QRT REPORT – FISHERY RESOURCES ASSESSMENT DIVISION

PROJECT CODE	**FRA/ASSESS/01**
PROJECT TITLE	**Development of knowledge based information system for marine fisheries sustainability**
SCIENTISTS	**T.V. Sathianandan,** J. Jayasankar, Somy Kuriakose, T.M. Najmudeen, K.G. Mini and Wilson T. Mathew
CENTRES	Kochi

The objectives of the project are (i) estimation of resource wise and region wise marine fish landings along with fishing effort expended (ii) develop a full fledged information retrieval system pertaining to marine fisheries and (iii) develop necessary database queries and front end for database management, processing of raw data, preparation of reports and updation of information.

The time tested stratified multistage random sampling design was adopted for collection of data and estimation of exploited marine fishery resources.

Year 2009

The estimation of individual species-wise landings for each state was also carried out for 2009 and this information were added to the Access data base for different quarters using the software developed in C++ and Visual Basic. Highlights of the estimates for 2009 are given below.

- The marine fish landings of India for the year 2009 has been estimated as 3.20 million tonnes recording a decrease of about 5,988 t against the estimate for 2008.
- The pelagic finfishes constituted 52%, demersal fishes 29%, crustaceans 15% and molluscs 4% of the total landings.
- The sector-wise contributions during the year 2009 are: mechanized 76%, motorized 21% and artisanal 3%.
- The west coast and east coast accounted for 55% and 45% respectively.
- The estimate of region-wise production showed that the north-west region comprising Maharashtra and Gujarat contributed 28% to the total

production, and the south-west region comprising Kerala, Karnataka and Goa contributed 27%.

- On the east coast, north-east region, comprising West Bengal and Orissa recorded 20% of the total, whereas the south-east region consisting of Andhra Pradesh, Tamil Nadu and Puducherry contributed 25%.

Contribution of major species/groups

- The estimated landings of oil sardine was 4,14,759 t during 2009 as against 4,45,407 t 2008, which formed 12.9% of the total marine fish landings in India.

- The landings of lesser sardine was 1,01,057 t which decreased by 14,236 t compared to the landings in 2008.

- A drastic reduction of about 35% was noticed in the landings of Stolephorus spp., the estimated landings being 56,837 t in 2009.

- The landings of Bombayduck increased to 1,12,289 t from 1,04,970 t in 2008.

- The landings of ribbonfish is 1,38,616 t which showed a decline by 6,928 t compared to that in 2008.

- Indian mackerel, one of the major single species contributor (5.8%) increased to 1,85,941 t from 1,56,608 t in 2008.

- Catfish landings recorded an increase of about 16% in 2009, the estimate being 1,07,593 t.

- Threadfin bream landings during 2009 is 1,30,739 t, registering an increase of about 2.4 % compared to the landings in 2008.

- In 2009, croaker landings is 1,95,411 t showing an increase of 14,960 t as compared to the landings in 2008.

- Silverbellies landings reduced to 68,517 t from 70,149 t in 2008.

- Penaeid prawn landings showed an increase of 14.9% in 2009, the estimate being 2,45,211 t.

- The estimated landings for non-penaeid prawns is 1,68,413 t. Compared to 2008 landings, a decrease of 11.6% was noticed in non-penaeid prawn landings.

- The estimate of cephalopod landings is 1,23,668 t, in 2009 showing a decline of about 23% compared to that of 2008.

Year 2010

During 2010, under this project, the Fishery Resources Assessment Division was involved in assessment of exploited marine fishery resources through national level sample survey following the time tested Stratified Multi-stage Random Sampling design. The estimation of individual species-wise landings for each state was carried out and added to the Access database for different months in 2010 using the software developed in C++ and Visual Basic.

- The marine fish landings of India during the year 2010 has been estimated as 3.35 million tonnes with a increase of about 1,42,146 t against the estimate of the previous year.
- The pelagic finfishes constituted 55%, demersal fishes 26%, crustaceans 14% and molluscs 5% of the total landings.
- The sector-wise contributions during the year 2010 were mechanized 79%, motorized 19% and artisanal 2%.
- The west coast and east coast accounted for 58% and 42% respectively.
- The estimate of region-wise production showed that the north-west region comprising Maharashtra and Gujarat contributed 25% to the total production, and the south-west region comprising Kerala, Karnataka and Goa contributed 32%.
- On the east coast, north-east region, comprising West Bengal and Orissa recorded 20% of the total, whereas the south-east region consisting of Andhra Pradesh, Tamil Nadu and Puducherry contributed 23%.
- Oil sardine formed 14.6% of the total marine fish landings in India.
- Landings of Indian mackerel, one of the major single species contributor (8%) increased by 44%, and catfish landings showed 20% decrease, threadfin bream landings decreased by 1% and penaeid shrimp landings increased by 6%.
- The landings of Stolephorus increased by 43%, non-penaeid shrimp landings decreased by 25% and cephalopod landings showed an increase of about 39%.

Year 2011

During the period the Fishery Resources Assessment Division was involved in assessment of exploited marine fishery resources through the national level sample survey and development of information and decision support systems for marine fisheries management and sustainability.

Resource wise and gear wise estimation of marine fish landings for the year 2011 was carried out adopting the time tested stratified multistage random sampling design for different fishing zones in 9 maritime states and two union territories. Individual species wise estimation of landings and gear wise effort were made for each of the states and a consolidated migratable national database was developed.

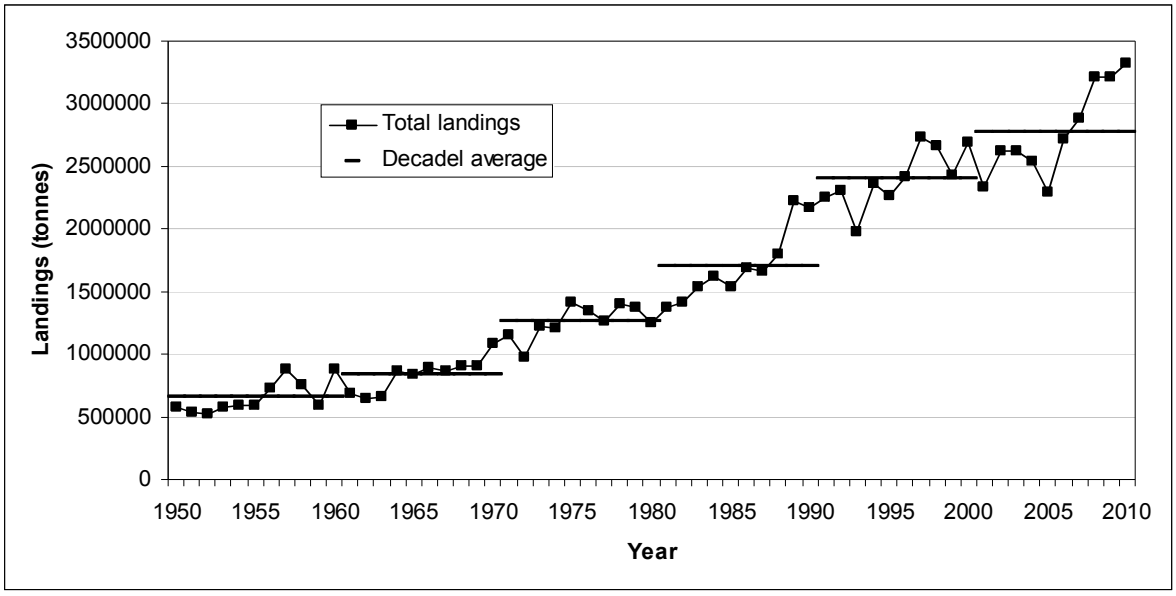
1. Digitization of historic data (prior to 1989) on marine fish landings available in old data sheets was also carried out.

2. Snippets of 2011 marine landings are as follows:
    - The marine fish landings in India during the year 2011 has been estimated as 3.82 million tonnes against 3.35 million tonnes in 2010 registering an increase of about 4.7 lakh tonnes.
    - The pelagic finfishes constituted 56%, demersal fishes 26%, crustaceans 14% and molluscs 4% of the total landings.
    - Sector-wise contributions during 2011 are mechanized 79%, motorized 19% and artisanal 2%.
    - The west coast accounted for 58% of the total landings and east coast 42%.
    - Oil sardine (Sardinella longiceps) remained as the most important single species contributing 15.94% to the total marine fish landings in the country. The estimated landings of oil sardine for 2011 is 6,09,111 tonnes against 4,88,204 tonnes in 2010.
    - The second important resource in terms of contribution towards total landings is Indian mackerel (Rastralliger kanagurta) accounting for 7.3% of total landings, the estimate for 2011 being 2,78,495 tonnes compared to 2,67,248 tonnes in 2010.
    - The estimated landings of other important resources are penaeid prawns 2,67,932 tonnes (7%), ribbonfishes 2,41,978 tonnes (6.3%), croakers 2,20,120 tonnes (5.8%), non-penaeid prawns 1,87,061 tonnes (4.9%), threadfin breams 1,74,079 tonnes (4.5%), cephalopods 1,56,824 tonnes (4.1%), lesser sardines 1,22,935 tonnes (3.2%) and Bombayduck 1,15,594 tonnes (3%).
    - Among the region-wise landing figures West coast regions were the major contributors with South-West region being the highest.

- A methodology for refinement of sampling coverage of primary stage units was evolved and the coverages were estimated. The overall coverage was estimated to be 5%.
- Weighted parametric and non-parametric sampling variances of the estimates of catch rates at zone-month level were computed.
- A methodology for retrospective geo-referencing of fishing grounds was finalised and as a test case five major landing centres of Kerala coast were focussed and a two-year trip map of fishing units prepared.

Status of Resources

Estimates of landings by different marine fish species were classified into 26 resource groups and a miscellaneous group and six decades data (1950-2010) on landings of each resource group were analysed by comparing consecutive decadal averages using Student's t for testing their significant differences. Coefficient of variations (CV) were also worked out for each decade. A simple criterion proposed by Mohamed et al. (2010) was used to assess the present status of stocks of different resources by classifying the stocks.



Elasmobranchs landings have shown high growth rate initially, it reduced later and had negative growth in the last decade. In the later half of the last decade there is slight increase in elasmobranches landings though statistically not

significant. Catfish landings fluctuated in an oscillatory manner and have shown high growth rate in the last decade. In the study on the status of catfishes (Arius spp.) along the Kerala and Karnataka coasts, this resource was classified under the 'collapsed' category (Mohamed et al., 2010). In the present study at the national level, catfishes comes under 'abundant' class. This is because the drastic reduction in the landings of catfishes in Kerala and Karnataka in the later decades might have been compensated by the increased landings in other states.

Positive growth was observed in the landings of clupeids throughout the period with its peak during the last decade. This is mainly due to the increased landings of oil sardine, the major contributor of this group, by extending its areas of intensive harvest to the entire south region both on east and west coasts. In the case of Bombay duck landings, there is positive growth throughout the period though a slower growth rate was observed in the later periods. The landings of silverbellies have shown upward growth from 1965 to 1990 and remained steady thereafter. Except for the period 1991-2000, the landings of pomfret showed positive growth over all decades. For mackerel landings, fluctuations were high during the first four decades and growth rate was maximum during 1991-2000. It showed negative growth during the last decade. Seerfish landings have shown positive growth through out the period with maximum growth during 1991-2000 and minimum during the last decade. The landings of tuna have shown steady growth from 1975 onwards and the growth rate gradually reduced over decades. Similarly, Barracudas landings have shown steady growth from 1981 onwards. Mullets landings have shown increase upto 2000 and slightly declined in the last decade. Unicorn cod landings have reduced over decades and its landings is very low during the last decade. Landings of flatfishes remained low until 1980, it showed increasing trend during the next two decades and the catch slightly reduced during the last decade. The crustaceans landings showed steady increasing trend from 1970 onwards and during the last decade the growth was only 2%. A consistent growth was observed in molluscs landings from 1975 onwards and the maximum

growth was observed during 1971-2000. The growth was comparatively low during 2001-2010.

Resources that have shown improvement in percentage contribution towards total landings during the last decade compared to 1950-60 period are clupeids, lizard fishes, perches, goatfishes, ribbonfish, carangids, seer fishes, tunnies, barracudas, mullets, flatfishes and molluscs. Crustaceans maintained the same level of percentage contribution. When the average annual landings of the different resources in the last decade were compared with that of 1950-60 it was found that only in the case of unicorn cods the average landings has come down. If we compare the average landings in the last five years (2006-10) with that during 1950-60 the resources for which the average landings have come down are flying fishes and unicorn cod. Similarly, when the average landings in the last five years were compared with that during 1981-90 (first decade in phase three), the average landings have come down for elasmobranches, flying fishes, big jawed jumber and unicorn cod.

The resources that have shown increase in average decadal landings through out the period are clupeids, Bombay duck, lizard fishes, half beaks and full beaks, perches, goatfishes, seer fishes, tunnies, barracudas and molluscs. In the last decade, the resources that have shown reduction in average landings in the second half compared to the first half are elasmobranches, Bombay duck, flying fishes and unicorn cod. But none of these reductions in landings are statistically significant. Resources that have shown significant increase in average annual landings in the second half of last decade compared to the first half are eels, clupeids, silverbellies, pomfrets and tunnies.

Criteria used for fish stock classification

Stock classification	Recent average catch in historical maximum (%)
Abundant	> 70

Less abundant	50 – 69
Declining	11 – 49
Depleted	6 – 10
Collapsed	< 5

Classification of different resource groups based on last three year average landings

No.	Resource group	2008-10 Average	Maximum so far	Year	%	Status
1	ELASMOBRANCHS	48355	75304	1997	64.21	Less abundant
2	Eels	11462	12997	1977	88.19	Abundant
3	Catfishes	94376	107573	2009	87.73	Abundant
4	CLUPEIDS	877576	929404	2010	94.42	Abundant
5	BOMBAYDUCK	108110	137790	1981	78.46	Abundant
6	LIZARD_FISHES	56612	59497	2009	95.15	Abundant
7	H$F_BEAKS	5628	6993	2000	80.48	Abundant
8	FLYING_FISHES	1149	13163	1989	8.73	Depleted
9	PERCHES	229906	251740	2008	91.33	Abundant
10	GOATFISHES	28498	33298	1991	85.58	Abundant
11	THREADFINS	10075	14846	1957	67.86	Less abundant
12	CROAKERS	188410	199740	1998	94.33	Abundant
13	RIBBON_FISHES	151399	235045	2006	64.41	Less abundant
14	CARANGIDS	164066	196868	1995	83.34	Abundant
15	SILVERBELLIES	71360	91538	1983	77.96	Abundant
16	B.J.JUMBER					
17	POMFRETS	52173	54217	1983	96.23	Abundant
18	MACKERELS	204077	291077	1989	70.11	Abundant
19	SEER_FISHES	50260	60801	2007	82.66	Abundant
20	TUNNIES	64462	79687	2008	80.89	Abundant
21	BILL_FISHES	7852	9073	2009	86.54	Abundant
22	BARRACUDAS	22330	24782	2010	90.11	Abundant
23	MULLETS	6880	9976	1994	68.97	Less abundant
24	UNICORN_COD	621	14566	1953	4.26	Collapsed
25	FLAT_FISHES	43970	63344	1992	69.41	Less abundant
26	CRUSTACEANS	480547	502806	1997	95.57	Abundant
27	MOLLUCS	157603	173365	2010	90.91	Abundant

In the analysis of the 26 resource groups for classification following the method suggested by Mohamed et al. (2010), it was found that 18 resources groups fall under ‘abundant’ class, 5 fall under ‘less abundant’ class and 1 each fall under ‘declining’, ‘depleted’ and ‘collapsed’ classes. All the important resource groups fall either under ‘abundant’ class or ‘less abundant’ class indicating good condition of their stock. The groups classified under ‘less abundant’ class

are elasmobranches, threadfins, ribbon fishes, mullets and flat fishes. Big-jawed jumper falls under 'declining' class, flying fishes under 'depleted' class and unicorn cod is the one that falls under 'collapsed' class. The two groups falling under 'depleted' and 'collapsed' classes require immediate management interventions for the recovery of these resources. Also, the one falling under 'declining' need caution and care to prevent further reduction in the stock. The study conducted along the coasts of Kerala and Karnataka status on landings by catfishes (Arius sp.) have classified catfishes under the 'collapsed' category. But at all India level it is abundant as the status in Kerala and Karnataka have been compensated by increased landings in other states.

Revalidation of Potential Yield

For the committee constituted by the Ministry of Agriculture for revalidation of potential yield of the Indian EEZ the potential yield and optimum fleet size for the maritime states West Bengal, Orissa, Andhra Pradesh, Tamil Nadu, Puducherry, Kerala, Karnataka, Goa, Maharashtra and Gujarat, were estimated.

Time series data on species-wise, gear-wise and state-wise marine fish landings and effort in hours of operation for different maritime states in the country during 2000-2008 were used to estimate potential yield for the area up to 100 m depth. The effort in hours were standardized and the time series data on landings for 28 groups were used for estimating potential yield based on Schaefer's model, both linear and non-linear types. The method based on simple high pass filter of the landings time series was also used to estimate potential yield for each state. The time series data on fishing effort used was in hours of operation which was standardized as given below:

Time series data on catch and standardized effort was used to fit the linear version of Schaefer's surplus production model and the potential yield for the species/group was obtained as the MSY where

$$MSY = \frac{-a^2}{4b}$$

with a and b the fitted values of the intercept and slope respectively for the linear relationship of CPUE on effort. In cases where the data does not fit well for the linear relationship, the non-linear version of Schaefer's surplus production model was followed and a genetic algorithm approach was used to estimate parameters of the model and MSY (Sathianandan and Jayasankar, 2009). For fitting linear model the module available in Microsoft Excel was used. For fitting the non-linear version of Schaefer's model the software developed by the division based on genetic algorithm approach was used.

For estimation of maximum sustainable fleet size, the potential yield estimated for a state was grouped into three as Demersal, Large Pelagics and Small Pelagics. The gears that catch these groups were then identified from time series data on gear-wise catch and the potential yield was distributed for each of the identified gears. The average catch per unit effort (CPUE) for the gears were calculated using catch and effort in hours during 2006-2008. By dividing the potential corresponding to a gear with its CPUE, the optimum hours of operations required to harvest the potential yield was obtained. Then for each type of gear the maximum sustainable fleet size was obtained by dividing the optimum hours with the product of trips per annum and hours per trip by the gear.

Potential yield estimates of demersal resources (in tonnes)

Sl.No.	Name of Group/Species	Total	Group Total
	Elasmobranches		85882
1	Sharks	48721	
2	Skates	5540	
3	Rays	31621	
	Perches		264301
4	Rock cods	27216	

5	Pig-face breams	14014	
6	Snappers	7521	
7	Threadfin breams	138886	
8	Bull's eye	33116	
9	Other perches	43548	
10	Catfishes	97700	65329
11	Eels	14822	10173
12	CROAKERS	222312	155796
13	BIG-JAWED JUMPER	11576	5286
14	THREADFINS	14643	9032
15	SILVERBELLIES	80910	60127
16	Indian drift fish		
17	GOATFISHES	24413	
18	LIZARD FISHES	39388	
19	**FLAT FISHES**		61188
	Halibut	1661	
	Flounders	149	
	Soles	59378	
20	Moon fish		
	Pomfrets		68409
21	Silver pomfret	40930	
22	Chinese pomfret	4842	
23	Black pomfret	22637	
24	King fish		
25	Trigger fish		
26	Black ruff		
27	Deep sea shark		
28	Green eye		
29	Other deep sea fishes		
30	Other fishes		
	Shrimps		450062
31	Penaeid prawns	242653	
32	Non-penaeid prawns	207409	
33	Deep sea shrimps		
34	Crabs	61429	57600
35	Stomatopods	35983	33740
36	Lobsters	2107	1976
37	Deep sea lobsters		
	Cephalopods		137296
38	Squids	60255	

39	Cuttlefish	71705	
40	Octopus	5336	
	Bivalves		150743
41	Oyster	16060	
42	Clams & cockles	113189	
43	Mussels	21494	
44	Windowpane oyster	0	
45	Gastropods	1951	
46	HALF BEAKS&FULL BEAKS	11624	
47	FLYING FISHES	9943	
48	BILL FISHES	7586	
49	UNICORN COD	1527	
	TOTAL	**1855795**	

Potential yield estimates of pelagic resources (in tonnes)

Sl.No.	Name of Group/Species	Total	Group Total
1	Wolf herring	20727	15894
2	Oil sardine	510501	391483
3	Other sardines	114708	87965
4	Hilsa shad	56985	43699
5	Other shads	11339	8695
6	BOMBAYDUCK	156651	117973
7	**Anchovies**		65753
	Stolephorus	65753	
	Coilia	33472	
	Setipinna	8817	
	Thrissina	6	
	Thryssa	39418	
8	**Other clupeids**	67531	149244
9	RIBBON FISHES	231862	217915
10	CARANGIDS		183321
	Horse Mackerel	37315	
	Scads	52778	
	Leather-jackets	14501	
	Other carangids	78727	
11	Indian mackerel	200830	200839
	Other mackerels	9	
12	**SEER FISHES**		75022
	S. commersoni	50270	
	S. guttatus	24610	
	S. lineolatus	90	
	Acanthocybium spp.	52	
13	**TUNNIES**		89383
	E. affinis	38646	
	Auxis. spp	15467	
	K. pelamis	8304	
	T. tonggol	8128	
	Other tunnies	18838	
14	BARRACUDAS	21941	19416
15	MULLETS	18651	7675
	Total	1906927	
	MISCELLANEOUS	74676	
	Total	**3837398**	

Fleet size estimated for different maritime states

Gear	West Bengal	Orissa	Andhra Pradesh	Tamil Nadu	Pondicherry	Kerala	Karnataka	Goa	Maharashtra	Gujarat	Total
Mechanized Multiday Trawlnet	1061	877	1412	927	0	2489	1312	133	883	1462	**10556**
Mechanized Trawlnet	0	121	404	2254	75	1121	729	191	1203	540	**6639**
Mechanized Gillnet	2826	1752	868	201	13	64	0	4	1676	615	**8019**
Mechanized Hooks & Lines	89	5	46	210	0	34	0	0	20	94	**499**
Total Mechanized	4656	2756	2867	3610	88	5055	2182	605	7130	3282	**32232**
Total Outboard	2192	3464	2906	22455	1567	19105	2330	348	1876	3976	**60218**
Total Non-Mechanized	414	977	5467	8634	94	3896	1403	171	1135	956	**23146**

Development of database and software

For the first time in the Institute, individual species level estimates of marine fish landings for different maritime states were made for different months for the years 2007, 2008, 2009, 2010 and 2011 and access database were created for these states with individual species level estimates. The national level database in access was created by combining individual state wise database on species level estimates by incorporating necessary changes in the master database. Estimates of landings for Gulf of Kutch in Gujarat received from the Gujarat state fisheries department were added into the database to finalise

the national individual species level database for these years. Database queries were developed for retrieval of information in tables for different combinations.

