

## PRESENT STATUS OF EXPLOITATION OF FISH AND SHELLFISH RESOURCES : OILSARDINE

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### ABSTRACT

Considerable fluctuations coupled with a general decline in the oilsardine landings have been observed along the southwest coast of India during 1984-85 to 1988-89. The catch and effort data for oilsardine fishery during the different seasons have revealed that postmonsoon period is the most productive period for the fishery. The decline in the fishery is attributed to the indiscriminate exploitation of juveniles and potential spawners by purse seiners and ring seines. The traditional sector has been adversely affected by the operations of purse seines in recent years in northern Kerala. Exploitation of spawning stock of oilsardine during the breeding season from May to September is of great consequence for the conservation of the resource. Eventhough good monsoon is most likely to have a positive impact on the stock size and facilitate spawning and recruitment, the likely advantage is offset by indiscriminate exploitation. Regulation of mesh size of boat seines and restricting the operations of purse seines and ring seines are expected to restore the fishery to its pre-eminent position and protect the interests of the traditional sector.

### INTRODUCTION

The oilsardine *Sardinella longiceps* which enjoys a pre-eminent position in Indian marine fisheries, is mainly caught from the coastal waters of Kerala and Karnataka and to some extent from Goa and Southern Maharashtra on the west coast. Over the years, large scale annual and seasonal fluctuations have been observed in the oilsardine landings. Despite the fact that investigations on its fishery and biology are being carried out for more than sixty years, the exact fishery dependant and fishery independent factors responsible for the fluctuations in its availability in the coastal fishing belt are not fully known. To forecast the vagaries in the fishery, information on the exploitable resources is a prime requisite. An attempt is made in this paper to analyse critically the fluctuations in the fishery as reflected in the landings in Kerala, Karnataka and Goa and its relation to the monsoon of the southwest coast.

The oilsardine fishery restricted to the narrow coastal belt of about 15 kilometres from the shore, used to be exclusively exploited by indigenous crafts and gears. The boat seine *Mathikkolli vala*, used exclusively for capturing oilsardine, and *Pathu vala* and *Thattum vala* operated till the late sixties have become obsolete with the introduction of nylon nets and their place has been taken over

by *Pattenkolli vala* which is used for the capture of small sized fishes especially oilsardine and mackerel in the inshore areas. Indigenous gears like *Rampani* and gill net have been important gears operated for oilsardine fishery in Karnataka. But the large scale introduction of purse-seine in Karnataka and purse-seine and ring seine in Kerala in the late seventies changed the trend in pelagic fish landings and made the most effective traditional gear *Rampani* in Karnataka and boatseines in Kerala almost obsolete. Purse-seines are operated within 50 metres depth, but the majority of the catches are realised from 11-20 m depth during the peak fishing season (September to January). Its mesh size at the time of introduction was 14-18 mm and this has been reduced to 8-14 mm in recent years in some units.

The fishery and biology of oilsardine of the southwest coast have been reviewed earlier by Nair and Chidambaram (1951), Nair (1960), Sekharan and Dhulkhed (1963), Sekharan (1965), Antony Raja (1969), Prabhu (1971), Prabhu and Dhulkhed (1970), Balan and Reghu (1979), Jacob *et al.* (1982) and Balan (1984). Nair and Chidambaram (1951) attributed the success of the fishery along the southwest coast to the abundance of small-sized immature oilsardine shoals in inshore waters. Hornell and Nayudu (1924), Devanesan (1943), Chidambaram and Menon (1945), Chidambaram

(1950) and Antony Raja (1969) reported that oilsardine exclusively feed on plankton, the major constituent being diatoms and suggested a direct relationship between the abundance of plankton and pelagic fishery landings. The shoreward movement of juveniles of oilsardine towards the end of southwest monsoon has been attributed to the abundance of the diatom *Fragilaria oceanica* and the prevalence of optimum temperature and salinity (Nair and Subrahmanyam, 1955). Mukundan (1971) stated that the abundance of planktonic food organisms during the postmonsoon period is due to the abundance of dissolved nitrogenous substances and slightly warmer temperature. Murty and Edelman (1970) observed some relation between the intensity of the southwest monsoon and the availability of oilsardine. Stock assessment of oilsardine off the west coast of India was reported by Kurup *et al.* (1989).

#### DATA BASE

The results of investigations based on the fishery and biological data of oilsardine collected from major fish landing centres at Goa, Karwar, Mangalore, Calicut, Cochin and Vizhinjam from February 1984 to August 1988 are dealt with in this paper. The resources have been studied based on gearwise catch, effort and maturity data from different centres and the quantitative estimates of the exploited stocks in different depth zones and seasons are also given. For the sake of convenience in discussing the fishery during different seasons, an year is divided into the three seasons, premonsoon (February-May), monsoon (June-August) and postmonsoon (September-January). The data on estimated total landings were collected from NMLRDC of CMFRI. The rainfall data were collected from the Indian Meteorological Department, Trivandrum.

#### OBSERVATIONS

##### *General fishery characteristics in different States*

Traditional gears like boat seine, shore seine and gill net are generally employed for oilsardine fishery all along the southwest coast. But the trend has considerably altered consequent to the operations of purse-seine and ring net in Goa, Karnataka and Kerala in recent years.

In Goa, the annual oilsardine landings varied from 917 t (1986) to 17,988 t (1988) with an annual

average of 7025 t and the majority was by purse-seine (Table 1). The average production during 1984-1988 period was 964 t in premonsoon, 12 t in monsoon and 6049 t in postmonsoon with seasonal percentages of 13.7, 0.2 and 86.1 respectively. In purse-seine, premonsoon (81.7%) and postmonsoon (97.4%) yielded the bulk of the catch; whereas in gill net, the corresponding percentages were only 12.2 and 0.9. The premonsoon production ranged from 94 t (1986) to 1418 t (1985), monsoon yield varied from 5 t (1985) to 55 t (1987) and postmonsoon landings from 643 t (1984) to 16,649 t (1988).

TABLE 1. Seasonal oilsardine production (t) in Goa during 1984-1988 and the average gearwise contribution

Year	Seasons			Total
	Premonsoon	Monsoon	Postmonsoon	
1984	303	-	643	946
1985	1418	5	2612	4035
1986	94	-	823	917
1987	864	55	9518	10437
1988	1339	-	16649	17988
Average	964.0 (13.7%)	12.0 (0.2%)	6049.0 (86.1%)	7025
Purse-seine	787.2 (81.7%)	11.0 (91.7%)	5892.1 (97.4%)	
Gill net	117.2 (12.2%)	-	53.1 (0.9%)	
Others	59.6 (6.1%)	1.0 (8.3%)	103.2 (1.7%)	

Oilsardine is mainly caught by purse seine in Karnataka and trawl net, gill net and shore seine land only limited quantities (Table 2). During 1984-88, the annual total landings varied from 18,174 t (1986) to 51,539 t (1987) with a mean of 37,145 t. The postmonsoon yielded peak landings of 73.2% of the total. The production during this season fluctuated from 7058 t (1986) to 45,567 t (1987) with an average of 27,195 t. The average premonsoon landing amounted to 9809.4 t forming 26.4% of the total landing. The landing during the monsoon was only negligible, 140.2 t forming 0.4%. Gill nets accounted for 40.2% of the landing during the monsoon. The landing during the premonsoon was 98.0% by purse-seine (9614.8 t) and the postmonsoon landing by purse-seine was 26128.2 t (96.1%).

The exploitation of oilsardine along the Kerala Coast is mainly by ring seine, boat seine,

TABLE 2. Seasonal oilsardine production (t) in Karnataka during 1984-1988 and the average gearwise contribution

Year	Seasons			Total
	Premonsoon	Monsoon	Postmonsoon	
1984	7442	-	27733	35175
1985	4278	150	32280	36708
1986	11067	49	7058	18174
1987	5470	502	45567	51539
1988	20790	-	23340	44130
Average	9809.4 (26.4%)	140.2 (0.4%)	27195.6 (73.2%)	37145
Purse-seine	9614.8 (98.0%)	63.8 (45.5%)	26128.2 (96.1%)	
Trawl net	6.1 (0.1%)	0.2 (0.1%)	89.8 (0.3%)	
Gill net	8.6 (0.1%)	56.3 (40.2%)	379.2 (1.4%)	
Others	179.9 (1.8%)	19.9 (14.2%)	98.4 (2.2%)	

purse-seine and gill net. The annual landing varied from 25,323 t (1986) to 134,905 t (1984) with an average of 73,874 t (Table 3). During the years 1984-88, the average premonsoon landing was 23,463.8 t (31.8%) and the postmonsoon average was 40,911.6 t (55.3%), whereas the monsoon fishery was 9498.6 t (12.3%). In the premonsoon, the percentage contribution in the landing by ring seine, boat seine, gill net and purse-seine were 31.6, 25.0, 22.7 and 12.4 respectively, whereas the corresponding percentages during the postmonsoon were 51.7, 16.7, 8.8 and 19.8. During the monsoon the majority of the landing was by ring seine (40.2%) and boat seine (45.1%).

