



Resource Assessment /
Fin fish Fisheries

Crustacean Fisheries

Molluscan Fisheries

Fishery Environment

Maine Biodiversity

Fishery Economics

Tissue culture/
Mariculture

Tuticorin Research Centre of CMFRI, Tuticorin

May 2014

Genesis and growth of TRC of CMFRI

Tuticorin Research Centre is one of the major research centre of CMFRI which was started as a 'survey centre' in 1948 and upgraded as a research unit in 1959. With further strengthening of the research activities, this was elevated to the status of a sub-station in 1969 and subsequently to a research centre in 1975. The centre has made several unique and valuable research contributions during the last six decades which has won national and international recognition.

Staff Strength (year wise)

	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014
Scientist	8	8	6	7	7
Technical Officers	7	9	8	8	6
Technical Assistants	17	20	14	14	14
Administration	9	9	9	9	9
Skilled Support Staff	19	18	17	17	15

Budget (year wise)

PLAN

Heads	2009-2010		2010-2011		2011-2012		2012-2013		2013-2014	
	Allotted	Expenditure								
	18,00,000	18,17,711								
Infrastructure			18,00,000	17,08,441	-----	-----	7,00,000	9,50,789	15,00,000	15,00,301
Adm.Expenses			3,50,000	3,94,420	1,00,000	1,15,011	2,00,000	3,29,007	3,50,000	3,60,059
Res.Expenses			2,00,000	2,47,775	7,00,000	6,91,424	10,00,000	12,91,764	11,50,000	11,49,868
Communication			20,000	29,722	50,000	44,926	1,50,000	38,033	2,00,000	44,651
Repair & Mtce.			-----				6,00,000	5,26,785	-----	
Operational Exp.			2,00,000	2,22,042	5,00,000	5,02,165	10,00,000	10,34,004	11,50,000	11,49,928

NON -PLAN

Heads	2009-2010		2010-2011		2011-2012		2012-2013		2013-2014	
	Allotted	Expenditure								
	12,00,000	13,75,377								
Infrastructure			5,00,000	10,37,311	5,00,000	4,99,078	7,00,000	7,04,349	4,50,000	6,46,745
Adm.Expenses			-----		1,00,000		50,000	50,887	3,35,000	3,45,507
					1,04,247					
Res.Expenses			1,50,000	2,20,094	2,00,000	1,92,136	2,00,000	1,93,058	2,80,000	2,92,530
Communication			20,000	8,894	1,00,000	4,305	25,000	17,542	17,500	8,117
Repair & Mtce.			1,00,000	1,25,128	2,50,000	2,50,265	2,50,000	2,33,942	5,55,000	5,33,158
Operational Exp.			4,50,000	5,08,900	3,00,000	2,98,570	3,00,000	2,98,913	1,45,000	1,42,281

Research Facilities

Fishery Biology Laboratory

Bivalve Hatchery

Gastropod Hatchery

Micro algal Laboratory

Marine Biodiversity Laboratory

Marine Repository

Research Vessel CADALMIN - IV

Marine pearl Farm

Research Projects : 2009-2014

Institute Projects

Project Code No.	Title of the project	Years	Status
PEL/IDP/01	Management advisories for sustaining marine fisheries of Kerala and Lakshadweep	2009 - 2010	Co-PI
PEL/IDP/03	Strategies for sustaining tuna fisheries along Indian Coast	2010-12	Co-PI
DEM/IDP/1	Management advisories for sustaining marine fisheries of Tamil Nadu and Puducherry	2010-2012	Co.PI-2
CF/IDP/02	Resource damage assessment in marine fisheries: Impact of selective fishing of juveniles, bycatch and discards in trawl fisheries- Thallumadi fishery	2010-2012	Co-PI
CF/RE/03	Recruitment dynamics of penaeid shrimps along the Indian coast	2009 to '11	Co-PI
FEM/01	Impact of anthropogenic activities on coastal marine environment and fisheries	2009-2012	Co.PI
FEM/02	Impact and yield study of environmental changes on the distribution shifts in small pelagic along the coast	2009-2011	Co.PI
MD/IDP/01	Technology development for seed production of shellfish	2009-'12	Co-PI
MD/IDP/02	Technological up gradation of molluscan mariculture	2009-'12	Co-PI-2
MD/IDP/03	Technology Development of brood stock, captive breeding and seed production techniques for selected marine food fishes and ornamental fishes i) Live feed culture ii) Breeding and seed production of Grouper	2010-2014 2009-10	Co-PI
MD/05	Mariculture of selected species of conservation importance	2009-'12	PI

MBD/RE/01	Understanding the threatened coral reef ecosystems of Southern India and designing interventions aimed at their restorations	2009-2012	Co-PI
FRAD/IDP/01	Sustainability profiling of major fisheries off Kerala – a multi-dimensional scaling approach	2009 to '10	Co-PI
	12 th Plan Projects		
FISHCMFRISIL 201200200002	Remote sensing assisted biodynamic forecasting paradigm for Indian Marine fishery resources	2012- conti..	Co-PI
FISHCMFRISIL 201200500005	Assessment of elasmobranch resources in the Indian seas	2012- conti..	Co-PI
FISHCMFRISIL 201202900029	Development of tissue culture technology for invitro production of pearls from the blacklip pearl oyster Pinctada margaritifera and refinement of in vitro pearl formation in Pinctada fucata	2012- conti..	Co-PI
FISHCMFRISIL 201200700007	Development of strategies for sustaining large pelagic along the coast of India.	2012- conti..	Co-PI
FISHCMFRISIL 201200800008	Development of Fishery Management Plans for sustaining marine Fisheries of Tamil Nadu and Puducherry.	2012- conti..	PI, CoPI-2
FISHCMFRISIL 201200900009	GIS based resource mapping of distribution and abundance of finfishes and shell fishes off Indian coast for suggesting operational based strategies for fisherie management	2012 - 2014	Co-PI-2
FISHCMFRISIL 201200800012	Development of Fishery Management Plans (FMPs) for the bivalve fisheries of India	2012 – conti.	Co-PI
FISHCMFRISIL	Evaluation of ornamental gastropod fisheries	2012-conti	PI

201201300013	and assessment of shell craft industry		
FISHCMFRISIL 201201400014	Sustainable molluscan mariculture practices	2012 - conti..	Co- PI
FISHCMFRISIL 201201500015	Bio inventorying and biodiversity valuation of marine organisms in selected marine eco systems along the Indian coast	2012 - conti..	Co- PI
FISHCMFRISIL 201201600016	Investigation on vulnerable coral reef ecosystems of Indian waters with special emphasis on formulation of management measures for conservation	2012 - conti..	Co- PI
FISHCMFRISIL 201201700017	Assessment of fishing impacts on biodiversity loss, with special reference to the threatened species to formulate management options for their protection	2012 - conti..	Co- PI
FISHCMFRISIL 201201800018	Ecosystem process of critical marine habit ats and development of protocols for restoration"	2012- conti..	Co.PI
FISHCMFRISIL 201201900019	Pollution and litter in the coastal and marine ecosystem and their impact	2012- conti..	Co.PI
FISHCMFRISIL 201202000020	Economics of Marine fisheries and sustainable management policy issues and interventions	2012 - conti..	Co- PI
FISHCMFRISIL 201202000021	An Input Output economic optimization model for marine fisheries at Tuticorin Fishing Harbour	2012 - conti..	Co- PI
FISHCMFRISIL 201202000023	Supply chain management of marine fisheries sector in India	2012-conti...	CoPI
FISHCMFRISIL 201202400024	Development and standardisation of seed production technologies of selected high value finfishes and shellfishes	2012- conti..	Co-PI
FISHCMFRISIL 201202800028	Genetics, Genomics and biotechnological applications in mariculture and fishery resources management	2013-conti..	Co-PI

Externally Funded Projects

Project Code No.	Title of the Projects	Year	Status
ICAR Mega Seed Project	Seed Production in Agricultural Crops and Fisheries-Microalgae	2011-2014	Co-PI
NICRA	National Initiative on climate resilient agriculture (NICRA)- Marine Fisheries	2011-Conti	Co-PI & C.C
2020600006	National Initiative on climate resilient agriculture (NICRA)	2011-2014	Co.PI
CMLRE, Kochi	Demonstration and transfer of technology of marine pearl culture (<i>Pinctada fucata</i>)	2008-13	PI
Min. of Env. & Forest, New Delhi	Mapping and resource assessment of pearl oyster banks of Tuticorin (Central Division) of Gulf of Mannar.	2012- conti	PI
Min. of Earth Sciences, CMLRE,Kochi	Assessment of Myctophid Resources in the Arabian Sea	2012-14	Co-PI

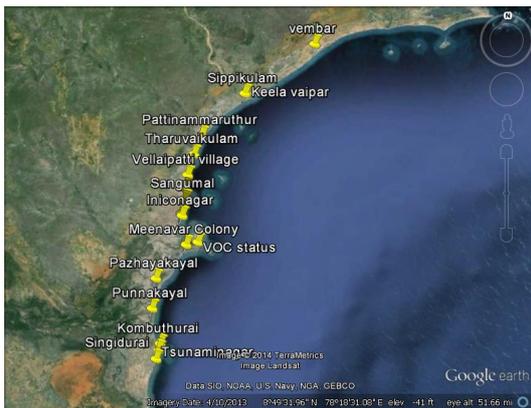
Research Project Highlights



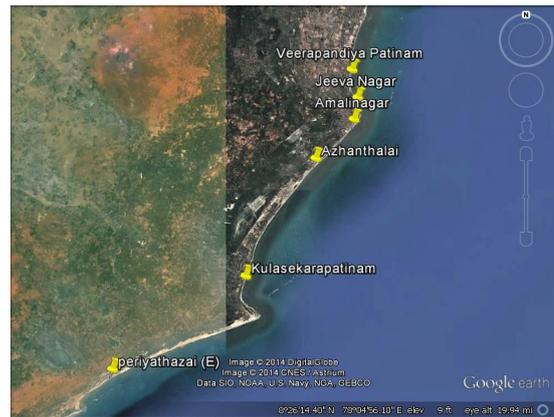
Fishery Resources Assessment

Major fishing zones covered for Resources Assessment

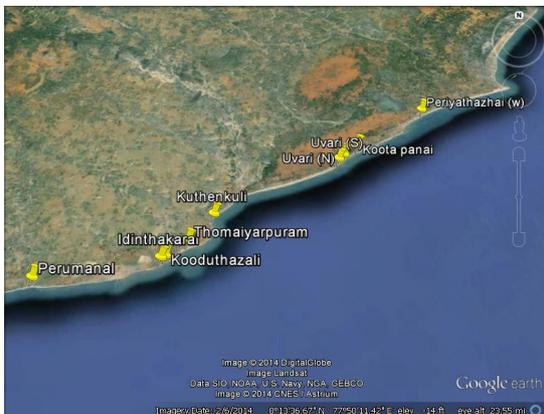
Zone TN. 15 – 18 Centres



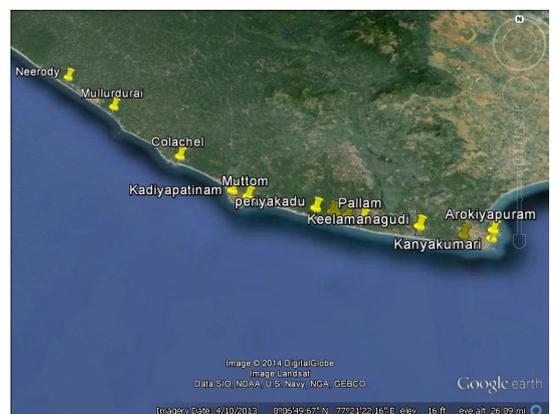
Zone TN. 16 – 7 Centres



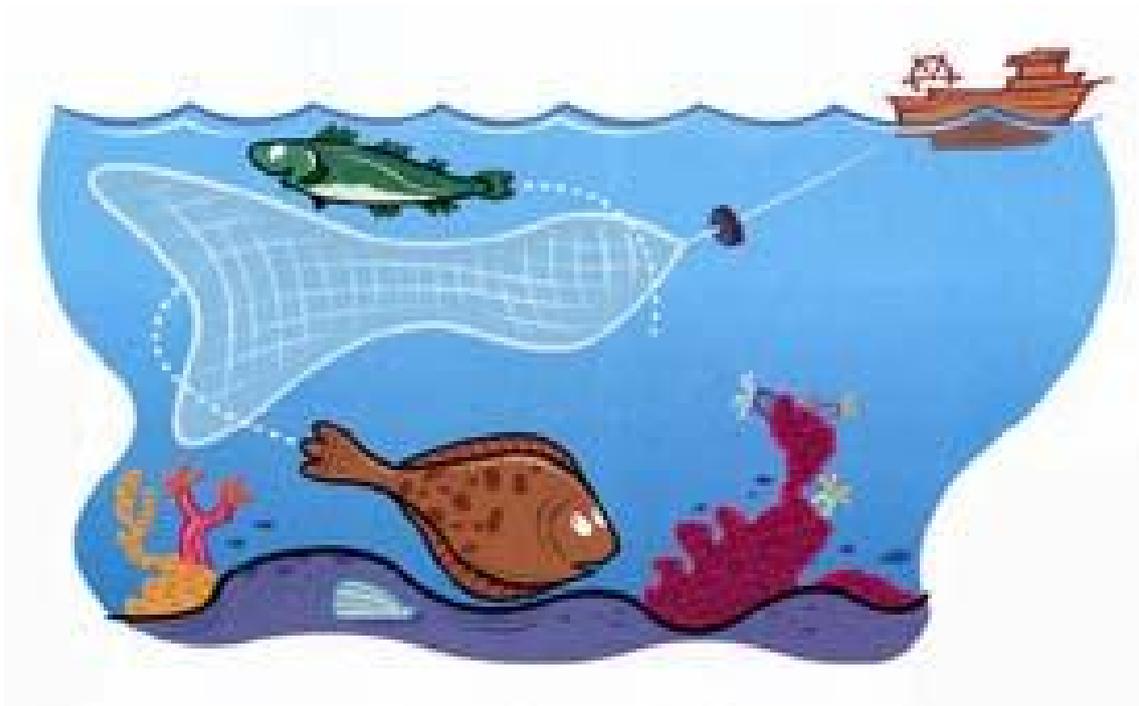
Zone TN. 17 – 10 Centres



Zone TN. 18 – 45 Centres



The Centre's FRAD staff covers all the four zones for Fishery resources Assessment. The data collected are consolidated and sent to Hqrs, Kochi for resource assessment



Finfish fisheries

Salient research findings under studies on Marine fin fish fisheries

Project : Management advisories for sustaining marine fisheries of Tamil Nadu
and Puducherry (DEM/IDP/1) 2010-
2011

Immediate Objective

- To quantify the biomass and to assess the status of exploited stocks
- To study the impact of fishing on the stocks and the vulnerability of stocks.

Work done:

The catch, effort and species composition of major pelagic resources such as sardine, mackerel, carangid, whitebait, seer fish and tuna were collected and quantified on a monthly and yearly basis. Biological reference points on the major stocks such as *Rastrelliger kanagurta*, tunas, seer fishes etc were found out.

Salient Results

The size range of important resources are as given below

Name of species	Paruvalai		Podivalai		Trawl	
	Size range	Mean	Size range	Mean	Size range	Mean
<i>S.commerson</i>	52-132	83.9	44-128	66.1	34-112	63.2
<i>T.albacares</i>	34-104	65.5				
<i>K.pelamis</i>	34-62	45				
<i>E.affinis</i>	32-68	44.9				
<i>S.orientalis</i>	32-64	49				
<i>R.kanagurta</i>			17-29	21.4		

BRPs based on empirical relationships are as follows

Name of species	Reference points in cm		
	Linf	Lmax	Lopt
<i>S.commerson</i>	132	135	86
<i>A.solandri</i>	125	122	81.5
<i>R.kanagurta</i>	30	29	18
<i>T.albacares</i>	106	104	68
<i>K.pelamis</i>	62	60	39
<i>E.affinis</i>	70	68	44.5
<i>S.orientalis</i>	66	64	41.9

Project: Strategies for sustaining tuna fisheries along Indian Coast (PEL/IDP/03)
2010-2011

Immediate Objective:

- To quantify the biomass and to assess the status of exploited stocks
- To study the impact of fishing on the stocks and the vulnerability of stocks.

Work done: The catch, effort and species composition of tuna resources were collected and quantified on a monthly and yearly basis. Biological reference points on the dominant, tunas were found out.

- The average C/E for total catch in drift gill net was 1139 kg and that of tuna was 812 kg. The catch was comprised mainly by tunas, seer fishes and bill fish
- The tuna catch is comprised by, *Euthynnus affinis*(46.2%), *Thunnus albacares* (32.7%), *Katsuwonus pelamis*(18.1%), *Sarda orientalis*(2.2%) and *Auxis* spp. Among which *S.orientalis* is seasonal
- Size range of different tuna species are: *T.albacares*: 34-104 cm; *K.pelamis*: 34-60 cm; *E.affinis*: 32-68 cm; *S.orientalis*: 32-64 cm

BRPs based on empirical relationships

Name of species	Reference points in cm			
	Mean	Lmax	Lnf	Lopt
<i>T.albacares</i>	65.5	104	106	68
<i>K.pelamis</i>	45	60	62	39
<i>E.affinis</i>	44.9	68	70	44.5
<i>S.orientalis</i>	49	64	66	41.9

Project: Management advisories for sustaining marine fisheries of Tamilnadu and Puducherry (DEM/IDP/01) 2011-2012

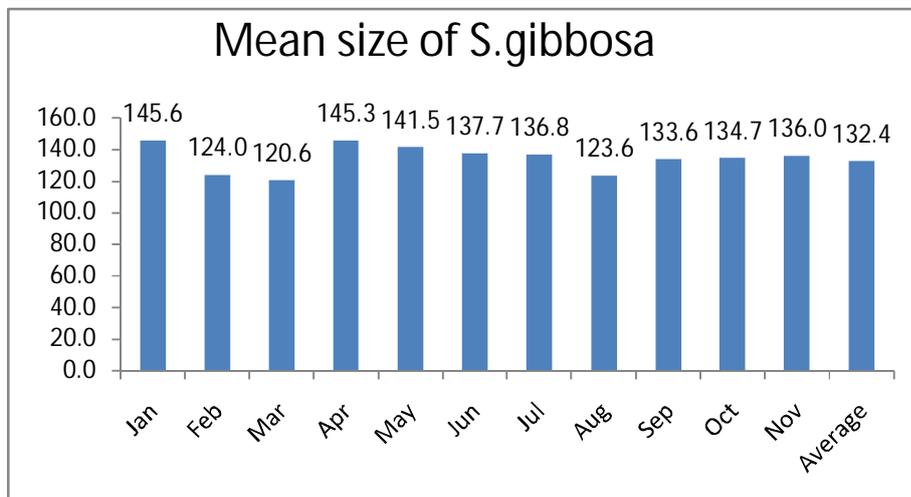
Immediate Objective:

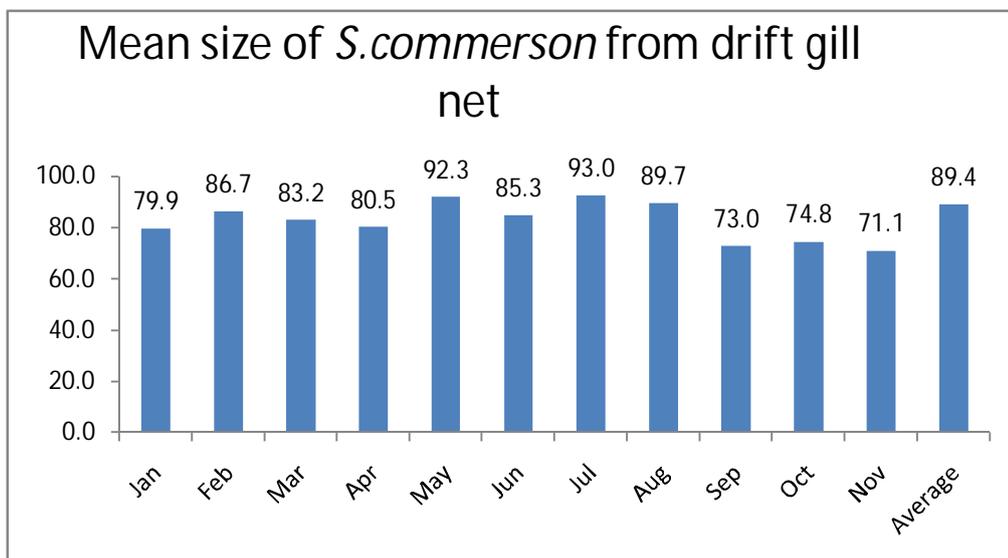
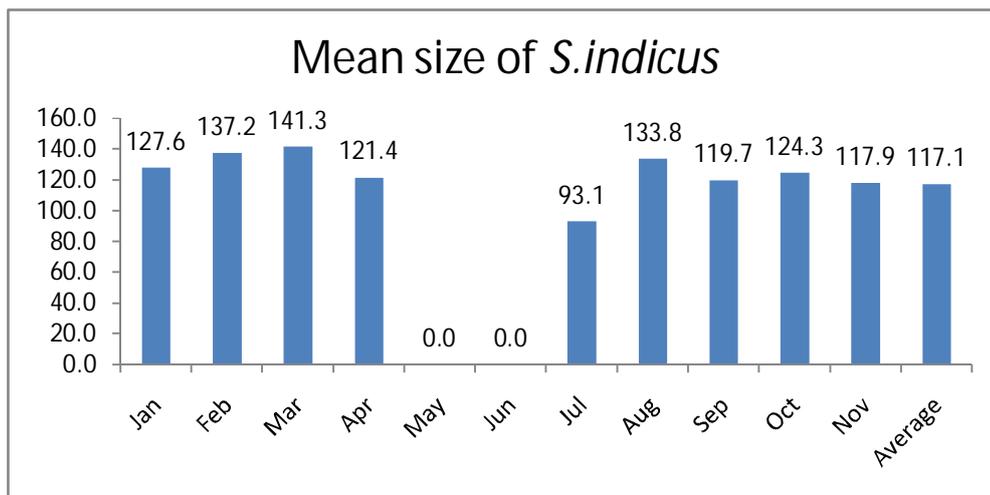
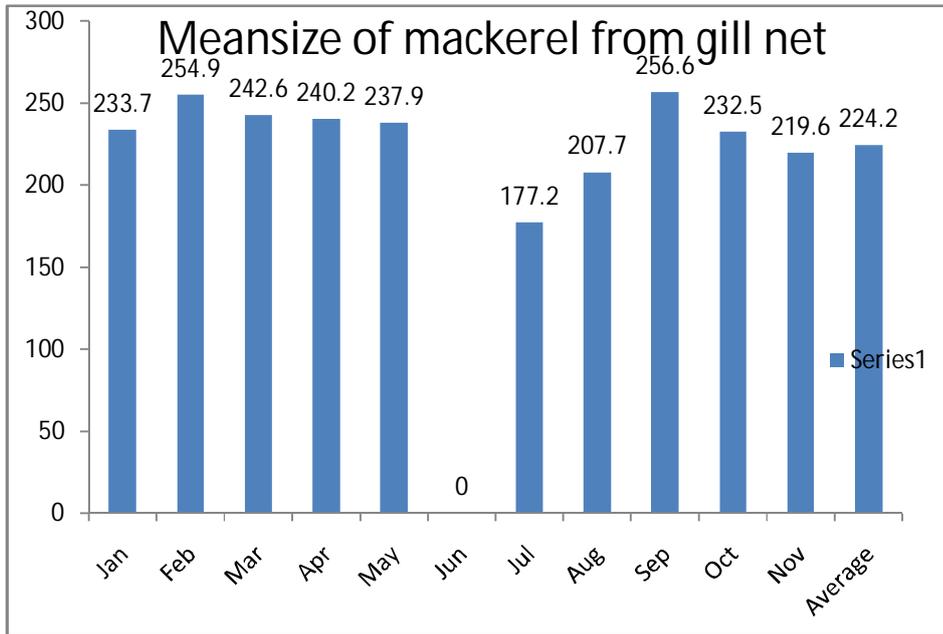
To quantify the biomass and to assess the status of exploited stocks

To study the impact of fishing on the stocks and the vulnerability of stocks.

Work done: The catch, effort and species composition of major pelagic resources such as sardine, mackerel, carangid, whitebait, seer fish and tuna were collected and quantified on a monthly and yearly basis. Impact of fishing on the major stocks such as *Sardinella gibbosa*, *Stolephorus indicus*, *Rastrelliger kanagurta*, *Scomeromorous commerson* etc were found out.

Mean size composition of important resources





Population parameters of major pelagic species

Parameters	<i>S.gibbosa</i>	<i>R.kanagurta</i>	<i>S.indicus</i>	<i>T.albacares</i>	<i>K.pelamis</i>	<i>E.affinis</i>	<i>S.commerson</i>
Lmax(cm)	17.0	30.0	15.5	150.0	74.0	70.0	144.0
L ∞ (cm)	18.8	31.5	16.28	159.25	77.7	73.7	150
K	1.24	1.2	1.8	0.51	0.88	1.3	0.65
Lc(cm)	13.4	21.8	11.6	56.0	39	39.8	66
Lm(cm)	12.2	18.6	12.5	81	43	44	-
W ∞ (g)	49	341	38	57630	7049	5882	-

Stock position based on Predictive model

Species	X-factor for Msy	% SSB of SSB _v at	
		Current level	MSY
<i>R.kanagurta</i>	Stock increases even after considerable	49	-
<i>S.gibbosa</i>	Stock increases even after considerable	40	
<i>S.indicus</i>	Stock increases even after considerable	51	
<i>K.pelamis</i>	2.5	28	10
<i>E.affinis</i>	2.2	32	12

Project: Strategies for sustaining tuna fishery along Indian coast (PEL/IDP/03)-Co-PI

2011-2012

Objective:

- To assess the magnitude and spatial and seasonal pattern of exploitation of tunas along the coast of mainland.
- To study variation in species diversity of exploited tunas over space and time
- Strengthening of catch, effort, L/F and biological data base from deep sea fishing sector
- To estimate the population parameters of species
- To study impact of fishing on stock

Work done: The magnitude and seasonal pattern of exploitation of tunas along Tuticorin coast have been found out besides its species diversity. The data base on the catch, effort, length frequency and other biological data such as food and feeding, maturity condition, sex ratio, fecundity etc of deep sea tunas such as *Thunnus albacares* and *K.pelamis* have been strengthened through weekly observation of the fishery and collection of the required data. This is the first work on these oceanic species from here. Impact of fishing on *K.pelamis* and *E.affinis* were studied.

