CMFRI
Special Publication
Number 30

SEMINAR ON POTENTIAL MARINE FISHERY RESOURCES

April 23, 1986

Central Marine Fisheries Research Institute
(Indian Council of Agricultural Research)
P. B. No. 2704, E. R. G. Road, Cochin-682 031, India
October 1987

SEMINAR ON POTENTIAL MARINE FISHERY RESOURCES

CMFRI Special Publication
Number 30

Central Marine Fisheries Research Institute
(Indian Council of Agricultural Research)
P. B. No. 2704, E. R. G. Road, Cochin-682 031, India
October 1987

Published by

P. S. B. R. JAMES
Director
Central Marine Fisheries
Research Institute
P. B. 2704, Cochin 682031
India

Compiled by

M. S. RAJAGOPALAN
Scientist S-3
Central Marine Fisheries
Research Institute
Cochin 682031

Printed at
Amarakerala Industries, Cochin 18

POTENTIAL MARINE FISHERY RESOURCES

K. M. JOSEPH AND M. E. JOHN
Department of Agriculture, Fisheries Division, Govt. of India, New Delhi-110 001

INTRODUCTION

Among the countries bordering the Indian Ocean, India has strategic advantages in exploitation of marine fish resources with its long coast line of 6100 km and rich and varied fishery resources within 2.02 million sq. km Exclusive Economic Zone. The present marine fish production of 1.85 million tonnes is less than half of the conservative potential estimate of 4.2 million tonnes (George *et al*, 1977). The trends in marine fish landings of past few years indicate that the coastal fisheries viz. oil sardine, mackerel, Bombay duck and penaeid and non-penaeid prawns may not contribute significantly for further increase in marine fish production of our country. Hence, while monitoring the resources for management of these stocks for conservation as well as exploitation up to the sustainable-yield level, we have to be on the look out for new potential resources in our EEZ.

Having assessed the demersal fisheries resources from the coastal areas within 70 m depth along east and west coasts at 1.71 million tonnes (Joseph, 1980) and about 0.15 million tonnes from 55-360m depth along north-west coast (Anon, 1979 and Bapat *et al*, 1982), Fishery Survey of India, since 1980, has been making all efforts to locate new fishing grounds and resources in our EEZ.

Results of the surveys conducted by the exploratory survey fleet in a number of sections of the EEZ for assessing demersal, pelagic and oceanic resources have been examined to provide knowledge on possible avenues of increasing fish production.

The marine fishery resources could be categorised into exploited, under-exploited and un-exploited resources. Among the under-exploited resources perches, nemipterids, carangids, lizard fish, catfish, barracuda, squids and cuttle fish along both the coasts and mackerel and lesser sardines along east coast could be mentioned. Of the un-exploited potential stocks, 'black ruff', 'big eye', Indian drift fish and deep sea crustaceans are few of the deep water resources recently located. There is no organised fishing by India for oceanic resources, viz, tuna and allied species and pelagic sharks, excepting the skipjack fishing around Lakshadweep islands. The recent long line survey for the larger pelagics have indicated possible commercial fishing in seas around India.

The major survey projects undertaken by Fishery Survey of India during 1980–85, the regions investigated under each project and details of the vessels deployed thereon are given in appendix-I.

UNDER-EXPLOITED DEMERSAL RESOURCES

The shrimp oriented growth of marine fisheries sector in India has left several parts of EEZ not supporting commercially viable concentration of crustacean stocks as unexploited. Besides, several species having protracted distribution over the continental shelf are exploited only up to about 50m depth owing to the limited operational range of large majority of mechanised trawlers.

The survey data collected by Fishery Survey of India vessels from different regions of Indian coast are examined and catch per unit effort of the major species/groups including the exploited stocks are furnished in Table 1.

Perches

Principally consisting of serranids, lutjanids and lethrinids, the group perches offer immense scope for increased exploitation along both the coasts. George *et al* (1977) has estimated potential yield of 2.5 lakh tonnes from Indian waters whereas

Table 1: Species-wise catch per unit effort obtained in demersal trawl survey from different regions of Indian coast

Species/group	Catch per hour (kg)				
	North-West coast	South-West coast	Wadge Bank &Gulf of Mannar	Lower east coast	Upper east coast
Elasmobranchs	44.46	4.73	12.67	6.70	10.65
Catfish	11.68	12.82	14.07	7.25	40.22
Perches	21.56	1.50	27.69	11.55	11.50
Pomfret	15.10	0.19	1.61	2.19	4.61
Ribbon fish	28.45	0.79	0.72	2.53	3.50
Sciaenids	30.09	0.14	0.38	9.57	16.04
Leiognathids	0.98	1.31	3.43	13.44	0.64
Nemipterids	25.49	30.15	17.40	6.56	10.92
Lizard fish	3.86	10.75	5.04	0.77	0.01
Caranx sp	3.78	3.58	8.70	8.96	7.10
Other carangids	20.95	9.63	3.90	15.83	26.65
Barracuda	0.81	1.19	7.13	3.02	3.37
Mackeral	1.19	1.56	2.56	5.75	28.26
Clupeids	5.03	0.48	0.57	5.17	10.87
Psenus indicus	0.10	6.72	1.38	9.51	5.21
Priacanthus sp.	0.23	12.69	5.21	7.08	9.32
Centrolophus sp.	—	21.60	0.21	1.80	0.71
Other deep sea fishes	—	7.09	0.02	0.21	0.18
Deep Sea prawns	—	3.00	0.14	0.78	0.05
Deep Sea lobster	—	8.83	0.25	0.10	—
Cephalopods	12.58	5.18	5.80	1.07	1.15
Other varieties	99.96	6.90	10.75	8.66	25.62
Total	331.30	132.80	129.63	128.50	228.45

the present landing is only about 12% of the estimate. Catch rate of this group obtained from the different regions and depth zones of Indian coast are given in Table 2.