#### Seasonal trend in the landings and fishing effort at different centres

**Goa:** The average purse-seine landing of oilsardine during the premonsoon, monsoon and postmonsoon was 282 t, 25 t and 938 t respectively (Table 4). In the premonsoon, the highest catch per unit effort of 839 kg was in 1984. An average of 23% of the total oilsardine catch was during this season with an average catch per effort of 390 kg. There was fishing only in August during the monsoon which contributed only 2% of the total annual oilsardine landings. Postmonsoon is the peak fishing season which accounted for about 75% of the total catch with an average catch per effort of

TABLE 3. Seasonal oilsardine production (t) in Kerala during 1984-1988 and the average gearwise contribution

Year	Seasons			Total
	Premonsoon	Monsoon	Postmonsoon	
1984	59987	12309	62609	134905
1985	37106	9415	40854	87375
1986	16291	59	8973	25323
1987	1712	17762	25486	44960
1988	2223	7948	66636	76807
Average	23463.8 (31.8%)	9498.6 (12.9%)	40911.6 (55.3%)	73874
Purse-seine	3040.2 (12.9%)	-	8111.4 (19.8%)	
Ring seine	7412.0 (31.6%)	3822.2 (40.2%)	21162.6 (51.7%)	
Boat seine	5873.0 (52.0%)	4285.0 (45.1%)	6852.8 (16.7%)	
Trawl net	71.4 (0.3%)	1.4 (0.0%)	109.2 (0.3%)	
Gill net	5324.0 (22.7%)	944.8 (9.9%)	3590.4 (8.8%)	
Others	814.6 (3.5%)	445.2 (4.8%)	1085.2 (2.7%)	

227 kg. In 1985-86 there was a sharp increase in the catch to 1604 t, but the landings declined in the next year. The seasonal percentage contribution to the total oilsardine catch was as high as 98% in 1986-87 with a minimum of 38% in 1984-85.

**Karwar:** The premonsoon of 1984-85 was more productive for oilsardine with a catch of 2222 t and the catch per effort was 1342 kg (Table 5). During the premonsoon of 1986-87, the effort declined by 57% over the previous year and the catches further declined by 35%. The catch per effort was 809 kg. Purse-seines were not operated during June and July and the landings during the monsoon are generally very poor. In 1985-86, the catches during the monsoon amounted to 114 t with a catch per effort of 905 kg. However, in 1986-87, even though the effort showed an increase by 29% over the previous year, the landings declined to 13 t. The postmonsoon is more productive than the other two seasons. During 1984-85, the postmonsoon accounted for 3096 t which formed 58.2% of the total catch of oilsardine that year. In 1986-87, the catches declined to 3377 t and the catch per effort also decreased.

TABLE 4. Seasonal fishing effort, oilsardine catch (tonnes) and catch per unit effort (Kg) of purse-seine at Panaji (Goa) during 1984-85 to 1987-88

Year	Premonsoon			Monsoon			Postmonsoon			Total C (t)
	E	C	C/E	E	C	C/E	E	C	C/E	
1984-85	336	282	839	196	-	-	3130	179	57	461
1985-86	858	515	600	109	5	46	4266	1604	376	2124
1986-87	608	14	23	175	55	314	3370	771	229	840
1987-88	1091	319	293	72	4	54	5775	1196	207	1519
Average	723	282	390	138	25	181	4135	938	227	989

**Mangalore :** Purse-seine is the only gear by which oilsardine is landed during the premonsoon period. Oilsardine catches and catch per effort in purse-seine during the premonsoon period was maximum in 1986, being 2395 t and 699 kg respectively when compared with other gears. Minimum catch and catch per effort of 362 t and 119 kg respectively were recorded during 1988 (Table 6). Purse-seines were not operated during monsoon period at Mangalore. Indigenous gear *Matubala* landed 31 t of oilsardine during the monsoon of 1987 with a catch per effort of 24 kg. Postmonsoon period was the most productive period for oilsardine landings. The landings of the postmonsoon period accounted for 85%, 96%, 41%, 96% and 92% of the annual landings during 1984-85, 1985-86, 1986-87, 1987-88 and 1988-89 respectively. The average catch per effort for the postmonsoon season of 1984-85 was 1177 kg; for 1985-86, 1468 kg; for 1986-87, 179 kg; for 1987-88, 1860 kg and for 1988-89, 330 kg. In 1987-88 postmonsoon period, tremendous revival of the fishery was observed when compared to the previous year and a record monthly catch to the

tune of 9713 t was recorded in September 1987 and minimum catch of 635 t in November. In 1988-89, the maximum catch of 1922 t was accounted in January 1989 and the minimum of 408 t in September.

**Calicut :** The composition of oilsardine in the annual fish landings varied from 13.6 to 33.2% with an annual average of 25.7%. The average annual landings of oilsardine during the four year period 1984-88 was 1873 t. The highest landing of 2719 t was during 1984-85 with a catch per standard effort of 374 kg and the lowest during 1985-87, being 626 t with the lowest catch per standard effort of 117 kg which was the lowest recorded so far from Calicut (Table 7). During 1984-88, 67.6% of the total oilsardine landings was during the postmonsoon period followed by premonsoon (17.6%) and the lowest during monsoon (14.8%). Major portion of the landings was affected by boat seine *Pattenkollu* (77.2%) followed by *Nethal vala* (20.5%) and the lowest was by *Mathichala vala* (2.3%).

TABLE 5. Seasonal fishing effort, oilsardine catch (tonnes) and catch per unit effort (Kg) of different gears of Karwar

	1984-85			1985-86			1986-87			1987-88			1988		
	E	C	C/E	E	C	C/E	E	C	C/E	E	C	C/E	E	C	C/E
<i>Purse-seine</i>															
Premonsoon	1656	2222.0	1341.8	2057	1100.7	535.1	889	718.9	808.7	725	204.8	282.5	505	56.0	110.9
Monsoon	20	1.5	75.0	126	114.0	904.8	89	13.1	146.8	41	7.8	190.2	91	-	-
Postmonsoon	4293	3096.8	721.4	4111	3782.8	920.2	2869	405.6	141.4	3523	2764.5	784.7	-	-	-
<i>Yendi</i>															
Premonsoon	424	1.0	2.4	533	-	-	340	-	-	482	-	-	613	3.2	5.2
Monsoon	882	1.0	0.0	1185	0.9	0.1	168	-	-	1362	1.6	1.2	1478	-	-
Postmonsoon	574	-	-	158	0.5	3.4	561	-	-	672	13.5	20.1	-	-	-
<i>Rampani</i>															
Premonsoon	1	0.9	900	-	-	-	-	-	-	-	-	-	-	-	-
Monsoon	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Postmonsoon	-	-	-	-	-	-	-	-	-	14	2.4	171.4	-	-	-

TABLE 6. Seasonwise catch (tonnes), fishing effort and CPUE (t) of oilsardine for different gears at Mangalore

Seasons	1984-85			1985-86			1986-87			1987-88			1988-89		
	E	C	C/E	E	C	C/E	E	C	C/E	E	C	C/E	E	C	C/E
<i>Purse-seine</i>															
Premonsoon	3826	1933	0.505	1378	627	0.455	3424	2395	0.699	2018	686	0.340	3044	362	0.119
Monsoon	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Postmonsoon	9135	10753	1.177	11409	16749	1.468	9203	1650	0.179	8621	16038	1.860	11961	3954	0.330
Total	12961	12686	0.979	12787	17376	1.359	12627	4045	0.320	10639	16724	1.572	15005	4316	0.288
<i>Mattubala</i>															
Premonsoon	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Monsoon	No Data			405	-	-	648	-	-	1327	31.31	0.024	1510	-	-
Postmonsoon	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	-	-	-	405	-	-	648	-	-	1327	31.31	0.024	1510	-	-

TABLE 7. Seasonal fishing effort, catch (tonnes) and catch per unit effort (Kg) of oilsardine by different gears at Calicut during 1984-'88

Year/Season	Pattenkolli vala			Mathichala vala			Nethal vala			Total		
	E	C	C/E	E	C	C/E	E	C	C/E	SE	C	C/SE
<b>1984-85</b>												
Premonsoon	2170	857	395	96	4	42	-	-	-	2180	861	395
Monsoon	895	206	230	172	1	6	-	-	-	900	207	230
Postmonsoon	1541	659	428	1252	58	46	1924	933	485	3858	1650	428
Annual	4606	1722	374	1520	64	42	1924	933	485	7271	2719	374
<b>1985-86</b>												
Premonsoon	941	101	107	86	-	-	-	-	-	941	101	107
Monsoon	469	212	452	22	1	45	841	221	263	957	434	453
Postmonsoon	2843	1498	527	1092	47	43	-	-	-	2933	1545	527
Annual	4253	1812	426	1200	48	40	841	221	263	4883	2081	426
<b>1986-87</b>												
Premonsoon	618	503	814	7	-	-	-	-	-	618	503	814
Monsoon	2702	19	7	27	2	74	-	-	-	2914	21	7
Postmonsoon	1854	80	43	349	9	26	41	12	293	2335	101	43
Annual	5174	603	117	383	11	29	41	12	293	5366	626	117
<b>1987-88</b>												
Premonsoon	342	61	178	-	-	-	-	-	-	342	61	178
Monsoon	700	224	320	277	23	83	2113	328	155	1799	575	320
Postmonsoon	2459	1361	553	367	18	49	125	50	400	2581	1429	553
Annual	3501	1645	470	644	41	64	2238	378	169	4393	2064	470
<b>1988-up to August</b>												
Premonsoon	57	13	228	70	1	14	57	-	-	62	14	228
Monsoon	893	48	54	84	1	12	-	-	-	903	49	54
<b>Average</b>												
Premonsoon	826	307	344	52	1	11	11	-	-	829	308	372
Monsoon	1132	142	213	116	6	44	591	110	84	1495	257	172
Postmonsoon	2174	900	388	765	33	41	523	249	295	2927	1181	403
Annual	4132	1349	326	953	40	43	1125	359	319	5251	1746	333

E = Effort; C = Catch; SE = Standard effort.

