QRT Report

Molluscan Fisheries Division
2009-2014

CENTRAL MARINE FISHERIES RESEARCH INSTITUTE

Introduction

The MFD has a mandate to work on cephalopod, bivalve and gastropod capture fisheries and farming of these molluscs. Besides it is also involved in fisheries modelling and management advice. During the period from 2009 to 2014 the division implemented 2 in-house projects under the XI plan and 3 projects during the XII plan. Scientists of the division were also associated with 10 other in-house projects led by other divisions. In addition to this, 8 externally funded projects with a total budget of more than Rs.14 crores were implemented successfully at various centers of the Institute. Out of this, 5 projects were completed and completion reports submitted to respective agencies. Two consultancy projects were also implemented by the division, of which one was an international consultancy.

More than 30 training programmes on fisheries conservation and management and front-line demonstrations of bivalve mariculture technologies were conducted by scientists of the division during the 5 years. Scientists of the division also published 107 articles on their research outcome in the form of research papers, technical and popular articles, training manuals, books etc. About half a dozen videos on technologies and awareness have also been produced which are available for public viewing in YouTube.

Currently, the scientific strength of the Division is precarious. It was 25 in 1999 and it decreased to 20 in 2004 and after creation of the mariculture division, it was 7 in 2010-11. Three former scientists of the division rejoined the MFD in 2011-12 and the strength increased to 9. After the current spate of retirements and movements, the current scientific strength of the division is 5 (see table below).

*	KS Mohamed	PS & HOD	Kochi
1	V Venkatesan	Scientist	Kochi
2	S Sethi	Scientist	Chennai (left for CIBA in May 2014)
3	Geetha Sasikumar	Senior Scientist	Mangalore
4	N Ramachandran	Principal Scientist	Vizhinjam (Rtd in Dec 2013)
5	PK Asokan	Principal Scientist	Calicut
6	I Jagdis	Principal Scientist	Tuticorin
7	MK Anil	Principal Scientist	Vizhinjam

Detailed reports of only those projects led by MFD scientists are provided here.

Research Programmes of MFD

Plan	Sl.no	Title of the project	2009-10	2010-11	2011-12	2012-13	2013-14
XIth Plan	1	Developing management advisories for sustaining marine fisheries of Andhra Pradesh (MF/IDP/01)*	√	√	√		
	2	Management advisories for sustaining marine fisheries of Kerala and Lakshadweep (PEL/IDP/01)	√	√	√		
	3	Management advisories for sustaining marine fisheries of Karnataka and Goa PEL/IDP/02	√	√	√		
	4	Appraisal of marine fisheries of Tamil Nadu and Pondicherry DEM/IDP/01	√	√	√		
	5	Application of trophic modelling in marine fisheries management MF/IDP/02*	√	√	√		
	6	Technological upgradation in Molluscan mariculture MD/IDP/02	√	√	√		
XII th plan	1	Development of Fishery Management Plans (FMPs) for the bivalve fisheries of India – FISHCMFRISIL201201200012*				√	√
	2	Evaluation of ornamental gastropod fisheries in India and assessment of shell craft industry– FISHCMFRISIL201201300013*				√	√
	3	Sustainable molluscan mariculture practices FISHCMFRISIL201201400014*				√	√
	4	Development of fishery management plans for sustaining marine fisheries of Kerala and Lakshadweep FISHCMFRISIL201200300003				√	√
	5	Development of fishery management plans for sustaining marine fisheries of Karnataka and Goa FISHCMFRISIL201200600006				√	√
	6	Development of fishery management plans for sustaining marine fisheries of Tamil Nadu and Puducherry FISHCMFRISIL201200800008				√	√
	7	Ecosystem process of critical marine habitats and development of protocols for restoration FISHCMFRISIL201201800018				√	√
		Health management in selected finfish and shellfish for mariculture and aquariculture& bioprospecting				√	√

	8	from marine resources FISHCMFRISIL201202600026					
	9	Aquatic feed biotechnology for mariculture and aquariculture FISHCMFRISIL201202700027				√	√

Sl No	Title of the Project	Location	Period	Amount (Rs. Lakhs)	Funding Agency
1	Farming and pearl production in the black lip pearl oyster *Pinctada margaritifera* *	Port Blair	2003-12	131.0	MoES
2	Demonstration of responsible fishing practices for the trawl fisheries of Gujarat State*	Kochi & Veraval	2008-09	24.0	MPEDA
3	Demonstration and transfer of technology of marine pearl culture *Pictada fucata*	Tuticorin	2007-12	47.65	MoES
4	Development of shallow water grow out techniques for the venerid clam *Paphia malabarica* (Chemnitz)and the corbuculid clam *Villorita cyprinoids* (Grey)*	Kochi	2008-11	12.0	DST
5	Utilization strategy for the oceanic squids in the Arabian Sea: A value chain approach *	Kochi	2008-13	629.8	NAIP
6	Value chain for high value shellfish (edible oyster and sand lobster) *	Kochi Tuticorin Chennai	2008-14	402.62	NAIP
7	Commercial viability of black pearl production in the A &N islands and conservation maricutlure of ETP gastropods. *	Port Blair	2012- 17	200	MoES
8	Mapping and resource assessment of pearl oyster tanks of Tuticorin (Central) division of Gulf of Mannar.*	Tuticorin	2012-15	35.09	MoEF

CONSULTANCIES

Plan	Sl.no	Name of the project	Location	Period	Amount (Rs. Lakhs)	Funding Agency
XI th plan	1	Project Preparatory Technical Assistance for coastal protection structures in Maharashtra, Goa and Karnataka *	Kochi Mangalore	2008-09	US$ 25,000	ADB
XII th plan	1	Assessment of Ecolabelling as tool for conservation and sustainable use of biodiversity in Ashtamudi Lake, Kerala (Southwest coast of India)*	Kochi	Dec.2012 to Sept.2014	36.7	GIZ (German International Cooperation)

* *Projects led by MFD scientists*

Training Programmes conducted by MFD

Year	Place	Topic	Duration	No. of participants	Organizer
2009	Moothakunnam	Mussel harvest	1	14	MFD
	Chettuva	Mussel Harvest	1	6	MFD
	Puthenvelikkara	Oyster farming	1	13	MFD
	Kottuvallikkad	Oyster farming	1	30	MFD
	Vaikom	Clam biology, Clam fishery, depuration, product development and conservation	1	102	Vaikom clam society and MFD
	Thankassery	Raft fabrication and moooring , cage fabrication, mabe image implantation	1	16	MFD
	Port Blair	Marine mabe and half pearl training programme	1	21 fisher women	MoES
2010	MFD,Kochi	ROV - Training	3	9	MFD & NAIP
	David Hall, Fort Kochi	Farming, purification and nutritional qualities of oysters	1	35 (Chefs of 5-star hotels)	MFD & CGH group of hotels
	Puthenvelikkara	Awareness programme on oyster depuration	1	25	MFD/NAIP
	H.M.Y.Sabha	Refresher training programme for	1	250	MFD/NAIP

	School, Kottuvallikkad	oyster farmers			
	VAP Unit, Moothahunnam	Value added product development	1	25	NIFPHATT/ NAIP/MFD
	Agatti	How to use modified Pablo boat for squid jigging	4	6	NAIP/MFD
2011	NAIP-RS unit, Moothakunnam	Remote setting and oyster spat rearing	1	25	MFD/NAIP
	Casino hotel, W.Island, Kochi	Business opportunities in oyster cuisine	1	250	MFD/NAIP/ CGH
	Chettuva	Mussel & Oyster farming	1	52	MFD
	Port Blair	Seed production of Blacklip pearl oyster in hatchery	1	12	
2012	MFD, Kochi	Squid ageing using statoliths	1	20 scientist and technical staff of MFD and DFD	NAIP
	ATIC Hall, CMFRI,Kochi	Mussel, clam and pearl culture	1	27 students (Regional technical V.H.S .S Thevara)	SEETTD
	Kozhikode	Mussel farming	2	31 farmers	CRC of CMFRI, Kozhikode
	South Goa	Mussel and oyster culture demonstration / training	1	Fishermen and entrepreneurs of South Goa in Sal Estuary	MFD, Mangalore and Kozhikode
	Cherai	Oyster farming and post harvest technologies	1	18 SHG members	MFD
	Kundapura,	Bivalve mariculture in Karnataka	1	Fisherme n & shrimp farmers	MPEDA
	Maharashtra	Mussel culture	1	32 farmers	GOI – UNDP – GEF

					Project
	Alappuzha	Kakka – Matsya thozilali sowhredha sangamam	1	60 (fisherme n and clam fishers)	Asoka trust for Research in Ecology and Environme nt / Community
	Vizhinjam	Techniques in marine designer pearl production	5	25 (officials from NABARD, university , State Dept. and students)	VRC of CMFRI / NFDB
	Rangachang, South Andaman	Andaman and Nicobar pearl oyster resource enhancement programe (ANPOREP)	1	67 students	MoES
2013	Port Blair	Pearl farming and hatchery techniques	1	11	Directorate of Fisheries
	MFD, Kochi	Oyster farming	1	34 farmers	MFD / NAIP
	Ratnagiri / Wadatar Maharashtra	Mussel and oyster farming	1	46 fisherwom en 10 fisherwom en	MFD, Kochi, Calicut RC & Mangalore RC
	Keelavaippar, Tamilnadu	Pearl surgery (10 days)	1	10 farmers	MFD, Tuticorin RC
	Mangalore	Impact of the aggregating devices on cuttlefish fishery	1	15 officials	MFD, Mangalore RC
	Kadalundi	Mussel culture	1	32 farmers	MFD, Calicut RC
2014	Tuticorin	Basic training in skin and SCUBA diving	1	12	MFD, Tuticorin RC
	Balathuruthi	Mussel culture	1	60 farmers	MFD, Calicut RC

	Vizhinjam	Techniques in marine designer pearl production	3	25 (officials from NABARD, Universities, State Dept. And Students	VRC of CMFRI / NFDB
	Kollam	Live oyster cuisine	1	Chefs of hotels and restaurants	MFD / NAIP

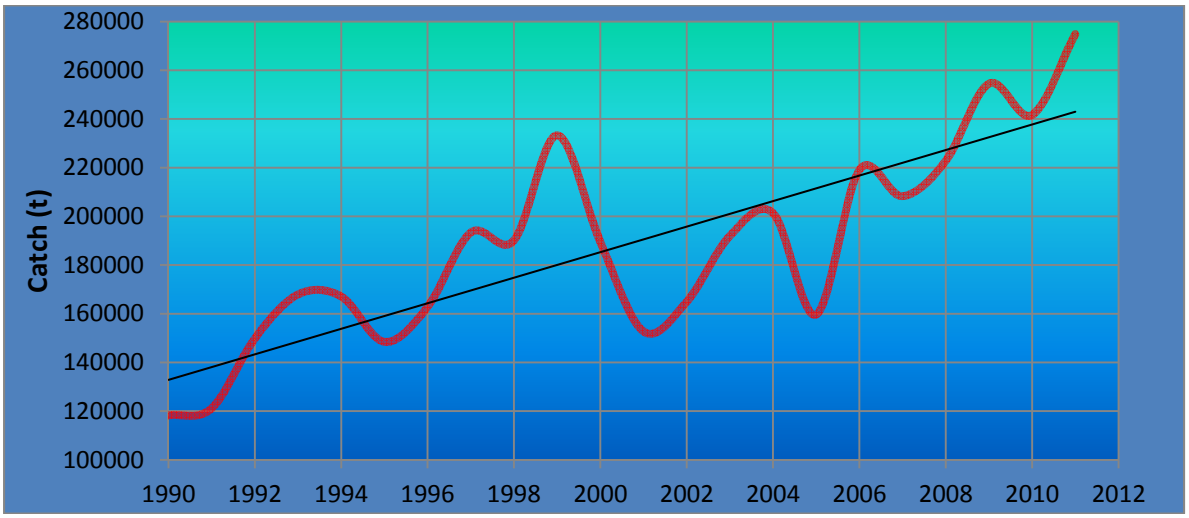
5 Significant Achievements of the Division

- Determined that FAD fishing for cuttlefish is destructive to the stock and as per CMFRI advice the Government of Karnataka has banned the fishing practice
- Developed Fishery Management Plan (FMP) for Ashtamudi Lake short-neck clam fisheries, based on which the Kollam District administration has formed the Ashtamudi Lake Clam Fisheries Governance Council (ACFGC) which is a fisheries co-management council for moving towards MSC ecolabelling
- Developed advisories (66 recommendations) for management of marine fisheries of Kerala including extension of trawl ban and new ban for ring seiners
- Developed all technological know-how for the launch of the oceanic squid value chain including fishing methods, area and season of abundance, stock abundance in relation to environmental factors, MSY and plan for exploitation.
- Enhanced the oyster value chain with protocols for depuration, steam shucking and live oyster consumption
- Produced the first cultured black pearl and protocols for hatchery production of blacklip pearl oyster spat.

Major Achievements of Research – Project-wise – In-house

Project:	**Developing management advisories for sustaining marine fisheries of Andhra Pradesh** MF/ IDP/01 – XI Plan
PI –	Dr. G. Syda Rao; Dr. Prathibha Rohit; Dr. G. Maheswaradu

The marine fishery production in the state fluctuated over the years, but has registered a gradual increasing trend. The total fish catch in Andhra ranged from 1,51,435 t in 2002 to 2,33,276 t in 1999 and further to 2,74,000 t in 2011 with an average annual production of 2,40,413 t during 2007-2011.



The pelagic finfishes comprising clupeids, scombroids, carangids and ribbonfish formed the bulk of the fishery and contributed 58.3% followed by demersal resources (26.6%) crustaceans (12.3%) and others (2.8%).

Major fish resources

Among finfishes, the pelagic group was dominant followed by demersal finfishes. Clupeids (42.25%) followed by mackerel (14%), tunas and billfish (13.88%), carangids (10.53%), ribbonfish (9.52%) and seerfish (3.47%) were the major pelagics landed along the Andhra coast. These resources not only contribute greatly to the state's catch but also form a significant portion of all India catch. Of the several pelagic fishes landed, seerfish and mackerel are commercially important and fetch a good price both in the local as well as other markets outside the state. Of the total all India landings, Andhra Pradesh contributed to around 14% of pomfret catch, 13% of seerfish catch and 12 of the mackerel catch. The tunas are another important emerging fishery resource group from Andhra Pradesh especially off Visakhapatnam coast. Of the different species of tuna contributing to the fishery, yellowfin tuna is the most important. As it is an emerging resource, it is still under fished and at present forms a minor component of the total fish catch of Andhra Pradesh. With targeted fishing already in action for exploiting these oceanic tunas, its contribution to the total fish catch of the region is bound to increase by several folds in the coming years.