Table 2: Catch per hour (kg) of perches in different regions and depth zones

Depth range (m)	North-west coast	South-west coast	Wadge Bank & Gulf of Mannar	Lower east coast	Upper east coast
Below 50	24.66	4.36	61.79	12.41	12.74
50-100	21.90	1.76	38.60	13.84	13.45
100-200	6.12	2.08	21.60	7.67	4.20
200-500	—	0.18	1.30	—	—

Wadge Bank indicated to have an encouragingly high density of perches, with catch rate of 67 kg/h. A highly productive perch ground yielding on an average 94.26 kg/h was located south-east of Cape Comorin below 50m depth. During July-September catch rate of perches obtained from this area was 153.4 kg/h and in April-June 130.7 kg/h. This conspicuous seasonal variation in yield pattern has been attributed to the presence of two stocks viz. the resident stock which is present on the fishing ground throughout the year and the migrant stock that appears on the bank during south-west monsoon (Sivalingam & Medcof, 1957; Sivalingam, 1969). In Gulf of Mannar higher concentration (26.5 kg/h) was recorded in 50-100 m depth zone. Along west coast Menon & Joseph (1969) have observed possibilities of handling fishing for serranids in the rocky patches beyond 60 m depth of Kerala coast. Survey of *M. T. Murena* in north-west coast indicated the highest catch rate of rock cods in lat 19° between 125-360 m depth yielding 43.5 kg/h in February-April. The group occured in fairly good concentration along east coast where average catch rate of 12-14 kg/h was recorded from areas up to 100 m depth.

Nemipterids

Nemipterids form one of the major components of trawl catches in west coast, contributing 38.7% in Kerala coast, 21.9% in Karnataka coast, 22.3% in Maharashtra coast south of Bombay and 23.8% in Wadge Bank. In east coast it formed rather low proportion making up 2.4% to 6.6% of trawl catch. The relative abundance represented by catch per hour of nemipterids obtained from the various depth strata of different regions is furnished in Table 3.

Table 3. Catch per hour (kg) of perches in different regions and depth zones.

Depth Range (m)	North-west coast	South-west coast	Wadge Bank & Gulf of Mannar	Lower east coast	Upper east coast
Below 50	10.88	26.68	3.64	2.88	6.66
50-100	30.52	18.75	14.81	9.71	14.32
100-200	44.20	66.90	81.77	13.38	4.81
200-500	—	—	2.87	—	—

From the table it will be seen that the highest yield of nemipterids was obtained from 100-200 m strata of Wadge Bank and Gulf of Mannar. Taken for Wadge Bank alone excellent catch rate of 425-430 kg/h has been reported between 70-100 fm. (128-183 m) depth with the nemipterid concentration reaching as high as 13.6 tonnes per sq. mile (Joseph *et al*, in press). It was observed that nemipterids enjoy dense distribution along the west coast in 100-200 m depth belt up to Maharashtra coast with peak catches in southern extremity of shelf gradually declining northwards. Stock from this zone is virtually unexploited and has good scope for exploitation.

Carangids

The landings of carangids comprising *caranx spp*, scads, horse mackeral, *Rachycentron sp.*, *Seriola sp* etc are about 0.43 lakh tonnes against the potential yield estimate of 2.65 lakh tonnes indicating considerable gap between the exploited and exploitable stocks. The survey results indicated that along both the coasts carangids contributed significantly to the demersal stock, forming 19 to 23% of catch in east coast and 15 to 21% in west coast. The group has very wide distribution in the entire shelf area, the choice varieties contributing bulk of catch in demersal landings from inner shelf and scads and horse mackeral chiefly making up the columnar resources in areas upto 200 m depth. Distribution pattern of carangids as revealed from trawl surveys in different regions of Indian coast is given in Table-4.

Table 4. Catch per hour (kg) of carangids in different regions and depth zones

Depth range (m)	North-west coast	South-west coast	Wadge bank & Gulf of Mannar	Lower east coast	Upper east coast
Below 50	7.69	24.87	19.45	13.65	46.11
50-100	14.64	20.85	14.77	39.26	31.77
100-200	77.96	4.31	14.28	33.01	22.82
200-500	—	1.20	0.52	—	—

Lizard fish

Lizard fish was reported from the entire shelf area of west coast with highest average catch of 10.75 kg/h from south-west coast, 5.04 kg/h from Wadge Bank and 3.86 kg/h from north-west coast. Distribution of the species was more concentrated in 100-200 m depth zone with catch rates ranging

from 12 to 25 kg/h. Along south-west coast lizard fish was found to have extended distribution even to the continental slope. The survey observation of Fishery Survey of India vessels indicated availability of lizard fish as furnished in Table 5.

Table 5. Catch per hour (kg) of lizard fish in different regions and depth zones

Depth range	North west coast	South West coast	Wedge Bank & Gulf of Mannar	Lower east coast	Upper east coast
Below 50	1.70	4.62	1.30	0.98	—
50-100	2.41	7.48	12.09	0.78	0.01
100-200	24.81	18 67	12.25	0.40	0.01
200-500	—	9.27	1.02	—	—

Catfishes

Catfishes formed 17.4% of catch in upper east coast, 5.6% in lower east coast, 2.8% in Wadge bank, 9.6% in south-west coast and 3.5% in north-west coast. The current landing is about 0.67 lakh tonnes against the potential yield estimate of 3.1 lakh tonnes. Relative abundance of catfish in different depth zones of various sections of Indian coast is given in Table 6.

