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Appraisal of Marine Fisheries of Kerala

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Introduction

Kerala ranks first in marine fish production of India forming nearly 25% (avg. 5.75 lakh tonnes) of the total annual production. The annual export of marine products from the state yields to the nation a foreign exchange of Rs. 1100 crores. There has been spectacular growth in the marine fisheries sector of the state due to fisheries friendly government policies, well developed harvest and post harvest infrastructure and increased demand for sea food both in the domestic and export markets. Kerala has been in the forefront in absorbing innovative and new technologies in fishing practices, which has led marine fisheries to take a complex structure. A growing demand for fish has fuelled a rapid increase of fishing effort in terms of fishing hours through multi-day fishing by the mechanized sector, extension of fishing grounds by the motorized sector especially the ring seiners and an increase in overall length of the trawlers and their fish hold capacities. Therefore there is urgent need to monitor the fisheries and ensure their sustainability. Presented below is a brief account of the status of marine fisheries of Kerala with special reference to 2005-2006 period and suggested measures for sustaining the fisheries.

Marine fish landings in Kerala

Marine fish production in Kerala during 1980-2005 fluctuated from 2.74 lakh t in 1981 to 6.62 lakh t in 1990 with an average of 5.14 lakh t. The annual marine fish landings from 1980-2005 shows two distinct growth phases. The first phase is from 1980-87 with an annual average landing of 3.34 lakh t and the second from 1988-2005 with an annual average of 5.74 lakh t (Fig. 1.). The estimated marine fish landings of Kerala during 2006 was 5.92 lakh tonnes (t) and compared to 2005 (5.36 lakh t) showed an increase of 10% which was higher than the annual average (1988-2005) catch of 5.74 lakh t.

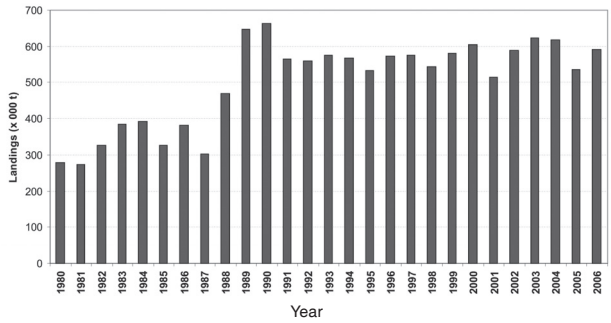

Fig. 1. Marine fish landings of Kerala during 1980-2006

During the period, the total average landings were constituted by pelagics (71%), demersal (15%), crustaceans (9%) and molluscs (5%) (Fig. 2). The highest landings (31%) occurred during the IV quarter (October-December) followed by III (July to September) quarter (27%) and the rest equally between the II and I quarters. During 2005, the mechanized (in-board engines) sector contributed 54%, motorized (out-board engines) 45% and the artisanal sector 1%. During 2006, the mechanized and motorized sectors contributed 56% and 42% respectively, while traditional sector accounted for 2% of the total landings. In the mechanized/motorized sector, among the various gears employed, ring seines (RS) contributed 49%, trawls 33%, drift gill nets / hooks & line units 18% of the landings by the sector.

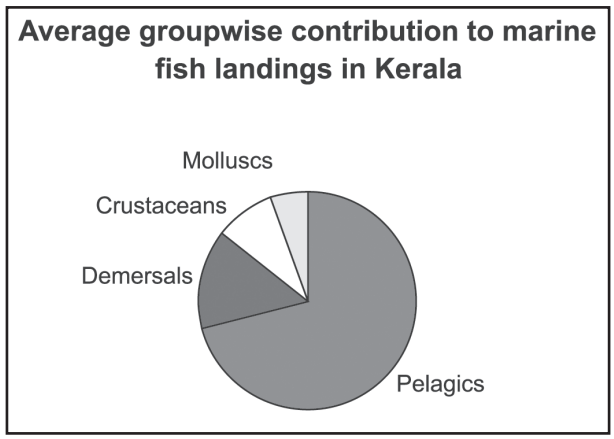

Fig. 2. Average groupwise contribution to marine fish landings of Kerala, 2005-2006

During 2005, estimate of district wise production showed that Kozhikode District contributed 21% followed by Kollam (16%), Malappuram (13%), Alapuzha (12%), Ernakulam and Thrissur (11% each) and the rest by other districts. However during 2006, landings were from Kollam (18%), Kozhikode (17%), Thrissur (16%), Ernakulam (12%), Trivandrum and Malappuram (10% each) and rest from the other districts such as Alappuzha, Kannur and Kasargod.