Table-1. Salient characteristics of major pelagic s are given below

Species	Length range(cm)	Mode (cm)	Mean(cm)
<i>T.albacares</i>	30-186	52&74	72
<i>K.pelamis</i>	28-78	58&60	54
<i>E.affinis</i>	20-66	48	45
<i>A.thazard</i>	28-54	36	37
<i>A.rochei</i>	20-30	26	26
<i>T.tonggol</i>	48-88	60	60
<i>S.orientalis</i>	28-60	32&40	41
<i>G.unicolor</i>	36-48	44	43
<i>C.hippurus</i>	28-122	38&72	64
<i>S.commerson</i>	26-152	84	88
<i>A.solandri</i>	86-138	100&102	109
<i>X.gladius*</i>	72-84	114	114
<i>M.indica*</i>	180-280	230&232	236
<i>I.platypterus*</i>	110-218	160	165

*Lower jaw fork length (LFL). Others are in fork length

Table-2. Optimum length of exploitation of some of the pelagic resources

Resource	Lmax(cm)	Linf(cm)	Lopt (cm)	Lopt/Linf
<i>S.commerson**</i>	152	155	102	0.66
<i>A.solandri**</i>	138	141	92	0.66
<i>T.albacares**</i>	186	189	125	0.66
<i>K.pelamis**</i>	78	81	52	0.64
<i>E.affinis**</i>	68	70	45	0.64
<i>T.tonggol**</i>	88	91	59	0.64
<i>X.gladius***</i>	184	187	124	0.66
<i>I.platypterus***</i>	218	221	148	0.67
FL, *LFL (Lower jaw fork length)				

Project : Development of Fishery Management Plans for sustaining the fishery of
Tamil Nadu and Puducherry (FISHCMFRISIL201200800008) 2012- 2014

Work done:

Database on fishery and biology of major resources exploited from Tamil Nadu coast were developed and updated. Comparison of this year's catch with previous year's catch was made to see the resources which contributed more in this year. A rapid assessment of the stock based on past ten years data was carried out and the present position of major stocks were arrived at. Studies on the stock assessment of major exploited resources are in progress though assessment employing Thompson and Bell Prediction method on Indian mackerel, *Rastrelliger kanagurta*, *Sardinella gibbosa*, *Katsuwonus pelamis* and *Euthynnus affinis* are completed.

Salient results:

Fishery: This year in Tamil Nadu, the total landing was 6.67 lakh tonnes out of which pelagic resources contributed 56.5 %, demersal including elasmobranchs 28.9%, crustacean 5.9% and molluscs 3.8%.

Among the pelagics, the major contributors were oilsardine forming 47.9% of the total pelagics, followed by other sardines (17.4%), carangids (11.4%), Indian mackerel (3.4%), and other clupeids 2.8%.

Among the demersals, the major contributors were silver bellies forming 41.3%, threadfin breams 7.26 %, croakers 6.97 %, pigface breams 6.03 %, catfishes 4.45 %, mullets 3.8 % and lizard fishes 3.48 %.

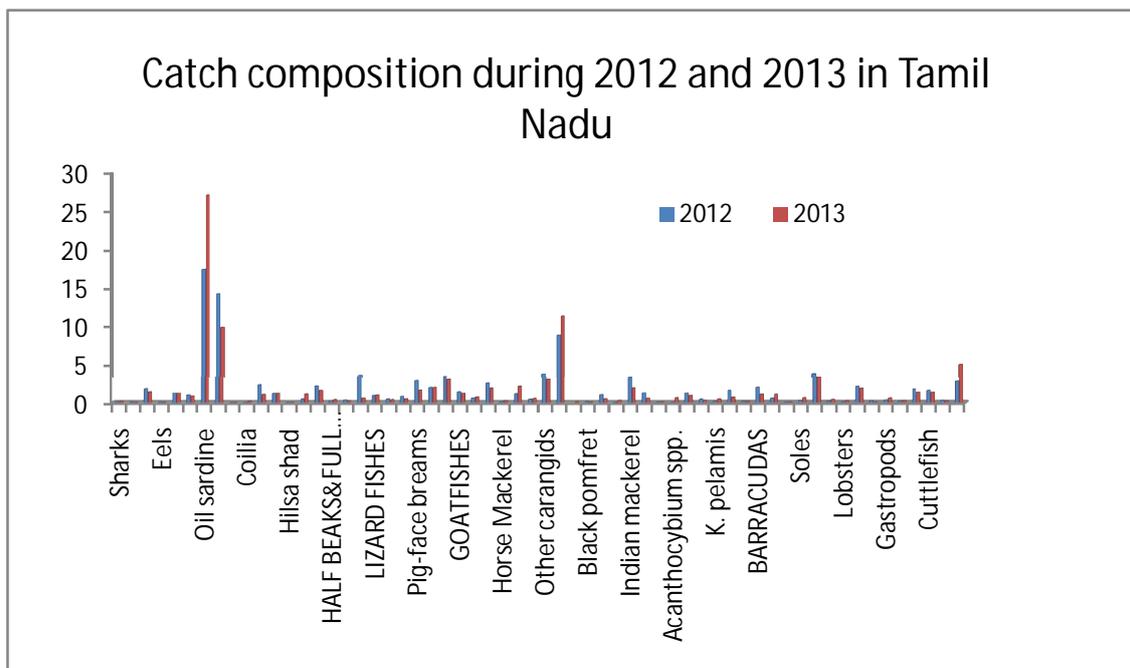
Among crustaceans, penaeid prawns formed 56.6 %, crabs 32 %, non-penaeid prawns 6.7 % and lobsters 3.9%. Among molluscs, squids and cuttlefishes remained the dominant groups forming 36.2 % each, followed by bivalves (15.5 %), gastropods (6.5 %) and octopus (5.7%).

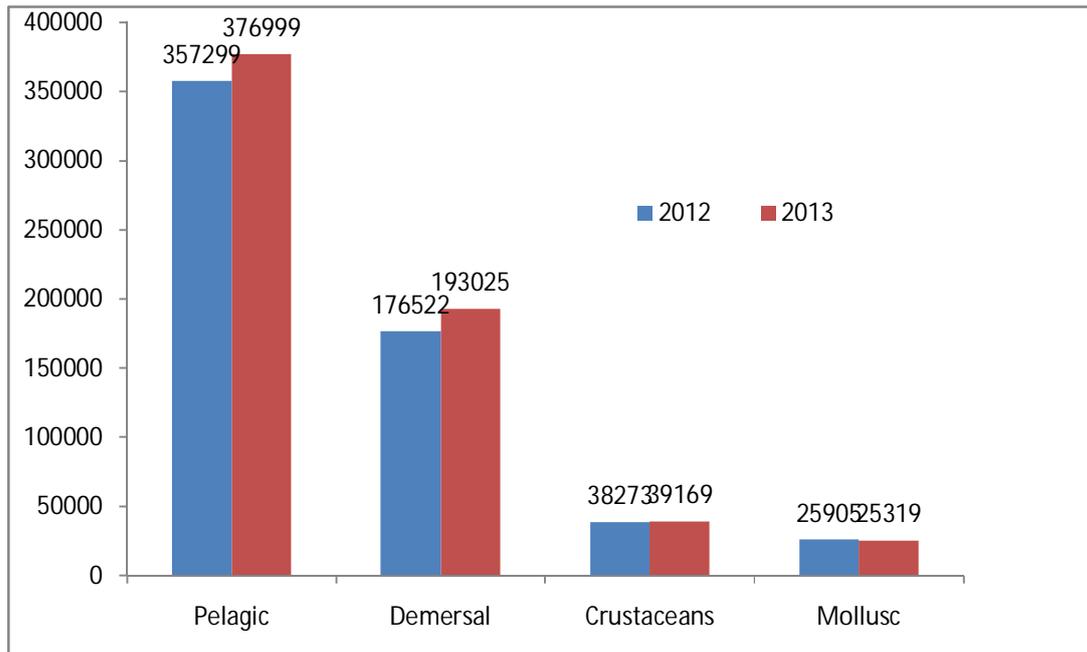
Gear wise contribution of landing showed that trawlers contributed almost 65 % of the total catch, followed by outboard gill netters (13.4 %), mechanized ring netters (7.7 %) and out board ring netters (6.4 %). As far as total number of gears operated, it could be seen that 62 % was accounted by outboard gill netters, 12.6 % by outboard hook and line, and 12.4 % by mechanized trawlers.

On comparison with previous years catch, it was seen that oil sardine continued to be the major contributor showing an increase of 69 % when compared to last year. Silver bellies landing also showed an increase of 40%.

Rapid assessment

The rapid stock assessment with 3 year running average and comparison of the maximum average landing with the recent average landing indicated that out of the 19 major resources, only one resource (shark) is found to be in declining status. Others are in abundant or less abundant category. The total catch is also in abundant category implying that the fishery is in general in a healthy state. The stock position of shark is in declining state. Since two of the sharks are in endangered list, the government is very vigilant and is imposing certain deterrents to discourage shark fishing.





Rapid assessment of stocks

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

Thompson and Bell prediction analysis:

K.pelamis:

				TamilNadu	Year:2013
F-factor	Yield(t)	Biomass	SSB	Value(Rs)*1000	%SSB
0	0	10344	9004	0	
1	3198	5545	4211	258655	46.8
1.5	3682	4503	3172	291555	35.2
2	3945	3816	2488	306397	27.6
2.5	4094	3340	2015	312588	22.4
3	4181	2999	1677	314373	18.6
3.5	4231	2747	1428	313844	15.9
4	4258	2557	1240	312105	13.8

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

Euthynnus affinis

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

			TamilNadu	Year:2013
F-factor	Yield(t)	Biomass	Value(Rs)*1000	
0	0	36385	0	
1	6252	35384	462030	
1.1	6206	34339	457946	
1.2	6155	33409	453488	

Rastrelliger kanagurta:

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

TamilNadu Year:2013					
F-factor	Yield(t)	Biomass	SSB	Value(Rs)*1000	%SSB
0	0	1287544	579328	0	%SSB
1	11733	1271797	563125	812826.5	97.2
1.5	16536	1262899	554061	1144796	95.6
2	20823	1253644	544679	1440695	94.0
2.5	24677	1244192	535138	1706237	92.4
3	28158	1234664	525558	1945745	90.7
3.5	31317	1225147	516024	2162659	89.1
4	34193	1215707	506601	2359803	87.4
4.5	36820	1206392	497335	2539532	85.8
5	39227	1197235	488259	2703838	84.3

Project: Development of Strategies to sustain the stock and fishery of large pelagics in Indian waters (FISHCMFRISIL201200700007) 2012-2014

Work done:

Database on fishery and biology of major large pelagic resources (tunas, seer fishes, bill fishes, dolphin fishes etc) exploited along Tuticorin coast was developed and updated. Studies on the stock assessment of dominant tuna and seer fish resources are in progress.

Fishery:

Tuna: In Tuticorin, totally 3816 t of tuna was landed by both drift gill net and podivala together of which 95 % was contributed by drift gill net and the rest by podivala. The most productive months were February, March and December. The species composition of tunas of multiday drift gill nets comprised of eight species (*Katsuwonus*, *pelamis*, *Thunnus albacares*, *Euthynnus affinis*, *Auxis thazard*, *A.rochei*, *Thunnus tonggol*, *Sarda*

orientalis and *Gymnosarda unicolor*). *T. albacares* was the dominant species forming 47 % followed by *K. pelamis* (33.7 %), *E. affinis* (15.4 %) and *A. thazard* (2.3 %). Others were nominal. In the small meshed (60-70 mm) gill net which was operated daily and nearer to the coast, *E. affinis* formed 51 %, *A. thazard* 44.5 % and *S. orientalis* 4%.

Size groups:

Species	Size range
Katsuwonus pelamis	30-76
Thunnus albacares	28-186
Euthynnus affinis	26-70
Scomberomorus commerson	
Acanthocybium solandri	
Istiompax indica	210-344
Istiophorus platypterus	122-214
Xiphias gladius	56-212

Landing of a tagged *I. indica*:

A tagged black marlin *I. indica* was landed on 1.2.13 which was actually netted on 31.1.13 from off Mandapam at depth more than 300 m. It had a size of 268 cm BL and 237 cm EFL. The fish was released by the African Bill Fish foundation on 3.2.12 near Tanzania. The days at liberty were nearly one year. This was the first record.

Record of largest black marlin:

On 25.3.13, one black marlin which was caught off Mandapam was landed at Tharuvaikulam. It had 422 cm TL, 344 cm BL and 292 cm EFL. This was found to be the largest marlin landed in India.

Thompson and Bell prediction Analysis

E. affinis:

The MSY and MSE are reached at f-Factor of 1.5 indicating scope for increasing the effort up to 50 % of the current level even the SSB is only 15.5 % of the virgin SSB at this level.

<i>E.affinis</i>		Tuticorin		2013	
F-factor	Yield(t)	Biomass(t)	SSB(t)	Value	%SSB
0			1023		
1	568	465	237	47649	23.2
1.5	583	379	159	47746	15.5
2	581	330	118	46532	11.5
2.5	575	298	92	45078	9.0

Skipjack

F-factor	Yield(t)	Biomass(t)	SSB(t)	Value(Rs)	SSB%
				*1000	
0		4041	3517		
1	1249	2166	1645	101037	46.8
1.5	1438	1759	1239	113889	35.2
2	1541	1491	972	119687	27.6
2.5	1599	1305	787	122105	22.4
3	1633	1172	655	122802	18.6

S.commerson

Tuticorin

2013

F-factor	Yield (t)	Biomass (t)	Value(Rs.) *1000	
0.4	425	495	152958	
0.5	434	395	153056	MSY&MSE
0.6	433	324	149595	
0.7	426	274	144428	
0.8	418	237	138586	
0.9	408	209	132632	
1	398	187	126860	
1.1	389	170	121412	
1.2	380	156	116345	

Katsuwonus pelamis: In skipjack, *Katsuwonus pelamis*, there is corresponding increase in yield and value with an increase of f-Factor implying that the current fishing is not adversely affecting the stock. *Scomberomorous commerson*: In this, both MSY and MSE are obtained when the effort is only 50% of the current level.

Project: GIS based resource mapping of distribution and abundance of finfishes and shellfishes off Indian coast for suggesting operational based strategies for fisheries management(FISHCMFRISIL201200900009)
2012-2014

A survey of all the landing centres situated in Tuticorin, Tirunelveli and Kanyakumari was taken up and collected data on the details of different craft and gear, their operational particulars. Besides these, data on details on the addition of new craft and gear, replacement of existing craft and gear, change in the targeting of resources etc were also collected. Details on the fishing ground on a latitude, longitude position, details of operation, catch details etc. from selected craft and gear from chosen landing centres are also taken.

In addition to this, the fish catches collected through experimental fishing along the coast of Tuticorin using Cadalmin –IV were analysed.

Project: National Initiative on climate resilient agriculture (NICRA) –
Marine Fisheries 2011-2014

Details on the biology and fishery of Indian mackerel(*Rastrelliger kanagurta*), yellow fin tuna(*Thunnus albacares*), skipjack tuna(*Katsuwonus pelamis*) , kawakawa (*Euthynnus affinis*) ,lesser sardine *Sardinella gibbosa* , whitebat, *Stolephorus indicus* are being collected, processed to arrive at any visible variation in the spawning or feeding dynamics of these resources. An attempt was also made to understand the carbon foot

prints of trawlers operated from Tuticorin fishing harbor. Exploitation to transportation level alone was considered.

Fecundity relationship: The relationship between fecundity and total length, body weight, gonad weight, and relative fecundity was as follows:

Fecundity- total length $F = -127485 + 803.4173 * TL$ $r = 0.37$ Sig.at 0.05

Fecundity- body weight $F = -1356 + 433.094 * Bwt$ $r = 0.44$ Sig

Fecundity-gonad weight $F = 15845 + 6529.782 * Gwt$ $r = 0.7$ Sig

Fecundity-Rel.fecundity $F = -0.84183 + 166.3548 * Rfec$ $r = 0.88$ Sig

Fecundity-Body weight $F = 409.561 + 0.087106 * Bwt.$ $r = 0.02$ N.S

The correlation was found to be significant in all the relationships except that of fecundity and body weight.

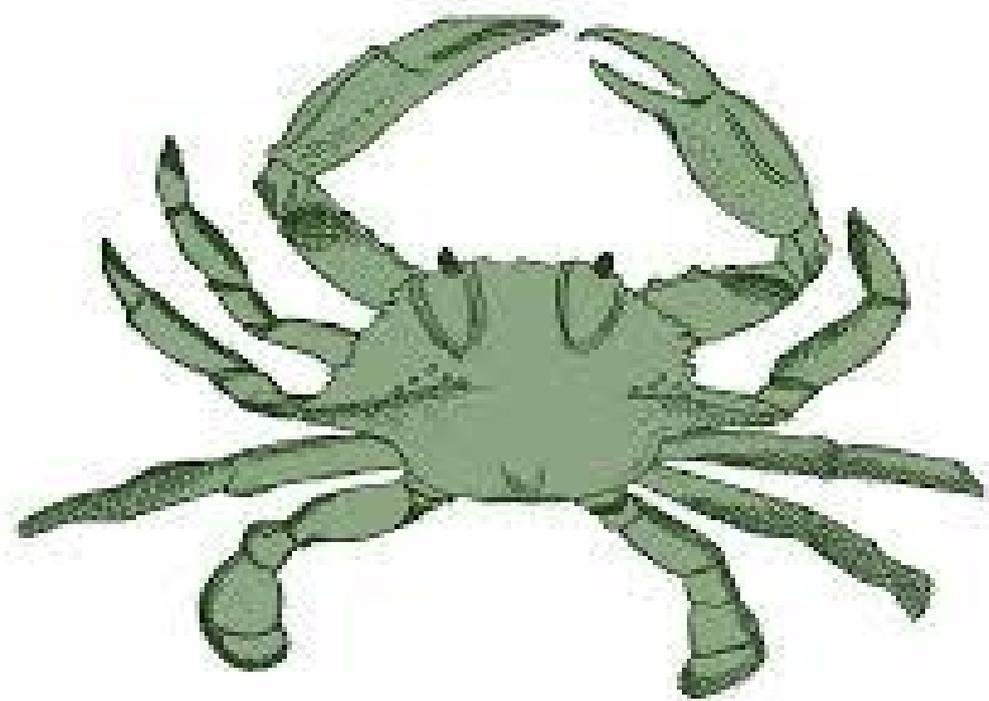
Size at first maturity: The size at 50% maturity was found to be 186 mm.

Length-weight relationship: The relationship was $W = 0.00387 * L^{3.31}$ ($r^2 = 0.99, n = 535$)
Length is TL in cm and weight in g.

It was found that out of the total emission of GHGs, 93 % was from fishing. This Life cycle Analysis (LCA) study is done for the first time and is a preliminary one.

Correlation of the reproductive indices such as Gonado-somatic index (GSI), Histo-somatic index (HSI) etc of commercially important fishes with the environmental parameters such as sea surface temperature, salinity, pH, chlorophyll, secondary production etc collected from the surface and bottom at 5, 10, 15 and 20 m depths was studied. Only the parameters which had correlation significant at 0.05 or 0.01 level are given below. It could be seen that there is negative correlation between salinity and GSI in *T.albacares*, *K. pelamis* and *Stolephorus indicus* whereas the correlation was positive between Histo-somatic index and salinity in *T.albacares* and *E.affinis*.

Resource	Reproductive index	Environmental parameters	Correlation value and significant level
<i>Thunnus albacares</i>	Gonado-somatic index(GSI)	Zooplankton	0.5 at 0.01level
		Salinity	-0.6 at 05 level
	Histo-somatic-index (HSI)	Salinity	0.6 at 0.01 level
<i>Katsuwonus pelamis</i>	GSI	Salinity	-0.47 at 0.05 level
<i>Rastrelliger kanagurta</i>	GSI	Chlorophyll	0.378 at 0.05 level
<i>Sardinella gibbosa</i>	GSI	SST	0.67 at 0.05 level
<i>Euthynnus affinis</i>	HSI	Salinity	0.51 at 0.05 level
<i>Stolephorus indicus</i>	GSI	Salinity	-0.536 at 0.05 level
	GSI	pH	0.573 at 0.05 level



Crustacean Fisheries

Salient research findings under studies on Crustacean fisheries

Project. 1 Recruitment dynamics of penaeid shrimps along the Indian coast (CF/RE/03)

Targets: Analysis of past data (1997-2007) of 3 important species of penaeid prawns (*Penaeus indicus*, *Metapenaeus dobsoni* and *Parapenaeopsis stylifera*) for catch, trawling effort and species composition. Analysis of monthly length –frequency distribution of 3 species (*P.indicus*, *M.dobsoni* and *P.stylifera*) for estimation of growth parameters. Estimation of size at first maturity . Estimation of size –fecundity relationship. Estimation of monthly egg production and identification of cohorts. Estimation of total mortalities. Estimation of natural mortality. Estimation of number of recruits and spawning stock . Estimation of relationships between number of recruits and environmental parameters. Estimation of limit reference points.

Achievements: Data collected on catch, effort, species composition and biology of prawns during the period 1997 - 2007 were collated and analysed. The results obtained were given below:

Fishery : Annual variations: During the period 1997-2007 the total shrimp catch varied from 523.7t to 1843.3 t. The maximum catch was in 1997 and the minimum was in 1999. Though the catch showed wide fluctuations during this period, there was some periodicity in the occurrence of minimum and maximum catch. Once the catch reached a minimum level, the succeeding year showed a substantial increase in the catch. The maximum catch in 1997 (1843t) reduced to 524t in 1999. This was followed by a sudden increase in 2000 (1612t) and gradually declined to a minimum in 2004 (537t). In 2005 again it shot up to a third peak (1735t) and after which a gradual decrease. Total shrimp catch did not show any significant correlation with CPUE and CPUH but it showed positive correlation ($P>0.01$) with effort.

Species composition: Among the thirteen species landed, the dominant species were *Metapenaeus dobsoni* (40.5%), *Parapenaeopsis stylifera* (25%) and *Penaeus indicus*

(16.2%). The variations of total catch showed significant positive correlation ($P > 0.01$) with the variations in the catch of *M.dobsoni* and *P.stylifera* but no significant correlation with *P.indicus*. This showed that the abundance of total shrimp catch was influenced by the abundance of the former two species only

Monthly variations: The average monthly shrimp catch varied from 2.572t kg to 207.571t with an average of 114.418t. The total shrimp catch was maximum in April where as CPUE and CPUH were maximum in June. In the case of *P.indicus* April accounted for the highest catch, CPUE and CPUH. There was good landing of *M.dobsoni* from December to June with a peak in January. In *P.stylifera*, the maximum catch was in May and a second peak was observed in December. In both the species the CPUE and CPUH were maximum in June. The analysis of variance showed that the monthly variation of effort, AFH, and catch of *P.stylifera* were significant at 0.05 level. The Catch per hour of *P.indicus* also showed significant monthly variation

Species composition: *M.dobsoni* dominated in the catch in January, February, March, May, June, November and December. *P.indicus* dominated in April (33%), *M.affinis* in August, *M.andamanensis* in September and *P.stylifera* in October .

Size range: In *P.indicus* the size ranged from 56 to 170mm in males and from 56 to 185mm in females. In *M.dobsoni*, it varied from 41 to 105 mm (male) and 41 to 120mm (female).

In *P.stylifera*, the size of males and females varied from 41 to 110 and 41 to 125mm respectively.

Sex ratio:

Species	Male	Female
<i>M.dobsoni</i>	45.1	54.9
<i>P.stylifera</i>	49.3	50.7
<i>P.indicus</i>	46.8	53.2

Asymptotic length (L_{∞}): In *P.indicus* The asymptotic length was 178 mm and 191 in males and females respectively. In *M.dobsoni*, it was 106 in males and 125 mm in females whereas in *P.stylifera*, it was 113mm and 135 mm respectively (Table-8).

Growth coefficient: The value of K was 1.6 in males and 2 in females of *P. indicus*, 1.8 (male) and 2 (female) in *M.dobsoni* and in the case of *P.stylifera*, it was 2.4 (male) and 2.55 (female)

Natural Mortality (M): This was found out from longevity using the formula

$$M = -\ln(0.1) / T_{max}. \text{ (Alagaraja, 1984)}$$

	Male	Female
<i>P.indicus</i> :	2.06	2.21
<i>M.dobsoni</i>	2.33	2.23
<i>P.stylifera</i>	3.54	2.79

Size at First maturity (L_m): This was found out using the method given by Udappa (1986). In *P.indicus* the L_m was 141.882 ± 1.5457 . The minimum size of mature females was 113mm. In *M.dobsoni* L_m was 77.4785 ± 1.0108 and the minimum size of matured females was 61mm. In *P.stylifera* , L_m was 80.23072 ± 1.3827 and the minimum size of matured females was 61 mm.

Size – fecundity relationship:

P.indicus: 58 numbers of fully matured specimens were used for this study. $Y =$

$0.00000000176 L^{6.566}$ ($r = 0.9587$). The minimum size of the fully matured female was 135mm.

M.dobsoni: 48 numbers of fully matured specimens were used for this study. $Y = 0.0000000558 L^{6.074}$ ($r = 0.973$). The minimum size of the fully matured female was 80mm.

P.stylifera: 80 numbers of fully matured specimens were used for this study. $Y = 0.0000196 L^{4.715}$ ($r = 0.986$) The minimum size of the fully matured female was 78mm.