Table 6. Catch per hour (kg) of lizard fish in different regions and depth zones

Depth range (m)	North-west coast	South-west coast	Wadge Bank & Gulf of Mannar	Lower east coast	Upper east coast
Below 50	13.31	45.68	11.67	2.53	24.22
50-100	11.98	17.92	3.37	13.62	53.21
100-200	2.59	2.35	0.75	8.34	15.77
200-500	—	—	0.08	—	—

Highest catch rate of 53.21 kg/h was recorded in 50–100 m depth belt of upper east coast followed by 45.68 kg/h from the inner coastal belt of south-west coast. Though the resource within 50m depth is being tapped to some extent, the stock in deeper water extending up to 150m remains largely unexploited.

Pomfrets

Some potentially rich demersal trawl grounds of pomfrets were located in relatively deeper water along both the coasts. In north-west coast it formed 4.6% of demersal catch and higher concentrations (18.83 kg/h) were recorded in 50-100 m depth zone. *M. T. Murena* identified productive grounds of the silver pomfret, *Pampus argenteus*, south of Veravel in 90–125 m depth range yielding 26.5 kg/h in January-February and 25.2kg/hr in September-October. The black pomfret, *Parastomateus niger*, was found to occur in high concentrations in 55-90 m off Bombay with 53.4 kg/h during April-May and 14.7 kg/hr in January-February. In Gulf of Mannar pomfrets contribute 3% of catch, predominantly formed of *P. argenteus* fished from the area 9-79. Maximum yield of 112.9 kg/h was obtained in December followed by 42.9 kg/h in March. Along east coast 1.7 to 2.0% of demersal catch was made up by pomfret, the lat. 15° N and 16° N in 50-100 m depth zone yielding 5.3 kg/h. In the northern latitudes 10.2 kg/h was obtained from the coastal belt within 50 m depth and 4.2 kg/h from 50-100 m range.

The present level of production of pomfret in the country is about 0.53 lakh tonnes and as per the potential yield estimates of George *et al* (1977) there is scope for expanded fishing to increase the production by another 60% of the current level.

Mackerel

In contrast to the dwindling catch trend in west coast mackerel landing has been steadily on the increase in east coast over the past several years. The recent figures of annual catch from the east coast has reached upto 0.2 lakh tonnes, a good percentage of which is reported to be taken by the mechanised trawlers.

From the demersal survey it was observed that distribution of mackerel extends along the entire east coast inside the 100 m contour with increasing catch rates in northern latitudes. In lower east coast it formed 5.4% of catch yielding 6 to 8 kg/h within 100 m depth. 12.4% of catch in upper east coast was formed of mackerel with an average catch rate of 28.3 kg/h. During 1985 *Matsya Darshini* recorded an average catch rate of 105 kg/h in lat. 20°-21°N within 60-120 m depth which formed 61.5% of trawl catch. The area 20-88 yielded the best results, mackeral catch in some of the hauls exceeding 2.5 tonnes. The ocuvrrence of mackerel in considerable magnitude in trawl catches from deeper waters indicates a possibility for development of mackerel fishery along the upper east coast.

Lesser Sardines

Productive areas of lesser sardines were identified in trawl surveys during 1983 and 1984 from the deeper waters along upper east coast. An average yield of 42 kg/h was obtained from the area 17-82 while the adjacent estern square recorded catch rate of 109 kg/h. The abundance was predominantly in 50-110 m depth range with peak concentration (123 kg/h) in 71-100 m belt. Though possibilities of higher production of this group from other sections of Indian coast is only marginal, it appears to have promising potential in the deeper waters of upper east coast.

Cephalopods

The interest of fishing industry for squids and cuttle fish is on the increase with some of the foreign markets quoting highly lucrative offers. The group which formed less than 0.1% of total marine landing during early seventies now represents over 1% of the catch landed. Being the principal target group, cephalopods are taken in sizeable quantity by the foreign trawlers operating in Indian waters under joint venture programmes. Survey reports indicate the cephalopods forming 4.1% of demersal catch from west coast and 0.6% from east cost. The general distribution pattern is given in Table 7.

Table 7. Catch per hour (kg) of Cephalapods from different regions and depth zones

Depth Range (m)	North west coast	South west coast	Wadge Bank & Gulf of Mannar	Lower east coast	Upper east coast
Below 50	9.22	3.33	6.97	0.66	1.30
50-100	14.81	6.80	9.04	1.06	1.19
100-200	8.02	6.00	3.34	1.05	—
200-500	—	0.04	0.33	3.86	0.90

Further examination of survey results revealed certain sections of Kerala coast, Maharashtra coast as well as Gujarat coast in 60–30 m depth yielding very high catch rates. Wadge Bank stock was characterised by the dominance of conspicuously large specimen of *Sepia pharaonis*. Sulochana & John (1983) have identified two productive grounds off Quilon and Calicut-Ponnani area along Kerala coast. The most recent observations of Matsya Nireekshani in October 1985 indicated the cephalopod component of above 200 kg in many of the hauls taken between 8°N and 11° N in 60–80 m depth. The most productive haul yielded 1.5 tonnes cuttle fish from the area.

In spite of the recent progressive trend, current landing of the group is only about 0.15 lakh tonnes as against the potential yield estimate of 1.8 lakh tonnes indicating possibility of a promising export oriented fishery.

Other Exploited Resources with Further Potential

Apart from the stocks described in the foregoing there are few other species/groups, as indicated in Table 8 below, with possibilities of increased exploitation by at least 50% or more of the current level of production, with extension of fishing effort to the outer shelf areas.

Table 8. Current landing, potential yield and area of occurance of other exploited resources having further potential.

Species/ group	Average landing for 1983 & '84 (lakh t.)*	P.Y estimate (lakh t.)	Main region of **occurance	Main depth of occurance (m)	Catch per hr. (kg)
Sciaenids	1.1	2.1	Upper east coast	50–100	24.3
			Lower east coast	50–200	20.8
Ribbon fish	0.6	2.7	North west coast	50-200	27.2
Barracuda			Gulf of Mannar	100-200	90.0
Elasmobranchs	0.5	3.1	Gulf of Mannar	100-200	48.3
			North west coast	upto 100	41.6

* Hand book on Fisheries Statistics 1985 (M,S) Ministry of Agriculture & Rural Development, N. Delhi.