Among the demersal fishes, croakers formed the dominant group (18.4%) followed by perches (18.4%), pomfrets (13.2%) goatfish (9.2%), catfish (9.2%) and elasmobranchs (11.0%) (Fig.5)
Crustaceans were dominanted by the penaeid prawns (78%) followed by crabs (17%) and non-penaeid prawns (3%). Prawns have always been the mainstay of the Andhra marine fishery and are the major

revenue earner for the state. Of late however, the catch of pelagic fishes like sardine and mackerel have increased but prawns still continue to be major revenue earner in the marine fisheries sector

F-multipliers for maximum Yield and Yield/Recruit for species caught in trawls (2007-2011)

Species	Maximum Y/R (g)	Maximum Yield (t)	Increase in Y/R (g) from the present	Increase in Yield (t) from the present	F-multiplier at maximum Y and Y/R	Level of Exploitation
Rastrelliger kanagurta	21.45	7630	3.73	1328	1.6	Under Exploited
Trichiurus lepturus	42.34	10135.7	0.17	40.7	1.4	Under Exploited
Nemipterus japonicus	22.934	3139.5	0.5	68.53	1.6	Under Exploited
Pennahia macrophthalmus	41.896	890.09	0.005	0.09	1.2	Optimally exploited
Upeneus vittatus	9.279	3920.67	1.258	531.17	3.0	Under Exploited
Saurida undosquamis	25.476	1375.44	0.512	27.64	2.2	Under Exploited
Metapenaeus monoceros males	3.90	315.3	0.01	0.3	0.8	Over exploited
Metapenaeus monoceros females	6.73	526.3	0.02	2.2	1.2	Optimally exploited
Metapenaeus dobsoni males	1.02	174.65	0.01	1.95	1.4	Under Exploited
Metapenaeus dobsoni females	1.155	227.13	0.005	1.23	0.8	Over exploited
Portunus sanguinolentus males	39.19	319.1	6.79	55.3	0.4	Over exploited
Portunus sanguinolentus females	30.35	560	6.85	126.3	0.2	Over exploited
Sepia aculeata	0.18	1.17	0.06	0.39	3	Under Exploited
Sepia pharaonis	0.31	1.15	0.1	0.37	3	Under Exploited
Loligo duvaucelli	0.01	1.79	0.004	0.72	3	Under Exploited

Yield/recruit of trawl caught species at precautionary F levels

(Lower limit, upper limit and mean values are given as three rows in the table)

Species	F when SSB is 20% of Initial SSB	Y/R when SSB is 20% of Initial SSB	$F_{0.1}$	Y/R at $F_{0.1}$	Present F	Present Y/R
Rastrelliger kanagurta	1.185-1.255; **1.22**	2.6-3.4; **3.0**	1.335 – 1.425; **1.38**	3.35-4.05; **3.7**	**0.79**	**17.72**
Trichiurus lepturus	0.3175-0.3285; **0.323**	19.6-22.6; **21.1**	0.233-0.245; **0.239**	18.45-21.15; **19.8**	**0.42**	**42.17**

Nemipterus japonicus	1.375-1.465; **1.42**	11.15-12.25; **11.7**	0.668-0.694; **0.681**	9.9-10.9; **10.4**	**1.10**	**22.43**
Pennahia macrophthalmus	2.225-2.415; **2.32**	20.2-22.2; **21.20**	0.975-1.025; **1.0**	17.6-19.4; **18.5**	**2.65**	**41.891**
Upeneus vittatus	2.275-2.465; **2.37**	2.0-2.4; **2.20**	0.935-1.005; **0.97**	1.7-2.1; **1.90**	**1.30**	**8.02**
Saurida undosquamis	0.97-1.01; **0.99**	9.9-11.3; **10.6**	0.7-0.74;**0.72**	7.1-9.1; **8.5**	**1.79**	**24.96**
Metapenaeus monoceros males	4.295-4.465; **4.38**	1.345-1.535; **1.44**	2.68-2.86; **2.77**	1.28-1.46; **1.37**	**12.02**	**3.89**
Metapenaeus monoceros females	2.955-3.185; **3.07**	2.15-2.65; **2.4**	1.86-1.96; **1.91**	2.0-2.4; **2.2**	**5.54**	**6.71**
Metapenaeus dobsoni males	4.105-4.275; **4.19**	0.32-0.36; **0.34**	2.6-2.78; **2.69**	0.315-0.345; **0.33**	**6.11**	**1.01**
Metapenaeus dobsoni females	3.35-3.65; **3.5**	0.365-0.435; **0.4**	2.885-3.035; **2.96**	0.36-0.42; **0.39**	**5.84**	**1.15**
Portunus sanguinolentus males	2.81-3.09; **2.95**	19.2-19.4; **19.3**	1.505-1.595; **1.55**	16.7-18.7; **17.7**	**5.27**	**32.4**
*Portunus sanguinolentus*females	2.99-3.19; **3.09**	17.85-19.55; **18.7**	1.385-1.475; **1.43**	16.9-18.7; **17.8**	**6.6**	**23.5**
Sepia aculeata	1.22-1.26; **1.24**	0.076-0.084; **0.08**	0.825-0.875; **0.85**	0.0635-0.0705; **0.067**	**1.61**	**0.121**
Sepia pharaonis	3.0-11.0; **7.0**	0.193-0.223; **0.208**	2.1-3.3; **2.7**	0.1055-0.1365;**0.121**	**1.67**	**0.210**
Loligo duvaucelli	0.575-0.605; **0.59**	0.0077-0.0119; **0.0098**	0.79-0.83; **0.81**	0.0078-0.012; **0.0099**	**1.2**	**0.006**

Management Advisories: to sustain the marine fisheries of the state on a long term basis

- Measures such as increasing the effort as suggested below to exploit the presently under exploited resources. However, in a multi-fisheries scenario a precautionary approach should be followed. Further, a marginal increase in catch by increasing the effort by several times will not be economical and viable. However, the present study has indicted the following scenarios:

- *Rastrelliger kanagurta, Trichiurus lepturus, Metapenaeus dobsoni and Metapenaeus monoceros*: maximum yield can be obtained by increasing the present fishing effort by 20 – 60%. The increase in yield at the increased fishing effort is 1328 t for Rastrelliger kanagurta at 160% of the present effort, 40.7 t for *Trichiurus lepturus* at 140% of the present effort, 2.2 t for *Metapenaeus monoceros* females at 120% of the present effort and 1.95 t for *Metapenaeus dobsoni* males at 140% of the present effort.

- Penaeid prawns: Present effort is optimum as the change in yield and yield per recruit is negligible and balances out on increasing/decreasing present fishing effort.

- Trichiurus lepturus: Only a minor increase in yield and yield per recruit is obtained by increasing the present fishing effort by 40%. Hence the present level of effort can be maintained.

- *Rastrelliger kanagurta*: About 21% increase in yield and yield per recruit is obtained by increasing the present fishing trawl effort by 60%, which is uneconomical. Therefore trawls targeting mackerel, ribbonfishes and penaeid prawns can continue to fish at the same effort.

- The yield and yield per recruit of cephalopods can be increased by 50% for cuttlefishes and by 67% for squids by tripling the present fishing effort. However the lack of trawlers targeting cephalopods alone and the trifling nature of the catch necessitates that the present fishing effort is continued.

- Similarly for some demersal resources namely, *Nemipterus japonicus, Saurida undosquamis* and *Upeneus vittatus* an increase in yield can be affected by an increase in fishing effort. The increase in fishing effort can be from 60% in the case of *Nemipterus japonicus* to 300% in the case of *Upeneus vittatus*.

- In sharp contrast to the above the demersal resource *Pennahia macrophthalmusis* being optimally fished. An increase in fishing effort by 20% will lead to only a negligible increase in yield of 2.2t.

- Most of the crustacean resources are over-exploited. This includes *Metapenaeus monoceros* males, *Metapenaeus dobsoni* females, *Portunus sanguinolentus* males and females. For all these resources fishing effort needs to be reduced from 20% to 80% for maximum yield. Specifically the increase in yield obtained is 0.3 t for *Metapenaeus monoceros* males at 80% of the present effort, 1.23 t for *Metapenaeus dobsoni* females at 80% of the present effort, 55.3 t for *Portunus sanguinolentus* males at 40% of the present effort and 126.3 t for *Portunus sanguinolentus* females at 20% of the present effort. Hence, trawls targeting these crustacean resources should immediately reduce effort drastically so as to fish at 40% of the present effort.

- Reducing fishing effort for a particular resource may be difficult in the case of multi-species trawl fisheries. Therefore a precautionary approach towards reducing fishing effort might be a better option.

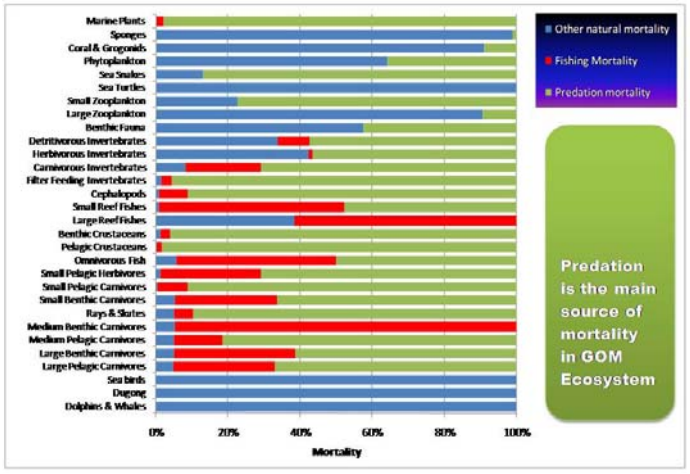
Project: **Application of trophic modeling in marine fisheries management**
MF/IDP/02 – XI Plan
PI – Dr. K. Sunil Mohamed

A trophic mass balance model of the Gulf of Mannar (GOM) ecosystem was created during the plan period. Area of GOM was estimated as 19,000 km^2, the eastern boundary being the international border with Sri Lanka . This includes the 10,500 km^2, Gulf of Mannar Marine Biosphere Reserve (GOMMBR). Using the ECOPATH software, 31 ecological groups were created from whales to phytoplankton and a detritus box was also created. The model was mass balanced and the following are the brief results.

	Group name	Trophic level	Habitat area (fraction)	Biomass in hab area (t/km2)	Biomass (t/km2)	P/B	Q/B	EE	P/Q
1	Dolphins & Whales	3.055	1.000	0.075	0.075	0.700	12.750	0.100	0.055
2	Dugong	2.000	1.000	0.070	0.070	1.800	12.800	0.100	0.141
3	Sea birds	3.841	0.019	0.005	0.000	0.300	91.700	0.240	0.003
4	Large Pelagic Carnivores	4.686	1.000	1.290	1.290	1.011	10.400	0.950	0.097
5	Large Benthic Carnivores	4.305	1.000	1.123	1.123	1.230	8.500	0.950	0.145
6	Medium Pelagic Carnivores	4.872	1.000	0.865	0.865	1.900	4.567	0.950	0.416
7	Medium Benthic Carnivores	4.156	1.000	0.698	0.698	2.340	12.340	0.950	0.190
8	Rays & Skates	3.854	1.000	4.235	4.235	2.543	12.000	0.950	0.212
9	Small Benthic Carnivores	3.847	1.000	5.234	5.234	5.468	9.456	0.950	0.578
10	Small Pelagic Carnivores	3.816	0.250	2.410	0.603	3.456	8.790	0.950	0.393
11	Small Pelagic Herbivores	2.006	0.330	2.200	0.726	1.440	31.000	0.950	0.046
12	Omnivorous Fish	3.165	0.330	6.789	2.240	4.567	16.000	0.950	0.285
13	Pelagic Crustaceans	3.221	0.330	2.345	0.774	1.700	4.880	0.950	0.348
14	Benthic Crustaceans	3.013	0.330	0.930	0.307	1.800	3.541	0.150	0.508
15	Large Reef Fishes	2.835	0.330	1.030	0.340	1.550	15.500	0.250	0.100
16	Small Reef Fishes	2.265	0.250	0.879	0.220	1.240	14.660	0.950	0.085
17	Cephalopods	3.896	1.000	0.290	0.290	1.250	18.700	0.950	0.067
18	Filter Feeding Invertebrates	2.180	0.054	7.130	0.385	0.390	2.330	0.450	0.167
19	Carnivorous Invertebrates	3.366	0.101	4.130	0.417	1.390	5.280	0.560	0.263
20	Herbivorous Invertebrates	2.000	0.043	151.570	6.563	4.000	8.240	0.240	0.485
21	Detritivorous Invertebrates	2.000	0.054	2.200	0.119	4.500	40.000	0.100	0.113
22	Benthic Fauna	2.050	1.000	0.800	0.800	12.500	40.000	0.100	0.313
23	Large Zooplankton	2.350	1.000	1.875	1.875	35.000	225.000	0.375	0.156
24	Small Zooplankton	2.000	1.000	1.875	1.875	60.000	300.000	0.375	0.200
25	Sea Turtles	3.084	1.000	0.010	0.010	0.200	3.500	0.240	0.057
26	Sea Snakes	4.850	1.000	2.450	2.450	2.700	6.700	0.850	0.403
27	Phytoplankton	1.000	1.000	20.340	20.340	70.000	0.000	0.100	
28	Coral & Grogonids	2.450	0.010	187.000	1.870	13.250	80.500	0.100	0.165
29	Sponges	2.200	1.000	6.840	6.840	1.480	9.000	0.100	0.164
30	Marine Plants	1.000	0.077	2610.000	200.970	15.000	0.000	0.021	
31	Detritus	1.000	1.000	150.000	150.000			0.069	

Most fishery groups had high EE indicating full utilization of biomasses within the system. Large reef fishes and benthic crustaceans had low EE indicating scope for greater exploitation. Predation mortality, rather than fishing mortality was the highest cause of mortality within the system (see fig).