Trawlers of 7.8 to 21.2 m OAL with 96 to 176hp installed engines conducted single multiday fishing trips of 4 to 12 days and landings were dominated by penaeid prawns, cephalopods, threadfin breams, ribbonfishes, lizardfishes, anchovies and elasmobranchs. The 65-70' OAL steel trawlers with 440-680 hp diesel engines, fitted with echosounders, GPS etc. specifically targeted cephalopods and deep sea prawns beyond 300 m depths. Gillnet units were operated from motorized and mechanized crafts and are classified based on mesh size as small mesh (<70 mm stretched mesh for anchovies, sardine, mackerel, *Lactarius*, prawn, mullet and *Polynemus*) and large mesh (>70 mm, for seerfish, tunas, sharks, pomfrets, lobsters). Ring seines were operated from in-board/outboard engine driven crafts with the gears commonly classified into two types, the large *thanguvala*/*ranivala* of size upto 800 × 90 m with 18-22 mm mesh and the small mesh *choodavala* of size 400 × 60 m with 8-12 mm mesh.

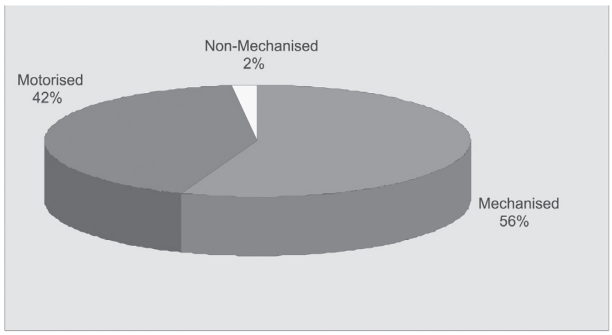

Fig. 3. Sectorwise marine fish landings of Kerala

Among the important groups, oil sardine, whitebaits, ribbonfishes, pomfrets, billfishes,

Table 1. Groupwise marine fish landings of Kerala during 2005 - 2006

Fishery Groups	Average landings (2005-2006)	Groupwise % contribution
Pelagic finfishes		
Oil sardine	222532	55
Other sardines	7249	2
Other clupeids	2558	1
Whitebaits	15224	4
Carangids	40014	10
Ribbonfishes	26235	7
Pomfrets	525	0
Mackerels	47801	12
Seerfishes	10099	3
Tunas	23707	6
Billfishes	1096	0
Barracudas	4310	1
Total pelagics	401347	100
Demersal finfishes		
Silverbellies	4895	6
Elasmobranchs	3121	4
Lizardfishes	8025	10
Rock cods & Snappers	4924	6
Threadfin breams	28328	35
Other perches	5924	7
Croakers	5772	7
Soles	17763	22
Other demersals	3130	4
Total demersals	81881	100
Shell Fishes		
Penaeid prawns	35264	44
Non-penaeid prawns	7851	10
Crabs	4254	5
Stomatopods	4237	5
Cephalopods	28033	35
Gastropods	1194	1
Total Shellfishes*	80831	100
Total landings	564059	

* (excluding bivalves)

sciaenids, rock cods, tunas, seerfish, cephalopods and penaeid prawns recorded an increase in the landings during 2006 compared to 2005 (Tables 1, 2). The long term potential yield (LTPY) of marine fish landings of Kerala was estimated as 6.63 lakh tonnes and the average long term Yield (ALTY) as 6.25 lakh tones (Table 3).