** Potential yield estimate by George *et. al.* (1977)

UNEXPLOITED DEEP SEA DEMERSAL RESOURCES

The fish stocks in peripheral shelf area and continental slope along both west coast and east coast are totally unexploited. In contrast to the multiplicity of species in coastal regions the demersal resources in outer shelf and slope are comprised of a few non-conventional species viz. "Big eye", "Black ruff", "Green eye" *Cubiceps sp, Epinnula sp* etc. and the deep sea crustaceans. Oommen (1985) has estimated the standing stock of deep sea fishes in south west coast between lat 7° to 13° as 8136 tonnes and that of deep sea crustaceans as 18146 tonnes.

"Black Ruff"

The "black ruff", *Centrolophus niger*, is the major component of deep sea resource in south-west coast contributing 21.6% of aggregate catch. The distribution of this species was found to be highly concentrated in areas beyond 200 m between lat 8° and 13° N. Joseph (1986) has reported an average catch of 158 kg/hr of this species from 200–500 m depth zone along Karnataka coast

which represents 68.9% of catch. Proportion of the species from Kerala coast between lat 8°-11° N within the same depth range was also quite significant (59.6%). The same depth zone in lower east coast yielded catch rate of 27.5 kg/hr whereas only trace quantities were obtained from upper east coast and north west coast. The size range of the species was 7-18 cm with modal class 12-14 cm.

"Big Eye"

Priacanthus spp. popularly known as "Big eye" or "Bull eye" is another potential deep water resource located all along south west coast and east coast in 50-400 m depth with peak concentration in 100–200 m. The average catch rates obtained from the different sections and bathymetric zones of the surveyed area are given in Table-9.

Table 9. Catch per hour (kg) of "Bull eye" obtained from different regions and depth zones.

Depth range (m)	North-west coast	South-west coast	Wadge Bank & Gulf of Mannar	Lower east coast	Upper east coast
Below 50	—	12.37	0.45	0.03	—
50-100	0.28	10.22	1.62	1.17	6.09
100-200	0.78	19.05	4.88	49.09	44.23
200-500	—	8.74	1.69	7.59	3.14

The group made up 9.6% of catch in south-west coast 4.02% from Wadge Bank and Gulf of Mannar, 5.46% from lower east-coast and 4.08% from upper east coast.

The genera was represented by four species viz. *Priacanthus hamrur, tayenus, P. cruentatus* and *P. arenatus.* Highest catch rates were obtained from south west coast during April-June and from east coast during December. The size range reported from west coast was 8-29 cm with 13-21 cm as the most dominant size group. The mean length reported from east coast was 16-18 cm. This variety has high demand in Singapore, Thailand, Taiwan, Hong Kong and other countries in the region and is taken in sizeable percentage by the chartered foreign trawlers.

Indian Drift Fish

Psenus indicus commonly called as Indian drift fish is another deep water resource reported from all regions, the percentage of which in total catch varied from 0.03% in north-west coast, 5.06% in south-west coast, 1.06% in Wadge Bank and Gulf of Mannar, 7.40% in lower east coast and 2.28% in upper east coast. In west coast it was observed that occurance of the species is more concentrated in areas south of Mangalore from where catch rate as high as 1700 kg/hr has been reported (Philip *et. al.* 1984). The yield per unit effort obtained in different regions and depth zones are given in Table 10. Size range of the species was observed to be 11-25 cm with 16-20 cm. as the predominant group.

Table 10. Catch per hour (kg) of *Psenus indicus* in different regions and depth ranges.

Depth Zone (m)	North-west coast	South-west coast	Wadge bank & Gulf of Mannar	Lower east coast	Upper east coast
Below 50	0.06	0.15	—	9.35	10.10
50–100	0.13	0.20	0.10	23.44	4.74
100–200	—	30.19	6.20	46.86	1.96
200–500	—	5.80	0.14	—	—

Other Deepsea Fishes

Few other deep sea species viz. *Chlorophthalmusa gassizi* ("Green eye"), *Cubiceps natalensis, Epinnula orientalis, Emmelichthys sp*, *Bathygadus* sp ("rat tail") and deep sea sharks totally accounting for 5.34% of catch was reported from south west coast. The "rat tail" and deep sea sharks were more available in Karnataka coast whereas occurance of the other three species was mainly between lat 8° and 10°N. The "green eye" made up 16.05% of catch obtained from 200–500 m depth zone of Kerala coast.

Due to the unfamiliarity of the deep sea fishes presently there is no local demand, thereby requiring efforts to promote

consumer acceptance of these varieties. On the meat characteristics of "big eye", "black ruff" and "green eye" the recent studies coducted by Fisheries College, Mangalore, revealed that they are quite comparable in nutritive terms to many of the common coastal species. The proximate composition indicated that all the species are protein rich, the values ranging from 14.40% to 17.54% (Philip *et al* 1984).

Deepsea Prawns

Deep sea prawns were found to occur between 150-400 m depth along south-west coast and east coast. The Integrated Fisheries project during late sixties and early seventies had surveyed the continental edge and slope of south-west coast and Gulf of Mannar. Observations on the distribution as well as stock estimates of deep sea prawns have been reported by Joseph (1970), Mohammed & Suseelan (1973) and Oommen (1980, 1985). Very high catch rates (113-224 kg/hr) were obtained from Kerala coast during 1968-70 and the highest density was from the Quilon Bank and the northern grounds extending upto Ponnoni. 43 to 45% of catch from the major squares 9-75 and 10-75 was formed of this crustacean group. Standing stock from south west coast between lat 7°N to 13°N has been assessed at about 5200 tonnes (Oommen, 1985).