Computer software modules in C++ and Visual Basic were developed for the estimation of individual species level marine fish landings and exporting of information into MS Access database. A data entry form exactly similar to the data entry sheets was developed integrating MS Access and Excel for entry of all the information collected from landing centres directly into the database and the field staff were trained to use it for data entry and data transmission through email. For maintaining data quality, a computer software was developed and introduced for checking the suitability of group codes and species codes entered in data files.

A self managing sample selection software has been Devised that works with the MS Access database as the backend and keeps track of the sampling fractions allocated to various zones of all the maritime states. The work programmes issued periodically to field staff located at different centres are now generated in bilingual (Hindi and English) format by the new software. The software has been enriched with a module which keeps track of the expenditure incurred and also of the possible last minute changes taking place in the programmes. As part of sprucing up the marine fish landing database, the species and group codes allotted have been undergoing review. Towards harnessing maximum benefit out of such updated information, a software routine has been developed. The software, CHKSPC, which is compatible with the existing data format can scan the entire set of files and check for the redundancy or inadmissibility of the four digit species code. From the output, the erroneous entries can be pinpointed and corrected.

Digitization of Historic Data

Historic data on marine fish landings available in old data sheets for different maritime states for the period 1971 to 1983 was digitized by deploying data entry operators on contract. As a part of digitization of historical data on marine fish landings, species coding was done for the years 1985, 1986, 1987 and 1988 and the data for these years were digitized into Access database for all the maritime states using the software developed integrating excel and access.

Impact of fishery regulations

Based on 20 years catch and effort time series of four categories of marine fishery resources, possible influence of fishery regulation like trawl ban was studied for all the maritime states of the country for the committee constituted by the Ministry of Agriculture to review the centrally implemented fishing regulations along east and west coast of the country.

PROJECT CODE	**FRA/ASSESS/02**
PROJECT TITLE	Decision support system for marine fisheries management
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CENTRES	Kochi

Project Objectives :

- Develop stock assessment tools in the context of Indian marine fisheries
- Incorporate Bayesian and other advanced methods to account for uncertainty in stock assessment models.
- Develop macro analytical models for assessment of marine fish stocks.
- To review the existing methodology in stock assessment, develop methods suitable to the tropical multi-species and multi-gear systems and development of software for fish stock assessment.

Details of work carried out under the Project:

- **Study of biomass dynamic model amenable for Bayesian analysis.**

  With the paradigm shift in the outlook towards model assisted stock assessment, inclusion of uncertainty at the parametric level has been hogging the limelight. With a view to incorporate the priori distribution and the related uncertainties, it has been taken up with the study of biomass dynamic growth models. For the normal catch and effort data the Fox variant of the Schaefers model has been focused upon. Routines have been written in R software and trial runs have been completed. For the purpose of incorporating priori

uncertainties MCMC algorithm based Gibbs sampling procedure has been planned with the help of Systat V12 and WINBUGS.

- **Searching for non-informative priors**

  Non-informative priors have been targeted initially for their robustness and manipulative ease. For the four parameters of the Schaefer' s model viz, Carrying capacity, intrinsic rate of growth, catch ability coefficient and initial biomass, various priors like rectangular, log normal, gamma and normal priors were tested. It was decided that the parameters may be given gamma priors and the error may by allotted Gaussians prior. Coding is underway using BUGS software.

  Apart from the assistance given by BUGS, a module available with the recently procured Systat V-12 package was also tested. The Monte Carlo- Markov Chain algorithm (MCMC algorithm) for Gibbs sampling was given trial runs for testing their suitability for Fisheries studies.

- **Programme code for Bayesian estimation of parameters**

  Developed the necessary programme code for Bayesian estimation of parameters of nonlinear Schaefer' s model using time series data on catch and effort with the help of WinBugs general purpose Bayesian estimation software. The developed code is given below.

```
model {
#Prior distribution of K is lognormal with 10% and 90% quantiles at 80 and
3000
K ~ dlnorm(5.042905,3.7603664) C(10,1000)
#Prior distribution of r: lognormal with 10% and 90% quantiles at 0.13 and
0.48
r ~ dlnorm(-1.38,3.845) C(0.01,1.2)
#prior distribution of q: instead improper (proportional to 1/q) use just
proper IG
iq ~ dgamma(0.001,0.001) C(0.5,100)
q <- 1/iq
```

```
#Prior distribution of sigma2: inv. gamma with 10% and 90% quartiles at 0.04
and 0.08isigma2 ~ dgamma(3.785518,0.010223)
sigma2 <- 1/isigma2
#Prior distribution of tau2: inv.gamma with 10% and 90% quartiles at0.05
and 0.15
itau2 ~ dgamma(1.708603,0.008613854)
tau2 <- 1/itau2
#Conditional prior distributions of Ps from state equations
Pmed[1] <- 0
P[1] ~ dlnorm(Pmed[1],isigma2) C(0.001,2.0)
for (t in 2:N){
Pmed[t] <- log(abs(P[t-1]+r*P[t-1]*(1-P[t-1])-C[t-1]/K))
  P[t] ~ dlnorm(Pmed[t],isigma2) C(0.001,2.0)
}
#Sampling distribution
for (t in 1:N){
  Imed[t] <- log(q*K*P[t])
  I[t] ~ dlnorm(Imed[t],itau2)
}
#Further management parameters and predictions
MSP <- r*K/4
EMSP <- r/(2*q)
P2008 <- P[N]+r*P[N]*(1-P[N])-C[N]/K
B2008 <- P2008*K
}
```

- **Multi-species analysis of marine fisheries using macro analytical approaches**

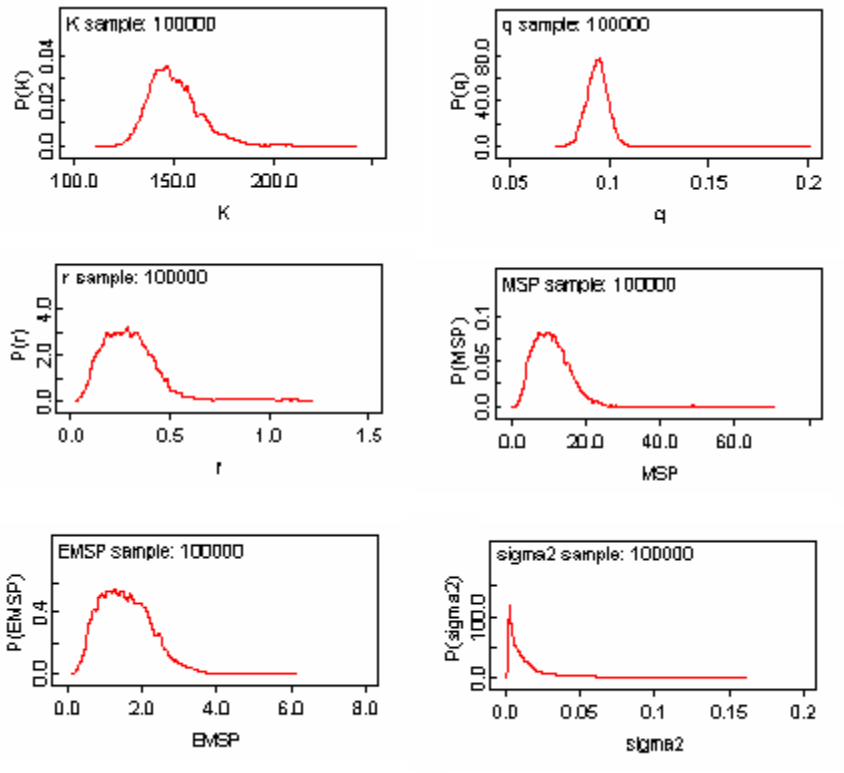
Multispecies analysis carried out using biomass dynamic models for Bombay duck and Hilsa landings of West Bengal. Biomass dynamic models can be modified to account for competitive and predation interaction between species. For a two-species case, the biomass at time t+1 is

$$B_{t+1} = B_t + rB_t\left(1 - \frac{B_t}{k} - cX_t\right) - C_t$$

where B_t is the biomass of the stock at time t, X_t is the biomass of the competing species , and c is a parameter that how much a unit of biomass of C_t reduces the relative growth of B, is the catch of the stock at time t and r and k have the usual Schafer model meanings . Effort standardisation was done using Nelder Mead algorithm using SAS

- **Bayesian analysis of catch and effort data of Tamil Nadu**

  To study the suitability of various options software which work based on the Markov Chain Monte Carlo (MCMC) algorithm of Gibbs Sampling were attempted. The OpenBugs, which is an open source effort to dish out MCMC based Bayesian analysis, was used to study the state-space models on various fisheries of India. The 15 year catch and effort data of Tamil Nadu were analysed using OpenBugs with 10000 replications using a modified lognormal - inverse gamma combination. The posterior densities of important parameters were plotted and the results were compared with the traditional estimates.



Bayesian probability density estimates of model parameters, maximum sustainable yield and biomass obtained for the surplus production model using time series data on catch and effort for Tamil Nadu.

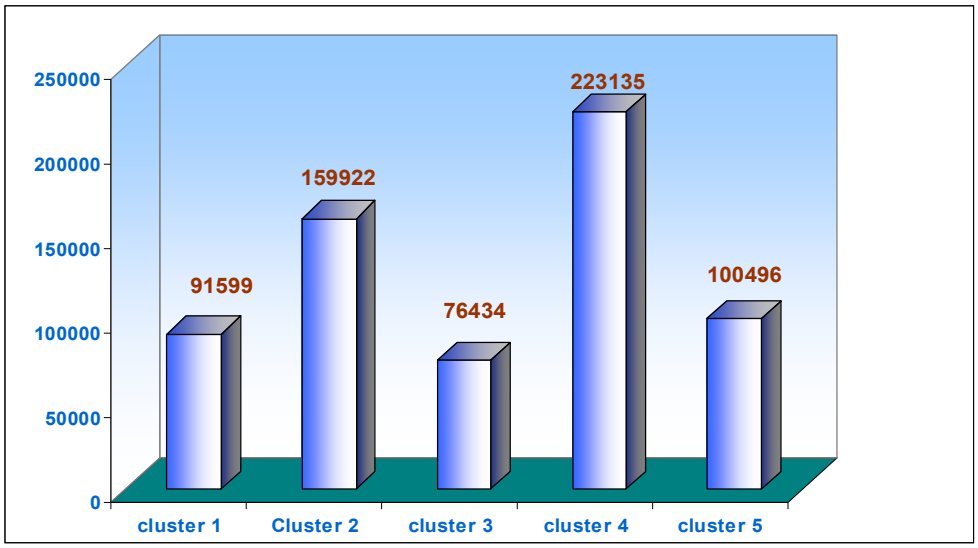
- **Posterior estimates of parameters of prominent fisheries of West Bengal**

  Assuming a state-space variant of the Schaefer' s model as the one which explains the relationship between effort and biomass, 100000 simulated runs were made using the WinBUGS software. The prior distributions assumed were inverse gamma for the precision of parameters, variances. The index and the biomass were assumed to have log-normal distribution. The input given were the catch and CPUE combos based on standardized efforts for the two main resources of West Bengal, viz., Bombay duck and Hisa shad. The posterior distribution and corresponding MSY estimates are given below:

- **Classification of the major fisheries harbours/centres (single centre zones)**

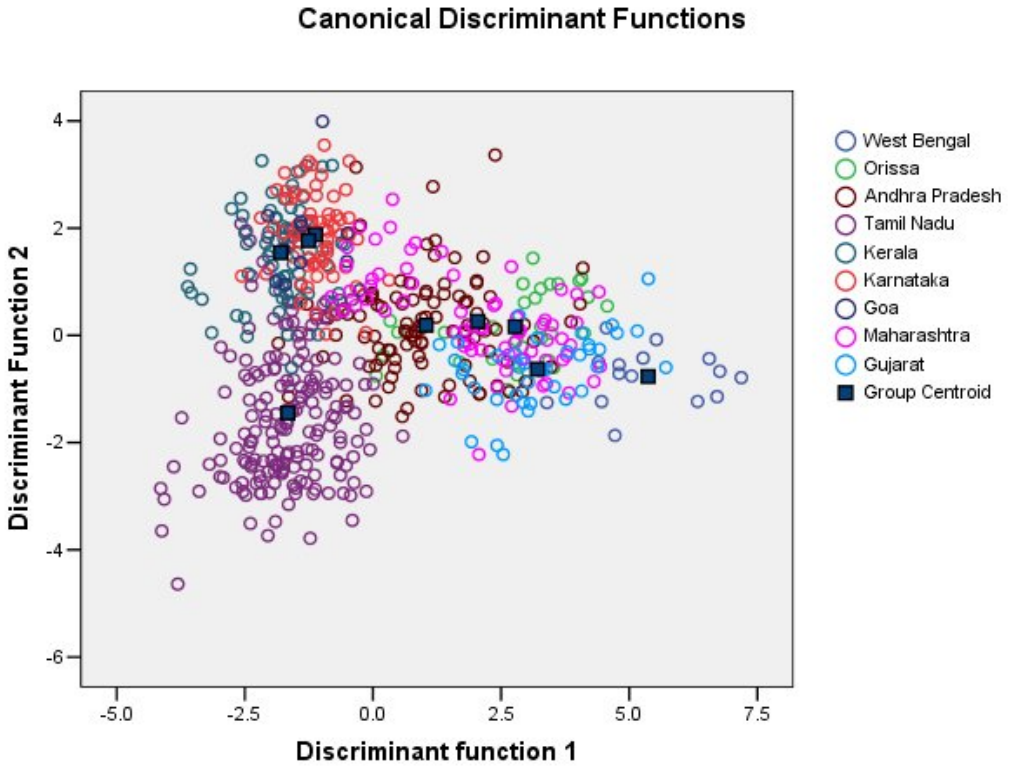
Cluster Analysis was done to classify the major fisheries harbours/centres which are classified as single centre zones based on monthly and annual marine fish landings during the five year period 2002-2006.

Clusters based on annual landings



- **Spatial and temporal distribution of commercial fisheries resources along the Indian coast**

  Spatial and temporal distribution of commercial fisheries resources along the Indian coast using discriminant analysis.



Scenarios of the coastal fisheries using surplus production model:

Using the commonly applied Schaefer's surplus production model attempts were made to study the impact of monsoon trawl ban on fisheries. The ban which has been introduced at different years in different states was considered as an effort reduction intervention and the path followed by the predicted Biomass of major resources of the state before and after the introduction of the ban was traced. In the post ban scenario another route was traced with assumed effort had there not been an effort reduction in the quarter concerned. The results of this analysis were quite different for different resources and there were patterns across the regions viz North West, South West, North East and South East.

The prominent resources considered were the following:

(i) Penaeid Prawns

(ii) Silverbellies

(iii) Threadfin Breams

(iv) Ribbon fishes

Apart from them for completion of conceptualisation and to further the isolation of impact of trawl ban some non-trawl specific species like oil sardine, mackerel etc were also focussed for a biomass dynamic model based study. The method adopted for this study is the use of catch rates computed based on the landings of the resource and the standardised effort of the particular group of gears concerned. For a comprehensive assessment gears were categorised into

(i) Seines

(ii) Trawl

(iii) Lines and variants

(iv) Gillnet

(v) Bagnet

(vi) Others

For the effort moderation the following algorithm was adopted:

(i) The catch and effort were pooled for major resources quarter-wise for each maritime state.

(ii) If the state belonged to the West coast the effort moderation quarter was assumed to be the third quarter. For the East coast it was assumed to be the second quarter.

(iii) The efforts used for the analysis were standardised for the target resource amongst all the gears that yielded the resource. The standardisation was based on catch rates (CPH / CPUE).

(iv) For the post ban years the simulated efforts were computed by the imputation of the ban quarter efforts with the average of the preceding and succeeding quarters and catches were also accordingly moderated.

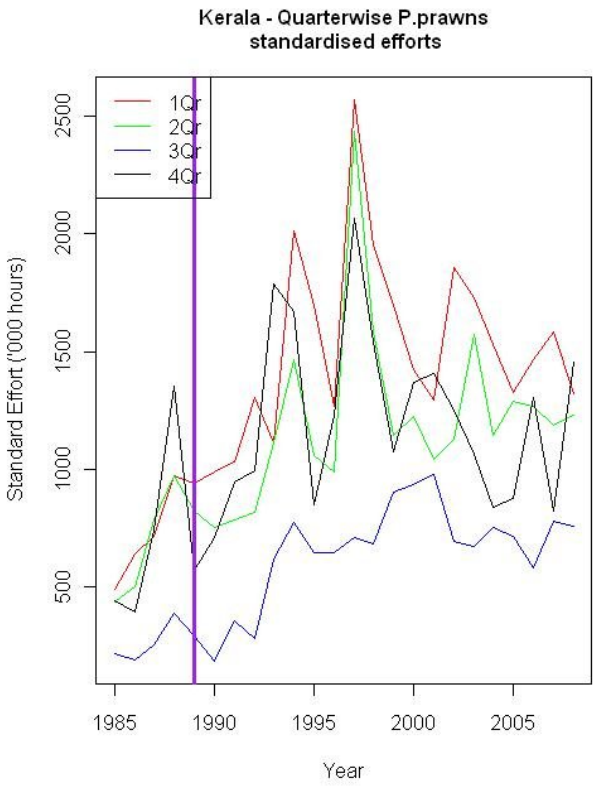
Schaefer's production function was fitted with the actual and moderated efforts for the entire period which ended in 2008. The results obtained for Kerala are given below:

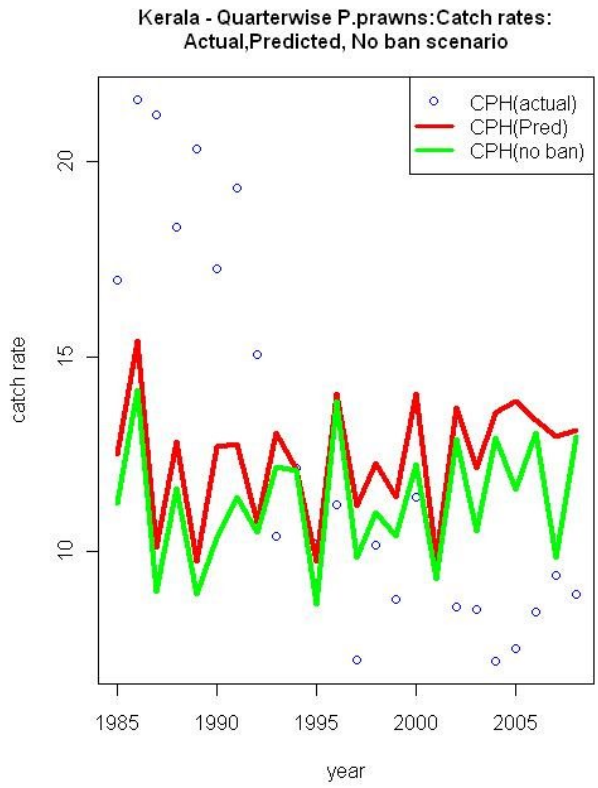
Kerala

This strategically important and technologically state has been the crucible of various developments in the fishing methodology which have been far reaching in terms of influencing neighbouring states as well as inducing many a policy based interventions. The state has been a pioneer in terms of use of outboard ctafts which have revolutionised the motorised sector of the fishery. The non mechanised as well as fully mechanised sectors have to actively consider the impact made by these motorised crafts both in terms of effort as well as catch rate. As most of these crafts remain active throughout the year they have a undeniable say in the resource availability, be it ban or no ban. For our present focus three important trawl resources of the state viz. Penaeid prawns, Cephalopods and Threadfin breams are being considered.

(i) Penaeid Prawns:

The following charts indicate the standardised fishing pressure trend over the quarters as well as the actual rates of catch in Kgs/ hour and the corresponding output of the Schaefer's Biomass dynamic model based estimated catch rate. The second chart also has a trend based on the fishing pressure imputed by using the other quarters of each year post ban scenario which could be taken as the "no ban" scenario with due precautions.



