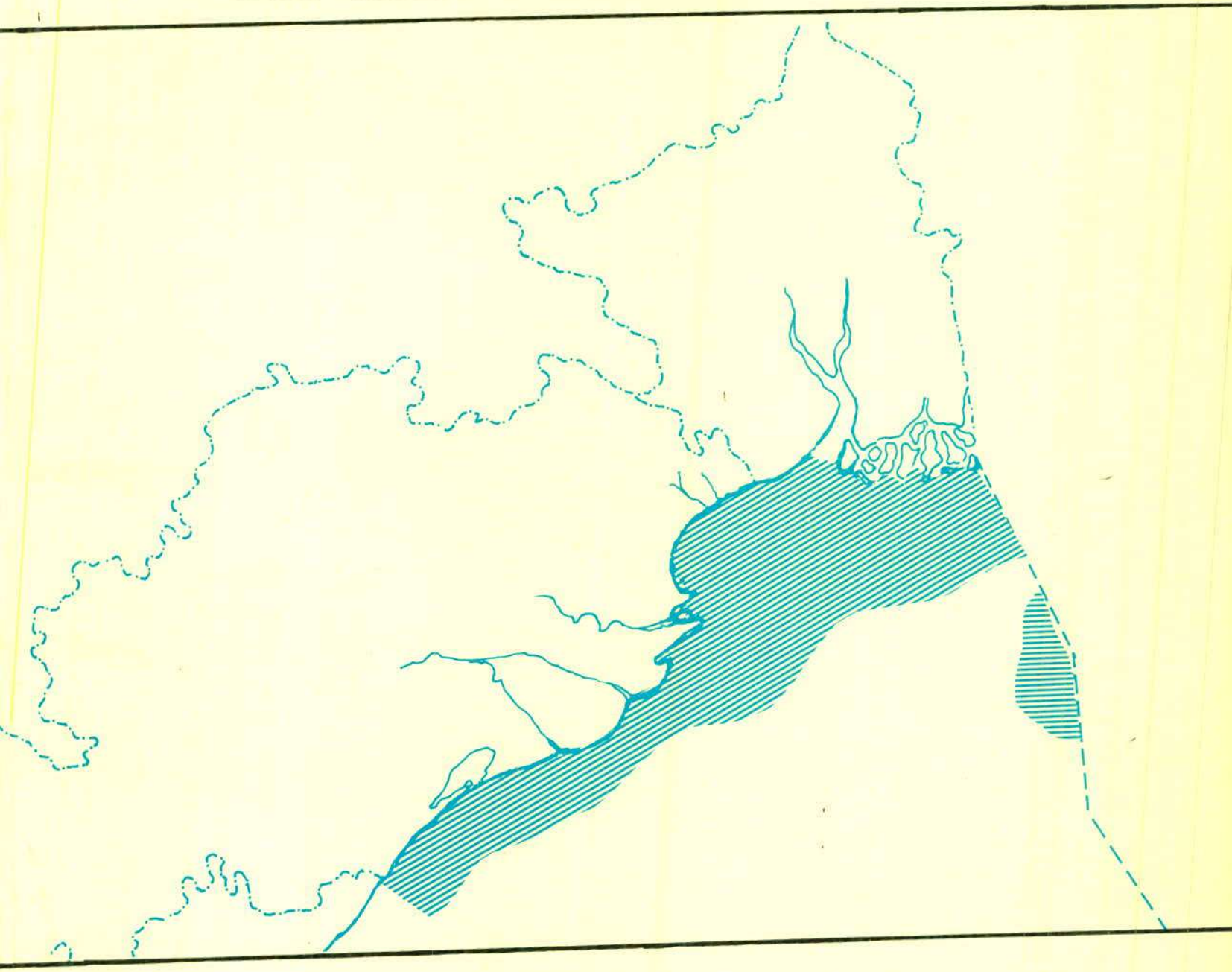
Bulletin 19

MARINE FISHERY RESOURCES OFF ORISSA-WEST BENGAL COAST



FISHERY SURVEY OF INDIA
Government of India
(Ministry of Food Processing Industries)
Bombay

November 1990

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1. INTRODUCTION

Orissa and West Bengal are among the maritime states which have registered relatively high level of growth rate in marine fish production during the VIth and VIIth Plans. Even then the contribution of these states to total marine fish production in the country is in the order of 5-6% only though the continental shelf area along these states forms about 10.5% of the country's shelf area. Despite having some of the most productive fishing grounds off the Orissa-West Bengal coast, fish production per unit area of the shelf is less than half of the national average. Obviously there are prospects for augmenting marine fish production from the region.

Information on fish stocks is a vital input in formulation of development strategies for exploitation and monitoring of marine fisheries. The Fishery Survey of India (formerly Deep Sea Fishing Organisation/Exploratory Fisheries Project) has been conducting surveys along the inshore areas off Orissa-West Bengal coast since the early sixties. Results of these earlier studies have been reported in the Bulletins of FSI (Joseph **et al.**, 1976; Joseph, 1980). Besides, Sekharan **et al.** (1973) have reported the results of trawling conducted by FSI vessels, along north-east coast during 1961-65. The distribution of shrimp stocks has been studied by Rao and Dorairaj (1973), based on the survey results during 1963 to 1968.

With the acquisition of larger vessels by FSI in 1979-80, the survey coverage was extended to outer continental shelf and slope. Based on these data the resource potential of Orissa coast has been studied by Sivaprakasam and Joseph (1986). More recently, Sudarsan and Somvanshi (1988) have made a study on fishery resources of the Indian EEZ with particular reference to upper east coast. Also a comprehensive appraisal of the fishery resources of the EEZ by Sudarsan **et al.** (1988) has covered the resources information along Orissa-West Bengal coast as well, upto March 1987. Consolidating the data collected during ten years upto March 1989 a detailed account of the fishery resources along Orissa-West Bengal coast with emphasis on demersal stocks is presented here. Estimates of maximum sustainable yield and additional harvestable yield are also indicated to enable policy decisions and scientific management for development of marine fisheries in the region.

2. COASTLINE AND CONTINENTAL SHELF

Orissa has a coastline of 476 km forming 6.3% of the total coastline of India. The continental shelf area upto 200m depth is about 24,000 sq km. Southern part of the coast has a narrow shelf whereas the coast off north Orissa is characterised by several estuarine systems and an extended continental shelf. Important among the major rivers flowing into the Bay of Bengal in this part of the coast are the Mahanadi, Devi, Brahmani and Dhamra. Chilka lake, the largest lagoon (area 1035 sq km) in the country is situated in the southern part of Orissa. The continental slope along the coast in 200-300m depth range has an area of about 1220 sq km.

West Bengal has a coastline of 158 km forming about 2.1% of the Indian coastline. This excludes the coastline of the Hooghly-Matla estuary. The continental shelf is characterised by vast deltas formed by the Hooghly river, Thakuran river and Matla river. The shelf area covers about 27,000 sq km of which half the area falls within 50m depth contour forming a vast stretch of shallow sandy and muddy area. Towards east, quite adjacent to the EEZ boundary, is the Swatch-of-no-ground. The continental slope area is about 400 sq km.

The extent of area in different depth zones along Orissa and West Bengal coast is given in Table 1.

Table 1. Continental shelf and slope area along Orissa-West Bengal coast

Depth zone (m)	Area (sq km)	
	Orissa	West Bengal
0-20	6820	13380
20-50	8650	2690
50-100	4810	3040
100-200	3550	8210
200-300	1220	400

Due to the characteristic configuration of the coastline and continental shelf (Fig. 1) demarcation of grounds between the states is only an approximation.

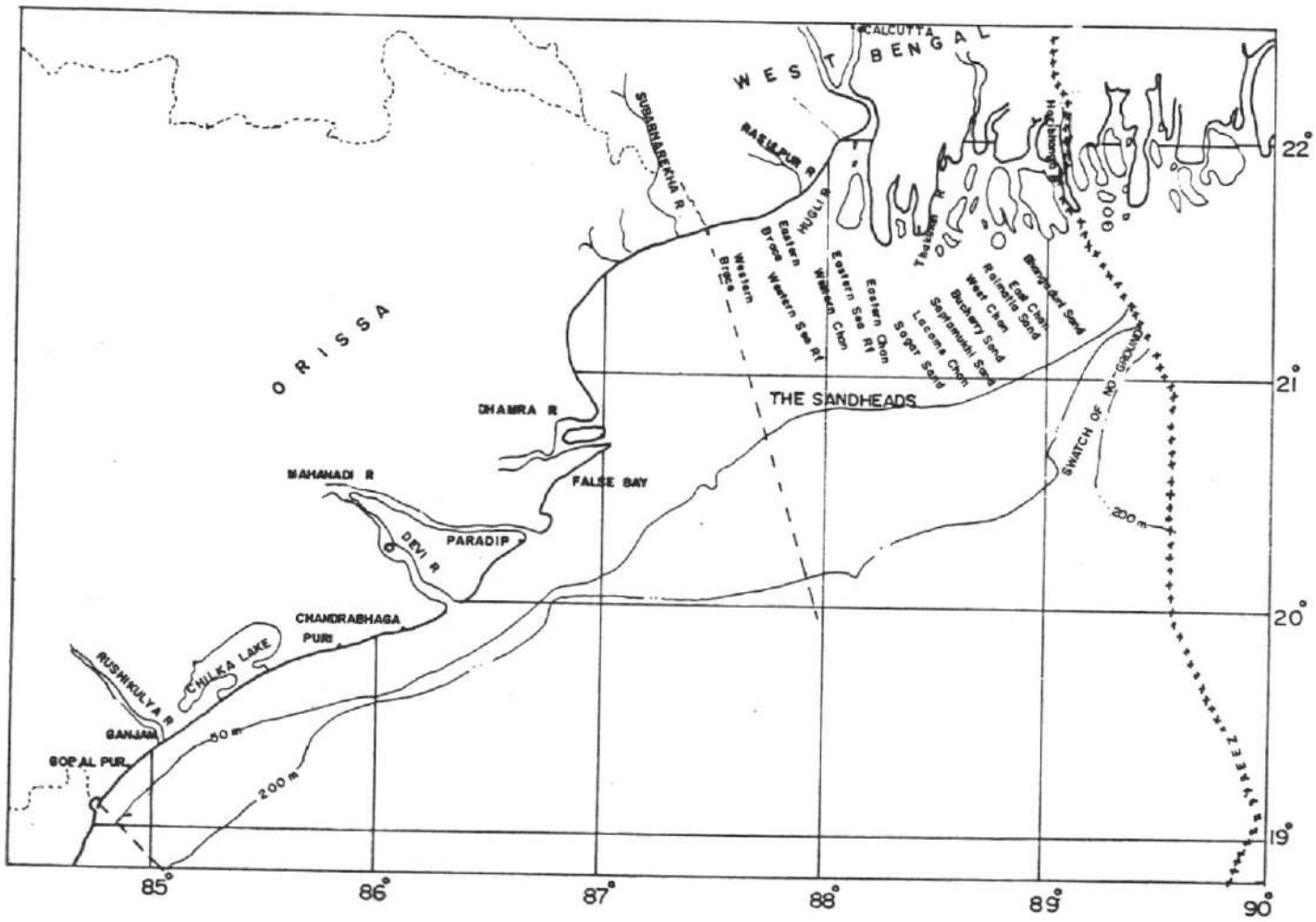


Fig. 1 Coastline and continental shelf along Orissa-West Bengal

3. PRESENT STATUS OF MARINE FISHERIES

3.1. Fishing villages and fishermen population

Spread over the four maritime districts of Balasore, Cuttack, Puri and Ganjam there are 236 marine fishing villages in Orissa. Fishermen households are over 20,000 and fishermen population 1,26,000. Fishermen engaged in actual fishing are about 30,700.

In West Bengal there are 303 fishing villages situated in the maritime districts of Midnapore and 24 Parganas. About 14,200 households are engaged in fishing and allied activities. Out of the total fishermen population of about 85,000 active fishermen are 19,800.

3.2. Fishing craft and gear

The type and number of craft and gear being operated from the states are given in Table 2. The mechanised boats operating in Orissa coast are 871 of which about 60% are trawlers and the rest gill netters. More of the mechanised boats operate from north Orissa whereas in southern districts fishing is still predominantly traditional. Number of traditional craft in the state is estimated to be 13,698 of which catamarans form about 60% and plank-built boats 30%.

Table 2. Fishing craft and gear in Orissa and West Bengal

Particulars	Orissa	West Bengal
Fishing craft		
Mechanised boats	871	1582
Motorised traditional craft	178	240
Non-motorised traditional craft	13520	4121
Total	14569	5943
Fishing gear		
Gill nets	21909	2467
Boat seines	3354	-
Fixed bag nets	2520	6200
Hook and lines	3267	869
Shore seines	1851	436
Trawl nets	1724	-
Others	1873	2839
Total	36498	12811

Source : Orissa - State Govt. (1988)

W.Bengal - Fishing craft : State Govt. (1985-86)
Fishing gear : CMFRI (1980)

In West Bengal mechanised boats are 1582, mostly gill netters and carrier boats. Among the traditional craft numbering 4361, about 98% are plank built canoes and the rest dugout canoes.

The number of fishing gear units in Orissa is about 36,500 consisting of gill nets, boats seines, shore seines, fixed bagnets, hooks and lines, trawls and others.

In West Bengal the fishing gear units are about 12,800 of which fixed bag nets account for about 48% and gill nets 20%.

