture (CBA) systems**

**FISHCMFRISIL201202500025 Innovations in sea cage farming and coastal mariculture**

Parallel experiments on sea bass juvenile nursery rearing and grow out in cement tanks and in open sea cages carried out. Site surveys were carried out in Thiruvallur district and Kancheepuram district for carrying out capture-based cage farming demonstration programmes. Compatibility experiments on rearing mullets, rabbit fishes, black pomfrets and sergeant fishes in lobster cages gave good results. Survey for finfish seed in and around Chennai and Kancheepuram Districts was done and local saline creeks & reservoirs adjacent to the Buckingham canal were identified for finfish and crustacean seed. Small PVC cage frames (1x 2x 1.5 m) were fabricated and tested for their buoyancy and load bearing in the tanks at the laboratory. Nursery rearing (in seawater) of *Chanos*, *Mugil cephalus*, *Megalops* sp and *Gerres* sp. was done successfully. One GI frame cage (1½" GI pipe / "c" class / 5 m outer diameter / 4 m inner diameter / 1 m rail height/ 4 m rail ring diameter) was designed, fabricated and installed in the open sea off Kovalam for lobster fattening. The cage was operated by the fishermen society of the Kovalam village and the harvest yielded Rs 32,000.00. One GI frame cage (1½" GI pipe / "c" class / 3 m outer diameter / 2 m inner diameter / 1 m rail height/ 2 m rail ring diameter) was designed and fabricated for cage rearing of finfish. In March 2014, 17 cm sized juveniles of cobia were stocked in 2m ID GI cage and seabass juveniles of 12-14 cm in the larger cage. All the cage operations are being carried out with the active involvement of a team of 10 trained fishermen youth (Association of Kovalam Progressive Fishermen – AKPF).

**MARINE BIOTECHNOLOGY DIVISION**

**MBTD/NUT/01 Formulation and evaluation of larval and growout feed for marine crabs, lobsters, ornamentals and cage farmed finfish (2009-'12)**

**FISHCMFRISIL201202700027 Aquatic feed biotechnology for mariculture and aquaculture (2012-'14)**

Pellet feed diets were developed for broodstock of spiny lobsters *P. ornatus*, *P. versicolor* and *P. polyphagus*. Broodstock of *T. unimaculatus*, however, did not respond to pellet diets, but showed partial response with semi-moist diets. High protein diet incorporating fish silage as base ingredients for pellet feeds were prepared with low cost binder and starch input for reducing the cost of production. At the end of the experiment, after 180 days, FCR of animals fed with clam, oil sardine, commercial pellet feed and our formulated pellet feed were 1:2, 1:6, 1:9 and 1:7, respectively. The behavioral/feeding response of sand lobsters to natural dietary items (clams, fishes, sand worm) was examined, and the possible cues available in the clam mantle fluids/tissue and other raw feeds such as fish extract and sand worm extract were studied to determine the factor(s) responsible for the feed preference of lobsters. The raw diets were also tested for the release of volatile compounds/free amino acids, and the relation to the animal's feeding responses.

**MBTD/PAT/01 Pathogen profiling, diagnostics and health management in maricultured finfish and shellfish**

**FISHCMFRISIL201202600026 Health management in selected finfish and shellfish for mariculture and aquaculture and bioprospecting for marine resources.**

Assessment of bacterial flora associated with the brooders of spiny and sand lobsters was carried out. Monitoring of the water samples from sump, reservoirs, pump input, rapid sand filter and wet lab was done regularly. The external surface of each lobster was examined for evidence of blisters, pitting, erosions or other damages to the carapace, appendages and tail. Various combat measures like phage therapy and ozone treatment for luminescent bacterial infections in sand lobster larval rearing systems were tried out.

**FISHCMFRISIL201202800028 Genetics, genomics and biotechnological applications in mariculture and fishery resources management.**

Studies on the dynamics of gonadal development in female sand lobster, *Thenus unimaculatus* were carried out. Changes in the ovary and the GSI during the reproductive cycle of the sand lobster were evaluated based on morphological, biochemical and histological observations. For studies on the characterization of the yolk protein, vitellogenin (Vg) gene, PCR using a pair of Vg gene specific primers based on the Vg gene sequence of other crustacean species was carried out, using total RNA extracted from ovary and hepatopancreas tissues of a reproductively mature female.