Seasonwise landings of oilsardine by different gears for the period 1984-85 to 1988 is shown in Fig. 1. The oilsardine landings during the premonsoon ranged from 14 to 861 t with an average of 308 t. The landings during the monsoon varied from 21 to 575 t with an average of 257 t. The landings during the postmonsoon varied from 101 to 1650 t with an average of 1181 t. The average standard effort during the different seasons was premonsoon, 829, monsoon, 1495 and postmonsoon, 2927. The average catch per standard effort was premonsoon, 372 kg, monsoon 172 kg and postmonsoon 403 kg. The annual standardised effort was highest during 1984-85 (7271) with a catch per standard effort of 374 kg and low during 1987-88 (4393) with a catch per standard effort of 470 kg which was the highest. The trends in the landings and catch per standard effort for the different seasons during 1984-88 are depicted in Fig. 2. The annual catch by *Pattenkolli* was the highest during 1985-86 (1812 t) with a catch per effort of 426 kg, whereas it was the lowest during 1986-67 (603 t) with a catch per effort of 117 kg. The highest catch by *Nethal vala* was during 1984-85 (933 t) with a catch per effort of 485 kg and the lowest catch of 12 t was in 1986-87 with a catch per effort of 293 kg.

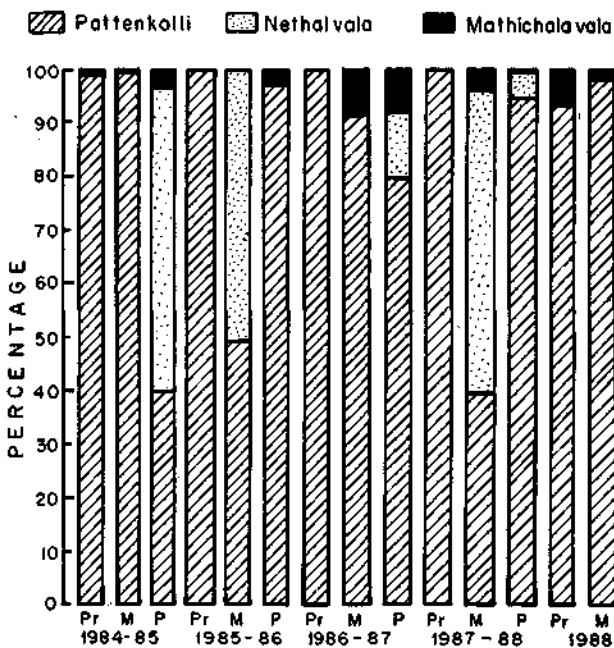


Fig. 1. Season wise landings (percentage weight) of oilsardine by different gears during 1984-88 at Calicut. (Pr = Premonsoon; M = Monsoon; P = Postmonsoon).

*Cochin*: The annual average landing at Cochin was 3761 t which showed a declining trend since 1984-85 with very low catches in 1987-88, when only 34.2 t were landed. Purse-seine contributed to 98.8% of the total catch with an annual catch rate of 1245 kg (Table 8). The ring seine contributed 0.9% with an annual catch rate of 351 kg. The contribution of trawl net was merely 0.28% with an annual catch rate of 0.22 kg.

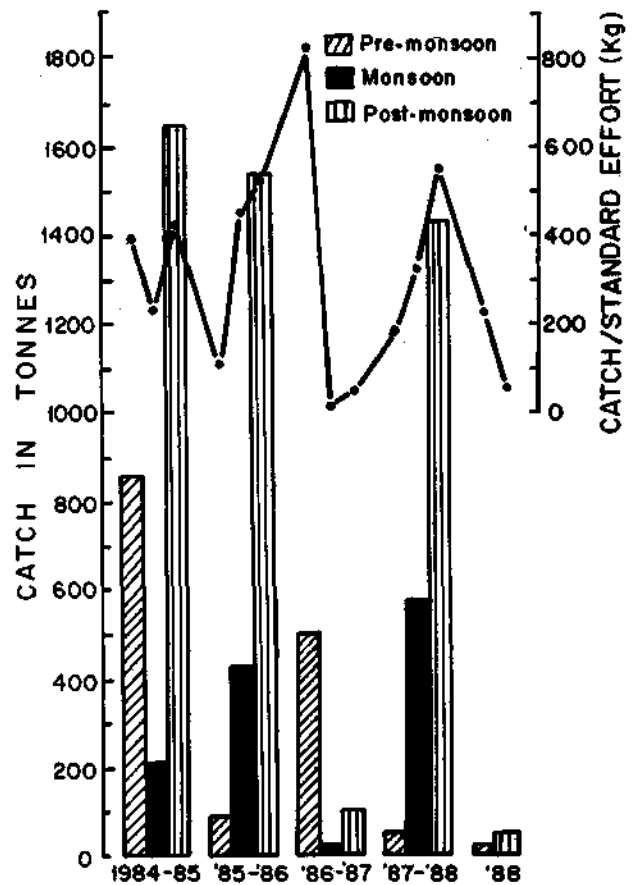


Fig. 2. Seasonal trends in the catches of oilsardine and catch per standard effort during 1984-88 at Calicut.

The annual catch rate in purse-seine declined from 1984-85 and reached an all time low during 1987-88 (Fig. 3). The catch improved in 1988-89 with a catch rate of 144.6 kg. The ring seine landed 99.8% of the oilsardine catch at Cochin during 1987-88. The seasonal contribution of the different gears to the oilsardine fishery at Cochin centre is given in Table 9. The purse seine on an average landed 1859.4 t and 1858.3 t respectively during the premonsoon and postmonsoon months with a catch rate of 1262.3 kg and 1228.2 kg respectively (Fig. 4). The ring seine operated throughout the year and on

an average landed 8177, 9004 and 15,463 t of oilsardine during the premonsoon, monsoon and postmonsoon periods with catch rates of 743.4 kg, 191.6 kg and 441.8 kg respectively.

**Vizhinjam :** The annual catch varied from 2.9 t in 1986-87 to 62.2 t in 1985-86 with an annual average of 30.6 t (Fig. 5). The highest catch (67%) was in premonsoon period followed by monsoon period (31%). In the postmonsoon period the catch formed only 2% of the annual catch. During the 5-year period more than 74% of the annual catch was landed in premonsoon months, except in 1987-88 when it was higher in monsoon period (82.3%). In

TABLE 8. Annual gearwise landings of oilsardine (tonnes) at Cochin for the period February '84 to January '89

Year	Gear operated			Annual
	Trawl net	Ring seine	Purse-seine	
1984-85	32.807	30.737	14098.964	14162.508
1985-86	16.783	11.169	4219.582	4247.534
1986-87	1.765	46.979	157.307	206.051
1987-88	0.000	34.196	0.057	34.253
1988-89	1.448	40.141	112.511	154.100
Total	52.803	163.222	18588.421	18804.446
Average	10.561	32.644	3717.684	3760.889
Percentage	0.281	0.868	98.851	100.000