As survey by FSI vessels was not species specific, but aimed at assessment of the fishery resources in general, the catch figures obtained in respect of this group do not fully reflect on the abundance picture of the stock enabling quantitative assessments. However, comparison of the resource structure in different regions and depth zones could be inferred. Highest catch rate of 17.09 kg/hr was obtained from the shelf edge and slope in Kerala coast followed by 10.22 kg/hr in the lower east coast. In Gulf of Mannar and upper east coast percentage of this component was rather low. The species available in south west coast was *Heterocarpus woodmasoni, H. Gibbosus, Aristeus semidentatus, Parapandalus Spinipeo, Plesionika Martia* and *Solenocera hextii,* whereas in east coast *Aristeus sp* and *Solenocere sp* made up the bulk of catch.

Some of the species were found to exhibit very distinct ecological preferences. *Heterocarpus* sp was predominant in 250–350 m depth whereas *Aristeus* sp was found to be more beyond 350 m in west coast. The east coast *Solenocera* sp was reported from 150 m depth onwards. Better catch rates were observed during June to September along east coast and September to February along west coast.

Deepsea Lobster

The deep sea lobster resource is formed of a single species, *Puerulus sewelli* which grows to a maximum size of 205 mm. Joseph (1971) has reported occurrence of the species in commercial concentrations along south west coast based on surveys of the Integrated Fisheries Project. Oommen (1985) has estimated the standing stock of 12,940 tonnes from south west coast and 1860 from Gulf of Mannar. Excellant catch rates ranging from 122 to 164 kg/hr was recorded along the south west coast during 1969-71. A declining trend observed from 1972 continued upto 1977 when abrupt increase in catch rates from 28 kg/hr to 149 kg/hr was recorded.

The recent surveys by FSI vessels, besides re-confirming availability of the species along Kerala coast, western slope of Wadge Bank and Gulf of Mannar identified new grounds off the Konkan coast. In lat. 13° N to 15° N within 200-300 m depth it was found to constitute 5.2% of catch with an yield rate of 12.4 kg/hr. The northern grounds in same depth zone extending upto lat. 18°N gave an average catch rate of 18 kg/hr.

Though Oommen (1985) has reported the most productive season for deep sea lobster fishery along south west coast as February to June the recent survey revealed existence of a protracted season of abundance as evidenced from the results of the most successful hauls recorded by Matsya Nireekshani.

Month	Haul duration (hrs.)	Deep sea lobster (kg)	Lat./Long.
February	2.50	400	8-78
August	2.50	550	8-75
October	1.66	150	8-75
December	2.50	350	8-75

COASTAL PELAGIC RESOURCES

Oil sardine and mackerel are the main coastal pelagic species being traditionally exploited along southwest coast of India. Present landings of these species are 2 and 0.4 lakh tonnes as against the standing stock of 4 and 3 lakh tonnes, estimated by the UNDP/FAO Pelagic Fisheries Project (Anon, 1976 b). The standing stock of 2 lakh tonnes white bait and O.6 lakh tonnes "shallow water mix" comprising scads, silverbellies and *Ambassis* spp has also been estimated within 40 m depth along southwest coast. However, the recent trend in landings of the conventiona species leaves little hope for expansion of the fishery.

Results of Survey by Purse-Seining

The recent purse-seine survey conducted by Fishery Survey of India vessels in 40-200 m depth revealed availability of other resources along the coastal areas falling outside the present zone of exploitation. The catch obtained by *Matsya Varshini* while surveying southwest coast was about 85 tonnes during 1984-85. Though mackerel and oil sardine constituted the major components, forming 33% and 17% of catch, respectively, it was significant to note that their period of availability in deeper waters differed considerably from the season of higher distribution in inner coastal areas. Mackerel catches were obtained mainly during June to November and sardine during September to November. Among the coastal tunas, schools of *Euthynnus affinis* (little tuna) were more often encountered, and a large shoal of 30 tonnes netted along Malpe coast during May 1984 was noteworthy. Frigate tuna (*Auxis thazard*) and bullet tuna (*A. rochei*) were the other species recorded. Among carangids *Alepes djeddaba, Alepes melanoptera* and *Decapterus* sp. were more commonly obtained. Result of a set made off Cape Comorin during February 1985, hauling up 3 tonnes of "rainbow runner" (*Elegatis bipinnulatus*) along with an asortment of 6 tonnes *Alepes melanoptera, Euthynnus affinis* and *Elecate nigra*, was significant.

Along east coast the yield rates were comparatively low. In southern areas the pelagic stock comprised of frigate tuna, horse mackerel and othor carangids, whereas in the upper east coast

esser sardines, frigate tuna, little tuna, pomfret and anchovies made up the catch.

The survey revealed that along both the coasts the shoals were obtainable mainly within 60 m depth. The results do not appear to indicate availability of any sizeable quantities of purse-seinable pelagic resources in deeper waters of continental shelf.

Columnar Resources

The columnar resource of northwest coast and upper east coast were surveyed by midwater trawling during 1979-81 (Sivaprakasm and Somvanshi, 1983). Northwest coast yielded average catch of 431.7 kg/hr, horse mackerel (*Megalaspis cordyla*) forming the mainstay of catches (70.3%). Other important groups contributing to the pelagic trawl catches were elasmobranchs (10%), pomfret (8.6%), ribbonfish (4.3%), sardine (1.5%), mackerel and seer fish (0.2% each). Along the upper east coast catch rate was 266.2 kg/hr, formed of sardine (36.9%), ribbonfish (7.2%), mackeral (5.2%), pomfret (3.0%), seer fish (1.1%) anchovies (0.8%), etc.