**FISHCMFRISIL201202900029 Development of tissue culture technology for *in vitro* production of pearls from the black lip pearl oyster *Pinctada margaritifera* and the refinement of *in vitro* pearl formation in *Pinctada fucata***

A new tissue/cell culture facility was established at the Madras Research Centre of CMFRI. *In vitro* culture experiments were carried out with mantle tissue of green mussel, *Perna viridis* and the blacklip pearl oyster *Pinctada margaritifera*. Different culture media including Leibovitz's L-15 medium, Medium 199 (M199) and sterile sea water were compared for the culture of mantle tissue explants. Effect of adding supplements such as Foetal Calf Serum (FCS), lipid mixture and yeast extract solutions, on growth and proliferation of mantle epithelial cells was also studied. Cell cultures were assessed in terms of culture initiation, cell yield and susceptibility to contamination.

**MBTD/BIOT/02 Biotechnological applications in mariculture and conservation**

DNA barcoding has been completed for **8 species of economically important marine catfishes** namely *Arius arius*, *Arius subrostratus*, *Arius maculatus*, *Osteogeneiosus militaris*, *Arius jella*, *Arius sona*, *Arius caelatus* and *Arius tenuispinis* (NCBI GenBank accession numbers FJ664341, FJ624208, JQ697691, JQ697692, JQ697693, JQ697694, JQ697695, JQ697696).

**MARINE BIODIVERSITY DIVISION**

**FISHCMFRISIL201201600016 Investigation on vulnerable coral reef ecosystems of Indian waters with special emphasis on formulation of management measures for conservation.**

Deep-sea sponge species new to science (*Semperella megaloxea* sp. nov.) from Andaman waters was collected and registered in World Porifera Database (WPD) and World Register of Marine Species (WORMS) Accession No. BB.1.1.2.1. Cited in the 'World Porifera Database' and the 'World Register of Marine Species'. Experiments on the propagation of soft coral *Dampia pocilloporaeformis* were carried out to study the substrate preference, attachment and growth. Removal of *Sinularia kavarattiensis* explants by cotton thread noose technique was standardized. The explants mounted on rock stones can be conveniently used for planting in large aquaria using as community display tank. Studies on the propagation of soft coral *Lobophytum pauciflorum* were carried out.

**FISHCMFRISIL201201700017 Assessment of fishing impacts on biodiversity loss with special reference to the threatened species, to formulate management options for their protection**

Biodiversity destruction in bottom set lobster gill net off Vethalai and the destruction caused by mini trawl in Palk Bay were assessed through quantitative and qualitative evaluation of the catch and by-catch. Methodologies for estimation of annual loss due to trawl by catch (Bio economic model) and for valuation of coral reefs by Millennium Ecosystem Analysis (MEA) have been standardized.

**SOCIOECONOMICS, EXTENSION & TECHNOLOGY TRANSFER DIVISION**

**SEE/PEM/01 Benefit cost analysis of marine fishery business and alternative investment options**

Price details for major fishes in landing center, wholesale and retail markets of Chennai have been collected and analyzed during 2010-11. Size wise variation at the landing centre price was highest for seer fish, pomfrets, penaeid prawns, non penaeid prawns and sharks. Economic efficiency of mechanized fishing and price behaviour of major marine fishes in Chennai, Nagapattinam and Nizampatnam were studied during 2011-12.

**SEE/PET/01 Impact of WTO regulations on Indian fisheries trade: A policy perspective**

Studies on fishery subsidies in India and the world were compiled. Database of subsidy programs reported in marine capture fisheries for 148 coastal countries was compiled spanning 1989 to 2008. Tradeoffs in domestic marketing and international trade of high value fish products in Chennai, Tamil Nadu were studied. Data on the pattern or expenditure for fish consumption, buying behavior, constraints in high value fish consumption, willingness to pay for high value fishes were collected from 240 consumers using well developed questionnaire.

**SEE/RE/05 Total factor productivity analysis of marine fisheries in India**

Diesel and kerosene subsidy for different fisheries sectors in Tamil Nadu during 1990-91 to 2010-11 were compiled. Tamil Nadu fisheries expenditure and subsidies on different heads from 1982-83 to 2011-12 were compiled from secondary sources during 2011-12. Various schemes formulated by State Fisheries Department to enhance welfare of the fishing communities were also assessed.

**FISHCMFRISIL201202000020 Economics of marine fisheries & sustainable management: Policy issues & interventions**

Economics of tuna fishing were worked out for MD trawlers operating from Chennai, Nizampatnam and Nagapattinam.