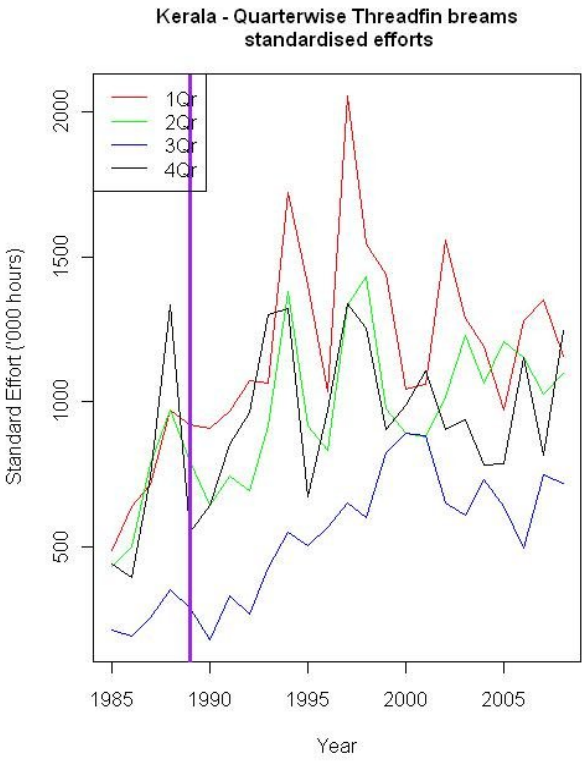


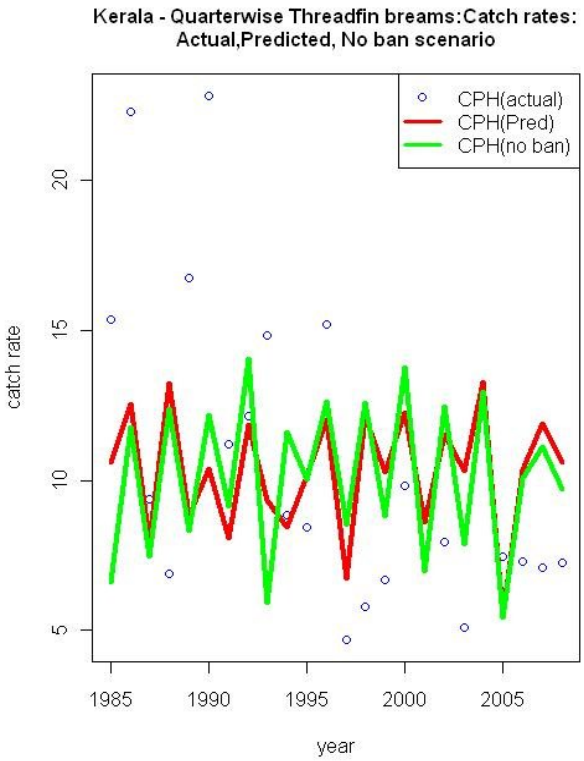
The effort plot shows a clear cut difference between the third quarter efforts and those during the other quarters. The important factor to not is that the pressure was low even before the assumed year of trawl ban impact. The catch rates calculated based on standardised effort for various constituents of trawl sector, indicates a sudden decline since 1990's, a clearcut exhibition of possible unduly high pressure around the period when regulation was imposed, although it cannot be attributed squarely on ban. The CPH could never reach the pre 1990 values of 15+ kg/ hour, but could stabilise around 10 Kg/ hour. Though the "no ban" scenario rate is slightly lower than the actual scenario prediction, it cannot be clearly concluded that ban had a distinct impact on the catch rates which is the most appropriate index of abundance.

(ii) Threadfin breams:

The following pair of charts show the impact of differing fishing efforts over the years on the catch rate of Threadfin breams of Kerala. Similar to the prawn scenario the regulated and "no ban" scenarios throw up almost similar estimates of catch rates which lies around the 10kg/ hour mark. The

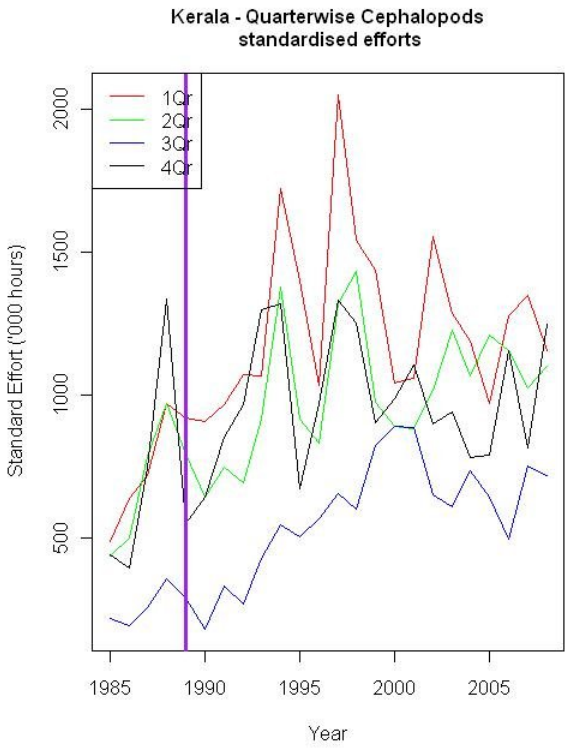
intertwining of the two worms clearly indicate that the abundance of this resource at the face value does not indicate any major difference which the regulation could have made. However the occasional drop in actual CPH to less than 5Kg/ hour is a matter of concern.

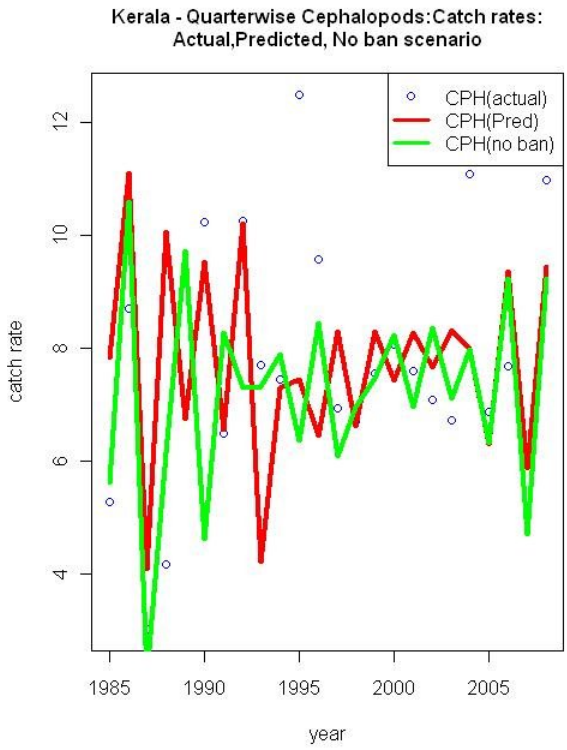




(iii) Cephalopods

The following chart shows the cephalopod scenario of Kerala since 1985. Here again the trends are interwoven





And lie so close to the actual values indicating a clear cut homogeneity of situation. Except for some minor palpable slides in 2003-2004 the "no ban" scenario very closely tows the actual scenario which can substantially weaken the argument that Cephalopods have substantially gained in terms of stock building because of trawl ban.

The summarised result for the impact of different states is given below:

Summary

State	Attribute	P. Prawns	Cephalopods	T. breams	R. fishes	Croakers
WB	Impact	Yes				
	Catch rate	stable				
	Effort	High increase				

OR	Impact	No				No
	Catch rate	Increasing				Declining
	Effort	High increase				High increase
AP	Impact	No			Yes	
	Catch rate	Stable			Stable	
	Effort	Stable			Stable	

State	Attribute	P. Prawns	Cephalopods	T. breams	Silverbellies	Croakers
TN	Impact	Marginal			Yes (collapse around year 2000)	
	Catch rate	Declining			Unstable	
	Effort	Stable			Increasing	
KER	Impact	Marginal	No	Marginal		
	Catch rate	Declining	Stable	Declining		
	Effort	Stable	Stable	Stable		
KAR	Impact	Yes		No		
	Catch	Declining		Increasing		

	rate					
	Effort	Increasing		Increasing		
MH	Impact	No impact post 2000				Yes
	Catch rate	Declining				Declining
	Effort	Stable				Stable
GUJ	Impact		Marginal			Yes
	Catch rate		Stable			Wavering
	Effort		Stable			Increasing

Using time series data on catch and effort by trawlers in Tamil Nadu during 1990-2010. Bayesian estimation of posterior probability densities of biomass indices, parameters of surplus production model and maximum sustainable yield were made.

Percentages of important species/groups in trawl landings in Tamil Nadu are

		Min	Max
1	SILVERBELLIES	11.12	26.80
2	Penaeid prawns	5.29	10.56
3	Other carangids	3.17	5.55
4	Cephalopods	4.00	7.60
5	Other sardines	2.65	9.48

6	Other perches	3.04	5.64
7	Pig-face breams	3.57	3.57
8	Crabs	2.95	4.31
9	CROAKERS	2.44	3.87
10	Non-penaeid prawns	3.45	3.45

- The computer software used for Bayesian estimation was WinBugs version 3.0.3 developed by the Medical Research Council Biostatistics Unit, Cambridge and Imperial College School of Medicine, London under the BUGS Project (windows version).
- Prior distributions for K and r were taken as lognormal
- Prior distribution for q was taken as Inverse gamma
- Prior distributions for process error variance and observation error variance were taken as Inverse gamma
- Prior distribution parameters were calculated by setting up 10% and 90% quantiles based on initial estimates
- Calculations for obtaining estimates of prior distribution parameters for lognormal and inverse-gamma probability distributions were made using alpha-beta solver software.
- Necessary WinBugs command script for the model were developed, model compiled and initialized before running the estimation updations
- For estimation based on the Markove Chain Monte Carlo estimation using Gibbs sampling 5 lakh updations were made and initial 1 lakh updations were ignored for the sake of convergence
- Iteration history and posterior probability density were examined after completing the updations

Schaefer model is: $$B_t = B_{t-1} + rB_{t-1}(1 - \frac{B_{t-1}}{K}) - C_{t-1}$$

$$I_t = qB_t$$

Bayesian non-linear state-space version of the above model used is

$$P_t = \frac{B_t}{K}$$

$$P_1 / \sigma^2 = e^{u_1}$$

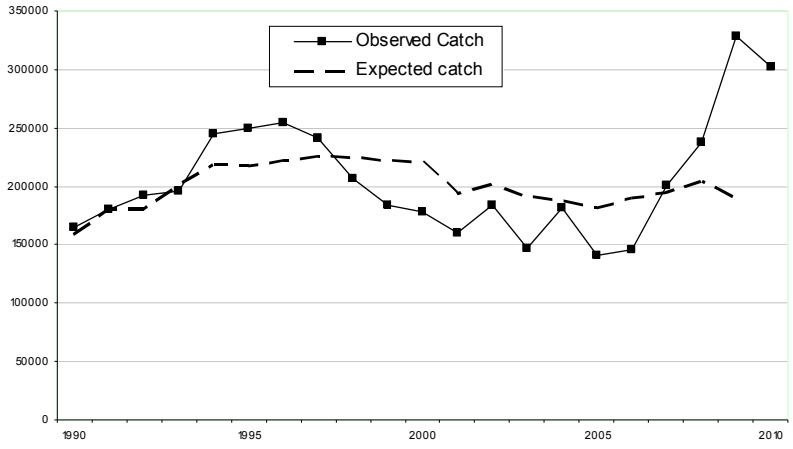
$$P_t / P_{t-1}, K, r, \sigma^2 = [P_{t-1} + rP_{t-1}(1 - P_{t-1}) - \frac{C_{t-1}}{K}]\, e^{u_t}$$

$$I_t / P_t, q, \tau^2 = q\, K\, P_t\, e^{v_t}$$

Parameters of the model to be estimated using Bayesian methodology are

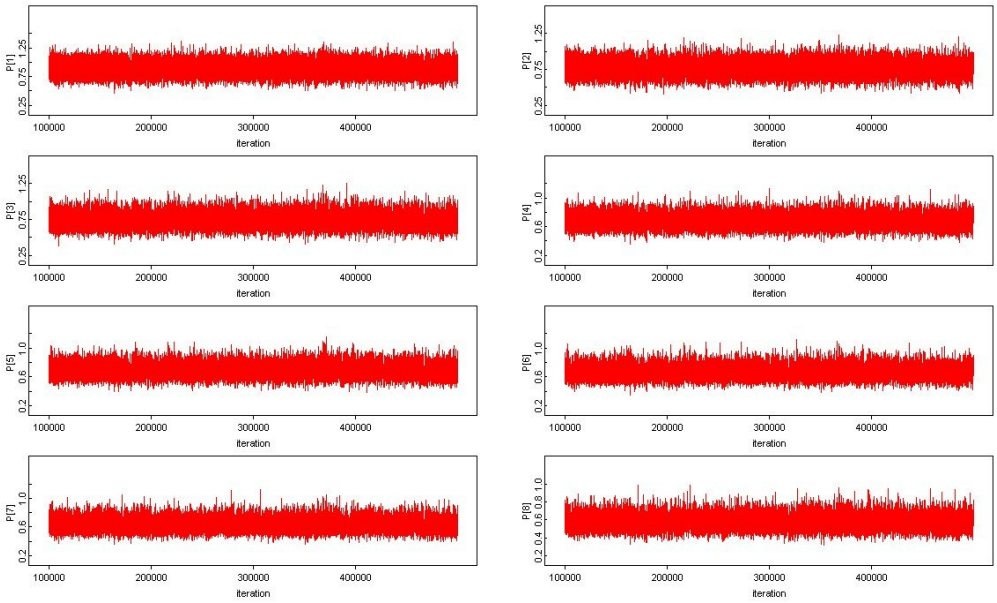
- The sequence of ratio of biomasses to K, Pt
- Carrying capacity, K
- Intrinsic growth rate, r
- Catchability coefficient, q
- Maximum Sustainable Yield (MSY)

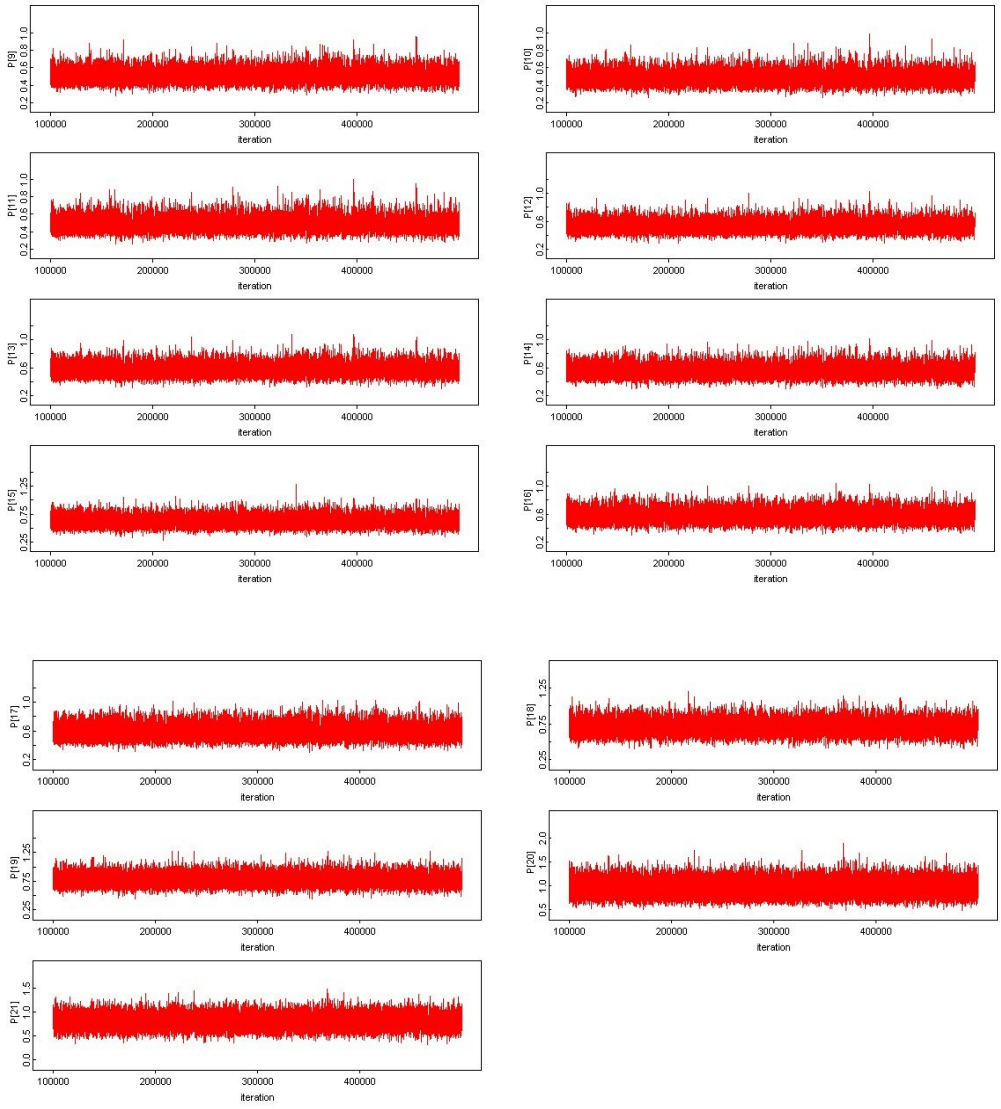
Initial estimates required for the MCMC algorithm using Gibbs sampling were obtained through genetic algorithm approach. The observed catch and expected yield calculated using the model fitted through genetic algorithm are shown below.



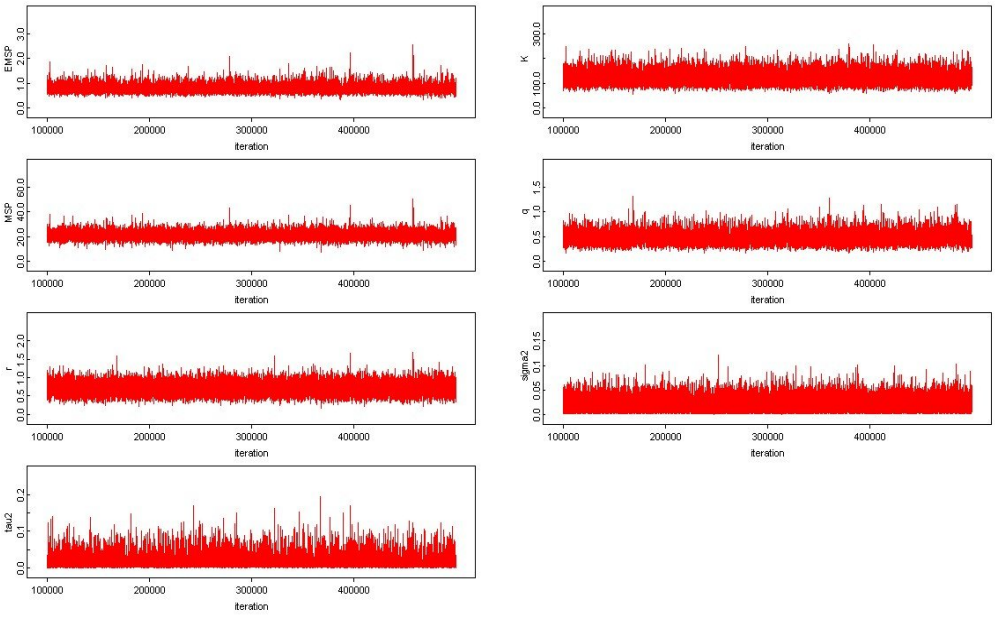
The Bayesian estimate of maximum sustainable yield (MSY) for trawlers in Tamil Nadu is about 2,11,000 tonneswhere as the average annual landings of trawlers in the state is 2,03,000 tonnes which is below the MSY level. As the difference is only 8,000 tonnes we may conclude that the present level of exploitation by trawlers in Tamil Nadu is almost near the optimum level.

History of Markove Chain Monte Carlo (MCMC) simulations carried out for estimation of the biomass indices P[1], P[2], ..., P[21].

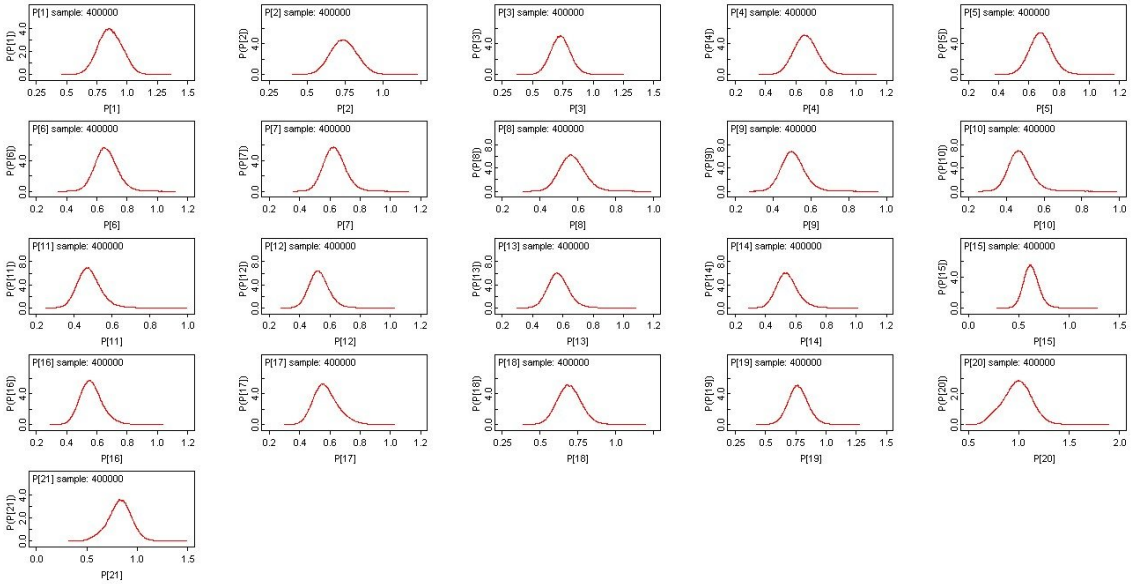


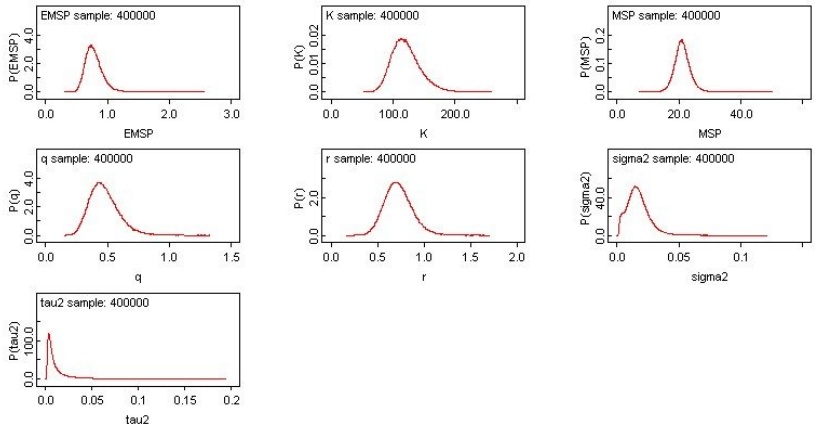


History of Markove Chain Monte Carlo (MCMC) simulations carried out for estimation of the other parameters .