Pelagic finfish resources

The average landing of pelagics during the period was 4.01 lakh t which formed 71% of the total marine fish landings of Kerala. It was mainly comprising of oil sardine (55%) followed by mackerel (12%) and carangids (10%) (Table 2). Ring seine (RS) was the most important gear for pelagics. In outboard RS units (motorized sector) oil sardine, scads and penaeid prawns dominated the landings, whereas in the inboard RS units (mechanized sector) landings were dominated by mackerel, lesser sardines, coastal tunas, juvenile seerfishes, ribbonfishes and larger varieties of carangids.

Oil sardine: The average landings of oil sardine during the period was 2.22 lakh t and contributed

Table 2. Groupwise landing trends of major fishery resources of Kerala

Fishery Groups	2005	2006	Percentage Contribution 2006	Percentage decrease/ increase
Pelagic finfishes				
Oil sardine	218796	226268	38.2	3
Other sardines	7251	7246	1.2	0
Other clupeids	2449	2667	0.5	9
Whitebaits	14879	15569	2.6	5
Carangids	46590	33438	5.6	-28
Ribbonfishes	11755	40715	6.9	246
Pomfrets	234	815	0.1	248
Mackerels	50498	45103	7.6	-11
Seerfishes	7434	12763	2.2	72
Tunas	19571	27843	4.7	42
Billfishes	603	1588	0.3	163
Barracudas	3810	4809	0.8	26
Total pelagics	**383870**	**418824**	**71**	**9**
Demersal finfishes				
Silverbellies	5633	4157	0.7	-26
Elasmobranchs	2959	3283	0.6	11
Lizardfishes	8542	7507	1.3	-12
Rock cods & Snappers	4405	5443	0.9	24
Threadfin breams	26949	29707	5.0	10
Other perches	6627	5220	0.9	-21
Croakers	5184	6360	1.1	23
Soles	18409	17117	2.9	-7
Other demersals	2521	3738	0.6	48
Total demersals	**81229**	**82532**	**14**	**2**
Shellfishes				
Penaeid prawns	31516	39011	7	24
Non-penaeid prawns	7236	8465	1	17
Crabs	5428	3079	1	-43
Stomatopods	1433	7040	1	391
Cephalopods	24764	31302	5	26
Gastropods	739	1649	0	123
Total Shellfishes*	**71116**	**90546**	**15**	**27**
Total landings	**536215**	**591902**		**10**

* (excluding bivalves)

Table 3. Average Long Term Yield (ALTY) and Long Term Potential Yield (LPTY) of fishery resources along Kerala coast

Resource	LPTY (t)	ALTY (t)
Oil Sardine	264372	236182
Mackerel	128411	106250
Penaeid prawns	71871	57894
Seer fishes	10162	7862
Cephalopods	43472	37658
Tunas	32615	22671
Silverbellies	6887	6176
Elasmobranchs	6968	6136
Lizard fishes	14126	13341
Rock cods	9386	6822
Snappers	2482	2066
Threadfin breams	55078	45163
Other perches	16488	13640
Sciaenids	17720	15665
Soles	27301	22802
Total	662890	624859

40% to the total marine fishing landings (TMFL) of Kerala. Small mesh (8-20 mm) ring seine contributed 90% of the landing followed by gillnets (8%) and trawls (1%). Size group of 92-172 mm formed the bulk of the landings. Resource was exploited at MSY level. During 2006 juveniles and pre-adults in outboard ring seines at Alleppey constituted 52% (+18% over last year) and 73% at Calicut. However, juveniles and pre-adults landed by the inboard ring seines were low (22%). Among lesser sardines, *S. gibbosa* dominated the catch.

Indian mackerel: Landings during 2006 (40715 t) showed a decrease compared to 2004 (54,011 t) and 2005 (50498 t). Ring seines were the major gear (76%), followed by gill nets (15%), trawl nets (5%) and hooks and lines (3%) while the non-mechanised sector contributed the rest. Along north Kerala (from Thrissur to Kasargod), 87% of the mackerel landings were by ring seine units, followed by trawl nets and gill nets. Along south Kerala (Ernakulam to Trivandrum) coast, ring seines contributed 52%, drift gill nets 27%, trawls 20% and hooks and lines 1%. In trawl net the size ranged from 85 to 280 mm with mean size of 173 mm. In the ring seine landings, size range was 105-260 mm and mean size 189 mm. The fishery off Kerala was conspicuous by the absence of large-scale juvenile recruitment during most of the period. Mackerel landings are at the Maximum Economic Yield (MEY) level and while present level of fishing can be continued, further increase in effort is not desirable.