**FISHCMFRISIL201202300023 Supply Chain management of marine fisheries sector in India**

The detailed break-up of costs incurred by market intermediaries of Chennai retail fish markets during 2012-13 was analysed. Three wholesale fish markets and fifty eight retail markets were surveyed in Chennai, Kancheepuram and Tiruvallur Districts. Viz., Saidapet, Chintadripet and Vanagaram during 2013-14.

## SPONSORED PROJECTS

### A VALUE CHAIN ON HIGH VALUE SHELLFISHES FROM MARICULTURE SYSTEMS (NAIP Project)

A lobster hatchery facility (with broodstock maturation unit, spawning unit, quarantine unit and LRT unit) was established in the New Mariculture Complex at Kovalam, Chennai. Nearly 400 adult sand lobsters can be held in the maturation facility. Two hundred juveniles were raised to adult stock and successful mating and egg laying was obtained in 50. About 18 animals spawned second time after completing one successful spawning and incubation. Two successive batches of sand lobster *Thenus unimaculatus* phyllosomal larval rearing during September 2012 produced final phyllosoma, nistos and seed. The seed produced reared in the nursery facility of the complex. Long shallow-basin raceways with circulating water connected to a filtration assembly, with low sedimentation rate, have been designed for mass larval rearing, with capacity to hold entire hatchlings from single brooder. Larval hatchery chamber has light controlled and temperature controlled (using air-conditioners and humidifiers) chamber housing the larval and nursery raceway system. A modification in the LRT and the water flow management was carried out with different stocking densities of phyllosoma. The new larval facility was upgraded with charcoal loaded pressure filters and cartridge filters and an additional ozoniser. Tests of larval efficiency against low salinity (27 - 32 ppt) showed that larval survival was poor at salinities less than 30 ppt. Phage therapy was attempted to develop autoimmunity in the larval mass against luminescent bacterial invasions. The *Vibrio* sp. cultured from the infected larvae was studied for establishing the metagenomic position of the pathogen in the larval flora and surrounding media, its abundance, activity and inhibiting properties. The population of microbes in the system will be magnified to derive the beneficial ones and to understand the harmful effects of the pathogen. Embryonic development in the egg was studied on a daily basis and the impact of temperature and salinity was evaluated. A significant finding is that temperature appears to be directly influencing the egg diameter, incubation period and larval size.

Molecular taxonomy works were undertaken to confirm the identity of the species and to remove ambiguities in identification. Nearly 16 sequences were tested (16S, 18S & COI) from samples of sand lobsters held in the Laboratory, and deposited in NCBI. The sequence of sand lobsters from the Chennai coast was found to match the sequence deposited for *Thenus unimaculatus*.

Biochemical analysis of larval stages at starvation / feeding / moulting / infection etc., were carried out to study variations in lipid profile. Lipid and amino acid profiles of the eggs in different stages of development were also analysed. A soft gel pellet bound with micronized ingredients and shaped to the required diameter and texture was developed for co-feeding the phyllosoma with the identified raw and live feeds.

Protocols were developed for for broodstock maturation and breeding in captivity, mass larval rearing upto final larval stages and settlement stage, with maximum survival rate of 20% upto final phyllosoma stage, grow-out of juvenile and seed-sized sand lobsters in closed recirculatory system at high densities with final production rate of 3-5 kg/sq.m., nutrition and health requirements and protocols for long distance transport of live lobster.

Trials on product development of sand lobster through value addition were done. Poster on the larval stages of *Thenus unimaculatus* was prepared, and was released by the Director.

Marketing was done in five star hotels in Chennai and variety of value added recipes and cocktail were prepared for promotion in the domestic market and among local consumers.

A training programme on lobster seed production was conducted by the Tropical Aquaculture Division of the Australian Institute of Marine Science (AIMS), Townsville (QLD, Australia) for Dr. Joe K. Kizhakudan for a period of 14 days, from 31<sup>st</sup> March to 16<sup>th</sup> April 2010. The training programme focused on different aspects of lobster hatchery rearing, including broodstock maintenance and performance, larval holding systems, water quality management, morphometric staging of larvae, nutritional profiling, feed preparation and feeding regimes and larval health issues & combat measures. One SRF has registered for Ph.D. under the project, at University of Madras under the supervision of Dr. Joe K. Kizhakudan, Co-PI.