Estimated posterior densities of biomass indices and other parameters.





Summary table of estimates of parameters

	mean	sd	MC_error	val2.5pc	median	val97.5pc
P[1]	0.8606	0.0993	0.0015	0.6712	0.8581	1.0550
P[2]	0.7419	0.0873	0.0014	0.5764	0.7402	0.9159
P[3]	0.7313	0.0817	0.0014	0.5755	0.7300	0.8976
P[4]	0.6655	0.0786	0.0013	0.5173	0.6636	0.8243
P[5]	0.6792	0.0757	0.0013	0.5355	0.6775	0.8346
P[6]	0.6609	0.0736	0.0012	0.5242	0.6577	0.8144
P[7]	0.6307	0.0721	0.0012	0.4989	0.6275	0.7824
P[8]	0.5698	0.0663	0.0011	0.4480	0.5669	0.7092
P[9]	0.5050	0.0612	0.0011	0.3938	0.5019	0.6345
P[10]	0.4745	0.0608	0.0011	0.3669	0.4706	0.6059
P[11]	0.4796	0.0632	0.0011	0.3695	0.4750	0.6182
P[12]	0.5289	0.0662	0.0012	0.4096	0.5253	0.6706
P[13]	0.5713	0.0700	0.0012	0.4440	0.5679	0.7208
P[14]	0.5431	0.0708	0.0012	0.4173	0.5385	0.6978
P[15]	0.6241	0.0752	0.0013	0.4855	0.6205	0.7825
P[16]	0.5633	0.0743	0.0013	0.4317	0.5582	0.7255
P[17]	0.5745	0.0820	0.0014	0.4336	0.5666	0.7560

P[18]	0.6926	0.0794	0.0014	0.5433	0.6905	0.8541
P[19]	0.7691	0.0822	0.0013	0.6134	0.7667	0.9377
P[20]	0.9850	0.1440	0.0017	0.6989	0.9887	1.2630
P[21]	0.8253	0.1196	0.0015	0.5732	0.8299	1.0510

	mean	sd	MC_error	val2.5pc	median	val97.5pc
EMSP	0.7804	0.1399	0.0023	0.5591	0.7634	1.0970
K	120.7000	22.9700	0.2819	82.6000	118.3000	172.5000
MSP	21.1000	2.5480	0.0280	16.4100	20.9700	26.5000
q	0.4736	0.1174	0.0019	0.2832	0.4601	0.7427
r	0.7222	0.1502	0.0018	0.4581	0.7121	1.0460
sigma2	0.0168	0.0087	0.0001	0.0029	0.0159	0.0369
tau2	0.0102	0.0105	0.0001	0.0017	0.0065	0.0406

Bayesian analysis of marine fish landings in Kerala

Time series data on total marine fish landings and fishing effort expended in terms of hours of operation for the period 1990 to 2010 corresponding to the maritime state of Kerala, was used here for estimation of posterior probability distributions of maximum sustainable yield (MSY) through Bayesian approach. The OpenBugs software, a Markov Chain Mote Carlo (MCMC) based Bayesian analysis tool, was used to study the state-space models of the fisheries of Kerala. OpenBugs codes for non-linear Schaefer model were used. The prior probability distributions for the Schaefer model parameters such as carrying capacity (K), intrinsic rate of growth (r), Virgin Biomass (B) and catchability coefficient (q) were also used as inputs for estimation in addition to the time series data on catch and effort. Informative Gaussian priors were used for K and r, non-informative Gamma priors were used for q, informative;

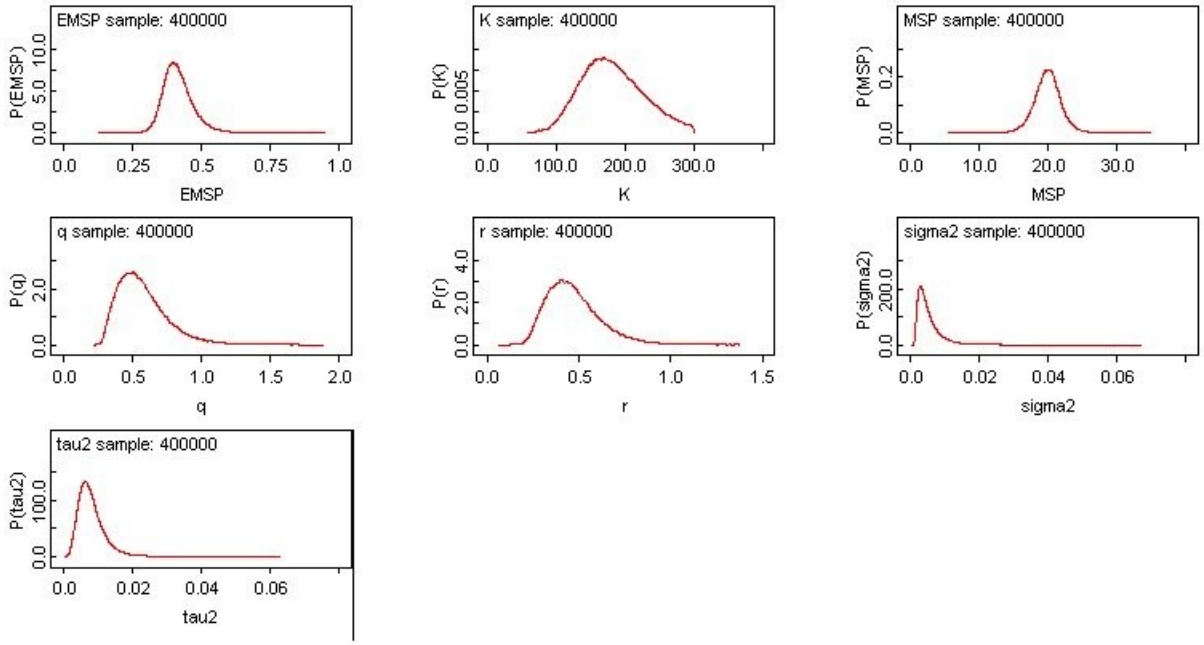
lognormal priors were used for B , informative inverse Gamma priors were used for process error variance and non-informative inverse Gamma priors were used for observation error variance. The mean, median, standard deviation and 97.5% confidence intervals were also worked out for all the parameters.

The Bayesian estimate of maximum sustainable yield (MSY) for trawlers in kerala is about 1,98,900 tonneswhere as the average annual landings of trawlers in the state is 1,59,179 tonnes which is below the MSY level. As the difference is 40,000 tonnes we may conclude that the present level of exploitation by trawlers in Kerala is below the optimum level.

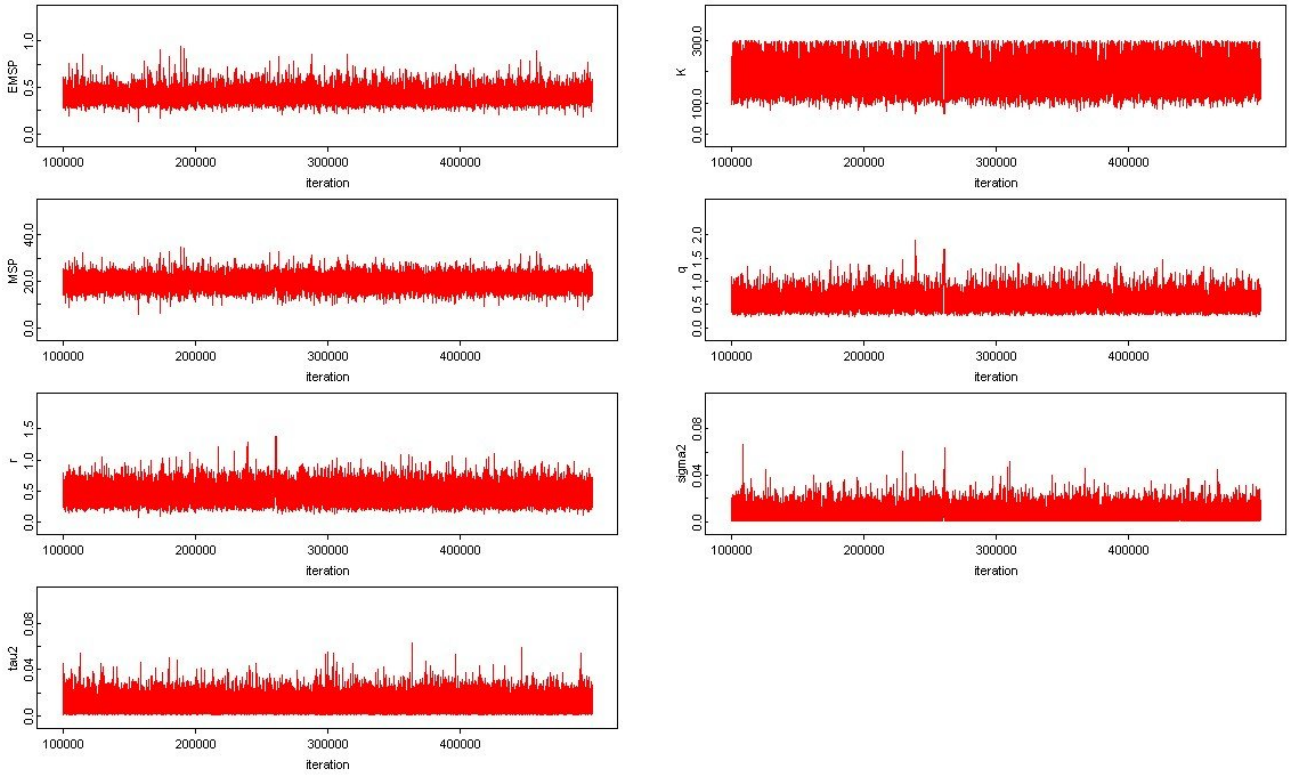
Estimates of parameters

	mean	sd	MC_error	val2.5pc	median	val97.5pc	start	sample
EMSP	0.4154	0.0556	0.00113	0.3266	0.4085	0.5432	25001	275000
K	178.2000	43.2000	1.32700	104.7000	173.4000	273.9000	25001	275000
MSP	19.8900	1.9420	0.02319	15.9300	19.9000	23.8100	25001	275000
iq	1.8750	0.5348	0.01702	1.0030	1.8080	3.0660	25001	275000
q	0.5794	0.1740	0.00545	0.3262	0.5532	0.9970	25001	275000
r	0.4781	0.1445	0.00406	0.2541	0.4591	0.8187	25001	275000
sigma2	0.0051	0.0032	0.00005	0.0015	0.0042	0.0136	25001	275000
tau2	0.0078	0.0037	0.00003	0.0026	0.0071	0.0168	25001	275000

Posterior densities of parameters estimated



History of simulations carried out for parameter estimation.



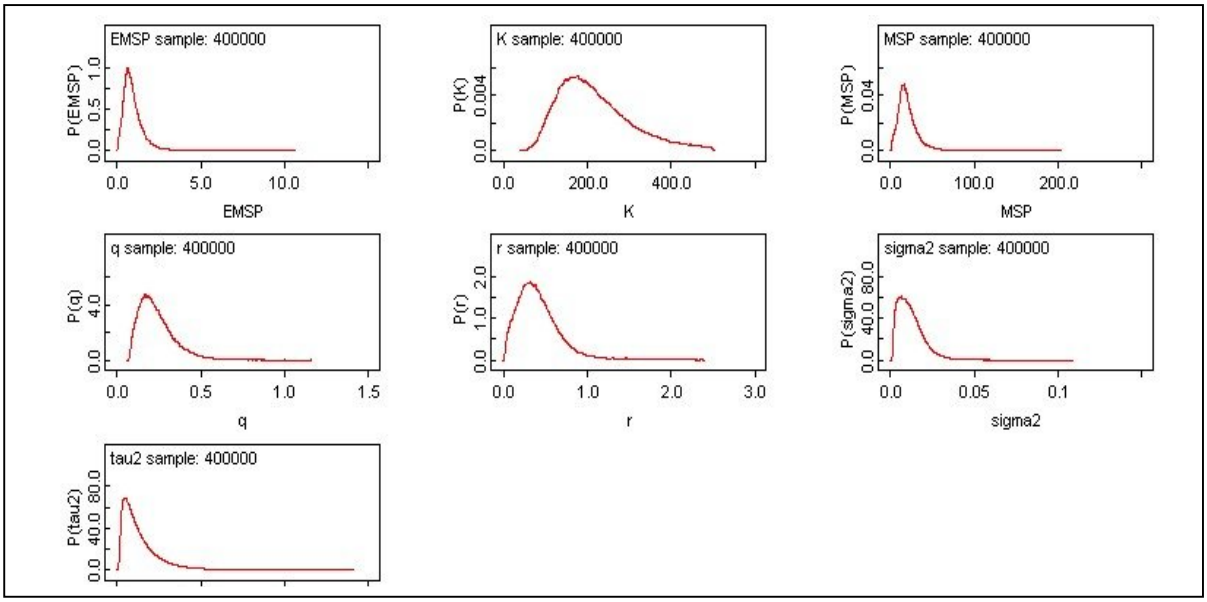
Bayesian analysis of marine fish landings in Karnataka

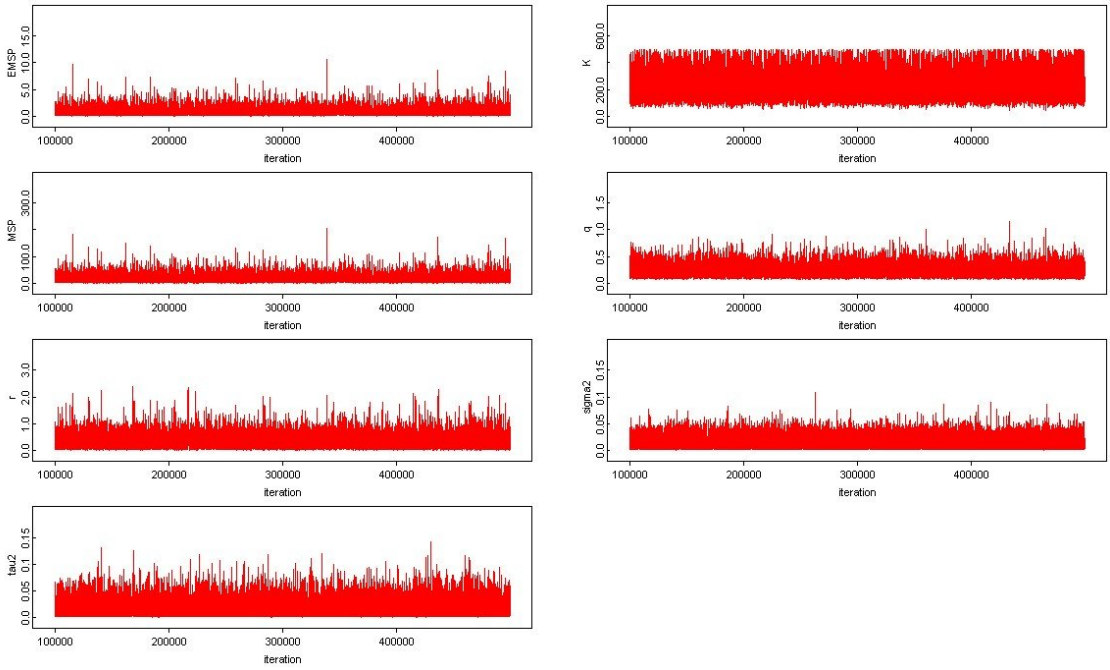
The Bayesian framework allows incorporation of prior information in to the scientific decision process. It also allows to have the estimates of posterior densities of the parameter of interest in addition to that of the parameters the model used. Time series data on total marine fish landings and fishing effort expended in terms of hours of operation for the period 1990 to 2010 corresponding to Karnataka was used for estimation of posterior probability distributions of maximum sustainable yield (MSY) through Bayesian approach.

The prior probability distributions for the Schaefer model parameters such as carrying capacity (K), intrinsic rate of growth (r), Virgin Biomass (B0) and catchability coefficient (q) were also used as inputs for estimation in addition to the time series data on catch and effort. Informative Gaussian priors were used for K and r, non-informative Gamma priors were used for q, informative lognormal priors were used for B0, informative Inverse Gamma priors were used for process error variance and non-informative inverse Gamma priors were used for observation error variance. The OpenBugs, computer software for Bayesian estimation using Markov Chain Monte Carlo algorithm (MCMC), was used to get the estimates of posterior densities of all the parameters and MSY. The mean, median, standard deviation and the confidence intervals were also worked out for all the parameters and are given below.

	mean	sd	MC_error	val2.5pc	median	val97.5pc	start	sample
EMSP	0.9825	0.6310	0.0145	0.1956	0.8384	2.5800	100001	400000
K	214.8000	83.7900	1.9230	91.8900	200.5000	416.9000	100001	400000
MSP	20.7900	12.3500	0.2792	3.9440	18.3000	51.5500	100001	400000
q	0.2366	0.1069	0.0027	0.0969	0.2140	0.5019	100001	400000
r	0.4349	0.2814	0.0077	0.0645	0.3848	1.1650	100001	400000
sigma2	0.0116	0.0073	0.0001	0.0021	0.0103	0.0290	100001	400000
tau2	0.0129	0.0100	0.0001	0.0022	0.0100	0.0389	100001	400000

Posterior densities of parameter estimation and history of simulations carried out for parameter estimation





PROJECT CODE	**FRA/IDP/01**
PROJECT TITLE	**Sustainability Profiling of major fisheries off Kerala coast – a Multi Dimensional Scaling Approach**
SCIENTISTS	**J. Jayasankar,** E. Vivekanandan, R. Sathyadhas, ,T.V. Sathianandan, Sharda, P. T., C. Ramachandran, Somy Kuriakose, T.M. Najmudeen, V.P. Vipin Kumar and K.G. Mini
CENTRES	Kochi, Calicut

Project Objectives :

- To formulate and device multi-disciplinary attribute scoring regimen for major fisheries of Kerala
- To identify the strata of participatory respondents involved in the fisheries dynamics

- To cluster and analyse the multi- disciplinary scores of various strata of clientele and profiling
- To validate the profiles by simulation exercises.
- To standardize a set of indicators which uniquely determine the five faceted sustainability of fisheries in Kerala
- To study the progress of fisheries of Kerala from this simultaneous study angle over a longer period.

This project envisages the usage of primary and secondary data with the aim of integrating various aspects of fishing and fishery towards arriving at an unique status on the sustainability of the fishery. The published macro and micro level quantitative as well as qualitative information would be processed for arriving at an indication of the sustainability of the fisheries. The project plans to study the Kerala fisheries and it covers the different gamuts of fisheries like the gear, area and resources. The fisheries targeted are

(i) South, mid and North Kerala fisheries
(ii) Prawn/shrimp fishery and small pelagic fishery
(iii) Seine and trawl fisheries
(iv) Fisheries around major centres like Munambam, Cochin FH, Vypeen, Vizhinjam, Chombala, Pudiyappa, Sakthikulangara and Beypore.

The proposed facets to be compared simultaneously are : Technobiological, Economic, Social, Ecological and Ethical. The clientele are classified into three categories, viz. fishermen, market/ middle men and observers. The issues like code of conduct for responsible fisheries, social conflict etc. were studied in depth so as to be modified to suit to the preparation of questionnaires/ schedules. Fifteen to twenty major aspects under each of the five domains of sustainability observation have been finalised.

Towards having a preliminary opinion about the view of observers on the Kerala fishery, a Delphi sampling procedure was applied to ten field staff of FRAD who were posed with questions related to economic, social, ecological and

technological aspects of the fishery. Their response clearly indicated the above normal performance on the technological front and a very poor performance on the ethical and social fronts. The sampling survey plan is being worked out on the basis of techno-social stratification of the stakeholders.

The primary aim of the project is to project the various fisheries, gear based, resource based as well as location based, on a comparable metric mapping based on multiple facets of factors contributing to sustainability. The project was proposed to cover the fisheries of southern, middle and northern parts of Kerala with specific focus on fisheries of small pelagics, crustacean as also the intra state differences prevailing around major harbours like Neendakara, Munambam and CochinFisheriesHarbour.