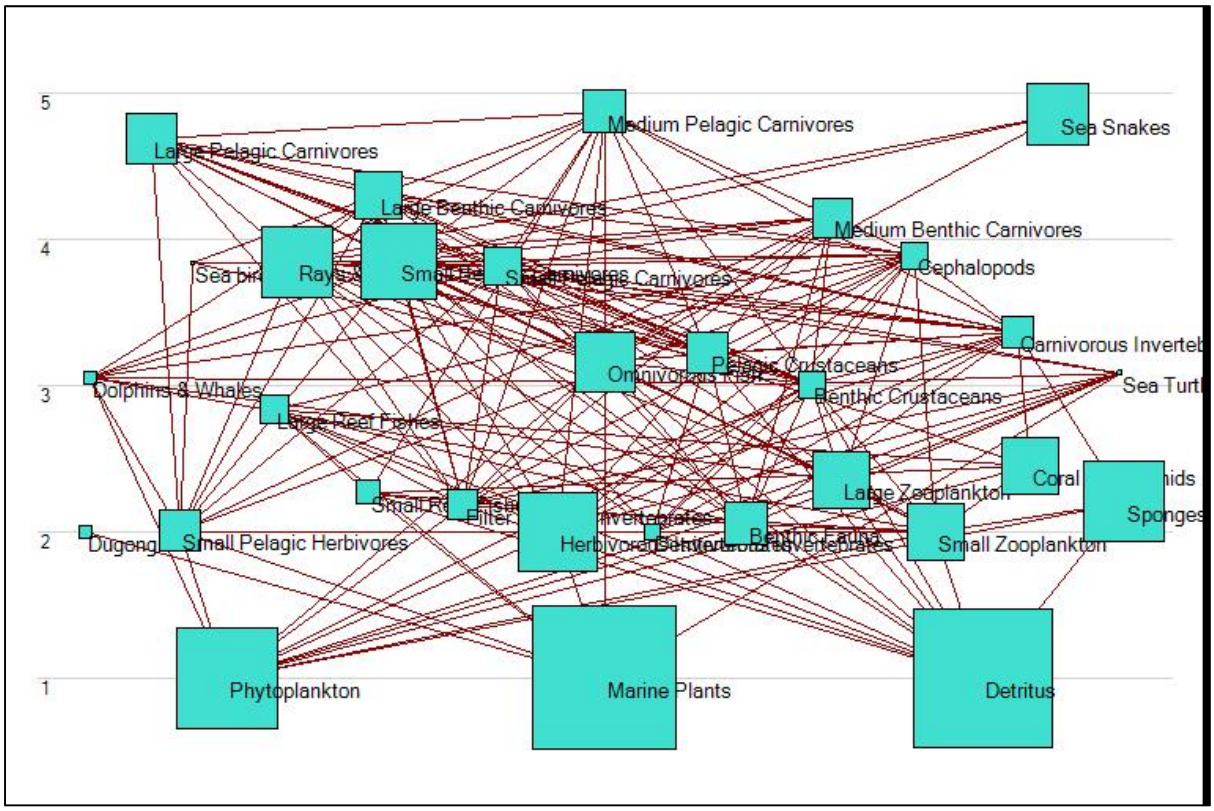
The summary statistics of the ecosystem indicates that the total system throughput is not very high, as the model considers only the Indian portion of the GOM. The mean trophic level of the catch is relatively high indicating dominance of higher trophic animals. The gross efficiency of the system is relatively high indicating that the system is not fully mature and is in the process of attaining full maturity.



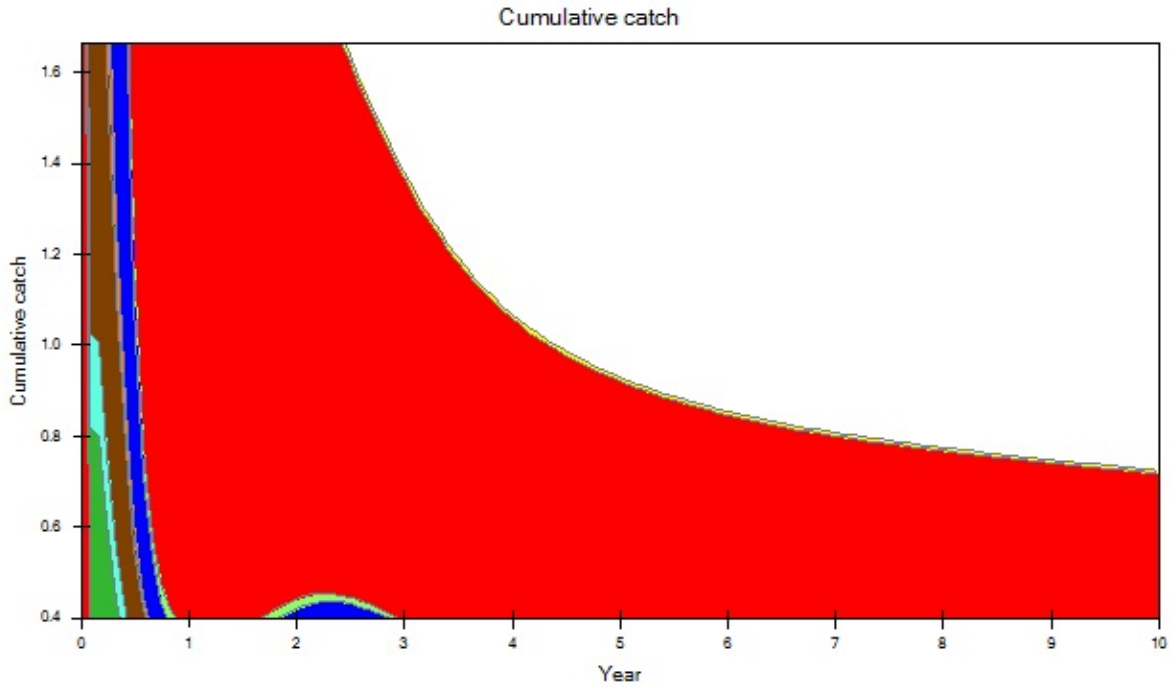
Parameter	Value	Units
Sum of all consumption	1527.0	t/km^2/yr
Sum of all exports	4415.0	t/km^2/yr
Sum of all respiratory flows	902.5	t/km^2/yr
Sum of all flows into detritus	4716.6	t/km^2/yr
Total system throughput	11561.1	t/km^2/yr
Sum of all production	4757.4	t/km^2/yr
Mean trophic level of the catch	3.47	
Gross efficiency (catch/net p.p.)	0.00512	
Calculated total net primary production	4438.4	t/km^2/yr
Total primary production/total respiration	4.9	
Net system production	3535.9	t/km^2/yr
Total primary production/total biomass	16.8	
Total biomass/total throughput	0.023	
Total biomass (excluding detritus)	263.6	t/km^2
Total catches	22.7	t/km^2/yr
Connectance Index	0.2	
System Omnivory Index	0.4	

The system summary statistics is shown in table >>>

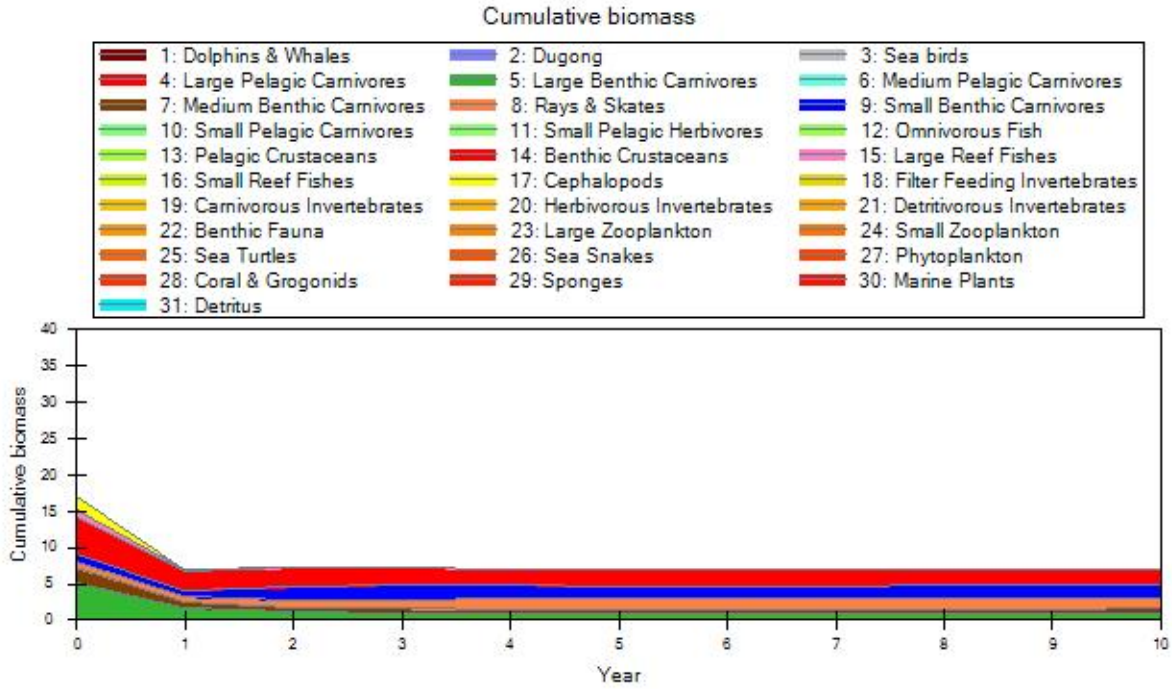
The biomass flow diagram scaled by trophic levels of the GOM model is shown below:

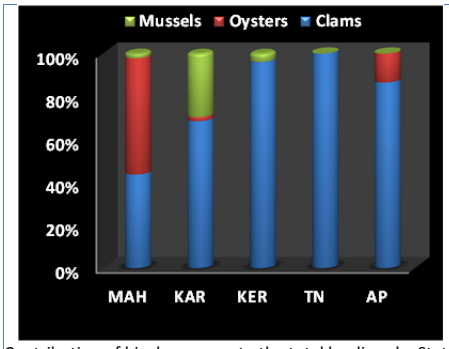


Using the ECOSIM module, simulation exercises were carried out to determine what would happen to biomass and catches in 10 years as a consequence of increasing effort.



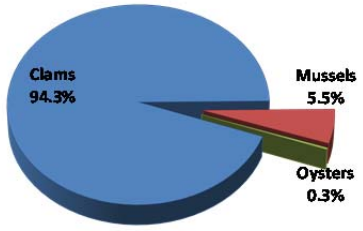
The simulation study showed that within 3-years, the cumulative catches would drop to below 80% of the existing catch if effort is allowed to increase at the rate at which it is currently being increased. A similar decrease in biomass at a faster rate can also be observed as shown below.





Contribution of bivalve groups to the total landings by State

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

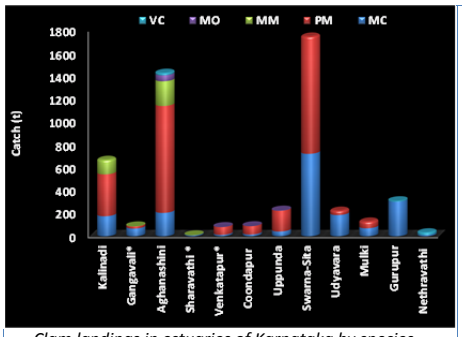


Contribution of clams, oysters and mussels to bivalve landings

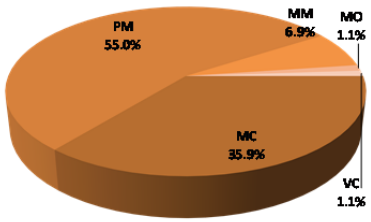
Placuna placenta

Estimated bivalve landings during Jan-Dec 2013

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

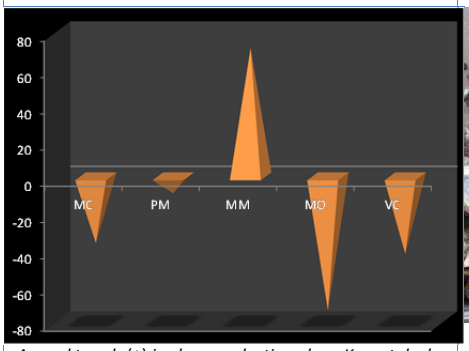


Clam landings in estuaries of Karnataka by species



Species composition of clams in Karnataka

Karnataka: In 2013, monsoon over the State of Karnataka exceeded the average by 17%, a huge jump from 2012. Following a 'break monsoon', the monsoon returned in full form in September, bringing a heavy downpour to the region. This resulted in a protracted low saline phase commencing from June to October, 2013 in the estuaries. Mortality of clams, *P.malabarica, M. casta, M. meretrix, M. opima* was observed in the estuaries. During 2013, the clam production in Karnataka was estimated at 5,041t. Clam production recorded a decreasing trend by 47% due to mortality in the latter half of 2013. *Meretrix casta* and *P. malabarica* contributed 91% to the total clam production. Biomass surveys were conducted in Nethravathi, Gurupur, Mulki, Sita and Swarna estuaries of Dakshina Kannada and Udupi District of Karnataka. Recruitment of *P. malabarica* and *M.casta* in Swarna and Sita estuaries was observed from November-February.



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

Dead bivalves collected from estuaries of Karnataka

Meretrix casta grading in Udupi, Karnataka

Black clam exploitation in Kerala

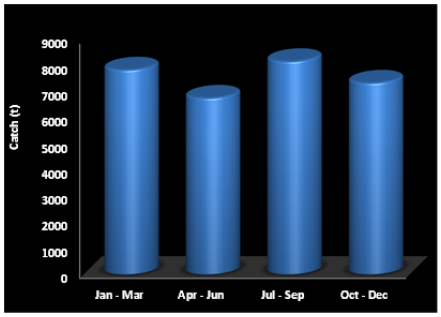
Kerala: Clams formed 96.1% of bivalve production in Kerala followed by mussels (3.8%) and edible oysters (0.1%).

Bivalve production along the **Malabar Coast** was estimated at 62,825 t contributing 59.4% to the State production. Clams, *M. casta, V. cyprinoides* and *P. malabarica* dominated the fishery (95%) contributing to 58.8% of the total clam fishery of the State. Green mussel *Perna viridis* constituted 3,103t forming 5% of the bivalve landings.

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

Black clam production in **Vembanad** during 2013 estimated at 30,178t showed a decrease by 19% in comparison with 2012 production (36,006 t). Maximum catch was recorded from Muhamma and

Clam grading in Kerala



Black clam catch in Vembanad

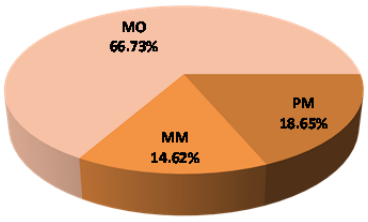
Vechoor clam shell society (72% of the catch). The black clam *Villorita cyprinoides* was the major species forming as much as 62% of the total. However, the production of black clams declined from a peak of 56,700t in 2007 to 39,481t in 2011 and 30178 t in 2013.

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

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

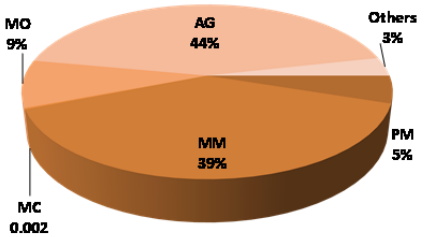
Population studies: Length based stock studies of *Perna viridis* along **Vizhinjam** coast was carried out for 2013 data. Per recruit analysis (constant recruitment, knife edge selection, deterministic) using the 'YIELD' software for 2012-2013 average data gave the following F based reference points.