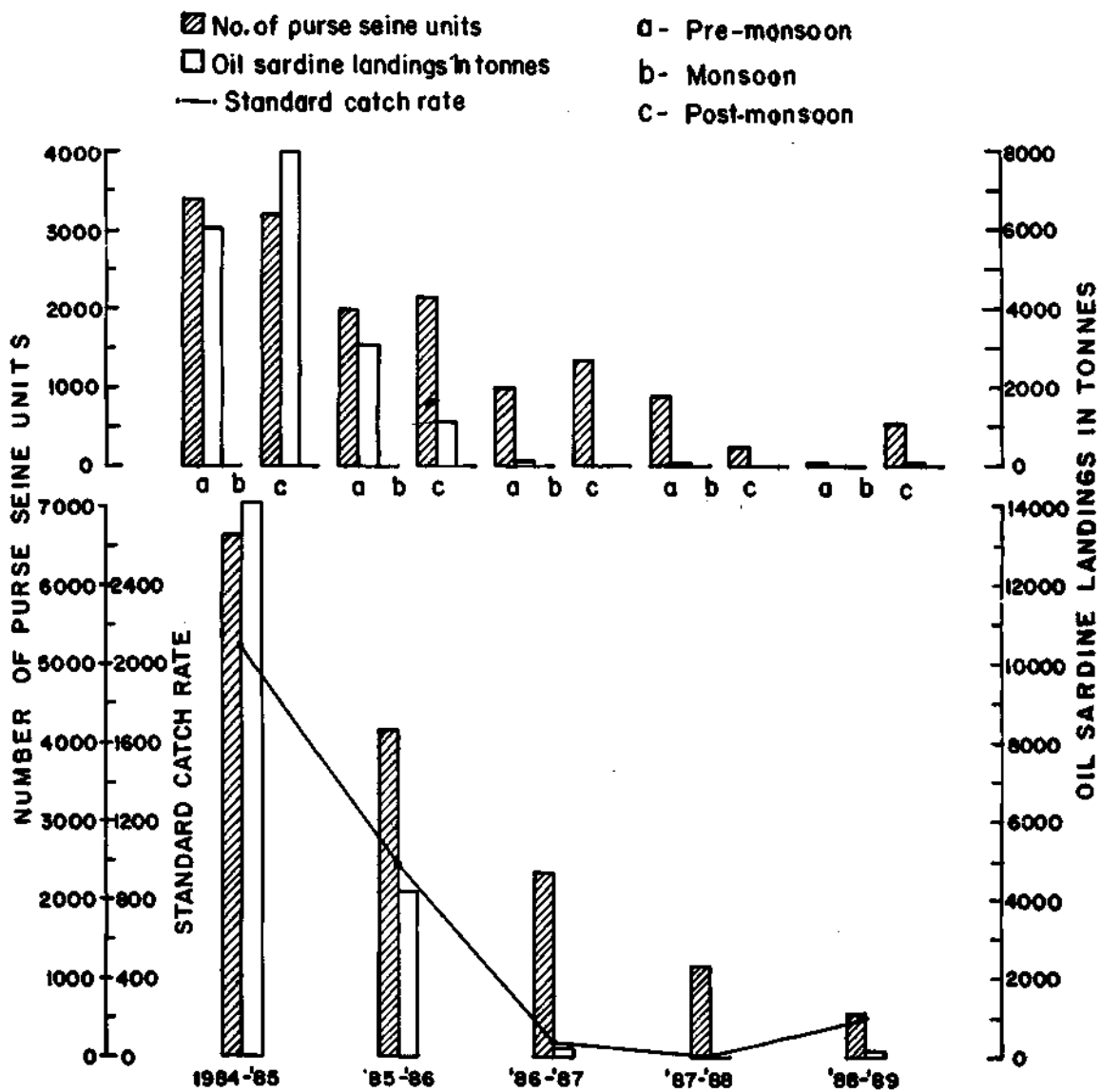


Fig. 3. Annual and seasonwise oilsardine landings at Cochin by purse-seine during February 1984 to January 1989.

TABLE 9. Average gearwise landing (Kg) of oilsardine at Cochin during the premonsoon, monsoon and postmonsoon months for the period February 1984 to January 1989

Season	Trawl net			Ring seine			Purse-seine		
	E	C	C/E	E	C	C/E	E	C	C/E
Premonsoon	18533	10035.6	0.541	11	8177.4	743.4	1473	1859422.6	1262.337
Monsoon	14135	7.8	0.00055	47	9004.2	191.579	No Operation		
Postmonsoon	15928	517.2	0.0325	35	15462.8	441.794	1513	1858261.6	1228.197
Total	48596	10560.6	0.2173	93	32644.4	376.456	2986	3717684.2	1245.038

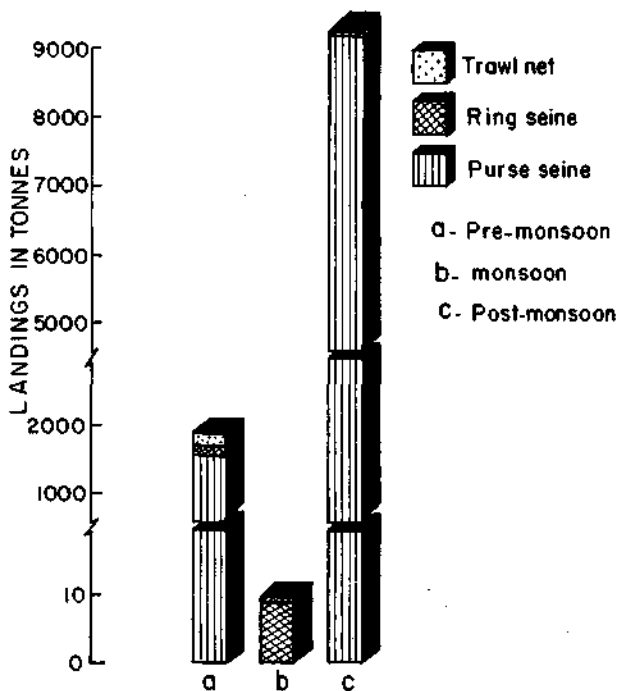


Fig. 4. Average seasonwise oilsardine landings at Cochin by different gears during February 1984 to January 1989.

1986-87 the fish was encountered only in premonsoon. The catch rate also showed simultaneous increase during premonsoon (4.1 kg). Maximum catch and catch rate was in May forming 16.5 t and 7.8 kg respectively. 88% of the *Chala vala* catch was landed in premonsoon, 9.6% in monsoon and 2.4% in postmonsoon period (Fig. 5). The catch per effort was also highest in premonsoon forming 4.05 kg. In boat seine nearly 96% of the catch was landed in monsoon and the rest in premonsoon. Shore seine landed oilsardine only in May (90%) and September (10%).

#### Depth-wise exploitation

At Calicut 76.9% of the oilsardine catch during 1984-88 was from areas with bottom depth

between 11-20 m, 12.1% with depth upto 10 m and 11.0% with depth between 21-30 m (Table 10). In general, the catch (1343 t) and catch per standard effort (300 kg) were the highest in depth range 11-20 m, followed by depth zone less than 10 m with a catch of 211 t and catch per standard effort of 327 kg (Table 11). The catch from depth zone 21-30 m was low (194 t) with a low catch per standard effort (221 kg). The standard effort expended in depth zone upto 10 m, 11-20 m and 21-30 m were 635, 3726 and 879 respectively. Thus, when comparing the catch per standard effort in the three zones, the yield was low in 21-30 m depth regions.

TABLE 10. Percentage of oilsardine caught (in quantity) from different depth zones during 1984-'88 at Calicut

Season	< 10 m	11-20 m	21-30 m
Premonsoon	2.9	85.1	12.0
Monsoon	6.2	61.1	32.7
Postmonsoon	15.7	78.1	6.2
Annual	12.1	76.9	11.0

The catch per standard effort in regions from 11-20 m bottom depth was always higher during all the years except in 1986-87 when the highest catch per standard effort was from depth upto 10 m. Better catches of oilsardine were sometimes obtained in slightly deeper areas in the monsoon and premonsoon seasons, whereas during the postmonsoon, good concentrations were in shallower regions. This supports the view that the offshoreward movement of sardine shoals begins towards the end of the postmonsoon season.

#### BIOLOGY

##### Size at first maturity

A total of 2576 fish were examined from February 1984 to August 1988 at Mangalore. Only those in maturity stage III and above were considered as mature. Size at first maturity has been estimated at 158 mm (Fig. 6).



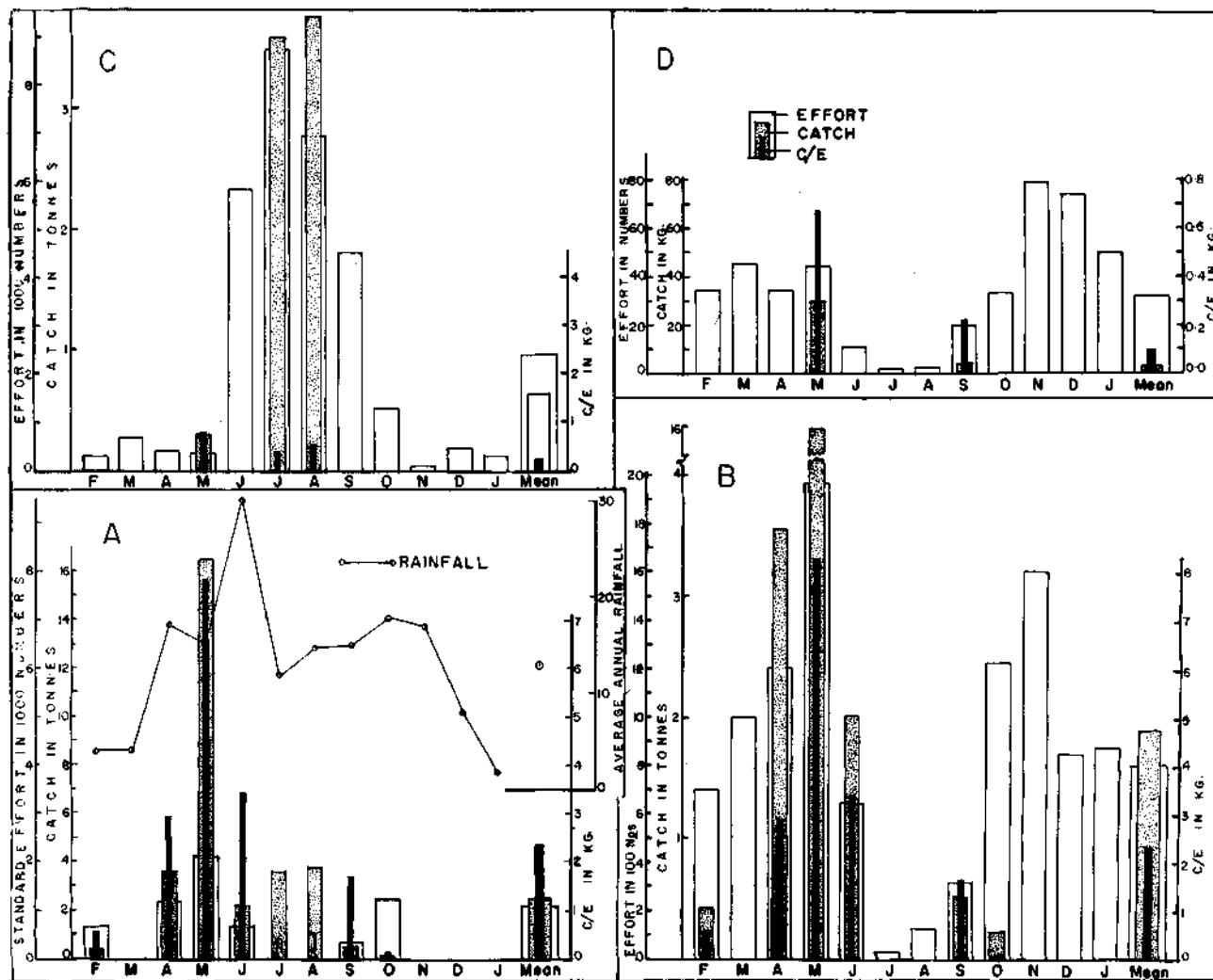


Fig. 5. Gearwise monthly effort, catch and C/E of oilsardine during 1984-85 to 1988 at Vizhinjam : A. Pooled data for all gears along with average monthly rainfalls, B. *Chala vala* (Gillnet), C. *Boat seine* and D. *Shore seine*.