### **OPEN SEA CAGE DEMONSTRATION FARMS IN INDIA (Under NFDB funding)**

Two cages were launched off the coast towards north of Chemmenchery village, and south of Kovalam at 4 fathoms depth for open sea cage farm demonstration on a fishermen participatory mode. An MOU was signed between the fishermen at Chemmenchery and MRC of CMFRI on December 31, 2009. 7000 sea bass with average size of 170-250 mm were stocked over a period of three days. The rearing period was six months. **Bumper harvest of 3.5t was obtained. The net production sold to TNFDC and a private retailer was 3.1 t. The sale proceeds from the harvest (Rs. 5,02,000/-) were handed over to the fishermen of Chemmenchery.** Two thousand lobster seed stocked in February 2010 grew to >0.74 g/day in 4 months, with a net survival rate of 80%. Nearly 500 mullet seeds grew to 300 g size. About 50 kg of rabbit fishes and 5 black pomfrets. At final harvest 200 kg of seed material gave a harvest biomass of 306 kg. Harvest of lobster grown in open sea cage in Pulicat was done in June 2009 and the value realized (Rs 27,750/-) was handed over to the fishermen who had participated in the demonstration programme.

### **NATIONAL INITIATIVE ON CLIMATE RESILIENT AGRICULTURE – MARINE FISHERIES COMPONENT**

Data on Sea Surface Temperature, Chlorophyll and Wind speed were downloaded from the websites of ICOADS (NOAA) and INCOIS and preliminary analysis was done. Available fish catch data (CMFRI) was tabulated along with the environmental data and correlations were studied. Three regions, Chennai (14°N -80°E), Nagapatnam (10°N-80°E) and Kanyakumari (8°N-78°E) were selected for retrieving the SST data over the last 105 years, from ICOAD database. Data of 105 years were sorted for four seasons namely post monsoon, summer, southeast and northeast monsoon. The trawl catch from North Tamil Nadu coast by trawl boats operating from Chennai Fisheries harbour was related to the average annual sea surface temperature over a period of 10 years. A comparison of data collected (primary and secondary data) over a timeline on the availability of spawning fishes along the Chennai coast was carried out to understand any significant alterations in the natural spawning patterns. The Indian Oil Sardine was taken as a case study and the availability of ripe and spawning fishes was assessed from the different sets of data assimilated. A significant observation is the gradual shift in the spawning season from January-March during 1977-'78 to June in 2011-12. The spawning seasons of six major resources (being studied under NICRA) supporting the commercial fishery at Chennai were mapped – *Sardinella longiceps*, *Rastrelliger kanagurta* (pelagic fishes), *Nemipterus japonicus* (marine

demersal fish), *Mugil cephalus* (euryhaline demersal fish), *Metapenaeus monoceros* (shrimp), *Loligo duvauceli* (cephalopod). There was a positive correlation between spawning activity of the species with rainy days. Further studies are being carried out to study the relation between spawning of this fish and quantum of rainfall. A similar study has been initiated in *S. longiceps* also. Spawning peaks of green mussel *Perna viridis* were observed to coincide high surface water temperature in Pulicat Lake and Ennore backwaters.

**Mariculture Component:** The effect of temperature on the incubation period, hatching efficiency, egg diameter, larval size, survival and larval conversion rate in different species of spiny and sand lobsters was studied through real-time observations on captive reared broodstock and larvae and from data collected from previous studies and published information. All the characteristics studied were found to be impacted by slight variations in the water temperature. Some of these effects can be turned to advantage in manipulating environmental conditions to effect better breeding and growth performance in captivity.

**ITK Survey:** Logbooks for trawlers and gillnetters were prepared in both Tamil and English. These were distributed to fishermen at select centres along the coast and the information collected and documented. The information collected from the ITK questionnaires were compiled. Garrett ranking technique was used to rank the fishermen's perceptions on different climatic parameters & their importance and major problems in fishing in the last 20 years. Total number of respondents was 500 from 5 districts in Tamil Nadu covering Chennai, Thiruvallur, Kanchipuram, Kanyakumari and Cuddalore.

**Life Cycle Analysis – Carbon footprint of marine fishing & allied activities from Chennai Fisheries Harbour:** Mapping of carbon dioxide emission from the boat building yard, net fabrication units, fish catch, processing plants, ice plants and fish consumption based from Chennai Fishing Harbour was done in a 360° direction.