Length-weight relationship

P.indicus: Male : $W (g) = 0.0022014 L (cm)^{3.4359}$ ($r = 0.97779, n = 728$)

Female: $W (g) = 0.0016404 L (cm)^{3.5502}$ ($r = 0.97999, n = 728$)

M.dobsoni: Male : $W(g) = 0.00993046 L(cm)^{2.7568}$ ($n = 715, r = 0.916$)

Female : $W (g) = 0.00628567 L(cm)^{3.0067}$ ($n = 772, r = 0.955$)

P.stylifera: Male : $W (g) = 0.0068812 L (cm)^{2.9607}$ ($r = 0.877, n = 632$)

Female: $W (g) = 0.004437 L (cm)^{3.14763}$ ($r = 0.926, n = 638$)

Spawning season :

Species	Primary peak	% of mature	Sec. peak	% of mature	Other seasons	% of mature	remarks
<i>M.dobsoni</i>	February	52	November	45	*August	54	* no fishery in all the years
<i>P.stylifera</i>	March	60	December	55	*August	47	* no fishery in all the years
<i>P.indicus</i>	April	52	December	52			

Population-fecundity index

Species	Primary peak	PFI(10 ¹⁰)	Sec. peak	PFI(10 ¹⁰)
<i>M.dobsoni</i>	January	69.97	March	62.74
<i>P.stylifera</i>	December	31.43	March	25.45
<i>P.indicus</i>	April	975	December	78.87

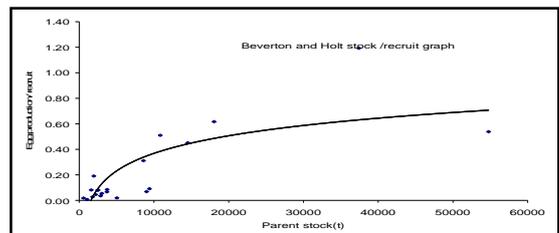
Annual egg production, recruits and survival at recruitment

Species	Average Egg production 10 ¹⁰	Recruits 10 ⁶	Egg recruit ratio
<i>M.dobsoni</i>	9.6	39.4	5843 : 1
<i>P.stylifera</i>	2.69	17.6	1532 : 1
<i>P.indicus</i>	8.38	4.90	17120 : 1

Stock per recruit relationship based on Beverton and Holt method

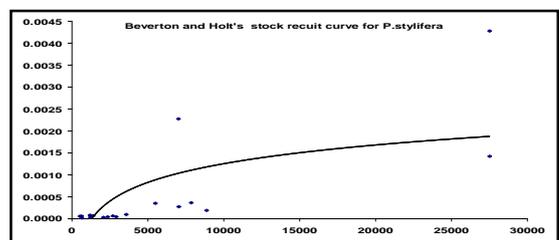
M.dobsoni : $Y = 0.05948 + 0.0000170228 X$

($r = 0.771$)



P. stylifera : $Y = -0.000113397 + 0.0000001067 X$

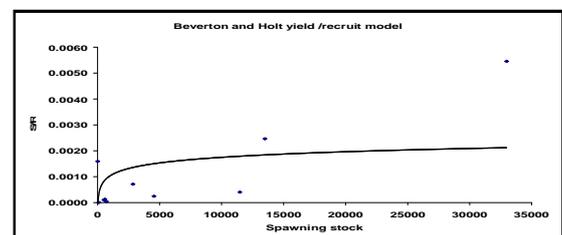
($r = 0.796$)



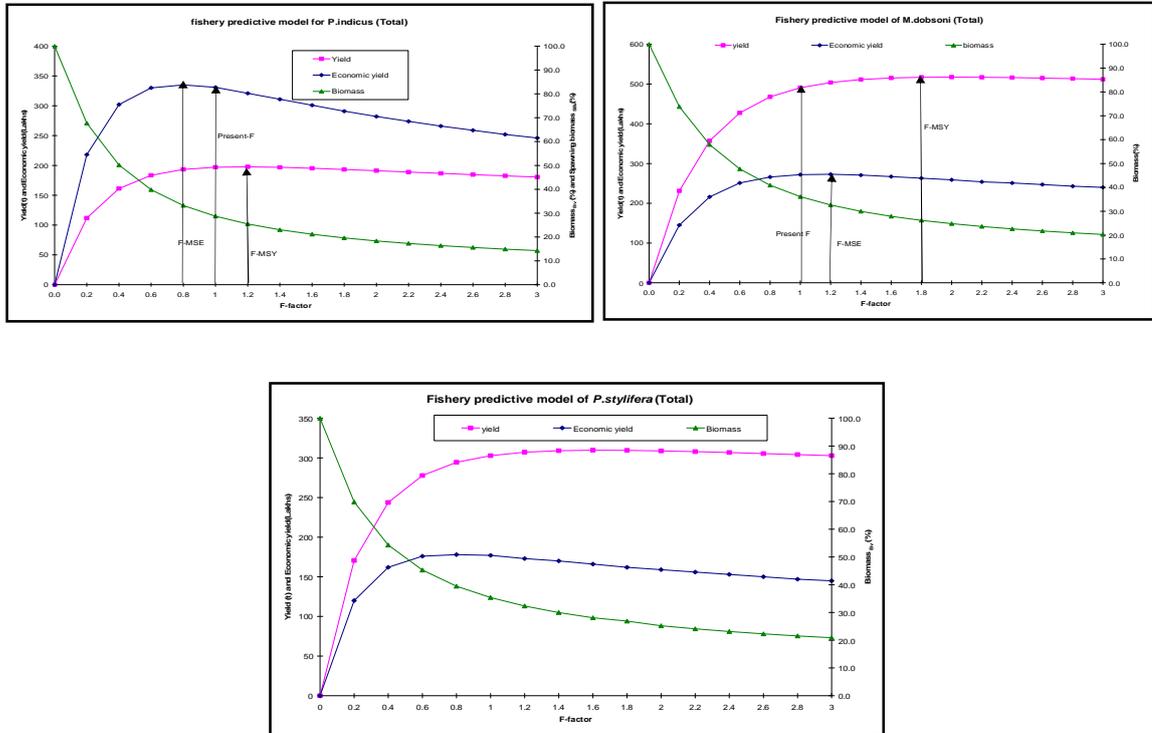
P.indicus : $Y = 0.000012908 + 0.0000001578 X$ ($r =$

0.935)

Where X = stock, Y = stock / recruit



Predictive analysis for MSY, MSE and spawning stock



Species	F-factor							
	MSY	MSE	% Total Biomass (Bv)		% Spawning Biomass of female (Bv)			
			at MSY	at MSE	at MSY	at MSE	Present	F at 20%
<i>P.indicus</i>	1.2	0.8	25.5	33.2	3.6	13.2	5.4	0.5
<i>M.dobsoni</i>	1.6	1.2	27.9	32.6	13	17.6	21	1.0
<i>P.stylifera</i>	1.4	0.8	30.0	39.5	12	22	18	0.8

Conclusion:

Though the fishery has not crossed the MSY level, the fishing pressure has to be reduced by 20% from the present level to attain the maximum sustainable economic yield. But in order to sustain the spawning biomass at least by 20% of the virgin biomass, the fishery has to be reduced by 50% from the present level

Project -2. Resource damage assessment in marine fisheries : Impact of selective fishing of juveniles, bycatch and discards in trawl fisheries (CF/IDP/02).

Targets:The target assigned under this project was impact of fishing on juveniles, bycatch and discards in thallumadi fisheries which is an indigenous trawl operated along the coastal waters of Tamil Nadu. The landing centre Motagopuram was selected for the study as this is a major landing centre exclusively for this gear. Data pertaining to the catch, effort and species composition of all the species landed by this gear was collected along with the biological information of the dominant species in the catch. Using these data, the impact of fishing on the stock of dominant resources besides biological loss in value due to growth over fishing of dominant species- *P.semisulcatus* were found out

Achievements: Fishery: During this period the annual catch of thallumadi was estimated as 104.7 t with a CPUE of 15 kg. Out of this prawns formed 41% (43 t), crabs 46% (48.5 t) , fishes 7 % (7 t) and cephalopods 6% (6 t). The monthly effort varied from 217 to 1008 and the annual effort was 6838 units. The dominant species in thallumadi catch was *Penaeus semisulcatus* (37%), *Portunus pelagicus* (20%), *P. sanguinolentus* (14%) and *Charybdis natator* (12%)

Prawns: Among the prawns 89 % was constituted by *P.semisulcatus* (38.4 t) and the rest by *P.latisulcatus* (4.9%), *P.maxillipedo* (2.2%), *M.moyebi* (1.9%), *P.indicus* (0.5%), *M.stridulans* (0.4%), *Metapenaeopsis sp.* (0.4%), *T.granulosus* (0.3%), *T. curvirostris* (0.2%), *T. sedili* (0.02%), *M.dobsoni* (0.02%), *P.canaliculatus* (0.04%). Alpheids formed 0.02% . The highest CPUE of *P.semisulcatus* was in May (15kg)

Crabs :Among the commercially important crabs *P.pelagicus* was the dominant species forming 42.3% (20.4 t) followed by *P.sanguinolentus* -29.6% (14.3 t) , *C.natator* – 24.9% (12 t) , *P.nipponensis* (0.5%) , *C.lucifera* (0.1%) *C.helleri* (1.3%) , *C. annulata* (1.4%) and *C.cruciata* (0.4%). The non-commercial small crab, *Thalamita integra* had also landed in thallumadi in small quantities which are either discarded along with seagrass and seaweeds or sundried along with trawl bycatch.

Fishes:Among the fishes the most dominant species was *Siganus* sp., followed by *Parupeneus indicus*, cat fishes, stone fishes, *Pomadasys* sp., *Cynogolssus* sp., *Ambassis* sp., *Lutjanus* sp. and *Lethrinus* sp. Juveniles of *Siganus* sp. are also discarded or sundried.

Biology: *P.semisulcatus*: Size range : The total length ranged from 41 to 180 mm in males and 41 to 105 mm in females. The monthly mean size varied from 77 to 116 mm . The annual mean size was 94 mm for males and 98 mm for females .

Sex ratio: Though the monthly percentage of males ranged from 38 to 61% and that of females from 39 to 62 % , the annual sex ratio was (1:1).

Size at first maturity: In males, it was at 103 mm and in females it was at 132 mm.

Virtual population analysis: In the yield by weight 32% (6.5 t) was juveniles of males and 68% (12.3 t) was juveniles of females. Whereas in the yield by number 59% of males and 90% of females were juveniles. In the total yield 72% were juveniles by number and 39% were juveniles by weight. The spawning stock biomass at the present level of exploitation is only 6.4% in males and 5.5% in females with respect to the virgin spawning stock.

Predictive analysis: The species is over exploited by 40%

Value loss:

Yield(%)	Male		Female		Total
	Juvenile	Mature	Juvenile	Mature	
No(%)	59	41	90	10	100
Weight (%)	22	78	68	32	100
Value (Rs.Lakhs)	9	32	23	17	81
Est. value for no. (Rs.L)	46	32	150	17	245
Loss (Rs.Lakhs)	37		127		164

The loss to the fishery in terms of value due to the exploitation of juveniles was 164 Lakhs.

Project-3. Management advisories for sustaining marine fisheries of Tamil Nadu and Puducherry (DEM/IDP/01) -2010 to 2012.

&

Project-4. Development of fishery management plans for sustaining marine fisheries of Tamil Nadu and Puducherry (FISHCMFRISIL201200800008)- 2012 to 2014

Targets: Collection of species- wise and gear- wise catch and effort data and analysis. Length frequency based stock assessment of major commercial species of prawns and crabs. Studies on trophodynamics of major species. Studies on maturity conditions in order to understand the spawning seasons. Studies on age and growth of selected commercial species. Estimation of biological reference points. Multi-species stock assessment by using virtual population analysis and Thompson and Bell model. Preparation of reports and scientific papers.

Achievements: During the above mentioned period, the details of fishery such as catch, effort, species composition and sex-wise biology (length, weight, sex ratio, food and feeding habits and maturity condition) of all the species of prawns , crabs and lobsters were collected from Seven major landing centres namely Tuticorin Fishing Harbour for mechanized trawl net, Mottaigopuram for indigenous trawl net (thallumadi), Punnaikayal for estuarine gill nets, Tharuvaikulam for marine gill nets and Kayalpattinam for lobster gill nets. In addition to this data on seasonal fishery of prawns crabs and lobsters were also collected from Periathazhai and Manappad. The data thus obtained were analysed and compiled for the period September 2010 to December 2013 and the salient results are given below.

Resource: Prawns: Trawl : Fishery: Catch and CPUE: In mechanised trawl net, the annual catch ranged from 159 t in 2013 to 978 t in 2012 with an annual average of 575 t. The average annual CPUE of inshore prawns was 5kg whereas the CPUE of deep sea prawns was 492 kg. The main fishing season for inshore prawns was August- September. The deep sea prawn fishery starts from November or December and ends in March or April with a peak in February.

Species composition in percentage by weight: A total of 42 species have been recorded in the commercial fishery and one species (*M. hilarula*) from the stomach of a demersal fish. The inshore prawn catch was constituted by 23 species. Among this *P. semisulcatus* (85.5%), *P. indicus* (6.9%) and *P. latisulcatus* (2.6%) were the dominant species. The other species were *P. monodon*, *P. penicillatus*, *P. merguensis*, *P. canaliculatus*, *P. uncta*, *P. maxillipedo*, *P. sculptilis*, *P. acivirostris*, *P. stylifera*, *M. moyebi*, *M. monoceros*, *M. dobsoni*, *M. affinis*, *M. toloensis*, *M. stridulans*, *M. mogiensis*, *T. curvirostris*, *T. granulosus*, *T. sedili* and *Alpheus rapacida*. Whereas in deep sea prawns the fishery was contributed by 19 species and the dominant species were *P. spinipes* (42.7%), *S. hextii* (26.7%) and *H. gibbosus* (21.9%). The other species were *A. alcocki*, *P. fissuroides indicus*, *P. jerryi*, *P. martia*, *M. andamanensis*, *M. coniger*, *S. alfonso*, *P. investigatoris*, *Haliporoides* sp., *H. woodmsoni*, *N. tenuispines*, *P. longipes*, *S. choprai*, *S. crassicornis* and *S. koelbeli*. Though *P. semisulcatus* was dominated in the inshore prawn catch in all the months, the main season was from June to January with a peak in August. The same trend of occurrence could be seen in *P. indicus* and *P. latisulcatus* too.

Biology of dominant species: Size range in mm:

The size range of prawns

landed by the commercial trawlers is given below:

2010-13	Species	Trawl		Jan-Dec 2011		Jan- Dec 2012		Jan- Dec 2013		Pooled
		Male	Female	Male	Female	Male	Female	Male	Female	
1	<i>P.semisulcatus</i>	91-215	106-225	71-180	71-260	96-215	96-250	96-180	106-240	71-260
2	<i>P. indicus</i>	126-165	126-170	76-190	71-190	101-165	96-185	121-170	116-190	71-190
3	<i>P. latisulcatus</i>	91-180	86-195	66-190	61-215	111-200	131-220	106-170	121-190	61-220
4	<i>P.penicillatus</i>	181-186			116-175		141-145			116-186
5	<i>P.merguensis</i>	181-185		151-160	181-215	166-170	191-210			151-215
6	<i>P.monodon</i>		100-210	191-225	176-280	146-185	113-215	176-180	236-240	100-280
7	<i>P.canaliculatus</i>			136-140						136-140
8	<i>M.moyebi</i>			61-110	56-110	56-75	56-90			56-110
9	<i>M.dobsoni</i>			61-100	66-120	61-85	66-110			61-120
10	<i>M.nonoceros</i>			76-100	76-135	106-110	106-140			76-140
11	<i>M.affinis</i>			71-95			131-135			71-135
12	<i>P.uncta</i>	63-90	80-150	61-95	51-145	66-90	76-115			51-150
13	<i>P. maxillipedo</i>	51-95	46-115	51-110	46-120	51-90	46-100			46-120
14	<i>P.acclivirostris</i>			51-55	51-65					51-65
15	<i>P.stylifera</i>			66-90	66-120					66-120
16	<i>P.sculptilis</i>			61-65						61-65
17	<i>M.stridulans</i>	56-60	66-75	51-95	46-85	46-70	46-85			46-95
18	<i>M.mogiensis</i>			46-65	66-70		51-65			46-70
19	<i>T.curvirostris</i>			51-65	56-70	51-50				51-70
20	<i>T.granulosus</i>				61-85					61-65
21	<i>T.sedili</i>			56-80						56-80
22	<i>Alpheus</i>				51-55					51-55
23	<i>A. alcocki</i>			76-85	96-170	146-150				76-170
24	<i>P. spinipes</i>	71-120		46-115	-	56-115		66-85		46-120
25	<i>P. martia</i>			53-95	-	65-75				53-115
26	<i>H.gibbosus</i>	66-140		36-145	-	56-115		56-125		36-145
27	<i>H.woodmasonii</i>			71-110		81-105				71-110
28	<i>S. hextii</i>	71-115	71-125	51-120	51-140	76-120	81-130			51-140
29	<i>S. choprai</i>			66-90	61-85					61-90
30	<i>S. koelbeli</i>			66-100	66-110					66-100
31	<i>S.crassicornis</i>				51-80					51-80
32	<i>P.longipes</i>			70-110						70-110
33	<i>P.jerry</i>	71-130		71-96		71-105	66-105	61-85	61-85	66-130
34	<i>P.fissuroides</i>			51-85	56-105	86-95				51-105
35	<i>P.investigatoris</i>	66-100		61-95		71-95				61-100
36	<i>P.retacuta</i>			70-95						70-95
37	<i>M.andamanensis</i>			61-115		71-110	61-115	66-100	71-85	61-115
38	<i>Haliporoides sp</i>	66-100		66-110		61-100				61-110
39	<i>N.tenuispines</i>			61-65						61-65
40	<i>P.ndicus var</i>			200						

Sex ratio: The annual sex ratio of different species of prawns is given below:

Species	Sex ratio (%)							
	2010		2011		2012		2013	
	Male	Female	Male	Female	Male	Female	Male	Female
P.semisulcatus	50	50	44	56	57	43	58	42
P. indicus	40	60	51	49	55	45	55	45
P. latisulcatus	54	46	49	51	33	67	57	43
P.penicillatus		100						
P.merguiensis		100	25	75	33	67		
P.monodon			47	53	35	65	100	
P.canaliculatus			100					
M.moyebi			19	81	42	58		
M.dobsoni			35	65	15	85		
M.nonoceros			58	42	17	83		
M.affinis			100			100		
P.uncta	67	33	20	80	58	42		
P. maxillipedo	45	55	45	55	46	54		
P.acclivirostris			20	80				
P.stylifera			28	72				
P.sculptilis			100					
M.stridulans	40	60	39	61	43	57		
M.mogiensis			60	40				
T.curvirostris			50	50				
T.granulosus				100				
T.sedili			100					
A. alcocki			2	98				
S. hextii	55	45	26	74	53	47		
S. choprai			25	75				
S. koelbeli			39	61				
S.crassicornis				100				
P.jerry					68	32	29	71
P.fissuroides			77	23				
M.andamanensis					58	42	73	27

Maturity condition: Spawning Season: *P. semisulcatus* spawns throughout the year with a peak in June and October. Whereas in *P.indicus* the peak months were January, May-June and October. The annual maturity condition of prawns is given below:

Species	Maturity stage of female (%)											
	2010			2011			2012			2013		
	IM	M	Berried	IM	M	Berried	Immature	mature	Berried	Immature	mature	Berried
<i>P.semisulcatus</i>	14	86		39	61		29	71		40	60	
<i>P. indicus</i>	11	89		47	53		46	54		54	46	
<i>P. latisulcatus</i>	32	69		33	67		50	50		96	4	
<i>P.penicillatus</i>		100			100			100				
<i>P.merguensis</i>		100			100			100				
<i>P.monodon</i>	50	50			100						100	
<i>M.moyebi</i>				66	34		52	48				
<i>M.dobsoni</i>				51	49		73	27				
<i>M.nonoceros</i>				80	20		22	78				
<i>M.affinis</i>								100				
<i>P.uncta</i>				7	93		64	36				
<i>P. maxillipedo</i>	90	10		68	32		89	11				
<i>P.acclivirostris</i>				25	75							
<i>P.stylifera</i>				30	70							
<i>M.stridulans</i>	100			75	25		100					
<i>M.mogiensis</i>				50	50		100					
<i>T.curvirostris</i>				100								
<i>T.granulosus</i>					27							
<i>A. alcocki</i>				35	65			100				
<i>P. spinipes</i>				71	29	72	74	26	30			
<i>H.gibbosus</i>	88	12	59	32	68	22	54	46	31			32
<i>H.woodmasonii</i>							100					
<i>S. hextii</i>	100			82	18		15	85				
<i>S. choprai</i>				87	13							
<i>S. koelbeli</i>				33	67							
<i>S.crassicornis</i>				100								
<i>P.longipes</i>				100								
<i>P.fissuroides</i>				40	60							

The annual feeding condition and dominant food items of prawns are given below:

Prawns	Average (2011-1013)							
	Feeding condition (%)			Food items (%)				
	Empty	¼ + 1/2	¾ +full	Crustacea	Mollusca	fish	foraminifera	Didigested/detritus /vegetative matter
<i>P.semisulcatus</i>	81	16	6	39	15	16	2	19
<i>P. latisulcatus</i>	67	29		10	10	28	0	15
<i>P.indicus</i>	70	28	1	11	21	28	0	22
<i>P.maxillipedo</i>	74	17		21	6	4	0	18
<i>P.uncta</i>	75	11		2	7	29	5	9
<i>M.moyebi</i>	77	22		22	4	7	0	18
<i>M.dobsoni</i>	70	29		10	2	6	0	32
<i>M.stridulans</i>	91	9		20	12	4	0	15
<i>S. choprai</i>	94	4						
<i>S. koelbeli</i>	83	11		34	0	0	0	17
<i>H.gibbosus</i>	93	8	1	24	1	20	0	29
<i>A. alcocki</i>	76	20		27	5	16	0	2
<i>S. hextii</i>	76	24		22	2	12	0	0
<i>P. spinipes</i>	57	27		3	1	3	0	44

Indegenous trawl (Thallumadi/push net):Fishery: The annual catch varied from 46 t in 2011 to 15 t in 2013 with an average of 34 t and the CPUE from 7 kg (2011) to 4 kg (2013) with an average of 7kg. The catch and CPUE showed a declining trend from 2011 to 2013.

The CPUE ranged from 3 kg to (April) 13 kg (September) with an average of 7kg.

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

Biology: Annual size range of other species is given below:

Size range	2010		2011		2012		2013	
Prawns	M	F	M	F	M	F	M	F
<i>P.semisulcatus</i>	31-145	56-135	31-145	56-135	56-170	56-200	51-190	48-190
<i>P. indicus</i>	56-125	56-130	56-125	56-130				
<i>P. latisulcatus</i>	61-105	86-195	61-105	86-195	76-120	66-145	66-100	71-100
<i>P.monodon</i>		121-135		121-135				
<i>P. canaliculatus</i>							91-95	96-100
<i>M.moyebi</i>	31-130	51-150	31-130	51-150	61-80	51-110	56-60	66-75
<i>M.dobsoni</i>	61-70	61-95	65-95	65-70				
<i>P.uncta</i>	76-80	71-75	76-80	71-96				
<i>P. maxillipedo</i>	31-90	31-95	31-90	31-95		76-80	56-60	
<i>M.stridulans</i>	41-65	26-85	41-65	26-85	56-65	56-80	56-60	66-70
<i>M.toloensis</i>	46-75	46-90	46-75	46-90				
<i>M.mogiensis</i>	48-60	48-60			46-70	56-60		
<i>T.curvirostris</i>	-	51-75	-	51-75				
<i>T.granulosus</i>	46-80	51-90	46-80	51-90	51-65	51-90		
<i>T.sedili</i>			46-55	51-65		81-85		
<i>Alpheus</i>						56-75		
<i>M.equidens</i>						61-65		

Annual sex ratio of prawns is given below:

	Sex ratio %							
2010-2013	2010		2011		2012		2013	
Prawns	M	F	M	F	M	F		
<i>P.semisulcatus</i>	54	46	54	46	50	50	46	54
<i>P. latisulcatus</i>	41	59	41	59	49	51	50	50
<i>P.indicus</i>	43	57	43	57				
<i>P.monodon</i>		100		100				
<i>P.canaliculatus</i>			60	40	100		66	34
<i>M.moyebi</i>	44	56	44	56	22	78	34	66
<i>M.dobsoni</i>	44	56	29	71				
<i>P. uncta</i>	8	92	8	92				
<i>P.maxillipedo</i>	44	56	44	56	42	58	100	
<i>M.stridulans</i>	28	72	22	78		100	50	50
<i>M.tolensis</i>	27	73	17	83				
<i>M.mogiensis</i>					100			
<i>T.curvirostris</i>	-	100	-	100				

Food items: The average annual percentage of food items of prawns are given below:

	2010				2011				
	Crustacea	Mollusca	detritus	fish	Crustacea	Mollusca	detritus	fish	Polychaete
<i>P.semisulcatus</i>	65	23	12		15	46	38	1	
<i>P.latisulcatus</i>	70	4	23	3	19	42	35	2	2
<i>P.indicus</i>	71	4	22	3					
<i>P.Maxillipedo</i>	54	5	41			19	55	1	
<i>M.stridulans</i>	42	45	13						
<i>M.tolensis</i>	45	13	39	3					
<i>M.Moyebi</i>						44		4	
<i>T.granulosus</i>	50	1	49						
<i>T.curvirostris</i>	50	1	49						
<i>P.monodon</i>	20		80						

Food	2012					2013	
	<i>P.semisulcatus</i>	<i>M.stridulans</i>	<i>P.maxillipedo</i>	<i>P.latisulcatus</i>	<i>T.granulosus</i>	<i>P.semisulcatus</i>	<i>P.latisulcatus</i>
Crustacea	17	45	72	15	50	49	100
Prawn	4						
Crab	0						
Mollusca	53	33	6	75	10	36	
Fish	1		4				
Detritus	4	20				3	
Digested	11	2	9	10	40	12	
Sea grass	9					1	
sea urchin	0						
Sea weed			9				

Gill net : Estuarine Fishery: The annual catch varied from 9.7 t (2012) to 16.5 t (2010) with an average of 12.2 t. The average monthly catch for the period 2010 -2013 varied from 118 kg to 2.9 t. Though the fishery was there throughout the year, the main season was September -November with a peak in November . A secondary peak was also observed in May.