**Spawning season**

At Mangalore, estimation of monthwise percentage of different stages of maturity of adult fish for the period from February 1984 to January 1988 showed that fish in advanced stages of maturity were available from April to October in good numbers in 1985-86, from May to October in 1986-87 and May to September in 1987-88 seasons. Spent fishes were encountered from September to January, indicating that oilsardine has protracted spawning season from May to October with a probable peak during monsoon months in Mangalore area. Sekharan and Dhulkhed (1963) have given spawning season of oilsardine from July to November at Mangalore.

Data on maturity stages for premonsoon, monsoon and postmonsoon are given in Table 12. Mature fishes were available in good numbers in premonsoon period during all the four years. Mature fishes were also observed during postmonsoon period of 1986-87 and 1987-88. During monsoon period of 1987, mature fish accounted for the bulk of the catch.

The estimated number of adults and the percentages of gravid and spent females in the landings during different years at Calicut are given in Table 13. The largest number of adults in the landings was in 1987-88 (8078<sup>104</sup>) which was almost double the annual average of 4080<sup>104</sup> and the lowest

TABLE 11. Seasonal and depthwise estimated standard effort, catch (tonnes) and catch per standard effort (Kg) at Calicut during 1984-'88

Year/Season	< 10 m			11-20 m			21-30 m		
	SE	C	C/SE	SE	C	C/SE	SE	C	C/SE
<b>1984-85</b>									
Premonsoon	78	4	51	1854	783	422	248	74	298
Monsoon	190	8	42	425	148	348	285	51	179
Postmonsoon	516	216	419	3240	1412	436	102	22	216
Annual	784	228	291	5719	2342	410	768	147	191
<b>1985-86</b>									
Premonsoon	24	2	83	848	93	110	69	6	87
Monsoon	39	4	103	633	289	457	285	141	495
Postmonsoon	361	208	576	1826	1280	701	746	57	76
Annual	520	214	412	2951	1662	563	1412	204	144
<b>1986-'87</b>									
Premonsoon	50	30	600	482	401	832	86	72	837
Monsoon	247	4	16	2243	15	7	424	2	5
Postmonsoon	123	29	236	1748	48	27	464	24	91
Annual	264	63	277	4128	464	112	974	98	101
<b>1987-'88</b>									
Premonsoon	42	12	286	220	22	100	80	27	338
Monsoon	212	56	264	1080	316	293	507	203	400
Postmonsoon	728	286	393	1580	954	604	273	189	692
Annual	1212	354	292	2398	1292	539	783	419	535
<b>1988-upto August</b>									
Premonsoon	-	-	-	21	10	476	41	4	98
Monsoon	184	7	38	328	19	58	391	23	59
<b>Average (1984-88)</b>									
Premonsoon	39	9	256	685	262	382	105	37	352
Monsoon	174	16	92	942	157	167	378	84	222
Postmonsoon	432	185	428	2099	923	440	396	73	184
Annual	645	211	327	3726	1343	360	879	194	221

during 1986-87 (1205<sup>104</sup>). The annual percentages of gravid individuals varied from 0.2% to 8.6% with an average of 4.7% of the landings, whereas spent females constituted 7.3% to 16.1% with an average of 11.9%. Considering both the gravid and spent individuals in the exploited population, it was concluded that the spawning period in North Malabar extended from May to October.

Fishes with gravid and spent gonads were observed in the landings at Cochin during the late

premonsoon and spent fishes formed the dominant group followed by gravid fishes during the monsoon months. At Vizhinjam the mature fish was more in February to April and spawners in May-June months. More spent fish was noticed in September. This indicated that at Vizhinjam the peak spawning might be during May-July or August, the monsoon period. It would appear that spawning takes place a little earlier along the southern Kerala Coast than that in the northern Kerala and Karnataka.

### Recruitment

The success of the oilsardine fishery along the southwest coast is mainly dependent on the recruitment strength of early juveniles (5-10 cm) during the postmonsoon months. Juveniles start appearing from late August and from then onwards form the mainstay of the fishery in the southern regions. Juveniles appear in the fishery from late September in the northern regions. The main

when early juveniles and mature fish occur in abundance, it would have some beneficial effect on recruitment.

### Age and growth

At Mangalore, in the beginning of the fishery early in September, adult fish appear in large numbers and by the end of September juveniles start appearing in the fishery. From October onwards recruitment of juveniles intensifies and

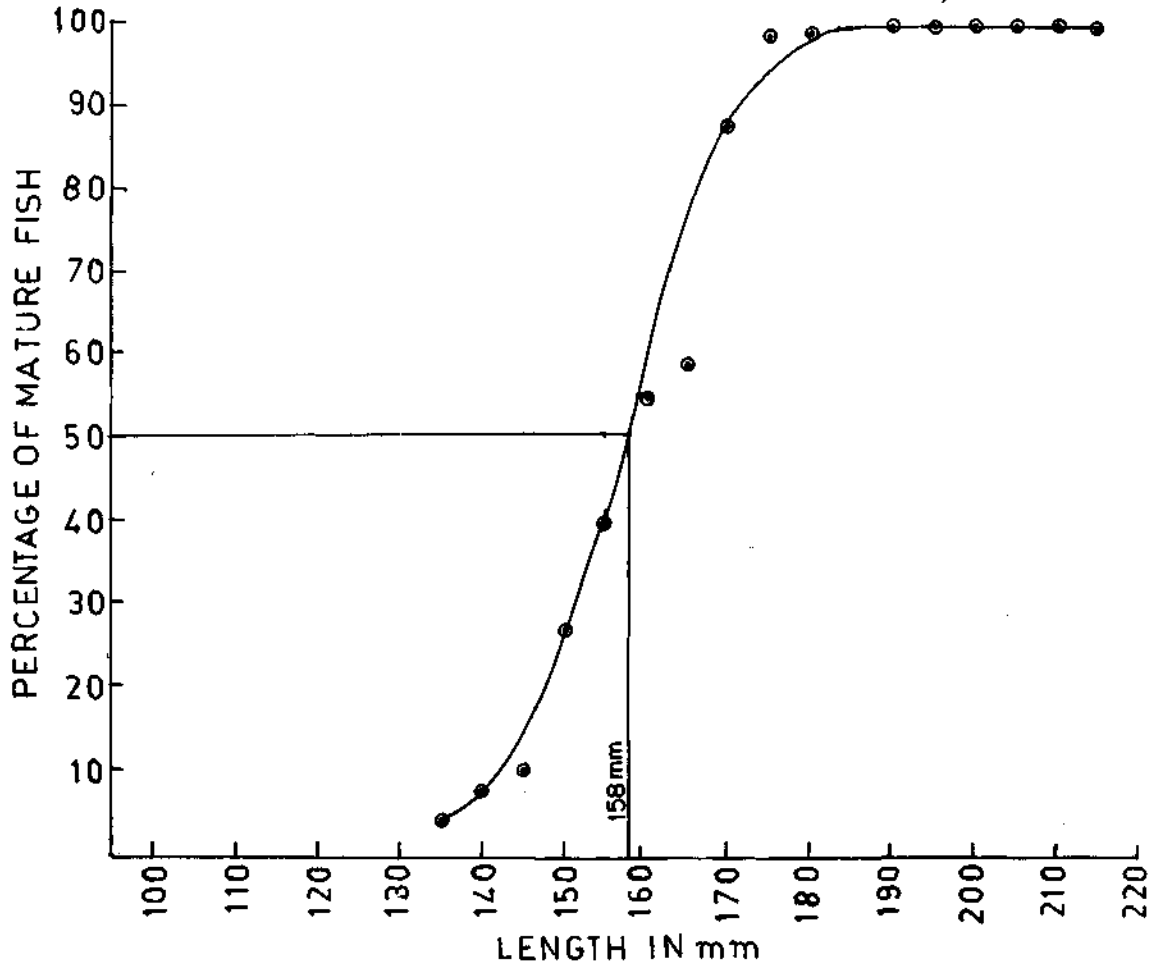


Fig. 6. Length at first maturity of oilsardine at Mangalore.