1. Finalisation of factors for Ethical and Ecological profiling

The project envisages the usage of primary and secondary data with the aim of integrating various aspects of fishing and fishery towards arriving at an unique status on the sustainability of the fishery. The published macro and microlevel quantitative as well as qualitative information would be processed for arriving at an indication of the sustainability of the fisheries. The project plans to study the Kerala fisheries and it covers the different gamuts of fisheries like the gear, area and resources. The fisheries targeted are

(i) South, mid and North Kerala fisheries
(ii) Prawn/ shrimp fishery and small pelagic fishery
(iii) Seine and Trawl fisheries
(iv) Fisheries around major centres like Munambam, Cochin FH, Vypeen, Vizhinjam, Chombala, Pudiyappa, Sakthikulangara and Beypore etc.

The proposed facets to be compared simultaneously are: Techno- biological; Economic; Social; Ecological and Ethical.An exhaustive list of these facets was made and from that 19 major ethical and ecological factors were identified.

2. Preparation of schedules and questionnaires for the survey

The primary data is planned to be collected in two survey schedules and the clientele are classified into three categories, viz. fishermen, market/ middle men and observers. The mode of data collection is by schedules and questionnaires to be dispatched as per a sampling plan through investigators. The schedules and questionnaires were under preparation for the survey.

As per the programme, rapid appraisal efforts were carried out in two approaches. The first one was the collection and collation of published information on various aspects: biological, technological, economic and social aspects pertaining to the locations under focus. Accordingly, during the past year, published records on the following parameters have been collected and stored as a database.

Attribute Description

- Reference Species name, family name, ISSCAP code etc.
- Locality Where the study was conducted
- Gear Gear used for sampling
- K Annual growth rate
- M Natural mortality
- F Fishing mortality
- Z Total mortality
- t0 Age at genesis
- SSB Spawning stock biomass
- MSY Various estimates of Maximum Sustainable Yields
- Lr Length at recruitment
- L_∞ Asymptotic length
- tr Age at recruitment
- tc Age at first capture

• Apart from these syndicated research output, certain other relevant information on the price fetched by species under focus as well as the trophic levels of the animals under study was also collected and processed to suit analysis.

• To get information on various other issues pertaining to sustainability, parameters of distinct contribution to the facets of social, technological, economic and ethical domains were finalized using the Delphi process involving the experts in the field.

The following is the schematic proportional sampling plan to be executed.

Area	Trawl	Seine	Hooks and Lines
South		VJM	
Middle	CFH, NDK, MUN	CFH	CFH
North	BEY	PUD,CHO	PUD,CHO,BEY

(VJM- Vizhinjam; CFH- Cochin Fisheries Harbour; NDK- Neendakara; MUN- Munambam; BEY- Beypore; PUD- Pudiyappa; CHO- Chombala)

Pilot survey for evaluation of schedules and questionnaires

Prepared questions related to social aspects pertaining to the fishery. The 19 questions were prepared which targeted mainly on

- socialization of fishing
- fishing community growth
- level of knowledge about environmental issues, e
- education level
- level of conflict with other sectors
- fishing income
- opinion on actual fishery regulations
- kin participation

The questions were prepared to target three major groups of respondents, viz core fishermen including owners and labourers, marketing individuals and observers. Apart from the social aspects, questions were prepared to collect information on parameters of distinct contribution to the facets of biological, technological, economic and ethical domains. The schedule consisted of around 65 questions. Pilot survey was conducted at Cochin and Munambam fisheries harbour in Ernakulam district. Personal interview was conducted among 15 persons from these harbours. Around 8 labourers from mechanized, inboard and ouboard boats were interviewed. Boat owners of the above three category were also interviewd. From the interview, most of the fishermen are worried about the between sector competion. Intrusion of unauthorised foreign vessels is another concern. Although most of the fishermen indicate that they would be happy to continue their chosen vocation, almost all turned down the possibility of their progeny getting into the seas. Majority of the core fishermen

interviewed were migrant labourers. The issue of regulated fishing has been welcomed by the fishers in general.

Sustainability profiling of Kerala fisheries

The sustainability profiling of Kerala fisheries, which has been planned to be based on primary as well as secondary data has been pursued by the conduct of the second round of survey involving more than 500 stake holders who are both fisher folk as well as fish marketing database has been populated with the results of the first round of survey wherein 100 stakeholders have been surveyed.

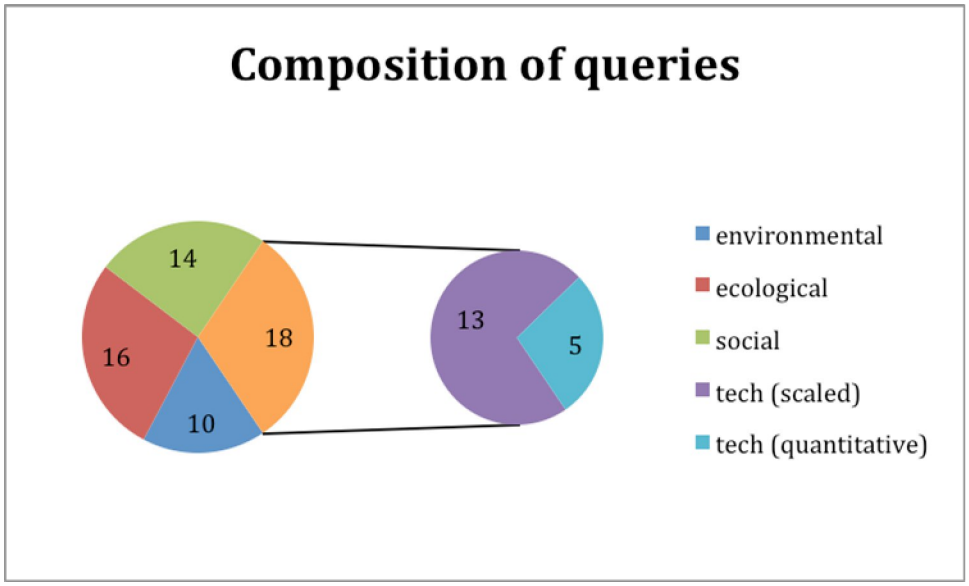
The preliminary analysis of data indicated the near uniformity on the techno-biological facets of sustainability amongst major landing centres of the state whereas the picture was quite variegated on the counts of socio- ecological bench marks.

The technological indicators which summarily define the technological innovations which are of vital importance to measure the extent of development of a fishery were studied and detail. The most appropriate indicators were short listed for further development into schedule/ questionnaire for use during surveys. The main shortlisted items were as follows:

Technological groupings:

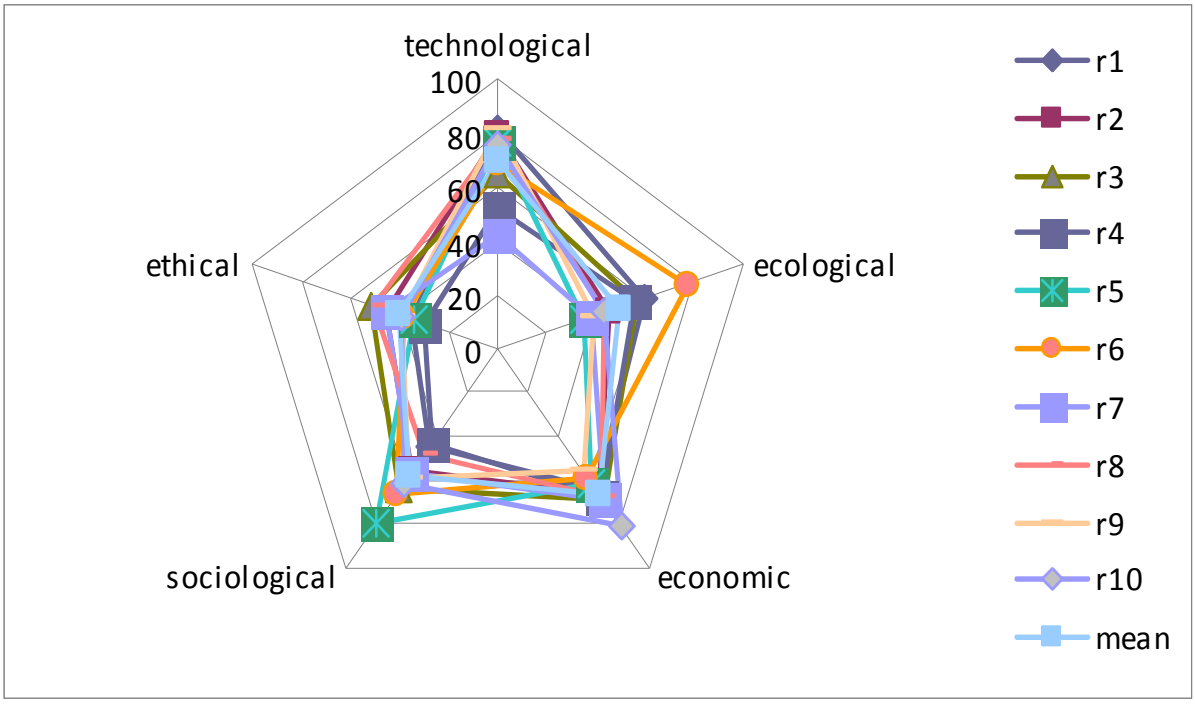
- Trip length - Actual
- Landing centres - Actual
- Presale processing - Qualitative 3 point
- Use of ice etc. - Qualitative 3 point
- Gear - Qualitative 3 point
- Selective Gear - Boolean
- FADs - Boolean
- GPS, Sonar etc. - Dummy variable
- Vessel Size - Qualitative
- Catching power - Ranked
- Gear side effects - Qualitative 3 point

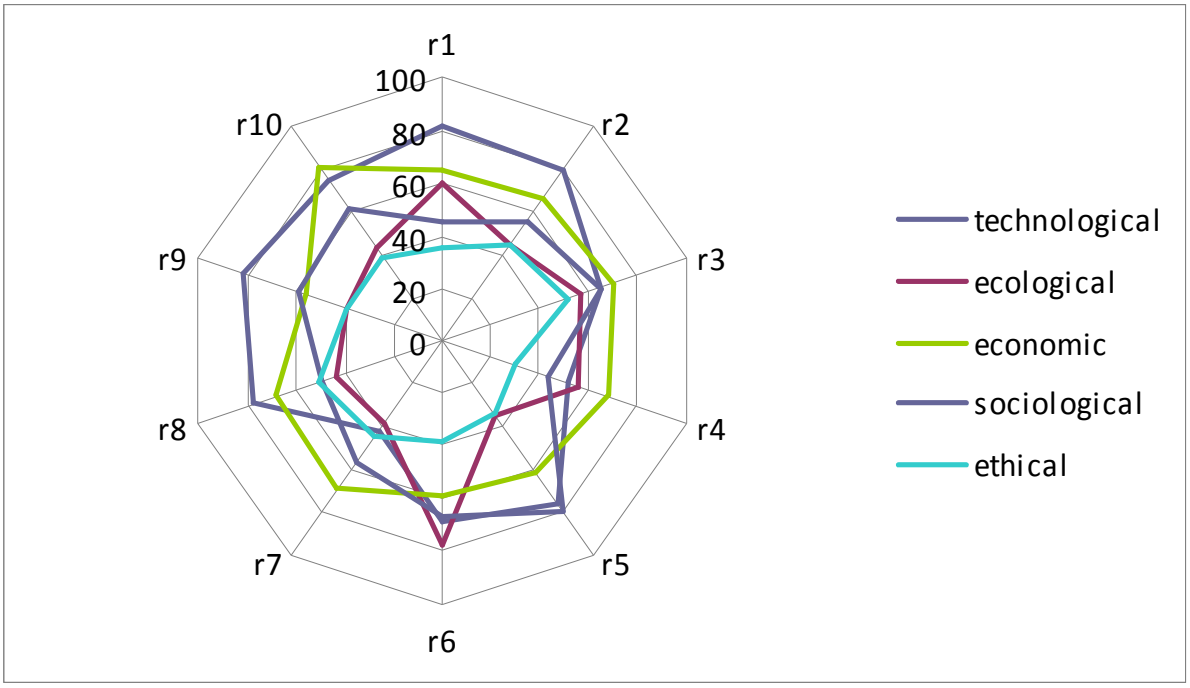
As it can be seen the grouping have been a mixed bag of qualitative and quantitative and efforts have been made to keep the nominal variables within three point scale.



Towards having an preliminary opinion about the view of observers on the Kerala fishery, a Delphi sampling procedure was applied to ten field staff of FRAD who were posed with questions related to economic, social, ecological and technological aspects of the fishery. Their response clearly indicated the above normal performance on the technological front and a very poor performance on the ethical and social fronts.

The spider plots of the response of the surveyed subjects is given below:





Under the project, a second round of sample survey was conducted with enumerators being employed for gathering information based on the social,

economic, biological- technical, ecological and environmental questions for the rating of fisherfolk selected under various zonal- gearwise and occupational grids across the southern, middle and northern regions of Kerala. The summary results are given below:

Survey Coverage	
Zone	Respondents
Central Zone	165
North Zone	146
South Zone	93
Total	404

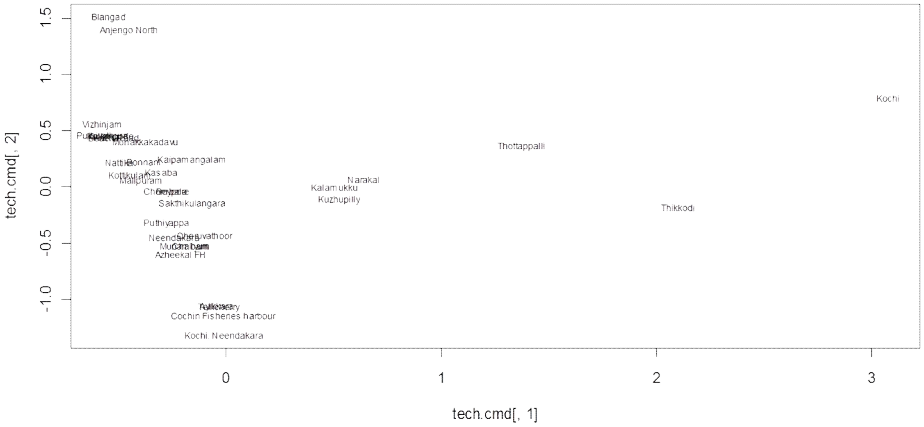
Fishing Category Coverage		
Zone	Category	# of resp.
Central	Core fishing	140
Central	Marketing & Allied	25
North	Core fishing	135
North	Facilitation	2
North	Marketing & allied	9
South	Core fishing	70
South	Marketing & Allied	23

Landing Centres	
Zone	CountOfzone
Aleppey	14
Anjengo	19
Ayikkara	14
Azheekal FH	21
Beach Road	10
Beypore	20
Blangad	10
Chaliyum	10
Cheruvathoor	15
Chombala	20
Cochin Fisheries harbour	15
Kaipamangalam	10
Kalamukku	12
Kasaba	10
Kizhur	5
Kollangode	5
Kottikulam	10
Kuzhupilly	3
Malipuram	9
Munakkakadavu	10
Munambam	20
Narakal	8
Nattika	10
Neendakara	20
Ponnani	14
Puthiyappa	20
Puthiyathura	11
Sakthikulangara	17
Tellicherry	15
Thikkodi	9
Vizhinjam	18

Based on the data collected from the survey, MDS analysis was performed to juxtapose landing points with respect to various domains like technological and economical etc. The snapshots of the results are given below:

MDS

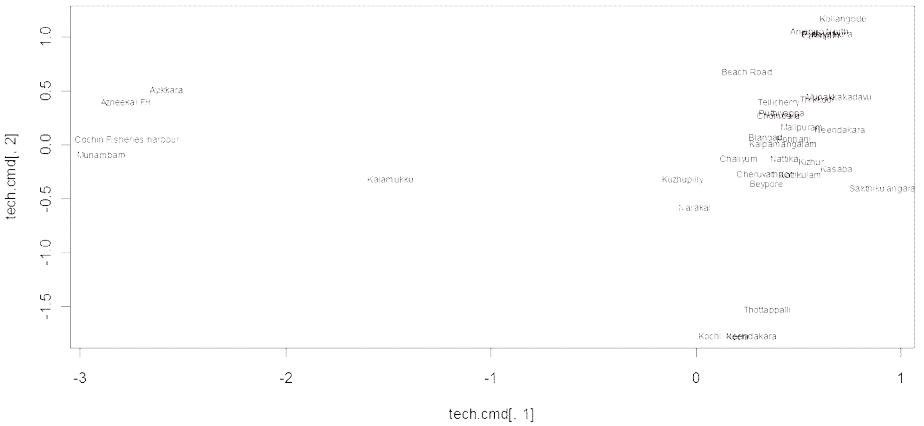
(Scatter Plot of Dimensions-Economics)



MDS

Scatterplot of Dimensions (Technological)

(Classical Non-metric Multi Dimensional Scaling- R language)



The following is the schematic proportional sampling plan to be executed.

Fishery / Area	Trawl	Seine	Hooks and Lines
South		VJM	
Middle	CFH, NDK, MUN	CFH	CFH
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(VJM- Vizhinjam; CFH- Cochin Fisheries Harbour; NDK- Neendakara; MUN- Munambam; BEY- Beypore; PUD- Pudiyappa; CHO- Chombala)

Towards ensuring smooth interaction with the three streams of the clientele viz core fishermen including owners and labourers, marketing individuals and the observers, trial interviews were held at a couple of landing centres. The overall sense was that of break even amongst most mechanised boat owners and that of workable profit among the motorised sector boats. As such the concept of dumping catches into the sea has been out of vogue with whatever caught being brought back as the market offers some price for all the landed resources. As the capital investment seems to be too high the concept of shared ownership is quite prevalent and in such arrangements there are sleeping partners who target their returns both on trip basis as well as on periodic returns basis. The increasing competition and the vagaries of catches within a short duration of time have been the top most points of worry of the fishermen. Although most of the fishermen indicate that they would be happy to continue their chosen vocation, almost all turned down the possibility of their progeny getting into the seas. The risk factor and the returns offered by alternative jobs have further dimmed the prospects of steady stream of new comers towards this business. Inter sectoral conflict is more pronounced than ever. But the silver lining in all these is the awareness and sense of cooperation with the administrators which by far the fisher folk as a real effort to shore up the resources. The issues of regulated fishing has been welcome by the fishers in generals with each coming out with their own version of regulation. The economics of the marketing opportunities heavily weighs in for the fishermen as most of them are ready to change locations, technology and even target resources to match up with the demands. The fishermen in general have a

sense of traditional wisdom standing them in good stead, but they are also not averse to using gadgets like echo sounder and fish finder etc.

The marketing activists have a preconceived knowledge of the daily happenings of the landing centre. They are obviously driven by the marketing pressures with bounties leading to lowering of rates and the scarcity hiking the asking rate. They form parts of networked processing group with better infrastructure facilities and their aim always is to shift the products with best possible time efficiency thereby maximising profit.

The general feeling of the observers is that due to permanent changes in the climate as a result of global warming, catches are steadily dwindling in spite of introduction of more powerful boats. They also feel that fishing has been slowly shifting from the traditional concepts to totally new models of fishing. The fishing methodology adopted also cannot be classified as the traditional ones, they feel.

In all the primary data produced by the survey would help in measuring the status of fisheries vis-a-vis technological, biological and economic attributes apart from very pertinent social factors as well. A judicious admixture of quantitative as well as scaled values could end up providing a best possible picture of various fisheries of the state.

PROJECT CODE	**FISHCMFRISIL201200100001**
PROJECT TITLE	**GIS based management advisory support information system for the marine fisheries sector**
SCIENTISTS	**T.V. Sathianandan,** J. Jayasankar, Somy Kuriakose, K.G. Mini, Grinson George, Wilson T. Mathew **and** Vinay Kumar Vase
CENTRES	Kochi, Veraval

The objectives of the project are (i) estimation of resource wise and region wise marine fish landings along with fishing effort expended (ii) develop a full fledged information retrieval system pertaining to marine fisheries and (iii) develop necessary database queries and front end for database management, processing of raw data, preparation of reports and updation of information.

Year 2012

During the period 2012-13 the Fishery Resources Assessment Division was involved in assessment of exploited marine fishery resources through the national level sample survey following the Stratified Multi-stage Random Sampling design developed by CMFRI and initiated preparations for development of GIS based management advisory support system for sustainable fisheries management.

The salient achievements under the project are:

- Resource wise and gear wise estimation of marine fish landings for the year 2012 was carried out adopting the sampling design for different fishing zones in 9 maritime states and two union territories.
- Individual species wise estimation of landings and gear wise effort were made for each of the states and the National Marine Fish Data Centre of the institute was updated with this information.

- Digitization of historic data on marine fish landings available in old data sheets was also carried out.

- Development of computer software and creation of database with micro information on individual boats landed.

Highlights

- Annual marine fish landings for India registered an all-time high of 3.94 million tonnes in year 2012 compared to 3.82 million tonnes in 2011 showing 3.4% growth with Kerala as the highest contributor, 8.4 lakh tonnes.
- Contribution from the four regions are northwest 11.4 lakh tonnes(29%), southwest 13.9 lakh tonnes(35.2%), southeast 10.1 lakh tonnes (25.5%) and northeast 4.0 lakh tonnes(10.2%)
- Important resources contributed to the total landings are oil sardine (18.3%), perches (8.7%), penaeid prawns (6.4%), ribbon fishes (6.0%) and carangids (5.5%).
- Contributions from pelagic, demersal, crustacean and molluscan resources are 21.2, 11.2, 5.0 and 2.0 lakh tonnes respectively.
- Mechanized vessels caught 30.7 lakh tonnes, motorized vessels with a catch contribution of 7.9 lakh tonnes and non-motorized vessels contributing a meager 0.8 lakh tonnes.
- Analysis of quarterly marine fish landing data indicate that fourth quarter witnessed peak fishing activity with nearly 13.3 lakh tonnes of harvest followed by first quarter with 10.6 lakh tonnes, third quarter producing nearly 9 lakh tonnes and second quarter the least with 6.5 lakh tonnes.