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



Species composition of clams exploited in Karapad Bay

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



Species composition of clams exploited in Kakinada

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

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

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

The 20-member Council with District Collector of Kollam District as Chairman has representatives from the following:

- Fisheries Department
- Marine Police
- Clam exporters
- Clam fishermen trade unions
- CMFRI scientists
- NGOs

As per the TOR, the Council will strive to:

- Adhere to scientific advice on sustainable clam stock management
- Use stakeholder involvement in development of regulations
- Make effective monitoring, accounting, and enforcement
- Put limits on fishing capacity based on scientific advice
- Proclaim conservative and strict catch limits
- Use precautionary approach to address uncertainty
- Make plans for habitat protection
- Take into account ecosystem considerations

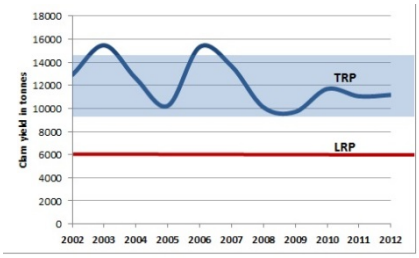
Short-neck Clam Fisheries of Ashtamudi Lake to become the first ecolabelled fisheries in India

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

Setting TRP & LRP for short-neck clam fisheries

In the guidelines included in the UN Fish Stocks Agreement two categories of reference points were defined: target reference points (TRPs) corresponding to situations considered as desirable and to be achieved on average; and limit reference points (LRPs) indicating situations that are undesirable and to be avoided at all costs.

On the basis of the current biomass estimate and B_{MSY} estimate for clams, the TRP and LRP are recommended. If the stock biomass falls below B_{lim}, then target fishing must cease for a period sufficient to rebuild the stock. The catch trend with respect to TRP (± 20%) and LRP is shown in figure.



A) **Fishery of the ornamental gastropods & Biology**

Monthly observations on the fishery of the regularly landed ornamental gastropods from various centres identified were made. The data include, the gear employed, number of fishing days, catch/unit effort, size/weight range of the individual species observed, other biological observations and the estimated exploited resources of the species concerned.

Tuticorin Centre

At Tuticorin, the exploited gastropods of ornamental importance were monitored regularly from the two landing centres - **Kayalpattinam and Kalavasal.** The major regularly landed ornamental gastropods by and bottom set gill nets are *Turbinella pyrum* and *Chicoreus ramosus.* Apart from the stray number of other ornamental gastropods such as *Murex spp, Lambis lambis, Babilona spp, Cypraea sp* etc are also landed by the bottom set gill nets primarily set for lobster and crabs.

In addition to the above regular exploitation of Fossilised *Turbinella pyrum* is exploited regularly from Kalavasal. These fossilised *T. pyrum* is mostly exported to Kolkata.

Kayalpattinam

A total of 40,126 nos live *T. pyrum* were caught at Kayalpatnam by 5,230 of units. There were 212 fishing days and the cpue was estimated to be 8 chanks/man-day. The size/weight ranges of the chanks are from 128-200mm with an average of 165mm and 250-2,200g with an average of 850g respectively.
Live *Chicoreus ramosus* landings was also observed throughout the year by the same gear. A total of 52,067nos were exploited by 5,230 boats in212 fishing days. The cpue of 10 nos/man-day. The size/weight ranges of the exploited *C. ramosus* ranged from 156-206 mm with an average of 188mm and 500-1,300 g and with an average of 650g at Kayalpattinam.

Kalavasal

The estimated exploited sacred chanks (*T. pyrum*) at Kalavasal was 35,065 nos by 5,312 boats in 243 fishing days. The catch/unit effort worked out to be 7 chanks. The size/weight of the exploited chanks ranged from 104-193 mm with an average of 163mm/370-950g with an average of 691g.

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

During this year the fossilized chank exploitation at Kalavasal was estimated to be 3,26,550 by 12,165 boats with a cpue of 27 chanks. The total fishing/exploitation days

The method of exploitation (diving using air hoses from compressors on board the vessel) is observed to be risky/unsafe. Though many risks have been reported the fishers venture for this kind of activity as it is very lucrative for them. Many un-reported mortalities and other associated risks have been noticed. Recently, the Govt.of Tamil Nadu has planned for procurement and supply of SCUBA equipment for fishers.

were 255. The size/weight range of the chanks ranged from 117-237mm with an average of 169mm)/400-1350g with an average of 780g. More and more numbers of vessels are being used for the exploitation of this fossilised resource and very good revenue is generated.

Fishery at Kollam

During the period, January - December, 2013, an estimated quantity of 210.6 tonnes of gastropods was landed by trawlers from this district. Compared to last year catch, the present catch showed reduction in 82%. Catch from two major landing centres namely Needankara Fishing Harbour (NFH) and Sakthikulankara Fishing Harbour (SFH) alone formed upto 97% of the catch landed at Kollam District. Annual avg. catch per unit effort at NFH and at SFH were 7.3 and 6.4 kg. The maximum catch and catch rate was observed during August at NFH and June at SFH (Fig. 2). The highest landings were recorded during the III quarter (July - Sep); percentage contribution being 37.8 % followed by II quarter (30.8 %), and IV quarter (28.6 %) (Fig. 1). In Quarter –wise centre catch, NFH showed maximum catch in Jul to Sep while SFH showed maximum catch during Apr to June.

Trawl nets operating up to 100m depth accounted for 97.9 % followed by other gears MOTHS (Mechanized others) and NM (Non mechanized).

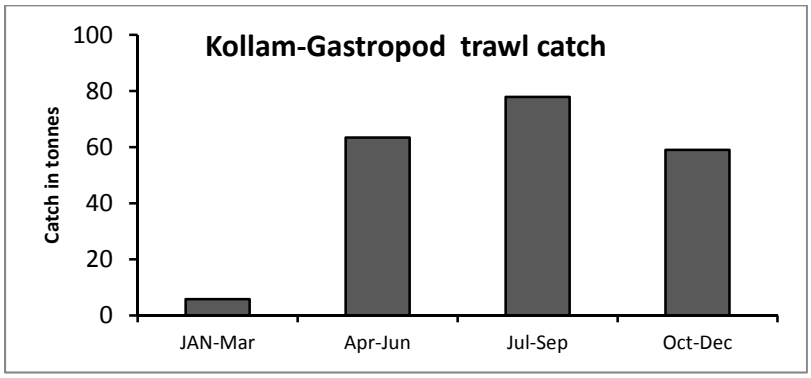


Fig.1 Quarter-wise gastropod production at Kollam

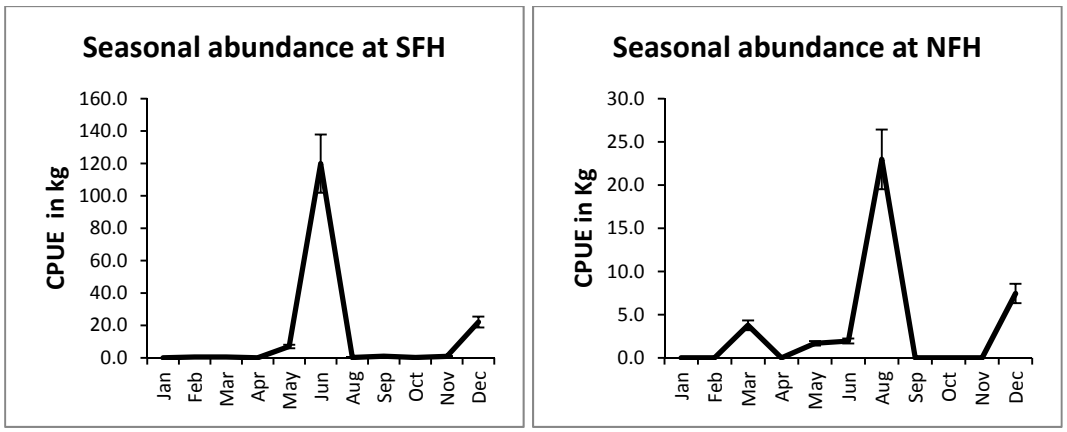
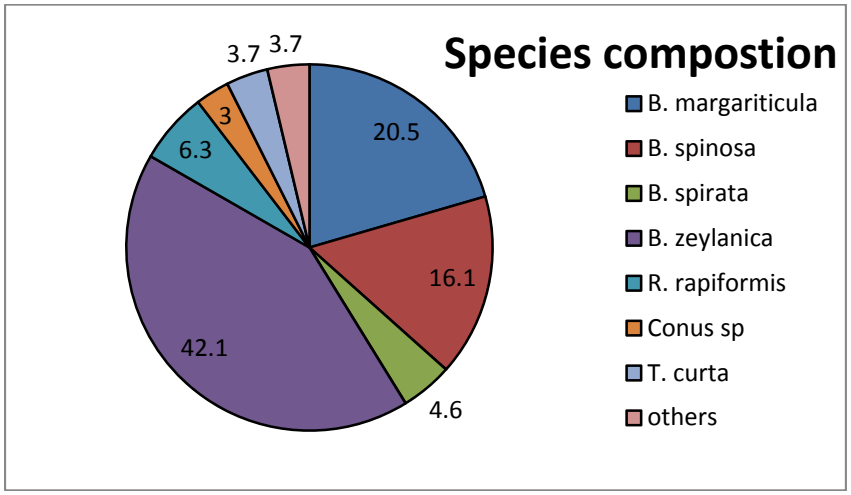


Fig. Seasonal Abundance

Species composition



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

Biology

Babylonia zeylanica length in the fishery ranged from 22.39 mm to 45.93 mm. The total weight of *B. zeylanica* ranged between 2.19 - 11.44 g, and meat weight 0.64g - 4.55g (dry wt. = 0.41-1.46g). The population was dominant by females; the sex ratio (Male to Female) was 1:14. The length range of *B. spirata* in the fishery ranged from 26.59 mm to 43.43mm and the total weight ranged between 4.15 – 19.29g and meat weight 1.48 – 6.48g (dry wt. = 0.48 – 2.5 g)

Bursa margariticula length in the fishery varied from 39.04mm to 63.45mm and the total weight ranged between 6.83 – 28.12 g and meat weight 1.5 – 7.49 g (dry wt. = 0.44 – 2.5 g). The population was dominant by females; the sex ratio (Male to Female) was 1: 1.43.

The length of *B. spinosa* ranged from 46.8 mm to 72.21 mm and the total weight ranged between 10.53 – 27.7 g and meat weight 2.35 – 6.38g. The population was dominated by females; the sex ratio (Male to Female) was 1: 3.25.

B) **Shell-craft industry survey**

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

The information was collated and the shell craft industry may be divided into four parts

- Raw material production unit
- Processing unit
- Finished whole shells and shell products unit
- Marketing unit

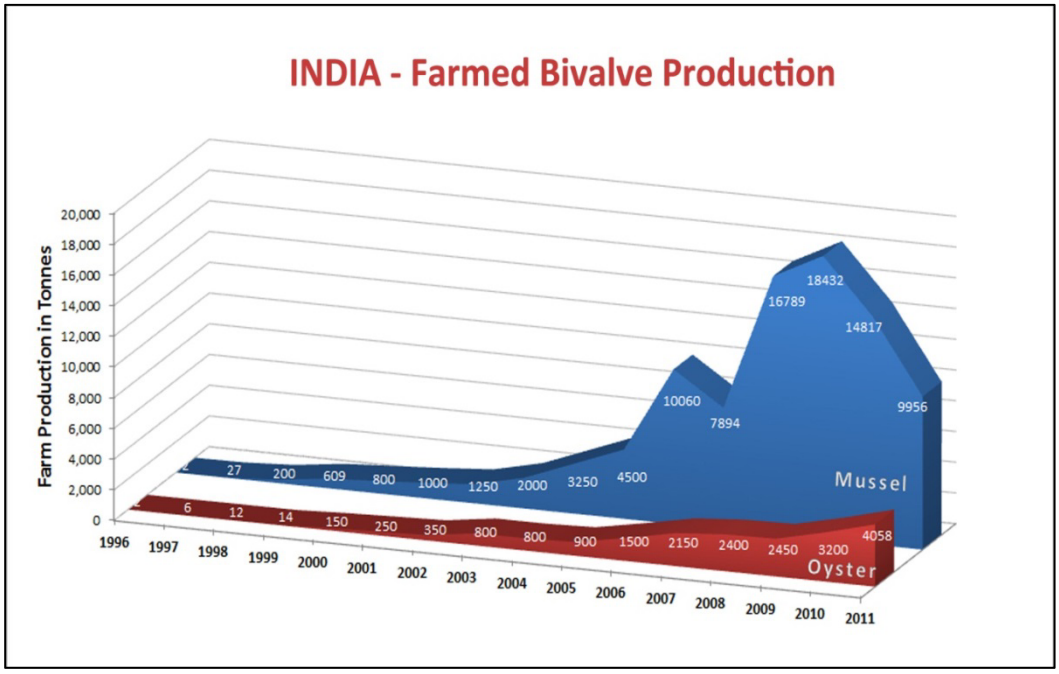
Fig. Polishing shells by allowing them in 5% Hcl in A) plastic trough B) in mud pot

Fig. Shell cutting and polishing unit

Fig. Decorative creature painted shells of *Natica* sp.

Farmed Bivalve Production

In India, bivalve farming has been in vogue for the past 16 years, mainly in the state of Kerala. The technologies were developed by CMFRI in the late nineteen seventies, and then through concerted demonstrations and extension efforts jointly with state fisheries agencies commercial farming of mussels and oysters became a practice among small-scale fishers and women self-help groups. Although there has been a slip in production of mussels in recent times, the production of oysters has shown a steady increase albeit at a slow pace. Currently, mussels form 71% and oysters 29% of the production. The recent setback in mussel farming are attributed to lack of adequate seeds, quality of seeds and issues of environmental overcapacity in the main farming area.



BIVALVE FARMING: SURVEY AND TRAINING

Identification of bivalve farming sites along coastal Maharashtra

Surveys were undertaken in October 2013 along the coastal districts of Maharashtra for identification of suitable sites for bivalve farming. Training on '*Mussel and oyster farming technique*' was imparted to fishermen in Kalbadevi area of Ratnagiri in collaboration with MPEDA.

Sites selected for oyster farming demonstrations during 2013-14

1. Dhabol
2. Ratnagiri (Kalbhadevi)
3. Wadatar

4. Achara

Sites selected for mussel farming demonstrations during 2013-14

1. Dhabol
2. Ratnagiri (Kalbhadevi)

The demo farm construction and training to groups were initiated in November 2013 by CMFRI

Sites selected for mussel farming demonstrations post 2014

1. Taramumbri
2. Devbagh

Training in bivalve farming

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


Bivalve farming training at Kalbhadevi, Ratnagiri

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

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

- Farming trials of *Saccostrea cucullata* in Mulki estuary: The rock oysters of 32.8±4.03 mm in the size range of 25-38 mm were stocked in netlon trays of 50 x 50 x 10 cm @ 16 kg/sq.m during November 2013 in Mulki estuary. The salinity in the culture site varied between 32 to 34.5 psu. The growth rates and survival of the oysters in the trays were monitored (Fig. 3 & 4). The mean monthly growth rate recorded was 1.87mm ranging from 0.86 to 2.89 mm in different units.