reason for the failure of the oilsardine fishery in 1986 at Mangalore was the failure of recruitment of juveniles during September-November. But in the following years recruitment of juveniles was very good and a record production of 9713 t was estimated in November alone. Oilsardine was recorded in *Matubala* catches at Mangalore only during monsoon season of 1987 and juveniles in strength were seen during August itself. Since purse seining is prohibited from June to August

fishes of wide range of length are observed in the catches. The modal sizes in the pooled frequency data for the quarterly periods of four years from 1984-85 to 1987-88 are presented in Fig. 7. The growth pattern of the different broods of oilsardine born in different years is evident from the progression of their modal sizes in the fishery at Mangalore. It is seen that brood 'A' attained a modal size of 125 mm, 170 mm, and 195 mm by the end of 12, 24 and 36 months respectively. Similarly the brood

TABLE 12. Seasonwise percentage of adult fish in different stages of maturity from February 1984 to January 1988 at Mangalore

Season/year	No. of fish examined	Immature/Resting	Maturity stages Maturing	Mature	Spent
<b>1984-85 (Annual)</b>	(871)	(45.74)	(6.77)	(35.07)	(12.42)
Premonsoon	436	44.50	13.53	34.63	7.34
Monsoon	-	-	-	-	-
Postmonsoon	435	46.97	0.00	35.50	17.53
<b>1985-86 (Annual)</b>	(1165)	(52.65)	(11.63)	(30.99)	(4.73)
Premonsoon	314	38.22	23.25	36.94	1.59
Monsoon	-	-	-	-	-
Postmonsoon	851	67.10	0.00	25.03	7.87
<b>1986-87 (Annual)</b>	(390)	(21.21)	(27.11)	(45.76)	(5.92)
Premonsoon	165	42.42	40.00	11.52	6.06
Monsoon	-	-	-	-	-
Postmonsoon	225	0.00	14.22	80.00	5.78
<b>1987-88 (Annual)</b>	(508)	(25.93)	(29.20)	(37.71)	(7.16)
Premonsoon	89	10.11	56.18	29.22	4.49
Monsoon	60	0.00	18.33	75.00	6.67
Postmonsoon	359	67.69	13.09	8.91	10.31

'B' grew to a modal size of 135 mm and 165 mm, and brood 'C' to 125 mm and 161 mm at the end of 12 and 24 months respectively. Brood 'D' attained a size of 130 mm by the end of 12 months. It would thus appear that the species grows to an average size of 128 mm, 166 mm and 195 mm by the end of first, second and third year of life at monthly growth rate of 10.67 mm, 3.17 mm and 2.42 mm respectively.

The size distribution of oilsardine at Vizhinjam in relation to the monsoon is given in Fig. 8. In the premonsoon period, the size range was 135-210 mm with a major mode at 165 mm. In the monsoon period, the frequency showed almost bimodal distribution. The size ranged between

105 mm and 205 mm and the main modes were at 120 mm and 160 mm. The commercial fishery was mainly dependant on 140-185 mm size group to which 73.5% of the fish belonged. In postmonsoon period the size range was 105-220 mm and the frequency showed a trimodal pattern with major modes at 125 mm, 165 mm and 195 mm. The commercial catch was represented by two groups, one in the size of 135-165 mm forming 39.1% and the other 185-200 mm forming 32.3%. Young fish below the size of 140 mm was present in the monsoon and premonsoon periods.

#### Seasonal abundance of different age groups

At Karwar, the premonsoon fishery was mainly supported by one and two year old fishes in 1984-85, three year olds in 1985-86, and zero and one year groups in 1986-87, while there was almost equal representation of zero, one and two year groups in 1987-88. The monsoon fishery was supported by two and three year old fishes during 1987-88. The postmonsoon fishery was constituted by zero year group fish.

The percentage age composition at Mangalore during the three season is given in Table 14.

TABLE 13. Estimated number ( $10^4$ ) of adults in the landings and percentages of gravid and spent females at Calicut

Year	1984-'85	1985-'86	1986-'87	1987-'88	1988 (Upto) Aug.	Average
Estimated number of adults	6595	4454	1205	8079	66	4080
Gravid (%)	5.9	8.6	2.6	0.9	0.2	4.7
Spent	13.6	7.3	11.2	13.7	16.1	11.9

It is evident from the Table that during the premonsoon season one year old fishes contributed heavily to the fishery during the years 1984, 1987 and 1988 while in 1985 two year class and in 1986 0+ year old fish dominated in the fishery. In monsoon season of 1987, 0+ year old fish occurred

lowest was in 1986-87 (4068<sup>104</sup>). The 0-year group dominated the landings during the postmonsoon months in all the years except 1985-86 when there was good landings of juveniles during the monsoon (Table 16). The strength of 1+ year group was moderately high during the premonsoon and post-

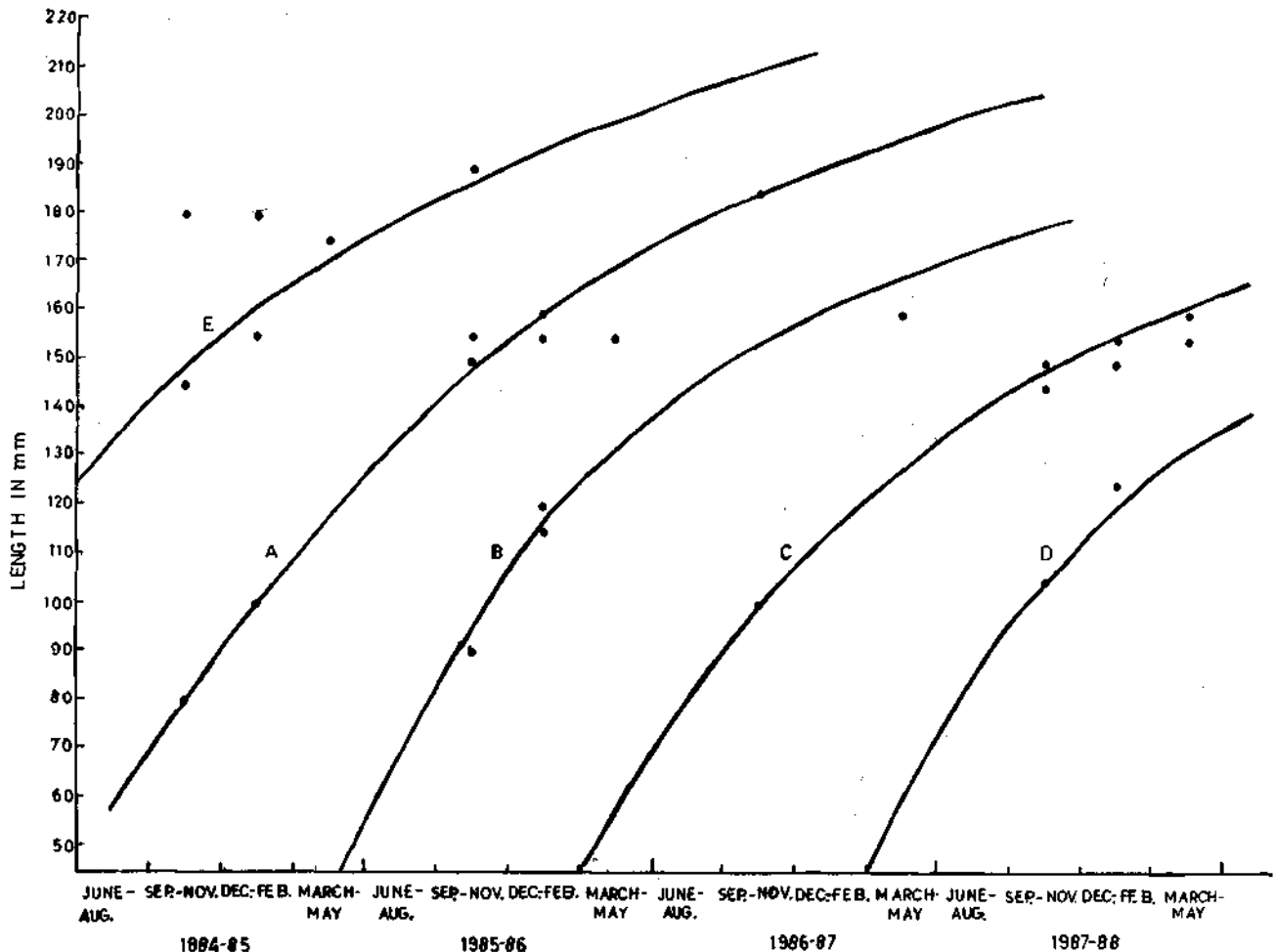


Fig. 7. Quarterly distribution of modal lengths of oilsardine at Mangalore.

in good quantities. During postmonsoon season in 1984, 0+ age group made the bulk, during 1985 one year old fish dominated, during 1986 two year olds dominated and during 1987 one year olds contributed heavily to the fishery.

The annual estimated average number of 0-year group in the landings at Calicut was 10627<sup>104</sup> whereas, the strength of 1+ year, 2+ year and above 2+ year age groups constituted 2574<sup>104</sup>, 1445<sup>104</sup> and 61<sup>104</sup> respectively, the annual landings being 14707<sup>104</sup> (Table 15). The largest number of oilsardine landed was in 1984-85 (33988<sup>104</sup>) and the

monsoon of 1984-85 and postmonsoon of 1985-86 and 1987-88 and generally very low during the monsoon in all the years except in 1987-88. The percentage of 1+ year old fish during 1987-88 was the highest among all the years despite the fact that the preceding year 1986-87 witnessed the lowest annual landings. The high landings of oilsardine during the postmonsoon months of September to January indicated indiscriminate exploitation of juveniles and potential spawners and consequent decline in recruitment in the ensuing spawning period.

