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Central Marine Fisheries Research Institute
(*Indian Council of Agricultural Research*)
Post Box No. 1603, Cochin - 682 018
www.cmfri.org.in

Marine Fisheries Information Service

PUBLISHED BY

Dr. A. Gopalakrishnan
Director, CMFRI, Cochin

EDITOR

Dr. Imelda Joseph
Principal Scientist

SUB - EDITORS

Dr. U. Ganga
Senior Scientist

Dr. Grinson George
Senior Scientist

Cover : *Silver Pompano fingerlings*

Cover Back : *Indigenously fabricated RAS Unit*

The Marine Fisheries Information Service *Technical and Extension Series* envisages dissemination of information on marine fishery resources based on research results to the planners, industry and fish farmers, and transfer of technology from laboratory to field.

From the Editorial Board.......

FAO estimates indicate that fish is one among the most traded food commodities worldwide, with per capita consumption showing a continual upward trend. The seafood export market has grown by almost 6 % during the last year and seafood exports from India are expected to cross the $10 billion mark by 2020. Simultaneously the needs of the domestic markets are also to be addressed since marine fish forms a healthy, protein rich food for a vast section of the population. The marine fish landing statistics of CMFRI indicate a some what stabilized landings of 3.78 million tonnes in 2013. Against this backdrop, the likely occurrence of the *El Nino* towards the end of 2014 and its probable adverse impact on the marine fishery resources production trends is a cause for concern. The health of the ecosystems that support the fish supplies are critical and the articles in this issue cover observations on capture fishery resources, market trends, ecosystem issues and like. Taking a cue from the global trends of marine fish production from culture systems, recently the institute has significantly focused on the development of technologies / facilities for initiating a sustainable mariculture system in the country. With a diverse array of prioritized species it is hoped that this effort can supplement capture fishery production in the near future. In this context, the present issue highlights the future strategies for augmenting seafood production through mariculture activities.

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Strategies and way forward to augment seafood production through finfish mariculture

Gopakumar, G., Abdul Nazar, A. K., Jayakumar, R., Tamilmani, G. and Sakthivel, M.
Mandapam Regional Centre of CMFRI, Tamil Nadu

The marine capture fisheries scenario in India is characterized by excessive fishing effort, overexploitation of certain resources and conflicts among the different stakeholders in the sector. Due to the larger dependency on inshore fisheries over the years, the production from these waters has reached a plateau and hence ensuring sustainability is inevitable. It has to be admitted that many of the management options are not practical to be implemented due to the multispecies nature and continuous spawning strategy which are characteristics of most of the tropical fish stocks. It is understood that any fisheries management regulations can be implemented only by taking into consideration the livelihood issues and other social aspects of the sector. It is also accepted that the increased demand in seafood cannot be met from capture fisheries alone. In this context, it is the need of the hour to resort to resource augmentation methods through mariculture and allied techniques.

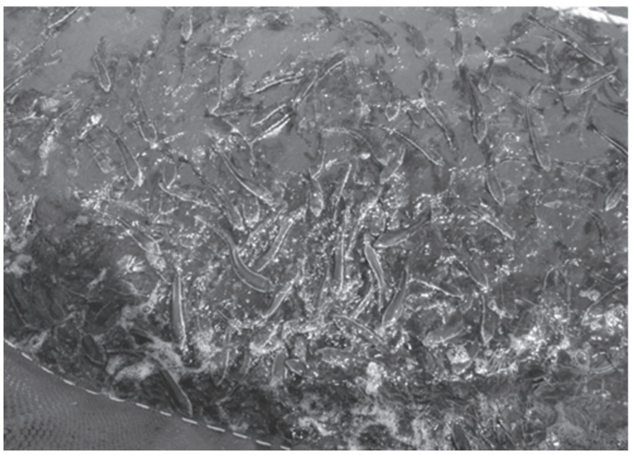
Mariculture has been contributing around 30.3% of the global aquaculture production by quantity and 29.2% of the total value. Finfish culture in the sea is expanding rapidly with an average annual rate of 9.3% from 1990 to 2010. The commercial level production of marine finfish from mariculture is still in its infancy in India. The chief farmed seafood production from in India is by coastal aquaculture of shrimps. Shrimp farming started in a big way in India in the early 90s especially in the coastal districts of Andhra Pradesh and Tamil Nadu. So far, shrimp remains as the single largest and maximum value earner among the seafood exported from the country. Shrimp farming in India, till 2008, was synonymous with the monoculture of tiger shrimp, *Penaeus monodon*. Since 1995, culture of *P. monodon* is affected by White Spot Syndrome Virus (WSSV) and the development of shrimp farming has become stagnant. Later in India, pilot-scale introduction of *L. vannamei* was initiated in 2003 and after risk analyses large-scale introduction was permitted in 2009. Of late *L. vannamei* farming is being threatened by outbreak of new diseases namely Early Mortality Syndrome (EMS), Acute Pancreatic and Haematopoietic Necrosis Syndrome (APHNS) and many viral diseases. Hence, a crop rotation with a commercially viable finfish species can be one of the best options for a long term solution for sustaining aquaculture sector. The major constraints for initiating and developing marine finfish farming in the country is the lack of seed production technologies for suitable high value species and the non-availability of commercially viable farming techniques. Now, with the development of indigenous technology for seed production and farming of cobia and silver pompano by Central Marine Fisheries Research Institute (CMFRI), there is great scope for diversification of farming practices. CMFRI has contributed to the development of following technologies/ facilities for initiating a sustainable mariculture production in the country

(i) Seed Production of Cobia

Fast growth rate, adaptability for captive breeding, cost effectiveness in production, good meat quality and high market demand are some of the attributes that makes cobia a candidate species for mariculture. Envisaging the prospects of cobia farming in India, broodstock development was initiated at the Mandapam Regional Centre of CMFRI

Indigenously fabricated RAS Unit

Marine finfish broodbank



Cobia fingerlings reared in the cage

Silver Pompano fingerlings

in sea cages during 2008 and the first successful induced breeding and seed production was achieved in March – April 2010. The Centre has also developed protocols for captive breeding, larval production and cage farming of cobia. Sub-adult cobia were collected from wild and stocked in sea cages and fed with squids, oil sardines and lesser sardines with vitamin premixes for developing as broodstock. Fishes weighing 9 kg and above were transferred and stocked in 60 tonne capacity FRP tanks/ 100 tonne capacity cement tanks with recirculation system in an on-shore hatchery facility at a male: female ratio of 2:1. Cannular biopsies were periodically taken to assess ovarian maturation. Usage of different hormones namely Luteinizing hormone-releasing hormone (LHRHa) and Human Chorionic Gonadotropin (HCG) were studied at different dosage levels to standardize the optimum dosage for spawning induction. Once the ova reach a size of 700 µm diameter, they were induced with HCG at the dose of 500 IU/kg body weight. The males are administered with a dosage of 250 IU/kg body weight. After spawning the fertilized eggs which are floating at the surface were collected and incubated in 2 tonne capacity rectangular/ circular tanks. The newly hatched larvae are stocked in 2 tonne capacity tanks containing filtered seawater at a stocking density of 5-10nos/ litre. The tanks are provided with mild aeration and microalgae at a density of $1x10^7$ nos./ml. The mouth of the larvae opens on 3rd day and the mouth size is around 230 µm and are fed with enriched rotifers upto day 10 at a density of 10-12 nos. per ml. Co-feeding of rotifers with enriched *Artemia* nauplii is carried out from 8 to 10 days of hatching. The *Artemia* nauplii are provided at a density of 5-6 nos/ml up to day 19. Weaning to larval inert feed is started from day 15 along with co-feeding of Artemia. From day 20, the feeding is entirely on inert larval feeds and frequent grading is needed to control cannibalism. Metamorphosis of the larvae starts from day 18th and all the larvae metamorphose into juveniles by day 21. Nursery rearing is carried out till day 55. During this stage, the fingerlings will be initially provided with artificial feed of 800μ size. After this the fingerlings of 3-4 inch size are supplied to the farmers for stocking in sea cages/ ponds for further rearing and grow-out culture.

(ii) Farming of Cobia

The farming protocols for the hatchery produced cobia fingerlings in sea cages with different feeding strategies were developed, tested and validated. This farming method has been adopted by private entrepreneurs, fishermen groups and farmers. The nursery reared juveniles were transferred to the grow-out sea cages at a stocking density of 3.0-5.0 kg/m^3 or 750 nos of juvenile cobia per 6m diameter cage of 3 metre depth. The juveniles were fed @ 5% total biomass of fish with chopped low-value fishes once in a day. The grow-out period was optimized for a period of 6- 7 months. The juveniles reached an average weight of 1.0 kg in 4 months and 2.5 – 3.0 kg in 6- 7 months.

(iii) Seed production of silver pompano Trachinotus blochii

Realizing the aquaculture potential of pompano in India, broodstock development was initiated in the year 2008 at the Mandapam Regional Centre of CMFRI. Wild collected 250 to 500 gm size pompano were stocked in sea cages of 6 m diameter and 3.5 m depth. The fishes were fed once in a day with trash fish. In April 2011, 4 numbers of cage reared adult pompano (1 female and 3 males) were selected and transferred to an indoor FRP tank of 10 m^3 capacity with photoperiod control facility (14 L: 10 D) for pre-conditioning the fishes to induced spawning. The brooders were fed with squid meat and fish roe once a day. Water quality was maintained by providing a flow-through system throughout the period. Periodic cannulations were carried out to assess the maturity of the fishes for induction of spawning. On 5th July 2011, intra-ovarian eggs of diameter above 500 μ were observed and the brooders were administered with HCG (350 IU per kg body weight). Spawning was recorded on 07/07/2011 after 38 h of hormone induction. The total number of eggs spawned was 1.30 lakh and 50 % were fertilized. The eggs hatched after 18 h of incubation at a temperature range of 30-31°C.

The newly hatched larvae were reared in FRP tanks of 2 m^3 capacity provided with mild aeration and green water at a cell density of 1 x10^5/ml. Copepods were introduced into the larviculture tanks to facilitate the first feeding of the larvae. On 3 dph (day post hatch), mouth opening was formed and the larvae were fed with enriched rotifers till 9 dph. Co-feeding with enriched *Artemia* nauplii was done during 10-13 dph and thereafter upto 19 dph with enriched *Artemia* nauplii alone by maintaining a density of 1-2 nos. per ml. Weaning to larval inert feeds was started from 20 dph till 24 dph. From 25 dph only inert feeds were provided. The metamorphosis of the larvae had started from 18 dph and all larvae were metamorphosed into juveniles by 25 dph. During 20-25 dph gradings were done to separate the shooters. It was also noted that after the critical stage mortality during 3-5 dph, mortalities were rather negligible.

Thereafter, the fingerlings were fed with progressively higher size range of larval inert feeds. The first phase of nursery rearing was done upto 35 dph in the hatchery with inert feeds and proper water quality management. On 35dph, the fingerlings with size range from 33-40 mm were ready for farm rearing. The survival as on 35 dph was estimated as 12%.