3.3. Infrastructure facilities

Details of fishing harbours and landing centres in Orissa and West Bengal are given in Table 3. In Orissa there are two fishing harbours and four major landing centres which altogether can accommodate about 700 mechanised boats. There are about 52 other fish landing centres in the state. One major fishing harbour at Paradeep has been approved by Government of India recently.

Table 3. Fishing harbours and landing centres in Orissa and West Bengal developed under Plan schemes
(Figures in brackets indicate capacity to accommodate mechanised fishing vessels)

Particulars	Orissa	West Bengal
Fishing harbours at major ports	-	Roychowk (15 deepsea vessels)
Fishing harbours at minor ports	Dhamra (50)	Digha (50)
	* Nuagarh (Astarang) (80)	
Fish landing centres with jetty facilities	Chandipur (28) Chudamani (40) Nairy (300) * Chandrabhaga (200)	Jalda (350) New Jalda (80) Junput (400) Kaarpai (130) Kalinagar (150) Ganeshpur (130)

* The schemes are yet to be completed.

(Source: Ministry of Agriculture, 1988)

In West Bengal a major fishing harbour with a capacity to accommodate 15 deepsea vessels has been established at Roychowk. Besides, there is one minor fishing harbour at Digha and six landing centres with jetty facilities, with an aggregate capacity for 1,290 mechanised boats. There are about 41 other fish landing centres in the state.

3.4. Marine fish production

Details of annual fish production and growth rate in Orissa and West Bengal are given in Table 4.

Orissa contributes about 2.95% to the marine fish production in the country. During the period 1979 to 1988-89 annual landing has grown from 32,000 tonnes to 60,000 tonnes. Average landing during the last 3 years was 57,800 tonnes. The trend in marine fish landing during the eighties indicates an impressive annual growth rate of 7.5% against the national average of 2.5%.

The rate of fish production per unit area of the continental shelf is about 2.4 tonnes per sq km which is almost half of the all India average. Compared to fish production along the southern states on east coast, which is 6 tonnes per sq km along Tamil Nadu coast and 4.2 tonnes along Andhra Pradesh coast, the production rate of about 2.4 tonnes per sq km in Orissa is at a rather low level.

Composition of catch (Table 5) indicates that jew fish (sciaenids) is the major component forming 19.1% of catch followed by cat fish (11.5%), pomfret (10.3%), elasmobranchs (6.2%) and hilsa (5.2%). Penaeid prawns formed 4.3% and non-penaeid prawns 0.2%. Demersal stocks account for about 59% of the total marine fish production in Orissa.

The share of West Bengal in total marine fish production in the country is about 2.86%. Annual landing during the period from 1979 to 1988-89 was in the range of 28,000 to 65,000 tonnes. Average landing during the last three years was 58,200 tonnes. The trend in marine fish production in the state during the eighties shows a growth rate of 5.7% per annum.

The average fish production from the shelf area along West Bengal coast is only 2.1 tonnes per sq km which is the lowest figure among all maritime states in the country.

It may be pointed out here that a wide disparity exists between the statistics of fish landing released by Government of West Bengal (Table 4) and the figures published by CMFRI especially for the years 1979, 1980 and 1981. The estimated landing by state Government for these years are 60,000, 65,000 and 28,000 tonnes respectively whereas the corresponding estimates by CMFRI are 10700, 6100 and 20100 tonnes. In the subsequent years the variation between the estimates are below 20%.

Major components contributing to the fishery in West Bengal are cat fish (15.4%), pomfret (14.6%), non-penaeid prawns (12.5%), Bombay duck (8.1%) and hilsa (6.4%). Proportion of demersal and pelagic components is about 59% and 41% respectively.

Table 4. Marine fish production ('000 tonnes) and annual growth rate (%) in Orissa and West Bengal, compared to all India figures

Year	Orissa		West Bengal		All India	
	Fish production	Growth rate	Fish production	Growth rate	Fish production	Growth rate
1979	32.0		60.0		1492.0	
1980	38.7	(+) 20.9	65.0	(+) 8.3	1554.7	(+) 4.2
1981	43.9	(+) 13.4	28.0	(-) 56.9	1444.8	(-) 7.1
1982	41.4	(-) 5.7	31.0	(+) 10.7	1427.5	(-) 1.2
1983	47.1	(+) 13.8	39.0	(+) 25.8	1519.3	(+) 6.4
1984	47.0	(-) 0.2	29.0	(-) 25.6	1779.4	(+)17.1
1985	52.4	(+) 11.5	34.6	(+) 19.3	1734.2	(-) 2.5
1986	56.5	(+) 7.8	50.5	(+) 46.0	1716.9	(-) 1.0
1987-88	57.0	(+) 0.9	61.8	(+) 22.4	1658.1	(-) 3.4
1988-89	60.0	(+) 5.3	62.4	(+) 1.0	1817.4	(+) 9.6
Average		(+) 7.5		(+) 5.7		(+) 2.5

Table 5. Percentage composition of marine fish landing in Orissa and West Bengal

Species/group	Orissa*	West Bengal**
Sharks, skates & rays	6.2	2.5
Cat fish	11.5	15.4
Hilsa	5.2	6.4
Other clupeids	22.5	14.5
Bombay duck	0.6	8.1
Perches	1.9	0.2
Jew fish (Sciaenids)	19.1	5.2
Threadfin bream	1.1	-
Ribbon fish	2.3	5.4
Horse mackerel	0.5	-
Other carangids	1.5	0.7
Silver belly	1.8	0.2
Pomfret	10.3	14.6
Mackerel	2.1	0.1
Seer fish	4.1	2.8
Penaeid prawns	4.3	2.9
Non-penaeid prawns	0.2	12.5
Squid & cuttle fish	1.1	0.3
Other fishes	3.7	8.2

Computed from: * Scariah **et al.** (1987); ** Philipose **et al.** (1987)

4. SURVEY OF MARINE FISHERY RESOURCES ALONG ORISSA-WEST BENGAL COAST

There have been some attempts by the state Governments in conducting experimental/exploratory fishing along the coast, the first of which was probably by the then Bengal Government in 1908 using a steam vessel Golden Crown. In 1950 the West Bengal Government acquired two Danish trawlers Baruna and Sagarika and conducted fishing from Calcutta. Subsequently in 1955 Japanese trawlers Kalyani I to V were added to the fleet. Results of fishing by the vessels Kalyani I to V from Gopalpur to Sandheads during 1959-62 have been discussed by Kuthalingam **et al.**, (1973). The state Government wound up their deepsea fishing project in 1964. During the sixties, the Orissa Government had also operated four 16 m Polish trawlers from Paradeep.

4.1. Resources surveys by FSI, 1960 - 79/80

Attempts by FSI to investigate the fishery resources of Orissa-West Bengal coast commenced in the early sixties. Results of these surveys upto 1974 have been discussed by Joseph **et al.**, 1976 (FSI Bulletin No.5) a brief review of which is given below.

Ashok and Pratap

The vessels M.T. Ashok and M.T. Pratap (LOA 25.4m, BHP 240, GRT 91.7) conducted extensive trawl fishing along the east coast during 1960-65. The Orissa-West Bengal coast in lat. 19° and 20°N was surveyed with a fishing effort of 611 hours. Results of survey in terms of catch per unit effort (CPUE) of trawling by area and depth are presented in Fig. 2.

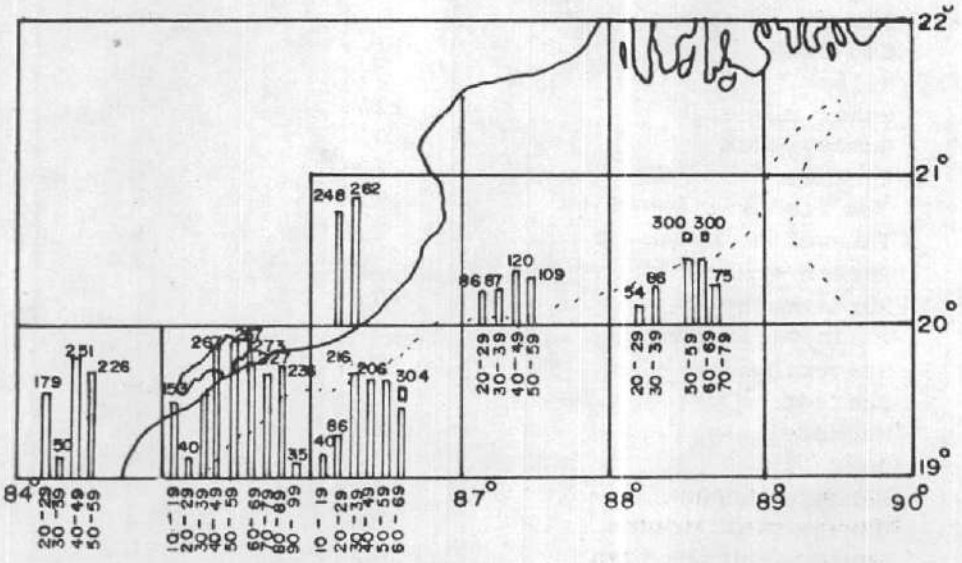


Fig. 2 Area-wise and depth-wise CPUE (kg/hr) obtained by Ashok and Pratap by bottom trawling along Orissa-West Bengal coast, 1960-65
(Source: FSI Bulletin No. 5)

Sagar Kumari and Sea Horse

Two smaller vessels viz., Sagar Kumari (LOA 10.5m, BHP 42, GRT 9.9) and Sea Horse (LOA 10.97m, BHP 56, GRT 12.8) have done trawl fishing in areas off Paradeep by spending an effort of 147 hours. Results of fishing by these vessels are given in Fig. 3.

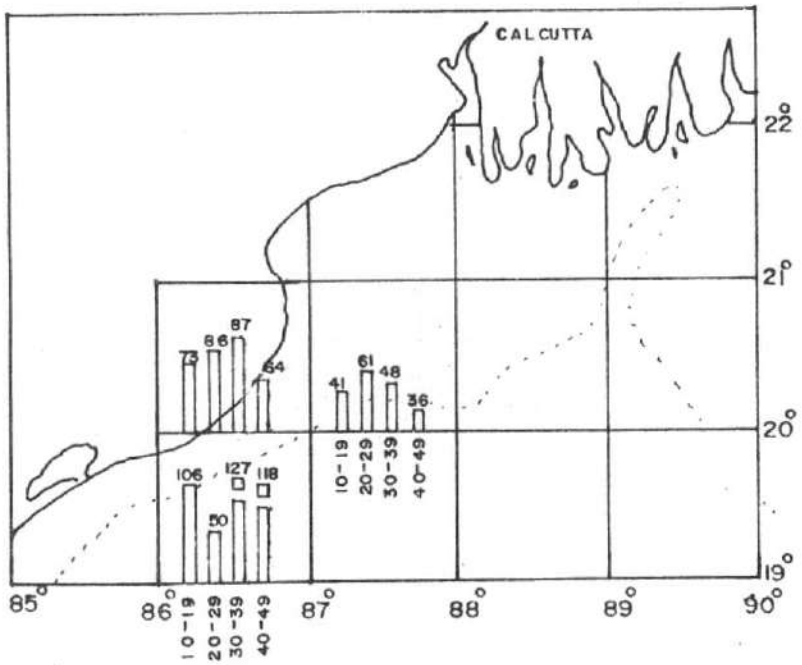


Fig. 3 Area-wise and depth-wise CPUE (kg/hr) obtained by Sagar Kumari and Sea Horse by bottom trawling along Orissa coast

(Source: FSI Bulletin No. 5)

Matsya Vigyani, 1973-74

Matsya Vigyani (LOA 31.8m, BHP 578, GRT 182.6) commenced trawl survey in 1973 based at Calcutta and continued to operate till 1982. The vessel did 208 hours fishing off Orissa-West Bengal coast till March 1974.

Combined survey effort and results, 1960-74

The fishing effort in trawl survey by all vessels together (also including 311 hours fishing by 17.5 m vessels) along the Orissa-West Bengal coast during 1960-74 totalled 1510 hours (Table 6). The area-wise sampling distribution is depicted in Fig. 4. Catch rate obtained by the different class of vessels is shown in Fig. 5 and the percentage composition of major species/groups in different depth zones is given in Table 7.