Species composition: The estuarine fishery is mainly for the species *Penaeus indicus*. Out of six species caught, *P.indicus* formed 91 %. Other species recorded in the fishery were, *P. semisulcatus* (7%), *M. dobsoni* (1%), *P. monodon* (0.4%), *M. moyebi* (0.1%). *M. monoceros* (0.002%)

Biology: Annual size range of prawns is given below:

Prawns	Gill net							
	2010		2011		2012		2013	
	M	F	M	F	M	F	M	F
<i>P.semisulcatus</i>	90-120	90-95			81-105	61-95	111-115	106-110
<i>P. indicus</i>	56-130	31-130	56-110	56-130	56-120	31-125	51-125	51-30
<i>P.monoceros</i>						111-115		
<i>P.monodon</i>	96-120				96-120			
<i>M.moyebi</i>	61-80	51-80	61-65	66-75		51-90		56-80
<i>M.dobsoni</i>	51-120	46-95	51-80	46-80	46-75	51-85		

Penaeus indicus: In total catch the male to female ratio was 1.0: 1.1 and there was not much variation in the monthly sex ratio and the Chi-square test showed that the variation was not significant. The estuarine fishery was exclusively for juveniles. Empty stomach condition dominated in all the months except in June. Poorly fed or quarter full dominated on that month. In the total catch, empty stomach formed 53% , quarter-full 22%, half-full 16%, three-fourth –full 6% and full 3%. _Unidentifiable Crustaceans dominated in the stomach (28%) followed by detritus (24%), sea grass (17%), digested (16%). Molluscans formed only 7%

Seasonal gill net fishery : Seasonal prawn fishery along the coasts of Manappad and Periathazhai for prawns starts with the onset of south-west monsoon and recedes by November-December. At Manappad, the catch varied from 84 kg in December to

4.4 t in July with an average of 1.9 t. The average CPUE was 3kg. The total catch during June –August was 7.5 t. The catch was mainly constituted by *P. indicus* (99.5%) followed by *P. semisulcatus* (0.5%).

At Periathazhai, the catch ranged from 880 kg in December to 96 t in July whereas the CPUE ranged from 4 kg to 16 kg. The total catch during the period June-December was 142 t with a CPUE of 10kg. The average monthly catch during this period was 20 t. *P. indicus* formed the major chunk of the catch (90%) and the remaining part by *P. semisulcatus*.

Biology of *P.indicus*: At Manappad, the size of males ranged from 116 mm to 185mm with a mode at 156-160 mm and that of females from 106 to 210 mm with a major mode at 156-160mm and a side mode at 166-170 mm. Males dominated in the catch by 53%. Matured stage formed 69 % of the female catch with a monthly ranged of 68% to 70%.

At Periathazhai, the size of males ranged from 123 to 195 mm and that of males from 131 to 235 mm. At periathazhai also Males dominated in the catch by 52%. Matured females dominated in all the months and in the total it formed 76%

Resource: Crabs: Trawl Fishery: The annual catch varied from 148 t in 2013 to 1397 t in 2011 with an average of 795 t. The CPUE ranged from 4 kg (2013) to 42 kg (2011) and the average annual CPUE was 23 kg. The monthly catch ranged from 2 t to 454 t and the CPUE from 4 to 308 kg. The minimum catch was in May and maximum catch was in April followed by June.

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

Biology: *Portunus sanguinolentus*: The width of *P. sanguinolentus* male ranged from 41 to 170 mm with a mode at 91-95 mm. In females, it ranged from 46 to 160 mm and the main mode was at 91- 95 mm. Females dominated in most of the months and in the total catch (57%) also. The Chi-square test showed that the variation of sex ratio was significant at 0.05 level. Matured males dominated in all months. In females also matured stage formed a good percentage throughout the year. However, generally matured stage dominated from January to July and immature stage dominated from August to December except in October. Empty stomach dominated throughout the year and in the total (60%) followed by quarter-full (20%), half -full (12%), three-fourth full (5%) and full (3%). In the stomach contents fish dominated (44%) in the annual average followed by crustaceans (32%) and molluscan shell pieces (18%) . Among crustaceans, crab parts were the major component.

Charybdis natator: The size of males ranged from 41- 135 mm with a mode at 66-70 mm and in females it ranged from 36 to 115 mm and the mode was at 66-70 mm. In 2010 and 2011 females dominated in the catch whereas in 2013 males dominated in the catch . In the total catch also females dominated by 53%. The Chi-square test showed that the monthly variation of sex is significant at 0.05 level. Mature males dominated in the catch throughout the period except in April where spent dominated and in November where immature dominated. In the case of females, matured stage dominated in the total catch (56%) and the peak spawning period was June-July. However, matured stage formed a good percentage in all the months. Berried stage formed 54% of the total females and impregnated formed 42%. The peak months of berried females were June-July and October. The impregnated stages were more in January and September where immature stage also dominated. Empty stomach dominated in both males and females in all the months and in the total it formed 59% followed by quarter full 17%, half full 13% Three-fourth full 8% and full 3%. In the stomach contents, fishes dominated in both males (41%) and females (53%) followed by unidentifiable crustaceans including crabs and molluscs. Other food items recorded were given in graph.

Portunus haani: The width of males ranged from 31 to 110 mm with a mode at 76-80 mm and females from 31 to 120 mm and the mode was at 61-65 mm. Males dominated over females on almost all months and in the total it formed 68%. The variation sex from 1:1 ratio was found significant. Mature males dominated in all months with peak in March. In females, matured stage was present throughout the year but the peak was in August, May and June. Berried stage dominated in May and December whereas impregnated condition dominated in March, October and June. Empty stomach dominated in all the months and in the total catch it formed 66% followed by half-full 13%, quarter-full 12%, three-fourth full 5% and full 4%. Fishes (44%) and unidentifiable crustaceans including crabs, prawns and squilla (44%) dominated in the stomach followed by molluscan shells.

Indigenous trawl (Thallumadi) Fishery: Catch and CPUE: The annual catch varied from 13 t in 2013 to 48 t in 2011 with an average of 28 t. The commercial fishery was constituted by 12 species. Out of this, *P. pelagicus* dominated (46%) followed by *C. natator* (26%), *P. sanguinolentus*. In the trash, *Thalamita integra* formed the main component. The other species were *P. haani*, *C. feriatus*, *C. annulata*, *C. bilineata*, *C. lucifera*, *C. helleri*, *P. vigil* and *P. convexus*.

Biology: Portunus pelagicus: The size of males ranged from 21 to 155 mm with a mode at 76-80 mm. In females, it ranged from 41 to 180 mm with a mode at 71-75 mm. Females dominated in most of the months and in the total (55%). In all the years the sex ratio showed significant variation from 1:1 ratio except in 2013. In males, immature stage dominated in all the months and in the total it formed 72%. Matured stage formed only 16% of the male catch and spent stage formed 12%. In females also the fishery mainly consisted by juveniles in all the months and in the total it formed 91%. Early maturing stage formed 3%, matured stage 6 and the spent stage formed only 1%. Berried condition formed only 0.4% in the female catch which were recorded in May, September and December. Impregnated females were present in the catch throughout the period with peak in June and August. In the total females it formed 26%. In males,

empty stomach dominated in all the months forming 69% in the total males followed by half-full 13 %. Quarter –full 12 %, three fourth full 3% and full 4%. In females also empty stomach dominated in all the months and in the total (71%) females followed by quarter-full (14%), half full (10%), Three fourth full (4%) and full (2%). In males, unidentifiable crustacean (34%) dominated followed by molluscan shells (28%), seagrass (16%), crabs (16%) and fishes (5%). In females also unidentifiable crustaceans dominated (35%) followed by molluscan shells (23%), fishes (14%), crabs (11%) and sea grass (9%).

Portunus sanguinolentus : The width of males ranged from 51 to 135 mm with a mode at 81-85 mm and in females, it varied from 41 to 150 mm with a mode at 81-85 mm. Females dominated in almost all the months and in the total catch (58%). The variation of sex ratio from 1:1 was significant at 0.05 level. In males, immature stage dominated in the catch except in January, March-April, June and October. In the total catch of males immature formed 63%. In females, immature stage dominated in almost all the months except during February-March in 2011. In the total catch, immature stage formed 82%. In the total catch of females, berried stage formed 9% and it recorded in considerable numbers during April –July. Impregnated condition formed 39 % and this condition was present almost throughout the year. Empty stomach dominated in most of the months and it formed 48% in the total catch followed by half-full (20%), quarter-full (13%), three-fourth full (8%) and full (10%). Unidentifiable crustaceans (36%) dominated in the stomach followed by fishes (24%), molluscan shells (13%). About 9% of the total stomach content was comprised by crabs.

Charybdis natator: The width of males ranged from 44 to 130 mm and that of females from 36 to 105 mm. The mode was at 56-60 mm in both males and females. The monthly sex ratio of this species fluctuated widely from year to year. Though males formed 49% in the total catch, the monthly variation of male to female ratio was significant. Immature males dominated in all the months except in March and June. In the total catch of males, immature stage formed 78%. In the case of females, 98 % the

female catch was comprised by immature stage. The matured stage formed only 2%. In the total catch 45% had empty stomach, 19% half –full , 17% quarter-full , 10% three-fourth full and 8% had full stomach. Unidentifiable crustaceans dominated in the total stomach contents (31%) followed by fishes (25%), crabs (19%) and molluscan shells 19%. Other food items recorded in minor quantities are given in graph.

Estuarine gill net (Njandu valai) Fishery: The annual catch varied from 39 t in 2013 to 66 t in 2011 with an average of 57 t. The annual CPUE ranged from 7.3 kg (2012) to 12.3 kg (2011) with an average of 9.5 kg. The monthly catch ranged from 2 t (September) to 8 t (November) and the CPUE from 6kg to 17 kg. The catch was comprised by 9 species and out of this, *P. sanguinolentus* dominated (55%) followed by *P.pelagicus* (16%), *C. natator* (15%) and *P. haani* (9%).

Biology: *Portunus sanguinolentus*: The size of males ranged from 56 to 240 mm with a mode at 106-110 mm and that of females 51 to 215 mm with a mode at 96-100 mm. A secondary mode was also recorded in females at 106-110 mm. Males dominated in the catch in most of the months and also in the total catch (57%). The monthly variation of males and females in the catch was found significant at 0.05 level. In males, matured stage dominated in the catch in most of the months and in the total catch of males matured stage formed 76%. In the case of females, Matured stage was present in all the months with peak in February, July –August. But in the total catch of females 68% was in immature stage and 33 % was in mature stage. Berried condition was present in the catch throughout the period with a peak in March and in total it formed 28%. Impregnated condition was also present in almost all months and in the total it formed 62%. Empty stomach dominated in most of the months and in the total catch it formed 73 % in males and 79% in females. Quarter –full stomach formed 11 % in males and 8% in females whereas as half –full stomach formed 10% in males and 7% in females. Three-fourth full and full conditions were 3 % each in males and 2% each in females. In males , the dominant food item was crustacean remains (46%) followed by fishes (38%) and molluscan shells (8%). Among crustaceans crabs dominated forming 21% in the total

food items and the rest were unidentifiable crustaceans which formed 25% of the total food items. In females, unidentifiable crustaceans formed 24% and crabs formed 22% which together formed 46 % of the food items. The second dominant food item was fishes (26%) followed by molluscan shells (14%). Other food items shown in the graph were occurred occasionally.

Portunus pelagicus: The size of males ranged from 26 to 165 mm and that of females from 26 to 155 mm. The modal classes were 116-120 mm and 106-110 mm for females and 106-110 mm for males. In the monthly catch, male to female ratio fluctuated widely and the variation from 1:1 ratio was found significant. However, females outnumbered (51%) slightly in the total catch. In males immature stage formed 49% followed by mature stage (43%) and spent stage (9%). Mature males were maximum in the catch during March-April. In females, immature stage dominated in the total catch (84%) and mature stage formed only 16%. The peak spawning was recorded in July and December. Berried condition was absent in the catch. Impregnated females were present in the catch in all the months and it formed 46% in the total catch. Empty stomach condition dominated in both males and females in all the months forming 90 in males and 89% in females in the total catch. In males, Crustaceans formed 49 % in the food items. In the total food items, 32% was unidentifiable crustaceans and 17 % was crabs. The other dominant food items in the stomach were molluscan shells (25%) and fishes (11%). In females unidentifiable crustaceans dominated (43%) followed by molluscan shells (32%) and fishes (15%). Crabs formed only 3% in the total food items.

Charybdis natator: The width of male ranged from 46 to 140 mm and female from 51 to 115 mm. A major chunk of the female catch (90%) distributed under the size group 61-90 mm. Males dominated in the catch in almost all months and in the total catch it formed 75%. The variation of sex ratio was found significant at 0.05 level. In males, Matured condition dominated in all the months except in January, June and November. In the total males, it formed 68%. In females, immature stage dominated in the total catch of females (61%) but matured females were also present in the catch in good

quantities with peaks in January and June. But the main spawning season was from June to March. Berried females observed in the catch during January -March, May and October-November. Impregnated females formed 35 % in the total females. Empty stomach condition dominated in most of the months both males and females and it together formed 84% of the total catch . In males, three fourth full formed 9% and full formed 1% whereas these conditions were absent in females. Instead quarter full formed 11% in females and half-full formed 4% in both males and females. Crustaceans dominated in the stomach contents of males forming 53% of the total stomach contents. Among crustaceans crabs formed 41% of the total food items and the rest (12%) were unidentifiable crustaceans. Molluscan shells formed 16% and fishes formed 11% of the total food items. In females also crustacean remains dominated (60%) followed by molluscan shells (16%) and fishes (14%). Crabs formed the main component of crustacean remains (35%) and the rest were prawns (14%) and unidentifiable crustaceans (11%)

Portunus haani: The width of males ranged from 56 to 100 mm with a mode at 76-80 mm. In females, the width varied from 46 to 95 mm and the mode was at 71-75 mm. The monthly male to female ratio showed wide variation from 1: 1. Males dominated in all months and in some months the catch was comprised by only males. In the total catch, 81 % was males. Matured stage dominated in males in all the months except April and August –November. About 68% of the total catch of males was comprised by mature condition. In females also matured stage dominated in all the months except May August and November and in the total it formed 63%. Berried females formed 29 % in total females. Impregnated females dominated in the catch of females and it formed 83%. Empty stomach dominated in all the months in males and it formed 96 % of the total males. In females also empty stomach condition dominated by 97%. Except in January and November, in all other months , the catch of females was comprised by empty stomach. In the stomach contents 80% were crustaceans mainly crabs and the rest were fishes.

Marine gill net:Fishery: The annual crab catch fluctuated from 48 t in 2011 to 234 t in 2012 and the average annual catch was 116 t. The CPUE ranged from 16 kg (2011) to 22 kg in 2012 with an average of 20 kg. The monthly catch varied from 2 t to 31 t and the CPUE from 7 kg to 31 kg. The highest catch was in January and the highest CPUE was in October.

Species composition: In the annual catch *P. sanguinolentus* dominated (36%) followed by *C. natator* (29%), *P. haani* (20%) and *P. pelagicus* (15%). In the average monthly catch *P. sanguinolentus* dominated in January and during July to November. In other months *C. natator* dominated. Other species recorded in the fishery in small quantities were *C. cruciata*, *C. orientalis*, *C. lucifera*, *C. helleri*, *C. annulata*, *T. prynna*, *S. serrata*, *C. petreus* and *C. granulata* and *C. miles*.

Biology: *Portunus pelagicus*: The width of males ranged from 61 to 185 mm and that of females from 56 to 190 mm. The modal class for males and females was 126-130 mm and 136-140 mm. Males dominated in most of the months and in the total catch (54%). The chi-square analysis showed that the variation of males and females from 1:1 ratio was significant at 0.05 level in all the years and in the total catch except for 2010.

Portunus sanguinolentus: The width of males ranged from 66 to 170 mm with a mode at 116-120 mm. In females, the width varied from 61 to 180 mm and the main modal class was at 116-120 mm. Males dominated in most of the months and in the total catch (61%). The fluctuations in sex ratio were found significant at 0.05 level. In males, mature stage dominated in most of the months. In some months either immature or spent dominated. In the total catch of males 73% was under matured condition. In females, matured stage were more during January to July and October. In the total catch of females either immature or spent stage dominated (49%) followed by matured stage (30%) whereas early mature stage formed 15% and late mature stage formed (6%). Berried stage formed only 18% in the total catch of females. More numbers of berried females were recorded during July and October. Impregnated females dominated in most of the months and in the total females it formed 58%. Empty

stomach dominated in all months in males except in March 2011 . In the total males, empty stomach formed 78% followed by quarter-full (9%), half-full (7%) , three-fourth full (4%) and full (2%). In females, empty stomachs dominated throughout the period and in the total females it formed 83 %. Other feeding stages were quarter-full (9%), half-full (5%), three-fourth full (3%) and Full (1%). In males, crustacean remains (crabs and crab eggs) dominated in the stomach contents (36%) followed by molluscan shells (33%) and fishes (21%). Other food items that occurred intermittently. In females also crustaceans dominated (49%) in the stomach contents. Among the crustaceans 36% were unidentifiable remains and the rest 13% were crab remains including crab eggs. Molluscan shells formed 33% in the total stomach contents and fishes formed 8%. A good percentage of sea grass was also recorded sporadically (6%).

Charybdis natator: In males, the width ranged from 36 to 130 mm and that in females from 41 to 110 mm. The modal class was at 76-80 mm in both males and females. Males dominated in all the months except in February 2012. In the total catch males formed 68%. The variation of sex ratio was significant at 0.05 level. Matured males dominated in the catch except in few months. In the total catch of males, it formed 61 %. The rest were either spent or immature. In females, Immature/spent stage dominated in the catch forming 62%. Matured stage formed 34% in the total catch of females and the main season was July – September. In the total females, berried stage formed 39% but the annual peaks were in different months. Non –impregnated stage dominated in the catch in most of the months and in the total catch, it formed 69%. The impregnated condition dominated in May, July and November. Empty stomach dominated in males in all the months which formed 77% in the total male catch. The remaining portion was comprised by quarter-full (9%), half-full (7%), three fourth – full (3%) and full (3%). In females also empty stomach condition dominated in most of the months . In the total female catch it formed 72 % and the rest were quarter-full (12%), half –full (7%) , three-fourth full (4%) and full (4%). In the stomach contents of males, crustacean remains dominated (58%) followed by molluscan shells (17%) and fishes (7%). Among crustaceans 35% of the total food items was in unidentifiable form and 21 % were crabs.

The other crustaceans were crab eggs, prawns and squilla. In females, crustaceans remains dominated in the stomach contents (53%) followed by molluscan shells (25%) and fishes (5%). Among crustaceans, 29% of the total stomach contents was in unidentifiable condition. Crabs and crab eggs together formed 22% of the total food items. .

Portunus haani :The width of males ranged from 36 to 105 mm with a mode at 76 -80 mm. In males, it ranged from 36 to 85 mm and the modal class was 66-70 mm. Males dominated in the catch in all the months except in June 2012 and November 2013. In the total catch males formed 76 % and the variation of sex ratio was significant at 0.05 level. Matured males dominated in all the months except in January and October 2012. In the total catch of males, 72 % was under matured condition. In females, immature/spent stage dominated (54%) in the total catch. Matured stage formed 46% in females. Matured females were present in the catch throughout the year but percentage was more during June - November. Berried females formed 30 % in the total catch and the peak months were January and November. Unlike other species of crabs, impregnated condition dominated in females of this species throughout the period. In the total catch of females it formed 87%. In males, empty stomachs dominated in all the months and in the total catch (95%) whereas quarter-full formed 3% and half -full formed 2%. Other well fed condition (Three fourth and full) formed only 0.6%. In females also empty stomach condition dominated in all the months and in the total females (88%). Quarter - full, half-full, three fourth-full and full were 6%, 3%, 2% and 1% respectively. Unidentifiable crustaceans dominate in the stomach (52%) followed by crabs (20%), fishes (13%) and molluscan shells (4%). Other items occurred sporadically are given in graph.

Resource: Lobsters

Gill net Fishery (Singi valai) : Catch and CPUE:The annual catch varied from 2 t in 2011 to 8 t in 2012 with an average of 4 t and the annual CPUE ranged from 0.2 kg (2011) to 2.4 kg (2012) with an average of 1.3 kg. The monthly catch varied from 98 kg to 1617kg

and the CPUE varied from 0.4 kg to 5 kg. The lowest catch and CPUE were in February and the highest catch and CPUE were in December followed by August.

Species composition: In the annual catch *Panulirus homarus* dominated in all the years and in the total catch (44%) followed by *P. ornatus* (39%) and *P. versicolor* (17%).

Biology: Biology of three species of lobsters are given below:

	<i>P.homarus</i>					
	2010-11		2012		2013	
Size range (mm)	Male	Female	Male	Female	Male	Female
TL (mm)	105-275	138-360	120-290	120-300	120-210	130-250
CL(mm)	40-110	50-125	48-120	55-120	47-90	45-120
Weight (g)	50-650	100-1600	70-550	100-930	67-380	60-570
Mean TL (mm)	165	194	166	187	160	180
Mean CL (mm)	69	79	70	75	66	89
Mean wt.(g)	203	322	185	271	151	408
Sex ratio(%)	57	43	56	44	54	46
	<i>P.ornatus</i>					
	2010-11		2012		2013	
Size range (mm)	Male	Female	Male	Female	Male	Female
TL (mm)	145-430	130-420	140-335	130-395	110-340	145-330
CL(mm)	60-175	55-155	55-133	65-160	40-185	55-155
Weight (g)	150-1850	100-1400	100-1300	120-2020	70-1300	110-1500
Mean TL (mm)	262	244	196	217	209	217
Mean CL (mm)	110	100	82	85	92	85
Mean wt.(g)	706	535	347	456	385	456
Sex ratio(%)	34	66	56	44	49.0566	51
	<i>P.versicolor</i>					
	2010-11		2012		2013	
Size range (mm)	Male	Female	Male	Female	Male	Female
TL (mm)	160-300	170-350	190-235	170-235	155-330	150-290
CL(mm)	70-130	70-150	90-125	80-95	70-150	90-130
Weight (g)	200-850	240-1200	300-550	175-550	100-300	430-650
Mean TL (mm)	228	258	215	202	155	150
Mean CL (mm)	94	115	108	88	70	90
Mean wt.(g)	423	684	402	342	100	430
Sex ratio(%)	42		50	50	23	77

Length weight relationship of Prawns: The length-weight relationship found out for different species are given below:

1. *P. semisulcatus*: Male: $W(g) = 0.000003811 L(mm)^{3.159}$ ($r^2 = 0.969$, $n=1018$)
 Female: $W(g) = 0.000003213 L(mm)^{3.2}$ ($r^2 = 0.974$, $n=1106$)
2. *P. Indicus*: Male: $W(g) = 0.0000015571 L(mm)^{3.301}$ ($r^2 = 0.961$, $n=458$)
 Female: $W(g) = 0.0000016419 L(mm)^{3.292}$ ($r^2 = 0.938$, $n=505$)
3. *P. Latisulcatus*: Male: $W(g) = 0.000001837 L(mm)^{3.294}$ ($r^2 = 0.974$, $n=206$)
 Female: $W(g) = 0.000003114 L(mm)^{3.2191}$ ($r^2 = 0.983$, $n=216$)
4. *P. Maxillipedo*: Male: $W(g) = 0.000016518 L(mm)^{2.843}$ ($r^2 = 0.816$, $n=328$)
 Female: $W(g) = 0.000009483 L(mm)^{2.990}$ ($r^2 = 0.871$, $n=364$)
5. *M. Moyebi*: Male: $W(g) = 0.000008023 L(mm)^{2.969}$ ($r^2 = 0.892$, $n=233$)
 Female: $W(g) = 0.000028346 L(mm)^{2.781}$ ($r^2 = 0.905$, $n=488$)

Length weight relationship of crabs

1. *P. haani*: Male : $W = 0.0001927 L^{2.869}$ ($r^2 = 0.828$, $n= 1028$)
 Female: $W = 0.0026013 L^{2.242}$ ($r^2 = 0.854$, $n= 408$)
2. *P. sanguinolentus*: Male : $W = 0.0000792 L^{2.908}$ ($r^2 = 0.909$, $n= 1173$)
 Female: $W = 0.000155 L^{2.762}$ ($r^2 = 0.852$, $n= 1090$)
3. *P. pelagicus*: Male : $W = 0.0001215 L^{2.835}$ ($r^2 = 0.875$, $n= 1173$)
 Female: $W = 0.00020091 L^{2.715}$ ($r^2 = 0.873$, $n= 1090$)
4. *C. natator*: Male : $W = 0.0001528 L^{3.071}$ ($r^2 = 0.927$, $n= 753$)
 Female: $W = 0.0001807 L^{2.715}$ ($r^2 = 0.889$, $n= 1000$)

Length weight relationship of Lobsters

1. *P. homarus* : Male : $0.000801 * TL^{2.4077}$ $0.015852 * CL^{2.2021}$
 Female: $0.000684 * TL^{2.4547}$ $0.00837 * CL^{2.391}$
2. *P. ornatus*: Male: $0.000446 * TL^{2.6921}$ $0.00189 * CL^{2.6921}$
 Female : $0.000875 * TL^{2.39990}$ $0.00738 * CL^{2.4072}$

Size at first maturity:

Species	Size (Lm50%) mm	
	Male	female
1. <i>P.semisulcatus</i>	103	132
2. <i>P. haani</i>	55	62
3. <i>P. pelagicus</i>	93	118
4. <i>C. natator</i>	55	55
5. <i>P. sanguinolentus</i>	77	105

Population parameters

Species		L_{∞}	K	M
1. <i>P. semisulcatus</i>	Male	241	1.8	2.4
	Female	266	1.8	1.7
2. <i>P. haani</i>	Male	103	1.3	2.1
	Female	96	1.1	1.3
3. <i>P. pelagicus</i>	Male	194	1.9	2.5
	Female	192	1.6	1.5
4. <i>C. natator</i>	Male	151	1.8	2.6
	Female	122	1.5	2.6
5. <i>P. sanguinolentus</i>	Male	242	1.6	2.5
	female	222	1.3	1.9

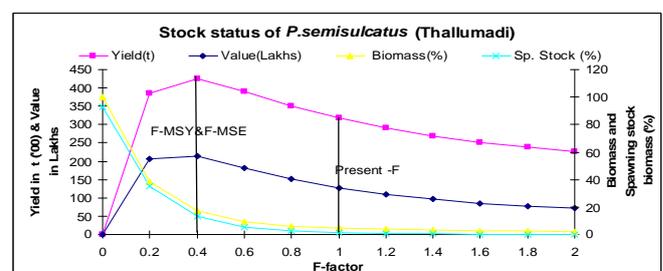
Stock assessment:

Thallumadi (Indigenous

trawl): This gear is being

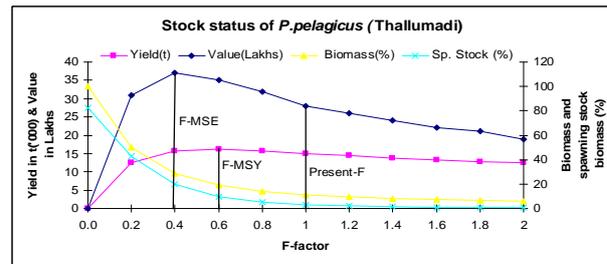
operated in coastal waters (near shore). The dominant species caught by thallumadi were *P.semisulcatus*, *P.pelagicus*, *P.sanguinolentus* and *C. natator*. So the stock status of these species in coastal waters were assessed.