TABLE 14. Age composition (%) of oilsardine during premonsoon, monsoon and postmonsoon period from February 1984 to January 1989 at Mangalore

Seasons/years	Age classes			
	0+ year	1 year	2 year	3 year
<b>1984-85 (Annual)</b>	(38.81)	(52.20)	(8.95)	(0.04)
Premonsoon	4.70	90.49	4.81	0.00
Monsoon	-	-	-	-
Postmonsoon	72.92	13.91	13.10	0.07
<b>1985-86 (Annual)</b>	(26.87)	(34.24)	(38.33)	(0.57)
Premonsoon	18.51	22.24	59.25	0.00
Monsoon	-	-	-	-
Postmonsoon	35.22	46.24	17.40	1.14
<b>1986-87 (Annual)</b>	(35.86)	(20.94)	(42.90)	(0.30)
Premonsoon	55.07	41.11	3.82	0.00
Monsoon	-	-	-	-
Postmonsoon	16.66	0.76	81.97	0.61
<b>1987-88 (Annual)</b>	(36.13)	(60.74)	(3.04)	(0.09)
Premonsoon	0.00	98.86	1.14	0.00
Monsoon	81.84	12.90	5.00	0.26
Postmonsoon	26.54	70.47	2.99	0.00
<b>1988-89 (Annual)</b>	(53.52)	(42.23)	(4.25)	(0.00)
Premonsoon	27.66	69.16	3.18	0.00
Monsoon	-	-	-	-
Postmonsoon	79.37	15.30	5.33	0.00

The estimated number of young oilsardine given in Table 17 shows that immature oilsardine of 0-year group constituted 50.8% (1987-88) to 85.5% (1988) of the annual landings in different years with an annual average of 72.3%. The percentage of juveniles landed by *Pattenkolli* varied from 19.4% (1984-85) to 85.5% (1988) in the annual total landings with an average of 32.1%. The percentage of juveniles landed by *Nethal vala* varied from 9.5% (1986-87) to 61.2% (1984-85) of the annual total landings with an annual average of 40.2%. The majority of the landings of juveniles were during the postmonsoon, both by *Pattenkolli* (21.9%) and *Nethal vala* (29.9%) and the lowest during the premonsoon (5.2%).

#### Instantaneous rate of mortality

Jackson's (1939) method has been applied for estimating value of instantaneous rate of mortality

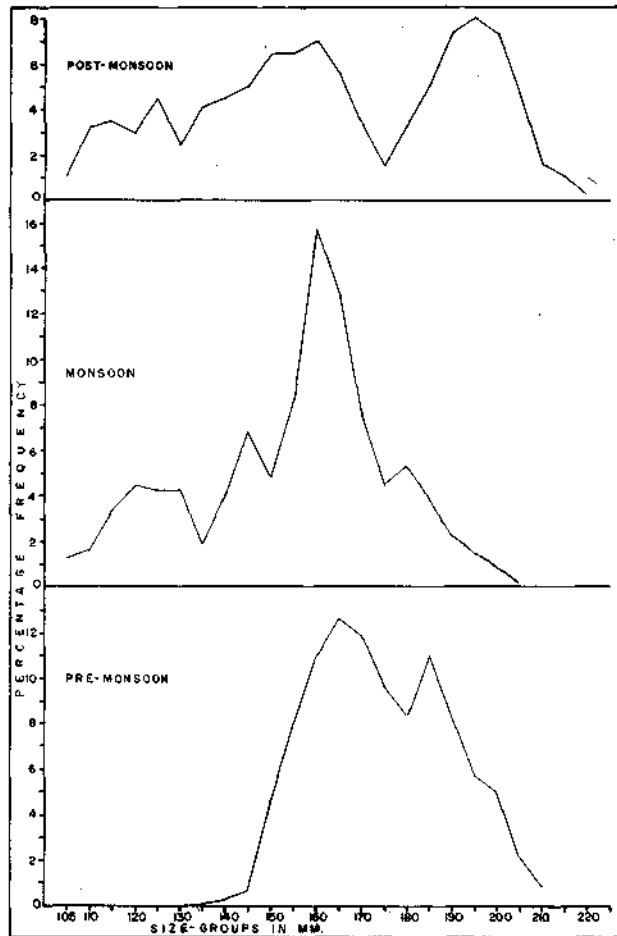


Fig. 8. Size frequency of oilsardine in different seasons (% frequency) at Vizhinjam.

(Z) at Mangalore. The value of Z was estimated as 3.05 for 1984-85/1985-86, 2.65 for 1985-86/1986-87 and 4.03 for 1986-87/1987-88. The average instantaneous rate of total mortality (Z) was 2.99.

Dhulkhed and Uma Bhat (1985) estimated annual rate of survival as 0.1 and the instantaneous rate of mortality (Z) as 2.3 for 1977-1981 oilsardine fishery by purse seine. When traditional gear *Rampani* was in operation at Mangalore, the Z value

TABLE 15. Estimated number ( $10^4$ ) of oilsardine by age in the landings at Calicut during 1984-'88

Age	1984-'85	1985-'86	1986-'87	1987-'88	1988 (upto August)	1984-1988 Average
0 year	27393	14153	2863	8337	390	10627
1 + year	3754	2464	968	5648	36	2574
2 + year	2744	1828	215	2416	21	1445
Above 2 + year	97	162	22	15	9	61
Total	33988	18607	4068	16416	456	14707

TABLE 16. Seasonwise estimated number ( $10^4$ ) of oilsardine by age in the landings at Calicut during 1984-'88

Age	1984-85			1985-86			1986-87			1987-88			1988 (upto August)	
	Pr	M	P	Pr	M	P	Pr	M	P	Pr	M	P	Pr	M
0 year	1631	-	25762	686	8098	5369	1389	41	1433	49	2766	5522	86	304
1 + year	2200	214	1340	328	399	1737	930	11	27	1007	1440	5201	20	16
2 + year	1269	530	945	318	389	1121	170	30	15	46	370	-	-	21
Above 2 + year	10	7	80	4	32	126	17	-	5	5	10	-	-	9
Total	6110	751	27127	1336	8918	8353	2506	82	1480	1107	4586	10723	106	350

was low and varied between 1.66 (Sekharan and Dhulkhed, 1963) and 1.3 (Prabhu and Dhulkhed, 1970). Thus the higher value of  $Z$  of the oilsardine in recent years is indicative that its population is subjected to heavy fishing pressure by the purse-seine fleet off the Mangalore Coast.

#### *Trend in the fluctuations in the catch in relation to the monsoons*

Considerable seasonal and annual fluctuations in the abundance of oilsardine have been observed all along the southwest coast. Analysis of the data for the period 1984-88 showed that at all major landing centres the highest catch was obtained during the postmonsoon period of September to January and the lowest catch was during the monsoon months of June to August. Examination of the data on rainfall, total oilsardine catches, fishing effort and catch rate at Mangalore during the premonsoon, monsoon and postmonsoon periods did not reveal any consistent relationship.

On annual basis also there was no relation between the rainfall and catch or catch rate in the oilsardine fishery at Mangalore.

At Calicut, the oilsardine landings were highest in 1984-85 (2718 t) when the rainfall was the highest (3070 mm) (Table 18). The lowest catch was in 1986-87 (625 t) when there was moderate rain (2514 mm), but the catch was better in 1987-88 (2065 t) when the rainfall was the lowest (1899 mm). When considering the rainfall in the monsoon season of all the years, rainfall was the lowest in the monsoon of 1987-88 (1026 mm), but the catch was the highest during that period (575 t). The highest monsoon rainfall was in 1985-86 (2075 mm) when the catch during that season was fairly good (434 t). During the postmonsoon, the rainfall though highest in 1987-88 (771 mm), catch during the season was only 1429 t, whereas the catch during the postmonsoon was highest in 1984-85 (1650 t) when the rainfall was moderate (611 mm). Figure 9 gives the average monthly oilsardine

TABLE 17. Seasonal abundance in number ( $10^4$ ) of young oilsardine below 140 mm and percent to the total oilsardine landings at Calicut during 1984-85-1988