Ribbonfish: Average ribbonfish landings during the period were an estimated 26235 t forming 5% of TMFL of Kerala. The landings of ribbonfish (*Trichiurus lepturus*) during 2006 were unusually high being an estimated 44,848 t which was nearly 4 times higher than in 2005. Districtwise, landings were mainly from Quilon (35%) followed by Kozhikode (25%), Ernakulam (19%), Kannur (9%), Trivandrum (6%) and the rest (6%) from other 5 coastal districts. Being migratory, the resource is highly seasonal along the Kerala coast. Multi-day and single-day trawlers contributed 55% of the ribbon fish landings followed by boat seine (33%) and hooks & line (5%). The peak fishery season was during monsoon and post monsoon periods (III and IV quarters) when 94% of the annual catch was landed. The size range of *T. lepturus* was 32-104 cm with fishery dominant groups in the size range 56-84 cm and mean length (ML) at 63.1 cm. The spawning stock biomass constituted 98% of the standing stock which was 4 times higher than 2005.

Carangids: Landings showed an increasing trend during the period (40014 t), forming 10% of the pelagic finfish landings and 7% of total fish landings of Kerala. Ringseines (42%), trawl (31%), boat-seines and shore-seines (14%), gillnets (8%) and hooks & lines (5%) contributed to the production. Scads (*Decapterus* spp. and *Selar crumenophthalmus*) dominated the carangid landings contributing 50 and 14% respectively followed by *M. cordyla* (8%).

Tunas: The average landings of tunas during the period were 23700 t. In 2006, tuna landings (27843 t) showed an increase of 42% compared to 2005 (19571 t). *Euthynnus affinis* (41%) dominated the catch followed by *Auxis* spp. (39%), *Thunnus albacares* (10%), *T. tonggol* (8%) and *Katsuwonus pelamis* (2%). Mechanized gill nets contributed 45% of the tuna landings, followed by hooks and lines (36.5%), ring seines (18%) and trawls (0.5%). The size range of yellowfin tuna (*T. albacares*) was 40-186 cm, but fishery groups that dominated were 50-96 cm constituting 76% of the catch. Skipjack tuna (*K. pelamis*) of size range 38-86 cm were landed with the size group of 48-62 cm fork length (FL) dominant. Massive recruitment of skipjack and

yellowfin tunas was observed in 2006. Exploitation rate (E) for coastal tunas (*A. thazard and E. affinis*) was 0.6. Compared to the previous year, E of oceanic skipjack was constant at 0.7, while for yellowfin it was comparatively low (0.4). Recruitment of *T. albacares* and *Auxis thazard* was higher during 2006 when compared to 2005.

Seerfish: Landings during the period averaged 10099 t and were constituted mainly by king seer *Scomberomorus commerson*. Gillnets contributed 77%, ring seines 12%, hooks and line (8%), trawl nets (1%) and non-mechanised gears (1%). The size range of *S. commerson* was 32-98 cm with 56-64 cm size group dominating. Annual mean size (59 cm) indicated a decline compared to 63 cm in 2005. Spawning stock constituted only 10% of standing stock and was 44% lower than in 2005.

Whitebaits: The white bait fishery was supported by *Encrasicholina devisi*, *S. commersonii*, *S. macrops*, *E. punctifer* (*S. buccaneeri*) and *S. waitei* with average landings of 15224 t. *S. buccaneeri* and *S. devisi* have very good consumer demand in the southern districts compared to northern parts in Kerala where it remains under-exploited.

Among the major pelagic resources exploited by different gears, most of the species had mean size above the minimum size at maturity except *S. longiceps* and *S. commerson* indicating heavy exploitation of juveniles and sub-adults of the oil sardine and king seer. Fishery related parameters of some important pelagics are given in Table 4.