(iv) Pond Farming of silver pompano

The first farming demonstration from the hatchery produced seed was carried out in a coastal pond at Antharvedi in East Godavari District, Andhra Pradesh and the growth performance, survival and productive capacity were evaluated. About 3,400 fingerlings of silver pompano (30.59 ± 0.24 mm mean length and 2.00 ± 0.04 g mean weight) were stocked into a one acre pond (0.4047 hectare) having 8 ± 1.2 ppt salinity. The salinity was gradually raised to

24 + 1.8 ppt during the farming period. The fish were fed with extruded floating pellet feed containing 30% to 50% crude protein and 6 % to 10 % crude fat. After 240 days of culture, 1305 kg of silver pompano were harvested and the survival rate was 91.32%. The FCR was 1:1.83.

(v) Marine finfish brood bank

The availability of required quantities of biosecure seed is the major prerequisite for the initiation and expansion of mariculture in the country. The major bottleneck in achieving commercial level seed production is the non-availability of a facility where the biosecure broodstock can be maintained and controlled spawning can be obtained year round. Broodstock management usually include collection and domestication of brooders as well as maturation control, spawning and egg production. Cobia being a very active fish which grows to large size, broodstock development is mostly practiced in sea cages. However, the broodstock developed in sea cages are susceptible to the changes in the water quality of the cage site and impact of harmful algal blooms. Consequently the broodstock developed in sea cages is not biosecure and hence can lead to spreading of diseases while farming is taken up on a commercial basis. If the broodstock can be maintained onshore in controlled facilities the loss of broodstock can be minimised and controlled breeding by manipulating the photo thermal regimes and spawning all through the year can be achieved. Based on this concept a marine finfish broodbank has been established at Mandapam Regional Centre of CMFRI.

(vi) Recirculating Aquaculture System (RAS)

Recirculating aquaculture systems (RAS) are tank-based systems in which fish can be grown at high density under controlled conditions. They are closed-loop facilities that retain and treat the water within the system itself. Recirculation systems use land based units to pump water in a closed loop through fish rearing tanks and consist of a series of sub-systems for water treatment which include equipments for solids removal, biological filtration, heating or cooling, dissolved gas control, water sterilization and photo-thermal control. Sustainable production of biosecure cobia seed all through the year employing photo-thermal conditioning is possible only in RAS. At Mandapam Regional Centre two RAS are installed for controlled broodstock development and breeding. The first successful off-season spawning of cobia through thermal regulation has been achieved in the RAS on 2nd December 2013. During this season the temperature in source seawater was 25.1 to 26.0°C and it was raised in the RAS to 29.7 to 30.3 °C, using titanium heaters.

Way forward

Seed availability is the major constraint for initiation of commercial level farming of marine finfishes. At present limited quantities of seeds of seabass, cobia and pompano are available from CMFRI, CIBA and RGCA. The huge demand for cobia and pompano seeds received at CMFRI from fish farmers and entrepreneurs is indication on the priority of the sector. Hence there is an urgent need to establish finfish hatcheries by fisheries development agencies/private sector to ensure the seed availability. In addition, it is required to intensify research programmes for the development of seed production techniques for at least one dozen species of high value marine fishes. In this context, CMFRI has already taken up broodstock development and seed production of orange spotted Grouper *Epinephelus coioides*, Indian Pompano *Trachinotus mookalee* and Malabar red snapper *Lutjanus argentimaculatus*. Initial success has already been obtained in broodstock development and seed production of *E. coioides* and *T. mookalee* at the Vishakapatnam Research Centre of CMFRI. Broodstock development of *L. argentimaculatus* is being pursued by CMFRI at Cochin and Karwar.

Development of farming systems especially sea cage farming deserves prime attention. Sea cage culture has been expanding in recent years on a global basis and it is viewed by many stakeholders in the industry as the aquaculture system of the millennium. Cage culture has made possible the large-scale production of commercial finfishes in many parts of the world and can be considered as the most efficient and economical way of growing fish. The rapid growth of the industry in most countries can be attributed to (i) suitable sites for cage culture (ii) well established breeding techniques that yield a sufficient quantity of various marine and freshwater fish juveniles (iii) availability of supporting industries such and feed, net manufacturers, fish processors etc. (iv) strong research and development initiatives from institutions, governments and universities and (v) the private sector ensuring refinement and improvement of techniques/ culture systems, thereby further developing the industry.

When compared to many countries in the Asia-Pacific Region, India is still in its infancy in sea cage farming. For the first time in India as part of R &D a marine cage of 15 m diameter with HDPE frame was successfully launched in 2007and operated at Visakhapatnam, in the east coast of India by CMFRI. Even though it cannot be taken as a commercially successful venture, a lot of lessons were learnt on designing and fabrication of cages and mooring systems. This has led to the development of better designs of cages of 6m diameter with improved mooring systems that can withstand rough sea conditions. Subsequent demonstrations of cage farming were undertaken along different parts of the Indian coast under a participatory mode with the local coastal fishermen. Successful sea cage farming demonstrations were conducted at Kanyakumari, Vizhinjam, Kochi, Mangalore, Karwar, Veraval, Mandapam, Chennai and Balasore. Cobia, Sea bass and spiny lobsters were the major groups employed for farming. These demonstrations have created an awareness regarding the prospects of sea cage farming in India. Many entrepreneurs, fishermen and farmers are coming forward to take up this venture. In this regard, the initiative taken by the Cobia Aquaculture Fishermen Welfare Association is worth mentioning.

Cobia Fisherman Welfare Association, a self help group from Rameswaram took up sea cage farming under the technical support of Mandapam Regional Centre of CMFRI. Ten cages of 6m diameter and 3.5m depth were fabricated and floated by them. All the investments in the fabrication of the cages, the cost of seeds, feeds and managing the sea cage farm were borne by the association. A total of 6400 fingerlings of hatchery produced cobia were supplied from Mandapam Regional Centre. The farming was initiated during November 2013. A total of 10 tonnes of fish was harvested during the fishing ban period and the fish weighed from 1.0 to 2.3 kg and the farm gate price was ₹ 270/ kg. This has created widespread interest among fishermen communities for taking up sea cage farming in the area.

To promote sea cage farming in the country, identification of suitable sites with proper depth, water quality and water current are required. Site selection survey and identification of suitable sites for cage farming by the entrepreneurs and farmers deserves urgent attention. Availability of logistic support for cage farming and it must be given careful consideration if a profitable business is to be established. Cage farming has to be promoted away from the human settlements, discharge points of industrial and municipal waste, so as to maintain ideal water quality for sea farming. Further, policy for leasing the suitable sites, bank finance, and governmental support through subsidy assistance are need of the hour.

The development of seed production technologies for at least a few species of high market value finfishes, establishment of hatcheries by fisheries development agencies, identification of appropriate cage farming sites, development of economically viable farming protocols, formulation of suitable grow-out feeds, health management protocols, development of mariculture policies, appropriate marketing strategies can go a long way to promote mariculture as a substantial contributor of sea food production of India.

Penaeid prawn resources along the east coast of India during 1991-2011

Maheswarudu, G., Sudhakara Rao G., Rajamani, M., Thangaraj Subramanian, V., Manmadhan Nair, K.R., Saleela, K.N., Dhanwanthari, E., Miriam Paul and Unnithan, A.K.
Central Marine Fisheries Research Instiute, Kochi

The east coast of India with a coast line of 2,688 km and continental shelf area of about 0.56 million km^2, provides a good habitat for the penaeid prawns in the adult phase. There are five major perennial rivers, number of creeks and low-lying areas offering nursery grounds for post larvae and juveniles that migrate to the sea after completion of nursery phase to get recruited to the fishery. Though as many as 23 species of penaeids are recorded along the east coast only about 19 species are supporting the regular fishery.

Craft&gear

Trawl nets are the major gearwhich is exploiting more than 90% of penaeid prawn along the east coast. Trawlers are of different types depending on the size of the boat, engine capacity and size of the gear. These are Pablo (9.14 m), Royya (9.75-10 m), Sorrah (11.4 m) and Sona (13.1 m) boats.The major fishing harbours/ landing centres, which are bases for operation of trawlers are Diamond harbor, Digha, Paradeep, Visakhapatnam, Kakinada, Chennai, Mandapam and Tuticorin. Besides these trawlers,*Thalluvalai* along the Tamil Nadu coast and stake nets along the Andhra Pradesh coast are also operated for exploitation of juvenile prawns in shallow coastal waters, estuaries, creeks and backwaters.

Penaeid prawn landings

Penaeid prawns, on average, contributed 9.8% of annual total marine fish landings along the east coast and theircontribution ranged from 5.5% to 13.8% during 1991 – 2011. On an average, east coast, contributed 29% of total penaeid prawn catch of India and its share ranged from 17.4% to 41.2% during the 21 years period. Average annual catch was 86,969 t and it ranged from 33,131 t in 1991 to 2,19,054 t in 2011. During 1991-2000 catch has fluctuated with 0.054 compound annual growth rate whereas during 2001-2010 sharp increase in catch was recorded with 0.156 compound annual growth rate. Overall increasing trend was observed during 21 years period (Fig.1). Average instead of mean state wise contribution of penaeid prawns shows Tamil Nadu contributed the highest (32%) followed by Andhra Pradesh (26%), West Bengal (22%),Odisha (19%), and Puducherry (1%). The highest catch was recorded from West Bengal and Odisha in 2011, from Andhra Pradesh in 2010 and from Tamil Nadu and Puducherry in 2009. The lowest catch was registered from West Bengal, Odisha, Andhra Pradesh in 1991, from Tamil Nadu in 2001 whereas from Puducherry it was in 1997 (Table1). West Bengal has the highest compound annual growth rate (0.211) followed by Odisha (0.192), Andhra Pradesh (0.056) and Tamil Nadu (0.033) during 21 years period, whereas Puducherry showed negative compound annual growth rate (-0.006). All states

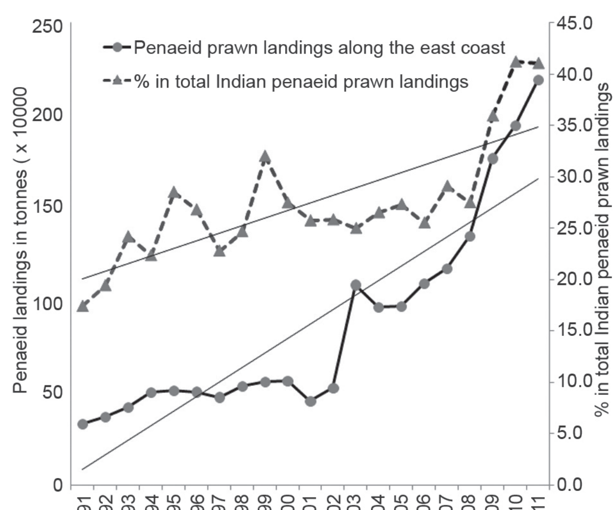


Fig. 1. Trends in penaeid landings and its share in total penaeid landings along the east coast

Table 1. Statewisepenaeid prawn landings (t) along the east coast during 1991-2011