Penaeus semisulcatus : In males, the MSY was obtained at F-factor 0.4 and MSE at 0.2. At MSY level the biomass was only 18% of the virgin biomass and the spawning stock was only 14% of the virgin spawning stock. But at MSE level (0.2) these values were 38% and 35% respectively. In the case of

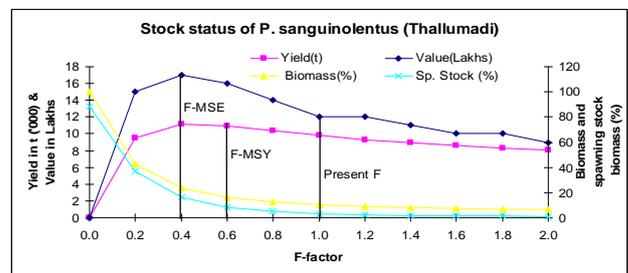


females, the factor for both MSY and MSE were obtained at 0.4. At this level the biomass was 17% and spawning stock biomass was 13%. When the values of males and females were combined, the MSY and MSE were obtained for the F-factor-0.4. Still the spawning stock was only 13%.

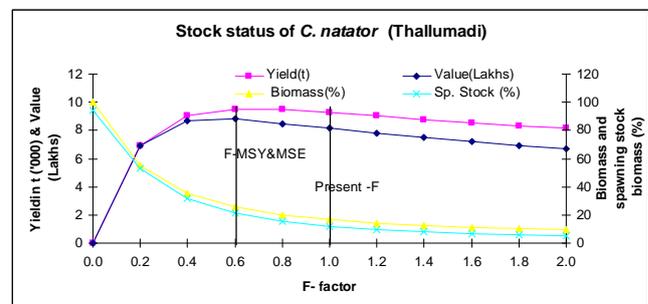
Portunus pelagicus: The MSY for this species was obtained at f-factor 0.6 and MSE at f-factor 0.4 for males. The biomass and spawning stock biomass at MSY levels were 21% and 13% and at MSE level were 30% and 22%. In the case of females also the same f-factors were obtained but the biomass was 18.3% and spawning stock was 8.4% at MSY and at MSE, these values were 29% and 19% respectively. When the values of males and females were pooled, the same trend was followed.



Portunus sanguinolentus: The MSY/MSE for males, MSY for females and MSY for the total were recorded at f-factor 0.6. The biomass at this level for male was 15% and for females was 16% whereas the spawning stock biomass was only 11% (male) and 6% (female). But for females and for the total catch, the MSE was obtained at f-factor 0.4. At this level, the biomass (24%) and spawning stock (14-16%) have shown improvement.



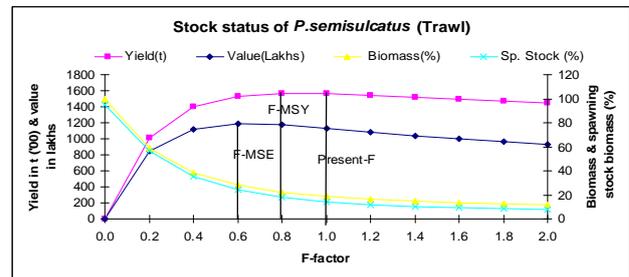
Charybdis natator: In males, the stock was overexploited by 40% with respect to the yield. But with respect to the value, it was overexploited by 60%. Whereas in



females, the MSY and MSE were recorded at the present level of fishing. However, in the total, the f-factor for MSY/MSE was at 0.6. The spawning biomass at this level was 14% for males, 31% for females and 21 for total .

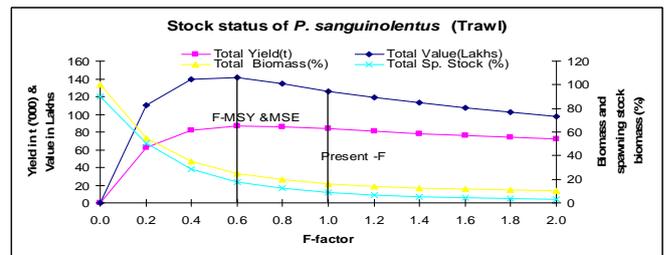
Mechanised trawl net: In mechanized trawl net, the dominant species of prawns and crabs were *P.semisulcatus*, *P.sanguinolentus* and *C. natator*. The results of their stock assessment studies are given below:

Penaeus semisulcatus: The MSY for males, females and total catch was obtained at f-factor 0.8. But the spawning biomass at this level was 21 % for males, 17% for females and 18% for the total.

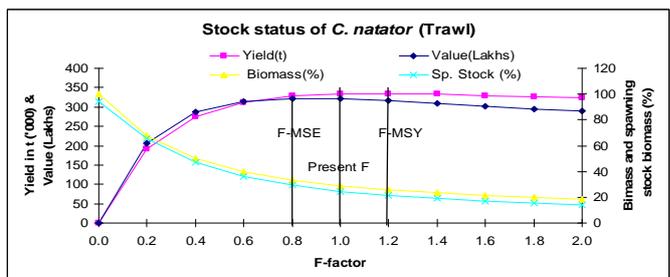


Whereas the MSE was obtained when the f-factor was reduced by 40% (f-factor 0.6) from the present level of fishing. At this state, the spawning stock would be 26 % for males and 24% for both females and total.

Portunus sanguinolentus: In both males and females, the MSY and MSE were at f-factor 0.6. In males, spawning biomass was 22% at MSY/MSE level and in females, it was 15% respectively at MSY/MSE. In the total the spawning stock biomass formed 18% at f-factor 0.6.



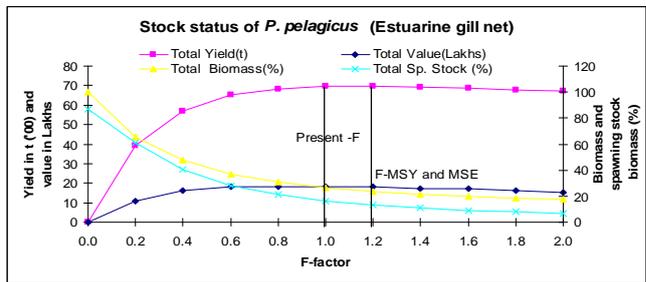
Charybdis natator: In males, the catch was over exploited by 20% with respect to yield but with respect to value it was overexploited by 40% . The F- factor for MSY was recorded at 0.8 and that for MSE at 0.6. The spawning stock at MSY and MSE levels were 25 and 32 respectively. But the females were not affected by the



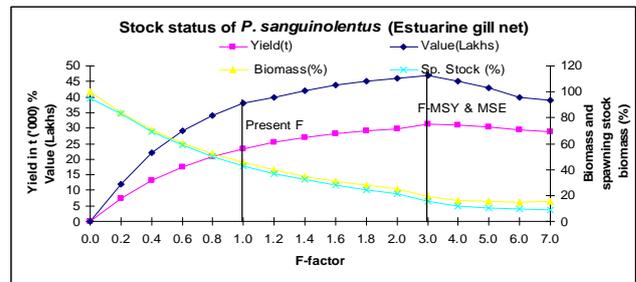
present level of fishing. The MSY was obtained at F-factor 1.8 and MSE at f-factor 1.2. The spawning stock biomass at MSY level was 19% and at MSE level was 26%. In the total, the MSY was recorded at F-factor 1.2 and F-MSE at 0.8. The total spawning stock biomass at MSY level was 21% and at MSE level was 29%.

Estuarine gill nets: In this gear the dominant species are *P. pelagicus*, *P. sanguinolentus* and *C. natator*. Their stock status is given below:

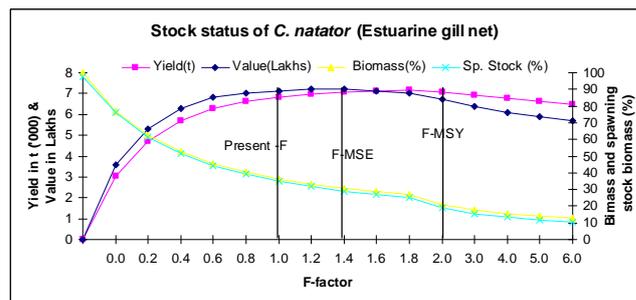
Portunus pelagicus: In estuaries, the stock was not affected by the present level of fishing. In males the MSY was obtained for the f-factor 1.4 and in females for the f-factor 1.0. The f-factor for the total was 1.2. But the spawning stock was only 23% for males, 11 % for females and 16% for the total at the present fishing level. So, the spawning stock would be affected adversely with the increase of effort.



Portunus sanguinolentus: At the present level of fishing, the stock was not over exploited. In males the MSY was obtained at f-factor 4 and MSE for the f-factor 3. The spawning stock biomass of male was 12% for the former and 18% for the latter. In females, the MSY and MSE were obtained when the f-factor was increased by 80% from the present level of fishing and the spawning stock at this level was only 8%. The MSY and MSE for the total was recorded at f-factor 3.0. The total spawning stock at this level was 15 %



Charybdis natator: This species was not overexploited at the present level of fishing. In males, the MSY and MSE were obtained

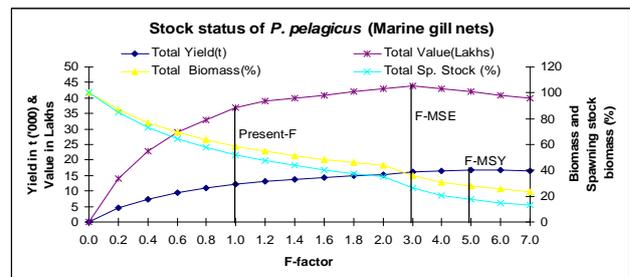


for the f-factors 1.6 and 1.4 respectively. In females, the MSY and MSE were recorded for the f-factor 6. The spawning stock biomass at this level was 20%. In order to reach the MSY for the total, the fishing pressure could be doubled but the MSE would reach at f-factor 1.4. The spawning stock biomass at MSY level was 25% and MSE level was 31%.

Marine gill net: In marine gill nets the dominant species of crabs caught were *P. pelagicus*, *P. sanguinolentus* and *C. natator*. The results of stock assessment studies of these species are given below:

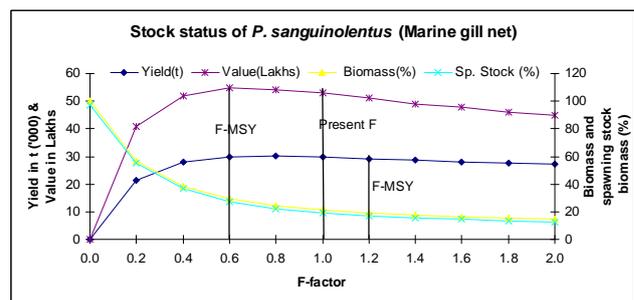
Portunus pelagicus: In males, the MSY and MSE were obtained for the F-factor 5.0. At this level the biomass was 30% and

spawning stock biomass was 23%. But in the case of females, though the MSY was for the same factor, the MSE was for the f-factor 3.0. At F-MSY level the spawning stock biomass of female was only 13%



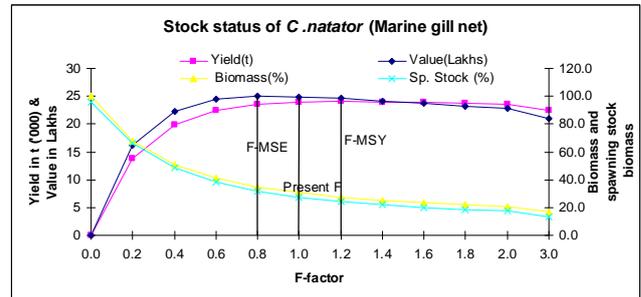
whereas at F-MSE level the spawning stock biomass was considerably high (23%). In the total also, MSE was obtained for the f-factor 3.0 and the total spawning stock biomass at this level was 26%.

Portunus sanguinolentus: In males, the MSY and MSE were obtained at f-factor 0.8. In females, the MSY was for the same f-factor but they reached the MSE at f-factor 0.6. At MSY level the male spawning stock biomass was 25% and that in females



was 19. At MSE level the spawning stock biomass of female was 24. For the total catch, the MSY was at f-factor 0.8 and MSE was at f-factor 0.6. At these levels the total spawning stock biomasses were 22% 24% respectively.

Charybdis natator: In males, the MSY was obtained for the present fishing level but the MSE was reached at f-factor 0.8. The spawning stock biomass for the former was 25 % and for the latter it was 29%. In females, both MSY and MSE were obtained at f-factor-2. At this level the spawning stock biomass was 24%. The MSY for the total was attained at 1.2 (f-factor) and the MSE was attained at 0.8 (f-factor). The total spawning stock at the MSY level was 24% and that at MSE level was 32%.



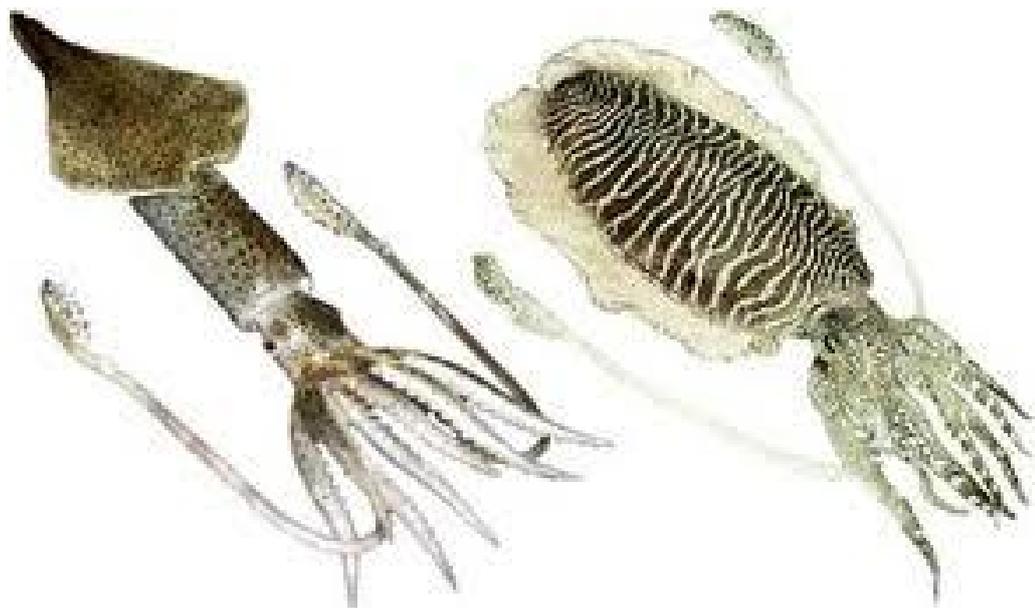
Conclusion: The stock assessment studies showed that the juvenile stock of prawns and crabs were over exploited by thallumadi (indigenous trawl net) . In the case of mechanized trawlers also the stock was slightly over exploited. So, in order to achieve a healthy fishery, the fishing pressure of the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

Project -7. GIS based resource mapping of distribution and abundance of finfishes and shellfishes off Indian coast for suggesting operational based strategies for fisheries Management (FISHSIL201200900009)

Targets: Inventorying of the different fishing methods adopted along Tuticorin , Tirunelveli and Kanyakumari. Collection of GPS coordinates and area of operation from each landing centre. Collection of data on effort, catch , species composition and length frequency of mechanized sectors with it geographic coordinates. Collection of data on economics of operation. Collection of species –wise biological information from commercial trawlers

Annual validation of data collected from different gears. Compilation of collected data on fishery and environment in GIS format.

Salient achievements: Developed data base on longitude and latitude of 20 landing centres of Tuticorin district, 8 landing centres of Tirunelveli district, 49 landing centres of Kanyakumari district. Also collected details of 44 type of gears operated along the coast of Tuticorin and Tirunelveli and 65 types of gears operated along the coast of Kanyakumari. In addition to this geo-referred data on catch, effort and species composition from trawlers of Tuticorin were collected and analysed for mapping using GIS based software. The monthly percentage of juveniles and adults of crabs and prawns caught by trawlers of Tuticorin were also found out. Apart from this, experimental fishing was conducted using Cadalmin –IV along the coast of Tuticorin. The catch of crustaceans was analyzed for species composition and biology.



Molluscan Fisheries

Project wise Salient research findings under studies on Molluscan fisheries

Project : Technology development for seed production of shellfish (2009-'12)

- ✓ Studies were carried out on various shellfishes such as pearl oyster *Pinctada fucata*, Edible clams *Paphia malabarica*, *Meretrix meretrix* during the period reported upon.
- ✓ Spawning experiments and larval rearing trials were conducted by adopting the standard protocol. Refining of the standard protocol for the disease elimination and feed rates were attempted on.
- ✓ The seeds produced successfully were utilized for rearing and mother oyster production, used in the CMLRE project experiments.

Pear oysters *Pinctada fucata*

Table.1. Year wise production of seeds and size range of *Pinctada fucata*

Year	2009	2010	2011	2012
Nos.	100,000	78,000	200,000	25,000
Size(mm)	2mm	2-3mm	3mm	5mm

Edible clams *Paphia malabarica* & *Meretrix meretrix*

About 1, 26,400 clams (685µ APM) settled initially on 17-20days post spawning.

Successful large scale, 30,000 baby clams of size 2.0mm were produced.

Successful large scale settlement of great clam *Meretrix meretrix* was also achieved on 14 days post spawning (=583µ and above 5.0 lakhs)

500 nos of baby clams at 45 days post settlement (5.6-7.0mm (6.3mm) could be finally produced. In the year 2012, a total of 10,000 seeds of *Paphia malabarica* and 70,000 seeds of *Meretrix meretrix* are produced.

Repeat experimentation on the use of Chloremphenicol as a chemical treatment for control of ciliates in the hatchery was again tried and a dose of 75-100 mg/ton of sea water/change was found to be effective in controlling the ciliate infection.

In some months, March and May 2010, heavy infestation of copepods in the rearing medium was observed, which also had negative impact on the success of the spat settlement.



Brooders of *Paphia malabarica*



Baby clams of *Paphia malabarica*



35 day old *Meretrix meretrix* seed



85 day old *Meretrix meretrix* seed

Project : Technological up gradation of molluscan mariculture (2009-'12)

Target :

Conduct experiment to study the growth and production of spats of pearl oyster

Conduct experiments on the possibility of sea ranching in identified areas.

Conduct experiments on the transplant and study growth and production of edible clams

About 2,500 hatchery produced pearl oyster seeds *Pinctada fucata* size ranging from 4.3-13.8mm (8.7mm) were transplanted to Sipikulam raft farm and stocked in velon netted cages for survival, growth and production estimates of mother oyster.

Sea ranching of pearl oyster seeds 12,000 nos (2009-10 & 2010-11) was done at harbour basin, Tuticorin



Table. 1. Growth (mm/wt) of the clams reared under intertidal 'Pen system' 2010-'11

Initial Length (mm)	InitialWeight (g)	Final Length (mm)	Final weight (g)
2.4 – 5.6 (4.3)	0.15-1.1 (0.4)	28.5 – 45.3 (38.2)	6.2 – 24.2 (12.9)

Table.2. Growth (mm/wt) of the clams reared under intertidal 'Pen system' 2011-'12

Pen No.	Initial length (mm)	Initial weight (g)	Final Length (mm)	Final weight (g)
1	3.0-9.0 (3.4)	0.19- 1.14 (0.53)	31.9-43.0 (37.1)	8.6-22.6 (12.6)
2	3.0-9.0 (3.4)	0.19- 1.14 (0.53)	34.8-39.4 (37.2)	9.6-21.5 (14.9)
3	3.0-9.0 (3.4)	0.19- 1.14 (0.53)	38.0-42.5 (39.6)	11.7-24.3 (14.2)
Average	3.4	0.5	37.9	13.9

Table. 3. Production potential of Karapad bay 2010-11

Nos. Stocked	Nos. survived	% survival	Stock density/m2	Production (Kgs)	Estt. Production/ha
2000	610	31	200 nos	6.5	7.22 tons

Table. 4. Production potential of Karapad bay 2011-12

Pen No.	Nos. Stocked	Nos. survived	% survival	Stock density/m2	Production (Kg)	Estt. Production/ha
1	3500	643	18.4	400 nos	10.0	11.11
2	3500	520	14.9	400 nos	7.5	8.33
3	3500	500	14.3	400 nos	7.5	8.33
Average	3500	544	15.8	400 nos	8.3	9.25

Steps in relaying clam seed, growth and production



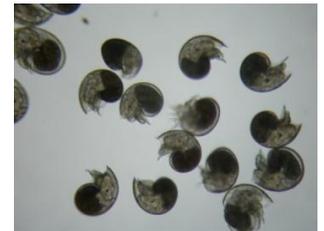
Project : Mariculture of selected species of conservation importance 2009-'12

I) Cowry shells

Survey for the Cowry shells were conducted in the Tuticorin Harbour basin area.

Five species of cowry shells ie., *Cypraea arabica*, *C. caurica*, *C. annulus*, *C. caputserpentis* and *Cypraea* spp in this area.

Observation on the spawning *C. arabica* in wild was made, partial hatch of the egg cases were observed. Veliger survived only for 5 days with *Isochrysis galbana* as feed.



II) *Chicoreus virgineus*

Brood stocks of *Chicoreus* spp 8 specimens of measuring 80-110 mm in size and 49-165 g (June 2009)

Year round maintenance with live clams as feed gave 100 % survival.

Spontaneous breeding commenced during June '09 and continued up to October '09 and ceased latter. Total number of egg capsules released ranging from 110-140 egg cases/spawning during June and decreased to 10-40 during October '09. The number of eggs in each of the egg cases was highly varying (about 100- 380 nos).

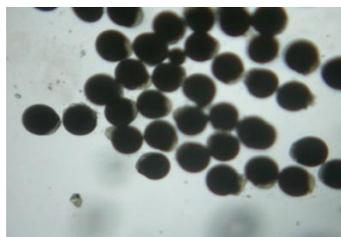
After an incubation of 20 days the veligers hatched. However after development the number of viable veligers within the egg case ranged only from 18-30 nos.

The newly hatched veliger showed differential lengths ranging from was 1.7 to 1.9 mm. Juvenile rearing was successfully done up to the size of 2.9 mm.

Spawning of *Chicoreus virgineus*



Developing eggs



Juvenile *C. virgineus*



III) Common spider conch shells

- Twenty four *Lambis lambis* brooders size/weight ranging from 148 to 184 mm and 50 to 400 g were maintained for breeding. The brood maintenance tank was

rectangular one ton FRP with 750l water and airlift system for replacement of 300 times over 24 hrs with algal feed 'adlibitum' was effective in continued maintenance and successful captive breeding for this species with nil mortality over a year period

- The conch shells in both the brood stock holding system mated and commenced spawning once on 09.11.2009, hatching of egg mass was done in separate tank and the newly laid egg mass took 5 days for complete hatching.
- Successful captive spawning in *Lambis lambis* was achieved during October/December 2010., December 2012, January 2013.
- The conch shell seems to exhibit annual cycle of maturation and spawning once in a year during October-December.
- Success was achieved for the January 2013 spawned veliger larva of conch shells in to a fully grown juvenile (period 76 days). A first time record for this species from Indian water and elsewhere.

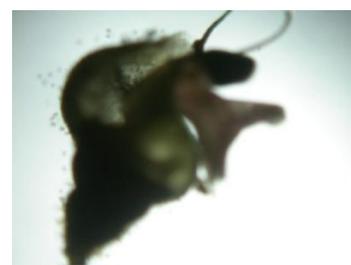
Spawning of Conch shells



Day 1 veliger



Metamorphosed larvae



IV) *Chicoreus ramosus*

- Brooders of *Chicoreus ramosus* (16 nos) size/weight ranging from 114.2-200mm/290-750g were maintained in the shellfish hatchery. Observations on the feed protocol for brood maintenance were studied. Average of 30 g of clam meat / day/10 brooder is required for maintenance of healthy brooders without any mortality over sixteen months period.
- Egg laying under hatchery condition started by December 2011, seven brooders were observed to spawn intermittently and in a communal pattern till February 2012.
- A total of 21 spawning occurred resulting in more than 1000 egg cases. The number of eggs ranged from 100-240 /egg case.
- Large scale systematic egg case rearing in different method was tried and good amount of juveniles were produced.



Project : Management advisories for sustaining marine fisheries of Tamilnadu and Puducherry 2011-12

- A total of 182 fishing days were observed and 1,478 nos of units (trawlers) have been operated from this centre.
- The total estimated cephalopod catch was 1,290 tonnes. CPUE was
- The major groups comprising was Squids, cuttle fish (79: 21) and octopuses in smaller quantity.
- The male: female sex ratio of *Sepia pharoonis* is 63: 37 and for *Loligo* sp is 56: 44 The size/weight ranges of *Sepia pharoonis* ranged from 77.0 to 345.0mm (218mm) /175g to 2,400g (871g) and for *Loligo* sp from 145mm to 210mm (225mm)/ 165g to 885g (398g).

12th Plan Projects.

Period: 2012-14

Project : Evaluation of ornamental gastropod fisheries and assessment of shell craft industry

At Tuticorin, the exploited gastropods of ornamental importance were monitored regularly from the two landing centres ie., 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.