Demersal finfish resouces

Average landings of demersal resources during the period 2005-2006 was 81881 t which formed 15% of the total landings of Kerala. Threadfin breams formed the major resource contributing 35% followed by soles (22%) and lizardfishes (10%) (Table. 2).

Elasmobranchs: Landings showed an increasing trend and average annual landings of elasmobranchs was 3121 t. Gearwise, gill nets and trawls contributed 36% each followed by hooks and line (10%) and rest

Table 4. Fishery related parameters of some important pelagics

Species	Length range (mm)	Mean size (mm)	LM (cm)	Fishery dominant size group (mm)	Exploitation rate (E)	Standing stock biomass (t)	Spawning stock (%)
S. longiceps	70-200	126	140	140-180	0.5	279069	40
R. kanagurta	85-280	173 (trawl) 189 (RS)	190	160-190	0.6	524970	73
S. commersonii	60-145	105	80	90-110	0.6	3234	45
S. macrops	55-100	73		70-99	0.8	873	49
E. devisi	55-145	85		80-110	0.7	2510	65
E. affinis	300-640*	460	430	380-520	0.6	16180	69
A. thazard	220-500*	360	300	300-400	0.6	20340	76
K. pelamis	380-860*	520	440	480-620	0.7	2362	93
T. albacares	400-1860*	820	720	500-960	0.4	5520	71
D. russelli	140-240	215	145	175-220	0.6	50770	90
M. cordyla	190-385	277	225	240-360	0.5	5932	70
T. lepturus	320-1040	631	560	560-840	0.8	30166	98
*S. commerson**	320-980	590	750	480-660	06	3326	10

*Fork length (FL)

by other gears. The annual catch rate in trawls ranged from 0.24 kg in 2005 to 0.36 kg in 2006, while in hooks and line and gillnet the average annual catch rate was 1 and 1.18 kg respectively. Elasmobranch landings were constituted by sharks (62%), rays (26%) and skates (12%). Of the elasmobranch landings by trawl, gill nets and hooks and line, employed in multiday mechanized fleets as well as outboard units are showing increasing landings of sharks. *Carcharhinus limbatus* is the dominant species landed by all gears, others being *C. melanopterus*, *C. sorrah*, *Sphyrna zygaena*, *S. lewini*, *Scoliodon laticaudus*, *Alopias vulpinus* and *Galaeocerdo cuvieri*. Among rays *Dasyatis* spp., *Trygon* spp. and *Aetobatus narinar*i were observed while among skates, *R. djeddensis* was the only species found in the catch. Peak elasmobranch fishery occurred during April to December period.

Flatfish: Average landings of soles during the period was 17763 t. Multi-day trawling contributed 86% to the total catch. Three species of flat fishes were commonly landed of which, *Cynoglossus macrostomus* was the dominant species followed by *C. dubius* and *C. arel*.

Groupers: The average annual catch of groupers ranged from 3830 t (2005) to 4530 t (2006) and were landed in trawl (76%), gill nets (10%), hooks and line (11%) and rest (3%) by other gears. Peak landings in trawl were during April-May and August and in gill nets during April and December-January, while in hooks and line, peak landings occurred during September. Species recorded in the catches included, *E. diacanthus*, *E. chlorostigma*, *E. longispinus*, *E. bleekeri*, *E. merra* and *Cephalopholis sonnerati*.

Lizardfish: The lizardfish fishery averaged 8025 t and was supported by *Saurida tumbil* and *S. undosquamis*. 97% of the landings were by trawlers. Of this, single day trawls contributed 13% and multi-day trawls 84%. Spawning stock biomass of *S. tumbil* and *S. undosquamis* during 2006 was 58 and 63% of the standing stock respectively. Fishing pressure on the two species were relatively high at 0.8 and 0.6 respectively.

Threadfin breams: *Nemipterus mesoprion* was the dominant species (64%) followed by *N. japonicus*. Exploitation rate of both the species along the malabar coast was very high (0.7) and indicates need for reducing fishing pressure. However, spawning stock of the two species was 74-79% of the standing stock. Bull's eye landings were mainly constituted by *Priacanthus hamrur* (94%).