Year	West Bengal	Odisha	Andhra Pradesh	Tamil Nadu	Puducherry	Total (east coast)	All India penaeid prawn landings	Contribution of east coastto all India penaeid prawn landings (%)	Total marine fish landings	Contribution of penaeid prawn landings to total marine fishlandings (%)	Total marine fish landings of east coast	Cntribution of penaeid landings to total marine fish landings of the east coast
1991	1223	1972	10759	18523	654	33131	190210	17.4	2251255	8.4	600917	5.5
1992	2677	2738	10797	20286	400	36898	189840	19.4	2310052	8.2	660693	5.6
1993	2754	2986	16200	19833	146	41919	173204	24.2	1976143	8.8	669937	6.3
1994	1247	2520	15513	30176	785	50241	224623	22.4	2359525	9.5	688127	7.3
1995	3352	5350	13863	28038	458	51061	178874	28.5	2258832	7.9	700222	7.3
1996	3799	3557	15138	27528	361	50383	187791	26.8	2380842	7.9	747442	6.7
1997	3030	2966	14193	27284	104	47577	208540	22.8	2692409	7.7	807752	5.9
1998	3123	2276	19011	28348	702	53460	216343	24.7	2635670	8.2	758894	7.0
1999	2704	4323	24967	23443	368	55805	174071	32.1	2401706	7.2	737464	7.6
2000	4272	6911	22657	22004	339	56183	204278	27.5	2652928	7.7	751484	7.5
2001	8780	4105	16221	16202	154	45462	176448	25.8	2292703	7.7	684856	6.6
2002	9434	4947	16391	21266	653	52691	203801	25.9	2589645	7.9	809999	6.5
2003	36104	8826	28382	34723	221	108256	432571	25.0	2587095	16.7	824638	13.1
2004	23905	12587	26607	32395	704	96198	362214	26.6	2538105	14.3	885609	10.9
2005	29646	17293	22158	27146	248	96491	352776	27.4	2295490	15.4	749385	12.9
2006	28135	13094	30350	35775	1619	108973	426416	25.6	2710988	15.7	866749	12.6
2007	28158	23077	33214	32078	500	117027	401688	29.1	2888461	13.9	1033225	11.3
2008	37703	29266	30656	35450	1441	134516	488669	27.5	3207205	15.2	1146745	11.7
2009	49191	54453	34001	37127	1861	176633	490722	36.0	3205453	15.3	1450125	12.2
2010	47952	73225	36922	35358	932	194389	471291	41.2	3346687	14.1	1411678	13.8
2011	68645	79111	33877	36840	581	219054	532851	41.1	3820207	13.9	1599885	13.7
Total	395834	355583	471877	589823	13231	1826348	6287221	29.0	55401401	11.3	18585826	9.8
Mean	18849	16933	22470	28087	630	86969	299391	29	2638162	11.3	885039.3	9.8
CAGR for 1991-11	0.211	0.192	0.056	0.033	-0.006	0.094	0.050	0.042	0.026	0.024	0.048	0.044
CAGR for 1991-2000	0.133	0.134	0.077	0.017	-0.064	0.054	0.007	0.047	0.017	-0.009	0.023	0.031
CAGR for 2001-2010	0.185	0.334	0.086	0.081	0.197	0.156	0.103	0.048	0.039	0.062	0.075	0.076

CAGR: Compound annual growth rate

including Puducherry had higher compound annual growth rates during 2001-2010 than those during 1991-2000.

Species Composition

Species composition of penaeid prawn catches along the east coast was computed using the species composition data collected at Paradeep, Visakhapatnam, Kakinada, Chennai, Mandapam and Tuticorin fishing harbours/ landing centres. Among the 23 species recorded 19 species had supported theregular fishery (Table 2). *Metapenaeus dobsoni* dominated the catch by contributing 21.4% followed by *M. monoceros* (3.2%), *Metapenaeopsis* spp (9.4%), *Penaeus semisulcatus* (9.2), *Fenneropenaeus indicus* (7.5%), *Parapenaeopsis maxillipedo* (4.3%),

Table 2. Common name and local names in four regional languages for penaeid prawns along the east coast

S.No.	Species	Common Name	Local name			
			Bengali	Oriya	Telugu	Tamil
1	*Metapenaeus dobsoni*	Kadalshrimp	Garangchingri	Khopra, Ranichingudi	Chinkiroyya	Chemakkaraeral
2	*Metapenaeus monoceros*	Speckled shrimp	Kara chingri	Khopra, Ranichingudi	Chakuroyya/ Kalandhan	Valuchaeral
3	*Penaeus semisulcatus*	Green tiger prawn	Bagda	Bagada, Katlareyya	Nooneroyya	Varieral
4	*Peneaus indicus*	Indian white shrimp	Chapra	Chapda, Tellareyya	Tellaroyya/ Narran	Vellaeral/ Vellaieral
5	*Metapenaeus affinis*	Jingashrimp	Chamneychingri	Khopra, Kalireyya	Gullaroyya/ Keliroyya	Chayavaluchaeral
6	*Penaeus monodon*	Giant tiger shrimp	Keleghari, Bagda	Bagada, Katlareyya	Katlaroyya	Karuvandueral/ Kathambaeral
7	*Penaeus merguiensis*	Banana shrimp		Chapda, Pettireyya	Kalliroyya	Vellaeral/ Vellaieral
8	*Parapenaeopsis stylifera*	Kiddi shrimp	Matka	Koddi, gullareyya	Gullaroyya / Karrkadi	Vandueral
9	*Parapenaeopsis hardwickii*	Spear shrimp	Lalchingri	Khodi, gullareyya	Gullaroyya/ Karrkadi	Vandueral
10	*Metapenaeus lysianassa*	Bird shrimp	—	—	—	Vellaiveluchaeral
11	*Solenocera spp.*	Coastal mudshrimp	—	Nallichingudi, Errareyya	Kukkaroyya	Kalleral
12	*Metapenaeopsis* spp.	Fiddler shrimp/ Velvet shrimp	—	—	Gullaroyya	Pottueral
13	*Parapenaeopsis maxillipedo*	Torpedo shrimp	—	—	Gullaroyya	Karikkada/ Vandueral
14	*Parapenaeopsis uncta*	Uncta shrimp	—	—	Gullaroyya	Vandueral
15	*Trachypenaeus* spp.	Rough shrimp	—	—	Garukugullaroyya	Vandueral
16	*Metapenaeus moyebi*	Moyebi shrimp	—	—	—	—
17	*Parapenaeus longipes*	Flamingo shrimp	—	—	—	Thattaieral
18	*Metapenaeus brevicornis*	Yellow shrimp	Chamneychingri	Khopra, Kali reyya	Pasupuroyya / Puvvalin	Manjavalucheral
19	*Penaeus japonicus*	Kuruma shrimp	Kaonra, Pamra	Bagada, Katlareyya	Kalliroyya	Kathampaeral
20	Other penaeids	—	—	—	—	—

Table 3. Species composition of penaeid landings by weight(t) along the east coast

	Species	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	Average	%
1	*Metapenaeus dobsoni*	6581	7592	10200	11423	9521	11281	9044	13867	11986	10670	8035	9064	10217	21.4
2	*Metapenaeus monoceros*	3384	3540	4818	5611	6636	5361	5647	8744	10111	8854	5971	6619	6271	13.2
3	*Peneausse misulcatus*	4524	4851	4332	3476	2503	5080	5520	4613	4347	4578	3644	4838	4382	9.2
4	*Peneaus indicus*	2926	3130	2928	4402	4116	3654	3412	4361	3262	3485	2769	3519	3568	7.5
5	*Metapenaeus affinis*	1000	1119	1558	1171	2297	1484	1275	1152	1498	2048	2407	2638	1460	3.1
6	*Peneaus monodon*	404	426	592	1389	734	811	616	667	791	966	791	961	739	1.6
7	*Peneaus merguiensis*	270	298	133	177	184	174	173	156	195	308	322	357	207	0.4
8	*Parapenaeopsis stylifera*	484	671	1321	2379	2288	2210	2418	2173	2398	2525	2512	2754	1887	4.0
9	*Parapenaeopsis hardwickii*	300	509	1444	819	2185	1962	2122	2119	2557	3483	3801	4224	1750	3.7
10	*Metapenaeus lysianassa*	637	1054	372	726	1271	796	762	528	821	1175	1269	1408	814	1.7
11	*Solenocera* spp.	452	545	1738	1650	2678	2358	1705	1982	2995	3278	2938	3241	1938	4.1
12	*Metapenaeopsis* spp.	4634	4999	3644	4144	5494	5104	4732	4202	3884	4015	3426	4165	4485	9.4
13	*Parapenaeopsis maxillipedo*	1264	1363	1551	3730	2853	2079	1822	2551	1829	1627	1227	1633	2067	4.3
14	*Parapenaeopsi suncta*	201	217	343	524	592	570	500	489	494	459	425	508	439	0.9
15	*Trachypenaeus* spp.	1459	1574	1538	2596	2770	2401	1830	1932	1741	1949	1287	1697	1979	4.2
16	*Metapenaeus moyebi*	264	284	689	1391	1449	2014	2409	677	2008	921	518	665	1211	2.5
17	*Parapenaeus longipes*	22	24	615	674	794	36	386	395	400	1123	693	758	447	0.9
18	*Metapenaeus brevicornis*	0	0	720	1111	661	681	669	1167	827	1571	978	989	741	1.6
19	*Penaeus japonicus*	0	0	77	92	55	47	51	37	42	64	44	44	47	0.1
20	Other penaeids	4327	4702	3306	2757	1980	2280	2485	1650	3619	2961	2404	2609	3007	6.3
	Total	**33131**	**36898**	**41919**	**50241**	**51061**	**50383**	**47577**	**53460**	**55805**	**56061**	**45462**	**52690**	**47654**	**100.0**

Trachypenaeus spp (4.2%), *Solenocera* spp (4.1%), *Parapenaeopsiss tylifera (*4%), *P.hardwickii* (3.7%), *M. affinis* (3.1%), *M. moyebi* (2.5%), *M. lysiansa* (1.7%), *P. monodon* (1.6%), *M. brevicornis* (1.6%) and *Parapenaeus longipes*. *M. brevicornis* has emerged as a regular species from 1993 onwards. Contribution of *P. stylifera*, *P. hardwickii*, *Solenocera* spp, *P. longipes* and *M. moyebi* had significantly increased from 1993 onwards. Threefold increase in the catch of *P. monodon* was observed in 1994 and thereafter its contribution was more or less stable. Contribution of *F. indicus, M. dobsoni, M. monoceros* and *P. maxillipedo* were gradually increased up to 1994 and since then their status was maintained.

West Bengal and Odisha: About 11 species supported the fishery of which *P. hardwickii* (24.1%) dominated followed by *M. dobsoni* (18.5%), *P. stylifera* (11.7%), *M. lysianassa* (10.4%), *Solenocera* spp (7.9%) and *M. monoceros* (6.6%). Commercial species like *P. monodon*, *F. indicus* and *P. merguiensis* contributed only in low quantities (Table4).