Resources abundance in marine fish landings

- Indian oil sardine dominated the marine capture landings with a recorded new height of 7.2 lakh tonnes.
- Hilsa landings from West Bengal witnessed a heavy decline over years from 84,269 tonnes in 2010 to 21,901 tonnes in 2011 and further to 9,981 tonnes in 2012.
- Indian mackerel also has shown a heavy decline from 2.8 lakh tonnes in 2011 to 1.7 lakh tonnes in 2012.

Production pattern sector wise

- Mechanized vessels were the major contributor to the fishery in comparison to their motorized and non-motorized counterparts.

- The effort expended in the fishery along the coast during 2012 indicates that the increased production is an outcome of a comparatively less effort than 2011.
- Northwest region is having a major share of fishing effort from mechanized vessels followed by southwest region.

Region wise landing patterns

- All maritime states and union territories except West Bengal and Orissa witnessed an increase in production during 2012 compared to the previous year.

Northwest coast: Marine fish landings for NW coast for the year 2012 is 11.4 lakh tonnes as against 10.3 lakh tonnes in 2011 recording 12.2 % growth. Gujarat with 66% of share in the landings is leading the region followed by Maharashtra with 27% and UT of Daman & Diu with 7%.

Southwest coast: The southwest region is the largest contributor to the total marine fish landings in India. The estimated landing during 2012 is 13.86 lakh tonnes, which forms about 35.1% of the all India landings. The maximum contribution was from Kerala (61%), followed by Karnataka (34%) and the remaining was from Goa. An increase of about 1.95 lakh tonnes is noticed in the region.

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

Northeast coast: The estimated marine fish landings in the region experienced a drastic decline from 6.9 lakh tonnes in 2011 to 4.0 lakh tonnes in 2012. The landings in West Bengal and Odisha are 1.6 and 2.5 lakh tonnes respectively during 2012 compared to 3.7 and 3.2 lakhs during 2011.

Year 2013

During 2013 the Fishery Resource Assessment Division was responsible for the assessment of exploited marine fishery resources through a scientific sample survey at the national level based on stratified multistage random samplings design, with stratification over time and space, developed by the Institute. Necessary modifications were made in the sampling design to suite the

requirements for estimation of species wise, gear wise and fishing zone wise monthly estimates of marine fish landings and fishing effort expended in terms of units of operation and hours of operation. Digitization of historic data continued with data collected starting from 1989.

The salient achievements of the division under the above research projects are:

- Resource wise and gear wise estimation of marine fish landings and fishing effort for the year 2013 was carried out using on data collected based on the sampling design for different fishing zones in 9 maritime states and two union territories.

- Individual species level estimation of landings and gear wise estimation on fishing efforts both in terms of fishing units and hours of operations were made for the nine maritime states and union territories of Puducherry and Damen & Diu and added to the National Marine Fisheries Data Centre of the institute.

- Digitization of historic data on marine fish landings available in old data sheets was also carried out starting from 1989.

- Development of computer software and creation of database with micro information on individual boats landed.

Highlights

- The provisional estimate of all India annual marine fish landings for the year 2013 is 3.78 million tonnes as against the all time high of 3.94 million tonnes during 2012 registering a reduction of about 1,55,883 tonnes (4%).
- Maritime states with high contributions toward total landings in the country during 2013 are Gujarat with 7.17 lakh tonnes, Tamil Nadu with 6.88 lakh tonnes and Kerala with 6.71 lakh tonnes.
- Compared to 2012 there is increased ladings in West Bengal (1,06,390 tonnes), Puducherry (12,472 tonnes), Maharashtra (49,489 tonnes), Tamil Nadu (42,486 tonnes), Goa (31,853 tonnes) and Damen & Diu (3,655 tonnes) and there is reduction in landings in Kerala (1,67,824 tonnes), Odisha (1,23,529 tonnes), Gujarat (34,732 tonnes), Andhra Pradesh (38,368 tonnes) and Karnataka (37,776 tonnes)
- Contribution from the four regions are northwest 11.6 lakh tonnes(30.7%), southwest 12.1 lakh tonnes(32.1%), southeast 10.2 lakh tonnes (27.0%) and northeast 3.9 lakh tonnes(10.2%)
- Important resources contributed to the total landings are oil sardine 6.0 lakh tonnes (15.7%), Ribbonfishes 2.5 lakh tonnes (6.7%), Non-penaeid

prawns 2.1 lakh tonnes (5.6%), Indian mackerel 2.0 lakh tonnes (5.3%), penaeid prawns 2.0 lakh tonnes (5.2%), and threadfin breams 1.8 lakh tonnes (4.8%).

- Assemblage of the resources are pelagic 2.12 million tonnes (56%), demersal 1.0 million tonnes (26%), crustacean 0.48 million tonnes (13%) and molluscs 0.20 million tonnes (5%).
- Contributions from the three sectors are mechanized 30.0 lakh tonnes (79.5%), motorized 7.0 lakh tonnes (18.6%) and 0.73 lakh tonnes (1.9%) from non-mechanized.

Resources abundance in marine fish landings

- Though the Indian oil sardine dominated the marine capture landings with 6.0 lakh tonnes compared to the record landings in 2012 the reduction is about 1.2 lakh tonnes.
- Hilsa landings from West Bengal showed a slight improvement to 41,448 tonnes as against 21,901 tonnes in 2011 and 9,981 tonnes in 2012 but still below the level of 84,000 tonnes in 2010.
- The landings of Indian mackerel showed slight improvement from 1.7 lakh tonnes in 2012 to 2.0 lakh tonnes still below the 2.8 lakh tonnes mark in 2011.

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

- The Government of Kerala has constituted an expert committee with CMFRI scientists as members to evaluate the impact of seasonal fishing ban on fishing wealth along the Kerala coast. As a part of this task the effect of seasonal fishing ban on marine fish landings in Kerala was evaluated using time series data on marine fish landings during 1961-2012 based on ARIMA intervention model.
- Based on Akaike's information criterion AIC and Schwarz's Bayesian Information criterion SBC the appropriate models determined are ARIMA(3,2,0) for total landings, ARIMA(2,2,0) for oil sardine landings and ARIMA(3,2,0) for the series with total landings excluding oil sardine.
- The ARIMA intervention models fitted explained 73.5% of the variability in the time series on total landings, 47.1% of the variability in oil sardine landings and 84.4% of the variability in the series with total excluding oil sardine.
- In the selected models all the model parameters are significant except the intervention parameter β_1 in the case of oil sardine series. This shows that the intervention model does not suit the oil sardine landings and the effect of seasonal fishing ban on oil sardine landings is not significant. As per the estimated model the increase in total landings in Kerala due to the

interventions in 1988 is about 2,18,000 tonnes which is a confounded effect of both seasonal fishing ban and introduction of outboard engines with ring seines.

- The ARIMA intervention model applied to the time series data on total landings excluding oil sardine was used to estimate the effect of seasonal fishing ban introduced in the state from 1988 onwards.
- As per this model the effect of seasonal fishing ban in Kerala was quantified to about 1,17,000 tonnes increase in ladings per annum.

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

- Dynamic factor analysis (DFA), a multivariate time series technique used to identify common trends in a set of time series sequences, was applied to all India annual landings during 1980 – 2010 of prominent 16 marine fishery resource groups and three common trends in their landings were estimated.
- The first common trend initially showed an increasing trend, reaches a peak and then comes down slightly and remains steady thereafter. The second common trend showed an initial decline and continued in almost the same level for some years and at the end it started increasing. The third common trend showed an increasing trend throughout the period with little fluctuations.
- The fishery resource groups were classified based on the factor loadings corresponding to the three common trends and represented using Venn diagram.
- Results revealed that carangids and Bombayduck contributed towards trend-1 only with positive and negative coefficients respectively.
- Both silverbellies and pomfrets contributed only towards trend-2 both with positive and almost equal factor loadings.
- Clupeids contributed only towards trend-3 with positive factor loadings. Croakers and mackerel contributed almost equally towards trend-1 and trend-2 whereas perches, seer fish, tunnies, flat fishes, crustaceans and molluscs formed a homogenous group contributing almost equally towards trend-1 and trend-3.
- Elasmobranchs also contributed towards trend-1 and trend-3 but with opposite sign.
- Catfish and Ribbon fish contribute towards trend-2 and trend-3 but with opposite signs.

Status of resources based on growth rates and Markov chain modeling

- Used resource wise all India landings during 1985-2012 to work out annual growth rates for consecutive years and used for Markov chain modeling to workout limiting probabilities for each resource.
- Nine different process states were defined for the Markov chain model based on the growth rates as given below.

Process States	Growth Rate
State-1	< -100
State-2	-51 to -100
State-3	-26 to -50
State-4	-1 to -25
State-5	0
State-6	1 to 25
State-7	26 to 50
State-8	51 to 100
State-9	> 100

- Limiting probabilities worked out based on the model for different resources are

Process States	Growth Rate	Sharks	Rays	Eels	Lesser sardines
State-1	< -100	0.00	0.00	0.00	0.00
State-2	-51 to -100	0.00	0.00	0.00	0.00
State-3	-26 to -50	0.08	0.04	0.04	0.04
State-4	-1 to -25	0.36	0.44	0.41	0.42
State-5	0	0.00	0.00	0.00	0.04
State-6	1 to 25	0.44	0.44	0.48	0.27
State-7	26 to 50	0.12	0.08	0.07	0.23
State-8	51 to 100	0.00	0.00	0.00	0.00
State-9	> 100	0.00	0.00	0.00	0.00

Process States	Growth Rate	Croakers	Black pomfret	Silver pomfret	S. commersoni
State-1	< -100	0.00	0.00	0.00	0.00
State-2	-51 to -100	0.00	0.00	0.00	0.00
State-3	-26 to -50	0.04	0.11	0.04	0.04
State-4	-1 to -25	0.42	0.22	0.38	0.42
State-5	0	0.00	0.12	0.04	0.00
State-6	1 to 25	0.46	0.35	0.42	0.38
State-7	26 to 50	0.08	0.20	0.12	0.15
State-8	51 to 100	0.00	0.00	0.00	0.00
State-9	> 100	0.00	0.00	0.00	0.00

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

Oil sardine

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

and 11.2% chance to remain in State-3 (growth rate between -26% and -50%). All other states have only negligible chances.

- Species that have more than 90% probability to remain in states 6 and 4 are Silverbellies (0.99), Catfishes (0.92) and Other carangids (0.96). Groups with 80% or more than 80% probability to fluctuates between states 4 and 6 are Silverbellies (0.99), Other carangids (0.96), Catfishes (0.92), Eels (0.89), Croakers (0.89), Rayes (0.88), Bombayduck (0.87), Snappers (0.86), Wolf herring (0.85), Other clupeids (0.85), Penaeid prawns (0.84), Silver pomfret (0.81), S. commerson (0.81) and Sharks (0.80).
- Among these species/groups those with almost equal change to fall in the two states so that they will have the tendency to fluctuates between the two states are Silverbellies (0.50 & 0.49), catfishes (0.49 & 0.43), Wolf herring (0.42, 0.42), S. commerson (0.42 & 0.39), Other carangids (0.46 & 0.46), Eels (0.48 & 0.41), Croakers (0.42 & 0.46), Rays (0.44 & 0.44), Bombayduck (0.43 & 0.44), Snappers (0.31 & 0.55), Other clupeids (0.39 & 0.46), Penaeid prawns (0.30 & 0.53), Silver pomfret (0.39 & 0.42) and Sharks (0.36 & 0.44)
- There are 29 resource groups for which the limiting probabilities are maximum for states-6 and state-4 respectively. Out of this 10 resource groups have more than 80 percent chance to fall in this two states. Similarly ther are 16 resources for which the limiting probabilities are maximum for state-4 followed by state-6 out of which 4 resources have more than 80 percent chance to fall in state-4 or state-6.
- Bivalves, S. lineolatus and Acanthocybium spp. have limiting probabilities maximum for State-2 and State-9.

PROJECT TITLE:	Marine Fisheries Census 2010

- Two workshops were conducted for the CMFRI staff involved in census operation in the research centres of CMFRI in November 2009 and February 2010.

- In March 2010, a pre-census survey was conducted to enumerate the number of households, and to fix the enumerators.

- Training for all the enumerators was completed during April 12-15, 2010.

- The basic frame for the census is the list of marine fishing villages collected from the state departments. These were verified, validated and updated through field visits.

- The actual census operation was carried out from 16 April to 15 May 2010.

- About 150 technical and scientific staff of CMFRI supervised the operation at field, district and state levels. About 2100 enumerators trained by CMFRI were employed for the 30-day census.

- The enumerators have collected information from about 11 lakh marine fishermen households distributed across 4050 fishing villages in the country.

- The states and union territories covered were West Bengal, Orissa, Andhra Pradesh, Tamil Nadu, Kerala, Karnataka, Goa, Maharashtra, Gujarat, Pondicherry, Daman and Diu.

- About 75,000 copies of the schedules in eight regional languages, namely, Gujarati, Marathi, Kannada, Malayalam, Tamil, Telugu, Oriya and Bengali, in addition to English and Hindi were used for data collection.

- Data collected through the census operation was computerized and stored in Access database using software developed in-house.

- Collation, compilation and pre-processing of data sheets containing the Marine Fisheries Census information collected in April- May 2010 was carried out with detailed listing and coding of states, districts, sub-districts (taluks, mandals, block etc.).

- Necessary computer software was developed in-house and data entry and digitization of collected information were carried out during October 2010 to March 2011. Information were stored in access database and periodically backed up in an IBM server and also on magnetic tapes.

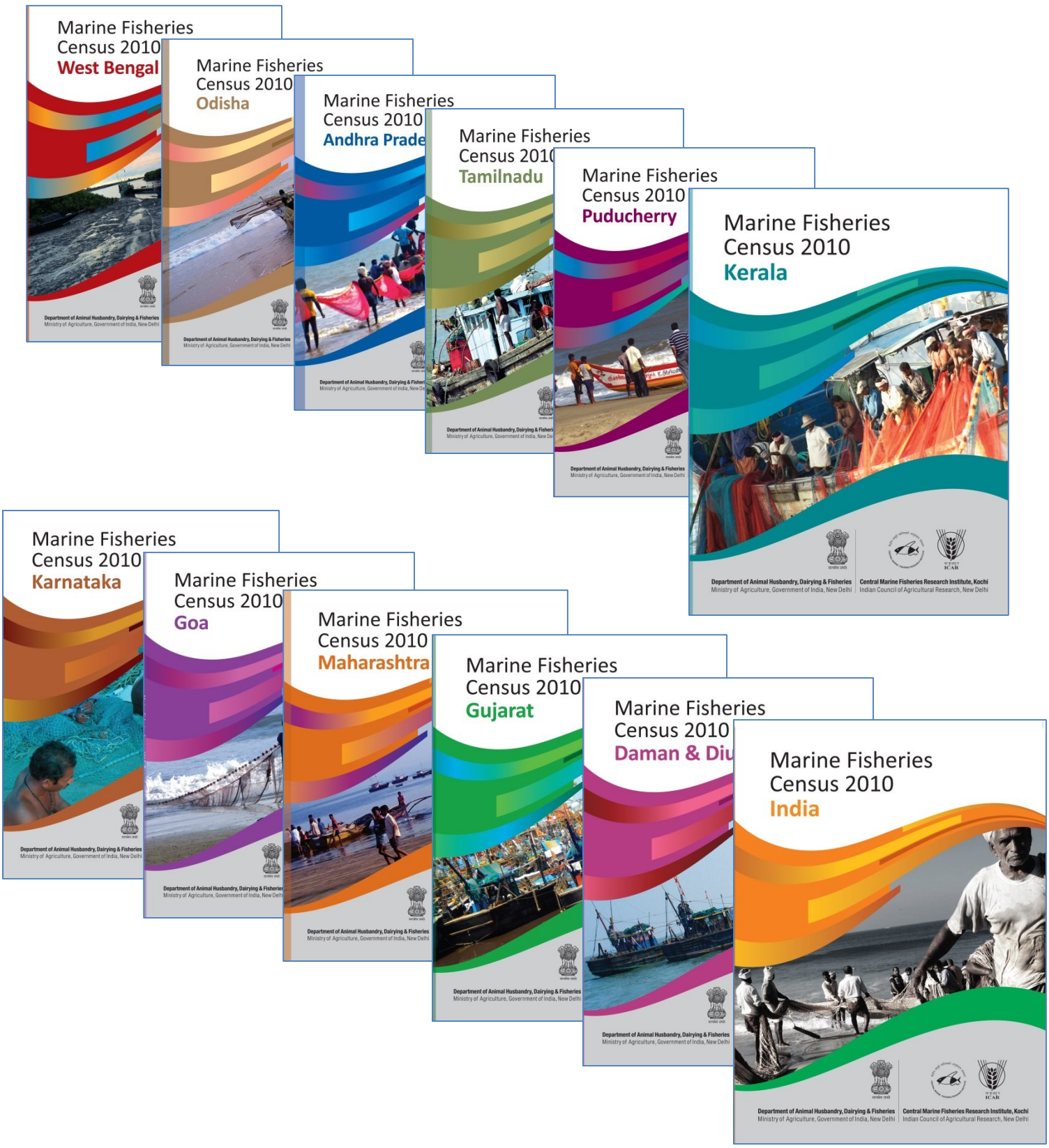
- Preliminary analysis and tabulation was done by developing queries in MS Access.

- Final validation workshops were conducted at different research/regional centres of CMFRI during October – November 2011 for validation of information collected on crafts and infrastructure facilities.

- Preparation of reports for all the maritime states and union territories were completed.

Summary of findings from Marine Fisheries Census 2010:

- There are 3,288 marine fishing villages and 1511 marine fish landing centres in 9 maritime states and union territories of Puducherry, Daman and Diu.
- The total marine fishermen population is 3.99 million in 8,64,550 households.
- Nearly 61% of the fishermen households are under BPL category.
- The average family size is 4.63 and the overall sex ratio is 928 females per 1000 males.
- Almost 58% of the fisherfolk are educated with different levels of education.
- About 38% marine fisherfolk are engaged in active fishing with 85% of them having full time engagement.
- About 63.6% of the fisherfolk are engaged in fishing and allied activities.
- Nearly 57% of the fisherfolk engaged in fish seed collection are females and 42.6% are males.
- Among the marine fishermen households nearly 76% are Hidus, 15% are Christians and 9% are Muslims.
- The overall percentage of SC/ST among the marine fishermen households is 17%.
- Nearly 32% of the adult fisherfolk have memberships in co-operatives.
- Among the marine fishermen households 1,31,012 families are having life saving equipments.
- In the marine fisheries sector there are 1,94,490 crafts in the fishery out of which 37% are mechanized, 37% are motorized and 26% are non-motorized.
- Out of a total of 1,67,957 crafts fully owned by fisherfolk 53% are non-motorized, 24% are motorized and 23% are mechanized.
- Among the mechanized crafts fully owned by fishermen 29% are trawlers, 43% are gillnetters and 19% are dolnetters.


Marine Fisheries
Census 2010
West Bengal
Marine Fisheries
Census 2010
Odisha
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Marine Fisheries
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Census 2010
Maharashtra
Marine Fisheries
Census 2010
Gujarat
Marine Fisheries
Census 2010
Daman & Diu
Marine Fisheries
Census 2010
India
Department of Animal Husbandry, Dairying & Fisheries
Ministry of Agriculture, Government of India, New Delhi
Central Marine Fisheries Research Institute, Kochi
Indian Council of Agricultural Research, New Delhi

Pre-Census 2015 workshops

1. Organized a one day pre-census workshop for the Marine Fisheries Census 2015 at CMFRI, Cochin in collaboration with DAHDF, Ministry of Agriculture, New Delhi on 28th May 2013. The workshop was attended by Director, CMFRI, Deputy Director General (Fisheries), DAHDF, Director General, Fishery Survey of India, Heads of Divisions and officials from state fisheries departments. Discussions on various problems encountered during the last census were discussed and remedies were suggested. Different data collection schedules used in Marine Fisheries Census 2010 was displayed and discussed and modifications suggested by the participants were incorporated.
2. Similar pre-census workshops were held at Research/Regional stations of CMFRI at Mumbai, Mangalore, Chennai and Vishakapattanam to finalise the data collection schedules to be used for Marine Fisheries Census 2015.

Publications

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- **Sathianandan, T.V.** and **J. Jayasankar**. 2009. Simulation model for evaluating the responses of management options on the demersal resources of Tamil Nadu coast. *Asian Fish. Sci*., 22(2): 681-690.
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- **Mini, K.G**., M. Kumaran, and **J. Jayasankar**. 2009. On use of post-stratification for estimating the marine fish landings. *Indian. J. Mar. Sci*., 38(4): 464-469.

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3. **Baby, K.G**. 2009. Occurrence of humpback whale at Thrissur. *Mar. Fish. Infor. Serv. T&E Ser.,* 200: 21.

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6. Gulshad Mohammed, Shubhadeep Ghosh and **B.V. Makadia**. 2009. Unusual heavy landing of *Otolitholides biauritus* and *Protonibea diacanthus* at Salaya landing centre, Jamnagar, Gujarat. *Mar. Fish. Infor. Serv. T&E Ser.,* 200: 22.