Sciaenids: Landings during the period averaged 5772 t and comprised of species such as *Johnius sina*, *J. macropterus*, *J. dussumeri*, *J. glaucus*, *J. vogleri*, *J. elongates*, *Otolithes ruber* and *O. cuvieri*. Landings were mainly by trawls (63%), gill nets (24%), ring seines (8%) and other gears (5%). Catch rate in trawls was 0.92 kg/h and showed slight increase compared to previous year. Catch rate in ring seines was 1.7 kg per unit effort compared to 2.9 kg in 2005. Fishery related parameters of some important demersals are given in Table 5.

Crustacean resources

Crustacean landings composing of penaeid and non-penaeid prawns, crabs and stomatopods were estimated at 57595 t and showed an increase of 26% compared to 2005. Penaeid and non-penaeid prawns comprised 68 and 15% respectively of the crustacean

Table 5. Fishery related parameters of some important demersals

Species	Length range (mm)	Mean size (mm)	Fishery dominant size group (mm)	Exploitation rate (E)	Standing stock biomass (t)	Spawning stock (%)
C. limbatus	800-2000	1039 (TR)	1000-1200			
		918 (GN)	800-1000	0.7	2886	50
		1510 (LL)	1500-2000			
N. japonicus	64-338	148	120-180	0.8	26570	79
N. mesoprion	62-269	134	100-150	0.7	20053	74
C. macrostomus	62-166	107	100-130	0.7	22789	52
E. diacanthus	90-320	170	120-190			
J. sina	55-199	132	120-150	0.7	11073	47

landings, followed by stomatopods (12%) and crabs (5%).

Penaeid shrimps: The landings of penaeid shrimps in the state in 2006 (39011 t) showed an increase of 24% compared to previous year. Among the various species landed, *Fenneropenaeus indicus*, *Metapenaeus dobsoni*, *M. monoceros*, *Parapenaeopsis stylifera* and *M. affinis* were dominant. At Cochin, the inshore shrimp fishery was dominated by *P. stylifera* (42%), *M. dobsoni* (39%) followed by *F. indicus*, *M. monoceros* and *S. choprai*. The deep sea prawn fishery was constituted by pandalids (68%) and rest by penaeids. *Plesionika spinipes* (31%), *H. gibbosus* (18%) and *H. gibbosus* was 61-140 mm, *H. woodmasoni* 66-135 mm and *M. andamanensis* 61-130 mm. Penaeid prawns (*F. indicus*, *M. dobsoni*, *M. monoceros*, *P. stylifera*) had exploitation rates of 0.65-0.78, while *M. affinis* had an E of 0.57. Most of shrimp resources were overexploited with low spawning stock biomass. Thomson and Bell yield analysis indicated that the MEY levels for most of the shrimp species has been attained and further increase in fishing effort by trawls is unsustaibale and should be discouraged through appropriate management legislations.

Fishing with mini-trawl (mesh size 15-20 mm) is rampant, especially along the Alleppy coast (Pallithode), for prawns which form 90% of the total catch by the gear. *P. stylifera* (64%) and *M. dobsoni* (35%) dominate the shrimp catch. As the gear is operated in the nearshore waters which are the nursery ground for *M. dobsoni* and *P. stylifera* the prawn catch composes mostly of juveniles and sub-adults which is detrimental to the shrimp fishery. The declining trend of shallow water shrimp fishery constituted by these species is continuing and operation of this gear needs to be banned for continued sustenance of the inshore shrimp fishery.

Lobsters: The landings of the deep-sea lobster, *Puerulus sewelli* decreased from 255 t in 2004 to 29 t in 2005, but showed an increase in 2006. Slipper lobster *Thenus orientalis* catches in 2006 decreased by 23% compared to previous year. Lobster landings at Thikkody, Dharmadam and Muttam along the north Kerala coasts were mainly by bottom set gill nets. *P. homarus* dominated the fishery, mostly exploited live and sent to Chennai for export and commanded a price of Rs. 800/kg for size of 200-350 g. The 41-119 mm size groups dominated and were mostly immature females.