- Conducted training for 60 fisherwomen on mussel farming for the Kudumbashree units (SHG) of the Balathurithi area under the Vallikunnu Grama Panchayat on 16 November

2013.All the SHG's were assured subsidy for the culture of mussels in the backwaters of Kadalundi estuary.

Report on cause of mortality of farmed mussels at Padanna

- Conduced study on the cause of motality of farmed mussels at Edayilakadu estuary and submitted the report entitled “Investigative report on mortality of farmed mussel in parts of Padanna Kayal, Kasargod District, Kerala during 2013-14" to the District fishery officials. Some of the suggested improvements were with regard to the construction of bund which causes problem not only in reducing the flow of food material for the mussels but also leads to eutrophication of the water body and hence recommended construction of a proper pillar bridges at Edayilakkadu and at Udumbanthala-Madakkal road. Also recommended restriction on the number of mussel farms to 75 from the next farming season onwards based on the carrying capacity of the Edayilakkadu area. There was no evident pathological condition in the dead mussels. The loss was estimated as 790 tonnes worth about Rs. 4 crores.

Mussel farm in Edayilakkadu, Padanne, Kasargod and dead mussels on rope

Farming trials of *Saccostrea cucullata* in Mulki estuary

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

Rock oyster culture trials in Mulki estuary, Karnataka

Mussel farmer receives Zilla Rajyostsava Award

Shri. Shankar Kundar, the mussel farmer from Kodikanyan, Udupi District of Karnataka was conferred with "*Zilla Rajyotsava Prashasti, 2013*" under the category "*Agriculture*" for adopting and practicing scientific mussel farming in Karnataka. The award was presented by Shri. Vinaya Kumar Sorake, Minister for Urban development and Udupi district in-Charge and Shri Promodh Madhwaraj, MLA.

The Zilla Rajyotsava Prashasti, 2013 awardees with Shri. Vinaya Kumar Sorake, Minister for Urban development and Udupi district in-Charge and Shri Promodh Madhwaraj, MLA

MABE PEARL OYSTER

Submission of a Frontline demonstration project on designer pearl culture to the Department of Fisheries to the Government of Kerala

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

Three day training program 'IMAGE PEARL PRODUCTION' was organized at Vizhinjam Research Centre of CMFRI from 19 - 21/02/2014. Twenty four participants from different parts of the country attended the training.

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

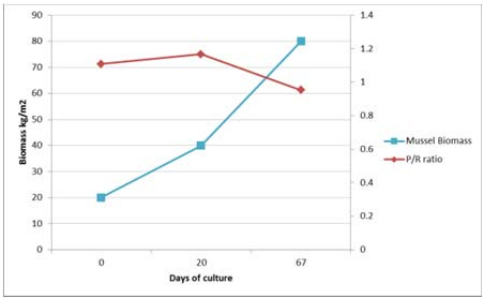
GASTROPODS

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

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

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

CARRYING CAPACITY OF ESTUARIES FOR MUSSEL FARMING



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

EXTENSION STUDIES ON MUSSEL FARMING

Ownership of Mussel Culture Enterprise:

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

The major independent variables were quantified and the average score obtained for the respondents (members of SHG) were converted into percentage value and are presented in the Table.

Table: Quantification of independent variables in Malabar locations

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

Major Achievements of Research – Project-wise – Externally Funded

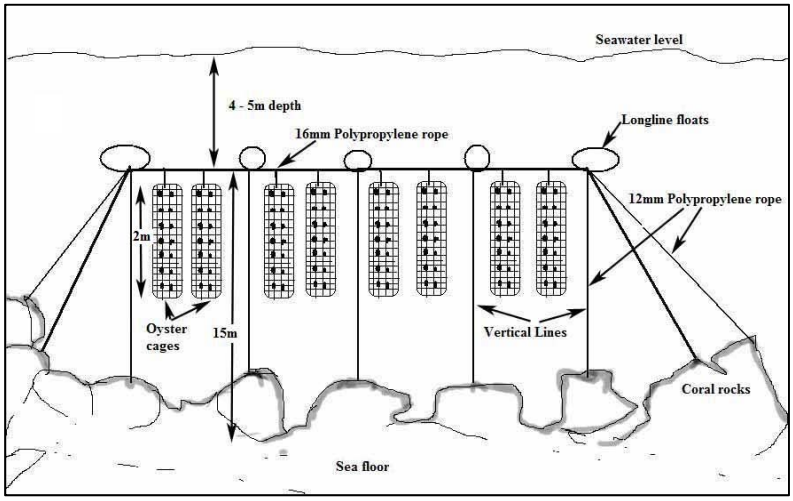
MoES Project: Farming and pearl production in black lip pearl oyster *Pinctada margaritifera* in Andaman & Nicobar Islands – XI Plan

Commercial viability of black pearl production in A&N Islands and conservation mariculture of ETP gastropods – XII Plan

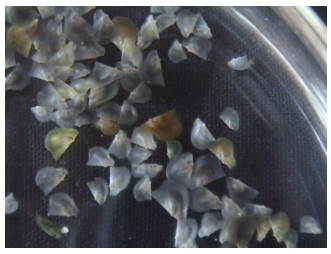
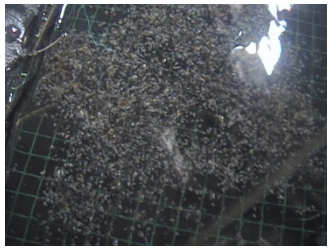
PI - Dr. K. Sunil Mohamed

The project was in operation during the Xth and XIth plan and is continuing in the XIIth plan. During these plan periods, the CMFRI has been able to make substantial progress in development of appropriate technologies for developing a black pearl production protocol in the A&N Islands with funding support from MoES. A list-down in brief of the technologies developed are:

- Established pearl farms and on-farm grow-out techniques using raft and submerged long-line systems (Polynesian method – see schematic diagram below)



- Established protocols for operating a mini black pearl hatchery and achieved success in continuous production of pearl spat (young ones)

Details of cultured Black pearl production

Particulars	Cultured Black Pearl - 1	Cultured Black Pearl - 2
Length (mm)	4.81	3.84
Width (mm)	3.65	3.14
Weight (mg)	76.8 [0.38 carats]	54.0 [0.27 carats]
Shape	Oval – baroque	Oval – baroque
Colour	Grey-black/ golden hue	Grey-black/ golden hue
Approximate value	US$ 50	US$ 40
Days of culture	307	368
Oyster details		
DVM (mm)	87.15	91.73
Thickness (mm)	25.89	25.34
Weight (g)	108.2	130.5
Depth of farm	7m	
Rearing in	Chaplets with wire mesh cover	
Method of farming	Sub surface longline	
Implantation technique	Tahitian – no narcotics	
Insertion	Mantle piece	
Percent recovery	15% (2/13)	

First cultured black pearls

Implanting nucleus by Tahitian pearl seeder

- Conducted training programmes to shellcraft artisans, women fishers on Mabe production and A&N Fisheries and Forest officials on hatchery techniques and launched a pearl oyster bed restoration programme (**ANPOREP**) for stock enhancement using hatchery reared spat The following training programmes were conducted:

    1. Conducted hands on training on "Marine mabe and half pearl training program for Fisherwomen" Sponsored by MoES, at Port Blair, on 25th August 2009.

    2. Conducted a training Programme on "Seed production of Blacklip pearl oyster in hatchery" Sponsored by MoES at Port Blair on 1and 2 February 2011.

    3. Conducted a training programme on "Andaman and Nicobar pearl oyster resource enhancement programme (**ANPOREP**)" Sponsored by MoES at Govt. Senior Secondary School, Rangachang, South Andaman, on 8th February 2012.

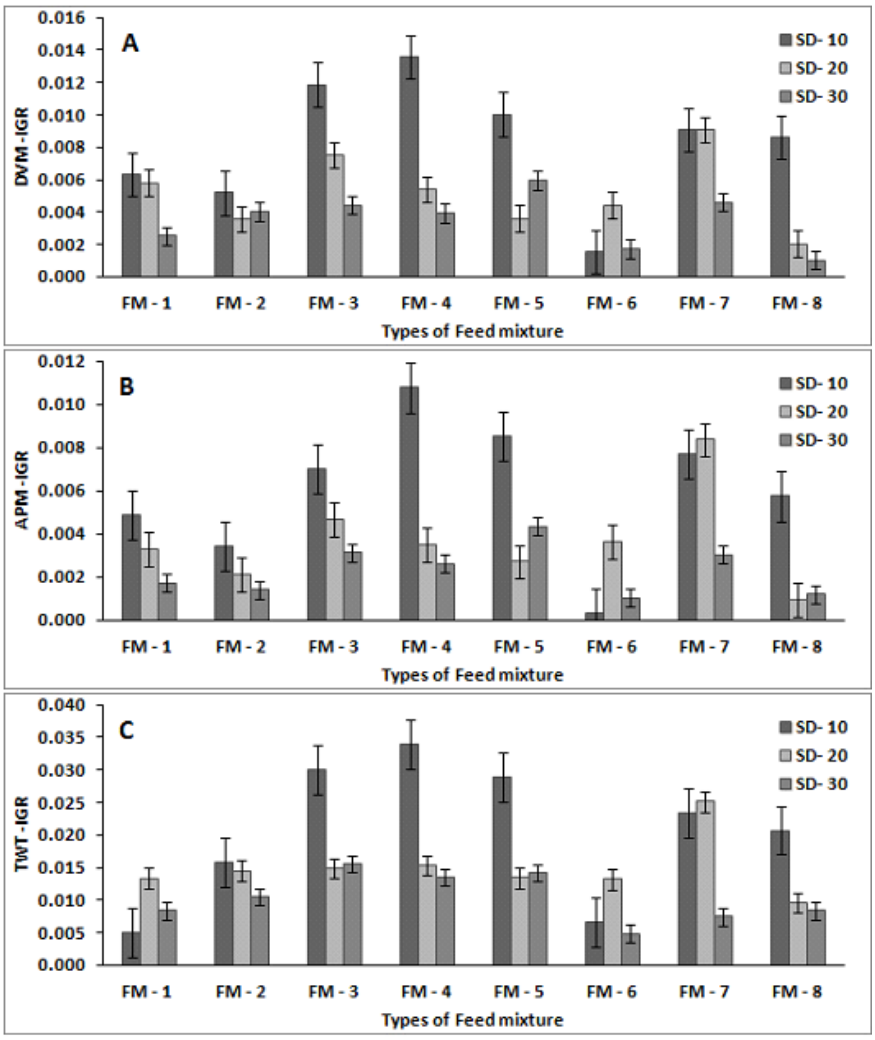
    4. Conducted a Demonstration programme on "Pearl farming and Hatchery techniques" Organized by Directorate of Fisheries, at Fisheries Training Centre, Port Blair, on 22nd November 2012.

Determining the apt combination of microalgae for spat rearing

- Among the feed mixtures tried out in the study, a combination of algae used in FM-3 (60 % *Chaetoceros calcitrans* with 10 % each of *Pavlova salina*, *Isochrysis galbana*, *Nannochloropsis oculata* and *Chlorella marina*) and FM-4 (60 % *Nannochloropsis oculata* with 10 % each of *Pavlova salina*, *Isochrysis galbana*, *Chaetoceros calcitrans* and *Chlorella marina*) were found ideal for spat rearing in hatchery conditions.

- Comparatively high cumulative mortality was recorded in higher stocking density. However, the feed mixtures did not show any influence on mortality rate with respect to stocking densities except control.

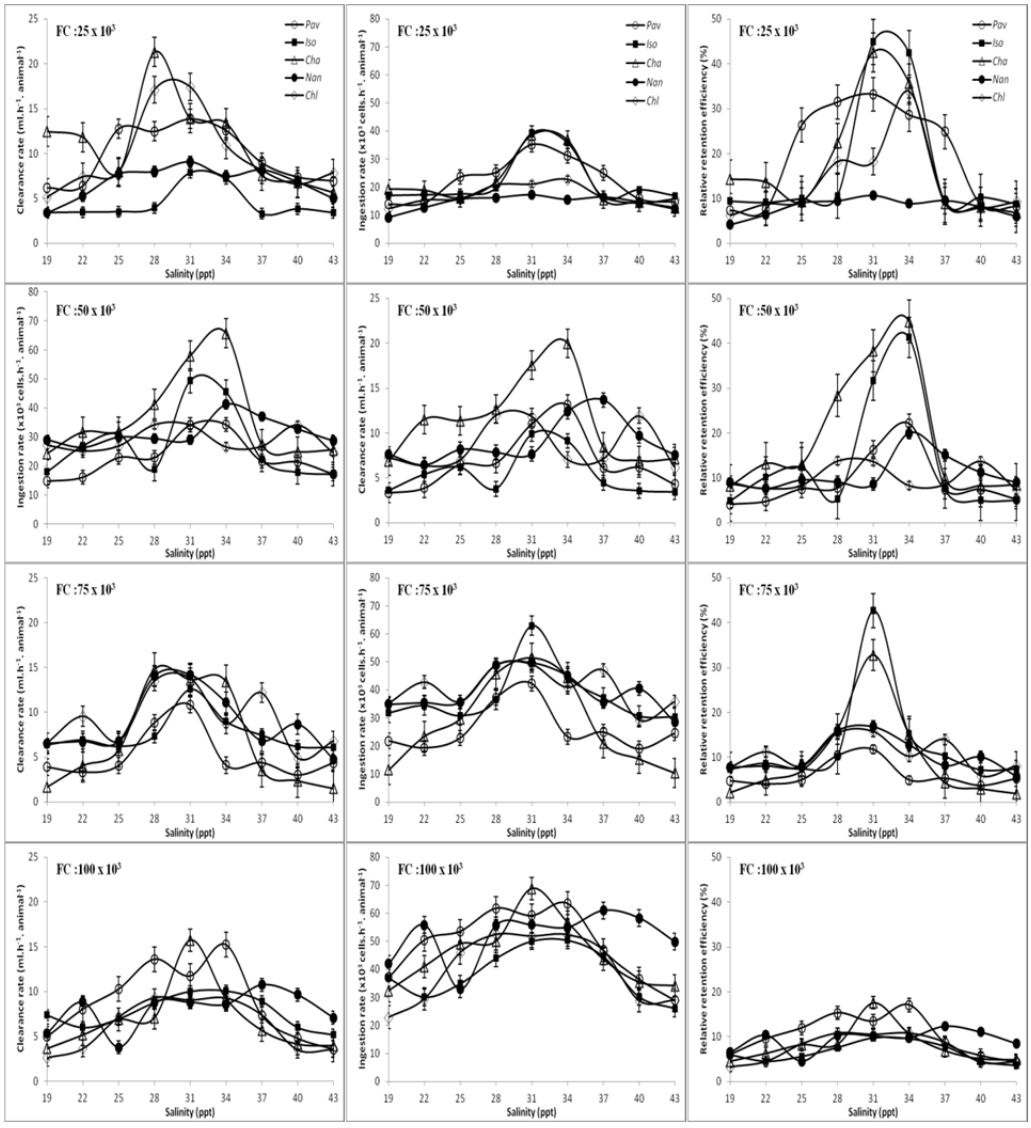
- A stocking density of 10 spat per 500 ml is an ideal stocking density with an optimum temperature ranging between 27 – 28 ^{o}C for maximum growth performance