Table 6. Year-wise and area-wise trawl survey effort (No.of hours) by FSI vessels along Orissa-West Bengal coast, 1960-74

Area / Year	19-84	19-85	19-86	20-86	20-87	20-88	21-88	Total
1960	-	17	103	8	100	-	-	228
1961	1	7	25	60	27	-	-	120
1962	9	89	84	11	5	-	-	198
1963	6	6	-	-	-	-	-	12
1964	65	116	23	8	6	-	-	218
1965	5	18	44	22	43	35	-	167
-								
1972	-	-	-	-	-	128	-	128
1973	-	-	-	-	-	74	-	74
1974	-	-	6	245	2	110	2	365
TOTAL	86	253	285	354	183	347	2	1510

(Source: FSI Bulletin No. 5)

Table 7. Percentage composition of major species/groups observed in trawl survey by FSI vessels along Orissa-West Bengal coast, 1960-74

Species/group	Depth zone (m)				
	0-19	20-39	40-59	60-79	80-90
Elasmobranchs	18	17	12	13	43
Prawns	7	4	3	3	-
Cat fish	4	9	21	25	7
Perch	-	1	-	-	-
Pomfret	3	1	-	-	-
Dhoma (Sciaenids)	14	7	-	-	-
Other quality fishes	1	1	11	9	20
Other fishes	53	50	53	50	30

(Source: FSI Bulletin No.5)

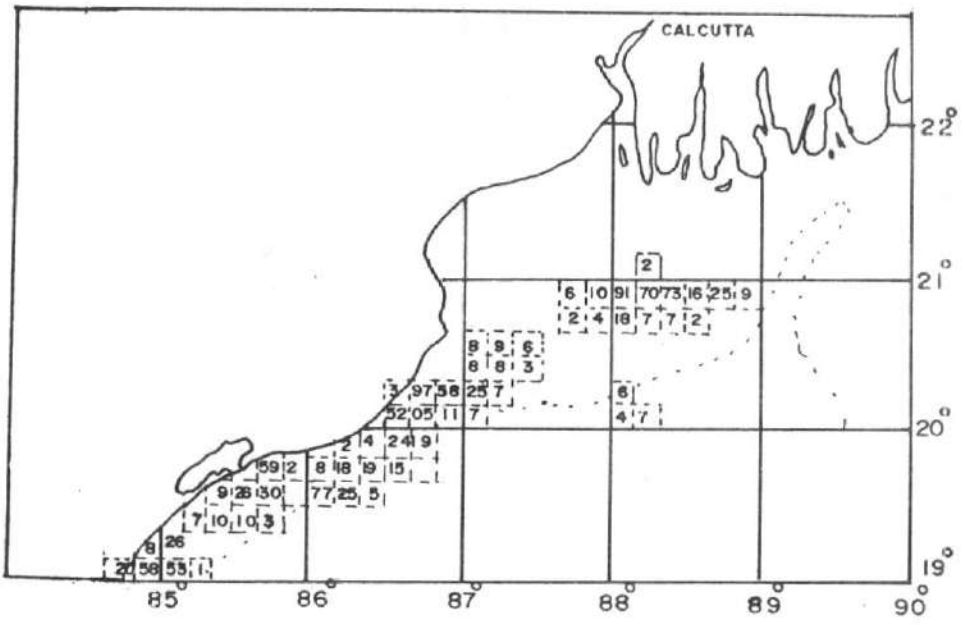


Fig. 4 Area-wise distribution of effort (trawling hours) along Orissa-West Bengal coast by all vessels together, 1960-74

(Source: FSI Bulletin No.5)

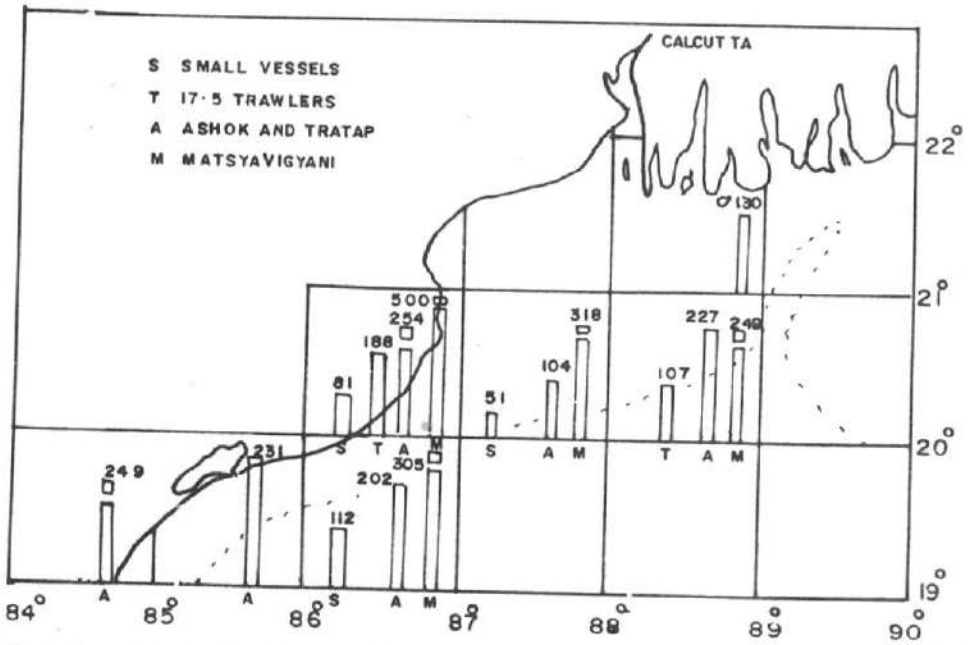


Fig. 5 CPUE (kg/hr) of trawling obtained by different vessels from Orissa-West Bengal coast, 1960-74

(Source: FSI Bulletin No.5)

Based on the results of fishing by M. T. Ashok, M. T. Pratap, 17.5m vessels and Matsya Vigyani the standing stock of demersal resources upto 50m depth along Orissa-West Bengal coast has been worked out as 1,76,369 tonnes (Joseph **et al.**, 1976) which forms 80.6% of standing stock of demersal resources from the upper east coast. Details of the estimate are furnished in Table 8.

Table 8. Estimate of stock of demersal resources within 50m depth along Orissa-West Bengal coast based on survey by M.T.Ashok, M.T. Pratap, 17.5m vessels and Matsya Vigyani during 1960-74

Area	Area (sq km)	Standing stock (tonnes)
19-84	510	3,245
19-85	3,400	20,066
19-86	2,040	17,936
20-86	3,400	22,586
20-87	7,570	32,426
20-88	2,720	10,550
21-86	935	3,626
21-87	8,500	32,967
21-88	8,500	32,967
Total	37,575	1,76,369

(Source: FSI Bulletin No. 5)

Matsya Vigyani, 1974-79

The vessel Matsya Vigyani continued trawl survey along the Orissa-West Bengal coast and the results from 1974-75 to 1978-79 are covered in Bulletin No. 2,4,6,8 and 9 of FSI. Altogether 2307 hours of sampling was done during the period (Table 9).

Table 9. Area-wise and year-wise trawl survey effort (No. of hours) by Matsya Vigyani 1974-79

Lat. N / Long. E	19°			20°			21°	
	85°	86°	87°	86°	87°	88°	87°	88°
Sampling hours								
1974-75	4	62	2	888	17	193	-	2
1975-76	-	7	-	15	10	403	-	-
1976-77	-	-	-	23	76	370	12	-
1977-78	-	-	-	-	-	42	-	-
1978-79	-	41	-	73	15	52	-	-
Total	4	110	2	999	118	1060	12	2

Summary of results obtained is furnished in Table 10. It may be

Table 10. Results of bottom trawl survey by Matsya Vigyani, 1974-79

Lat. N / Long. E	19°			20°			21°	
	85°	86°	87°	86°	87°	88°	87°	88°
Sampling hours	4	110	2	999	118	1060	12	2
CPUE (kg/hr)								
Sharks, skates & rays	23.5	38.1	52.5	18.6	54.4	46.9	71.7	25.0
Cat fish	-	9.3	52.5	5.6	5.4	4.6	0.8	-
Eel	-	16.2	-	2.6	1.0	2.6	-	-
Pomfret	-	20.9	56.0	12.8	3.5	2.4	3.7	-
Prawns	-	2.4	18.0	22.2	1.6	4.9	4.2	-
Perches	-	8.2	53.0	1.9	8.2	2.3	-	-
Ghol	-	-	-	0.3	0.4	0.9	8.3	-
Sciaenids (small)	-	0.1	-	0.4	0.2	-	-	-
Other quality fishes	9.8	22.0	270.5	50.0	1.6	7.4	-	-
Other fishes	46.7	78.1	109.5	154.1	120.8	151.3	197.8	105.0
TOTAL	80.0	195.3	612.0	268.5	197.1	225.3	286.5	130.0

seen that significantly high catch rate of prawns was recorded in some of the areas. Details of these findings are discussed seperately.

17.5 m vessels, 1972-80

Two 17.5 m vessels, Meena Grahi and Meena Prasarak, based at Paradeep conducted demersal resources survey from 1973/74 to 1980. Five vessels viz. Meena Tarangini, Meena Saudagar, Meena Gaveshak, Meena Prasarak and Meena Pradata conducted trawl survey from Calcutta for varying periods during 1972-79. The fishing effort by these vessels along Orissa-West Bengal coast totalled 6005 hours.

Results of survey by the 17.5m vessels are discussed in detail by Joseph, 1980 (FSI Bulletin No.10). Catch per unit effort of important groups of fishes obtained in this survey is given in Table 11.

Table 11. CPUE (kg/hr) of important varieties of fish obtained from Orissa-West Bengal coast by 17.5m vessels, 1972-80

Depth zone (m)	0-19	20-39	40-59
Fishing effort (hrs)	2647	3346	12
CPUE (kg/hr)			
Sharks, skates and rays	16.6	20.1	2.8
Eel	2.2	2.2	2.9
Cat fish	2.6	5.4	0.7
Karkara	0.1	0.9	-
Ghol	0.3	0.3	-
Koth	-	0.8	-
Dhoma	21.6	29.0	1.1
Pomfret	4.2	3.9	-
Seer fish	1.9	0.5	-
Butter fish (**Lactarius** sp.)	0.4	0.6	-
Carangids	0.1	0.2	-
Perches	2.1	0.3	0.7
Ribbon fish	0.5	0.5	-
Prawns	8.8	13.1	0.4

(Source : FSI Bulletin No.10)

Prawns yielded average CPUE of 8.8 kg/hr within 20m depth and 13.1 kg/hr in 20-39 m depth zone. The area-wise and depth-wise catch rates of all fish is depicted in Fig.6. Observation on seasonal variation (Fig. 7) indicated that the period from October to January is more productive.

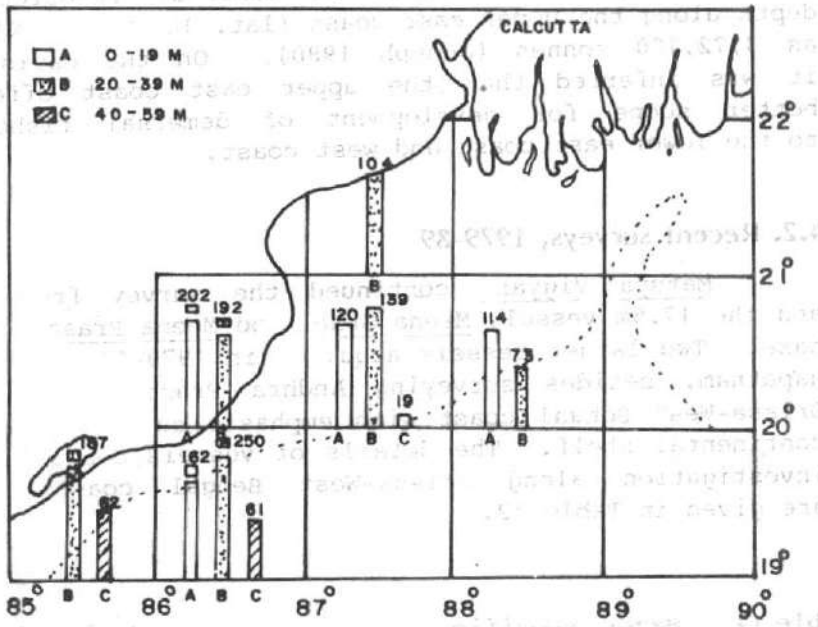


Fig. 6 Area-wise and depth-wise CPUE (kg/hr) obtained by 17.5m vessels from (Orissa-West Bengal coast, 1972-80

(Source: FSI Bulletin No. 10)

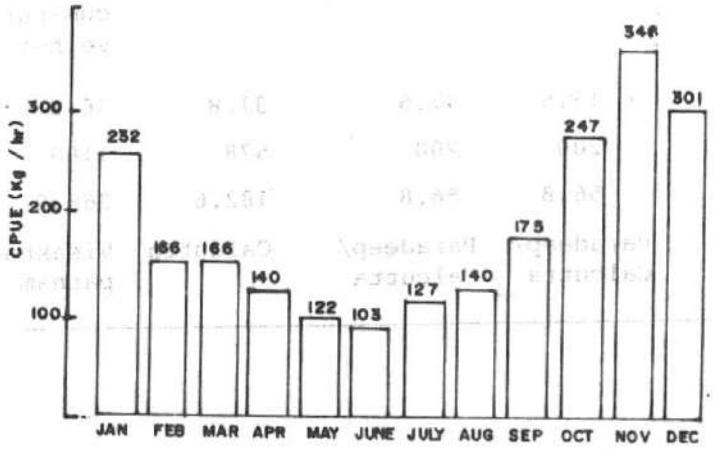


Fig. 7 Month-wise CPUE (kg/hr) obtained by 17.5 m vessels along Orissa-West Bengal coast, 1972-80

(Source: FSI Bulletin No. 10)

The potential yield of demersal resources within 75m depth along the upper east coast (lat. 16°N to 21°N) was estimated as 3,72,100 tonnes (Joseph 1980). On the basis of the study it was inferred that the upper east coast offers relatively better scope for development of demersal fisheries compared to the lower east coast and west coast.

4.2. Recent surveys, 1979-89

Matsya Vigyani continued the survey from Calcutta base and the 17.5m vessels Meena Grahi and Meena Prasarak from Paradeep base. Two larger vessels acquired in 1979-80 and based at Visakhapatnam, besides surveying Andhra Pradesh coast, covered the Orissa-West Bengal coast with emphasis on resources in the outer continental shelf. The details of vessels deployed for resources investigation along Orissa-West Bengal coast during 1979-89 are given in Table 12.