Andhra Pradesh: About 18 species supported the fishery. *M. dobsoni* (19.1%) dominated followed by *M. monoceros* (25.2%), *Solenocera spp*. (7.1%), *M. brevicornis* (4.8%) *P. stylifera* (4.1%), *F. indicus* (3.8%), *M. affinis* (3.3%), and *M.* spp (3.0%). Other highly commercial species like *P. monodon* (1.8%), *P. semisulcatus* (1.3%) and *P. merguiensis* (0.6%) were contributed in low volumes only.

Tamil Nadu and Puducherry: About 16 species contributed to the fishery. *P. semisulcatus* contributed high (17.3%) followed by others (16.2%), *M. dobsoni*(15.8%), *P. indicus*(11.8%), *P. maxillipedo* (8.1%), *Trachypenaeus* spp (7.7%), *M. monoceros* (6.9%), and *M. moyebi*(4.5%). The commercial species like *P. monodon* (1.7%) and *P. merguiensis* (0.04%) were contributed in low quantities.

This is the first report on species composition of penaeid prawn landings along the east coast of India from different maritime states such as West Bengal, Odisha, Andhra Pradesh, Tamil Nadu and Puducherry. Species composition, size range and modal groups of both sexes of commercial species at different fishing harbours/landing centres of present report can be utilized for future comparative studies.

Table 4. Species wise landings (t) of penaeid prawns along West Bengal and Odisha coasts

Species	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	Total	Mean	%
Metapenaeus dobsoni	1151	1951	1377	849	1201	1386	1105	1057	1178	1617	1863	2079	16814	1401	18.5
Metapenaeus monoceros	114	193	293	113	305	377	329	416	533	961	1107	1236	5978	498	6.6
Penaeus semisulcatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Penaeus indicus	73	124	11	5	17	15	17	22	28	82	94	105	594	50	0.7
Metapenaeus affinis	128	218	695	551	1349	819	824	553	685	1373	1582	1766	10543	879	11.6
Penaeus monodon	11	18	38	22	35	30	50	51	72	151	174	195	848	71	0.9
Penaeus merguiensis	33	55	29	25	78	58	101	114	151	261	301	335	1542	128	1.7
Parapenaeopsis stylifera	242	410	554	402	1166	966	839	631	852	1323	1524	1701	10610	884	11.7
Parapenaeopsis hardwickii	300	509	929	486	1906	1638	1590	1630	2112	3147	3626	4047	21921	1827	24.1
Metapenaeus lysianassa	597	1011	234	443	1123	722	625	415	715	1032	1189	1327	9432	786	10.4
Solenocera spp.	102	173	289	160	1096	819	343	376	507	972	1119	1249	7205	600	7.9
Metapenaeopsis spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Parapenaeopsis maxillipedo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Parapenaeopsis uncta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Trachypenaeus spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Metapenaeus moyebi	0	0	0	0	0	0	0	0	0	0	133	149	282	23	0.3
Parapenaeus longipes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Metapenaeus brevicornis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Penaeus japonicus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Other penaeids	444	752	1291	710	426	524	173	134	195	265	171	191	5277	440	5.8
Total	**3195**	**5415**	**5740**	**3767**	**8702**	**7356**	**5996**	**5399**	**7027**	**11183**	**12885**	**14381**	**91046**	**7587**	**100.0**

Table 5. Species wise landings (t) of penaeid prawns along the Andhra Pradesh coast

Species	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	Total	Mean	%
Metapenaeus dobsoni	2871	2881	5669	4264	3573	5904	4120	6758	7297	5675	3903	3944	56859	4738	29.1
Metapenaeus monoceros	2414	2422	3195	3058	4086	3311	3607	6173	8104	6016	3443	3479	49310	4109	25.2
Penaeus semisulcatus	397	399	290	340	170	78	160	113	132	204	135	136	2553	213	1.3
Penaeus indicus	952	956	705	458	686	596	455	485	497	581	517	523	7413	618	3.8
Metapenaeus affinis	510	511	674	571	496	455	299	421	678	410	708	716	6449	537	3.3
Penaeus monodon	216	217	285	1010	328	257	184	74	302	242	184	186	3485	290	1.8
Penaeus merguiensis	184	185	105	152	106	114	70	41	42	48	21	21	1089	91	0.6
Parapenaeopsis stylifera	0	0	612	1006	664	616	1008	772	954	825	821	830	8107	676	4.1
Parapenaeopsis hardwickii	0	0	515	333	279	324	531	488	445	336	175	177	3603	300	1.8
Metapenaeus lysianassa	0	0	120	225	84	74	138	113	106	143	80	81	1162	97	0.6
Solenocera spp.	68	68	1418	1228	1404	1121	982	1052	2064	1750	1352	1366	13871	1156	7.1
Metapenaeopsis spp.	0	0	377	396	105	509	223	322	549	827	1290	1304	5900	492	3.0
Parapenaeopsis maxillipedo	0	0	0	0	0	0	0	0	0	26	36	36	99	8	0.1
Parapenaeopsis uncta	0	0	0	0	0	0	0	0	0	182	188	190	560	47	0.3
Trachypenaeus spp.	0	0	16	0	143	0	0	0	0	127	86	86	458	38	0.2
Metapenaeus moyebi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Parapenaeus longipes	0	0	187	34	148	36	6	41	128	873	518	524	2496	208	1.3
Metapenaeus brevicornis	0	0	720	1111	661	681	669	1167	827	1571	978	989	9373	781	4.8
Penaeus japonicus	0	0	77	92	55	47	51	37	42	64	44	44	553	46	0.3
Other penaeids	3147	3158	1234	1237	876	1015	1691	954	2800	2672	1742	1760	22284	1857	11.4
Total	**10759**	**10797**	**16200**	**15513**	**13863**	**15138**	**14193**	**19011**	**24967**	**22573**	**16221**	**16391**	**195626**	**16302**	**100.0**

Table 6. Species wise landings (t) of penaeid prawns along the Tamil Nadu and Puducherry coasts

Species	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	Total	Mean	%
Metapenaeus dobsoni	2559	2760	3154	6309	4748	3991	3819	6052	3511	3378	2269	3041	45593	3799	15.8
Metapenaeus monoceros	857	924	1330	2439	2245	1673	1711	2154	1474	1877	1421	1904	20008	1667	6.9
Penaeus semisulcatus	4127	4452	4041	3137	2332	5002	5359	4500	4215	4375	3509	4702	49752	4146	17.3
Penaeus indicus	1900	2050	2211	3938	3413	3043	2940	3854	2736	2822	2157	2891	33957	2830	11.8
Metapenaeus affinis	361	390	190	50	452	209	152	178	135	265	117	157	2655	221	0.9
Penaeus monodon	176	190	269	357	371	523	381	542	417	573	433	580	4813	401	1.7
Penaeus merguiensis	54	58	0	0	0	2	2	0	1	0	0	0	117	10	0.04
Parapenaeopsis stylifera	242	261	155	972	458	628	571	769	593	377	166	223	5415	451	1.9
Parapenaeopsis hardwickii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Metapenaeus lysianassa	40	43	18	58	65	0	0	0	0	0	0	0	224	19	0.1
Solenocera spp.	282	304	31	262	178	418	380	554	424	555	467	626	4483	374	1.6
Metapenaeopsis spp.	4634	4999	3268	3748	5389	4595	4509	3881	3335	3188	2136	2862	46543	3879	16.2
Parapenaeopsis maxillipedo	1264	1363	1551	3730	2853	2079	1822	2551	1829	1601	1191	1597	23430	1952	8.1
Parapenaeopsi suncta	201	217	343	524	592	570	500	489	494	277	237	318	4760	397	1.7
Trachypenaeus spp.	1459	1574	1522	2596	2627	2401	1830	1932	1741	1823	1202	1611	22318	1860	7.7
Metapenaeus moyebi	264	284	689	1391	1449	2014	2409	677	2008	921	385	516	13008	1084	4.5
Parapenaeus longipes	22	24	428	640	646	0	380	354	272	250	174	234	3425	285	1.2
Metapenaeus brevicornis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Penaeus japonicus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Other penaeids	736	792	781	810	678	740	621	561	625	24	491	658	7516	626	2.6
Total	**19177**	**20686**	**19979**	**30961**	**28496**	**27889**	**27388**	**29050**	**23811**	**22305**	**16356**	**21919**	**288017**	**24001**	**100.0**

Table 7. Size range (mm) and mode (mm) of commercial species of penaeid prawns at different landing centres along the east coast.

Landing centre & species	1992		1993		1994		1995		1996		1997		1998		1999		2000		2001	
	Size range	Mode	Size range	Mode	Size range	Mode	Size range	Mode	Size range	Mode	Size range	Mode	Size range	Mode	Size range	Mode	Size range	Mode	Size range	Mode
Paradeep																				
P. monodon																				
Male	91-250	210-220	91-240	201-210	91-250	211-220	0	0	91-250	201-210	101-250	211-220	91-240	201-210	101-260	201-210	101-240	201-210	0	0
Female	91-300	241-250	91-300	241-250	101-300	171-180	0	0	91-290	241-250	201-290	241-250	91-290	241-250	91-290	211-220	101-300	231-240	0	0
P. merguiensis																				
Male	116-170	146-150	116-180	141-145	111-170	136-140	0	0	111-170	146-150	111-180	146-150	111-170	146-150	111-180	146-150	111-170	146-150	0	0
Female	116-205	161-165	121-195	151-155	111-205	151-155	0	0	111-195	161-165	111-205	151-155	111-200	161-165	111-210	161-165	111-215	136-140	0	0
M. affinis																				
Male	71-105	116-120	66-155	106-110	71-170	111-115	0	0	66-160	111-115	76-155	111-115	71-155	116-120	71-155	111-115	71-160	106-110	0	0
Female	71-185	131-135	66-180	126-130	71-185	116-120	0	0	71-185	126-130	71-185	126-130	71-185	131-135	71-180	126-130	71-185	126-130	0	0
M. monoceros																				
Male	76-140	121-125	81-145	111-115	76-150	111-115	0	0	76-145	111-115	71-145	111-115	71-140	111-115	76-150	116-120	81-150	111-115	0	0
Female	76-195	131-135	76-185	136-140	71-185	141-145	0	0	71-190	136-140	71-180	131-135	71-170	131-135	71-185	131-135	71-185	131-135	0	0
M.dobsoni																				
Male	0	0	0	0	0	0	0	0	46-100	76-80	46-100	71-75	46-100	66-70	41-100	81-85	41-100	71-75	0	0
Female	0	0	0	0	0	0	0	0	51-115	91-95	41-110	81-85	46-115	81-85	41-115	76-80	51-110	81-85	0	0