Instantaneous growth rates (IGRs) in DVM, APM and TWT of P. margaritifera spat reared with various feed mixtures (FM 1 - 8) in different stocking densities (SD - 10, 20, 30)

Filter Feeding of *Pinctada margaritifera* spat

- This study has revealed that the feeding performance of pearl oyster *P. margaritifera* spat was comparatively better in salinities ranging from 28 to 37 ppt among the tested salinities.
- But a perfect feeding performance was noticed with a narrow range of salinity between 31 to 34 ppt
- The performances of these parameters were better in the optimal algal concentration of 50 x 10^3 cells.ml^{-1} with filter pumping processes at its full capacity
- The study has revealed that the best live feed for the blacklip pearl oyster spat should have a size of above 3 µm with cell concentration of 25 to 50 x10^3 cells.ml^{-1} required for nursery rearing



Clearance rate (CR), Ingestion rate (IR) and retention efficiency (RE) of P. margaritifera spat for 5 species of microalgae in different salinities and food concentrations (FC)

MPEDA Project - Demonstration of Responsible Fishing for the Trawl Fisheries of Gujarat
Final Report Submitted December 2009

PI - Dr. K. Sunil Mohamed

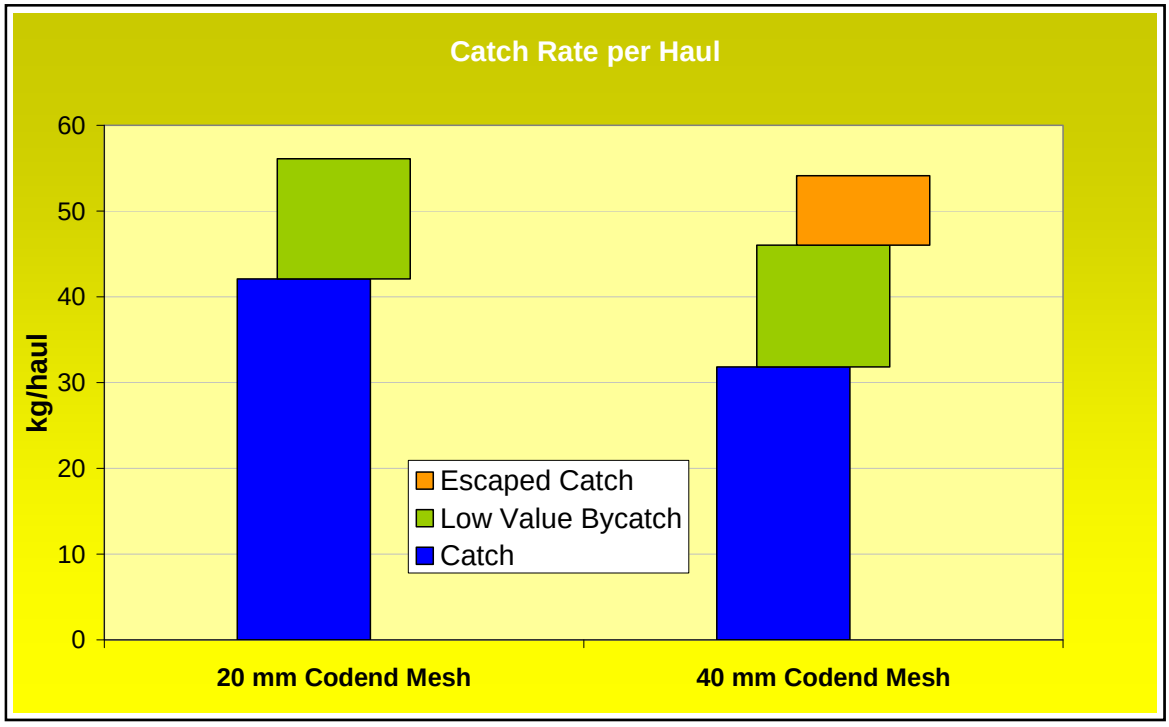
The project was proposed by CMFRI to tackle the problem of excessive young and juvenile fish and shellfish caught in trawls operated with small mesh sizes throughout the country. The MPEDA organized several meetings with the seafood industry and fisher groups to find a solution to this problem. The majority opinion was that trawl owners are not convinced that there would be profitability in trawl operations if government notified mesh sizes were used. Hence MPEDA agreed to fund a project to demonstrate the use of MFRA notified mesh sizes for trawl boats of Gujarat in tune with the FAO code of conduct for responsible fisheries. The industry offered the use of 3 trawl boats in Gujarat for use in the project. The project was jointly executed by CMFRI and CIFT.

Three commercial trawl vessels were operated for one fishing season. This also brought to light the fact that Gujarat vessels are operating in areas down south off Maharashtra (see fig below)

Trawl Haul Legend
1. October – Dark Green
2. November – Black
3. December – Blue
4. January – Red
5. February – Dark Gray
6. March – Cyan
7. April – Yellow

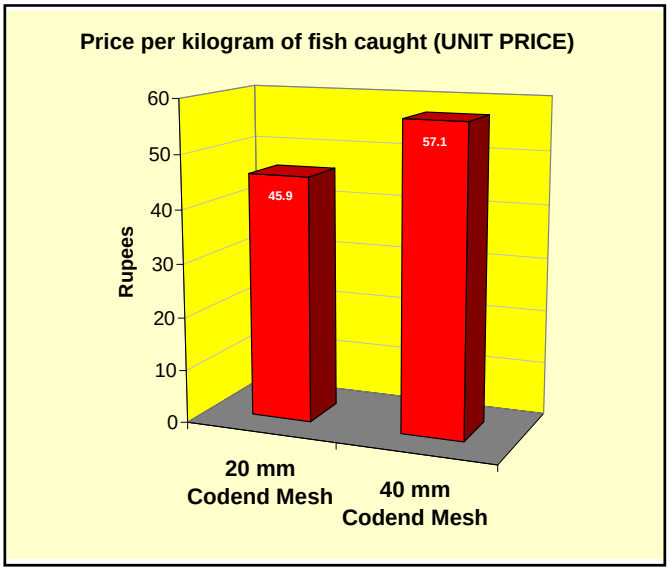
Vessel-wise and month-wise trawl geo-locations

- Results of the study indicate that the average amount of fish which escapes because of using 40 mm cod-end mesh instead of the usual is 8.1 kg/haul. This amounts to roughly 20% of the catch.
- The average loss per haul in monetary terms is Rs. 23 which is about 1.3% of the total revenue realized per haul.
- The average CPUE between trawls using 20 and 40 mm CEM were not significantly different ($P > 0.05$).



Change in average CPUE due to use of 40 mm cod-end mesh. Note that there is no difference in the proportion of LVB in both meshes

Difference in unit value of fish caught due to use of 40 mm cod-end mesh



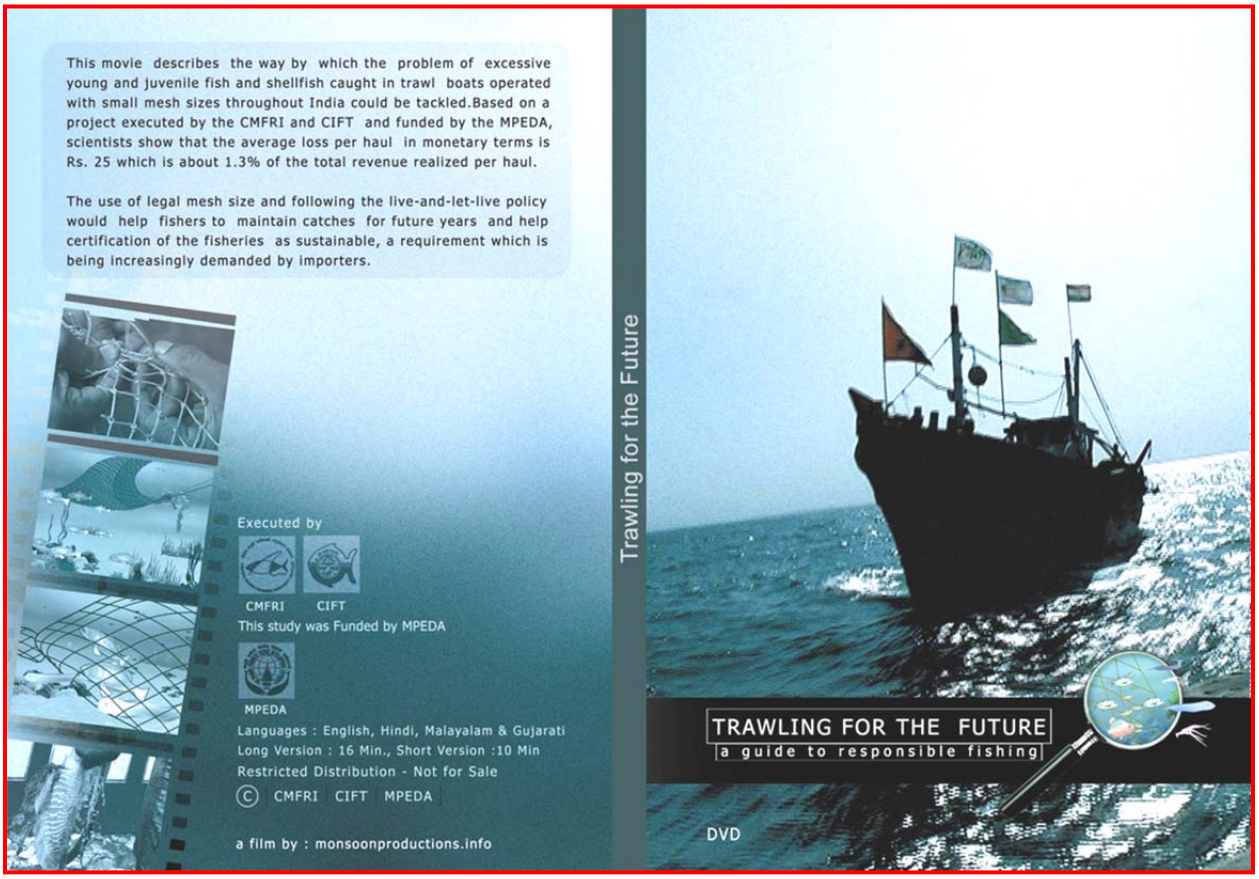
- When using 40 mm cod-end mesh there will be an increase in unit value of the fish caught by 24%. This happens because of the absence of small fishes in the catch, raising the unit value of the catch.
- Clear rightward shifts in modal lengths were seen in most species when the number of animals per haul was compared on the basis of length between 20 and 40 mm CEM trawls.
- The main expense in operational costs was due to diesel (85%) and the remaining was on ice, others and oil. On an average the monthly profit was about Rs. 76,000.

- Since the loss in terms of value of escaped catch was determined as 1.3% on account of using 40 mm square cod-end mesh, it is not expected to make any significant impact on vessel economics and overall profitability of operations.

On the other hand, the use of legal mesh size would pave the way for certification of the fisheries as sustainable, a requirement which is being increasingly demanded by importers.

These results need to be brought to the notice of the fishers, boat owners, seafood industry, NGOs and concerned government departments at the centre and state. It is recommended that MPEDA through its official machinery give wide publicity by holding seminars, movie screening and discussion forums in all maritime states.

A 16 minute video entitled **TRAWLING FOR THE FUTURE – A GUIDE TO RESPONSIBLE FISHING** was produced in 4 languages (English, Gujarati, Hindi and Malayalam). The English version in low resolution format has been uploaded into the youtube website for wider viewing (http://www.youtube.com/watch?v=AUaixPHjpSk and http://www.youtube.com/watch?v=mCyGpsCuMnA). ***Current YouTube hits >20,000***



MoES Project: Demonstration and transfer of technology of marine pearl culture (*Pinctada fucata*) Completed February 2013

PI - Dr. V. Kripa/ Dr. I. Jagadis

At Kollam

Scientific

- ✓ Growth of pearl oysters at Kollam was fast comparing to other centres, however, boring and fouling were the major natural hindrance for the programme apart from poaching.
- ✓ 16,000 hatchery produced pearl oyster spats of average size 3.8 DVM, HL 4.1 and Thickness 0.8 mm was transported from Tuticorin shellfish hatchery during May 2010 had grown to a size of 36.1 DVM, HL 31.9 and Thickness 11.9 mm over a period of five months.
- ✓ 1,500 adult pearl oyster of average size 54.2 DVM, HL 52.1 and Thickness 22.3 mm was successfully transported to Kollam from Tuticorin shellfish hatchery without mortality and reared at Kollam Farm for training and nucleation.
- ✓ Growth, survival and production of 'mabe' pearls were tested experimentally.

Manpower development

- ✓ A total of fifteen fisher folks have been successfully trained and nucleated over 1,500 oysters.

Societal

- ✓ The Technology of 'Mabe' or Image pearl production was introduced successfully to three Self-help group namely Chakara, Kadalamma and Chaithanya. Five members from each group were trained and the fisherwomen became capable of producing about 10% quality 'mabe' images.



At Lakshadweep, Kalpeni Island

Scientific

- ✓ 3,900 spats transported in December 2010 were subjected to growth studies.
- ✓ 600 Nos of adult oysters were raised for further studies and implantation.
- ✓ Growth, survival and production of 'mabe' pearls tested experimentally.

Manpower development

- ✓ 12 day long training programme on Marine Pearl Culture was conducted at Kalpeni Island for educated youth from Lakshadweep. 29 participants including on Asst. Director of Fisheries attended the programme from 2-01-2010 to 13-01-2010 held at the Senior Basic School, Kalpeni.
- ✓ All the theoretical and practical aspects of pearl culture techniques including the raft fabrication and deployment to spat rearing and growth studies were imparted to the trainees.

Societal

- ✓ The training was inaugurated by Mr. M.K. Shai Koya, Chairperson of Village Panchayat (DWEEP) on 2-01-2010 at a function presided by Mr. K. Nijamuddin Koya, the Sub Divisional Officer, Kalpeni. Certificates to the trainee participants were awarded by the Chairperson V (D) P in the valedictory function held on 13-01-2010.
- ✓ The Self-help Group viz "Manakkam" was established as the result of the project.