Table 12. Major specifications of vessels deployed for survey along Orissa-West Bengal coast during 1979-89

Name of vessel	Meena Grahi	Meena Prasarak	Matsya Vigyani	Matsya Darshini	Matsya Shikari
Type	Trawler	Trawler	Trawler	Trawler-cum-purse seiner	Combination trawler
OAL (m)	17.5	17.5	31.8	36.5	39.5
BHP	200	200	578	1160	1740
GRT	56.8	56.8	182.6	268.8	352.0
Base of operation	Paradeep/ Calcutta	Paradeep/ Calcutta	Calcutta	Visakha-patnam	Visakha-patnam

The vessel Matsya Darshini, in addition to bottom trawling, conducted pelagic/columnar resources survey by purse-seining and midwater trawling for limited durations. All the other vessels were engaged exclusively in demersal resources survey and monitoring. Details of gear used by these vessels are furnished in Table 13.

Table 13. Survey methods and fishing gear used by different vessels along Orissa-West Bengal coast during 1979-89

Vessel	Type of survey conducted	Fishing gear used	Mesh size (mm)
Meena Grahi	Bottom trawling	24 m FT	50-140
Meena Prasarak		28 m ST	36-50
Matsya Vigyani	Bottom trawling	35 m FT	45-140
Matsya Darshini	Bottom trawling	44 m star model FT	40-200
		45.5 m Expo model FT	40-400
	Midwater trawling	12 fm x 12 fm MWT	40-540
	Purse seining	416.5 m x 94 m PS	18.4
Matsya Shikari	Bottom trawling	34 m FT	80-400
	Midwater trawling	69 m x 64.40 m MWT	40-1800

FT = Fish trawl, ST = Shrimp trawl, MWT = Midwater trawl, PS = Purse seine

4.2.1. Pelagic resources survey

Survey of pelagic resources of Orissa-West Bengal coast could be taken up in a very limited way only due to different constraints. The sporadic efforts by purse-seining and midwater trawling, though could not lead to precise understanding on quantitative aspects of the stock, have given indications of the stock components and their likely distribution.

Midwater trawling

Matsya Darshini, during 1980-81 conducted 34.75 hours midwater trawl survey in areas 19-85 and 19-86 along the Orissa coast. Out of 20 tows made 11 were successful and the catch per succcessful tow was 233 kg. The catch obtained per hour of survey was 64.5 kg and 95.9 kg respectively from the two areas (Table 14). The major components were sardines, sharks and cat fish.

Table 14. Results of midwater trawl survey by Matsya Darshini along Orissa coast

Lat. N	19°	
Long. E	85°	86°
Survey effort (hrs)	24.50	10.25
CPUE (kg/hr)		
Shark	18.0	20.5
Cat fish	1.6	1.0
Eel	0.3	-
Seer fish	0.2	-
Sardine	36.6	61.8
Other fishes	7.8	12.6
total	64.5	95.9

Depth-wise abundance of the columnar stock indicated higher CPUE (127.9 kg/hr) in 30-50m depth zone of long. 85° followed by 118.6 kg/hr in 50-100m depth zone of long. 86° (Table 15).

Table 15. Area-wise and depth-wise CPUE (kg/hr) obtained in midwater trawl survey by Matsya Darshini

Lat. N	Long. E	Depth zone (m)	CPUE (kg/hr)
19°	85°	30-50	127.9
		50-100	38.9
19°	86°	30-50	68.0
		50-100	118.6

Purse seining

Matsya Darshini conducted pelagic survey by purse-seining to a limited extent during 1980-85. The major areas 19-84, 19-85, 19-86 and 20-87 were sampled. Altogether 34 sets were made in 29-217 m depth range. The results are given in Table 16. Though not very encouraging, these results are indicative of availability of shoaling fishes in the survey area. The major catch components were horse mackerel (39.7%), lesser sardine (18.1%), shark (16.2%), seer fish (9.6%), little tuna (3.3%), caranx (2.7%), yellowfin tuna (1.9%) and skipjack (1.1%). Abundance of these stocks are however to be established.

4.2.2. Demersal resources survey

Details of trawl survey conducted along Orissa-West Bengal coast between April 1979 and March 1989, other than the data of 17.5 m vessels for 1979-80 which has already been covered in earlier publication,are presented here.

17.5 m vessels

During 1980-82 two vessels, Meena Grahi and Meena Prasarak operated from Paradeep base and conducted trawl survey for 1640 hours along the Orissa coast. With the closure of Paradeep base in 1982 these vessels were transferred to Calcutta base and continued survey upto 1985-86. Two more vessels of this class operated from Calcutta for short durations during this period. The details of sampling by the 17.5 m vessels over the years are given in Table 17. Aggregate fishing effort by the 17.5 m vessels along Orissa-West Bengal coast was 2547 hours. The vessels operated 24m fish trawl with codend mesh of 50mm at an average trawling speed of 2 knots.

Matsya Vigyani

Matsya Vigyani conducted trawl survey along West Bengal coast during 1979-82 spending a total effort of 680 hours. Distribution of sampling in the different areas is given in table 18. Trawling was done by 35m fish trawl with codend mesh of 45mm at an average trawling speed of 2.5 knots.

Matsya Darshini

Matsya Darshini, the combination trawler-cum-purse seiner, based at Visakhapatnam was engaged in survey of resources along the upper east coast. The vessel covered the Orissa-West coast by bottom trawl survey during 1980-81 and 1985-87. The aggregate sampling effort was 1205 hours. Distribution of sampling in different areas over the years is given in Table 19. The main gear operated

Table 16. Results of pelagic resources survey by purse-seining obtained by Matsya Darshini along Orissa coast, 1980-85

Year	Month	Area	Sets made	Depth of operation (m)	Total catch (kg)	Catch details (kg)
1980	Nov	19-85	4	41-138	138	Little tuna 100, Shark 38
1983	Feb	19-86	5	56-95	6300	Horse mackerel 5000, Shark 700, Caranx 300, Moon fish 300
1984	May	20-87	2	53-71	-	-
		19-84	1	42	450	Yellowfin tuna 235, Sardine 100, Seer fish 75, Shark 40
	July	19-84	1	29	985	Shark 820, Skipjack 128 Seer fish 25, Others 124
	Sep	19-85	2	40-217	882	Seer fish 545, Little tuna 200, Others 83, Silver belly 54
		20-87	5	85-134	40	Shark 40
	Oct	20-87	1	68	-	-
		19-86	1	172	-	-
	Nov	19-85	1	40	529	Seer fish 275,Sardine 203 Caranx 44, Skipjack 7
		20-87	1	38	-	-
	Dec	19-85	1	84	-	-
		19-86	2	48-55	-	-
1985	Jan	19-84	1	42	-	-
		19-86	1	146	-	-
	Feb	19-85	3	35-119	3240	Sardine 2000, Shark 350 Seer fish 300, Anchovies 150, Little tuna 120, Others 320
		19-86	1	66	30	Shark 30
	Apr	19-85	1	36	120	Misc. fish 120

Table 17. Sampling intensity (No.of fishing hours) by 17.5m vessels in trawl survey along Orissa-West Bengal coast, 1980-86

Base	Name of vessel	Year						Total
		1980-81	81-82	82-83	83-84	84-85	85-86	
Paradeep	Meena Grahi	532	145	-	-	-	-	677
	Meena Prasarak	646	317	-	-	-	-	963
Calcutta	Meena Shodak	-	-	20	-	-	-	20
	Meena Grahi	-	-	137	216	9	-	362
	Meena Prasarak	-	-	235	149	77	38	499
	Meena Anaveshak	-	-	-	-	-	26	26
	TOTAL	1178	462	392	365	86	64	2547

Table 18. Distribution of sampling (No.of fishing hours) by Matsya Vigyani in trawl survey along West Bengal coast, 1979-82

Lat. N / Long. E	20°		21°		Total
	87°	88°	87°	88°	
1979-80	123	93	95	49	360
1980-81	18	109	21	35	183
1981-82	46	18	35	38	137
TOTAL	187	220	151	122	680

Table 19. Distribution of sampling (No.of fishing hours) by Matsya Darshini in trawl survey along Orissa-West Bengal coast, 1980-87

Lat. N / Long. E	19°		20°					21°	Total
	84°	85°	85°	86°	87°	88°	89°	89°	
1980-81	8	17	-	-	-	-	-	-	25
1985-86	-	-	6	20	399	390	74	6	895
1986-87	3	36	6	3	129	98	7	3	285
TOTAL	11	53	12	23	528	488	81	9	1205

by the vessel was 44m Star model trawl net with codend mesh of 40mm. Also 45.5 m Expo model trawl with same codend mesh was used for limited periods. Trawling was done at an average speed of 3.5 knots.

Matsya Shikari

Matsya Shikari also based at Visakhapatnam and engaged in survey of Andhra Pradesh and Orissa coasts had done 1975 hours of trawling along Orissa coast. The details of sampling distribution is shown in Table 20. The gear operated was 34m fish trawl with a codend mesh of 80mm, at a trawling speed of 3.5 knots.

Table 20. Distribution of sampling (No.of fishing hours) by Matsya Shikari in trawl survey along Orissa-West Bengal coast, 1979-89

Lat. N	19°			20°			Total
Long. E	84°	85°	86°	86°	87°	88°	
1979-80	11	204	73	9	17	5	319
1980-81	-	236	7	-	-	-	243
1981-82	-	1	-	-	-	-	1
1982-83	2	128	60	11	47	48	296
--							
1986-87	8	207	109	4	-	-	328
1987-88	4	265	141	-	-	-	410
1988-89	3	262	113	-	-	-	378
TOTAL	28	1303	503	24	64	53	1975

Combined sampling effort

All the survey vessels together have done 6407 hours fishing in bottom trawl survey along Orissa-West Bengal coast during 1979-89. Year-wise and vessel-wise effort details are given in Table 21.

Table 21. Aggregate sampling effort (No.of fishing hours) in bottom trawl survey by FSI vessels along Orissa-West Bengal coast, 1979-89

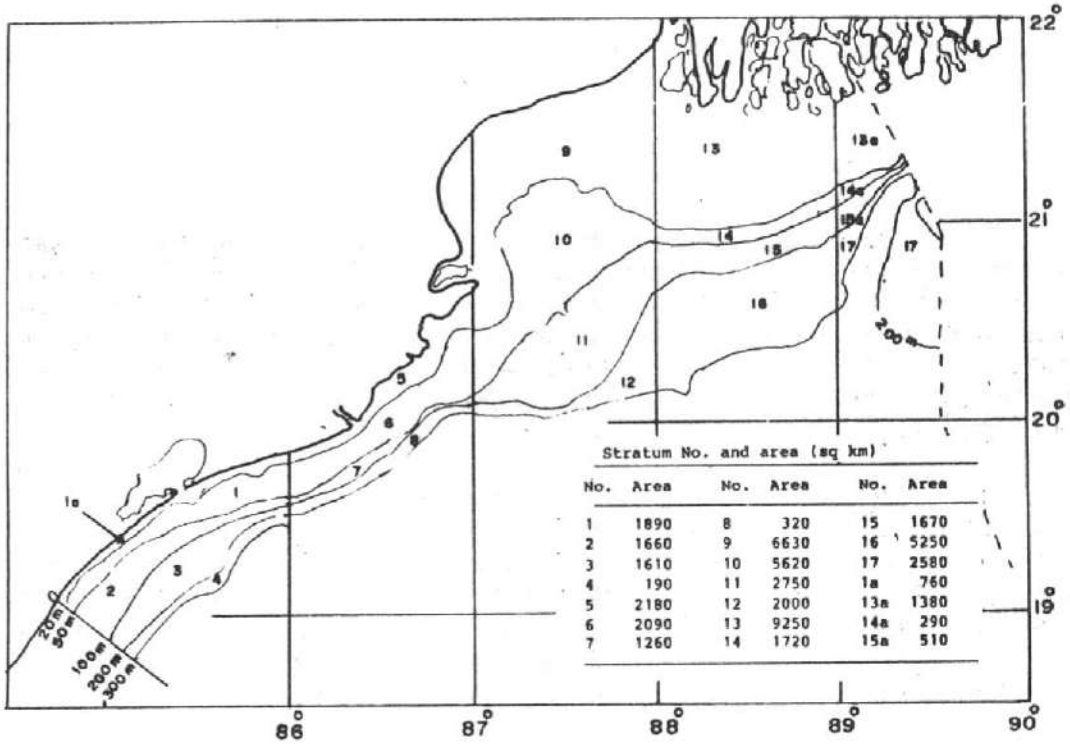
Year	17.5m vessels	Matsya Vigyani	Matsya Darshini	Matsya Shikari	Total
1979-80	*	360	-	319	679
1980-81	1178	183	25	243	1629
1981-82	462	137	-	1	600
1982-83	392	-	-	296	688
1983-84	365	-	-	-	365
1984-85	86	-	-	-	86
1985-86	64	-	895	-	959
1986-87	-	-	285	328	613
1987-88	-	-	-	410	410
1988-89	-	-	-	378	378
TOTAL	2547	680	1205	1975	6407

* Not included

Survey area and stratification

The Orissa-West Bengal coast extends from lat. 18°40' to 21°35'N and long. 84°50' to 89°35'E. In long. 85° the survey extended from 20m to 300m depth whereas in the remaining areas sampling was between 10m and 200m depth.

For analysis of data and presentation of results a post-stratification scheme is adopted wherein the stratum boundaries are defined by longitudes and depth contours. The survey area is divided into 17 strata as indicated in Fig. 8.