Table. 1. Catch/effort and CPUE (nos) of live *Turbinella pyrum* at Kayalpattinam and Kalavasal landing centres 2012-'14

Year/Centre	2012-'13		2013-'14	
	Kayalpattinam	Kalavasal	Kayalpattinam	Kalavasal
<i>Turbinella pyrum</i>	70265/6544/11	51878/5339/10	40126/5230/8	36065/5312/7
<i>Chicoreus ramosus</i>	28252/3224/9	78524/2519/31	52067/5230/10	74151/5312/14
Fossilised <i>Turbinella pyrum</i>	-	2,93,600/10630/28	-	3,26,550/5312/14

Table.2. Size/weight ranges of live *Turbinella pyrum* and fossilized chanks at Kayalpattinam and Kalavasal landing centres 2012-14

Year / Centre	2012-13	2013-14	2012-13	2013-14
	Kayalpattinam		Kalavasal	
<i>Turbinella pyrum</i>	112-229(163mm) 110-1450 (627)	128-200 (165mm) 250-2,200 (850g)	111-213(169mm) 200-1150(570g)	104-193(163mm) 370-950(691g)
<i>Chicoreus ramosus</i>	80-207(179mm) 50-1100 (695g)	156-206 (188mm) 500-1300(650g)	147-207(189mm) 200-1410(915g)	148-198 (176mm) 330-1100(676g)
Fossilised <i>Turbinella pyrum</i>	-	-	113-226(168mm) 290-1700(816g)	117-237(169mm) 400-1350(780g)

** The method of exploitation is observed to be of a risky/unsafe method of diving using air hoses from compressors on board the vessel. Though many risks have been reported the fisherfolks 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. has planned for procurement and supply of SCUBA equipment for this divers.

- Ornamental shell craft industry was surveyed and data on the procurement, processing and shell craft making were documented
- Photographing of all the gastropods used in shell craft industry is being carried out for preparation of group posters.

Project : Development of Fishery Management Plans for sustaining Marine Fisheries of Tamil Nadu and Puducherry (2013-14)

- Cephalopod fishery at Tuticorin fisheries harbor monitored. The total fishing days for the reporting period ranged from 182-197 with units ranging from 26,465 to 29,580 with a catch range of 1290 to 1682 tonnes. The CPUE for the period ranged from 48.7 to 56.9 kgs. The average % composition of *S. pharoanis*: *Loligo sp* was 80:20.
- The size and weight range of *S. pharoanis* was 77-400mm/175-3,900g while *Loligo sp.* ranged from 110-400mm/100-1600g respectively.

Project : Development of Fishery Management Plans (FMPs) for the bivalve fisheries of India 2012-14

- Exploited clam resources from two centres namely Karapad Bay and Palayakayal were monitored for all fishery parameters and documented. % composition of the various clams species for the period was *K. opima*: *P. malabarica*: *M. meretrix* was 34:36:30.

Total clam picking days for period ranged from 167-202. Total exploited bivalves ranged from 30,096 to 62,196 kgs.

Table. 1. Annual Size and weight ranges of various clam species exploited at Karapad Bay 2012-14

Species	<i>K. opima</i>				<i>P. malabarica</i>				<i>Meretrix meretrix</i>			
Parameter	Length (mm)		Weight (g)		Length (mm)		Weight (g)		Length (mm)		Weight (g)	
Minimum	31.0	26.5	12.0	11.2	32.0	24.3	09.0	09.5	33.0	41.4	27.0	23.3
Maximum	51.0	48.4	30.0	27.9	51.0	49.5	33.0	31.6	69.0	74.5	97.0	103.4
Average	45.0	38.1	24.7	22.1	44.0	40.8	28.0	20.6	59.0	58.1	62.0	67.8

Project : Sustainable molluscan mariculture practices 2012-14

- Successful long term maintenance of brood animals (Muricids & Strombids) were achieved by establishing inbuilt recirculation breeding system in one ton FRP tanks.
- Feed protocol for both the groups were worked out.
- Successful breeding of both the groups achieved, larval rearing protocol standardised and successful larval rearing and life cycle closing was achieved.
- Life cycle closing and rearing upto 76 days in case of strombid *Lambis lambis* was first of its kind in Indian waters and elsewhere.

Externally Funded Project

Project : Demonstration and transfer of technology of marine pearl culture (*Pinctada fucata*)
CMLRE, Kochi

The project was carried out at three different places Kollam, Lakshadweep Is. and at Tuticorin. Fisherwomen groups were imparted training and demonstration of Marine pearl culture. Based on the performance, the Island territory has included pearl culture as an activity for funding. The fisherwomen at Sipikulam (Tuticorin) were successfully trained in all aspect and were successful in culturing spherical pearls.

Detailed project proposal for further follow up was prepared and given to the village.

The project was successfully completed and final report submitted to the Funding agency

Project: Mapping and resource assessment of pearl oyster banks of Tuticorin (Central Division) of Gulf of Mannar. Min. of Env. & Forest, New Delhi

Target :

- 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
- To document the pearl oyster population in the productive beds along with associated fauna/flora
- To prepare a 'Data Base' for all the productive pearl beds.

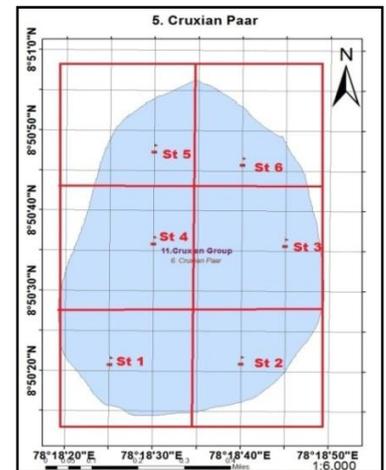
Group Map generation:

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.

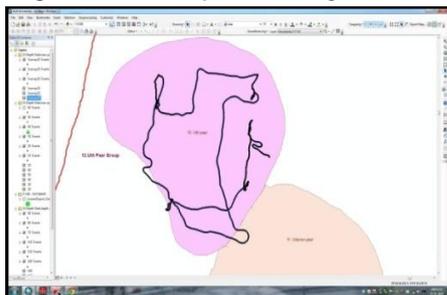
Grid Map for survey

To plan 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,

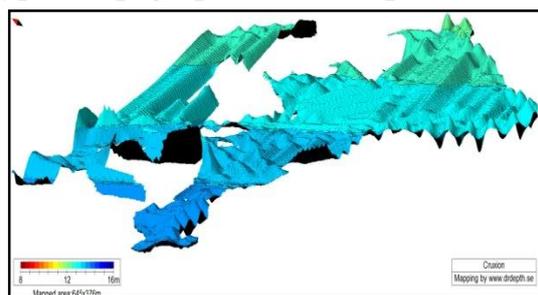
For underwater survey created Grid map for area to be surveyed. The size of the each grid is equal size that is 15 sec (450 meters) and also obtaining the consecutive data from the digitised data like distance from old harbour to each pearl bank,



Digital data acquisition by Sonar



Typical topographic view of a pearl bed



Ground truth Survey

Dives were made at the respective grids by three divers simultaneously and the area surveyed for availability of pearl oysters, associated fauna and other environmental parameters, soil samples were collected and documented for analysis.



Fishery Environment

Salient research findings under studies on Fishery environment

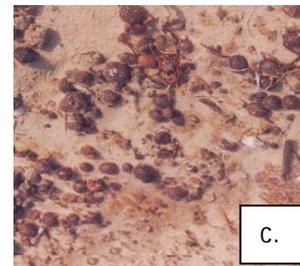
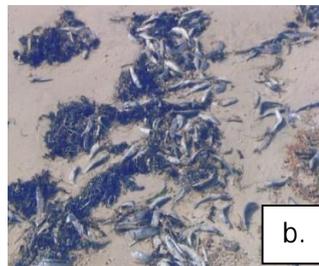
Project. Impact of anthropogenic activities on coastal marine environment and fisheries (FEM/01)

Targets :

1. To assess the impact of urban domestic sewage and anthropogenic activities along Tuticorin coast.
2. Quantification of toxic heavymetals metals like Hg and As in edible fish resources along Tuticorin etc.
3. Quantification of nonbiodegradable substances along Tuticorin coast.

Achievements and highlights

- ❖ Studies were conducted to elucidate the impact of anthropogenic activities on coastal waters of Tuticorin at three stations. ie., untreated municipal sewage discharge in to the open sea at Threspuram (St.1), waste water from fishing activity discharge in to the open sea at Punnakayal, and mercury containing industrial effluent discharge into the open sea at Kayalpatinam (St.3) etc., by studying the water quality variables.
- ❖ Studies were also conducted to find out the possible cause of fish mortalities happened at two locations along Tuticorin coastal waters (in the Karapad Bay and along Pattanamaradur coast).



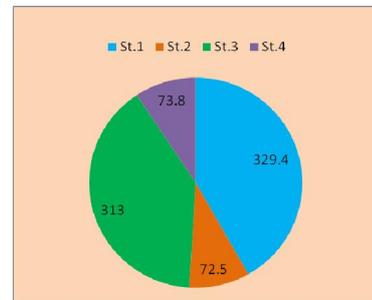
Fish mortality incidents happened

a). In the Karapad Bay and b). Along Pattanamaradhur c). Oil balls pollution

- ❖ Quantified the toxic heavy metals (Mercury and Arsenic) loads from (in) the seawater, sediment and bivalves of two polluted stations and in the tissues of commercially important fishes *Rastrelliger kanagurta*, *Sardinella gibosa*, *Carangoides ignobilis*, *Strongylura crocodiles* (fin fishes), *Charybdis natator* and *Penaeus indicus*, *Portunus sanguinolentus* and *Heterocarpus gibbosus* (crustaceans), *Crassostrea madrasensis*, *Chicoreus ramosus*, *Meretrix meretrix*, and *Turbinella pyrum* (molluscs) from different landing centres of Tuticorin.
- ❖ Monitored the amount of non-bio degradable substances and their seasonal variability along four beaches of Tuticorin.



Non –biodegradable substances



Percentage composition

Project. Impact and yield study of environmental changes on the distribution shifts in small pelagic along the coast (FEM/02) .

Targets

1. To study the hydrobiology variables off Tuticorin.
2. To study the phyto and zooplankton component off Tuticorin.
3. To elucidate the impact of environmental parameters on the abundance and distribution of small pelagic fauna from the inshore waters off Tuticorin .

Achievements and highlights

- Quantified the hydrological variables of surface and bottom waters of two stations off Tuticorin at varying depth (5 and 20 ms) by onboard sampling (RV Cadalmin).

- Studies were conducted on qualitative and quantitative estimation on phyto and zooplankton constituents at two stations off Tuticorin.
- Studies were conducted to quantify the length, weight and maturity conditions off mackerel and oil sardine samples off Tuticorin to study the variability of their distribution with respect to environmental parameters.
- Studied the gut content constituents of both oil sardine and mackerel to assess the correlation with respect to field data.
- Analysis of otoliths of both mackerel and oil sardine to assess the variability of calcium and strontium levels with respect to environmental parameters.

Project : Understanding the threatened coral reef ecosystems of Southern India and designing interventions aimed at their restorations (MBD/RE/1).

Targets

1. To study the holothurian resources of Gulf of Mannar and to elucidate conservation strategies for the exploited sea cucumber resources.

Achievements and highlights

- ❖ Studies were conducted to estimate the numerical density, biomass and habitat preference of holothurians in selected parts of erstwhile Pandian island (St.1-an unprotected station with human interference and habitat interference and St.2- protected area inside the harbour) by visual assessment method.
- ❖ Studies were also conducted to assess the sediment as well as water quality criteria of these stations to elucidate the reasons for variations.

Project. Development of fisheries ecosystem restoration plans for critical marine habitats (FEM/RE/03).

Targets To conduct survey on restoration programmes.

Achievements and highlights

- A survey was conducted along Punnakayal areas and information on mangrove restoration programme was collected .

- The proforma on case studies of mangrove restoration programme was completed and submitted.

Project: Pollution and litter in the coastal and marine ecosystem and their impact.

Targets:

- To study the impact of anthropogenic activities along Tuticorin coast.
- To quantify the toxic heavy metals like Hg and As in the marine environment and biota especially in the edible fish resources along Tuticorin.
- To evaluate the composition and abundance of marine litters along the beaches of Tuticorin.

Achievements and highlights

- Studies were made on the impact of anthropogenic activities at 3 polluted stations and compared with an unpolluted station. The impact assessed were like discharge of effluents like fly ash containing slurry and hot water discharge from a coal fired thermal power plant and the impact of handling hazardous chemicals through loading and unloading activities at the major port on the Tuticorin coastal water ecosystem.
- Quantification of toxic heavy metals like Hg and As in water and sediment samples three stations, commercial fish samples (10 species) of assorted size including different stages of growth and sex along Tuticorin.
- Analysis were made on the quantitative and qualitative estimation of micro plastic particles in the fishing grounds of varying depth 5-20m off Tuticorin.
- As a part of nation wide survey on beach litter along Indian coast, survey was made along 15 beaches to quantify of marine litter along Tuticorin.

Project: Ecosystem process of critical marine habitats and development of protocols for restoration.

Targets:

- To assess the seasonal variation of hydrology, productivity and sediment quality of two selected critical habitat of Tuticorin coast.
- To identify the habitat dependent seabirds in the coastal region of Tuticorin.

Achievements and highlights

- Studies were made on the seasonal variation of hydrology, productivity and sediment quality of two selected critical habitat like sea grass bed area opposite to the Tuticorin Port trust administrative blocks which is under the threat of port reclamation activities as St.1 and the mangrove beds nearer to the salt pan area adjacent to Hare Island, threatened due to the discharges from salt pans of Tuticorin coast.
- Studies were made on the species availability and numerical variation of avian fauna of two different habitats of Tuticorin coast ie., station 1 (St.1)- the fly ash dyke of Tuticorin Thermal Power plant and station 2 (St.2)- the salt pans areas nearer to Karapad Bay were collected on monthly twice basis (during low and high tide) to notice the impact of tides on the faunal constituents if any

Project: National Initiative on climate resilient agriculture (NICRA) – 2020600006

Targets

- Collection of primary (real time) data on 14 oceanographical parameters from the surface and bottom waters of four stations of varying depth (5-20meters) off Tuticorin on a monthly basis.
- Collection of zooplankton samples for quantitative and qualitative studies from the sub surface off four stations of varying depth (5-20meters)off Tuticorin.
- Correlation of environmental parameters and zooplankton biomass with the spawning, fecundity and gono- somatic index of commercial fishes off Tuticorin.

Achievements and highlights

- Collected the primary (real time) data monthly on 14 oceanographical parameters from the surface and bottom waters of four stations of varying depth (5-20meters) by conducting on board samplings.
- Quantified the real time data on species composition and biomass of zooplankton constituents at the subsurface waters of four stations of varying depth (5-20meters) on a monthly basis.
- Correlated the environmental parameters and zooplankton biomass with the spawning , fecundity and gono Somatic Index of commercial fishes off Tuticorin.
- Data were processed and submitted the reports.



Tissue culture & Mariculture

Salient research findings under studies on Tissue culture and Mariculture

Project title: Development of tissue culture technology for in-vitro production of pearls from the blacklip pearl oyster *Pinctada margaritifera* and refinement of *in-vitro* pearl formation in *Pinctada fucata*

Salient findings

Training given to the scientists of Madras Research Centre to initiate the work of tissue culture at Chennai .

Cultures were organized with the mantle tissue of Pearl oyster (*Pinctada fucata*), Abalone(*Haliotis varia* L.) and Pteria sp.

Cultures were organized and maintained separately in different combinations of media M199 with and without the addition of aminoacids to study the effect of aminoacids with cell proliferation.

Cell count was taken after 18 days and found more cell proliferation from pearl oyster followed by Pteria and abalone (28.275, 14.475, 12.136 x 10⁴ cells/ml) with aminoacid incorporation in cultures. *In vitro* tissue culture experiments using mantle tissue of the green mussel *Perna viridis* were carried out.

Two different culture media, Leibovitz's L-15 medium and Medium 199 (M199) were compared for the culture of mantle tissue explants.

Effect of adding supplements such as Foetal Calf Serum (FCS) and yeast extract solutions, on growth and proliferation of mantle epithelial cells was also studied.

L-15 media was found to be better suited media for primary culture of mantle cells. Supplementation of culture medium with 10% FCS and 0.1% yeast extract medium further augmented cell proliferation.

Project title : Genetics, Genomics and biotechnological applications in mariculture and fishery resources management

Salient findings

Explant culture of muscle tissue initiated with abalone adductor muscle.



Different types of cell growth were noted in culture.

The growth comprises different types of cells characteristic of foot muscle which included secretory cells, microvillous like cells etc.

An experiment on artemia was conducted with 3 different salinity ranges, 60-65, 80-85 and 100 and above.

The growth was better in 80-90ppt salinity range than the other two combinations



Project : Development and standardisation of seed production technologies of selected high value finfishes and shellfishes

Highlights

Training Programme on 'Microalgal Culture and Water Quality Management in Aquaculture system' was conducted.

12 species of microalgae maintained by culturing and subculturing

Mass production of Nannochloropsis was done in 1ton tanks and harvested by centrifugation and filtration. The collected biomass is freeze dried.



MD/IDP/02 Technological upgradation of molluscan mariculture-Tissue culture of pearls

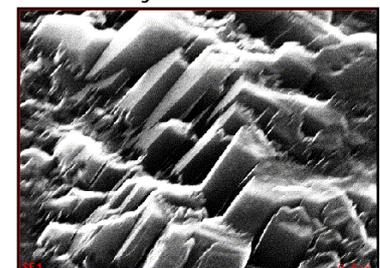
Highlights

Studies with different species of pearl producing mollusks revealed that all the species are capable of producing cells in this in-vitro technique and retained the ability to produce pearl sac and nacre crystals.

Hence it is confirmed that this technology has the potential to pave the way for the

production of pearls of various colors from different species of molluscs. Formation of pearl layers or nacre is proved through the confirmatory Raman spectroscopic analysis, SEM and EDAX in various experiments.

It is proved that pearl sac can be formed from the free cells of



explant cultures. The experiments conducted here revealed that shell bead is the best material for nacre adhesion.

Dr. Awaji and Dr. Machii in Aqua-Bio Science Monographs, Vol. 4, No. 1, pp.1–39 (2011), the pioneer and authority in pearl formation studies from Japan who had publications on pearl formation studies from 1957 onwards referred and emphasizes our work (Suja and Dharmaraj 2005; Dharmaraj and Suja 2006 and Suja *et al* 2007) as future prospects of Pearl culture.

Project title: Development of brood stock, captive breeding and seed production techniques for selected marine food fishes and ornamental fishes

Project subtitle: Breeding and seed production of grouper.

Highlights

Two fixed cages were erected in the Karapad bay of Tuticorin, groupers were collected. 21 groupers were maintained in cage and hatchery

Average weight and length was increased from 710 gm /33.12cm to 1933.3 gm/ 49.41 cm within 15 months. A Growth rate of 81.53 gm/ 1.08cm per month was attained for the fishes in captivity. The fish with a minimum size of 25cm/300 gm was grown up to 39.5 cm /1000 gm within one year.

Project subtitle: Live feed culture

Highlights: Rs. 50,970 was generated to the Institute by the sale of microalgae from July 2010 to March 2012.

Rotifer, *Brachionus rotundiformis* was cultured in four different nutrient medium and found the highest rate of growth in the third week in cultures grown in Nannochloropsis with Chlorella and extra vitamins.

Twelve species of microalgae stock cultures were maintained in the phytoplankton laboratory.

SEED PRODUCTION IN AGRICULTURAL CROPS AND FISHERIES-

Sale of microalgae

An amount of ₹ 1, 11,180/- was generated during April 2012 to March 2014.

Salient research findings under studies on Biodiversity

Projects. Bioinventorying and biodiversity valuation of marine organisms in selected marine ecosystems along the Indian coast 2012-14

Salient findings

- The specimens got the accession numbers (ANs) from Marine Biodiversity Referral Museum, CMFRI, Kochi are; Spot fin cardinal fish, *Apogon queketti* Gilchrist, 1903; Iridescent cardinal fish, *Pristiapogon kallopterus* (Bleeker, 1856); Lantern bellies, *Acropoma hanedai*, Matsubara, 1953; Two stripe goby, *Valenciennesa helsdingenii* (Bleeker, 1958); Large toothed cardinal fish, *Cheilodipterus macrodon* (Lacepede, 1802); Brown-banded cusk eel, *Sirembo jerdoni* (Day, 1888); Blackspotted gurnard, *Pterygotrigla arabica* (Boulenger, 1888); Spotwing flying gurnard, *Dactyloptena macracantha* (Bleeker, 1855); Butterfly flying-gurnard *Dactyloptena papilio* (Ogilby, 1910); Young ones of bigeye thresher, *Alopias superciliosus* Lowe, 1841; Ovoviviparous eggs of bigeye thresher, *Alopias superciliosus* Lowe and Snapper, *Lutjanus indicus* Allen, 2013.
- The species of fishes deposited in Marine Biodiversity Museum, Tuticorin are Scribbled leatherjacket filefish, *Aluterus scriptus* (Osbeck, 1765); Silver-cheeked toadfish, *Lagocephalus sceleratus* (Gmelin 1789); Smooth dwarf monocle bream, *Parascolopsis aspinosa* (Rao and Rao, 1981); Twohorn gurnard, *Lepidotrigla bentuviai* Richards and Saksena, 1977; Froghead eel, *Coloconger raniceps* Alcock, 1889; Oriental flying gurnard, *Dactyloptena orientalis* (Cuvier, 1829); Smooth dwarf monocle bream, *Parascolopsis aspinosa* (Rao and Rao, 1981); Twohorn gurnard, *Lepidotrigla bentuviai* Richards and Saksena, 1977; Leaflip or spotted soapfish, *Pogonoperca punctata* (Valenciennes, 1830); Birdled jawfish, *Opistognathus nigromarginatus* (Rüppell, 1830); Young ones of spinetail mobula, *Mobula japanica* (Müller and Henle, 1841); Young ones of spotted eagle ray, *Aetobatus narinari* (Euphrasen, 1790); Granulated guitarfish, *Glaucostegus granulatus* (Cuvier, 1829); Dwarf monocle bream, *Parascolopsis eriomma* (Jordan and Richardson, 1909); Slender threadfin bream, *Nemipterus zysron* (Bleeker, 1856); Yellow boxfish, *Ostracion cubicus* Linnaeus, 1758; Blue tile fish, *Malacanthus latovittatus* (Lacepede, 1801) and Titan cardinalfish, *Holapogon maximus* (Boulenger, 1888)

- Bioindicators for biodiversity valuation of marine organisms was identified based on the primary and secondary source.



Alopias superciliosus Lowe, 1841
Young ones : GA.6.1.1.1
Ovoviparous eggs : Misc. 40



Apogon queketti Gilchrist, 1903
GB.31.9.1.156



Lutjanus indicus Allen, 2013
GB.31.88.7.31



Pristiapogon kallopterus (Bleeker, 1856)
GB.31.9.1.70



Pterygotrigla arabica (Boulenger, 1888)
GB.38.25.9.30



Acropoma hanedai, Matsubara, 1953
GB.31.2.1.2



Dactyloptena papilio (Ogilby, 1910)
GB.38.12.1.4



Valenciennesa helsdingenii (Bleeker, 1958)
GB.31.66.230.1



Dactyloptena macracantha (Bleeker, 1855)
GB.38.12.1.2



Sirembo jerdoni (Day, 1888)
GB.28.4.18.1

- Prepared a systematic list of marine invertebrates (opisthobranch from southwest coast of India), marine mammals, marine reptiles and sea birds (from India)

Projects: Investigations on vulnerable coral reef ecosystems of Indian waters with emphasis on formulation of management measures for conservation 2012-14

Salient findings

- The underwater survey study was carried during the period 2012-13 and 2013-14 in Tuticorin harbour (Lat. 08°45' 01".79" N; Long. 78° 12' 10".75" E) by Line Intercept Method (coral resources estimation) & underwater visual census (reef fish's estimation). During study period, patchy growth and many new recruits of hard corals were observed in the deployed stones/concrete blocks of the jetty area. The transect area consists of 25.91% live coral, 30.56% dead coral, 17.97% dead corals with algae and rest 25.56% is contributed by sand, stones and concrete blocks. The reef of the present study falls under the "fair" category as the linear scale of live coral cover was 25.9 % which is falls between 25 - 50%.
- The percent contributions of different live coral forms are Faviidae (18.4%), Dendrophyllidae (6.1%), Acroporidae (1.0%), and Poritidae (0.4%). The relative abundance of live corals in the transect area is dominated by Faviids (71.4%) and Dendrophyllids (23.69%) followed by Acroporids (3.73%), and Poritids (1.49%). The results revealed that the massive forms of corals were dominant in most of the areas followed by foliose and branching forms.
- Faviids dominated by *Favia* sp. and *Favites* sp.; *Turbinaria* sp. dominates in Dendrophyllids. *Acropora* sp. dominates among Acroporids. Dead corals were mostly dominated by Acroporids and dead corals with algae were dominated by Faviids. The overall coral mortality index was found to be 0.74 and it was found to be greater than 0.33 thus the reef is classified as "sick".
- A community diversity analysis was carried out to discern the species status for the sampling areas were also derived. The Shannon indices of diversity were low varying

from 0.26 and 1.38. The low diversity may attributed to the developments of Tuticorin harbour, oil pollution and industry which have caused significant damage in the Gulf of Mannar area (UNEP, 1985) and the disturbance, competition and stress are the important factors drives the diversity and abundance of fauna and flora in natural ecosystem (Houston, 1994).

- Coral associated fauna encountered during survey are mullets (*Mugil* sp., *Liza* sp.), silver biddies (*Gerrus* sp.), apogonids, parrot fishes (*Scarus* sp.), groupers (*Epinephelus* sp.), platycephalids, *Cyprae trigris*, *Cyprae* sp., *Trochus* sp. and unidentified gastropods were found in the deployed stones.

Projects: Assessment of the fishing impacts on biodiversity loss, with special reference to the threatened species, to formulate management options for their protection 2012-14

Salient findings

- Rapid survey on fishing gears and fishing practices along Vembar, Tuticorin to Neeroodi, Kanyakumari revealed that gill nets (bottom set and drift), trawl net (including mini-trawl & pair trawl), hook and lines, shore seines, ring seines and traps are the major gears and trawler, vallams (wood and FRP) and catamarans (wood and FRP) are the major crafts operated along coast.
- The technical characters of the gears used in Tuticorin coast were documented. The bottom set gillnets (BSGNs), trawl nets, skin diving and ring seines found to be destructive in nature. Based on the impacts on the biodiversity, bottom set gill net was identified for the study.
- In Tuticorin, various type of BSGNs locally called as singivalai (for lobster), sanguvalai (for gastropods) nanduvalai (for crabs), eralvalai (for shrimps), and thrukaivalai (for rays and skates) are being used in the fish landing centres of Kelavaipar, Sippikulam, Vellapati, Tharuvaikulam, Threspuram, Kayalpattinam (Singithurai), Periyasampuram and Amalinagar.