Visakhapatnam																				
M.monoceros																				
Male	76-160	111-115	86-185	126-130	86-170	126-130	86-170	0	86-165	126-130	93-168	121-125	93-168	121-125	98-178	136-140	81-180	136-140	71-175	136-140
Female	81-200	146-150	86-210	146-150	96-205	161-165	96-200	0	86-200	141-145	93-203	146-150	93-208	141-145	83-203	161-165	91-215	161-165	71-205	131-135
P. indicus																				
Male	111-195	161-165	101-200	146-150	121-195	166-170	121-195	0	121-205	161-165	103-198	166-170	113-193	156-160	113-193	161-165	126-190	156-160	121-195	151-155
Female	116-210	181-185	81-210	166-170	131-230	186-190	131-230	0	121-215	166-170	123-208	186-190	128-238	166-170	113-238	186-190	121-205	151-155	106-205	166-170
P.semisulcatus																				
Male	0	0	0	0	126-215	181-185	0	0	0	0	133-223	171-175	113-228	176-180	0	0	111-200	166-170	101-240	176-180
Female	0	0	0	0	131-250	231-235	0	0	0	0	138-238	201-205	93-238	211-215	0	0	106-255	191-195	106-260	206-210
Kakinada																				
M.monoceros																				
Male	46-165	81-85	0	0	41-145	86-90	0	0	51-160	66-70	46-170	91-95	46-130	81-85	51-145	86-90	51-130	81-85	46-135	81-85
Female	41-175	76-80	0	0	36-180	86-90	0	0	46-190	76-80	46-185	91-95	41-155	81-85	51-165	86-90	51-160	86-90	46-170	91-95
P.indicus																				
Male	76-185	126-130	0	0	86-180	116-120	0	0	81-180	121-130	81-180	131-140	81-170	131-140	71-180	121-130	81-170	121-130	81-180	121-130
Female	51-215	121-125	0	0	81-200	126-130	0	0	51-200	121-130	81-270	131-140	71-190	131-140	71-200	121-130	81-180	121-130	81-190	121-130
P.monodon																				
Male	91-260	181-190	0	0	86-230	156-160	0	0	101-230	171-180	101-250	161-170	91-220	181-190	81-240	151-160	101-240	151-160	91-230	131-140
Female	91-300	181-190	0	0	101-270	161-165	0	0	101-280	191-200	81-270	161-170	91-240	181-190	101-300	151-160	111-280	161-170	91-290	151-160
M.dobsoni																				
Male	41-105	66-70	0	0	41-100	66-70	0	0	0	0	41-100	76-80	31-100	66-70	31-95	66-70	41-90	66-70	41-90	66-70
Female	41-115	76-80	0	0	41-110	76-80	0	0	0	0	41-110	76-80	41-110	66-70	31-115	81-85	41-110	81-85	36-115	66-70
Chennai																				
M.dobsoni																				
Male	46-105	71-75	46-150	71-75	46-105	81-85	0	0	0	0	0	0	46-110	66-70	0	0	0	0	46-110	61-65
Female	46-110	81-85	46-110	86-90	41-105	86-90	0	0	0	0	0	0	41-115	66-70	0	0	0	0	41-115	61-65
P.maxillipedo																				
Male	46-105	81-85	41-105	76-80	46-105	71-75	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Female	46-105	81-85	41-115	81-85	41-115	86-90	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mandapam																				
P.semisulcatus																				
Male	76-200	126-130	76-165	116-120	86-160	116-120	91-155	111-115	81-150	106-110	91-150	116-120	86-150	106-110	91-160	116-120	96-160	111-115	96-150	121-125
Female	71-215	131-135	76-205	126-130	86-200	116-120	96-200	141-145	86-200	126-130	96-200	126-130	86-190	116-120	91-205	136-140	96-205	126-130	101-200	126-130
Tuticorin																				
P.semisulcatus																				
Male	101-172	0	95-188	0	86-175	126-130	0	0	96-160	121-125	0	0	0	0	0	0	0	0	96-190	116-120
Female	91-226	0	106-205	0	86-235	161-165	0	0	96-225	161-165	0	0	0	0	0	0	0	0	101-235	151-155

Water quality indexing of coastal waters off Cochin

Prema, D., Jeyabaskaran, R., Kaladharan, P., Khambadkar, L.R., Anilkumar, P.S., Nandakumar, A., Valsala, K.K. and Kripa, V.
Central Marine Fisheries Research Institute, Kochi

Water Quality Index (WQI) condenses the information from numerous water quality parameters into a simpler version which can be used to appraise and compare water quality data from a number of sites as well as to look at trends of water quality over a period of time from a single site. WQI is means for simplifying the reporting of detailed water quality assessment and providing meaningful summaries of overall water quality and its trends. It also creates an output that is easy to understand for managers and non-technical public.

WQI is not meant to replace a detailed analysis of environmental monitoring data, nor should it be used as the only device for management of water bodies. Rather it gives a broad overview of the environmental performance of the assessed aquatic system. Water quality indices for the year 2002 and 2012 were prepared, using the grading of selected environmental indicators (Table 1), as per USEPA (2004). The data on water quality at selected sites off Cochin on monthly intervals was used. The selected environmental indicators were dissolved oxygen (DO, mg l^{-1}), dissolved inorganic phosphorus (DIP, mg l^{-1}), dissolved inorganic nitrogen (DIN, mg l^{-1}) and chlorophyll a ($\mu g\ l^{-1}$). These indicators were assessed, based on estimation of water samples using standard analytical methods (APHA, 1981) for DO, dissolved orthophosphate, NO_2 -N, NO_3 -N, total NH_3- N and chlorophyll a.

Table 1. Range of selected environmental indicators for water quality indexing

Ranking	Grade colour	DO mg l^{-1}	Chl a µg l^{-1}	DIP mg l^{-1}	DIN mg l^{-1}
Good	Green	> 5	<5	<0.01	<0.1
Fair	Yellow	2-5	5-20	0.01-0.05	0.1-0.5
Poor	Red	< 2	>20	>0.05	>0.5

Table 2. Water Quality index of surface waters, off Cochin (January-December 2002)

Latitude	Longitude	Depth	DO mg l^{-1}	DIP mg l^{-1}	DIN mg l^{-1}	Chl a µg l^{-1}	WQI
09°58' 13" N	76° 14' 50" E	5m	5.58	0.032	0.021	1.054	Good
09° 57' 24" N	76°09' 06 '' E	10m	5.77	0.020	0.010	0.823	Good
09° 57' 6" N	76°06' 27 ''E	20 m	6.74	0.027	0.005	0.443	Good

Table 3. Water Quality Index of surface waters, off Cochin (January - December 2012)

Latitude	Longitude	Depth	DO mg l^{-1}	DIP mg l^{-1}	DIN mg l^{-1}	Chl a µg l^{-1}	WQI
09° 58' 13" N	76° 14' 50" E	5m	5.27	0.012	0.076	1.52	Good
09° 57' 24" N	76° 09' 06 '' E	10m	7.01	0.006	0.011	0.777	Good
09° 57' 6" N	76° 06' 27 ''E	20 m	7.20	0.008	0.035	0.268	Good

The results obtained were judged against the corresponding baseline range concentrations quoted by National Coastal Assessment Report (USEPA, 2004) after arriving at the annual mean and graded accordingly as good, fair and poor for each environmental indicators *viz*. DO,DIP, DIN and Chl a, for each site.

For a site to be ranked as good, it should have not more than one indicator rated as fair. For a site to be ranked as fair, it would have one indicator rated as poor or two or more indicators rated as fair. A site would be ranked as poor if it had two or more indicators rated as poor.

Accordingly, the selected sites, off Cochin were indexed for water quality for the years 2002 and 2012.

The water quality indexing shows that the quality of near-shore waters, off Cochin has not been deteriorated. There is also an indication of improvement in quality of water with regard to the content of dissolved inorganic phosphorus at 10m and 20 m depths. These stations were ranked 'fair' during 2002, whereas in 2012, they are of rank 'good'. But it is always better to remain cautious and not pollute the near-shore waters which support fisheries.

Upsurge in exports and price rise of mackerels in the retail markets of Kerala

Aswathy, N. and Narayanakumar, R.
Central Marine Fisheries Research Institute, Kochi

The finfish export from the country witnessed remarkable progress in the late 90s due to the reduction in the catch rates of export oriented items such as shrimps and cephalopods. The less stringent quality control measures in major importing countries promoted the exports of finfishes which helped the exporters to bridge the gap in capacity deficiencies and attain scale economies. There was a boost in the exports of low value pelagics such as oil sardines and mackerels due to increase in the purchase prices of high value finfishes such as pomfrets, seerfishes and ribbon fishes. As per the MPEDA statistics, the export of mackerels from India was initiated in 1994 and there was sharp increase in exports from 2009 onwards. Mackerels which were once considered as cheap fishes now fetches ₹160/kg in the retail markets of Kerala and crossed ₹ 150/kg in many of the neighbouring states such as Karnataka and Goa during the post monsoon season of 2013. In this context, a time series analysis on the landings, exports and landing centre and retail prices of mackerels for the period 1994-2010 was done to assess the impact of exports on the domestic prices of mackerels in the country.

Trend of landings and exports of mackerels from India

More than 90% of the mackerels were exported in the frozen form initially. IQF exports started during the year 2003 occupied 45 % of the total value of mackerels exported from the country in 2010. The preferred counts for export were 4/6, 6/8, 10/ 12, 14/16. Mackerels were mainly exported form Kerala, Karnataka, Goa and Gujarat. The total mackerel landings in the country increased from 2.05 lakh tonnes in 1994 to 2.67 lakh tonnes in 2010 while the exports increased from a mere 620 t to 69,356 t during same period. The unit value realized at the export market increased from ₹ 21.23/ kg to ₹ 63.14/ kg in 2010. The exports as percentage to total landings increased from a mere 0.30 to 26% in 2010. The landings showed a compound annual growth rate of -0.95% during 1994-2010 period whereas the exports showed a Compound Growth

Table 1. Trend of Landings and export of mackerels from India

Years	Landings (t)	Exports (t)	Value (₹ lakh)	Unit value (₹/kg)	Exports as % of landings
1994	205844	620	132	21.23	0.30
1995	176803	2636	864	32.77	1.49
1996	274135	11253	3481	30.93	4.10
1997	222141	5961	1936	32.48	2.68
1998	175617	6261	2293	36.62	3.57
1999	208128	11637	3310	28.44	5.59
2000	134020	16215	5036	31.06	12.10
2001	88580	10960	4107	37.48	12.37
2002	94033	8691	3284	37.78	9.24
2003	111885	5701	1959	34.36	5.10
2004	141774	7341	2592	35.3	5.18
2005	125424	9127	3383	35.22	7.28
2006	141919	14329	7164	50	10.10
2007	180117	19788	8073	40.79	10.99
2008	158927	19538	12713	65.07	12.29
2009	186128	43546	29862	68.58	23.40
2010	267251	69356	43794	63.14	25.95
CGR(1994-2010)	-0.95	17.85	24.29	5.42	

Source: CMFRI Annual Reports
Statistics of marine products exports, MPEDA

Rate (CGR) of 17.85% in terms of quantity and 24.29% in terms of value.