No.	Area	No.	Area	No.	Area
1	1890	8	320	15	1670
2	1660	9	6630	16	5250
3	1610	10	5620	17	2580
4	190	11	2750	1a	760
5	2180	12	2000	13a	1380
6	2090	13	9250	14a	290
7	1260	14	1720	15a	510

Fig. 8. Scheme of stratification
(The stratum with suffix 'a' are not sampled. Results of adjacent stratum assumed)

5. RESULTS OF DEMERSAL RESOURCES SURVEYS

The 17.5m vessels, in 2547 hours of sampling within 50m depth, netted a total catch of 230.9 tonnes. Five strata spread over the longitudes 86°, 87° and 88° were covered. The CPUE in different strata ranged from 74.9 to 107 kg/hr. High catch rates of 106-107 kg/hr were obtained from within 20m depth in long. 87° and in 20-50m depth zone in long. 88°. The strata-wise and species-wise catch rates obtained are given in Table 22. The stratified mean CPUE was worked out as 97.3 kg/hr using the formula:

$$\bar{x}_{st} = \frac{\bar{x}_a \cdot \text{area (A)} + \bar{x}_b \cdot \text{area (B)} + \text{-----}}{\text{area (A+B+ -------)}}$$

where $\bar{x}_{st}$ = stratified mean CPUE

$\bar{x}_a, \bar{x}_b,$ ---- = mean CPUE in stratum A,B and so on

Aggregate catch obtained by Matsya Vigyani in 680 hours trawling within 100m depth was 90.2 tonnes. The vessel surveyed six strata (No. 9,10,11,13,14 and 15) with more sampling in the grounds off West Bengal coast. Catch per hour was in the range of 103.7 to 172.9 kg. The strata-wise survey results are shown in Table 23. Stratified mean CPUE obtained from the sampled area is 140.7 kg/hr.

Matsya Darshini did sampling upto 200m depth and covered 12 strata. Highest CPUE of 214.8 kg/hr was obtained from 50-100m depth zone of long. 86° (stratum 7) followed by 200.4 kg/hr from long. 84-85° (stratum 2) and 199.7 kg/hr from long. 88° in the same depth range (stratum 15). Strata-wise and species-wises catch rates are given in Table 24. Stratified mean CPUE recorded in the survey was 141.8 kg/hr.

Matsya Shikari also sampled 12 strata in 20-300m depth range. The survey results are presented in Table 25. It may be seen that the highest catch rate of 345.8 kg/hr was obtained off West Bengal coast in 50-100m depth range (stratum 15) followed by 335.8 kg/hr from the same depth zone in long. 86° off Orissa coast. The 100-200m depth zone all over the coast yielded low CPUE in the range of 38.1 to 59.4 kg/hr. The lowest catch rate of 14 kg/hr was recorded in the continental slope area in 200-300m depth. Stratified mean CPUE in the sampled area works out to 211.6 kg/hr. The trawl sampling hours and the resultant CPUE obtained in each strata by the different vessels are depicted in Fig. 9 and Fig.10.

Table 22. Species-wise CPUE obtained in bottom trawl survey by 17.5m vessels, along Orissa-West Bengal coast, 1980-86

Stratum No.	- 5	6 -	9	10 -	14
Longitude (E)	86°	86°	87°	87°	88°
Depth zone (m)	0-20	20-50	0-20	20-50	20-50
Sampling hours	74.8	1073.3	141.1	1047.9	210.2
CPUE (kg/hr)					
Sharks, skates & rays	15.4	7.8	19.9	15.6	35.6
Eel	-	0.8	-	0.7	0.7
Cat fish	2.3	1.3	2.8	3.2	6.9
Ribbon fish	-	1.6		0.6	-
Perches	1.5	0.3	-	0.6	0.9
Pomfret	0.2	0.8	-	1.5	0.4
Sciaenids (small)	0.6	0.2	9.8	6.7	10.4
Threadfin bream	-	-	-	1.7	0.1
Silver belly	1.3	3.5	3.3	3.8	-
Caranx	-	0.3	-	0.6	0.7
Prawns	2.7	4.7	-	2.7	0.2
Squid & cuttle fish	-	-	-	0.5	-
Seer fish	-	0.2	-	0.2	-
Mackerel	-	-	1.0	0.4	0.2
Clupeids	-	-	0.2	0.2	0.8
Other fishes	50.9	57.3	70.0	59.6	49.2
TOTAL	74.9	78.8	107.0	98.6	106.1

Table 23. Species-wise CPUE obtained in bottom trawl survey by Matsya Vigyani along Orissa-West Bengal coast, 1979-82

Stratum No.	9	10	11	-	13	14	15
Longitude (E)	87°	87°	87°		88°	88°	88°
Depth zone (m)	0-20	20-50	50-100		0-20	20-50	50-100
Sampling hours	63.0	239.0	36.0		9.20	233.0	17.0
CPUE (kg/hr)							
Sharks, skates & rays	45.7	49.2	43.7		38.0	44.4	43.0
Eel	-	1.4	1.4		0.2	0.4	-
Cat fish	15.6	12.5	15.2		7.1	11.2	24.6
Ribbon fish	-	-	-		-	-	-
Perches	-	3.2	1.5		0.3	2.6	0.8
Pomfret	0.7	1.6	0.7		0.2	2.9	1.2
Sciaenids	9.8	4.8	8.4		4.0	2.1	2.1
Prawns	-	0.3	-		-	0.1	0.3
Seer fish	-	0.1	-		0.1	-	-
Horse mackerel	-	0.1	0.1		-	0.3	1.9
Other fishes	101.1	81.6	69.2		53.8	45.1	65.5
TOTAL	172.9	154.8	140.2		103.7	109.1	139.4

Table 24. Species-wise CPUE obtained in bottom trawl survey by Matsya Darshini along Orissa-West Bengal coast, 1980-87

Stratum No.	1	2	3	-	6	7	-	10	11	12	-	14	15	16	17
Longitude (E)	84,85°	84,85°	84,85°	-	86°	86°	-	87°	87°	87°	-	88°	88°	88°	89°
Depth zone (m)	20-50	50-100	100-200		20-50	50-100		20-50	50-100	100-200		20-50	50-100	100-200	100-200
Sampling hours	22.0	41.5	11.7		3.7	19.9		198.0	316.9	12.8		43.9	161.5	283.0	90.0
CPUE (kg/hr)															
Sharks,skates & rays	11.3	4.6	-		4.1	19.5		16.3	6.5	-		7.1	3.8	1.4	2.8
Eel	1.6	-	-		-	0.4		11.4	0.8	-		1.6	1.2	-	-
Cat fish	11.9	5.9	-		2.7	14.6		6.2	5.8	-		8.6	3.7	0.1	0.3
Ribbon fish	-	-	-		2.7	3.3		38.1	4.6	0.1		15.9	5.1	0.7	5.9
Perches	21.8	27.5	-		1.4	5.8		8.6	7.7	-		10.5	4.0	0.6	8.3
Pomfret	-	1.4	-		0.6	1.5		13.2	5.4	-		5.7	3.0	-	-
Sciaenids (small)	-	-	0.1		-	-		5.9	2.0	-		4.3	4.1	1.1	1.1
Ghol	-	-	-		-	2.8		0.6	1.2	-		0.1	0.3	0.3	-
Lizard fish	-	-	-		0.8	1.2		0.5	0.7	-		-	0.6	0.1	-
Threadfin bream	0.7	-	-		-	3.0		0.1	-	-		1.6	3.2	0.7	1.5
Silver belly	23.3	0.6	-		10.9	103.7		22.0	10.9	-		2.9	1.1	-	-
Goat fish	2.5	0.6	-		-	1.3		1.0	2.2	3.4		2.5	2.6	1.0	-
Caranx	1.5	2.0	-		-	2.0		4.6	7.6	2.4		2.4	2.7	1.5	0.1
Bulls eye	-	-	8.1		-	-		-	0.6	16.6		0.2	1.5	11.1	22.0
Indian drift fish	-	-	-		-	12.1		0.3	21.0	0.4		0.2	3.2	16.7	1.5
Prawns	-	0.2	-		0.3	0.1		0.2	0.3	-		1.1	0.8	-	-
Lobster	-	-	-		-	-		-	0.1	-		1.1	-	-	-
Squids & cuttle fish	-	-	-		-	0.1		-	0.1	-		-	-	-	-
Seer fish	6.2	1.9	-		-	-		1.9	0.5	-		1.1	0.3	0.1	-
Mackerel	9.1	59.6	-		-	6.0		2.4	29.1	3.5		0.1	141.6	107.0	115.3
Horse mackerel	-	-	-		-	9.2		2.5	2.8	-		1.4	-	0.1	-
Scads	-	-	14.2		-	-		-	6.6	11.4		-	3.5	14.3	14.5
Clupeids	11.0	17.5	-		-	7.3		-	-	-		8.2	10.3	1.4	0.2
Deepsea prawns	-	-	-		-	-		-	-	-		-	-	-	-
Other fishes	65.3	78.6	-		2.7	20.9		44.9	27.6	-		13.5	3.1	1.0	0.4
TOTAL	166.2	200.4	22.4		26.2	214.8		180.7	144.1	37.8		90.1	199.7	159.2	173.9

Table 25. Species-wise CPUE obtained in bottom trawl survey by Matsya Shikari along Orissa-West Bengal coast, 1979-89

Stratum No.	1	2	3	4	- 6	7	8	- 10	11	12	- 15	16
Longitude (E)	84,85°	84,85°	84,85°	84,85°	86°	86°	86°	87°	87°	87°	88°	88°
Depth zone (m)	20-50	50-100	100-200	200-500	20-50	50-100	100-200	20-50	50-100	100-200	50-100	100-200
Sampling hours	319.4	698.5	204.5	106.8	186.8	307.4	33.0	8.8	35.2	20.8	40.4	12.0
CPUE (kg/hr)												
Sharks,skates & rays	8.6	5.7	1.3	0.6	8.0	8.7	0.1	28.3	2.3	-	-	-
Eel	0.2	0.1	-	-	0.3	0.4	0.1	0.2	-	-	-	-
Cat fish	23.5	98.1	6.6	-	16.9	43.8	-	24.3	5.3	-	5.2	-
Ribbon fish	7.3	1.8	-	-	3.6	1.0	-	-	-	-	-	-
Perches	7.5	8.8	1.0	--	-	5.9	-	-	-	-	-	-
Pomfret	5.4	3.6	-	-	13.0	6.7	-	2.4	4.1	-	-	-
Sciaenids (small)	6.3	1.1	0.9	-	5.0	5.4	-	-	-	-	-	-
Ghol	0.1	0.3	-	-	13.4	0.7	-	-	-	-	-	-
Lizard fish	1.3	1.7	0.1	-	0.9	0.3	-	-	-	-	-	-
Threadfin bream	2.8	12.9	0.2	-	1.8	7.3	1.2	-	86.1	-	74.9	-
Silver belly	19.0	9.1	-	-	12.9	7.8	-	-	-	-	-	-
Goat fish	2.5	1.4	-	-	3.1	1.9	-	-	-	-	-	-
Caranx	5.4	5.1	0.4	-	6.3	9.8	0.2	-	-	-	139.8	-
Bulls eye	-	1.2	28.5	4.7	0.4	18.9	24.4	-	8.5	38.1	105.2	290.4
Indian drift fish	0.6	10.3	0.4	-	1.8	26.7	-	-	14.2	-	-	-
Prawns	0.2	-	0.1	-	0.1	0.1	-	-	-	-	-	-
Black ruff	-	0.7	0.4	0.9	-	-	6.1	-	-	-	-	-
Squid & cuttle fish	0.7	0.9	0.6	1.8	0.8	1.1	-	-	-	-	-	-
Seer fish	3.3	0.7	-	-	2.4	1.0	0.4	-	-	-	-	-
Mackerel	6.6	76.4	5.5	-	5.9	93.6	-	-	20.8	-	-	-
Horse mackerel	16.6	13.2	6.4	-	18.5	17.6	-	-	4.8	-	0.7	-
Scads	7.1	12.5	3.3	-	-	34.8	0.6	-	2.8	-	-	-
Clupeids	5.9	0.7	-	-	3.2	1.8	-	-	0.6	-	-	-
Deepsea prawns	-	-	0.1	1.0	-	-	-	-	-	-	-	-
Other fishes	8.9	26.0	3.6	5.0	16.2	40.5	0.2	18.1	45.5	-	20.0	-
TOTAL	139.8	292.3	59.4	14.0	134.5	335.8	33.3	73.3	195.0	38.1	345.8	290.4