At Sipikulam Village, Tuticorin District

Scientific

- ✓ Successful transplant of Hatchery produced oyster, growth and production of adult oysters were monitored. A growth rate of 4.5 mm/month was achieved.
- ✓ Environmental monitoring for farming proved Sipikulam area a suitable site for farming of nucleated oysters for pearl production.
- ✓ Fouling and boring in this area was found to be negligible.
- ✓ **Fisher folk successfully carried out the nucleation, culture of oysters and spherical pearl production in the village and produced commercial grade pearls in their 'First attempt'.**

Manpower development

- ✓ A Mabe pearl training programme at Sipikulam village for 32 fisherwomen was conducted under MoES/CMLRE project during June 2009.
- ✓ A 10 days hands on training programme on Nucleus implantation during July-August 2009 for 10 village women from Tuticorin and Pudukottai area under MoES/CMLRE project.
- ✓ A 10 day training programme on spherical nucleus implantation was conducted for two batches of beneficiaries (10 Fisherwomen) under MoES/CMLRE project during September 2010 and January-February 2011.
- ✓ A refresher 'Mabe pearl' training programme at Sipikulam village for 1st batch fisherwomen (5 nos.) was conducted under MoES/CMLRE project during January-February 2011.

Societal

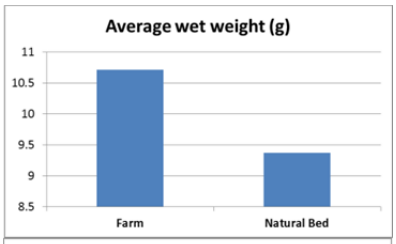
- ✓ A total 10 villagers trained and a group is formed.
- ✓ A project proposal was prepared for continuation of activity and handed over to the beneficiaries for submission to State Fisheries Department and follow up.

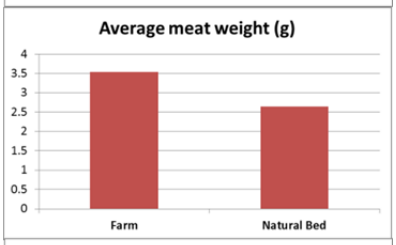
DST Project: **Development of shallow water grow- out techniques for the clam *Paphia malabarica* (Chemnitz) and the Corbiculid clam *Villorita cyprinoides* (Gray)**

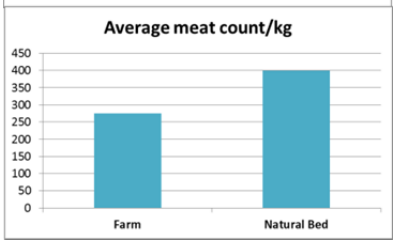
PI – Dr. N. Suja (Post-Doctoral Fellow)

Trials on different on-bottom and off-bottom of shallow water culture methods for *Paphia malabarica* and *Villorita cyprinoides* were done at Ashtamudi Lake and Vembanad Lake respectively. The farming trails had duration of about 6-7 months.

- On-bottom pen system was found to be the best for both species
- Optimum stocking density was 550/m^2 for both species
- Both species preferred ~70-80% sandy substratum
- About 30% improvement in meat weight and counts could be obtained by scientific re-laying

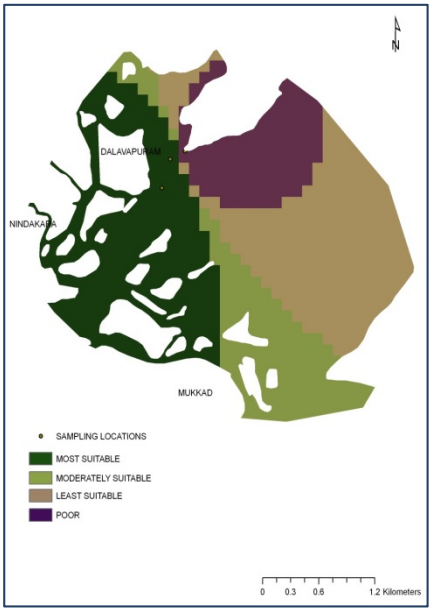






Status of Black Clam Fisheries Studied

- Nearly 4,000 fishermen harvest the black clams year-round.
- Each collects 150–200 kg/day.
- Upon returning from the harvesting beds, the fishermen and their families cook the clams and separate their meats from their shells using simple sieves.
- Fishermen's wives sell the meats within their local villages and save some for their families to eat. The shells are sold through organized fishermen societies to various industries.
- The stocks of black clams seem to be declining slowly in the southern part of the lake because the water has been getting fresher, but they are not declining in the northern half.
- A likely threat to the landings may be a lack of fishermen in the future.
- Black clam Minimum Legal Size (MLS) fixed as 20 mm APM based on SFM
- MLW was calculated as 3.4 g whole weight
- L_∞ was assessed as 56.2 mm APM
- K value was estimated as 0.935
- The reproductive load (SFM/L_∞) and mean generation time were determined as 0.35 and 0.72 respectively
- L_{opt} was calculated as 28.05 mm APM



Areas suitable for clam farming GIS maps

Based on clam biomasses and physic-chemical conditions of clam beds, areas suitable for clam farming was delineated in Ashtamudi and Vembanad Lake ecosystems.

NAIP Component-2: **Fishable potential and exploitation strategy for oceanic squids (Cephalopoda) in Arabian Sea: *A value chain approach***

PI - Dr. K. Sunil Mohamed

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

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

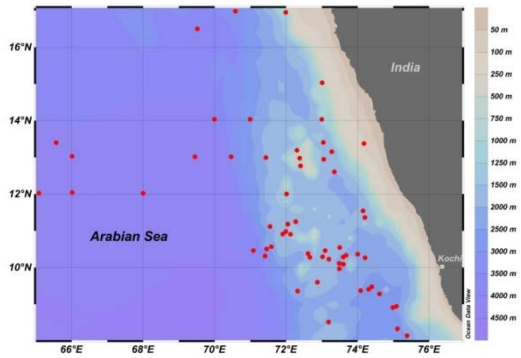
- This value chain project is unlike other schemes operating under CN2 of NAIP. The uniqueness is due to the fact that there is no current PCS for the commodity (oceanic squids) which is targeted in the project. Therefore, establishing a baseline was difficult, particularly as envisaged in the example reports provided by NAIP. The base-line survey to find out the most likely short-term impact of implementing the project on the seafood processing sector (industry) as well as in domestic markets was designed and carried out during June-August, 2009.

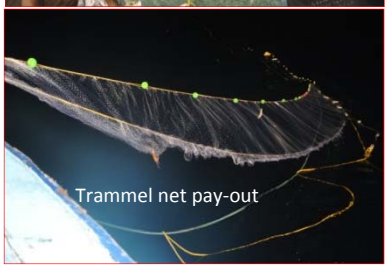
- A commercial fishing trawler *MV Titanic*, of >20 m Overall Length was modified for commercial squid jigging operations. Five mechanical squid jigging machines with pulling power 90-100 kg were installed. An accessory generator and aerial lighting system comprising of 18 1.5 Kw halogen lamps were set for lighting.

Modification work on board MV Titanic for conversion to squid jigger

- The conventional Pablo boats used for pole and line fishing for skipjack tunas was modified into a squid fishing boat with lights. The lights were powered by a 25 KVA petrol start and kerosene run generator. Four incandescent lights of 500 W each were used for attracting squids. Pablo boat with Overall Length 8 m from Agatti Island was leased for conversion.

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





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

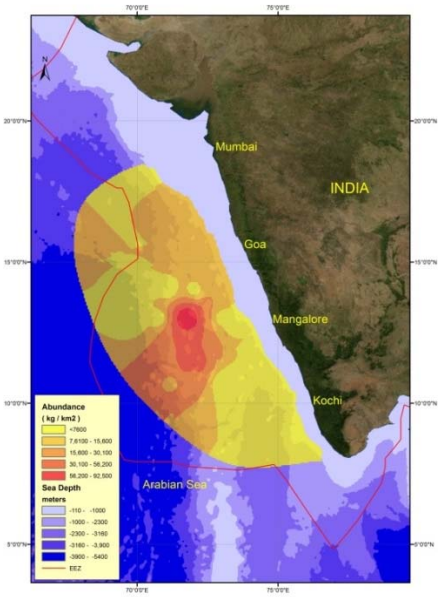
- It was established that purse seining and gillnetting with light attraction from converted 20m LOA commercial fishing boats are the most efficient gears for exploiting oceanic squids in the Arabian Sea.

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

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

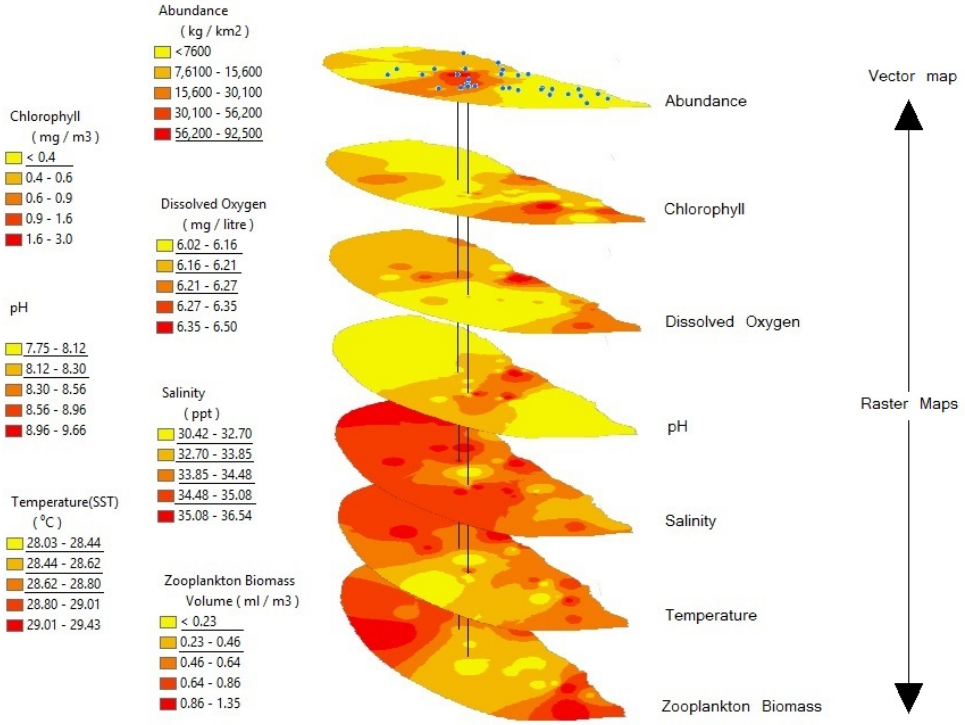
- Maximum abundances were related to areas with low SST (28.0-28.6°C), low chlorophyll (<0.4 mg/m^3), lower salinity (30.4-33.8 PSU) and high pH and dissolved oxygen values.

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



Oceanic squid abundance map in GIS format created based on 2010-13 surveys

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



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

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

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

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

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

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

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

NAIP CN-2 Project: **A value chain on high value shellfishes from mariculture systems**

PI - Dr. V. Kripa/ Dr. T.S. Velayudhan/ Dr. V. Venkatesan

This project was implemented to develop a sustainable high-value shellfish value chain by encompassing enhancement of mariculture production through refinement of seed production techniques, commercialization of farming techniques, production of value-added products like ready–to–serve/ cook products with special emphasis on food safety and quality, popularization and promotion of farmed products, production of oyster flavor extract and commercialization of farmed value-added products. To achieve this, a consortium was formed with NIFPHATT to work jointly to address various issues in the high value shellfish value chain. The support of women Self Help Groups, BFDA, Kollam, and High-end restaurants were also used in implementation of project activities in the coastal villages. These new developments were documented through videos and placed in the website www.oysterandlobster.naip.org.in and YouTube. The technical achievements and lessons learned in the sub-project during February 2009 – March 2014 are briefly presented here under.

- Self Help Groups women interested in oyster high-value shellfish were identified and trained in oyster farming techniques for achieving higher yield. Oyster seeds in ren from the hatchery were supplied to SHGs with farm materials such as nylon rope, bamboo poles etc. Technical guidance was provided throughout the crop growth and harvest. Harvested oyster were converted into value added products at VAP unit at the village itself and in NIFPHATT plant.

- Two types of value chains were developed i.e., fresh live oyster traded directly to high-end restaurants and VAP products which were sold through the NIFPHATT fish stall.

- An oyster hatchery with a production capacity of one lakh spat (seed) per annum developed in KVK complex in Narakkal which is the first unit for training farmers in technical protocols of oyster seed production.



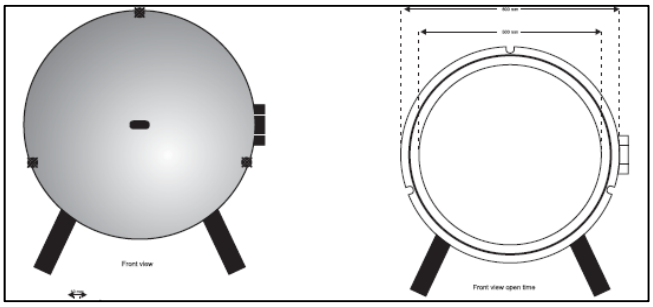
- Innovations were made in oyster productivity enhancement and supply chain management. The estimated farmed production was 4700 tonnes during 2013, indicating an increase of 12 % over that of 2012 (4202 t) and 47 % over that of 2011 (3200 t).
- Innovations were made in cultchless spat production at hatchery and growing them as a single oyster. Uniform shape and sized cultchless spat were grown in farms which fetched higher price

to the farmer. A remote setting unit was developed at Moothakunnam, villagers were trained on transfer of pediveliger larvae for remote setting.

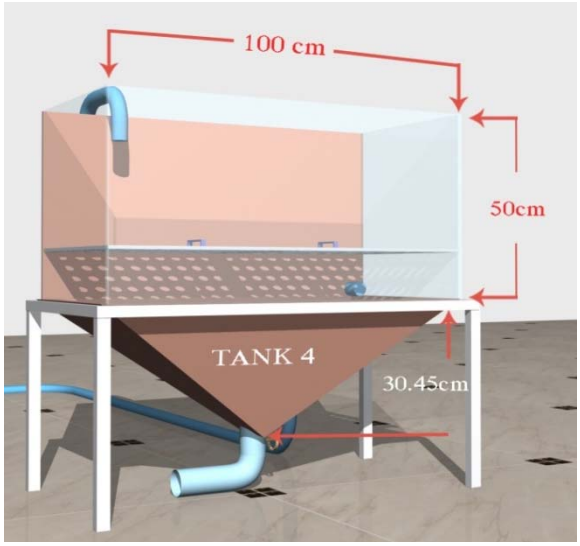
- A common village facility for depurating oysters on a large scale was developed. The unit has facilities for sea water purification, jet washing facilities and specially designed tanks where 3000 oysters can be depurated in a single run of 12 h.