Major export destinations

India exports mackerels to Thailand, Malaysia, Singapore, US, UAE, Saudi Arabia and Vietnam. In 2010, 72.55% of the total volume of mackerel exports were to Thailand followed by Malaysia (14.81%). Mackerel is a highly preferred fish in Thailand and is used for making a variety of products including canned mackerel in tomato sauce, mackerel salad, grilled mackerel, spicy fried mackerel and mackerel chilli paste. Thailand imports more than one lakh tonne of frozen mackerels every year for which India is the major supplier (External trade statistics, Thailand, National news bureau of Thailand). Imported mackerels are used both for local consumption and also as raw materials for re-processing industry. Mackerel eating festivals are also celebrated every year in Thailand.

Price trends

In Kerala, the mackerel landings showed wide fluctuations from 74,233 tonnes in 1995 to 33,854 tonnes in 2000 and then to 39,914 tonnes in 2012. Analysis of landing centre and retail prices over the years showed that there was 67%, 20% and 44% increase in landing centre prices during 1995-2000, 2000-05 and 2005-10 periods respectively. At retail level, the price increases were 43, 11 and 58% respectively during 1995-00, 2000-05 and 2005-10 periods. The fishermen's share in the consumer's rupee increased from 60% in 1995 to 75% in 2005 and thereafter declined to 60% in 2012 with huge exports of mackerels from the country. This is a clear indication of scarcity of mackerels in the state which has contributed to escalation of prices in the retail market and lower share for the fishermen in the consumer's rupee. In contrast, the low unit value realized from exports indicates that the exporters were able to get the preferred grade of mackerels at a lower rate from the landing centres. The unit value realized at the export market was well below the retail prices in Kerala being ₹ 63.14/kg in 2010. The maximum unit value realized was for consumer pack (₹ 140/kg) and headless (₹ 98/kg).

The marine products exports reached US$3.5 billion in 2012-13.The WTO agreement and several

Table 2. Mackerels exports to Thailand and Malaysia (2010)

Particulars	Malaysia		Thailand	
	Q (tonnes)	V (₹ lakh)	Q (tonnes)	V (₹ lakh)
Frozen mackerel	4280	2551	21237	13495.41
IQF Indian mackerel whole round	790	508.06	5304	3685.45
IQF mackerel	5206	3123.64	23780	15903.48
Total	**10276 (14.81%)**	**6182.7**	**50321 (72.55%)**	**33084.34**

Source: Calculated from Statistics of marine products 2010, MPEDA

Table 3. Average landing centre and retail prices of mackerels in Kerala

Years	Landings (t)	Landing centre price (₹/kg)	Retail price ₹/kg)	Fishermen's share in consumer's rupee (%)
1995	74,233	18	30	60.00
2000	33,854	30	43	69.77
2005	50,498	36	48	75.00
2010	68,511	52	76	68.42
2011	72,078	66	100	66.00
2012	39,914	72	120	60.00

free trade agreements signed by the country in recent years also favored the Indian marine exports. The ASEAN-India Free Trade Agreement (AIFTA) which came into effect on 1st January 2010 and the consequent elimination of the tariffs opened up new export opportunities of marine products to south-east Asian countries including Thailand, Malaysia and Singapore. Even though the exports help to curb the trade deficit in the country, caution need to be taken to protect the interests of domestic consumers. Since marine fishes are good source of protein to the low income groups in the country, exorbitant rates of price increase in the retail markets affect the domestic consumers. Considering the nutritive value and high preference for mackerels in the country, measures need to be taken to bring down the retail prices of mackerels in the country. Since the export prices of mackerels are well below the retail prices in the country, fixing Minimum Export Prices (MEP) for mackerels may help to curb the exports. In addition, the existing capacity of exporting firms can be effectively diverted for supply of fresh and frozen mackerels to domestic consumers at affordable rates.

Economic perspective of trader's discounts and other reductions in marine fish marketing in Kerala

Aswathy, N., Narayanakumar, R., Pushkaran, K.N., Suresh, V.K., Sunil, P.V., Harshan N.K. and Solomon, K.
Central Marine Fisheries Research Institute, Kochi

In the traditional fish marketing system, fish was sold by the fisher-women who carried the fish to rural markets or to individual households. There was little role for the intermediaries and the entire margins realized went to the fishermen households. The technological transformation in the marine fishing sector resulted in large scale increase in trade volume and improvements in fish marketing

Table 1. Discounts and marketing costs in major harbours Landing Centre in Ernakulam District

Particulars	Cochin Fisheries Harbour	Munambam Fisheries Harbour	Kalamukku Landing Centre
Discounts for fishes	10-15%	10-15%	10-15%
Discounts for shrimps and cephalopods	12.5 %	12.5 %	12.5 %
Auction charges	5%	5%	7%
Marketing costs			
Unloading fish from boats	₹ 2000/ ₹ 1 lakh of fish	₹ 1500/ boat	₹ 1000/ boat
Ice cost for shrimps and cuttlefishes	₹ 37.5/box	₹ 40/box	₹ 30/ box
Ice cost for fishes	₹ 35/ box	₹ 35/ box	₹ 35/ box
Weighing, packing and icing(fishes)	₹ 53/ box	₹ 58/ box	₹ 15/ box
Weighing, packing and icing (shrimps and cuttle fishes)	₹ 1.95/kg	₹ 1.85/kg	₹ 0.75/kg
Total marketing cost (₹ per kg of fish)	5.00	4.00	3.00
Total marketing cost (₹ per kg of shrimps and cuttlefishes)	6.00	4.5	3.5

system with the involvement of several intermediaries to perform the different marketing functions. This necessitated huge amounts of money for initial payments for fishing as well as fish marketing activities. As both the fishermen and traders depended on private money lenders for meeting their financial needs, these intermediaries decided the prices at the harbours and could exert complete control over the trade. The prices at the landing centres were usually decided by the cartels formed by the traders and commission agents and the fishermen were prone to exploitation in terms of discounts and other kinds of reductions at the harbours.

The practice of deducting nearly 10-15 % of the actual auction amount as trader's discount (*Lelakkizhivu*) was existing in the harbours and fish landing centres in Kerala since the last 25 years with the proliferation of mechanized fishing. The discounts were charged in order to adjust for the discrepancies in weights as prices were fixed based on eye observation during auctioning. The traders and commission agents in Ernakulam district demanded a hike in the trader's discounts to 20 % and the fishermen were reluctant to pay this amount. The agents withdrew from auctions in the harbours which led to drastic decline in fish prices for few days in the post monsoon season of 2013.

Table 2. Average landing centre and retail prices of fishes / shrimps in Ernakulam in the post- monsoon season (2013)

Name of fish	Landing centre price(₹/kg)	Actual price received by fishermen (₹/ kg)	Retail price (₹/kg)	Fishermen' share in consumer's rupee (%)
Ribbon fishes	160	128	220	58.18
Cuttle fishes	200	165	280	58.93
Squid	300	247	340	72.79
Shrimps (*P. indicus*)	320	264	380	69.47
Shrimps (*M. dobsoni*)	160	132	220	60.00
Mackerels	100	80	160	50.00
Scads (small)	120	96	200	48.00
Seer fish (medium)	440	352	560	62.86
Pomfrets-black (medium)	300	240	400	60.00
Pomfrets-white (medium)	280	224	380	58.95
Oil sardine	60	48	100	48.00

Table 3. The income earned by women collecting fish in Punnappara landing centre

Age group (years)	Number of women	Quantity collected kg/fishing unit				Average income earned (₹/day)/day	
		Peak Season		Lean season		Peak season	Lean season
		Shrimps	Fish	Shrimps	Fish		
5-10	15	2	5	0.5	2	530	185
11-20	10	2.5	7	0.5	4	705	285
21-50	70	3	8	0.5	5	820	335
>51	25	3.5	10	0.5	5	975	335

The agitations by the fishermen unions led to discussions with different stake holders including Government officials, commission agents, traders and representatives boat owners and other fishermen. The fishermen demanded for fixing a standard procedure of fish trade based on weight, but no fruitful decisions were arrived at could be. In this context, an economic perspective of the different forms of discounts and reductions at different harbours in Kerala and their likely impact on the fish prices and fishermen's share in consumer prices are analysed.

The marketing margins consisting of trader's discounts and auction charges varied from 17.5% for shrimps to 20% for fishes in different harbours. For export oriented items such as shrimps and cephalopods, the discount at the harbor was 12.5% of the actual auction rate for delayed payments and 13% in the case of immediate payment. For fishes, the discount ranged from 10 to 15% depending on the time of payment. The marketing costs at the harbour included ice and labour costs. The labour costs for loading, unloading, icing and packing varied in different harbours. For shrimps and cephalopods the rate was fixed per kg whereas for finfishes the rate was fixed per box of fish handled. The average marketing cost per kg of fish ranged from ₹ 3.00 to.5.00/kg and that of shrimps from ₹ 3.5 to.6.00/kg in different harbours.

The retail price of export oriented items such as shrimps and cephalopods did not show much increase in the retail markets of Kerala and the fishermen received better share for these items. Among the fish items, the fishermen received better share for seer fishes (62.86%) while it ranged between 48 to 68% for other fish items. In the absence of traders discounts, the fisherman's share in consumer's rupee will increase by 15% at the harbours.

Types of discounts in the traditional fish landing centers in Alappuzha

In addition to trader's discounts, several other forms of reductions are prevailing in the traditional fish landing centres Kerala. The traditional fishermen were forced to give few baskets of fish free of cost after auctioning on the grounds of compensation for traders in the event of any distress sales or difficulties in disposing the fish. In addition, fishes were given free of cost to the local people, poor or family members who approach the landed boat. This was according to the traditional belief of getting better catches if fishes were donated to people in the locality. In the traditional fish landing centers in Alleppey, fisherwomen and other poor people in the locality received fish free of cost from the landed canoes. In the absence of local people to collect fish from boats, women from Cuddalore, Tamil Nadu have started begging fish from the landed fishing units since past 10 years. Whose spouses reached Alappuzha as migrant labourers. In addition to collecting fish from boats, they do sorting of fish also. Nearly 100 women along with kids were engaged in collecting fish from the canoes and selling it. They approach each boat with small baskets and the collected fish is pooled, sorted and sold at the landing centre. In addition to this, they did sorting of mixed basket of fishes for which also they received small amounts of fish as payment.

The peak season in Punnapra landing centre was during June - September and the lean season was during January - March. The average income earned per day by the women collecting fish in Punnapra landing centre varied from ₹ 530 to ₹ 975 during peak season and ₹ 185 to ₹ 335 per day in lean season. They reached the fish landing centres at around 6 am and work up to noon and the working hours may extend up to 6 pm during the peak fishing seasons. Women and children belonging to the age groups of 5 - 50 years and even more were engaged in this activity. They were able to collect 2-3.5 kg of shrimps and 5-10 kg of fish from a single boat during peak season and 0.5 kg of shrimp and 2-5 kg of fish during lean season.

Even though the intermediaries facilitate the smooth functioning of the marine fish trade in the state, the huge margins charged by them and unscrupulous practices such as discounts and other forms of reductions have resulted in low profits realized by the fishermen. On the other hand, the consumers are forced to pay high prices for majority of fishes in the state owing to huge demand both from domestic and export sectors. The transformation of the marine fishing sector to multibillion dollar business necessitated huge investments in both in the harvest and post-harvest sectors. Lack of sufficient financial resources available with the fishermen and traders enable the intermediaries to exert control over the trade. Institutional finance for fish trade and market intervention by forming fisher cooperatives is essential for protecting the interests of both fishermen and consumers.