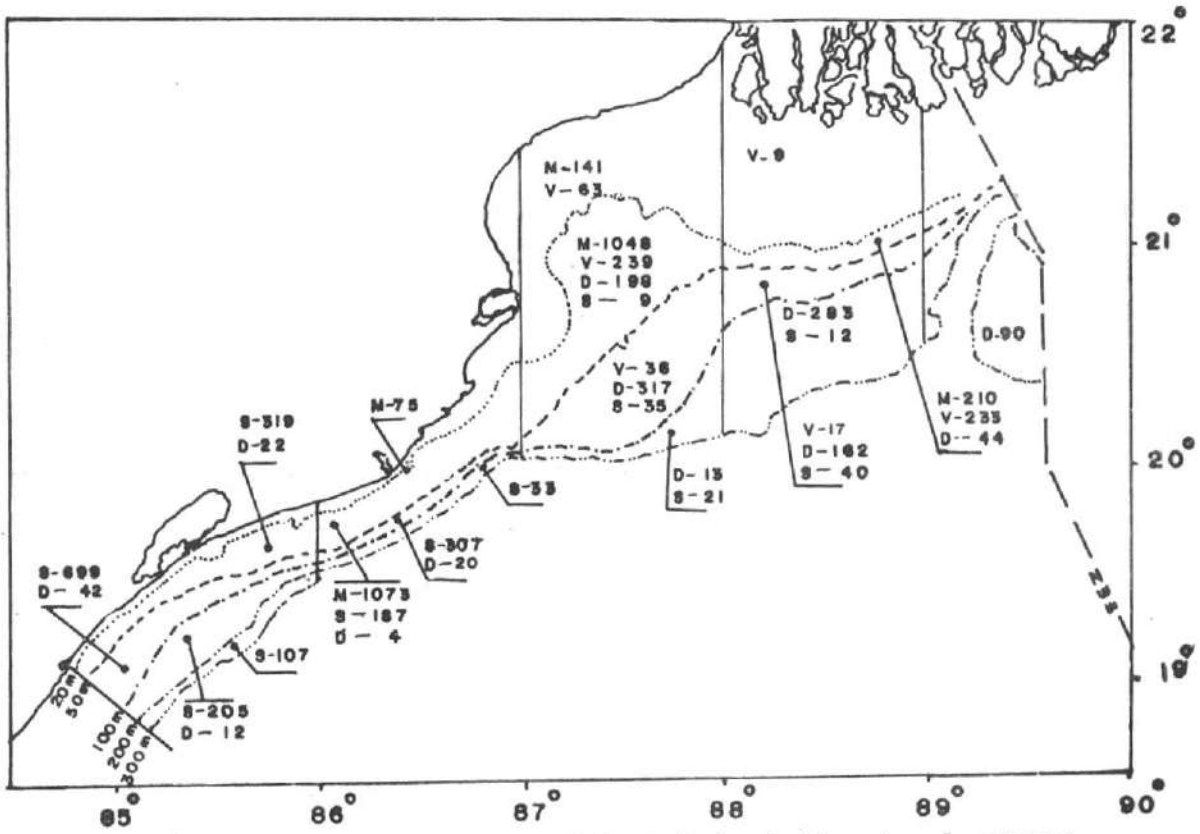


Fig. 9 Sampling intensity (No.of hours) in bottom trawl survey by different vessels along Orissa-West Bengal coast, 1979-89
(M = 17.5m vessels, V = Matsya Vigyani,
D = Matsya Darshini, S = Matsya Shikari)

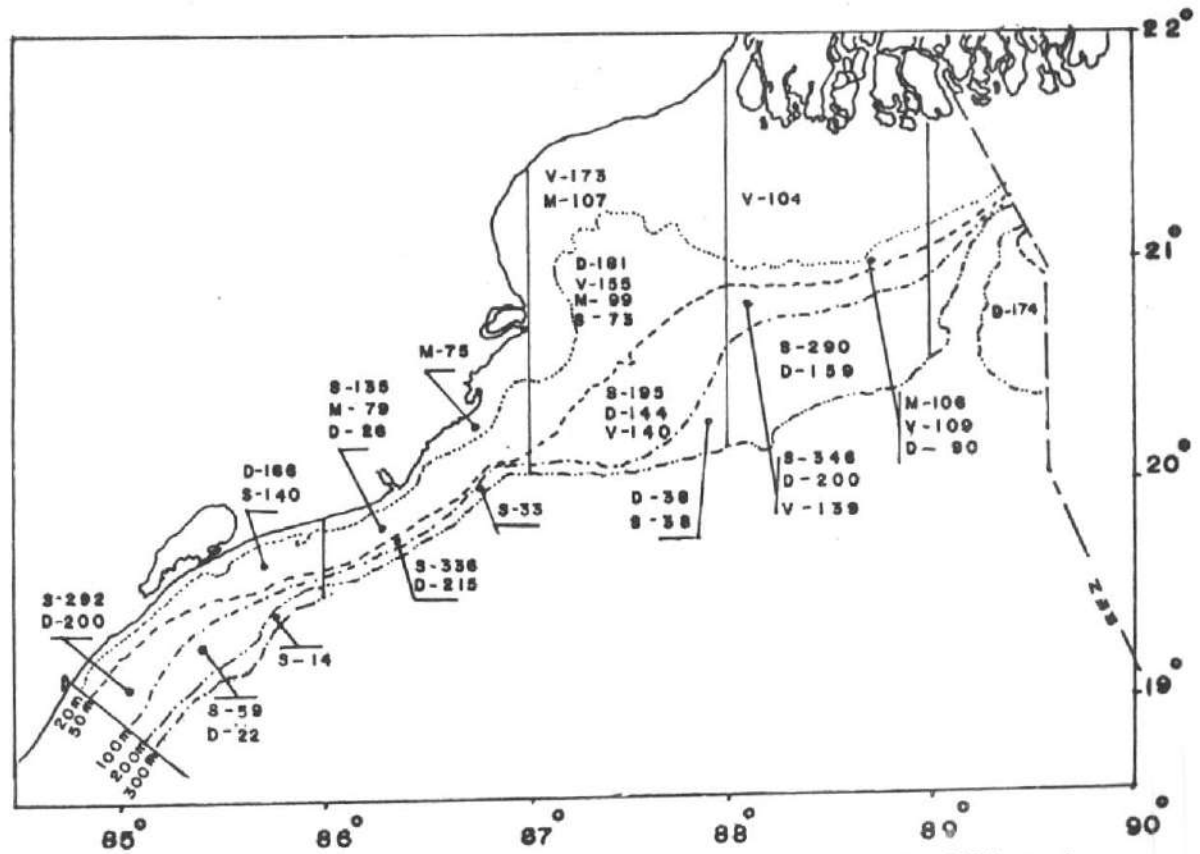


Fig. 10 CPUE (kg/hr) obtained in bottom trawl survey by different vessels along Orissa-West Bengal coast, 1979-89
(M = 17.5m vessels, V = Matsya Vigyani,
D = Matsya Darshini, S = Matsya Shikari)

5.1. Estimation of stock density

As sampling by different vessels was done using trawls of different sizes operated at different speeds the catch rates obtained are not directly comparable. Before pooling, the CPUE data was therefore to be converted to mean density of the stock. There are several strata which had been surveyed by more than one vessel and in such cases the data set generated by maximum sampling input is considered. This CPUE data was further transformed to absolute density indices by "swept area" method using different combination of parameters for different class of vessels as given in Table 26.

Table 26. Parameters used for estimation of "swept area" and stock density

Particulars	17.5m vessels	Matsya Vigyani	Matsya Darshini	Matsya Shikari
Head rope length (m)	24	35	44	34
Wing spread of net (%)	40	40	40	40
Trawling speed (knots)	2	2.5	3.5	3.5
Catchability coefficient	0.5	0.5	0.5	0.4

The strata-wise density of demersal stocks thus obtained is furnished in Table 27. The highest stock density of 9.52 tonnes/sq km was observed off Orissa coast in 50-100m depth zone in long. 86° followed by 8.29 tonnes/sq km in the same depth range in long. 84-85°. In the 20-50m depth belt, high density was recorded off West Bengal in long. 88° (5.97 tonnes/sq km). In the 100-200m depth belt also the grounds off West Bengal indicated relatively high stock density (2.79 to 3.05 tonnes/sq km). The distribution of demersal stock density in the different strata surveyed is given in Fig. 11 and that of dominant species in Fig. 12 a-h. Percentage of major components is given in Fig. 13.

The stratified mean density in the shelf area along the Orissa coast was found to be 3.71 tonnes/sq km. For the depth zones of 0-20m, 20-50m, 50-100m and 100-200m the respective values are 5.21 tonnes, 4.73 tonnes, 6.36 tonnes and 1.62 tonnes.

Along the West Bengal coast the stratified mean density was calculated as 3.61 tonnes/sq km and the values for four depth zones as above are 3.78 tonnes, 5.81 tonnes, 3.23 tonnes and 2.77 tonnes respectively.

Survey coverage of continental slope (200-300m depth) was limited to long. 85° only and the estimated stock density is 0.397 tonnes/sq km.

Table 27. Density (kg/sq km) of demersal stocks along Orissa-West Bengal coast

Stratum No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Longitude (E)	84,85°	84,85°	84,85°	84,85°	86°	86°	86°	86°	87°	87°	87°	87°	88°	88°	88°	88°	89°
Depth zone (m)	20-50	50-100	100-200	200-300	0-20	20-50	50-100	100-200	0-20	20-50	50-100	100-200	0-20	20-50	50-100	100-200	100-200
Sharks, Skates & rays	244	162	37	17	866	227	247	3	1119	877	114	-	1172	2002	67	25	49
Eel	6	3	-	-	-	9	11	3	-	39	14	-	6	39	21	-	-
Cat fish	666	2782	187	-	129	479	1242	-	158	180	102	-	219	388	65	2	5
Ribbon fish	207	51	-	-	-	102	28	-	-	34	81	2	-	-	89	12	103
Perches	213	250	28	-	84	-	167	-	-	34	135	-	9	51	70	11	146
Pomfret	153	102	-	-	11	369	190	-	-	84	95	-	6	23	53	-	-
Sciaenids (small)	179	31	26	-	34	141	153	-	551	377	35	-	123	585	72	19	19
Ghol	3	9	-	-	-	380	20	-	-	-	21	-	-	-	5	5	-
Lizard fish	37	48	3	-	-	26	9	-	-	-	12	-	-	-	11	2	-
Threadfin bream	79	366	6	-	-	51	207	34	-	96	-	-	-	6	56	12	26
Silver belly	539	258	-	-	73	366	221	-	186	214	191	-	-	-	19	-	-
Goat fish	71	40	-	-	-	88	54	-	-	-	39	60	-	-	46	18	-
Caranx	153	145	11	-	-	179	278	5	-	33	133	42	-	39	47	26	2
Bulls eye	-	34	808	133	-	11	536	692	-	-	11	291	-	-	26	195	386
Indian drift fish	17	292	11	-	-	51	757	-	-	-	369	7	-	-	56	293	26
Prawns	6	-	3	-	152	3	3	-	-	152	5	-	-	11	14	-	-
Black ruff	-	20	11	26	-	-	-	173	-	-	2	-	-	-	-	-	-
Squid & cuttle fish	20	26	17	51	-	23	31	-	-	28	2	-	-	-	-	-	-
Seer fish	94	20	-	-	-	68	28	11	-	11	9	-	3	-	5	2	-
Mackerel	187	2167	156	-	-	167	2654	-	56	22	510	61	-	11	2482	1876	2022
Horse mackerel	471	374	182	-	-	525	499	-	-	-	49	-	-	-	-	2	-
Scads	201	355	94	-	-	-	987	17	-	-	116	200	-	-	61	251	254
Clupeids	167	20	-	-	-	91	51	-	11	-	156	-	-	39	181	25	4
Deep sea prawns	-	-	3	28	-	-	-	-	-	11	-	-	-	-	-	-	-
Misc. fishes	244	737	105	142	2863	457	1149	6	3937	3354	325	-	1662	2773	54	18	7
TOTAL	3957	8292	1688	397	4212	3814	9522	944	6018	5546	2526	663	3200	5967	3500	2794	3049