The industrial fisheries survey in northwest coast by *M.T. Murena* during 1977 provided fairly good idea on the columnar resources in 55-360 m depth (Anon, 1979; Bapat *et al* 1982). The average catch recorded in pelagic/midwater trawling was 402kg/hr, the yield from different depth zones, viz. 55-90m, 91-125 m and 126-360 m, being 394, 541 and 265kg/hr respectively, indicating the middle depth range as richer in pelagic resources. Encouraging catch rates, as high as 1480 and 1207kg/hr were obtained during February-April in depth ranges 91-125 m and 126-360 m. In April-June the inner depth belt yielded 628 kg/hr, and the pattern of fish distribution indicated declining trends with increasing depths. The catch per unit effort of major pelagic groups obtained from each depth strata and their percentage in total catch is given in Table.11.

Table 11. *Distribution pattern and percentage of major pelagic species from northwest coast recorded by M. T. Murena*

Species	Catch per hour (kg)				Percentage
	50-90m	91-12m	126-360m	Total	
Horse mackeral	51.27	474.15	188.44	158.61	39.45
Ribbon fish	147.53	35.67	53.56	109.57	27.25
Pomfrets	39.10	8.72	1.09	26.73	6.65
Elasmobranchs	46.05	13.93	7.05	33.14	3.23
Catfish	21.28	1.76	0.12	13 87	3.45
Eel	20.15	0.14	0.09	12.82	3.19
Perches	14.32	3.03	2.05	10.02	2.50
Sciaenids	16.36	0.02	0.11	10.40	2.58
Other varieties	37.99	3.90	12.41	48.82	6 97
Total	394.05	541.32	264.92	402.08	—

Horse mackerel, the predominant columnar species with a catch rate of 158.61 kg/hr formed 39.4% of total catch. Substantial yield rate of 474.15 kg/hr was obtained from the depth range 91–125 m. During the most productive season, viz. February-April, catch rates in the three depth ranges were in the order of 54, 1422 and 944 kg/hr. The ground north of okha in lat 22°N within 91 to 125 m depth proved to be the richest ground in this season. During the second quarter of the year good yield rate of this species was obtained along the Porbander, Veraval and Bombay regions.

Ribbonfish represented by *Trichiurus lepturus* and *T. savala* occurred over the entire area of investigation and formed 27.25% of catch with an average catch rate of 109.57 kg/hr. Significantly high yield rates were obtained in the Bombay-Dwaraka region mainly in 55-90 m stratum.

The silver pomfret, *Pampus argenteus*, gave an average catch rate of 7.68 kg/hr and accounted for 1.91% of pelagic catch. The depth range 55-90 m contributed to the major part of catch and the yield rate showed declining trend with increasing depth. The highest catch rate of this species occurred in the area bounded by latitude 22°20' - 23°00'N and longitude 67°00-68°30' E, from where catchup to one tonne per haul was obtained during January-February. The second region, where these species occurred in significant concentration, was between Dwaraka and Porbander. The black pomfret, *Parasromateus niger*, formed 4.74% of pelagic landings and was taken at a catch rate of 19.05 kg/hr. Highest concentration of the species was obtained during February-April from 55-90 m depth.

Apart from the species discussed above, catfish, eel, perches, sciaenids, sharks, rays, scombroids and carangids were the major components, contributing 1 to 4% of the pelagic catch. The general conclusion that could be drawn from the survey was that highly productive grounds of columnar resources are available over the north west region of Indian shelf. These resources are as yet unexploited and offer possibilities of developing a viable fishery by developing appropriate types of vessel and gear.

OCEANIC RESOURCES

Tunas, bill fishes and sharks constitute the exploitable large pelagic resources from high seas. The tuna fleets of non-Indian Ocean countries viz, Japan, Republic of Korea and Taiwan, were known to operate in Indian Ocean since 1950's. Potential yield estimates of tuna and related species in Indian Ocean range from 0.51 to 0.79 million tonnes whereas the landings are around 0.22 million tonnes only (FAO, 1980). Several authors (Gulland, 1971, Suda, 1974; Suzsuki, 1979; Silas, *et al*, 1979. Silas and Pillai 1982, Silas 1983; Dwivedi and Devaraj, 1983)have given detailed account of the stocksize and distribution of tuna resources in Indian Ocean and scope for increased production. The status of pervailing tuna fishery in the EEZ's of India,

Maldives and Sri Lanka has been discussed by and Sivasubramaniam (1985).

The average annual landings of tuna from Indian seas during the last decade was 11,500 tonnes and its share in all - India fish production ranged from 0.03 to 1.92%. There is no organised fishery in the country for tunas except the pole and line fishing in Lakshadweep Islands mainly for skipjack tuna. Eapen (1964) and Joseph (1972) have discussed on developmental prospects of tuna fishing in Indian waters based on the preliminary resource apprisal surveys conducted during the sixties. Fishery Survey of India during the last few years has been exploring the extent and magnitude of tuna resources in Indian seas deploying the longliner *Matsya Sugundhi*. The results obtained during October'83 to December '85 are discussed here, enabling a preliminary assessment of the resource position of tunas and related species. A fairly good coverage by operating about 2 lakh hooks was made in the Arabian Sea including Lakshadweep waters, Bay of Bengal including Andaman and Nicobar seas and the equatorial waters.

Four scombroid species viz. yellowfin tuna (*Thunnus albacares*), bigeye tuna (*T. obesus*), skipjack tuna (*Katsuwonus pelamis*) and albacore (*T. alalunga*) formed the major component of catch (46.07%). Billfishes consiting of striped marlin (*Tetrapturus audax*), blue marlin (*Makaira nigricans*), black marlin (*M. indica*), sail fish (*Istiophorus platypterus*) and broad bill sword fish (*Xiphias gladius*) accounted for 9.3% and pelagic sharks 41.2%. Dolfin fish, seer fish and other varieties made up the rest of catch. But the resource composition in different oceanic regions showed marked variations as given in table 12. Percentage of tuna in equatorial sea was 62.3% whereas in Andaman area tuna formed only 35.76% of catch. Joseph (1986) has analysed the percentage composition of tuna in squares of 5° lat. x 5° long. and found that the area lying between lat. 0°-5°N and long. 65°-70°E yields the highest proportion of tuna (87.2%).