Scope for mechanized fishing of teleosts with light attraction in Southeastern Arabian Sea

Ragesh, N., Sajikumar, K.K., Remya, R., Geetha Sasikumar, Koya, K.P.S. and Mohamed, K.S.
Central Marine Fisheries Research Institute, Kochi

The sense of vision coupled with powers of chemoreception is used by many fishes to orient and perform activities such as foraging, breeding and avoiding predators. In such cases their behaviour is affected by light stimuli, natural or artificial. These responses include changes in schooling behaviour, spatial distribution, migration, reproduction etc.

In fishing, artificial lights are often used to find or lure fish which are then harvested with encircling nets or other gears. In India light fishing is not widely practiced except for Chinese dipnet fishing in backwaters of Kerala.

Under an NAIP funded project on oceanic squids CMFRI conducted an extensive study for the exploration of resources purple back flying squid *Sthenoteuthis oualaniensis* in the Arabian Sea using a trawl converted for squid jigging using light attraction. The vessel operated bright overhead lights (18 metal halide lamps, 1.5 kW each) at night, for attracting and aggregating squids near the vessel and it was observed that besides squids a number of marine fishes were also attracted to the light. Major groups of fishes thus attracted were halfbeaks, sardines, anchovies, mackerel, horse mackerel, scads, dolphin fish and tunas.

Oceanic fish aggregation using lights

During August 2009 to April 2013 Hooks and lines operation was carried out in the squid fishing ground (8°N to 17°N lat 64°E to 76°E long) at night after 2 to 5 h of illumination. Six to eight numbers of hooks (#8,10) were tied alternately on a Polyamide monofilament line (50 m length and 0.8 mm thickness) and used for tuna and other pelagics. Sharks were caught by # 1-01 hooks with 1 mm thickness line of 50 m length.

Hook and line operations conducted in the squid jigging grounds in Arabian Sea, contributed a total catch of 925 kg of fishes (Table.1), of which 75% was contributed by tunas such as *Euthynnus affinis* (Little tuna), *Sarda orientalis* (striped bonito), *Auxis rochei* (Bullet tuna), *Katsuwonus pelamis* (Skipjack tuna), *Thunnus albacares* (Yellowfin tuna) (Fig.2). The other groups in the catch were moonfish *Mene maculata*, horse mackerel *Megalaspis cordyla*, sharks such as *Carcharhinus falciformis* (Silky shark), and *C. limbatus* (Blacktip shark).

Table 1. Species composition in Hook and line catch at squid fishing ground

Fish group	Species	Size range (cm)	Avg catch wt.(kg)
Tuna	*Euthynnus affinis*	25-35	200
	Sarda orientalis	30-45	200
	Katsuwonus pelamis	30-45	120
	Thunnus albacares	30-60	100
	Auxis rochei	15-20	70
Others	*Megalaspis cordyla*	20-30	45
	Mene maculata	12-20	48
	Scomberoides tol	15-30	10
	Carcharhinus falciformis	75-100	72
	Carcharhinus limbatus	70-100	60

Coastal fish aggregation using lights

On the basis of aggregation of fishes observed in the oceanic waters, experimental light fishing trials with a purse-seiner was carried out in the coastal waters off Mangalore (Fig.2). Using a combination of two fishing vessels, *MV Titanic*, equipped with metal halide lights which served as the light source or the 'light-vessel' and *MV Angel*, a purse-seiner which functioned as the fishing vessel for setting and hauling the nets operations were made between 12° 49' N and 74° 46' E, 12° 53' N-74° 39' E and 12° 56' N-74° 40' E at 27 m depth during 11-14 January, 2013.

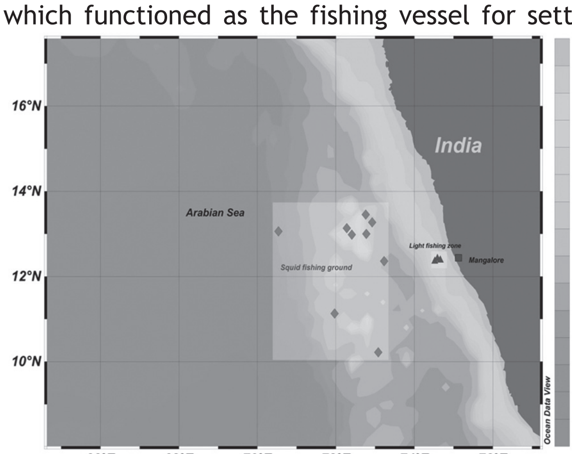


Fig. 1. Map showing the offshore H&L operation grounds and coastal purse seine net operation ground.

The fishing operation was conducted at night, between 21.00-22.00h. On reaching the ground, fish schools were aggregated using luring lights. Fishing operation began when the aggregation of fish was found adequate. The anchor of the light-vessel is hauled up and the net is shot surrounding the aggregated school of fish and the light-vessel. Once the purse-line is hauled, the light-vessel leaves the net by pushing the float line underwater and passing across the float-line.

Purse-seine catch was estimated as 12.1 t of mix pelagics from the coastal waters off Mangalore. The major groups contributing to the catch were Thryssa *sp.*, Carangids, squids, mackerel, whitefish, black pomfret, seer fish, dolphin fish, shrimps and miscellaneous fishes (Table 2). They were caught during a total of 3 fishing trips that carried out 2 hauls per trip. Maximum aggregation was recorded after five hours of illumination. The purse seine net operation without light conducted in the same cruise caught 1.5 t sardines only. The light fishing trials with purse-seine harvested mixed pelagics of commercially importance in a short period of time.

Light fishing is one of the best methods for aggregating and harvesting commercially important species during new moon phases. Light assisted purse-seining attempts to harvest fishes whose capture with standard purse-seines becomes ineffective when fishes are found in numerous small schools. Similarly, in situations where they are poorly concentrated or spread over vast areas, the

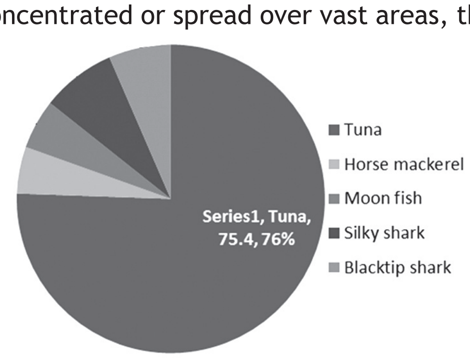


Fig.2. Mean percentage of species-wise catch in hook and line operations

Table 2. Catch composition in purse seine with different time intervals of illumination

Fish catch in purse seine net		***Duration of illumination (h) & Quantity (kg)***		
Species composition	**Common name**	**Qty (kg in 2 h)**	**Qty (kg in 3 h)**	**Qty (kg in 5 h)**
Thryssa mystax	Moustached thryssa		3000	5000
Carangids:				
Alepes djedaba	Shrimp scad	500	1000	1000
Megalaspis cordyla	Horse mackerel			
Decapterus russelli	Indian scad			
Rastrelliger kanagurta	Indian mackerel	100	100	
Lactarius lactarius	Faise trevally	100		
Uroteuthis				
(Photololigo) duvauceli	Indian squid	50	200	400
Parastromateus niger	Black pomfret	20	25	30
Scomberomorus commerson	Spanish mackerel	10		200
Trichiurus lepturus	Grey ribbon fish			200
Coryphaena sp.	Dolphin fish			200
Metapeaneus dobsoni	Flower tail shrimp	2		
Miscellaneous		5		
Total		787	4325	7030
Grand total		12,142 kg		

use of light enables concentrating them and capturing large quantities in a relatively short period of time. Purse seining with light is an option in coastal areas while hook and line operation can be considered as an accompanying gear during light assisted squid fishing in oceanic grounds. However, care should be taken to avoid the incidental catch/ by-catch of small sized and immature aggregating juveniles or non-commercial groups which may be attracted to the light. Furthermore, caution has to be exercised in determining the number of light fishing units in each fishing zone otherwise it may lead to over exploitation of resources.

Fig. 3. Purse seine net operation off Mangalore by MV Angel with light

Paired and unpaired trawling at Munambam F.H. and mini harbour

Sijo Paul and Hezekiel, K. C.
Central Marine Fisheries Research Institute, Kochi

Trawlers of Munambam F.H. and Munambam MiniHarbour after the initial catch of *Nemipterus* spp. in August had resorted to a different fishery in September 2013. The Trawlers had gone in pair and in single form to exploit the *Trichurus lepturus*, *Sepia pharoanis* and *Loligo* spp. They had gone for 6-8 days of average fishing days per trip at a depth range of 30-40m for *Sepia pharoanis*, *Loligo* spp. and 70-80m

Munambam fisheries harbour

Date/ Species	No. of units	Average catch / unit (kg)	Average rate / kg (₹)	Total revenue realized (₹)
03/09/2013				
T. lepturus	45	1175	100	52,87,500
Loligo spp.	45	719	180	58,23,900
Sepia pharaonis	45	956	250	107,55,000
13/09/2013				
T. lepturus	55	5462	120	3,60,49,200
Loligo spp.	55	408	180	40,39,200
S. pharaonis	55	258	240	34,05,600
18/10/2013				
T. lepturus	60	4880	130	3,80,64,000
Loligo spp.	60	1311	180	1,41,58,800
S. pharaonis	60	1882	230	2,59,71,600
22/10/2013				
T. lepturus	52	3061	125	1,98,96,500
Loligo spp.	52	1044	180	97,71,840
S. pharaonis	52	833	220	95,29,520
29/10/2013				
T. lepturus	62	5917	120	4,40,22,480
Loligo spp.	62	1446	180	1,61,37,360
S. pharaonis	62	1579	230	2,25,16,540

Munambam mini harbour

Date/ Species	No. of units	Average catch / unit (kg)	Average rate / kg (₹)	Total revenue realized (₹)
06-09-13				
T. lepturus	24	883	120	25,43,040
Loligo spp.	24	276	190	12,58,560
S. pharaonis	24	244	250	14,64,000
07-09-13				
T. lepturus	16	1095	130	22,77,600
Loligo spp.	16	314	190	954,560
S. pharaonis	16	229	250	9,16,000
23-09-13				
T. lepturus	29	3750	125	1,35,93,750
Loligo spp.	29	600	180	31,32,000
S. pharaonis	29	369	220	23,54,220
24-09-13				
T. lepturus	25	4725	125	1,47,65,625
Loligo spp.	25	269	180	12,10,500
S. pharaonis	25	177	220	9,73,500
03-10-13				
T. lepturus	35	4996	120	2,09,83,200
Loligo spp.	35	700	180	44,10,000
S. pharaonis	35	1026	230	82,59,300
04-10-13				
T. lepturus	22	2724	130	77,90,640
Loligo spp.	22	705	180	27,91,800
S. pharaonis	22	870	230	44,02,200
23-10-13				
T. lepturus	31	4033	120	1,50,02,760
Loligo spp.	31	746	180	41,62,680
S. pharaonis	31	817	230	58,25,210
24-10-13				
T. lepturus	26	3170	125	1,03,02,500
Loligo spp.	26	709	180	33,18,120
S. pharaonis	26	609	230	36,41,820

depth range for *T. lepturus*. The fishing ground was towards North West of Munambam F.H. The Trawlers with similar Horse power engines were paired together so that while trawling the speed of both trawlers could be well adjusted in such a way that the ropes of trawlnet will hold the mouth of the net with a maximum opening enabling and ensuring a better catch. The single trawlers had operated in the conventional method. While returning they go for the *Loligo* spp.or *Sepia pharaonis* catch so that both can be brought fresh to the harbour to fetch a better price.