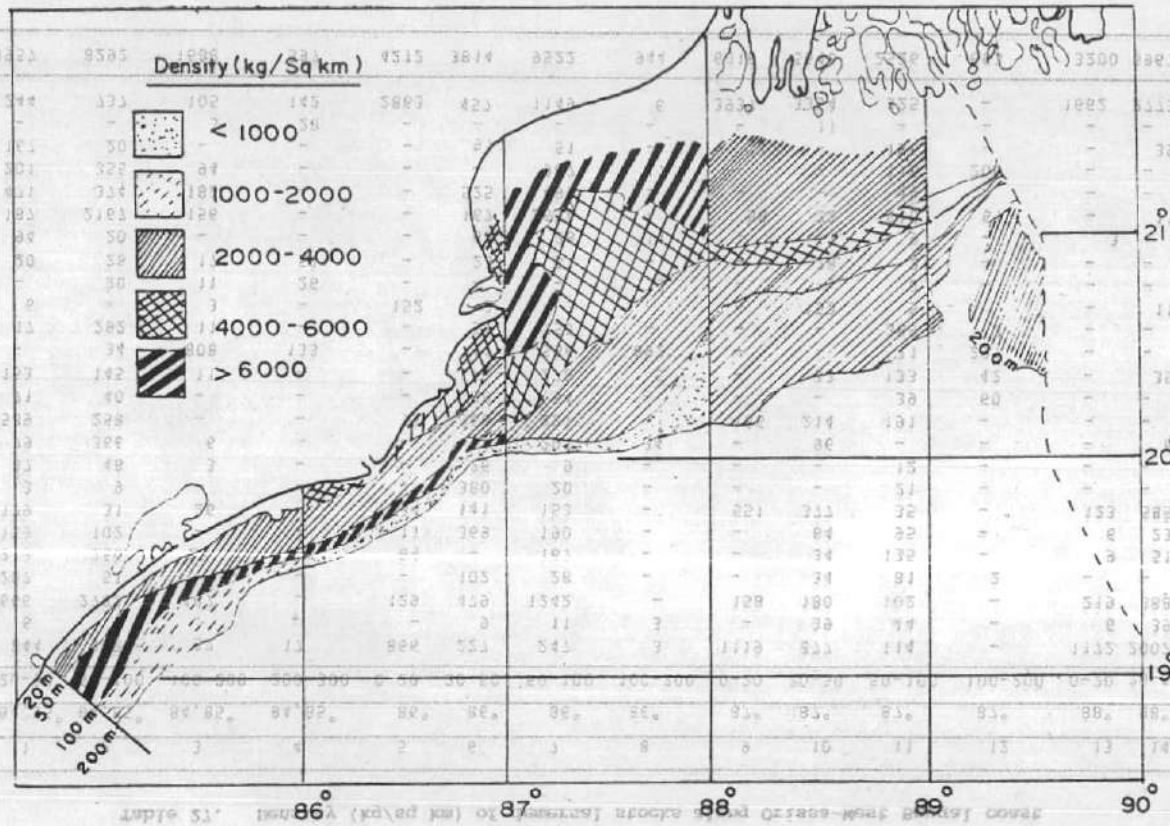


Fig. 11 Density of demersal resources along Orissa-West Bengal coast

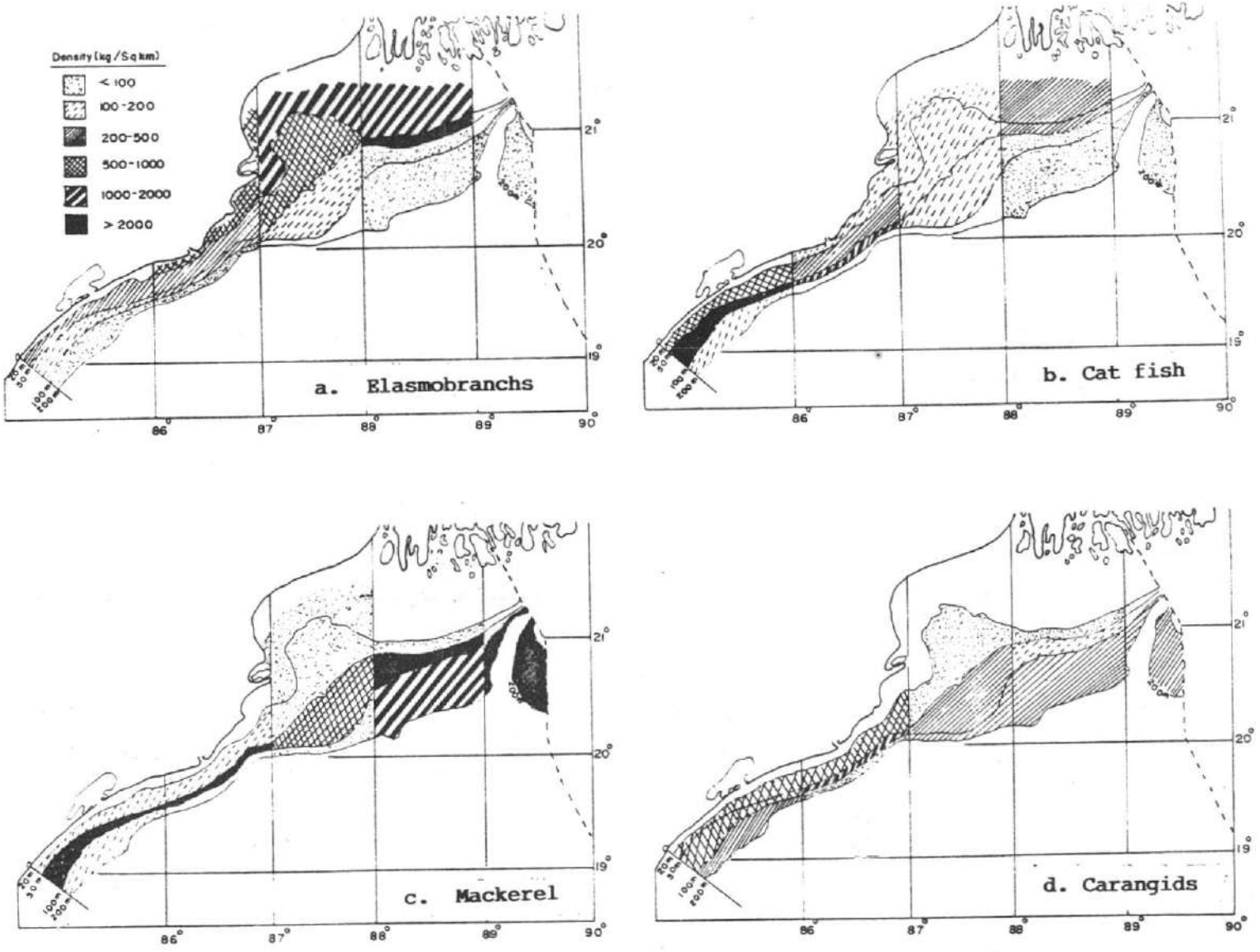


Fig. 12 a-d Density of major demersal stocks along Orissa-West Bengal coast

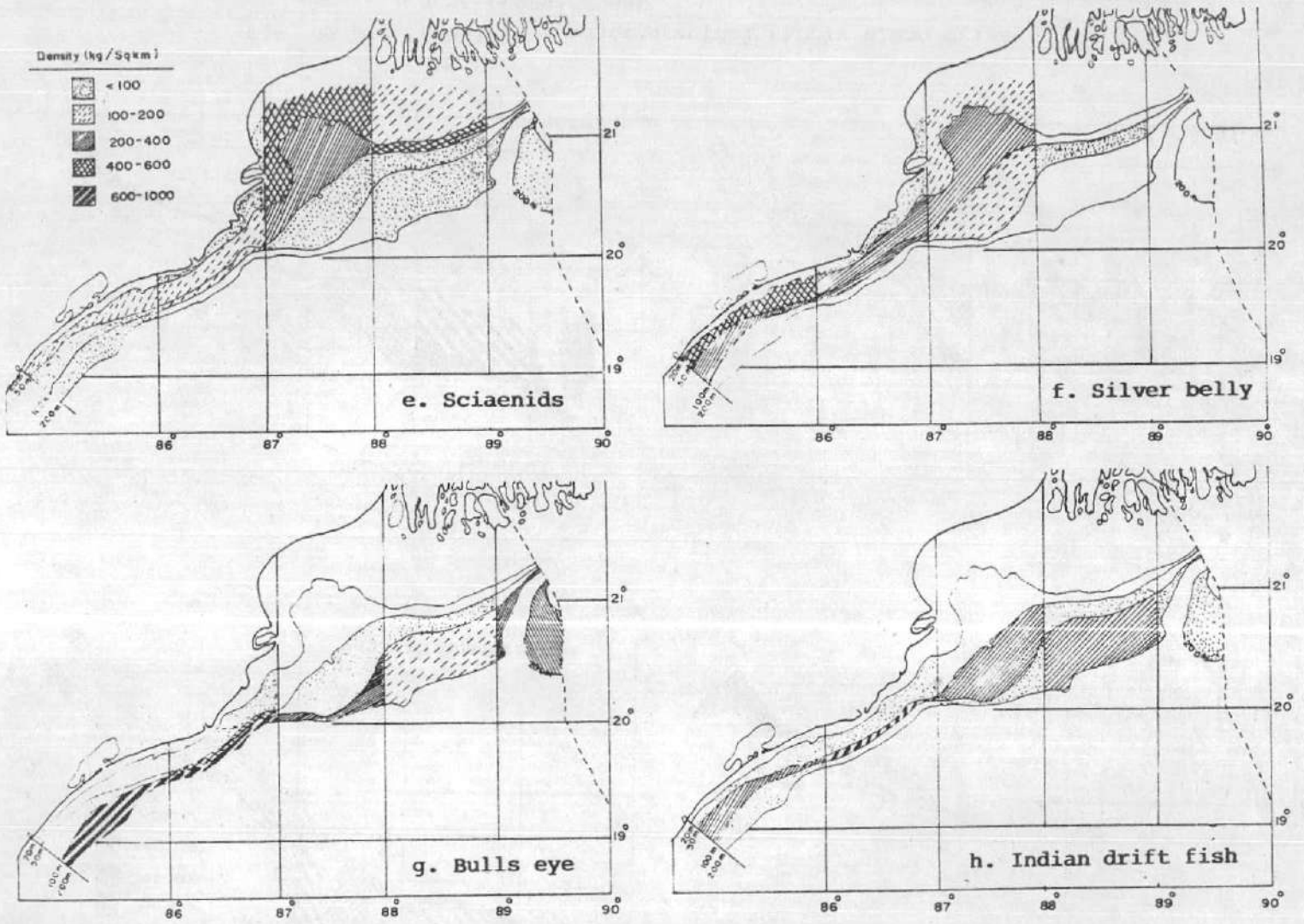


Fig. 12 (continued), e-h

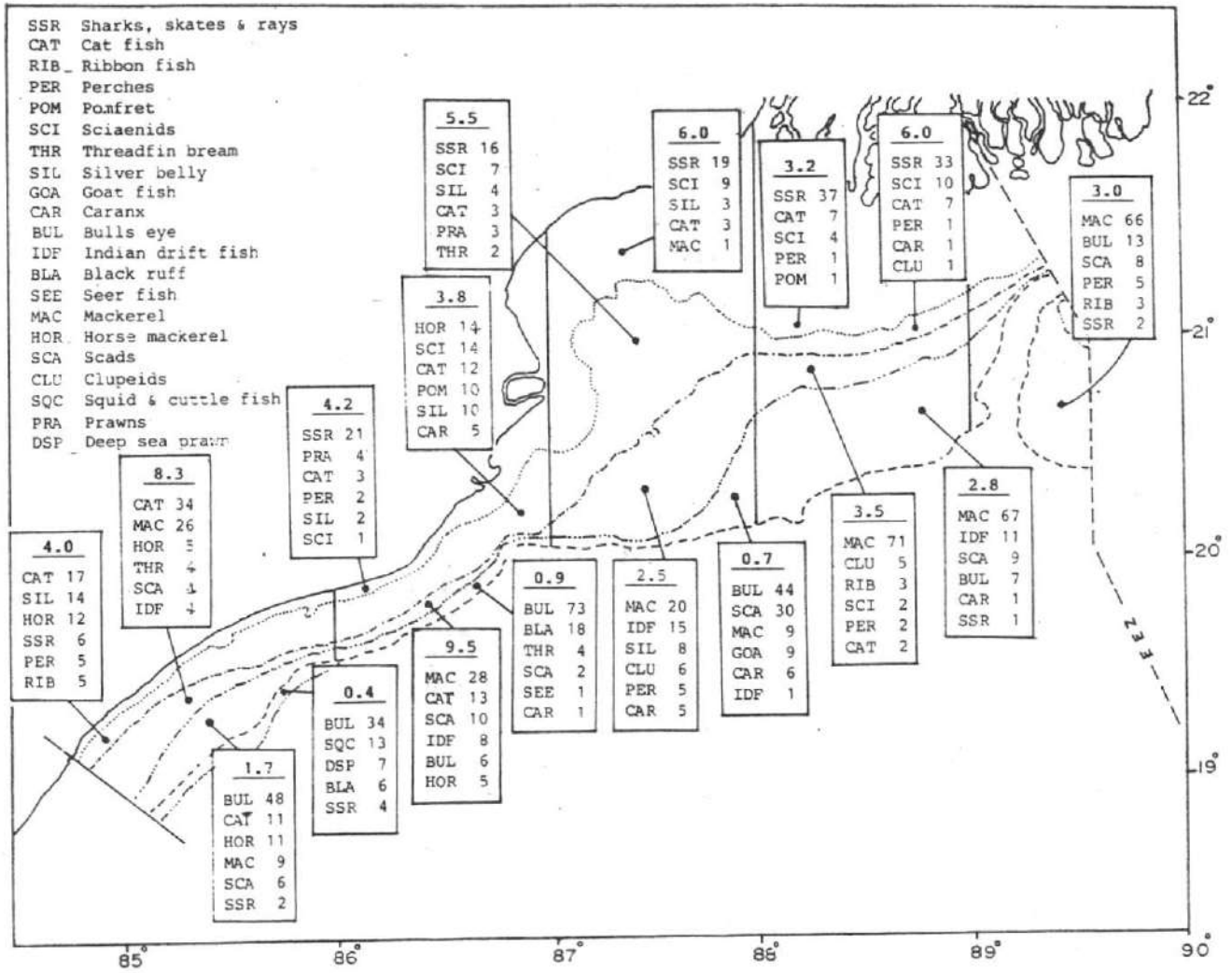


Fig. 13 Strata-wise density (tonnes per sq km) of demersal resources (first figure in each data set) and percentage of major components

5.2. Estimation of biomass

The biomass of demersal stocks computed for each strata is shown in Table 28. The total biomass in the continental shelf along the Orissa-West Bengal coast is estimated to be 2.1 lakh tonnes of which Orissa coast accounts for 1.12 lakh tonnes and West Bengal coast 0.98 lakh tonnes. It can be seen that 32% of the biomass in the continental shelf of Orissa is in 0-20m depth, 36% in 20-50m depth, 27.4% in 50-100m depth and 3.7% in 100-200m depth. Along the West Bengal coast the vast area within 20m depth supports 51.4% of biomass and the outer shelf area in 100-200m depth zone have 23.2% of the stock. The composition of the stock in different depth zones along Orissa and West Bengal coasts may be seen in Tables 29 and 30.