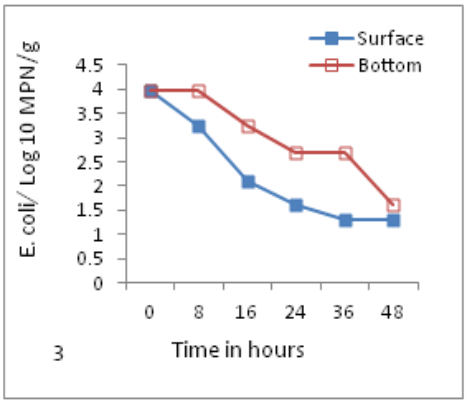
- An automated heat shucking unit with steam production and promoting fuel efficiency and reducing physical labour was developed. The unit can heat shuck 500 oysters in 6 minutes using pressurized steam.



- A depuration display unit (DDU) for ensuring consumer confidence in high end restaurants was developed. This has facilities for water storage and purification and a transparent display unit where 250 oysters can be maintained in live condition.



- Depuration protocols were developed by evaluating the levels of coliforms, *E. coli*, *Vibrio* and *Salmonella* before and after depuration in a fill-and-draw system.



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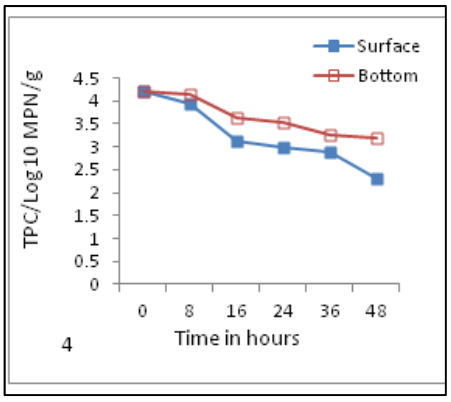

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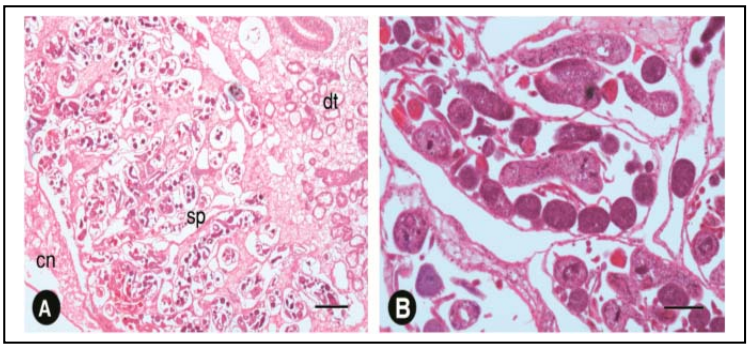
- Oyster value added products were developed with the brand name *Muzuris*. Eight ready to eat oyster products (Oyster pickle, Oyster curry in coconut milk, oyster curry with vegetables, battered and breaded oysters, marinated oysters, cold smoked oyster, frozen oyster soup) and one ready-to-cook oyster product, IQF-oysters were developed. Large scale production of the most preferred product i.e., oyster curry and cold smoked oyster were done and market promotion was attempted in Ernakulam district.

- Nutrient profiles of the processed oysters were analyzed and this was used for printing as 'Oyster Fact Sheet' in oyster products which were marketed.
- Oyster nectar technology was developed. Based on this, two products were also developed viz., frozen oyster rasam and frozen oyster soup.

- The value of live oysters was increased from Rs. 1 to Rs. 10 per oyster. Value for depurated steam shucked oyster meat increased from Rs. 65 to >Rs. 300 owing to value addition thereby improving the livelihood status of the SHGs.

- A live oyster transportation protocol was developed for long distance transport of live oysters using a thermocol cool box.
- Evaluation of the health status of edible oysters from the different locations such as Tuticorin, Kollam and Cochin were made by assessing the general health condition through condition index values (CI) and recording the presence of parasite, intensity of infection, prevalence and extent of tissue pathology caused by it.



- Oyster farm ecology was studied in detail. hydrologic parameters like TSS, salinity, pH, productivity, ammonia, nitrate, nitrite, phosphate, total suspended solids , phytoplankton biomass , microbial load, of the seawater at the farm site and control site were monitored

- The Quilon Social Service Society (QSSS), a Kollam based private NGOs, has adopted the oyster processing technologies developed under the NAIP scheme on high-value shellfish for processing yellow foot clam (*Paphia malabarica*). Owing to this value chain, price of clam meat is increased from Rs. 65/kg to 200/kg thereby improving the livelihood status of the SHGs.

- Techniques for broodstock maturation and breeding in captivity for the sand lobster were standardized. Mass larval rearing protocol up to final larval and settlement stage, with maximum survival rate of 20% up to final phyllosoma stage was developed.

MoEF Project: **Mapping and resource assessment of Pearl oyster banks of Tuticorin (Central) Division of Gulf of Mannar**

PI – Dr. I. Jagadis

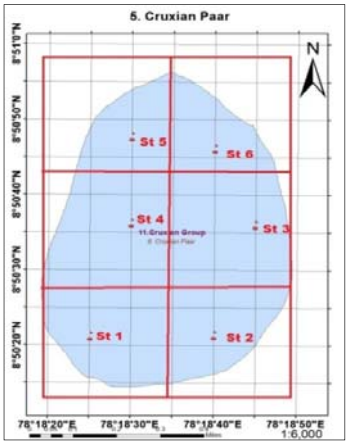
The target for the project were 1) To prepare the topographic map of all the known pearl beds lying in the central (Tuticorin) division and to identify the productive and non-productive pearl beds; 2) To document the pearl oyster population in the productive beds along with associated fauna/flora and 3) To prepare a 'Data Base' for all the productive pearl beds.

Group Map generation

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

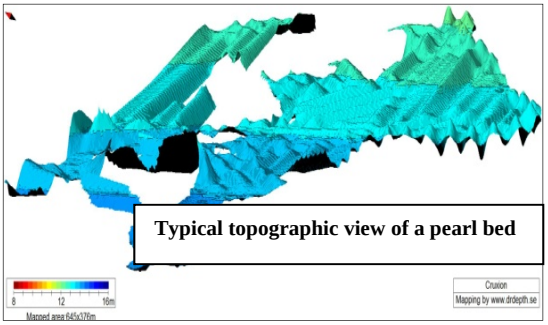
Grid Map for survey

Conducted underwater survey, Grid Maps were prepared with help of arc-GIS software by obtaining digital information like grid map, strip map & way point map form vessel navigation.



A typical Grid Map for fixing dive sites – Cruxion Paar>>

- The size of the each grid is equal size that is 15 sec (450 meters) and also obtaining the consecutive data from the digitised data like distance from old harbour to each pearl bank
- Surveys were conducted at 6 'paars' – Devi, Cruxion, Crixion Thoondu, Vantheevu Arupagam, Nagarai and Utti - and data obtained on environmental and topographical aspects were documented .
- Nenjurichan and Pulipoondu paar groups were surveyed initially for ground truthing and environmental data, soil nature (grain size), fauna/flora availability were obtained.
- For biological status 'dives' were conducted using SCUBA on the predetermined dive spots in each dive grids (450 sqM) and data documented.
- No significant pearl oyster populations were observed in all the pearl beds so far surveyed.
- Preliminary observations showed clear damage to the near shore pearl beds. The pearl beds have become almost flat due to the physical disturbances (repeated trawling?).



Typical topographic view of a pearl bed

Publications

Year	International	National	Technical articles	Popular articles	Training manuals/ Teaching resources	Books/Book chapters/ Bulletins/ Special publications/manual	Brochure/ CDs	Monograph	Image	Seminar/ conferences	Videos	Total
2009	2	3	2				1			4	1	13
2010	5	1	2	4		1				3		16
2011	2	4	2	1		1				12	4	26
2012	2	8	8	2	1	3				8		32
2013	4	8	14	5	6	3		1	1	8		50
2014	1											1
Total	**16**	**24**	**28**	**12**	**7**	**8**	**1**	**1**	**1**	**35**	**5**	**138**

Websites Developed

Under the NAIP scheme, 2 project websites have been developed and maintained by the division incorporating all achievements and information developed under the projects

http://www.oysterandlobster.naip.org.in/

http://www.oceanicsquids.naip.org.in/

Awards & Honours

AWARDS

1. **TVR Pillay Aquaculture Award 2011** – to M/s Dr. K. Sunil Mohamed, Dr. T. S. Velayudhan, Dr. V. Kripa, Mr. Mathew Joseph, Ms. Jenni Sharma, Mr. P. S. Alloycious, Dr. P. K. Asokan and Dr. P. Laxmilatha for commercialization of mussel and oyster farming technologies in Kerala state and for post-harvest technologies and VAP products from bivalves.

2. **Certificate of Merit** from the Director Vigyan Prasar (GOI) in a function of Rashtriya Vigyan Chalachitra Mela & Competition 2013 for the documentary film on oyster farming.

HONOURS

Dr. K.S. Mohamed – Became a member of the 15-member global Technical Advisory Board (TAB) of the Marine Stewardship Council (MSC), London from December 2011.

Dr. P. Laxmilatha - Committee Member of Mussels Standards Technical Committee to consolidate the draft document of Best Aquaculture Practices for mussel farming organized by Global Aquaculture Alliance

Infrastructure

The following facilities were added to MFD during the period:

Hatchery

1. Blacklip pearl oyster hatchery at Port Blair, A&N Islands
2. Oyster hatchery at KVK, Narakkal

Farms

3. Submerged long-line and raft farms for blacklip oysters at Port Blair
4. Bivalve rack farms at Sathar Island, Moothakunnam, Kollam, Mulki etc

Depuration & VAP Unit

5. Depuration and VAP unit for oysters and other bivalves at Moothakunnam, Ernakulam

Laboratory

6. Squid ageing Laboratory at Kochi

Survey Vessel

7. MV Titanic a coastal fishing trawler converted to squid jigger and operated squid biomass surveys for 4 years from 2011 to 2013

Major Assets Acquired

Sl. No.	Equipment	Amount spent (Rs. In lakhs)
1	Power generator	3.2
2	UV-spectrophotometer	3.6
3	Microscope (stereozoom + software + camera)	5.0
4	FRP/lLRT tanks	11.1
5	Purification tanks	4.1
6	Automatic grain size analyser	3.6
7	Current meter	4.2
8	High resolution stereo microscope	14.2

9	Underway CTD	26.3
10	Flurometer	12.2
11	Squid jigging machinery	21.0
12	Diesel Generator (part of above)	3.7
13	Isaac Kidd Mid-water Trawl (IKMT)	15.4
14	Remote Operated Vehicle (ROV)	29.1
15	Plankton net	3.5
16	Night vision binocular	3.7
17	Trinocular microscope	5.8
18	SIGMA plot software	4.5

Product/ Process/ Technologies Developed

Products

- Several oyster and oceanic squid products in collaboration with NIFPHATT which were test marketed in Kochi successfully

Processes/ Technologies

- Blacklip pearl oyster spat production process
- Blacklip oyster farming protocols
- Black pearl and mabe pearl production technology
- Depuration protocols for oysters and clams
- Development of live oyster value chain
- Depuration display unit for high-end restaurants
- Process for steam shucking of oysters and clams (patent application made in 2013)
- Oceanic squid capture using squid jigging, gillnetting and purse seining

Policy Guidance

- Determined that FAD fishing for cuttlefish is destructive to the stock and as per CMFRI advice the Government of Karnataka has banned the fishing practice
- Developed Fishery Management Plan (FMP) for Ashtamudi Lake short-neck clam fisheries, based on which the Kollam District administration has formed the Ashtamudi Lake Clam Fisheries Governance Council (ACFGC) which is a fisheries co-management council
- Part of team which developed advisories for management of marine fisheries of Kerala including extension of trawl ban and new ban for ring seiners

HRD – Deputations Abroad

- Dr. K.S. Mohamed

    1. Working Group meetings of the **Marine Stewardship Council** at MSC offices in London, UK - May 2012 & April 2013

    2. Technical Advisory Board (TAB) meetings of **Marine Stewardship Council**

        - Berlin – December, 2011
        - Singapore - October, 2012
        - Lisbon – December, 2013

    3. Ecosystem Characterization Workshop conducted by BOBLME from 9 to 11 February, 2014 at Phuket, Thailand

- Dr.Geetha Sasikumar

    1. Training on "**Age estimation of squid and fish**" at the Department of Primary Industries (DPI), Fisheries Victoria, Queens Cliff, Australia from 23 March to 1 April 2012 under the NAIP project "Utilization strategy for oceanic squids (Cephalopoda) in Arabian Sea: A value chain approach".

- Dr. Laxmilatha P

    1. Participated in the **Mussels Standards Technical Committee** meeting as Committee Member to consolidate the draft document of Best Aquaculture Practices for mussel farming, held during 18^{th} – 19^{th} June 2012 at Manchester, United Kingdom, organized by Global Aquaculture Alliance.

- Dr. I. Jagdis - Workshop on **Drugs from Marine Muricids** at Southern Cross University, Lismore, Australia, November, 2012

Major Event – ShellCon 2014

The Shellfish food festival - ShellCon 2014 was organized by Central Marine Fisheries Research Institute (CMFRI), Kochi during 22nd to 23rd March, 2014 under the NAIP Value chain on high value shellfish. More than 3000 people attended the event. The aim of ShellCon was to:

- Build awareness among the general public on shellfish (oysters, mussels and clams) as a highly nutritious food with several health benefits, such as better immunity, mental and reproductive alertness.
- Bring together research and development professionals in the government and in the private sector to debate on the progress made in shellfish farming in the country and evolve policy on future development.

In connection with the ShellCon, the following programmes were arranged

- Cookery Competition
- ShellCon Exhibition open to public
- Music and songs for the public
- Roundtable conference on shellfish farming and business development
- Cookery show on how to make Arikadukka by iconic chef from Calicut
- Prize distribution to cookery competition winners

The Roundtable in ShellCon 2014 was held on 23rd March at CMFRI, Kochi with the aim of getting all bivalve farming/ processing/ marketing subject experts on one table to discuss the current status of bivalve shellfish mariculture in India, its problems and prospects and business development strategies. The roundtable which had 4 subject rounds was chaired by Dr. E.G. Silas, former Vice Chancellor, Kerala Agricultural University and former Director of CMFRI.

The Subject Rounds

- Round 1: Production and Farming
- Round 2: Post-harvest and hygiene issues
- Round 3: Marketing domestic and export strategy
- Round 4: Consumption-Consumer acceptance