Table-12 *Percentage composition of longline tuna catch in different oceanic regions*

Species/group	Arabian sea	Bay of Bengal	Andaman sea	Equatorial sea
Tuna	47.59	38.19	35.76	62.30
Bill fishes	8.13	19.10	10.60	6.28
Pelagic sharks	42.47	39.18	43.71	30.89
Other varieties	1.81	6.53	9 93	0 53

Among tunas, yellowfin was the most dominant species, contributing 91.7%, with wide distribution in the Indian seas and adjoining areas. Availability of bigeye tuna was significant in equatorial sea, whereas skipjack tuna was more frequently hooked from east coast. Albacore was observed to have rather limited distribution, confining to the Andaman and Nicobar seas.

The average number of fish obtained per 100 hooks was 2.67. The rate of hooking in general was observed to be the highest in Arabian sea (3.32%) followed by east coast (1.99%), equatorial waters (1.91%) and Andaman sea (1.51%). The highest hooking rate of 12.9% was recorded in area 14-72 followed by 11.3% in 13-73 and 8.2% in 14-71.

The hooking rate in respect of the four species of tuna together was 1.23%, west coast yielding comparatively high rate (1.58%) followed by equatorial sea (1.19%). The areas in lat. 13°N and 14°N off the Mangalore-Karwar coast were found to be the richest grounds from where average rates as high as 9.67%, 6.74%etc. were recorded. The distribution pattern of yellowfin tuna which formed about 92% of tuna catch essentially remained the same. Sulochann *et al* (1986) has worked out in detail spatial distribution pattern of this species in Arabian Sea. Bigeye tuna were hooked at higher rate (0.5%) in the area 3-77 south of equator followed by 5.68 and 7-91 (0.4% each) in the northern hemisphere. Hooking rate of marlins was high (0.38%) in east coast

and the minimum (0.12%) in equatorial sea. Pelagic sharks indicated high catch rate (1.41%) in Arabian Sea, the latitudes 13°N to 15°N giving the highest yield rate of 2.87%. The hooking rate of major species of tunas, billfishes and pelagic sharks in 1° squares have been documented by Varghese *et al* (1984).

As abundance pattern of the major species varied considerably in different months in different oceanic regions comprehensive information on the seasonal fluctuations in catch rate becomes imperative for planning any strategy of exploitation. The hooking rates of important groups worked out on a bimonthly basis in respect of Arabian sea is furnished in Table 13 The post-monsoon season commencing from September formed the productive season for tuna longline fishery.

Table 13. *Hooking rate (%) of major fish groups from Arabian Sea in different seasons.*

	Tuna	Billfishes	Pelagic sharks	others
Jan — Feb	0.56	0.17	0.14	0.19
Mar — April	3.16	0.39	1.84	0.39
May — June	0.31	0.31	0.89	0.05
July — Aug	0.77	0.10	0.01	0.19
Sept — Oct	1.48	0.21	1.56	0.02
Nov — Dec	2.74	0.34	1.67	0.04

Though the table shows 3.16% hooking of tuna during March-April, reliability of the information is rather low as it is based on a single sampling. From a highly productive ground (14-72) identifield off Mangalore-Karwar within 150 miles from the coast excellant hooking rate of 23.9% yellowfin tuna was recorded during October 1985, which further reached a phenomineal level 33.5% during January'86. In the least coast, in Andaman sea and equatorial waters only preliminary surveys have been completed and sampling was therefore confined to a few months. Observations in east coast indicate first quarter of the year as the best season for tuna fishing with 1.13 to 1.18% hooking, whereas in equatorial waters higher catch rates (1.22 to 2.19%) were obtained during October and November.

Bigeye tuna yielded higher catch rate in November and December whereas skipjack did not show any definite seasonal availability pattern. Marlins were caught more in east coast during February-March.

From the survey it emerged that some areas within Indian EEZ is highly productive with encouraging hooking rate for tuna. The average catch rate in thc surveyed area for all tuna together and separately for yellowfin tuna was 1.23% and 1.13% respectively. These indices are considerably higher and favourably compared with those hooking rates recorded from Indian Ocean by Japanese (8.23%), Korean (0.62%) and Taiwanese (0.17%) longliners during the late Saventies. Sivasubramaniam (1985), while analysing tuna longline catches from the seas boardering India, Maldives and Sri Lanka reported yellowfin tuna hooking rates as 0.07% between lat. 0°-5°N in long. 70°-75°E, 0.19% between lat. 0°-5°N in long. 75°-80°E and 1.50% between lat 5°-10°N in long 75°-80°E. The present study reveals much higher catch rate, ranging from 0.36% to 3.08% tunas when examined in squares of 5° lat x 5° long. Druzhinin (1973) reported catch rate of 16.7 kg. tuna per 100 hooks in the western Arabian sea in lat. 10°-15°N which roughly works out to 0.5% hooking by number. The share of tuna in longline catch from Arabian sea was only 15% as per earlier records (Anon, 1976 a) whereas the present survey indicates 49.59% of longline catch as tunas. All these suggest that with the release in fishing pressure consequent to withdrawal of alien fleets from Indian seas the cateh rates have considerably revived and resource availabillty is no more a constraint in tuna exploitation.