Season	1984-'85		1985-'86		1986-'87		1987-'88		1988 (upto August)		Average	
	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%
<i>Pattankolli</i>												
Premonsoon	1631	4.8	686	3.7	1389	34.1	49	0.3	86	18.8	768	5.2
Monsoon	-	-	3294	17.7	41	1.0	-	-	304	66.7	728	5.0
Postmonsoon	4962	14.6	5369	28.9	1045	25.7	4718	28.7	-	-	3219	21.9
Annual	6593	19.4	9349	50.3	2475	60.8	4767	29.0	390	85.5	4715	32.1
<i>Nethal vala</i>												
Premonsoon	-	-	-	-	-	-	-	-	-	-	-	-
Monsoon	-	-	4804	25.8	-	-	2766	16.9	-	-	1514	10.3
Postmonsoon	20800	61.2	-	-	388	9.5	804	4.9	-	-	4393	29.9
Annual	20800	61.2	4804	25.8	388	9.5	3570	21.8	-	-	5912	40.2
Total	27393	80.6	14153	76.1	2863	70.3	8337	50.8	390	85.5	10627	72.3

landings and rainfall at Calicut and surface temperature and salinity in the inshore fishing grounds for the period 1984 February to 1988 August. The average monthly rainfall was highest during June (922 mm) followed by July (560 mm). The fishery was generally high from September to January and very low from April to June. The values of average surface water temperature and salinity ranged from 27.0°C to 28.2°C and 31.9‰ to 33.35‰ during the postmonsoon months of September to December when the oilsardine landings were also higher. The surface temperature and salinity for the monsoon months of June, July and August are not available, but these are likely to be slightly lower than in the other months due to the rains. Even though the rainfall and oilsardine landings during different seasons did not show any direct relationship, it could be generalised that the oilsardine landings were better two or three months after fairly heavy rains when the surface temperature and salinity were somewhat lower. It was also seen that both higher temperature and higher salinity normally from January were associated with decrease in oilsardine landings. Prabhu and Dhulkhed (1970) stated that the best catches of oilsardine at Mangalore area were during September to December when the temperature and salinity ranged from 25.5°C to 28.6°C and 28.98‰ to 34.36‰ respectively. According to Suresh and Reddy (1980), good catches of oilsardine at Mangalore Coast in 1967-77 were in September to March when the temperature ranged from 27.7°C to 29.9°C and surface salinity ranged between 32.6‰ and 34.9‰. Thus it is seen that intermediate values of surface temperature and salinity together with fairly strong monsoon which enrich the nutrient supply in the surface and subsurface layers of the sea would be favourable for good oilsardine fishery.

The analysis of the oilsardine landings and rainfall data at Cochin showed that fairly good rain during the monsoon probably had some positive

impact on the abundance of juvenile oilsardine during the succeeding postmonsoon months. Reduced rain fall intensity might have an adverse impact on the shoal formation at the surface. Murty and Edelman (1970) suggested that monsoon intensity above a critical value was favourable for the enrichment of the sea by nutrients and oxygen which in turn would result in higher oilsardine landings.

At Vizhinjam, the premonsoon period was the peak season for oilsardine fishery and postmonsoon was the lean period. This indicated that here the fishery was dependant on the northeast monsoon in October-December and hence a good fishery after that in the ensuing premonsoon period of February-May.

#### DISCUSSION

The present low level of total landings of oilsardine in the inshore coastal belt upto 30 m depth zone all along the southwest coast during the period 1984-88 clearly indicates that there is considerable decline in the landings over the years. The postmonsoon period is the most productive period for oilsardine fishery. In spite of the increase in effort, there has not been any increase in the total oilsardine landings which shows that the yield is not commensurate with the increase in effort. There is only a downward trend in the total oilsardine landings and the catch per effort with the adoption of ring seines and purse-seines which implies that the traditional sector has been adversely affected.

Examination of the data on rainfall, total oilsardine catch, fishing effort and catch rate during the premonsoon, monsoon and postmonsoon periods at Mangalore, Calicut and Cochin did not reveal any consistent relationship. On annual basis also, there was no correlation between the rainfall and catch or catch rate in the oilsardine fishery.

TABLE 18. Seasonal rainfall (mm) and oilsardine landings (tonnes) at Calicut

Season	1984-'85		1985-'86		1986-'87		1987-'88		1988-'89	
	Rainfall	Catch	Rainfall	Catch	Rainfall	Catch	Rainfall	Catch	Rainfall	Catch
Premonsoon	484	861	369	101	101	503	102	61	362	14
Monsoon	1969	207	2075	434	1756	21	1026	575	2010	49
Postmonsoon	617	1650	333	1545	657	101	771	1429	-	-
<b>Total</b>	<b>3070</b>	<b>2718</b>	<b>2777</b>	<b>2080</b>	<b>2514</b>	<b>625</b>	<b>1899</b>	<b>2065</b>	<b>2372</b>	<b>63</b>



Studies on growth and age revealed that oilsardine grows to 128 mm in the first year, 166 mm in the second year and 195 mm in the third year of its life with monthly growth rate of 10.67 mm, 3.17 mm and 2.42 mm at respectively. Size at first maturity has been estimated at 158 mm at Mangalore. Data on maturity indicate that the species has protracted spawning season from May to October. Mature fishes are generally available in good numbers during late premonsoon period and monsoon period. Whenever catches of breeders have been during May-June, oilsardine fishery in premonsoon months are also very good. Good concentration of spawners in the coastal waters off the coast just at the onset of monsoon appears to be a good indicator for better recruitment and good production in the postmonsoon period.

The oilsardine resources off the southwest coast appear to be under heavy fishing pressure by purse-seine fleets as evident from the high instantaneous mortality rate (Z) of 2.99 in recent years. In spite of an increasing trend in purse-seine operations in Cochin and Southern Karnataka, there has

been no increase in the total oilsardine landings of Kerala and Karnataka (Silas *et al.*, 1986). According to Alagaraja *et al.* (1982), the purse-seine operations have increased the landings in Karnataka, but this increase is not reflected in the total landings. Decline in the total oilsardine landings and the increase in the purse-seine and ring seine catches only indicate that their operations have affected the catches of indigenous gears operating in the nearshore waters in all the regions. Fishery dependant factors like rate of exploitation and size at capture seem to have a greater impact on the available stocks and recruitment of oilsardine than fishery independant factors. Unrestricted operations of purse-seines and ring seines would not only be detrimental to the fishery, but also would adversely affect the catches by traditional gears and the activities of the artisanal fishermen. Decline in the total oilsardine catches during the past few years clearly indicates that adverse effects on the traditional sector have already set in. Conflict has already started between indigenous operations and purse-seine/ring seine operators in the fishing grounds.

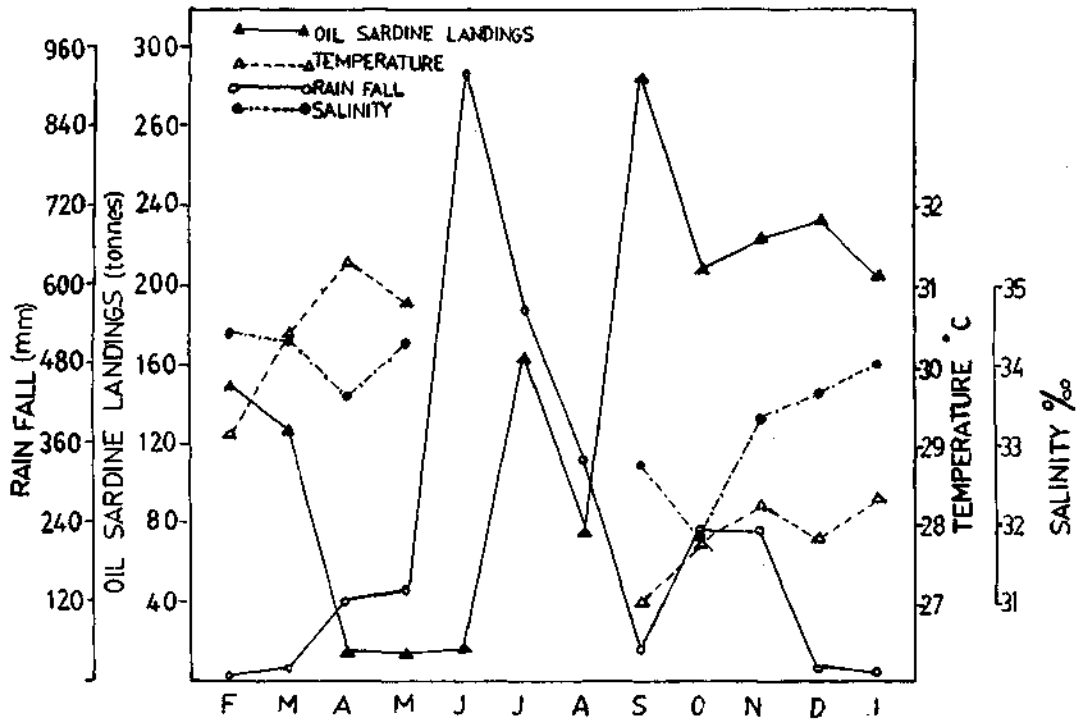


Fig. 9. Oilsardine landings, rainfall, temperature and salinity at Calicut (Pooled data 1984-88).

## CONCLUSIONS

Large scale indiscriminate fishing for juveniles of oilsardine by purse-seine and ring seine in Kerala and Karnataka will have dangerous repercussions on the future yield from the fishery. To protect the resource and to increase the total annual yield in future, such indiscriminate fishing practices should be controlled. Considering the adverse impact of purse-seine and ring seine operations, it is suggested that measures as indicated below will ensure sustainable yield from the fluctuating oilsardine resources and safeguard the interests of the traditional sector which is labour intensive by giving better economic returns.

1. The cod end mesh size of boat seines (*Pattankolli*

type) operated by country crafts should not be less than 13 mm.

2. The number of purse-seines and ring seines (mini purse seines) now being operated in Kerala, Karnataka and Goa may be reduced by 50%. The mesh size should not be less than 14 mm. The operations by purse-seines and ring seines should be permitted only from October to March.

3. Simulated commercial fishing operations and monitoring the exploited stocks have to be made at regular intervals and environmental factors such as rainfall, temperature and salinity have to be studied to ascertain the abundance of the oilsardine population and for taking suitable management measures to sustain the fishery.

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