7. Anil, M. K., H. Jose Kingsly, B. Raju, **K.K. Suresh** and Rani Mary George. 2009. A note on the leatherback turtle *Dermochelys coriacea* (Vandelli, 1761) rescued at Vishinjam, Kerala. *Mar. Fish. Infor. Serv. T&E Ser.,* 200: 23.

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2. **Baby, K G** (2010) *Stranding of a Dolphin (Stenella longirostris) at Thalikulam Landing Centre,Thrissur District, Kerala.* Marine Fisheries Information Service T&E Series (204). p. 20.
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5. **Ramani, K and Ammini, P L and Srinivasan, J and Haja Najeemudeen, S and Beena, M R and George, K P and Seynudeen, M B and Subbaraman, G and Anandan, K and Khambadkar, Latha L and Augustine, Sindhu K and Pugazhendi, D and Rudhramurthy, N and Subramani, S and Seetharaman, S and Kather Batcha, H and Sankaralingam, S** (2010) *An overview of marine fisheries in India during 2007.* Marine Fisheries Information Service T&E Series (203). pp. 1-14.
6. Thangavelu, R and Ghosh, Shubhadeep and Mohamed, Gulshad and **Zala, M S** and **Dhokia, H K** (2010) *By-catch of the gastropod Tibia spp. in gillnets operated along Gujarat coast.* Marine Fisheries Information Service T&E Series (204). pp. 16-18.
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8. Zacharia, P U and Mohamed, K S and **Sathianandan, T V** and Asokan, P K and Krishnakumar, P K and Abdurahiman, K P and Durgekar, N Raveendra and Shettigar, Veena (2011) *Alpha, beta and gamma diversity of fished marine taxa along the southwest coast of India during 1970-2005.* Journal of the Marine Biological Association of India, 53 (1). pp. 21-26.

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2. Chaniyappa, M and Bhatt, Uma S and Sasikumar, Geetha and Dineshbabu, A P (2011) Heavy landings of Sardinella longiceps by purseseiners at Malpe Fisheries Harbour, Karnataka. Marine Fisheries Information Service (207). pp. 32-33.
3. Mohan, S and Rajan, S and Rajapackiam, S (2011) Rare occurrence of the oilfish Ruvettus pretiosus along Chennai coast. Marine Fisheries Information Service (207). p. 38.
4. Mohan, S and Rajan, S and Vasu, R (2011) Rare occurrence of deepsea snake mackerel off Nagapattinam coast in the Bay of Bengal. Marine Fisheries Information Service (207). p. 36.
5. Baby, K G (2011) Hooks and line fishery of cuttle fish from the artificial trap at Blangad, Thrissur. Marine Fisheries Information Service (208). pp. 32-33.
6. Baby, K G (2011) Spinner dolphin Stenella longiostris washed ashore at Blangad, Thrissur District. Marine Fisheries Information Service (208). p. 36.
7. Mohan, S and Rajapackiam, S and Rajan, S (2011) Unusual heavy landings of jellyfish Crambionella stulhamani (Chun) and processing methods at Pulicat landing centre, Chennai. Marine Fisheries Information Service (208). pp. 27-29.
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9. Sethi, S N and Rajapackiam, S and Jaiganesh, P and Rudramurthy, N (2011) Occurrence of trigger fishes at Chennai. Marine Fisheries Information Service (208). pp. 20-21.
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2. Dinesh Kumar, S and Nair, Rekha J and Kuriakose, Somy (2012) First record of Centroberyx rubricaudus (Liu and Shen, 1985) (Beryciforms: Berycidae) from Indian waters (Andaman Islands). *Indian J. Geo-Mar. Sci.*,42 (1): 871-875

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5. Goutham-Bharathi, M. P., Kaliyamoorthy, M., Dam Roy S., Krishnan, P., Grinson George and Murugan, C. 2012. Sonneratia ovata (Sonneratiaceae) – A New Distributional Record for India from Andaman and Nicobar Islands. Taiwania, 57(4): 406–409.

6. Kamal Sarma, Prabakaran K., Krishnan P., Grinson G and Anand Kumar A. 2012. Response of a freshwater air-breathing fish, Clarias batrachus to salinity stress: an experimental case for their farming in brackishwater areas in Andaman, India. Aquacult Int, DOI 10.1007/s10499-012-9544-2.

7. Kamal Sarma, Anand Kumar A., Krishnan P., Grinson G., Prabakaran K., Dam Roy S and Srivastava R.C. (2013)Impact of coastal pollution on biological, biochemical and nutritional status of edible oyster in Phoenix

Bay Jetty and North Wandoor of Andaman. *Indian J. Anim. Sci.*,83 (3): 321–325.

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9. Nair, Rekha J and Praveen, P and Dinesh Kumar, S and Kuriakose, Somy (2012) First record of the Dwarf monocle bream, Parascolopsis baranesi from Indian waters. *Indian J. Geo-Mar. Sci.*,41 (5): 395-397.

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3. S. Rajapackiam, S. Mohan, N. Rudramurthy and R. Vasu (2012). Unusual landings of cusk eel *Monomitopus nigripinnis* at Chennai. *Mar. Fish. Infor. Serv., T&E Ser.*, No. 209: 14.

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5. S. Rajapackiam, S. Mohan, R. Vasu and P. Jaiganesh (2012). Heavy landings of bigeye and pinjalo snappers at Chennai Fisheries Harbour. *Mar. Fish. Infor. Serv., T&E Ser.*, No. 209: 19-20.

6. Sijo Paul (2012). Pair trawling at Sakthikulangara. *Mar. Fish. Infor. Serv., T&E Ser.*, No. 209: 20-21.

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6. Ministry of Agriculture, Krishi Bhavan, New Delhi and CMFRI, Kochi (2012) Marine Fisheries Census 2010 Part II. 3 Andhra Pradesh.CMFRI; Kochi.

7. Ministry of Agriculture, Krishi Bhavan, New Delhi and CMFRI, Kochi (2012) Marine Fisheries Census 2010 Part II. 4 Tamil Nadu. CMFRI; Kochi.

8. Ministry of Agriculture, Krishi Bhavan, New Delhi and CMFRI, Kochi (2012) Marine Fisheries Census 2010 Part II. 5 Puducherry. CMFRI; Kochi.

9. Ministry of Agriculture, Krishi Bhavan, New Delhi and CMFRI, Kochi (2012) Marine Fisheries Census 2010 Part II. 6 Kerala.CMFRI; Kochi.

10. Ministry of Agriculture, Krishi Bhavan, New Delhi and CMFRI, Kochi (2012) Marine Fisheries Census 2010 Part II. 7 Karnataka.CMFRI; Kochi.

11. Ministry of Agriculture, Krishi Bhavan, New Delhi and CMFRI, Kochi (2012) Marine Fisheries Census 2010 Part II. 8 Goa.CMFRI; Kochi.

12. Ministry of Agriculture, Krishi Bhavan, New Delhi and CMFRI, Kochi (2012) Marine Fisheries Census 2010 Part II. 9 Maharashtra.CMFRI; Kochi.

Publications during 2013

Papers in research journals (national/ international)

1. Aswathy, N and Narayanakumar, R and Shyam, S Salim and Vipinkumar, V P and **Kuriakose, Somy** and Geetha, R andHarshan, N K (2013) *Total factor productivity growth in marine fisheries of Kerala*. indian Journal of Fisheries, 60 (4). pp. 77-80
2. George, Grinson and Desai, D V and Gaonkar, C A and Aboobacker, V M and Vethamony, P and Anil, Arga Chandrashekar(2013) *Barnacle larval transport in the Mandovi-Zuari estuarine system, central west coast of India.* Journal of Oceanography, 69 . pp. 451-466.
3. George, Grinson and Krishnan, P and Dam Roy, S and Sarma, Kamal and Goutham Bharathi, M P and Kaliyamoorthy, Mand Krishnamurthy, V and Srinivasa Kumar, T (2013) *Validation of Potential Fishing Zone (PFZ) forecasts from Andaman and Nicobar Islands.* Fishery Technology, 50 . pp. 1-5.
4. Kirubasankar, R and Dam Roy, S and George, Grinson and Sarma, Kamal and Krishnan, P and Ramkumar, S andKaliyamoorthy, M and Goutham Bharathi, M P (2013) *Fishery and Exploitation of Malabar Grouper, Epinephelus malabaricus (Bloch & Schneider 1801) from Andaman Islands.* Asian Fisheries Science, 26 . pp. 167-175.
5. Manjusha, U and Jayasankar, J and Remya, R and Ambrose, T V and Vivekanandan, E (2013*) Influence of coastal upwelling on the fishery of small pelagics off Kerala, south-west coast of India.* Indian Journal of Fisheries, 60 (2). pp. 37-42.
6. Mini, K G and Kuriakose, Somy and Ammini, P L and Augustine, Sindhu K (2013) *Evaluation of multispecies marine fishery in West Bengal, India using diversity indices.* Indian Journal of Fisheries, 60 (2). pp. 43-47.
7. Mohamed, K S and Sathianandan, T V and Kripa, V and Zacharia, P U (2013) *Puffer fish menace in Kerala: a case of decline in predatory control in the southeastern Arabian Sea.* Current Science, 104 (4). pp. 426-429.
8. Mohanty, P C and Mahendra, R S and Bisoyi, Hrusikesh and Tummula, Srinivasa Kumar and George, Grinson and Nayak, Shailesh and Sahu, B

K (2013) *Assessment of the coral bleaching during 2005 to decipher the thermal stress in the coral environs of the Andaman Islands using Remote Sensing.* European Journal of Remote Sensing, 46 . pp. 417-430.

9. Nair, Rekha J and Dinesh Kumar, S and Sijo Paul, and Kuriakose, Somy (2013*) Occurrence of two serranid fish from Indian waters with a note on their taxonomy.* Marine Biodiversity Records, 6 (41). pp. 1-4.
10. Nair, Rekha J and Dinesh Kumar, S and Geetha, P M and Kuriakose, Somy (2013) *Range extension of the striped triggerfish Xanthichthys lineopunctatus (Tetraodontiformes: Balistidae) from India*. Marine Biodiversity Records, 6 (52). pp. 1-3.
11. Said Koya, K P and Ganga, U and Jayasankar, J and Gireesh, R and Retheesh, T B and Thangaraja, R and Abdussamad, E M (2013) *Observations on fishery and biology of yellowfin tuna Thunnus albacares (Bonnaterre, 1788) from Lakshadweep waters.* Indian Journal of Fisheries, 60 (3). pp. 119-122.

Technical articles (peer reviewed)

1. Behera, Pralaya Ranjan and Edward, Loveson and Moshe, Ch. (2013) *Olive ridley turtle Lepidochelys olivacea (Eschscholtz, 1829) washed ashore at Visakhapatnam.* Marine Fisheries Information Service; Technical & Extension Series (216). pp. 25-26
2. Edward, Loveson and Behera, Pralaya Ranjan and Muktha, M and Moshe, Ch. (2013) *Occurrence of the goldband fusilier, Pterocaesio chrysozona (Cuvier, 1830) along Visakhapatnam, east coast of India.* Marine Fisheries Information Service; Technical & Extension Series (216). p. 14.
3. Geetha, R and Divipala, Indira and Vinod, K and Kizhakudan, Shoba Joe and Manivasagam, M and Zacharia, P U (2013)*Coastal vulnerability to climate change: A pilot study in Cuddalore district of Tamil Nadu.* Marine Fisheries Information Service; Technical and Extension Series (217). pp. 42-45.
4. George, Grinson, Baby, K.G., Jacob, A.Y., Sijo Paul, Somy Kuriakose and Sathianandhan, T.V. (2013) *Mud bank formation in Kerala during the south-west monsoon of 2013.* Marine Fisheries Information Service; Technical and Extension Series (217). pp. 32-35.
5. Jayasankar, J and George, Grinson and Ambrose, T V and Manjeesh, R (2013) *Marine Geographic Information Systems and Their Application in Fisheries Management.* **In**: Marine Geographic Information Systems and Their Application in Fisheries Management. Soam, S K and Sreekanth, P D and Rao, N H,**(eds.)** New India Publishing Agency, pp. 437-449. ISBN 9789381450802
6. Kizhakudan, Joe K and Kizhakudan, Shoba Joe and Joseph Xavier, V and Krishnamurthy, S and Yousuf, K S S M andSundar, R and Manibal, C and Ponniah, R and Pakkiri, D and Janakiraman, A and Chandrasekharan, S and Chakrapani, Gand Chandrasekharan, M P (2013) *Preliminary observations on broodstock development and spawning of Indian Halibut*

Psettodes erumei (Bloch & Schneider, 1801) in captivity. Marine Fisheries Information Service; Technical & Extension Series (218). pp. 27-29.

7. Kizhakudan, Shoba Joe and Raja, S and Gupta, K S and Thiagu, R and Sethi, S N and Kizhakudan, Joe K and Geetha, Rand Vivekanandan, E and Zacharia, P U (2013) *Observations on spawning activity of green mussel Perna viridis in relation to surface water temperature in Pulicat Lake and Ennore backwaters.* Marine Fisheries Information Service; Technical & Extension Series (218). pp. 29-31.
8. Mathew, Wilson T and Sreenivasan, J (2013) *Overview of the marine fish landings in Andhra Pradesh during 2012.* Marine Fisheries Information Service; Technical and Extension Series (217). pp. 41-43.
9. Mini, K G and Ghosh, Shubhadeep and George, Grinson (2013) *Non-operational trawlers and ban on Hilsa export by Bangladesh adversely impacts the fish availability in West Bengal.* Marine Fisheries Information Service; Technical & Extension Series (216). pp. 35-36.
10. Mohan, S and Rajan, S and Vasu, R (2013) *Occurrence of a rare species of red crab, Ranina ranina (Linnaeus 1758) along Chennai coast.* Marine Fisheries Information Service; Technical & Extension Series (218). pp. 4-5.
11. Nair, Rekha J and Sijo Paul, and Dinesh Kumar, S (2013) *Record of a rare Sharp-tail sunfish, Masturus lanceolatus Liénard, 1840 (Tetraodontiformes: Molidae) landing from South-west coast of India.* Marine Fisheries Information Service; Technical & Extension Series (218). p. 7.
12. Pradeep Kumar, K C and Chandran, K (2013) *Azhikode South fishermen set example to reduce use of polythene carry bags.* Marine Fisheries Information Service; Technical and Extension Series (217). p. 7.
13. Purushottama, G B and Ramkumar, S and Thakurdas, and Hotagi, Jayadev S (2013) *Unusual landing of the sharks at Sassoon dock landing centre, Mumbai.* Marine Fisheries Information Service; Technical & Extension Series (218). pp. 17-18.
14. Pugazhendi, D (2013) *Comparative study of Marine Fisher-folk census 2005 and 2010 of Tamil Nadu.* Marine Fisheries Information Service; Technical & Extension Series (218). pp. 37-40.
15. Rao, G Syda and George, Grinson (2013) *Green Technologies in Marine Fisheries for Sustainably Exploiting and Conserving the Blue Carbon - CMFRI Initiatives and Accomplishments.* In: Souvenir: International Symposium on Greening Fisheries towards Green Technologies in Fisheries, 21-23 May 2013, Kochi.
16. Rao, M V Hanumantha and Uma Mahesh, V and Satish Kumar, M and Suresh Kumar, P and Ghosh, Shubhadeep (2013)*First report on Sillaginopsis panijus (Hamilton, 1822) off Visakhapatnam coast, Andhra Pradesh.* Marine Fisheries Information Service; Technical and Extension Series (217). p. 27.
17. Rao, Ramesh B (2013) *Mini purseseine operation recorded for oil sardine catch at Jiwna and Bharadhkhol-Divegar landing centres in Raigad region of Maharashtra.* Marine Fisheries Information Service; Technical and Extension Series (216). pp. 4-5.

18. Rao, Ramesh B (2013) *Stranding of dead dolphin noticed near Mondova-Saswane sea shore Raigad district, Maharashtra.* Marine Fisheries Information Service; Technical & Extension Series (216). p. 26.
19. Sathianandan, T V (2013) *Status of Marine Fisheries Resources in India - An Overview.* In: ICAR funded Short Course on "ICT -oriented Strategic Extension for Responsible Fisheries Management, 05-25 November, 2013, Kochi.
20. Sathianandan, T V and Mohamed, K S and Kuriakose, Somy and Mini, K G and George, Grinson and Augustine, Sindhu K(2013) *Diversity in fished taxa along the Indian coast during 2012.* Marine Fisheries Information Service; Technical and Extension Series (216). pp. 3-4.
21. Satish Kumar, M and Uma Mahesh, V and Rao, M V Hanumantha and Ghosh, Shubhadeep and Maheswarudu, G (2013)*Heavy landing of barred seer fish Scomberomorus commerson (Lacepede, 1800) at Visakhapatnam fishing harbour, Andhra Pradesh.* Marine Fisheries Information Service; Technical and Extension Series (216). pp. 5-6.
22. Satish Kumar, M and Uma Mahesh, V and Rao, M V Hanumantha and Ghosh, Shubhadeep (2013) *Incidental landing of lesser devil ray Mobula diabolus (Shaw, 1804) at Dummulapeta and Bhairavapalem, Andhra Pradesh.* Marine Fisheries Information Service; Technical & Extension Series (216). pp. 17-18.
23. Sijo Paul, (2013) *Bumper catch of Rastrelliger kanagurta at Cochin Fisheries Harbour.* Marine Fisheries Information Service; Technical & Extension Series (218). p. 16.
24. Sijo Paul, (2013) *Fibre boat fishery using combined gears.* Marine Fisheries Information Service; Technical & Extension Series (218). p. 36.
25. Sijo Paul, (2013) *First report of Lagocephalus sceleratus (Gmelin, 1789) from Kollam coast.* Marine Fisheries Information Service; Technical and Extension Series (215). p. 34.
26. Sijo Paul, (2013) *Rare bluntnose sixgill shark Hexanchus griseus landed at Sakthikulangara Fisheries Harbour, Kollam.*Marine Fisheries Information Service;
27. Sundaram, Sujit and Jadhav, D G (2013) *First record of Octopus aegina Gray, 1849 from Maharashtra waters.* Marine Fisheries Information Service; Technical and Extension Series (217). pp. 22-23.Technical and Extension Series (215). p. 31.
28. Swathi Lekshmi, P S and Chaniyappa, M (2013) *Migrant women labourers in Puffer fish processing.* Marine Fisheries Information Service; Technical and Extension Series (217). pp. 8-9.
29. Thomas, V J and Hezhakiel, K C and Varghese, Molly and Sreekumar, K M (2013) *Whale shark, Rhincodon typus landed at Kalamukku fish landing centre, Kerala.* Marine Fisheries Information Service; Technical and Extension Series (217). p. 8.
30. Mathew, Wilson T and Sreenivasan, J (2013) *Overview of the marine fish landings in Andhra Pradesh during 2012*. Marine Fisheries Information Service; Technical and Extension Series (217). pp. 41-43.

Training Programmes/Workshops Organized

Year 2009

Training Programmes Organised

- Training programme for five apprentice trainees under the State Govt. Programming and Systems Administration Assistant (PASAA) Scheme which was initiated in to a six month IT applications training module - October, 2008 to March 2009 at CMFRI, Kochi.
- One day training on "Uniform mode of collection of data" to the State Fishery Officials – 18th May, 2009 at State Institute of Fisheries Technology, Kakinada.
- Training programme for seven Senior Scientists/Scientists of CMFRI on fishery resources assessment - 1st to 15th July, 2009 at CMFRI, Kochi.

Workshops

- Zonal workshop under the Central Sector Scheme on "Strengthening of database and GIS for fisheries sector – Marine Fisheries Census 2010" for the field staff of Kerala, Karnataka and Goa - 23rd to 25th November, 2009 at CMFRI, Kochi.
- Zonal workshop under the Central Sector Scheme on "Strengthening of database and GIS for fisheries sector – Marine Fisheries Census 2010" for the field staff of Maharashtra and Gujarat - 30th November to 2nd December, 2009 at Mumbai Research Centre of CMFRI, Mumbai.
- Zonal workshop under the Central Sector Scheme on "Strengthening of database and GIS for fisheries sector – Marine Fisheries Census 2010" for the field staff of Tamil Nadu and Puducherry - 3rd to 5th December, 2009 at Madras Research Centre of CMFRI, Chennai.

- Zonal workshop under the Central Sector Scheme on "Strengthening of database and GIS for fisheries sector – Marine Fisheries Census 2010" for the field staff of West Bengal, Orissa and Andhra Pradesh - 30th November to 2nd December, 2009 at Visakhapatnam Regional Centre of CMFRI, Visakhapatnam.

Year 2010

- Conducted the Second workshop under the Central Sector Scheme on "Strengthening of Database and Geographical Information System for fisheries sector – Marine fisheries Census" for the Field staff at Headquarters and various Regional/Research/Field Centres of CMFRI during 15 to 23 March, 2010.

Year 2011

International training

- *An international training course termed as Regional Training Course on "Strengthening Fisheries Data Collection and Stock Assessment" was jointly organized by CMFRI and Fishery Survey of India under funding from the Bay of Bengal Programme Inter-Governmental Organization (BOBP-IGO). The training program was conducted for capacity building of member countries of BOBP-IGO on species identification, fisheries data collection and fish stock assessment. The participants were junior and middle level officials from member countries - Bangladesh, India, Maldives and Sri Lanka. The training course was for two weeks from 25th April to 7th May 2011 with the following objectives. During the training course the participants were trained by expert faculties in CMFRI and FSI through theory and practical classes in different laboratories. Also, they were exposed to the fishery through field trips and vessel cruise.*

- Orientation training programme for the newly joined ARS Probationary scientists was organized as a part of FOCARS training in the division from 12th to 17th January, 2012. In all, seven scientists participated in the training programme. Topics on the divisional activities like Fish Stock assessment, Sample survey estimation and Statistical Computing software (SAS) with practical classes on sample survey estimation were covered in the training programme. Field visit to Munambam Fisheries Harbour was also arranged.