**Coastal vulnerability assessment in Cuddalore district of Tamil Nadu:** The impact of natural disasters like floods, cyclones and rising sea levels are evident in many coastal pockets of Tamil Nadu. A preliminary survey of the coastal districts in the state revealed that Cuddalore district has been the worst affected of all districts in the recent past. A group of ten villages (Thazhanguda, Sonankuppam, Sothikuppam, Rasapettai, Chithirai Pettai, Thammanampettai, Pettodai, Reddiarpettai, Samiyarpettai, Chinnur Pudupettai) based on climate change impact vulnerability indices, were selected and 100 households from each village were randomly interviewed under Integrated District Level and Sustainable Management (IDLAM) programme under the project on National Initiative on Climate Resilient Agriculture (NICRA). Vulnerability Indices developed based on indicators and sub-indicators of climate change following the method given by Patnaik and Narayan (2005) revealed that Pettodai village was most vulnerable, followed by Reddiarpettai, Sothikuppam and Thammanampettai.

## **IMPACT, ADAPTATION AND VULNERABILITY OF MARINE FISHERIES ON CLIMATE CHANGE (ICAR Network Project)**

The dominant small pelagic fishes, oil sardine (*Sardinella longiceps*) and the Indian mackerel (*Rastrelliger kanagurta*) were found to extend their distributional range to northern latitudes in the Arabian Sea and Bay of Bengal. It was also found that these small pelagics extend

their distribution to subsurface and midwater depths with the warming of these areas. The spawning season of two dominant demersals, the threadfin breams *Nemipterus japonicus* and *N. mesoprion* has shifted to cooler months off Chennai. From the sea surface temperature (SST) data prior to, during and after the 1998 coral bleaching events in the Andaman, Nicobar, Lakshadweep, Gulf of Mannar and Gulf of Kachchh regions of the Indian Seas, the Degree Heating Months (DHM) accumulations of the hotspot anomalies were estimated. Laboratory experiments were conducted on the effect of seawater temperature on seven marine phytoplankton species. The CO<sub>2</sub> emission of marine fishing boats was also estimated.

#### **STUDIES ON MARINE MAMMALS OF INDIA EEZ AND CONTIGUOUS SEAS**

During May and June 2009, eight boat based short surveys were undertaken in Cochin backwater areas. Between April and December 2009, five oceanic surveys were carried out onboard FORV *Sagar Sampada* to assess marine mammal diversity and their distribution in oceanic waters of Indian Seas and Indian Ocean. A total of 505 hours of survey effort was made in 71 days to cover about 3900.5 nautical miles during the period. A total of 27 sightings of two species of baleen whale and five species of delphinids were recorded, which comprised of about 1074 individuals. A total of 370 fishermen of different age groups, comprising 200 fishermen from nine districts of Maharashtra and 170 fishermen from three districts of Kerala were interviewed to collect indigenous knowledge of fishermen on marine mammals.

#### **BIOPROSPECTING OF GENES AND ALLELE MINING FOR ABIOTIC STRESS TOLERANCE (NAIP subproject under Component 4)**

Pure isolates of marine microalgae representing different habitats of Indian Coast (Gulf of Kachchh, Odisha, Andhra Pradesh, Tamil Nadu, Goa and hot springs in Himachal Pradesh) were isolated. Morphology (colour of culture, cell size, shape, cell inclusions, flagellar organization, movement patterns of the organism etc. by microscopic examination) and molecular (18S rDNA, rbcL, CO1 and ITS genes) techniques were employed for the accurate identification and characterization of the isolates. Complete characterization of 5 genes conferring tolerance to high salinity was carried out. Genes such as phytoene synthase, phytoene desaturase and desaturase *D* conferring tolerance to abiotic stressed conditions were partially characterized. Suppression Subtractive Hybridization (SSH) study has been carried out. From *Dunaliella* sp. SSH library (under salinity stress), 16 genes including 3 novel genes (not reported so far, some hypothetical proteins) were partially characterized, which might be conferring tolerance to the survivability of microalgae under hyper-saline conditions.

#### **UTILIZATION STRATEGY FOR OCEANIC SQUIDS (CEPHALOPODA) IN ARABIAN SEA: A VALUE CHAIN APPROACH (NAIP subproject under component 2)**

Nucleotide sequence of cytochrome oxidase subunit 1 gene was generated from samples of oceanic squids and analyzed with the NCBI BLAST and Barcode of Life Database. The sequences were also aligned with other related species and the phylogenetic tree was constructed using Neighbor Joining and Maximum Parsimony methods. Pairwise genetic distance (Kimura 2-parameter method) values were also calculated.