- On scoring (based on the resource damage) the landing centre Kelavaipar, Sippikulam, Vellapati and Periyasampuram was found to be “high” where BSGNs are operated as major gear; Kayalpattinam (Singithurai) and Sangumal (North L.C) was “medium” where BSGNs being the major gear but the usage has been reduced day by day; Tharuvaikulam, and Amalinagar is “low” where the resource damage due to BSGNs was high previously but nowadays resource damage is low as fishermen were shifting to others gears.
- In the BSGN (Nandu valai), *Portunus pelagicus*, *P. sanguinolentus*, *Charybdis natator* & *C. lucifer* dominates the catch and other species contributes the catch are *C. feriatus*, *C. annulata*, *C. lucifer*, *C. orientalis*, *Calappa philargius*, *Calappa* sp. & *Podophthalmus vigil*. Bycatch includes Elasmobranchs (*Chiloscyllium* spp.), Lobsters (*P. homarus* & *P. ornatus*), Gastropods (*Lambis* spp. & *Chicoreus* spp.), Corals (*Acropora* spp., *Pocillopora* sp., *Turbinaria* spp., & *Montipora* spp.), Starfishes (*Pentaceraster mammillatus* & *Protoreaster linckii*), Seurchins (*Temnopleurus toreumaticus* & *Salmacis virgulata*), Finfishes, Sponges (Demospongiae groups), Seaweed and Seagrasses.
- The major vulnerable/threatened/endangered groups like elasmobranchs, gastropods, hard corals, gorgonids, sponges, and sea cucumbers were encountered in the gill nets and trawl nets. Other groups like the sea grasses, sea urchins, and starfish’s occurrence were high in gill net. The following table shows the list of banned species (as per Wild Life Protection Act) encountered in the gill nets and trawl nets.

Species	Gear	Status
<i>Rhincodon typus</i>	Gill net	Schedule I Part II A - Fishes
<i>Rhynchobatus djiddensis</i>	Trawl net	Schedule I Part II A - Fishes
<i>Sygnathids</i>	Mini trawl	Schedule I Part II A - Fishes
<i>Lambis crocata</i>	Gill net	Schedule I Part IV B - Mollusca

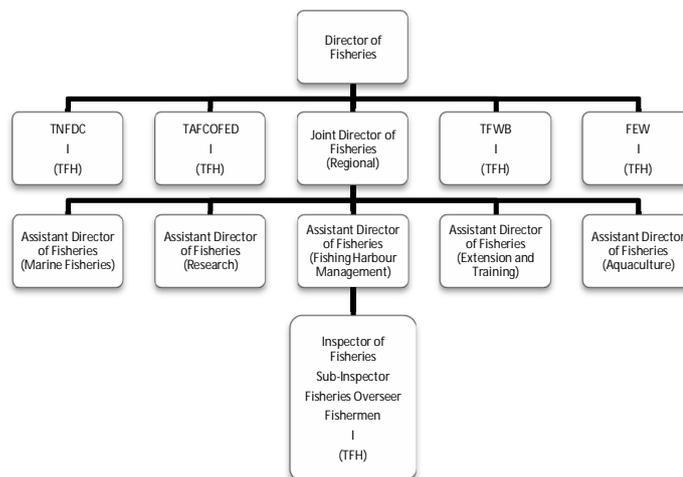
<i>Fasciolaria trapezium</i> (<i>Pleuroploca trapezium</i>)	Gill net	Schedule I Part IV B - Mollusca
<i>Sponges</i>	Gill net	Schedule III Sponges (all calcarears)
<i>Gorgonids</i>	Gill/Trawl net	Schedule I Part IV B - Coelenterates
<i>Hard corals</i>	Gill/Trawl net	Schedule I Part IV B - Coelenterates

Projects: An input output economic optimization model for marine fisheries at Tuticorin Fishing Harbour 2012-14

Salient findings

- Private/public participants/institutions involved in Tuticorin Fishing harbor
- Collected complete information on infrastructure facility and institutional arrangements along with various forms right at the fishing harbour.

Institutional arrangements (for State Fisheries Department) in the TFH



- Rights/Restrictions at TFH: Tuticorin Fishing Harbour is a landing centre which follows the unique rules and regulation of Tamil Nadu Marine Fisheries Regulation Act and Wild Life Protection Act as well. All the mechanized fishing vessels are

operating above 3 Nautical miles from the sea shore and the fishing time is restricted between 5.00 am and 9.00 pm. Single day fishing and the fishery is characterized by multi-species, multi-fleet with multi-sized boats. The fuel subsidy, all welfare scheme payment during ban and lean periods and other subsidizing schemes are distributed through State Fisheries Department.

- Existing Mechanised fishing boats available at Tuticorin TFH: As on 28.05.2012, 307 mechanised fishing boats are available at TFH. The length of the boat varies from 10 to >20 m where the maximum numbers were found between 15 and 20 m (228). The power-wise (in HP) was varies from <120 to >400 where the maximum numbers were found between 120 and 150 (116).
- The ongoing National Fisheries Development Board (NFDB) project which includes fixing and strengthening of warf, parking areas, loading areas, internal concrete road, improvement of electrical arrangements, sleep way renovation and extension of 6 m drainage. To enhance hygienic handling, the drainage was planned to include sewage treatment plant so that treated water will be used for washing the auction hall and remaining water could be pumped into sea.
- The mechanized fishing crafts data were collected at Tuticorin fishing harbour for the period from April, 2013 to March, 2014. The economic analysis of Tuticorin Fishing Harbour has been done. Even though multiday fishing is economically beneficial but it is not followed for the sake of resource conservation and adherence to local socio-economic constraints.

Projects: Remote sensing assisted biodynamic forecasting paradigm for Indian marine fishery resources 2012-14

Salient findings

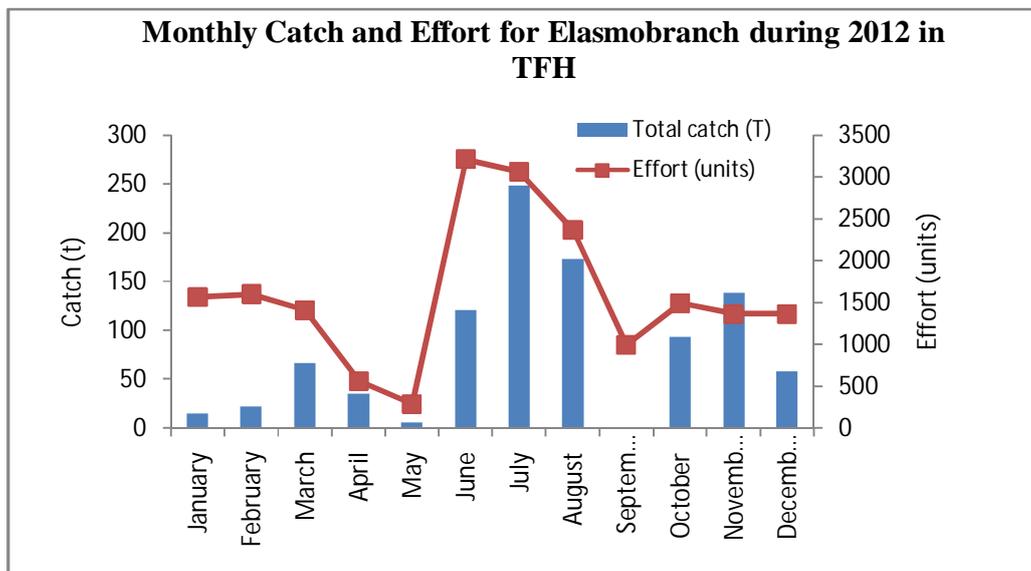
- The major fishery resources in the Tuticorin area have been identified from the archival data. The secondary information on chlorophyll related hydrographic information along Tuticorin has been collected and grids for sampling have been identified along Tuticorin coast, Gulf of Mannar.

- The physicochemical characteristics and the biological factors of the Gulf of Mannar area were collected from the secondary sources. The average values in the Gulf of Mannar region area are as follows;
 - Atmospheric Temperature: The highest temperature range of 28.5 to 32.5°C was observed during summer period.
 - Water temperature: The water temperature showed temporal variation with higher temperature during April (28 to 31°C) and lower during January (25 to 28.1°C).
 - Suspended Solids: In general the waters of Gulf of Mannar were characterized by low suspended solids (5 to 62 mg/l). The maximum value was being at Tuticorin.
 - Salinity: The salinity was found to vary widely from 31.9 to 35.19 ppt.
 - pH: The water pH varied from 8.0 to 8.45.
 - DO & BOD: DO vary from 3.3 ml/l to 5.98 ml/l. The lower DO value of 3.3 ml/l observed at Arumuganeri this might be due to the influence of industrial discharges. The BOD levels were in the range between 0.033 mg/l and 3.79 mg/l.
 - Nutrients: The levels of Inorganic Phosphate were appreciably high 1.91 $\mu\text{mol/l}$. Arumuganeri area higher level of Inorganic Phosphate while Tuticorin area exhibited very high level of Total Phosphorus (13.38 $\mu\text{mol/l}$) which might be attributed to the discharge of industrial effluents. Nitrite level were in the range of 0 - 0.899 $\mu\text{mol/l}$. Nitrite was recorded as high as 7.85 $\mu\text{mol/l}$ at Tuticorin. Both the total nitrogen (56.35 $\mu\text{mol/l}$) and Ammonia levels (15.77 $\mu\text{mol/l}$) were relatively higher at Vembar as compared to other area. Silicate varied from 0.11 to 10.20 $\mu\text{mol/l}$.
 - Chlorophyll: Chlorophyll concentration in the Gulf of Mannar varied from 0.005 mg/m^3 to 22.42 mg/m^3 . The concentrations of Chl-a were in the order of Tuticorin>Mandapam>Koodankulam>Vembar>Kanyakumari>Arumuganeri.
 - Organic carbon: The Organic carbons varied widely from 0.01% to 1.89 % with the high value being at Vembar area.

Projects: Assessment of Elasmobranch resources in the Indian seas 2012-14

Salient findings

- During the year 2012-14, observed landings and collected information on the elasmobranch species composition from Tharuvaikulam (gill net), Threspuram (gill net and hook & line), Tuticorin Fishing Harbour (trawl net). The elasmobranch landings were also observed from Vembar, Vellapati and Kayalpattinam (gill net).

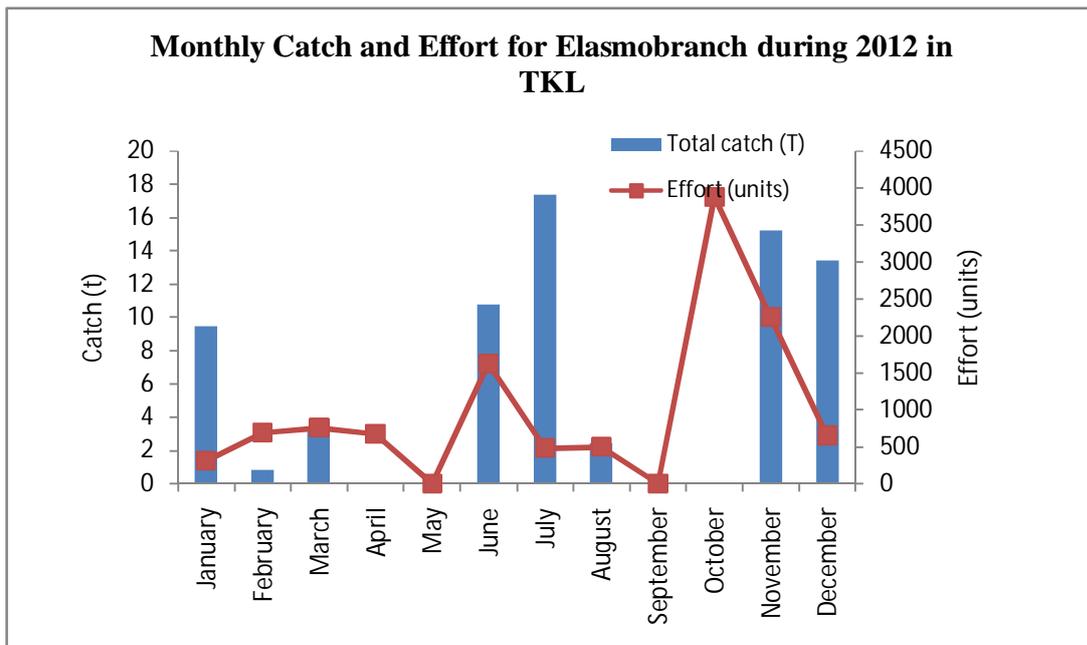


Year 2012

Tuticorin Fishing Harbour (TFH)

- The total marine fish landing in TFH during the year 2012 was 34474.428 t of which elasmobranch catch contributes 2.78 % (980.244 t). The percentage contributions of different elasmobranch groups are; rays (88.7 %), skates (10.1%), and sharks (1.2 %). The dominant species in the trawl net catches were *Himantura bleekeri* and *H. uranak* (among rays), *Centrophorus* sp. (among sharks) and *Rhinobatus* sp. (among skates).
- The total fishing days (units) operated during 2012 in TFH was 205 (19319) where the maximum units gone immediately after the ban period i.e., during the months June (3214), July (3069) and August (2367) with the actual fishing days of 26, 25 and

21 respectively. The CPUE ranges from 9.79 kg (June) to 101.53 kg (November) with an average CPUE of 44.64 kg. The percent composition of rays in TFH during the year 2012 is *Acetobatus* sp. (22.2%), *Gymnura* sp. (1.2%), *Himatura* sp. (56.2%), *Neotrygon* sp. (2.2%), *Pastinachus* sp. (3.9%), and *Rhinoptera* sp. (14.2%).



Tharuvaikulam (TKL)

- The total elasmobranch catch during the year 2012 was 72.571 t and the gill net is one of the major gear contributes the elasmobranch landings. The percentage contributions of different elasmobranch groups are; sharks (62.7 %), and skates (37.3%). The dominant species in the trawl net catches were *Mobula* sp. (among rays), and *Carcharhinus* sp. (among sharks). The total fishing units operated during the year 2012 in TKL was about 11800. The CPUE in TKL ranges from 1.2 kg (February) to 36.3 kg (July) with an average of 11.0 kg in the year 2012. The percent composition of rays in TFH during the year 2012 is *Mobula* sp. (58.6%), *Himatura* sp. (15.6%), and *Neotrygon* sp. (25.9%) and sharks are *Alopias* sp. (55.7 %), *Scoliodon* sp. (16.3 %), and *Carcharhinus* sp. (28.0 %).

- During the year 2013-14, observed landings and collected information on the elasmobranch species composition from Tharuvaikulam (gill net), Threspuram (gill net and hook & line), Tuticorin Fishing Harbour (trawl net). The elasmobranch landings were also observed from Vembar, Vellapati and Kayalpattinam (gill net). In Tuticorin Fisheries Harbour, the total effort was 28349 and the estimated landed catch from trawlers was 38023 tonnes. The total elasmobranch catch was estimated to 1179 tonnes of which rays dominates with 901 tonnes followed by skates (190 tonnes) and Sharks (87 tonnes).

Year 2013-14

- The drift gillnet fishery at Tharuvaikulam landing centre has total effort of 7362 and the estimated catch was 7266 tonnes. The total elasmobranch catch was estimated to 432 tonnes of which rays dominate with 287 tonnes followed by sharks (145 tonnes).
- The Hook & line and drift gillnet catch at Therspuram (Tuticorin North) has monitored. The total effort during December-March was 3246 and the estimated landed catch was 2357 tonnes. The total elasmobranch catch was estimated to 63 tonnes of which rays dominate with 51 tonnes followed by skates (12 tonnes).
- Length-frequency analysis and biological studies were carried out for *Neotrygon khulli* (Müller & Henle, 1841), *Chiloscyllium griseum* Muller & Henle, 1838 and *Rhinobatos granulatus* Cuvier, 1829. The biological observations were also done in *Mobula japonica* (Müller & Henle, 1841) and *Mustelus* sp.
- Pups of *M. japonica* (Müller & Henle, 1841), *Aetobatus narinari* (Euphrasen, 1790), *A. superciliosus* (Lowe, 1841), *N. khulli* (Müller & Henle, 1841 *R. granulatus* Cuvier, 1829); egg case of *C. griseum* Muller & Henle, 1838 and Chimaera was observed.
- Rare species like *Neoharriotta pinnata* Schnakenbeck, 1931, *Echinorhinus brucus* (Bonnaterre, 1788), *E. cookei* Pietschmann, 1928, *Pseudocarcharias kamoharai* (Matsubara, 1936), and *Rhina ancylostoma* Bloch & Schneider, 1801 was reported.

Funded Projects

Project: National Initiative on Climate Resilient Agriculture - Marine fisheries
2012-14

Salient findings

Component - Integrated District Level Adaptation and Mitigation (IDLAM)

Year 2012-13

- To develop IDLAM for climate change under NICRA initially Ramanathapuram district of Tamil Nadu was selected.
- To assess the climate change vulnerability of coastal livelihoods: Impacts, preparedness and mitigation options the following villages namely Dhanuskodi (Ramakrishnapuram, Mundaraiyarchatiram), Olaikuda, Mangadu, Thoppukadu, Pamban, Chinnapalam from Ramanathapuram district has been selected.
- To assess the climate change vulnerability of coastal livelihoods: Impacts, preparedness and mitigation option data was collected from 300 households.
- For carbon budgeting survey data was collected from 100 households.
- Based on the observation it is inferred that climate change may be attributed as one of the factors in the sea level increase in addition to other parameters like sea erosion.
- Majority of the respondents opined that the drastic change in the catch composition, reduction in the catch, increase in effort, change in fishing grounds, fishes caught in yester decade are not available were very high impacts directly or indirectly due to climate change in fisheries.

Year 2012-13

- Tuticorin district of Tamil Nadu was identified for the developing integrated district level adaptation and mitigation for climate change. Threspuram village of Tuticorin district of Tamil Nadu was identified for assessing the climate change vulnerability of coastal livelihoods: Impacts, preparedness and mitigation option & carbon budgeting; data was collected from 100 households each.

- The vulnerability index will be calculated based on the Patnaik and Narayan model for each coastal village in Tuticorin district. Parameter, Attribute, Resilient indicator and Score (PARS) methodology was applied in an effort to understand the indicator factors of coastal vulnerability in the selected fishing villages of Tuticorin district.

Projects: Assessment of Myctophid Resources in the Arabian Sea 2012-14

Salient findings

- The project has been initiated and recruitment of the scholar is under process.
- The project has been initiated and recruitment of the scholar is under process. Literature has been collected on the myctophid resource in the Arabian Sea.



Fishery Economics

Salient research findings under studies on Fisheries Economics

Project : Benefit cost analysis of marine fishery business and
 alternative investment options 2007-2012

Achievements

During the period under report a detailed survey was conducted in Tharuvaikulam fishing landing centre off Tuticorin coast to compare the economics of multiday fishing by trawlers using gillnets at Tharuvaikulam landing centre with the practice of single day fishing at Tuticorin Fishing Harbour using trawl nets by trawlers. At Tharuvaikulam landing centre 350 traditional vallams and 85 mechanised gillnetters are operating side by side. Data collected from owners of 65 mechanised gillnetters and other participants of the fish marketing system. Collected data were tabulated, analysed and a preliminary report is being presented here. Tharuvaikulam landing centre located at $8^{\circ}53'42''N78^{\circ}09'58''E$ is a fast developing fish landing centre off Tuticorin coast. It is important to note that the mechanized boats of Tharuvaikulam use gillnets only for their multiday fishing operation, while in other locations (Vembar, Tuticorin, Veerapandianpattinam) mechanized bottom trawling is carried out. It is important to note that, both mechanized and traditional vessels are operating side by side and they land their catches at the same beach and sell their fish to the same merchants. The biggest difference between the two sectors is the gear they use and their range of operation.

For the sake of comparison, the randomly selected respondents were divided into two groups namely the Mechanised boats of smaller size with OAL of less than 47 feet and the other group with OAL of more than 47 feet. Economics of fishery business enterprises were compared based on the survey data.

Project: A diagnostic study on dimensions, causes and ameliorative strategies of poverty and marginalization among the marine fisher folks of India.

2007-'12

As per the technical program, five fisherman families actively engaged in fishery related activities were contacted and a self-explanatory questionnaire was given to them along with instruction to fill the same for a whole year about day-to-day expenditure details. However, after three months selected respondents refused to continue the exercise. So, the work was discontinued.

Project: Coastal Rural Indebtedness and Impact of Microfinance in Marine Fisheries Sector.

2010-'12

To achieve the targets proposed in the project for the year the questionnaire in local language was prepared and pre-tested before the actual survey. Sixty samples boat owners, workers, traders were collected from three different landing centers at Kayalpattinam, Tuticorin and Tharuvaikulam. The data is being tabulated for further analysis.

Project: An Input-Output Economic Model for Marine Fisheries at Tuticorin Fishing Harbour

2012-'13

Facilities available at TFH

- TFH, which was constructed in 1968 has 17 acres of total area including berthing area of 2.7 acres to accommodate about 400 medium sized mechanized trawlers. The total length of the jetty is 800m and the depth in the berthing area is 3m. The harbor has fish landing place with a separate hall/platform for prawns, lobsters, goatfishes, cephalopods, big fishes, small fishes, rays and trash fishes.
- There are three fuel stations, a high mast light, cold storage, a tube ice plant, mechanical workshop for dry-docking the vessels, boat building yard for construction of new trawlers, net mending centre for repair of nets and warehouses for storing the dry fishes.

- Separate panchayat union for mechanized boats and country craft; separate association for mechanized boat owners, mechanized boat labourers and auctioneers. Apart from the government offices of fisheries department, there are many mechanical workshops, boat building yards, battery shops and other establishments which deal with spares and gear materials.

Mechanized fishing boats at TFH

- Presently, there are 307 mechanized fishing boats registered/re-registered with State fisheries department/Marine Product Export Development Authority (MPEDA). The number of boats added into operational fleet has gone up from mere two in 1998 to a maximum of 49 in 2010.
- The length and breadth of the boat along with the engine power has increased tremendously over the period. (Table 2). In order to reach the distant fishing grounds, engine power is being increased every year with the present maximum level of >600HP.

Fishing days and efforts

- Data collected for the period from 2010 to 2012 indicated that on an average nearly 197 fishing days per annum with 16 days per month was recorded. The estimated efforts per month varied from 595 units in April to a maximum of 3084 units in June, i.e. immediately after the annual fishing ban period. Though there were 307 registered trawlers at TFH, on an average 100 out of 244 berthed boats went for The recorded minimum fishing units (24) was recorded in the month of December, while the maximum of 156 units was registered during the month of July.

Fish landings at TFH

- The estimated total catch at TFH during 2012 was 23958 tons. Nearly 67% of the total catch was *Leiognathus* sp., followed by unspecified by-catches. Highly

priced fish species accounted for less than 15% of the total catch. The estimated value of the total landings was Rs.1265 million during 2012 (Table 3).

Input-Output Economic Model

- Regular monitoring and data collection from selected mechanized trawlers of different size groups is being carried out to generate bio-economic data for the input-output economic model being developed for TFH.
- Bench-mark survey was conducted to collect the information on the private/public participants/institutions involved in development and management of Tuticorin Fishing Harbour (TFH). Fig 1.shows the interlinked institutional arrangements at TFH.

Fish catch and Tuticorin Fishing Harbour

- As it can be seen from table 3, the estimated total catch at TFH during 2012 was 23958 tons. Nearly 67% of the total catch was Leiognathussp. followed by unspecified by-catches (by catch). Highly priced fish species accounted for less than 15% of the total catch. Fig 2 presents the month-wise fish landings at TFH during 2007-2011, while table table 4 presents the month-wise utilisation of fishing units during 2007-11. The estimated value of the total landings was Rs.1265 million during 2012.

Fig 1. Figure showing various participants involved in Tuticorin Fishing harbour (TFH)

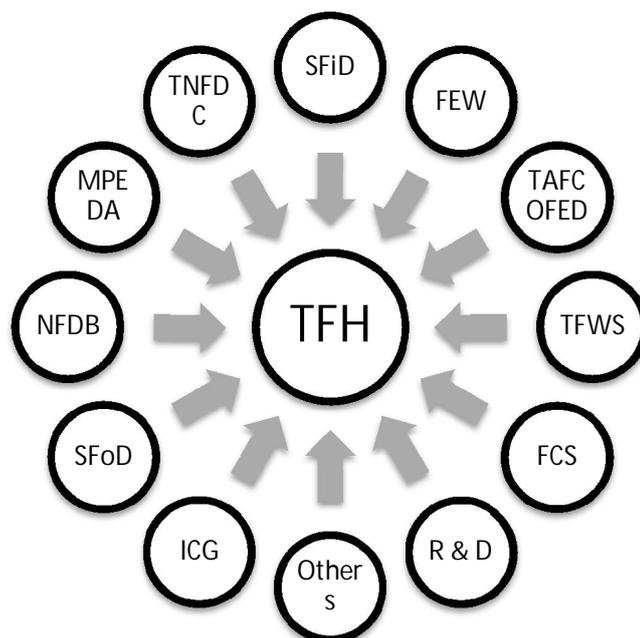


Table 1. Monthly average price at TFH during 2012

Months	Average price (₹)	Maximum		Minimum	
		Rs/kg	Species	Rs/kg	Species
January	79.69	500.00	P.Senisulcates	5.00	Benthodesmustenus
February	82.61	375.00	P.Indicus	6.00	Benthodesmustenus
March	84.40	313.00	Epinephelus	19.00	Leiognathussp
April	Seasonal fishing ban period (April 15 th to May 29 th)				
May					
June	122.13	410.00	Scomberomoruscommerson	7.00	Scarus
July	122.59	1300.00	P. arnatus	7.00	Diptexygonatussp
August	109.45	1400.00	P. arnatus	8.00	Diptexygonatussp
September	89.10	525.00	P. arnatus	15.00	R.granulatus
October	115.30	1250.00	P. arnatus	3.00	Diptexygonatussp
November	76.94	387.00	Pampus	11.00	Leiognathussp
December	121.48	500.00	P.Senisulcates	25.00	Leiognathussp
ALL	100.37	696.00		10.60	

Project: Economics of marine fisheries and sustainable management: Policy Issues and Interventions. 2012-'13

- Threshpuram landing centre of Tuticorin was selected for the project. Owners of motorized boats and liners totaling 137 were contacted for the detailed survey. The survey indicated that boats with an average length of 20 feet were fitted with inboard/outboard engines up to 15HP.
- Chalaivalai, podivalai, ayilavalai and hook lines were the major gears used at Threshpuram landing centre. Gear-wise economics of operation was estimated for the sake of comparison.
- The recorded average fish catch per boat was 672kgs valued at Rs.81781 during the month of December – January. After deducting all operational

expenditures involved, the net income for the owner was Rs.35945 while it was Rs.32712 for the crews as wage.