Another observation made was that of the quality of *Trichirus lepturus* caught by Chinese engine trawlers and Indian engine trawlers. Chinese engine trawlers have higher capacity (280HP,240HP-Yu-chai; 495HP– Waiche; 455HP Yanmar; 427HP– Sinotrek), so while they trawl, the impact on the fishes is more and there is a chance for the fishes in the trawlnet to roll off while hauling due to high speed. The silver enamel coating on the *T. lepturus* is sheared off so that it looks like an older catch. The price of *T. lepturus* with enamel (fresh looking) obtained ₹ 130/- per kg while that with less enamel (looking old) obtained ₹100/- kg as average prices.

This catch was witnessed in the start of September 2013, which had reached its peak by mid September and prevailed upto1st week of October 2013. The catch details and the revenue obtained on observation days are given in the table.

T. lepturus kept for auction at Munambam fisheries harbour

Fresh looking *T. lepturus* kept for auction at Munambam fisheries harbour

Rare occurrence of blunthorn lobster *Palinustus waguensis* Kubo, 1963 from the southwest coast of India

Rekha Devi Chakraborty, Maheswarudu, G., Radhakrishnan, E.V., Purushothaman, P., Kuberan, G., Jomon Sebastian, Thangaraja, R.
Central Marine Fisheries Research Institute, Kochi

On 12th September, 2013 three specimens of the rare deep-sea blunt horn lobsters were landed in the multiday trawlers operating at a depth of 150-250 m, off Sakthikulangara along the southwest coast of India. These three specimens consisted of two males and a single female. The specimens were in good condition but did not depict the characteristic reddish colour (Fig. 1). In general these lobsters are distributed from shallow to deep waters from 0 to 180 m depth range. The ratio of carapace length to total length of *P. waguensis* was 0.44 and 0.39 for male and 0.438 for female specimens while this ratio was found to be slightly lower (0.32) in the records of Chennai. This is the first report of the occurrence of *P. waguensis* after a long gap of 45 years after the reports of George (1965) from Calicut along the southwest coast of India which was misidentified as *P. mossambicus*.

Aberrations in the feeding behaviour of the Indian Mackerel, *Rastrelliger kanagurta*

Supraba V., Dineshbabu A.P., Sujitha Thomas, Prathibha Rohit and Rajesh K.M.
Mangalore Research Centre of CMFRI, Mangalore

The food and feeding habits of the mackerel have been studied extensively, which suggest that mackerel generally adopts either filter feeding or preying on the individual animals. Plankton consisting of copepods, diatoms and dino-flagellates and small crustaceans such as the *Acetes* sp. are reported in their feed. However, a deviation from the normal feeding habit was observed in the gut analysis of mackerel collected on 8th October 2013 from trawlers at Mangalore Fisheries Harbour. Among the 50 stomachs analysed 4% contained oil sardines juveniles and 2% had digested squid remains as a food item. The specimens which ranged from 192 mm to 285 mm in total length and weighed 67 g to 224 g were mature with their gonad in spent or spent recovery stages. The semi-digested oil sardine present in the gut of mackerel ranged in size from 36 to 81 mm.

Mackerels generally swim with their mouth agape and planktonic organisms are consumed by filtering them through numerous gill rakers present. Picking and feeding on juveniles of oil sardines and squids on the other hand is done by visual selection. The present study thus indicated that mackerel use both modes (filtering and visual selection) of feeding and is capable of feeding on fishes and squids.

Fig.1. Sardines (semidigested) in the guts of mackerels

Sea erosion impact at Yermal, Dakshina Kannada, Karnataka

Vinay Kumar Vase, Rajesh, K. M., Sampath Kumar, G. and Prathibha Rohit
Mangalore Research Centre of CMFRI, Mangalore

Sea or coastal erosion occurs mainly through the actions of currents and waves and results in the loss of naturally formed sea walls and sediment in some places and accretion in others There has been a dramatic increase in coastal erosion over the last two decades and is expected to continue as sea level rises and storm frequency and severity increases. Bada Yermal and Thenka Yermal in Dakshina Kannada are minor landing centers where *Kairampan*i (Shore seine) canoes with the traditional nets and small entangling nets are operated. Fishing operation during this year was severely affected due to extensive sea erosion in the region where the wave breaker were totally washed off and the adjacent road was fully destroyed.

Frequent and severe erosion in the coastal areas results in loss of invaluable natural habitat. In this process, the nesting, breeding and feeding areas of turtles, birds and other sea dependent animals are completely destroyed.

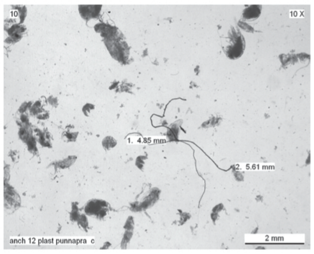
Coastal land reclamation, construction of huge concrete structures, destruction of mangrove areas is the main cause for increased sea erosion. Construction of sea walls and placing varied shaped concrete structures along the beach helps in reducing the impact of sea erosion to a certain extent. Restoration of mangroves is so far the best solution for beach or coastal erosion. Beach restoration projects have proved that adding sand in the right quantities, properly engineered and maintained, can make a beach last forever. Such well proved restoration activities may be taken up along Dakshina Kannada coast to minimize the impact of sea erosion.

Microplastics in the gut of anchovies caught from the mud bank area of Alappuzha, Kerala

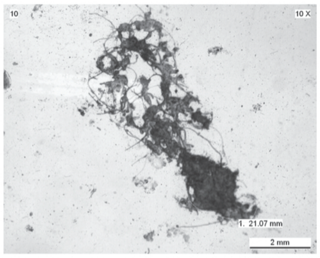
Kripa,V., Preetha G.Nair, Dhanya, A.M., Pravitha,V.P, Abhilash K.S., Abbas A. Mohammed, Dhannesh Vijayan, Vishnu, P. G., Gishnu Mohan, Anil Kumar, P.S., Khambadker, L. R. and Prema, D.
Central Marine Fisheries Research Instiute, Kochi

Marine litter or the non-degradable wastes generated due to anthropogenic activities, has been recognized as one of the major threats to coastal marine ecosystem in the 21st century. These originate mainly from land and enter the aquatic ecosystem through land runoff and also when they are discarded by human beings directly into the coastal waters. The impacts of marine litter on the ecosystem can vary from physical destruction of habitats to mild or fatal effects on aquatic biota. If the litter is large like the plastic sheet then it affects the functioning of the ecosystem which indirectly affects the fauna. However, microplastics are more dangerous and directly affect the health marine life.

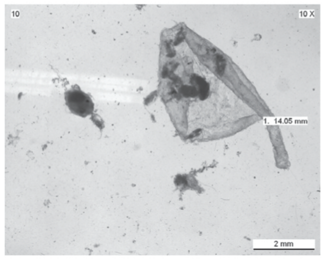
Microplastics are small plastics of size less than 5mm. Some researchers consider only particles less than 1mm as microplastics. These can enter the food chain and affect the fauna directly. Larger



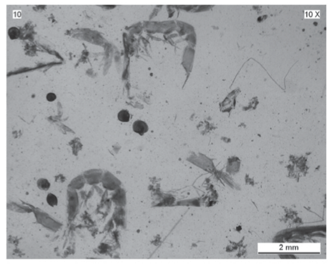
Threadlike microplastics in the gut of Anchovy along with other digested matter



Several strands of microplastics in the gut of Anchovy along with other digested matter



Larger piece of non biodegradable waste in the anchovy gut



Macrozooplankton and bivalve spat in the anchovy gut

plastic material which originally float in the water can become coated with silt and then float in the column waters. These can degrade, become brittle and the fragments can form micro plastics. Also fishing nets and other nylon material which wither on the beaches can fragment and then these can enter the coastal waters through land runoff or during tidal inundations.

In August 2013 (02/08/13), as a part of larger investigation on mud banks, fish samples collected from a mud bank region, Punnapara (9°44. 33' N and 76°17.52' E) in Alappuzha district, Kerala from a depth of 4 to 6 m were analyzed. Gut of two main species in the fishery, oil sardine *Sardinella longiceps* and the anchovy, *Stolephorus commersonnii* were processed as per standard fishery biological methods and the gut contents were observed under microscope.

There were no microplastics in the gut of oil sardine and the main contents were phytoplankton and micro zooplankton. However of the 16 nos of anchovies with length 6 to 12 cm (average 9.06 cm) and weight ranging from 2 to 12 gm (average weight 6.6 gm), 6 nos were found to have microplastics of length ranging from1.14 mm to 2.5 mm (Fig.1 to 3). The main food items were phytoplankton, zooplankton (Lucifer, copepod, tintinnids) bivalves and prawn (nekton) (Fig.4). One significant observation was the large number of bivalve spat in the gut of anchovies during this period. In the benthos samples also bivalve spat formed a major component (48.9%). As a part of the mud bank study, plankton and benthos were also collected and analysed. However, there were no microplastics in these samples collected from the same area. The gut content of anchovy collected from the same site during the subsequent months did not contain any microplastics.

During July- August the mud bank region had high levels of suspended solids. Unlike sardine, anchovies are known to have two feeding modes, filter feeding on small food like phytoplankton and microzooplankton and selective preying (active biting) on larger zooplankton, small nekton and benthos. The anchovies would have ingested the microplastics either from the turbid water while feeding on larger plankton like Lucifer or while preying on the benthic bivalves. In the subsequent months (non mud bank season), the gut of both the species did not have any microplastics. Incidentally there were no bivalves also.

Reports of plastic pieces of 3 cm length and 0.5 cm width in large pelagic like tuna in Arabian Sea (Ref: Sajikumar *et al.*, 2013, MFIS, No.217) and mackerel caught from the coastal waters off Mangalore (Ref.Sulochanan *et al.*, 2011, MFIS, No 208) indicate that pieces/ strands of plastic enter the food chain.

The fact that the anchovies had microplastics in their gut is a matter of concern. How these plastics affect the health of fish is not known. If these are eliminated in the faeces then there is no problem. But if they remain the body, then chances of affecting the fish directly and other marine biota through food chain is possible. Since fish consumers degut the fish before cooking, chances of microplastics affecting human beings through sea food consumption are negligible.

MFIS