## **ESTABLISHMENT OF NATIONAL AGRICULTURAL BIOINFORMATICS GRID IN ICAR (NAIP Subproject)**

The bioinformatics works of the institute were coordinated with the fisheries domain NBFG, Lucknow and lead institute IASRI, New Delhi.

### **ICAR OUTREACH ACTIVITY ON FISH GENETIC STOCKS**

Molecular characterization of *Pinctada fucata* (Pearl oyster) and *Crassostrea madrasensis* (Edible oyster) collected from different natural habitats was carried out using different mitochondrial DNA markers like Cytochrome b, ATPase and Control region. Degenerate primers were designed & synthesized from regions having homology among different oyster species for the amplification of 650bp fragment of Cytochrome b gene.

### **WOMEN EMPOWERMENT AND FISHERIES SECTOR IN KERALA NATP PROJECT (During 2010-11)**

The role of fisherwomen in processing and marketing of fish and fishery products as a source of income generation and livelihood option in Kerala was evaluated. The levels of employment and income between fisherwomen involved in low value fish processing vis-à-vis value added fishery products and between fisherwomen as retailers and vendors were compared to estimate the social, political and economic empowerment of fisherwomen involved in processing and marketing of fish and fishery products in Kerala and to suggest policy options for empowerment of fisherwomen through fisheries oriented activities in Kerala.

### **TRIBAL SUB PLAN (2013-'14)**

**Capacity Building Training Programmes for Irula community in Thiruvallur and Kancheepuram districts of Tamil Nadu - hands on capacity workshop** - A series of two-day capacity building training programmes for 60 Schedule Tribe (Irulas) members from coastal villages of Thiruvallur and Kancheepuram districts was organized at the Kovalam Field Laboratory of the Madras Research Centre of CMFRI during 18-25 March 2014, under the Tribal Sub Plan. The training programmes aimed at helping them adopt sustainable livelihood options such as cage farming, marine ornamental fish culture and oyster and mussel farming, depuration and marketing. The trainees were awarded certificates on completion of the sessions at the end of the second day. The preliminary interaction and feedback was compiled for identifying the skill, interest and resource availability in each identified village for future programmes and effective technology transfer.

## **CONSULTANCIES**

### **Installation of artificial reef off Pulicat to enhance biological resources and livelihood of fishermen (for Chennai Water Desalination Plant)**

The project was implemented at Vairavankuppam village at a cost of Rs 16,94,000/-. The project was initiated prior to April 2009 and completed in August 2009. Artificial reefs were designed, fabricated and deployed off Vairavankuppam village by the fishermen on participatory mode after site selection through underwater surveys. Completion report has been submitted to the client organization.

**Establishment of four artificial reefs by fishermen on participatory mode along Tamil Nadu coast for marine fishery resources enhancement (for TN Fisheries Department)**

The project was implemented at Vairavankuppam village at a cost of Rs 40,00,000/- The project was initiated prior in March 2009 and completed in June 2010. Artificial reefs were designed, fabricated and deployed off Vairavankuppam village by the fishermen on participatory mode after site selection through underwater surveys. Completion report has been submitted to the client organization.

**Site selection and monitoring of artificial reefs in eleven selected locations in Tamil Nadu (For TNFD; code 6016000070)**

The project had commenced in October 2005 and was completed in April, 2009. Completion report was submitted to the Director of Fisheries. A video documentary was released showing the maturation of the deployed reefs and aggregation of fishes at the site.

**Installation of artificial reefs in nearshore waters of two districts in Tamil Nadu (6016000096) for IFAD assisted Post-Tsunami Sustainable Livelihoods Programme (PTSLP) of the Tamil Nadu Corporation for Development of Women (TNCDW)**

Start date: July 2011. Part I (Site Survey & selection) completed in August 2011. Deployment of 200 reef modules in the coastal waters off Goonankuppam village in Thiruvallur district and 200 off Kovalam in Kancheepuram district completed in March 2014. Impact study to be carried out for one year. Total fund: Rs 7,93,000/-

**Installation of Artificial Reefs in the inshore waters of four districts of Tamil Nadu (5001-1933) for IFAD assisted PTSLP (TNCDW)**