Crabs: Landings in 2006 declined by 43% compared to previous year. *Charybdis feriatus* (57%) dominated crab landings at Cochin and *P. sanguinolentus* (78%) at Calicut. The fishery of *C. feriatus* improved during 2006. Thomson & Bell prediction yield indicated that the exploitation of *C. feriatus* can be increased, whereas the fishing pressure on *P. pelagicus* has to be decreased.

Molluscan resources

The average cephalopod catch during the period was 28033t. Cephalopod catch in Kerala during 2006 increased by 26% to 31.302 and catch rate by 26% compared to previous year. Cuttlefish contributed 52% of the cephalopod landings followed by squids (37%) and rest by octopus (1%). Trawlers contributed about 90% of cephalopod catch and rest by hooks & line (H&L). *Sepia pharaonis*, *S. aculeata* and *Sepiella inermis* (cuttlefish), *Loligo duvaucelli*, *Doryteuthis sibogae* (squids), *Octopus membranaceous*, *O. dolfusi*, *Cystopus indicus* were observed in the fishery. Peak abundance was observed during June and August to October period. Spawning congregation of squids occurred during post-monsoon. At Vizhinjam, FAD units were widely used for cephalopod fishing. Exploitation rates indicated ample scope for increasing the catch.

Based on life history parameters and size groups occurring in the fishery, Minimum Legal Sizes (MLS) were determined for 3 species of cephalopods and recommended to MPEDA.

Species	Mantle length (mm)	Total live weight (g)
L. duvaucelii	80	25
S. pharaonis	115	150
O. membranaceous	45	15

The bivalve resources included the green mussel *Perna viridis* which formed 90% of the total bivalve production followed by clams (*Meretrix casta*, *Villorita cyprinoides*) (9%), and rest by the edible oyster, *Crassosstrea madrasensis*. The size range of *Perna viridis* in the fishery was 16-97 mm with mean size 67mm. Mature and spent females occurred during the post monsoon months.

Plate 1. Inboard ringseiner along the Malabar coast

Plate 2. Outboard ringseine unit

Plate 3. Outboard gill net units along the Malabar coast

Plate 4. Bumper shrimps catch in a trawler at Neendakara Fisheries Harbour

Plate 6. Heavy landings of ribbonfish at Cochin

Socio-economic and behavioural studies

Conservation orientation to be found high across the mechanized, motorized and traditional sectors indicating a positive behavioural change that should be harnessed through more extension interventions by concerned agencies in the State. Constraints felt by fishermen crew and boat owners were low, first sale price which was followed by depletion in resource and high fuel cost.

Management Options

Shift from Open-acess to user rights

The present marine fisheries scenario of the state is a free and open access system and consequently there is intense competition for the resources among the various sectors, a lot of unhealthy fishing practices and gears being introduced and a generally stagnation in the marine fisheries production. Protecting the interest of artisanal fishers from unequal competition with mechanized vessels and thereby ensuring their socio-economic security is also important. To rein in unsustainable increase in fishing effort it is

recommended that the following points are considered.

- Mandatory registration and licensing of all motorized and mechanized boats.
- Review of registration and licensing every five years.
- Upward revision of the registration, licensing fees and berthing charges to discourage new entrants.

Reduction of fishing effort and capacity

The fishery regulation through effort reduction that is in vogue is chiefly aimed at the trawl fishery. In recent years, there has been significant increase of the motorized sector, especially the ringseine fishery and the mini-trawl fishery along the Kerala coast, causing concern for sustenance of some of the exploited stocks. There has also been dimensional changes in the ringseine gear giving wider coverage and efficient catchability. Similarly, the increase in the time spent for fishing in the mechanized sector by undertaking multiday voyage and use of sophisticated electronic devices for fish finding and communications has resulted in increased fishing efficiency. Action points suggested are

- Fixing and capping the size and power of the boats in each sector by imposing upper limits for the length and horsepower, especially the large ring seiners operating in Kerala.
- Restriction of multi-day fishing by fixing upper limit for absence from the shore in all the states.
- Discourage further increase in fishing effort by restriction of licensing for new boat.