Project : Supply chain management of marine fisheries sector in India 2012-'13

Market structure – Supply side

- In order to identify and ascertain the commonly followed marketing channels, participants in the marketing channel and to create a profile of each type of traders and their transactions were recorded.
- Data from commission agent cum wholesalers at Tuticorin, Tiruchendur, Manapad and Palayamkottai were collected and analysed to estimate the marketing cost in a predominantly common marketing channel of *Fishers -> Wholesale Trader cum retailers -> Retailers -> Consumers*.
- The quantitative transaction of individual traders varied from 140kg to 1750kg/day and the type of fish traded depends on the market. Apart from the value of the purchased fish, the traders meet the expenditure of around Rs.10172 towards transportation, loading and other marketing expenditure.
- Local retailers handle up to 47kgs/day and their daily transaction varies from Rs.3600 to 10400. Most traders go to wholesale market/landing centre on alternate days to replenish their supply.





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Kannan, K and Ranjith, L and Suresh Kumar, K and Sathakathullah, S M and John James, K and Madan, M S (2013) *Occurrence of Parascolopsis eriomma (Jordan and Richardson, 1909) and P. aspinosa (Rao & Rao 1981) from Tuticorin coast*. Marine Fisheries Information Service; Technical and Extension Series (217). pp. 23-24.

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L. Ranjith, K. P. Kanthan, K. Radhakrishnan and K. Murugan (2014). *Whale shark landed along Tuticorin coast*. Cadalmin: CMFRI Newsletter., 140. pp.12.

Oral presentations

Asha,P.S Presented a paper on “ Development of hatchery techniques of an over exploited sea cucumber *Holothuria spinifera* Theel – a tool for its conservation” at the National seminar on Marine Resources- Sustainable Utilization and Conservation held on 11 – 12th December 2009 at St. Mary's College, Thoothukudi – 1.

Asha,P.S Delivered a lecture on “Biodiversity of Echinoderms with special reference to sea cucumber resources of India” at the National Conference on Marine Biodiversity” held at Department of Marine Science School of Marine Sciences., Bharathidasan University., Tiruchirappalli., Tamil Nadu. On 17th Sept'10.

Asha,P.S Presented a paper in Hindi on “Holothurian resources of India and conservation measures and won cash award for Best Presentation of article in hindi in the ‘National Official Language Seminar conducted on the subject Biodiversity on 10-10-2011 at CMFRI, Kochi.

Asha,P.S Presented the theme paper on “The status of sea cucumber fisheries and management in India” on 13th Nov'12 at the workshop on “ Sea Cucumber Fisheries an Ecosystem Approach to management in the Indian Ocean organized by Food and Agricultural Organization (FAO) and Western Indian Ocean Marine Science Association (WIOMSA) at Zanzibar of Tanzania.

Conservation, Held at Department of plant biology and plant biotechnology, St. Mary's College, Tuticorin. P.19.

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Asha, P.S. P.Kaladharan, K.Diwakar and G. Santhanavalli 2011. Impact of sewage discharge and waste from fishing activities on the water quality variables off Tuticorin coast. In the abstract of 9th IFF on Renaissance in Fisheries: Outlook and strategies, hosted by CMFRI, Kochi p. 244-245.

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C. P. Suja 2013. Tissue culture - An innovative Biotechnological Alternative to sustain

Pearl production . Book of Abstracts. International Conference on Ecosystem Conservation, Climate Change and Sustainable Development. 3-5 October 2013, Thiruvananthapuram, Kerala, India.p.346

- Sarada, P. T. (2011) Reproductive dynamics and stock assessment of *Metapenaeus dobsoni* (Miers, 1878) exploited by trawlers off Kozhikode-Kerala, south west coast of India (Abstract in 9th IFF)
- Sarada, P. T. (2011) Stock assessment and recruitment dynamics of kiddi prawn, *Parapenaeopsis stylifera* (H. Milne Edwards, 1837) from Puthiappa-Kozhikode, south-west coast of India (Abstract in 9th IFF)
- Sarada, P. T. (2011) Stock assessment and reproductive dynamics of Indian white prawn, *Penaeus (Fenneropenaeus) indicus* H. Milne Edwards, 1837 exploited by trawlers off Kozhikode-kerala southwest coast of India (Abstract in 9th IFF)
- Sarada, P.T. and K. John James (2012) Spatio- temporal species diversity of marine prawns and their biology from the fishery at tuticorin, south east coast of India. Second Indian Biodiversity Congress (IBC) 2012 (Book of Abstracts of National Seminar 9-11 December 2012 p. 53)

International seminar attended

Asha, P.S. Attended the International seminar jointly organized by CMFRI and NACA on "Emerging issues in Asian Aquaculture" held at CMFRI on 12th May 2011.

Deputation abroad

Dr. I. Jagadis. Deputed to Southern Cross University, Lismore, Australia for a Joint Indo Australian Workshop on 'Nutraceuticals from Muricid mollusks between 01 to 16th November 2012. Delivered a lecture on 'Molluscan fisheries of India and molluscan breeding capabilities of CMFRI.'

Dr. Asha, P.S. Deputed to attend an international workshop on "Sea Cucumber Fisheries an Ecosystem Approach to management in the Indian Ocean organized by Food and Agricultural Organization (FAO) and Western Indian Ocean Marine Science Association (WIOMSA) at Zanzibar of Tanzania during the period 12-16 Nov'2012 and Presented the theme paper on "The status of sea cucumber fisheries and management in India" on 13th Nov'12.

Training conducted

I. Jagadis

2009-'13

A ten day training programme with a course fee of Rs 10,000 per trainee was conducted at the Tuticorin Research Centre of CMFRI from 20-10-09 to 31.10.09. The participants were from Maharashtra, Karnataka and Andhra Pradesh.

'Mabe' pearl training programme at Sipikulam village for 32 fisherwomen was conducted under MoEs/CMLRE project during June 2009.

A 10 day hands on training programme on 'Nucleus implantation' during July- August 2009 for 10 village women from Tuticorin and Pudukottai area under MoEs/CMLRE project.

Training programme on ' Surgical Nucleation and pearl production in Indian Pearl oyster ' conducted at Tuticorin Research Centre of CMFRI, Tuticorin under the auspices of Human Resources Development Cell, CMFRI, Kochi from 18th to 28th December 2013.

Training programme on 'Basic training in Skin and SCUBA diving ' conducted at Tuticorin Research Centre of CMFRI, Tuticorin under the auspices of Human Resources Development Cell, CMFRI, Kochi from 23rd December 2013 to 19th January 2014.

Asha, P.S

2013

Co-ordinated a training programme on "Micro algal culture and water quality management in aquaculture system " and took theory and practical classes on water quality management and analysis of water quality parameters to 14 trainees from various parts of India during 9-13 Dec'13 and also served as the food and refreshment committee member and in the hall arrangement and accommodation committee for the programme.

Teaching materials

Jagadis, I. 2009 'Seed production and farming of Indian pearl oyster *Pinctada fucata*' In Winter School on Recent Advances in Breeding and Larviculture of Marine Finfish and Shellfish.

Jagadis, I. 2013 'Hatchery seed production of Indian pearl oyster *Pinctada fucata*'

Jagadis, I. 2013 'Farming of Indian pearl oyster, *Pinctada fucata*'

Jagadis, I. 2013 'Spherical Cultured pearl production in Indian pearl oyster *Pinctada fucata*'

In Course Manual on 'Techniques in Marine Designer Pearl Production. p. 20-26; 27-31; 42-46. Held at VRC of CMFRI, Vizhinjam.

Suja C.P and Asha P.S 2013. Algal culture and water quality management in Aquaculture system. held at Tuticorin R.C of CMFRI, 9th-13th December 2013. p.63

Madan, M S and Ranjith, L and Radhakrishnan, K and Kanthan, K P and Aswathy, N (2013) *Harbour Based Fisheries Management in Thoothukudi District – A Case of Thoothukudi Fishing Harbour*. In: ICAR funded Short Course on "ICT – oriented Strategic Extension for Responsible Fisheries Management, 05-25 November, 2013, Kochi.

P.T.Sarada and K. John James 2013. Identification of commercially important prawns, crabs and lobsters. In training manual 'Fishery Assessment Methodology (FAM) workshop' Pages 61 – 95.

Sivadas, M. 2012 Taxonomy of clupeids. In: Capacity building workshop on Taxonomy and identification of Pelagic finishes. CMFRI, 17-22 December 2012.

Sivadas, M. 2013. Identification of commercially important pelagic fishes. In: M.Sivadas and P.T.Sarada(Eds). Training Manual. Fishery Assessment Methodology (FAM) Workshop, 17-19 October 2013 at Madras Research Centre of Central Marine Fisheries Research Institute, Chennai: 1-38.

Sivadas, M. 2013. Fishery Methodology exercises. In: M.Sivadas and P.T.Sarada (Eds). Training Manual. Fishery Assessment Methodology (FAM) Workshop, 17-19 October 2013 at Madras Research Centre of Central Marine Fisheries Research Institute, Chennai: 103-112

Training programme attended

- Sarada, P.T. Participated in the Centre of Advanced Faculty training in fisheries research management at CIFE Mumbai from 22.3.2010 to 11.4.2010
- Sarada, P.T. Data analysis using SAS at CIFT Kochi, from 1.2.2014 to 7.2.2014
- Sarada, P.T. Participated in the Centre of Advanced Faculty training in fisheries research management at CIFE Mumbai from 22.3.2010 to 11.4.2010
- Sarada, P.T. Data analysis using SAS at CIFT Kochi, from 1.2.2014 to 7.2.2014
- Ranjith, L. Attended a state level consultative workshop are jointly organized by MPEDA & NETFISH on "Towards sustainable Fishing" on 29th August 2013 at Fisheries College & Research Institute, Tuticorin.
- Ranjith, L. Attended the training program on "SAS for Data Reduction and Multivariate Analysis" at CIFE, Mumbai during the period from 11.02.2013 to 16.02.2013
- Ranjith, L. Participated and presented a lecture (in Hindi & English) on "A short description of CMFRI and its role in Marine Fisheries" in the Scientific Seminar held on 28.03.2014 at Heavy Water Plant, Department of Atomic Energy, Govt. of India, Tuticorin. Attended in-house "Inauguration workshop" on "Remote sensing assisted biodynamic forecasting paradigm for marine fishery resources" at HQrs. Kochi from 16.10.2012 to 19.10.2012.
- Ranjith, L. Participated in ICAR funded short course on "World Trade agreement and Indian Fisheries Paradigms: A policy outlook" at HQrs. Kochi from 17.09.2012 to 26.09.2012.
- Ranjith, L. Attended in-house Inception Workshop on "Assessment of fishing impacts on biodiversity loss, with special reference to the threatened species, to formulate management options for their protection at Madras Research Centre of CMFRI, Chennai from 21.09.2012 to 22.09.2012.

Ranjith, L. Attended a talk on "Marine Biodiversity" for the fisher folks of Tharuvaikulam village organized by Forest Department, Thoothukudi on 22.05.2012

Ranjith, L. Attended one day "Hindi Workshop" was conducted on 24.08.2013 at Tuticorin Research Centre of CMFRI, Tuticorin.

Ranjith, L. Attended two days "Preparatory Workshop" regarding the project Remote Sensing assisted Biodynamic Forecasting Paradigm for Indian Marine Fishery Resources at Space Application Centre, Ahmedabad during 18-19 July 2013.

Training Programme conducted

I. Jagadis

2009-2013

A ten day training programme on "Surgical Nucleation and pearl production" a course fee of Rs 10,000 per trainee was organized at the Tuticorin Research Centre of CMFRI from 20-10-09 to 31.10.09. The participants were from Maharashtra, Karnataka and Andhra Pradesh.

A 'Mabe pearl' training programme at Sipikulam village for 32 fisherwomen was conducted under MoEs/CMLRE project during June 2009.

A 10 day hands on training programme on 'Nucleus implantation' during July- August 2009 for 10 village women from Tuticorin and Pudukottai area under MoEs/CMLRE project.

Training programme on ' Surgical Nucleation and pearl production in Indian Pearl oyster ' conducted at Tuticorin Research Centre of CMFRI, Tuticorin under the auspices of Human Resources Development Cell, CMFRI, Kochi from 18th to 28th December 2013.

Training programme on 'Basic training in Skin and SCUBA diving ' conducted at Tuticorin Research Centre of CMFRI, Tuticorin under the auspices of Human Resources Development Cell, CMFRI, Kochi from 23rd December 2013 to 19th January 2014.

Asha, P.S.

2013.

Co-ordinated a training programme on "Micro algal culture and water quality Management in aquaculture system"

Book Chapters

Asha, P.S 2010. Biotechnological significance of holothurians in (Hindi) Matsyagandha Series part - ix. *CMFRI Spl. Pub.* No: 102 : 59-62.

Asha, P.S. Mary K.Manissery, M.S Madan and K. Diwakar 2011. Holothurian resources of India and conservation measures, in Biodiversity . *CMFRI Spl. Pub.* No: 106, 35-37.

Asha, P.S 2012. Breeding and culture of sea cucumbers in India: In the Manual on Advances in Aquaculture Technology, held at Department of Marine Science, Bharathidasan University., Tiruchirappalli., Tamil Nadu. p. 18.

Asha, P.S 2013. SCEAM Indian Ocean country report – INDIA . In the Report of the FAO Workshop on Sea cucumber Fisheries: An Ecosystem Approach to Management in the Indian Ocean (SCEAM Indian Ocean). FAO Fisheries and Aquaculture Report No. 1038. 53-54.

Asha, P.S. Diwakar K, Santhanavalli, G and Mary K.Manissery., 2013. Numerical density and biomass of sea cucumber *Holothuria atra* Jaeger at two stations of varying protective measures at Erstwhile Pandian Island, Tuticorin, Gulf Of Mannar: In the abstract of Second International Conference on Ecosystem Conservation, Climate change and sustainable development, organized by Department of Aquatic Biology and Fisheries, University of Kerala at Thiruvananthapuram, Kerala India. p. 18.

Rao, G Sudhakara, A.P. Dineshababu, P.T.Sarada and Chellappan, K (2013) Prawn Fisheries Estuarine prawns. In: Handbook of Marine Prawns of India. Rao, G. Sudhakara and Radhakrishnan, E V and Josileen, Jose,(eds.) Central Marine Fisheries Research Institute, Kochi, pp. 231-244.

Sarada, P. T (2013) *Prawn fisheries of Kerala*. In: Handbook of Marine Prawns of India. Rao, G Sudhakara and Radhakrishnan, E V and Josileen, Jose,(eds.) Central Marine Fisheries Research Institute, Kochi, pp. 247-266.

Sarada, P T (2013) Species *Parapenaeopsis stylifera*. In: Handbook of Marine Prawns of India. Rao, G Sudhakara and Radhakrishnan, E V and Josileen, Jose, (eds.) Central Marine Fisheries Research Institute, Kochi, pp. 297-318.

Sarada, P T (2013) Species *Penaeus indicus*. In: Handbook of Marine Prawns of India. Rao, G Sudhakara and Radhakrishnan, E V and Josileen, Jose, (eds.) Central Marine Fisheries Research Institute, Kochi, pp. 247-266.

Sarada, P T (2011) Generic Characters of *Parapenaeopsis Alcock, 1901*. In: Handbook of Prawns. Radhakrishnan, E V and Josileen, Jose and Pillai, S Lakshmi, (eds.) Central Marine Fisheries Research Institute, Kochi, pp. 37-44.

Books

Lipton, A P and Rao, G Syda and Jagadis, I (2013) Indian Sacred Chank. Central Marine Fisheries Research Institute, Kochi.

Participation of Scientific staff in National & International conferences

Meetings attended

Sivadas, M. Member of the expert team constituted by NFDB to study schemes for development of Fisheries and visited Lakshadweep during 24-28 May 2011

Sivadas, M. Tenth Scientific advisory committee meeting of SCAD KVK on 26.9.2012 at their premises at Vagaikulam, Tuticorin.

Sivadas, M. Fishermen meet arranged by State Fisheries department at Tuticorin on 3.1.2014 and 4.1.2014 to get the feedback of fishermen on fishing ban.

Workshop conducted

Sarada, P.T. 2009. Workshop on classification of Invertebrates' (19.8.2009) to the teachers of Sarva Shiksha Abhayan

Workshop participated

- Sarada, P.T. Workshop on 'Reproductive dynamics and stock assessment of crustaceans' at Kochi from 18.7.2011 to 27.7. 2011.
- Sarada, P.T. Workshop on 'Prawn taxonomy: recent advances and revision of nomenclature' from 14.2.10 to 19.2.11.at Kochi
- Sarada, P.T. Workshop on 'HYPM' on 16.3.2012
- Sarada, P.T. Workshop on data compilation and analysis using 'Primer' from 27.1.2012 to 28.1.2012 at Kochi.
- Sarada, P.T. Participated in Second Indian Biodiversity Congress at IISC, Bangalore during 9-11 December 2012 and presented a paper.
- Sivadas, M. Project workshop under the project 'National Initiative on Climate Resilient Agriculture (NICRA) for XI plan' at Kochi on 4-5,February 2011
- Sivadas, M. Tuna workshop conducted at HQrs during 24-30 July 2011
- Sivadas, M. IOTC working party meeting on Neritic Tunas and the Capacity Building workshop at Chennai during 14-18 November 2011.
- Sivadas, M. Completion workshop on tuna and preparation of scientific papers during 27-30 November 2011 at HQrs. Kochi.
- Sivadas, M. Attended and presented papers at 9IFF at Chennai during 19-22 December 2011
- Sivadas, M. Scientific seminar in Hindi conducted by Heavy Water Plant at Spic Nagar, Tuticorin on 7.2.12

- Sivadas, M. Inception workshop on the project on 'GIS based resource mapping of distribution and abundance of fin fishes and shell fishes off Indian coast for suggesting operational based strategies for fisheries management' at Mangalore on 17.8.2012 and 18.8.2012
- Sivadas, M. Second Indian Biodiversity Congress at IISC, Bangalore during 9-11 December 2012
- Sivadas, M. Capacity building workshop on taxonomy and identification of pelagic fin fishes at CMFRI, Kochi during 17-23 December 2012 and prepared and presented a lecture on 'Taxonomy of clupeid fishes and key characters for identification'.
- Sivadas, M. National strategic workshop on small scale fisheries, India at Chennai on 10-11 January organized by BOBP
- Sivadas, M. Fishery Assessment Methodology (FAM) workshop for state-wise project associates held on 14-15 June 2013 at Kochi
- Sivadas, M. Winter school on ICT-oriented strategic extension for responsible fisheries management at CMFRI Kochi on 18.11.2013 as a resource person and gave a lecture on 'Issues in responsible management of small scale fisheries in India'.
- Sivadas, M. GIS based resource mapping workshop at Mangalore Research Centre during 7.1.2014 to 8.1.2014.
- Ranjith, L. Attended "AusAID Ecotoxicology Training Workshop" on 2nd to 6th December, 2013 under Commonwealth Scientific and Industrial Research Organization (CSIRO) - Indian Institute of Toxicology Research (IITR) - National Bureau of Fish Genetic Resources (NBFGR) project on "Safe Water for the Future" held at NBFGR, Lucknow, India.
- Ranjith, L. Attended two 4 days "Workshops on Communicating Science Effectively" : the first on scientific paper writing (14th to 17th October, 2013) and the second on scientific presentation (18th to 21st November, 2013) organized by Bay of Bengal Large Marine Ecosystem (BOBLME) Project and the Marine Biological Association of India (MBAI) at Kochi, India.

Seminar attended

All the Scientist of the Centre attended 9th Indian Fisheries Forum (19.12.2011 to 22.12.2011) and presented papers in oral and poster session

Oral presentations

Asha. P.S Presented a paper on “ Development of hatchery techniques of an over exploited sea cucumber *Holothuria spinifera* Theel – a tool for its conservation” at the National seminar on Marine Resources- Sustainable Utilization and Conservation held on 11 – 12th December 2009 at St. Mary’s College, Thoothukudi – 1.

Asha, P.S. Presented a paper in Hindi on “Holothurian resources of India and conservation measures and won cash award for Best Presentation of article in hindi in the ‘National Official Language Seminar conducted on the subject Biodiversity on 10-10-2011 at CMFRI, Kochi.

Asha, P.S. Presented a paper on “ Numerical density and biomass of sea cucumber *Holothuria atra* Jaeger at two stations of varying protective measures at Erstwhile Pandian Island, Tuticorin, Gulf Of Mannar:” on 03-10-13 at the second International Conference on Ecosystem Conservation, Climate change and sustainable development , organized by Department of Aquatic Biology and Fisheries, University of Kerala at Thiruvananthapuram, Kerala India during 3-5 October 2013.

Asha, P.S. Delivered a lecture on “Biodiversity of Echinoderms with special reference to sea cucumber resources of India” at the National Conference on Marine Biodiversity” held at Department of Marine Science School of Marine Sciences., Bharathidasan University., Tiruchirappalli., Tamil Nadu. On 17th Sept’10.

Asha, P.S.Delivered a lecture in Tamil on “ Sea cucumber resources in the Gulf of Mannar: Issues of conservation and management” in the ICSF-BOBLME training programme on “ Enhancing Capacities of Fishing Communities for Resource Management at Akkalmadam and Ramand of Ramanathapuram district, Tamil Nadu during October 23-26 2013.

Asha, P.S. Delivered a lecture on "Breeding of seacucumbers in India" to the Maldivian officials at the International Training programme on "Customised Mariculture" at Mandapam Regional Centre on 4.12.13.

Asha, P.S. Delivered a lecture on "Marine Science and Conservation of Marine Resources" in the DBT sponsored "INSPIRE" Internship Science Camp at Kamaraj College, Tuticorin on 30th November 2013.

Ranjith, L. Presented the project entitled "Remote sensing assisted biodynamic forecasting paradigm for Indian marine fishery resources in the "India-EU Workshop on Marine Primary Production" organized by Nansen Environment Research Center under the project Indo-European research facilities for studies on marine ecosystem and climate in India at Kerala University of Fisheries and Ocean Studies, Cochin during the period from 12.03.2013 to 15.03.2013.

Infrastructure and physical facilities developed



Expansion of Central block to accommodate scientist, laboratories Library

Renovation of Shorehall



Renovation of RV. Cadalmin IV

Human resource development efforts for different categories of staff

Staffs are periodically sent for attending short training courses in different aspects

Management

Frequency of staff meeting

Monthly meetings of Scientist and other staffs were held, discussions on the project related matters and general functioning of the centres.

Staff Amenities

Facilities available for staff

i) Housing in Campus

Not available, proposals sent for consideration

ii) Travel office

Good transport facility is available in the town to reach office by the staff members. The centre also has sufficient number of vehicles for undertaking project related tours

iii) Education Facilities for children

Good education facilities are available in the city

Linkages

A good linkage with the State Fisheries college is maintained

Scientists attend the scientific and academic meetings

Serves as external subject experts

Sports, recreational research and vocational health facilities to the staff

The centre has an active Recreation club. The club conducts Sport and games every year. Organises special lectures by experts, Medical camps etc.

Collaboration with others

Local institutions in the area (educational, research and infrastructural facilities)

Nil

National Institutes and agricultural Universities

Nil

International Institutions

Nil

Extension and development agencies

Nil

Research Extension linkages

Demonstration and extension project was conducted at Sipikulam villagers on "Marine pearl culture"

Consultancies

A proposal is being prepared for developing a 'Shell fish hatchery' at Goa for a private entrepreneur.

SWOT Analysis of the Centre

Strength

- Research Vessel 'Cadamin IV' (43.6 feet) equipped GPS, echosounder, wireless communication system, water sampler, plankton net and trawl net) for effective and meaningful underwater explorations, fishery and hydrographic studies.
- Basic Skin & SCUBA underwater diving equipments for the underwater diving studies and effective training.
- Fishery biology laboratories for the taxonomic and fishery biological studies
- Fishery Environment laboratory for analysis of oceanographic (water & sediment) parameters; heavy metals and plankton studies.
- Tissue culture laboratory for *in-vitro* tissue culture experiment using mantle tissues of bivalves for pearl production.
- Bivalve and gastropod hatchery for technology development and refinement of bivalves and gastropods of conservation importance.
- Microalgal laboratory with 12 microalgal stock cultures for the larval feed requirement of the bivalve/gastropod hatcheries and also for commercial sale to hatcheries, universities and colleges.
- Marine Museum house to more than 450 fin/shellfishes besides good number of hard/soft corals, sponges, gorgonids, sea grasses, sea cumpers, star fishes, sea snakes, stuffed sail fish, pup of dolphin, skeleton of whale and many rare/vulnerable/endangered species serve as a reference Museum and as a knowledge centre for the students and public.
- Good liaison with the Port trust, State fisheries department, Fisheries College and other allied departments.

Weakness

- Reduced number of Scientific staff
- Additional scientists for the major divisions of fisheries
- Lack of technical and skilled staffs for the fishery and oceanographic cruises
- Insufficient technical and skilled staffs for the assistance in effective data collection/conduct of experiment.
- Lack of accessibility to the islands of Gulf of Mannar.

Opportunity

- Further strengthening of ties between state fisheries department, fisheries college and other fisheries department & universities
- First hand role in planning and policy tweakings

Threats

- Peer shows by other institutions though not to the core values are projected, which may turn out to be diluting factor of importance of CMFRI regional/research centre than anticipated