Start date: Dec 2011. Part I (Site Survey & selection) completed in March 2012. Deployment of 200 reef modules in the coastal waters off Maduthukuppam village in Nagapattinam district completed in August 2013 and 200 each off Anichankuppam in Villupuram district and Sothikuppam in Cuddalore district completed in March 2014. Deployment in Kancheepuram district to be completed in May 2014. Impact study to be carried out for one year. Total fund: Rs 19,90,000/-

**Installation of Artificial Reefs in the inshore waters in two villages in Kancheepuram district of Tamil Nadu (5001-1934) for Department of Fisheries, Tamil Nadu**

Start date: Dec 2011. Part I (Site Survey & selection) completed in April 2012. Deployment of 180 structures in Nemmelikuppam village and 180 in Mudaliarkuppam village in Kancheepuram district completed in February 2014. Impact study to be carried out for one year. Fabrication of reef structures for Vavathoorai village in Kanyakumari district completed; deployment in progress. Total fund: Rs 30,00,000/-

**Installation of Artificial Reefs in the inshore waters of seventeen villages along Tamil Nadu coast (4001-637) for Department of Fisheries, Tamil Nadu**

Start date: April 2012. Site survey and selection for deployment of artificial reefs in seventeen villages spread in the districts of Thiruvallur, Kancheepuram, Cuddalore, Nagapattinam, Pudukottai and Tuticorin has been completed. Invitation and award of tenders for fabrication and deployment of reefs is in progress. Total fund: Rs 2,60,80,000/-

**Marine Rapid EIA study and preparation of MEIA report for M/s Sindhya Power Generating Company Private Limited's 2 x 660 MW Coastal Thermal Power Project at Perunthottam village, Sirkazhi taluk, Nagapattinam district**

Start date: February 2011. Rapid impact study was carried out at the specified site through underwater survey, environmental and biological sampling, experimental fishing and laboratory tolerance tests. The project was completed and the completion report was submitted to the clients in December 2012. Total fund: Rs 21,80,000/-

**PUBLICATIONS**

**S**cientific papers

In journals (peer-reviewed; first author from the Centre )	: 30
In journals (peer-reviewed; co-authors from the Centre)	: 18
Relevant to the centre	: 23

**T**echnical articles

First author from the Centre	: 16
Co-author(s) from the Centre	: 9
Relevant to the Centre	: 20

**P**opular articles

First author from the Centre	: 39
Co-author(s) from the Centre	: 4
Relevant to the Centre	: 35

**S**ymposia/Seminars/Workshops

First author/Presenting author from the Centre	: 32
Co-author(s) from the Centre	: 16
Relevant to the Centre	: 31

**B**ooks

First author from the Centre	: 2
Co-author(s) from the Centre	: 1
Relevant to the Centre	: -

## Book chapters

First author from the Centre	: 7
Co-author(s) from the Centre	: 6
Relevant to the Centre	: -

## Teaching resources

First author from the Centre	: 9
Co-author(s) from the Centre	: -
Relevant to the Centre	: 5

## Pamphlets/posters/extension bulletins

First author from the Centre	: 1
Co-author(s) from the Centre	: 2
Relevant to the Centre	: -

## AWARDS/HONOURS

### Institutional awards

- Second Prize for Best Fish at Indaquaria 2010 organised by MPEDA at Chennai (8-10 January 2010)
- Third Prize for Best Stall at Indaquaria 2010 organised by MPEDA at Chennai (8-10 January 2010)

### Individual Award

- **Best paper award** given to **Dr. Joe K. Kizhakudan, Dr. Vidya Jayasankar and Dr. A. Margaret Muthu Rathinam** for paper titled Biotechnological Interventions in Crustacean Aquaculture (in Hindi), published in CMFRI's Matsyagandha 2009.
- **Dr S.N. Sethi** awarded **Young Scientist** in the field of Fish & Fishery Science in National Symposium on Prospects, Utility & Challenges of Biotechnology in Agricultural Development (November 11-12, 2011) from Society of Biological Sciences & Rural Development 10/96, Gola Bazar, New Jhansi, Allahabad-211019, Uttar Pradesh, India
- Zacharia P.U., Rekha J. Nair, Somy Kuriakose, Jayasankar J., Dinesh Kumar, S., Dinesh Babu, A.P., Sujitha Thomas, **Shoba Joe Kizhakudan**, Najmudeen, T.M., Anulekshmi Chellapan and Mohammed Koya, K. 2013. Distributional shift of pelagic Indian oil sardine and Indian mackerel towards northern Indian Ocean: a climate change induced scenario? **BEST PAPER awarded at ECOCASD 2013 – Second International Conference on “Ecosystem Conservation and Sustainable Development”, 3-5 October 2013, Thiruvananthapuram, Kerala, India**
- G.B. Purushottama, Thakurdas, C. Anulekshmi, **Shoba Joe Kizhakudan**, P.U. Zacharia and V.D. Deshmukh. 2013. Fishery and biology of *Rhizoprionodon oligolinx*, Springer, 1964, (Family: Carcharhinidae) exploited along north-west coast of India. **BEST POSTER (Third) awarded at the National conference on “Strategies for bridging the yield gap in fisheries and aquaculture”, 24-25 March 2014, College of Fisheries, Mangalore, Karnataka, India.**