Workshops

- Conducted the "Marine Fisheries Census 2010 data validation workshop" for the State of Kerala at CMFRI, Cochin from 27-10-11 to 29-10-11

- Conducted the "Marine Fisheries Census 2010 data validation workshop" for Karnataka and Goa at Mangalore RC, Mangalore from 28-10-11 to 29-10-11

- Conducted the "Marine Fisheries Census 2010 data validation workshop"for Tamil Nadu and Puducherry at Mandapam RC from 28-10-11 to 29-10-11 and at Chennai RC from 31-10-11 to 01-11-11 respectively

- Conducted the "Marine Fisheries Census 2010 data validation workshop" for the States of Maharashtra and Gujarat at Mumbai Research Centre, Mumbai from 31-10-11 to 01-11-11 and at Veraval RC from 03-11-11 to 04-11-11 respectively

- Conducted the "Marine Fisheries Census 2010 data validation workshop" for the States of West Bengal, Odhisha and Andhra Pradesh at Visakhapatnam RC, Visakhapatnam from 08-11-11 to 12-11-11

Year 2012

Workshops

1. A workshop on ChloRIFFS- Chlorophyll based Remote sensing assisted Indian Fisheries Forecasting System was organized during 17-18 October 2012 at CMFRI, Kochi.

Year 2013

- Conducted the Pre-Census Workshop at MRC of CMFRI Mumbai from 2-1-2014 to 4-1-2014 under the Central Sector Scheme on "Strengthening of Database and Geographical Information System for fisheries sector – Marine Fisheries Census" – funded by DAHDF, Ministry of Agriculture, New Delhi

- Conducted the Pre-Census Workshop at MRC of CMFRI Madras from 7-1-2014 to 9-1-2014 under the Central Sector Scheme on "Strengthening of Database and Geographical Information System for fisheries sector – Marine Fisheries Census" – funded by DAHDF, Ministry of Agriculture, New Delhi

- Conducted the Pre-Census Workshop at MRC of CMFRI Mangalore from 16-1-2014 to 18-1-2014 under the Central Sector Scheme on "Strengthening of Database and Geographical Information System for fisheries sector – Marine Fisheries Census" – funded by DAHDF, Ministry of Agriculture, New Delhi

Programme Participation

Year 2009

Dr. E. Vivekanandan, Dr. J. Jayasankar

- Attended the consultation meet with the State Fisheries Minister on draft marine fisheries (Regulation & Management) bill 2009 at NASC Complex, New Delhi on 12th February, 2010

Dr. E. Vivekanandan, Dr. T.V. Sathianandan, Dr. J. Jayasankar, Dr. Somy Kuriakose, Dr. T.M. Najmudeen, Dr. K.G. Mini, Shri Wilson T. Mathew

- Conducted the zonal workshop under the Central Sector Scheme on "Strengthening of database and GIS for fisheries sector – Marine Fisheries Census 2010" for the field staff of Kerala, Karnataka and Goa at CMFRI, Kochi, during 23rd to 25th November, 2009

Dr. E. Vivekanandan, Dr. J. Jayasankar, Dr. Somy Kuriakose

- Conducted Zonal workshop under the Central Sector Scheme on "Strengthening of database and GIS for fisheries sector – Marine Fisheries Census 2010" for the field staff of Tamil Nadu and Puducherry at Madras Research Centre of CMFRI, Chennai, during 3rd to 5th December, 2009

Dr. T.V. Sathianandan, Dr. J. Jayasankar

- Attended the meeting of the standing finance committee for the approval of the Central Sector Scheme on "Strengthening of database and GIS for fisheries sector – Marine Fisheries Census 2010" held at Krishi Bhavan, New Delhi on 7th October, 2009

Dr. T.V. Sathianandan

- Attended the workshop on "Construction of the Gulf of Mannar trophic model" held at Tuticorin Research Centre of CMFRI, Tuticorin during 30th to 31st October, 2009

Dr. T.V. Sathianandan and Shri Wilson T. Mathew

- Conducted Zonal workshop under the Central Sector Scheme on "Strengthening of database and GIS for fisheries sector – Marine Fisheries Census 2010" for the field staff of Maharashtra and Gujarat, at Mumbai Research Centre of CMFRI, Mumbai during 30th November to 2nd December, 2009

Dr. J. Jayasankar, Dr. T.M. Najmudeen

- Conducted the zonal workshop under the Central Sector Scheme on "Strengthening of database and GIS for fisheries sector – Marine Fisheries Census 2010" for the field staff of West Bengal, Orissa and Andhra Pradesh, at Visakhapatnam Regional Centre of CMFRI, Visakhapatnam during 30th November to 2nd December, 2009

Dr. J. Jayasankar

- Attended the training programme on "Project monitoring and evaluation" under the aegis of NAIP conducted by NAARM, Hyderabad from 30th March to 4th April, 2009
- Attended the fifth meeting of the "Working group for monitoring implementation and review of IOTC resolution" held at Fishery Survey of India, Mumbai on 21st August, 2009
- Attended the "Fourth advanced programme on Cyber Laws, Information Security and Computers" sponsored by Department of Science and Technology, Govt. of India at Indian Institute of Public Administration, New Delhi from 7th to 13th September, 2009
- Attended the first meting of the "Committee for working out the modalities to adopt a uniform validity period for both Letter of Permission (LOP) and vessel registration" held at Krishi Bhavan, New Delhi on 5th October, 2009

Dr. K.G. Mini

- Attended the National Official Language seminar on "Fish farming in cages" and delivered a talk on "Applications of Geographic Information System for spatial decision system in cage culture" at CMFRI, Kochi on 26th August, 2009

Year 2010

Dr. E. Vivekanandan, Dr. Somy Kuriakose.

- Conducted the second workshop under the Central Sector Scheme on "Strengthening of database and GIS for fisheries sector – Marine Fisheries Census 2010" at CMFRI, Kochi during 15th to 16th March, 2010

Dr.T.V. Sathianandan, Sr. Scientist, and J. Srinivasan, Technical Officer

- Conducted the Second workshop under the Central Sector Scheme on "Strengthening of Database and Geographical Information System for fisheries sector – Marine fisheries Census 2010" at VRC of CMFRI, Veraval during 15 to 16 March, 2010.
- Conducted the Second workshop under the Central Sector Scheme on "Strengthening of Database and Geographical Information System for fisheries sector – Marine fisheries Census 2010" at MRC of CMFRI, Mumbai during 18 to 19 March, 2010.

Dr. J. Jayasankar, Shri S. Haja Najeemudeen, Technical Officer

- Conducted the Second workshop under the Central Sector Scheme on "Strengthening of Database and Geographical Information System for fisheries sector – Marine fisheries Census 2010" at Contai FC of CMFRI, Contai during 15 to 16 March, 2010.
- Conducted the Second workshop under the Central Sector Scheme on "Strengthening of Database and Geographical Information System for fisheries sector – Marine fisheries Census 2010" at Puri FC of CMFRI, Puri during 18 to 19 March, 2010.
- Conducted the Second workshop under the Central Sector Scheme on "Strengthening of Database and Geographical Information System for fisheries sector – Marine

fisheries Census 2010" at VRC of CMFRI, Visakhapatnam during 22 to 23 March, 2010.

Dr. J. Jayasankar, Sr. Scientist

- Attended consultation meet with the State Fisheries Minister on draft marine fisheries (Regulation & Management) Bill 2009 at NASC Complex, New Delhi on 12th Feb., 2010
- Attended Sixth meeting of "Working group" constituted for monitoring and review of implementation of IOTC resolutions at Krishi Bhawan, New Delhi on 15th Feb., 2010
- Attended the project workshop on 4-5 February,2011 for implantation of Council monitored Plan Project on National initiative on Climate Resilient Agriculture (NICRA) for XI th plan

Dr. Somy Kuriakose

- Attended the training programme on "Emotional Intelligence and art of communication" at CMFRI, Cochin on 9.11.2010
- Attended the "20th Swedeshi Science Congress" organized by Swedeshi science movement and CMFRI, at CMFRI, Kochi from November 6 to 8, 2010.
- Attended the project workshop on 4-5 February,2011 for implantation of Council monitored Plan Project on National initiative on Climate Resilient Agriculture (NICRA) for XI th plan

Dr. Somy Kuriakose and Smt. P.L. Ammini, Technical Officer

- Conducted the Second workshop under the Central Sector Scheme on "Strengthening of Database and Geographical Information System for fisheries sector – Marine fisheries Census 2010" at CRC of CMFRI, Calicut during 18 to 19 March, 2010.

Dr. T.M. Najmudeen, Sr. Scientist, Shri Wilson T. Mathew, Scientist and Shri D. Pughazendhi, Technical Officer

- Conducted the Second workshop under the Central Sector Scheme on "Strengthening of Database and Geographical Information System for fisheries sector – Marine fisheries Census 2010" at MRC of CMFRI, Chennai during 15 to 16 March, 2010.
- Conducted the Second workshop under the Central Sector Scheme on "Strengthening of Database and Geographical Information System for fisheries sector – Marine fisheries Census 2010" at Mandapam RC of CMFRI, Mandapam during 17 to 18 March, 2010.
- Conducted the Second workshop under the Central Sector Scheme on "Strengthening of Database and Geographical Information System for fisheries sector – Marine fisheries Census 2010" at TRC of CMFRI, Tuticorin during 19 to 20 March, 2010.

Dr. Mini K.G., Scientist (SS)

- Attended the training programme on "SAS- A comprehensive Overview" at GKVK, Bangalore from 9 Aug to 16 Sep 2010
- Attended the training programme on "Emotional Intelligence and art of communication" at CMFRI, Cochin on 9.11.2010
- Attended the "20th Swedeshi Science Congress" organized by Swedeshi science movement and CMFRI, at CMFRI, Kochi from November 6 to 8, 2010.

Dr. Mini K.G., Scientist (SS) and Smt Latha Kambadkar, Sr. Technical Assistant

- Conducted the Second workshop under the Central Sector Scheme on "Strengthening of Database and Geographical Information System for fisheries sector – Marine fisheries Census 2010" at MRC of CMFRI, Mangalore during 15 to 16 March, 2010.
- Conducted the Second workshop under the Central Sector Scheme on "Strengthening of Database and Geographical Information System for fisheries sector – Marine fisheries Census 2010" at KRC of CMFRI, Karwar during 18 to 19 March, 2010.

Year 2011

Dr.T.V. Sathianandan, Head & Sr. Scientist and Dr (Mrs) Somy Kuriakose Sr. Scientist

- Participated in the training programme on "Current Approaches and Applications of Bio-informatics in Agricultural Research" held at Central Tuber Crops Research Institute, Thiruvananthapuram during 28th March to 6th April, 2011

Dr.T.V. Sathianandan, Head & Sr. Scientist

- Attended the meeting-cum-workshop on "Towards more effective role of Heads of Divisions and Regional Stations in ICAR Institutes" held at Central Institute of Agricultural Engineering, Bhopal during 14-15, June 2011

Dr.T.V. Sathianandan, Head & Sr. Scientist, Dr. J. Jayasankar, Sr. Scientist

- Participated in the Eighth Technical Monitoring Committee Meeting of DADF project on "Strengthening database and GIS for the fisheries sector" held in Shillong, Meghalaya on 3rd June, 2011

- Attended the workshop on "Marine Fisheries in India" organized by Department of Animal Husbandry Dairying & Fisheries in collaboration with World Bank on 7th July 2011 at World Bank, Lodhi Estate, New Delhi

- Attended the "BOBLME (Bay of Bengal Large Marine Ecosystem) workshop on assessing the data and assessment potential on Indian mackerel (Rastrelliger Kanagurta)" held at Kochi during 01-02 December, 2011

Dr.T.V. Sathianandan, Head & Sr. Scientist, Dr. J. Jayasankar, Dr (Mrs) Somy Kuriakose Dr. (Mrs) Mini K.G. Scientist Sr. Scientists and Shri Wilson T. Mathew, Scientist

- Participated in Dr. S. Jones Centenary Colloquium on Challenges in Marine Mammal Conservation & Research in the Indian Ocean (CIMCAR) organized by

The Marine Biological Association of India during 26-27 August 2011, at CMFRI, Kochi

Dr. (Mrs) Mini K.G. Sr. Scientist

- Participated in the training programme on "Data mining and GIS applications in Agriculture during 28th March to 8th April, 2011.

Shri Wilson T. Mathew, Scientist

- Participated in the workshop on"National initiative on climate resilient agriculture (NICRA)" at CMFRI, Cochin on 5-2-2011
- Participated in the workshop on "CIMCAR Jones colloquium on marine mammals" held at CMFRI, Cochin during 27-27, August, 2011
- Participated in the "National Official Language seminar on Biodiversity" at CMFRI, Cochin on 10-10-2011

Year 2012

Dr T.V. Sathianandan, Principal Scientist & Head, FRAD

1. The meeting of the Heads of Divisions, Scientist-in-Charge of Regional & Research Centres and Directors of Fisheries Research Institutes convened by the Director General, ICAR at NASC Complex, DPS Marg, New Delhi on 15th March 2013.

2. Delivered an invited lecture on "VARIMA time series modelling" in the summer school on " Forecast modelling in crops" organized by the Indian Agricultural Statistics Research Institute at New Delhi on 1st August 2012.

Dr. T.V. Sathianandan and Dr. J. Jayasankar

3. The 10th Meeting of the Technical Monitoring Committee for the central sector scheme "Strengthening of Database and GIS for Fisheries Sector" of the Department of Animal Husbandry Dairing and Fisheries, Ministry of Agriculture, New Delhi held at Bhubaneswar on 29.01.2013.

Dr J. Jayasankar, Principal Scientist

4. As a resource person during the workshop entitled 'Biometrical Analysis using SAS' at IGKV Raipur, Chhattisgarh, from 23rd Jan to 25th Jan 2013.

5. Interaction meeting with Oceanography Group of NRSC, Hyderabad on 1st Feb, 2013.

6. As a resource person at the IASRI, New Delhi sponsored NAIP consortium training programme on "Strengthening of Statistical Computing for NARS" held at SwamyKeshavanand Rajasthan Agricultural University, Bikaner, Rajasthan on 6th March, 2013.

7. Participated and delivered an invited lecture entitled "GIS applications in Marine Resource Management" at the Workshop on GIS applications in Natural Resource Management, held under the aegis of NAARM, Hyderabad from 19th February, 2013 to 22nd Feb 2013. Served as a resource person at the training programme entitled "SAS for data reduction and Multivariate Analysis" conducted by CIFE, Mumbai on 14th Feb 2013.

8. Second meeting to work out the fleet plan for oceanic and deep sea resources of Indian EEZ held on 19.03.2013 under the aegis of DADF, New Delhi at BoBP, Chennai.

Dr Somy Kuriakose, Sr. Scientist

9. Attended the Workshop on Statistical Analysis of Time series data with Applications during Jan 14-16, 2013 at CUSAT, Cochin.

Dr. Grinson George, Sr. Scientist

10. Attended Pan Ocean Remote Sensing Conference (PORSEC) – 2012 at Kochi from 05-09 Nov 2012

11. Attended Training Course on Field Trial & QTL analysis using R & R/QTL at ICRISAT, Patancheru from 02-06 Dec 2012

12. Served as a resource person and delivered lecture in India-EU Workshop on Marine Primary Productionduring 12th-15thMarch 2013 at Kerala University of Fisheries And Ocean Studies, Panangad, Cochin organized by NERCI, Kochi as part of their INDO-MARECLIM project.

Year 2013

Dr. T.V. Sathianandan, Head FRAD & Principal Scientist

1. Attended the meeting as a member of the expert committee to study "the impact of trawl ban along Kerala coast" in the chamber of Hon'ble Minister for Fisheries, Government of Kerala at Trivandrum on 18-5-2013

Dr. Somy Kuriakose and Dr. Mini, K.G.

2. Dr. Somy Kuriakose and Dr. Mini, K.G. attended the BOBLME - IOTC Fisheries Stock Assessment Training Workshop organized by Bay of Bengal Large Marine Ecosystem Project and the Indian Ocean Tuna Commission at Bangkok, Thailand during 20-24, May 2013.

Dr. T.V. Sathianandan and Dr. Grinson George

3. Dr. T.V. Sathianandan and Dr. Grinson George participated and presented in the international conference on "greening fisheries- towards green technologies in fisheries" during 21-23 May 2013 at Cochin.

Dr.J. Jayasankar and Dr. Somy Kuriakose

4. Dr.J. Jayasankar and Dr. Somy Kuriakose attended the NICRA Review meeting held at CMFRI Kochi during 11-12 April 2013.

Dr. T. V. Sathianandan, Head (I/C) FRAD and Principal Scientist & Dr. J Jayasankar, Principal Scientist

5. Attended the two days workshop during 18-19 July 2013 at Space Application Centre, Ahmedabad to discuss and finalise the liaison with Space Application Centre regarding the project on "Remote Sensing Assisted Biodynamic Forecasting Paradigm for Indian Marine Fishery Resources".

Dr. T. V. Sathianandan, Head (I/C) FRAD and Principal Scientist and Dr. Mini K. G., Sr. Scientist

6. Participated in the 11th meeting of Technical Monitoring Committee for the Central Sector Scheme on "Strengthening of Database and GIS for Fisheries

Sector" of the Department of Animal Husbandry Dairying and Fisheries at The International Centre, Dona Paula, Goa on 30-08-2013 and gave a presentation on Marine Fisheries Census 2015.

Dr. J Jayasankar, Principal Scientist

7. Attended the meeting of DG, Directors of Fisheries Research Institute on "Performance indicator" held at NCAP, New Delhi on 17-7-2013

8. Attended General Management Programme for Scientist from August 26 to September 6, 2013 sponsored by Department of Science & Technology, Government of India held at ASCI, New Delhi

9. Participated in the IV Meeting of the committee to work out the fleet size of EEZ on 11th September, 2013 conducted by DAHD & F at New Delhi

Dr. Grinson George, Senior Scientist

10. Delivered lecture as resource person on "Information retrieved from satellite images for managing marine fishery resources in Indian coastal waters" in short term training programme for engineering college teachers on "Imaging Techniques- ImTec '13" during 17th – 21st June 2013 at CUSAT, Cochin.

11. Participated and delivered lecture in the two days preparatory workshop on "ChloRIFFS project" at Space Applications Centre, Ahmedabad during 18-19 July 2013.

12. Participated and delivered lecture in the one day brain storming session on 27th August 2013 to discuss and finalise the reprocessing chain of different OCM LAC-360 m data at National Remote Sensing Centre, Hyderabad.

13. Completed NAIP international training during 17 October 2013 – 15 January 2014 at Plymouth Marine Laboratory, UK.

Dr. J Jayasankar, Principal Scientist, Dr. Mini K.G., Sr. Scientist, Sh. J. Srinivasan, Asstt. Chief Technical Officer and Sh. S. Haja Najeemudeen, Sr. Technical Officer

14. Conducted the Pre-Census Workshop at VRC of CMFRI Visakhapatnam from 10-12-2013 to 11-12-2013 under the Central Sector Scheme on "Strengthening of Database and Geographical Information System for

fisheries sector – Marine Fisheries Census" – funded by DAHDF, Ministry of Agriculture, New Delhi

Dr Somy Kuriakose, Sr. Scientist

15. Participated in the International Conference on 'Ecosystem Conservation, Climate change and Sustainable Development: (ECOCASD-2013)' organized jointly by the Dept. of Aquatic Biology & Fisheries, University of Kerala, Thiruvananthapuram, Directorate of Environment & Climate Change, Govt. of Kerala and Ambo University, Ethiopia during period from 3rd to 5th October, 2013, at University of Kerala, Thiruvananthapuram.

Dr. Mini K.G., Sr. Scientist

16. Attended 4th Workshop-cum-Installation training programme under the NAIP Consortium on Strengthening Statistical Computing for NARS held at University of Agricultural Sciences, Bangalore during November 15-16, 2013.

Dr. TV Sathianandan, Head I/C and Principal Scientist, Sh. S. Haja Najeemudeen, Sr. Technical Officer

17. Conducted the Pre-Census Workshop at MRC of CMFRI Mumbai from 2-1-2014 to 4-1-2014 under the Central Sector Scheme on "Strengthening of Database and Geographical Information System for fisheries sector – Marine Fisheries Census" – funded by DAHDF, Ministry of Agriculture, New Delhi

Dr. TV Sathianandan, Head I/C and Principal Scientist, Sh. Wilson T. Mathew, Scientist, Smt. K. Ramani, Sr. Technical Officer and Sh. K.P. George, Technical Officer

18. Conducted the Pre-Census Workshop at MRC of CMFRI Madras from 7-1-2014 to 9-1-2014 under the Central Sector Scheme on "Strengthening of Database and Geographical Information System for fisheries sector – Marine Fisheries Census" – funded by DAHDF, Ministry of Agriculture, New Delhi

Dr Somy Kuriakose, Sr. Scientist, Dr. Mini K.G., Sr. Scientist, Sh. J. Srinivasan, Asstt. Chief Technical Officer and Smt. Sindhu K. Augustine, Sr. Technical Assistant

19. Conducted the Pre-Census Workshop at MRC of CMFRI Mangalore from 16-1-2014 to 18-1-2014 under the Central Sector Scheme on "Strengthening of Database and Geographical Information System for fisheries sector – Marine Fisheries Census" – funded by DAHDF, Ministry of Agriculture, New Delhi