REFERENCES

ANON, 1976. a. Report of the National commission on Agriculture. Vol. VIII, Fisheries

ANON 1976. b. A synopsis of information of pelagic fish resources of the south west coast of India. Progress report No. 18. *UNDP/FAO-PFP(IND/ 75/638) Phase-1*

ANON, 1979. Report on cruise of M. T. Murena in north-west coast of I n d i a, Exploratory Fisheries Project, Bombay

BAPAT, S. V. *et al* 1982. Fishery resources of the Exclusive Economic zone of the northwest coast of India. *Bull., CMFRI, 33' 1982*

DRUZHININ, A. 1973 Fishery resources of Gulf of Aden and some abjacent areas: *FI:SF/DP 9/12/ PDY 64/501/7. FAO, Rome.*

DWIVEDI, S. N, AND M. DEVARAJ, 1983. Tuna fisheries of the Indian Ocean and development prospects in Indian EEZ. *Tuna update 83.*

EAPEN, P. K. 1964 Tuna longline operations in westcoast *Indian Sea Foods,*11 (i)

GEORGE, P. C., B. T. ANTONY RAJA, AND K. C. GEORGE, 1977. Fishery resources of the Indian Exclusive Economic Zone *Souvenir, Silver Jubilee, IFD, Cochin,*

GULLAND, J. A; 1971. *The fish resources of the Ocean.* Fishing News (Books) Ltd. England.

JOSEPH, K. M., A study of the deep sea prawn resources of the south west coast of India, *Sea Food Export Journ. 1*(8)

JOSEPH, K. M., 1971 Crustacean Fisheries of the west coast of India, *IOFC/ DEV/71/21-23.*

JOSEPH, K. M., 1972. Some observations on the exploitation of Indian Ocean tuna resources. *Seafood Export Journ* 4 (8)

JOSEHA, K. M., 1930 Comparative study of the demersal fishery resources of the Indian waters as assessed by 17.5 m trawlers. Bull, Project No. 10

JOSEHH K. M., 1986. Some observations on potential fishery resources from the Exclusive Economic Zone (EEZ). *International Seminar on "Training and Education for Marine Fisheries Management and Development" CIFNET, Cochin.* Jan. 1986.

MUHAMMED K.H., AND C. SUSEELAN, 1973. Deepsea prawn resources off the southwest coast of India. *Proc. Symp. Living Resources of The seas Around India, Spl. Pub. CMFRI.*

OOMMEN VARGHESE, P., 1980. Results of the exploratory fishing in Quilon bank and Gulf of Mannar. *Bull. No.4 IFP, Cochin*

OOMMEN VARGHESE, P., 1985. Deep sea resources of the south west coast of India *Bull. No. 11 IFP, Cochin.*

PHILIP, K. M., B. PREMCHAND, G. K. AUHAD AND P. J. JOSEHH, 1984. Note on the deep sea demersal resources of Karnataka - North Kerala coast. *FSI/Bull/14/34.*

SILAS E. G., M. S. RAJAGOPALAN, AND P. P. PILLAI, 1979. Tuna fisheries in India; Recent trends. *Mar. Fish. Infor. Serv. T&E Ser; 13.*

SILAS, E. G., AND P. P. PILLAI, 1982. Resources of tunas and related species and their fisheries in the Indian Ocean. *CMFRI Bulletin 32.*

SILAS, E. G. 1983. Development of tuna fisheries - Is resource availability the constraint? *Tuna updata 33.*

SIVALINGAM, S., 1969 Wadge Bank trawl fishery studies. Part III. Nature and composition of resident population. *Bul. Fish. Res. Stn. Ceylon (20)*

SIVALINGAM, S. AND MEDCOF, 1957 General features and productivity of the Wadge Bank trawl fishing. *Bull. Fish. Res. Stn. Ceylon (20)*

SIVASUBRAMANIAN, N., 1985. Tuna fishery in the FFZ's of India Maldives and Sri Lanka. *BOBP/WP/3s (R AS/81/051.*

SIVAPRAKASAM, T. V. AND V. S. SOMVANSHI, 1983 Report status of resources of test fishing operations carried out by the E. F. P. for the World Bank aided Gujarat Fisheries Project Part I, Gujarat and Part II, Andhra Pradesh.

SUDA, A., 1984. Recent status of resources of tuna exploited by long line fishery in the Indian Ocean. *Bull. Far. Seas fish. Res. Lab. 10.*

SULOCHANAN, P., M. E. JOHN AND N. V. NAIR, 1976. Preliminary observations on tuna resources of the Arabian sea with particularreference to distribution pattern of Yellowfin tuna, *Thunnus albacares* (Boana terre). *International Seminar on "training and education for marine fisheries Management and development" CIFNET, Cochin, Jan 1986.*

SULOCHANAN, P. AND M. P. JOHN, 1982 Cephaloped resources of south west coast of India. *Symp. Harvest and post harvest technology of fish, CIFT, Cochin, Nov 1982*

SUYUKI, S., 1979. Stock assessment of Yellowfin tuna in the Indian Ocean: *SAWS/BP/21.*

VARGHESE, K. K., M. E. JOHN AND V. SIVAJI, 1984. Some observations on the tuna resources of Indian Ocean. *FSI/Bull/13/84*

APPENDIX I

Major Survey projects carried out by Fishery Survey of India during 1980-85 in the different regions of Indian coast and details of vessels deployed

Survey project	Region	Vessel	GRT	BHP
I Demersal resources survey	North-west coast	Matsya Nireek-shani	329.36	2030
		Matsya Varshini	268.88	1160
	South-west coast	Matsya Shakti	327.18	825
		Matsya Viswa	327.18	825
	Wadge Bank & Gulf of Manner	Matsya Nireek-shani	See above	
	Lower east coast	Matsya Jeevan	328.13	825
	Upper east coast	Matsya Shikari	352.47	1740
II Pelagic resources survey	West coast	Matsya Varshini	See above	
	East coast	Matsya Harini	257.95	750
III Tuna longline survey	Indian EEZ& equatorial sea	Matsya Sugundhi	243.45	650