## **PARTICIPATION OF SCIENTISTS IN INTERNATIONAL CONFERENCES/ WORKSHOPS/SYMPOSIA/SEMINARS**

6

### **National conferences/workshops/symposia/seminars : 85**

Meetings	: 36
Seminars/Symposia	: 11
Workshops	: 34
Exhibitions	: 5

### **Meetings/events organized by the Centre**

Fishermeen/stakeholder meets	22
Harvest mela	1
Inauguration of hatchery complex	1
Exhibition stalls	5
Open House for school students	3
Trainings	4
Workshops	3
Hindi workshops/Hindi week	5

### **Participation of Scientists of the Centre in committees**

RAC (CARD, TN Fisheries Dept)	1
Ph.D Examination	1
Selection	26

## **TRAINING PROGRAMMES ORGANISED**

1. Training programme on Advanced Models on Fish Stock Assessment and Biodiversity Analysis organized at the Madras Research Centre of CMFRI, Chennai from 12-20 March, 2012.
2. Training programme on Fishery Assessment Methodology (FAM) organized at the Madras Research Centre of CMFRI, Chennai from 17-19 October, 2013.
3. Three 2-day capacity building training programmes for 60 Schedule Tribe (Irula) members from coastal villages of Thiruvallur and Kancheepuram district organized at the Kovalam Field Laboratory of the Chennai Research Centre of CMFRI during 18-25 March, 2014, under the Tribal Sub Plan.

## **HUMAN RESOURCE DEVELOPMENT EFFORTS FOR DIFFERENT CATEGORIES OF STAFF**

### **TRAINING PROGRAMMES ATTENDED BY STAFF OF MRC OF CMFRI, CHENNAI DURING 2009-2014**

Scientists	:13
Technical Staff	:4
Administrative Staff	:2

### **RESOURCE GENERATION**

Through sale of cage cultured sea bass and lobsters	₹5,61,750/-
Through Consultancy projects	₹315,30,500/-
Through auction of analysed fish samples	₹37,429/-
Through sale of CMFRI products at exhibitions	₹5,500/-
<b>TOTAL</b>	<b>₹321,35,179/-</b>

### **SPORTS**

The Centre has participated in the ICAR sports meets listed below –

- 1. ICAR south zonal sports meet held at SBI, Coimbatore** 20th- 24th Jan 2009  
participant : P.Jaiganesh, Technical Assistant T-3, Football & Volleyball.
- 2. ICAR south zonal sports meet held at CIFT, Kochi** 23rd- 27th Feb 2010  
participant : P.Jaiganesh, Technical Assistant T-3, Volleyball  
S.Chandrasekharan SSS, Carroms  
S.Seetharaman, Technical officer T-5, chess
- 3. ICAR south zonal sports meet held at IIHR, Bangalore** 7th-11th Feb 2011  
participant : P.Jaiganesh Technical Assistant T-3, carroms  
P.Rajendran, Field Assistant T-1, Volleyball, Athletics  
S.Chandrasekharan, SSS, Carroms & chess
- 4. ICAR south zonal sports meet held at NAARM, Hyderabad**, 27th Feb-3rd Mar 2012  
participant : P.Jaiganesh, Technical Assistant T-3, volleyball smashing
- 5. ICAR south zonal sports meet held at SBI, Coimbatore** 18th -22nd Feb 2013  
participant : Dr.Sathyanarayana Sethi, Scientist, volleyball (Winners )  
S.Chandrasekharan, SSS, carroms
- 6. ICAR Interzonal sports meet held at NAARM, Hyderabad** 17th-20th Dec 2013  
participant : Dr.sathyanarayan Sethi, Scientist, Volleyball.