Closed season/closed area/Marine Protected Areas (MPAs)

To ensure sustainable yields from the exploited stocks, fishery regulations enabling effort reduction, rebuilding of the stocks and ecosystem rejuvenation through closure of fishery for a specified period of time is inevitable. Along Kerala coast, restriction of the number of days of fishing during monsoon is recommended to protect the spawning stocks from capture by mechanised fishing vessels and allow natural replenishment of the fish stocks. The idea is that if the fish are protected from fishing, they live longer, grow larger and produce an exponentially increasing number of eggs.

The suggested measures are:

- Closed fishing season from 15th June to 31st July, made mandatory.
- Only non-motorized and low horse powered motorized (up to 10 HP) OBM/IBM vessels to be allowed to operate during the closed season.
- Identify suitable areas and declare as MPAs and no-fishing zones.

Mesh-size regulations and curbs on destruction of fish juveniles

The fine meshes of gears like trawls and bag nets cause large-scale destruction of juveniles of many important commercial fishes. The fishing for shrimp seed along the coastal waters is causing destruction of valuable ichthyoplankton including larvae and juveniles of commercially important species of finfishes and shellfishes which leads to growth overfishing and impaired recruitment to the fishery. The recommended minimum stretched codend mesh size (CEMS) of trawl net is 35 mm to ensure sustainable exploitation of the fish and shrimp stocks. As regards to lobster resource, the Minimum Legal Size (MLS) for capture of four species of lobsters is to be followed to ensure sustainable exploitation of the resources. Seerfish juveniles are landed by trawlers as well as drift gill nets and it is recommended that awareness should be created among fishermen and fish traders on the need to allow small fish to grow. Although optimum mesh size of a seerfish targeting gill net is 152 mm, most commonly multimesh gill nets of 90-100 mm mesh are employed, resulting in a lot of unselective fishing and increased landings of juveniles. A MLS of 75 cm is recommended for *S. commerson* to allow juveniles to grow and ensure sufficient recruitment by allowing spawning when they reach a minimum size of 70 cm. The juvenile fishing by all gears should be stopped forthwith and interventions required are:

- Complete ban on landing and marketing of juvenile fish.
- Minimum export size for high value resources such as lobsters and seerfishes.

- Awareness creation.

Diversification of vessels and targeting specific resources

To ease out fishing pressure in the inshore waters, the existing vessels may be suitably upgraded/ modified as multipurpose/combination vessels to harvest the under-tapped resources like tunas, bill fishes, pelagic sharks and oceanic squids available in the oceanic and deeper waters. The suggested options are:

- Diversification of fishing to passive fishing by large mesh gill nets, squid jigging and hooks & lines
- Promote deep-sea fishing of the tuna resources by resource specific craft and gear

Participatory management and strengthening of conservation oriented extension services

Management of fisheries can be made more effective if the principal stakeholders are involved in the decision-making and its implementation. Fishermen cooperatives can be formed and vested with the responsibility of protecting the fisheries resources they harvest. They should be made aware of the biological and environmental basis for sustainability of fish stocks by constant interactions with the scientific community. Such interactions will make the implementation of the management measures/options smooth and effective. Awareness on benefits of conservation of fish stock is presently minimal and has to be created and strengthened through extension services of Central and State Fisheries institutions/agencies with a participatory management approach.

Stregthening of Management Information System

It has been now well recognized that the basic requirement for knowledge based fisheries management is availability of reliable and adequate data on the resources and their dynamics including economics of fishing. The scientific data acquisition mechanism already in place by research Institutes such as CMFRI can be valuably supported by an effective fishing data feedback system with active participation and co-operation of fishing vessel operators. The state must develop mechanisms to generate a reliable database on marine fish landings and fishing effort, which could be used for understanding dynamics of the fisheries as well as for regulating their exploitation. Supply of data on fishing effort and catch to the fisheries Department should be made mandatory for all mechanized fishing crafts especially trawlers and large ringseiners.