Table 28. Biomass of demersal fish resources along Orissa-West Bengal coast

(in tonnes)

Longitude	Orissa				West Bengal				Total
	84°,85°	86°	87°	Total	87°	88°	89°	Total	
Depth zone (m)									
0-20	3013	9184	23350	35547	16550	29504	4416	50470	86017
20-50	7493	7972	25899	41364	5268	8176	1731	15175	56539
50-100	13760	11999	4774	30533	2172	5847	1786	9805	40338
100-200	2717	302	1107	4126	252	14657	7866	22775	26901
TOTAL	26983	29457	55130	111570	24242	58184	15799	98225	209795
200-300	75	Not estimated due to inadequacy of data							

Table 29. Biomass of major demersal resources in different depth zones along Orissa coast

(in tonnes)

Depth zone (m)	0-50	50-100	100-200	Total
Sharks, skates and rays	11448	794	60	12302
Cat fish	4501	6375	301	11177
Ribbon fish	918	273	3	1194
Perches	905	880	46	1831
Pomfret	1594	587	-	2181
Sciaenids	5544	390	-	5934
Threadfin bream	763	868	20	1651
Silver belly	4068	1069	-	5137
Horse mackerel	2344	1343	292	3979
Other carangids	935	842	90	1867
Bulls eye	24	751	2008	2783
Indian drift fish	152	2136	30	2318
Squid & cuttle fish	231	84	27	342
Mackerel	1169	7905	353	9427
Others	42315	6236	896	49447
TOTAL	76911	30533	4126	111570

Table 30. Biomass of demersal resources in different depth zones along the West Bengal coast

(in tonnes)

Depth zone (m)	0-50	50-100	100-200	Total
Sharks, skates and rays	19659	243	255	20157
Cat fish	3570	228	22	3820
Ribbon fish	32	264	332	628
Perches	211	269	432	912
Pomfret	181	196	-	377
Sciaenids	4149	217	178	4544
Threadfin breams	101	123	132	356
Silver belly	713	206	-	919
Horse mackerel	-	42	9	51
Other carangids	97	450	2206	2753
Bulls eye	-	66	2129	2195
Indian drift fish	-	440	1607	2047
Squid & cuttle fish	27	1	-	28
Mackerel	193	5851	15088	21132
Others	36712	1209	385	38306
TOTAL	65645	9805	22775	98225

6. CRUSTACEAN RESOURCES

Till the late seventies production of prawns from the Orissa-West Bengal coast was relatively at a very low level compared to other coastal segments in the country. Information on prawn resources of this region was first reported by Kuthalingam **et al.** (1963, 1973), Rao (1969) and Rao and Dorairaj (1973) based on results of Kalyani I to V during 1950-62. However, the highly productive prawn grounds in the region were firmly established in survey by the 17.5m vessels of FSI during 1974-75. Average catch rates of 24.4 kg/hr and 17.5 kg/hr were recorded from the area 20-86 and 19-86 respectively off Orissa coast. In the meanwhile some commercial deepsea trawlers had started exploiting the prawn resources in the region mainly off Orissa. The findings were re-confirmed in 1975-76 and the 20-40m depth zone was identified to give the highest average yield of 25.2 kg/hr. A comparison of CPUE of prawns obtained from different regions

of the Indian coast during the year revealed a high level of abundance off Paradeep (Orissa) as indicated in Table 31.

Table 31. CPUE (kg/hr) of prawns obtained in survey by 17.5m vessels from different regions of Indian coast during 1975-76

Depth range(m)	Below 20	20-40	40-60	60-80
Region				
Goa	6.5	1.4	0.2	-
Mangalore	1.9	0.6	0.6	-
Cochin	10.7	3.0	1.4	5.0
Visakhapatnam	-	1.9	2.3	-
Paradeep	11.8	25.2	-	-

(Source: FSI Bulletin No. 4)

During 1976-77, the 17.5m vessels operating from Calcutta located productive shrimp grounds off West Bengal with average CPUE of 26.2 kg/hr from 40-60m depth and 21.6 kg/hr from 60-80m depth. A relative picture on magnitude of catch rates of shrimps obtained from the different regions surveyed is given in Table 32.

Table 32. CPUE (kg/hr) of prawns obtained in survey by 17.5m vessels from different regions of Indian coast during 1976-77

Depth range (m)	Below 20	20-40	40-60	60-80
Region				
Goa	1.6	0.5	0.2	-
Cochin	2.5	1.5	-	-
Visakhapatnam	0.6	0.3	0.2	-
Paradeep	7.9	11.4	-	-
Calcutta	3.7	1.3	26.2	21.6

(Source: FSI Bulletin No.6)

It was in the year 1977 the most productive shrimp ground along Indian coast, the Sandheads off Orissa-West Bengal, was located by the vessel Matsya Vigyani operating from Calcutta. Sudarsan (1977) and Sudarsan and Joseph (1975) have reported on this significant finding. In January-February 1977 the vessel netted about 4 tonnes prawns in 107 hours fishing by stern trawling. The percentage of prawns in total catch varied from 6% to 17% in the three voyages undertaken. The relative distribution of prawns as observed in the survey is depicted in Fig.14. The details of sampling effort, CPUE recorded in different areas and the depth-wise catch particulars are given in Table 33. Of the different areas surveyed the highest catch rate of 52.1 kg/hr was obtained from area 20-89/6A, situated close to the swatch of no-ground. Depth-wise, 50-80m zone was found to be highly productive.

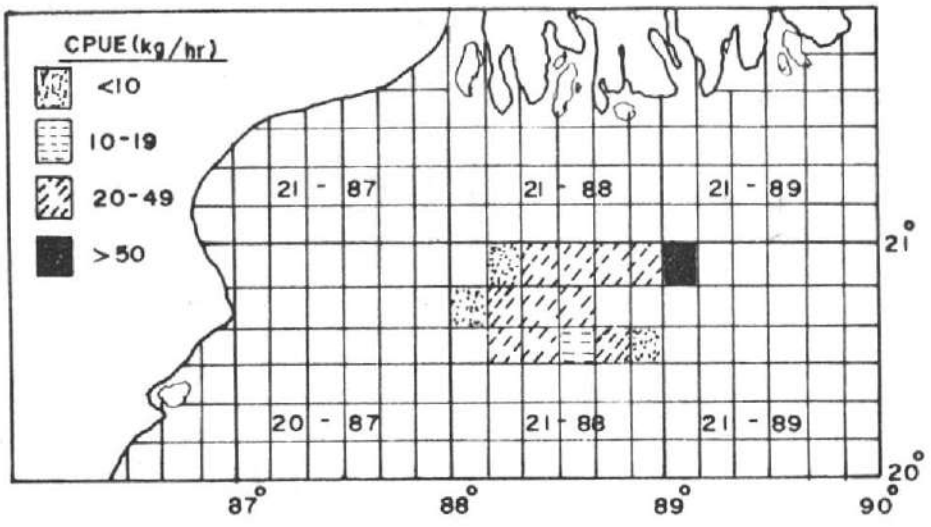


Fig. 14. Distribution of penaeid prawns observed in trawl survey by Matsya Vigyani along Orissa-West Bengal coast, Jan-Feb 1977

(Source: Sudarsan, 1977)

Table 33. Area-wise and depth-wise catch of prawns obtained in trawl survey by Matsya Vigyani along Orissa-West Bengal coast, Jan-Feb 1977

Area	Effort (hrs)	Total catch (kg)	CPUE (kg/hr)	Catch (kg) in different depth zones(m)						
				Below 30	30-40	40-50	50-60	60-70	70-80	80-90
20-88/4B	2.00	45	22.5	-	-	-	-	-	45	-
20-88/4C	4.30	32	7.1	-	-	12	-	-	20	-
20-88/4D	2.30	40	16.0	-	-	-	-	40	-	-
20-88/4E	2.00	40	20.0	-	-	-	-	40	-	-
20-88/4F	2.00	3	1.5	-	-	-	-	3	-	-
20-88/5A	2.00	10	5.0	-	10	-	-	-	-	-
20-88/5B	7.30	345	47.2	-	-	-	65	280	-	-
20-88/5C	9.30	370	39.7	-	-	-	100	270	-	-
20-88/5D	2.00	75	37.5	--	-	-	-	75	-	-
20-88/6B	3.30	30	8.5	-	-	-	-	30	-	-
20-88/6C	7.00	300	42.8	-	-	-	-	280	-	20
20-88/6D	13.30	402	29.8	-	-	-	202	200	-	-
20-88/6E	26.00	964	37.0	-	25	90	265	504	80	-
20-88/6F	16.00	790	49.4	110	-	-	-	290	390	-
20-89/6A	7.00	365	52.1	-	-	-	-	215	150	-

(Source: Sudarsan and Joseph, 1975)

The catch consisted of several species viz. **Penaeus monodon, P. semisulcatus, P. indicus, P. penicillatus, Metapenaeus monoceros, M. dobsoni, M. ensis** and **Solenocera indica.** The medium sized species, **P. penicillatus** and **Metapenaeus** spp. formed about 95% of prawn catch of which **M. ensis** and **M. monoceros** were the dominant species.

Based on results of survey by Matsya Vigyani, Sudarsan (1977) has assessed the standing stock of penaeid prawns from the 28,000 sq km area within 40 fm depth in the four major areas 20-87, 20-88, 21-87 and 21-88 in the order of 10,000-13,000 tonnes.

The location of rich prawn grounds off Orissa-West Bengal coast during 1974-77 paved the way for development of an industrial shrimp fishery exploiting this resource, based at Visakhapatnam. By 1978 about 20 shrimp trawlers of above 23m OAL were introduced in this region and the size of fleet has now grown to about 170. Besides, since 1985 there is also an intermediate class of vessels of about 15m OAL, popularly known as mini-trawlers, participating in the fishery. Their number has been placed at around 65.

7. MAXIMUM SUSTAINABLE YIELD

Due to different levels of exploitation of stocks in the different depth zones, calculation of MSY needed different approaches.

7.1. Demersal fin fishes

As the coastal areas within 50m depth is under fairly high level of exploitation the MSY is computed by the formula

$$MSY = 0.5 (Y + MB)$$

where Y is the current yield, M is the natural mortality coefficient and B, the biomass (Gulland, 1983).

As the survey data used in assessment of biomass pertain to the period of last ten years the current yield is taken as the average yield during the corresponding period to which is added the by-catch reportedly discarded by deepsea shrimp trawlers. These vessels, now numbering about 170 mostly based at Visakhapatnam, operate along the Orissa-West Bengal coast between False Bay and the Sandheads. The fishing is targetted to the high value shrimp catches which form hardly 10-15% of the netted catch. Most of the by-catch is thrown overboard and no estimate of the discarded catch is available. However, based on study of by-catches in commercial shrimp trawlers by George **et al.** (1981) it is found that by-catches account for about 87.8% of total catch along east coast. Assuming this proportion to be valid in case of the deepsea shrimp trawlers as well, and considering the annual average landing of 4615 tonnes shrimps (1984-1986) by these vessels, it is estimated that a catch of about 33,000 tonnes demersal fin-fishes are fished out by the deepsea trawlers from Orissa-

West Bengal coast annually. Though the catches are not landed, fishing mortality to that extent has been caused on the stocks. Therefore while assessing the stock size this catch is considered along with the current landing. Operation of these trawlers is mostly confined within 20-80m depth. For the purpose of assessment the by-catch is apportioned to below 50m depth and 50-100m depth zone off Orissa and West Bengal in proportion of extent of area in each of the segments. The total catch is then split into the species components based on the percentage composition of demersal stocks in the respective areas as observed in the surveys.

It is assumed that current landing is harvested mostly from inner shelf area within 50m depth. Therefore the factor Y in the formula in respect of 0-50m depth zone includes the entire current landing and the proportionate by-catch by deepsea trawlers. As regards the 50-100m depth belt it represents the by-catch alone.

Beyond the 100m depth line the resources are virtually unexploited and the MSY estimate is arrived at by applying the conventional formula

$$MSY = 0.5\ MBv$$

where M is the natural mortality coefficient and Bv, the virgin biomass

In the absence of estimates of M for most of the species in the region the above equations are applied in conjunction with the value of M=1 as often used in assessment of tropical multispecies trawl fisheries.

The estimate of maximum sustainable yield of demersal finfish resources from the continental shelf along Orissa and West Bengal is given in Table 34. Along Orissa coast the estimated potential yield is 77,391 tonnes of which 75.1% would be from 0-50m depth, 22.2% from 50-100m depth and 2.6% from 100-200m depth. In the shelf area off West Bengal the demersal finfish stock is assessed to have the potential of 70,188 tonnes; 74.9% from 0-50m depth, 8.9% from 50-100m depth and 16.2% from 100-200m depth. The potential of component stocks in each depth zone may be seen from Table 34.

Table 34. MSY of demersal finfish stocks in the continental shelf along Orissa-West Bengal coast

(in tonnes)

	ORISSA				WEST BENGAL			
Depth zone (m)	0-50	50-100	100-200	Total	0-50	50-100	100-200	Total
Sharks, skates & rays	7942	449	30	8421	12183	156	128	12467
Cat fish	5390	3602	151	9143	5548	146	11	5705
Ribbon fish	841	155	2	998	628	168	166	962
Perches	982	498	23	1503	204	173	216	593
Pomfret	3402	331	-	3733	3379	126	-	3505
Sciaenids	7686	221	-	7907	3809	138	89	4036
Threadfin breams	745	490	10	1245	98	78	66	242
Silver belly	2881	604	-	3485	503	135	-	638
Horse mackerel	1539	759	146	2444	-	28	5	33
Other carangids	828	609	45	1482	167	290	1103	1560
Bulls eye	19	425	1004	1448	-	42	1065	1107
Indian drift fish	96	1207	15	1318	-	288	803	1091
Mackerel	956	4466	176	5598	128	3681	7544	11353
Other fishes	24835	3383	448	28666	25931	773	192	26896
TOTAL	58142	17199	2050	77391	52578	6222	11388	70188

7.2. Crustacean resources

The survey findings as well as current landings are taken into account for assessing the MSY of penaeid prawns whereas the approximations on likely potential of non-penaeid prawns and other crustaceans are based on the current production figures. The marine landing of different crustacean groups in Orissa and West Bengal is given in Table 35.

Table 35. Annual average landing (in tonnes) of crustaceans in Orissa and West Bengal, 1986-88

Resource	Orissa	West Bengal
Penaeid prawns	1381	9733
Non-penaeid prawns	2389	4439 *
Other crustaceans	347	194 *

Source: State Governments

* State Govt. figures not available
CMFRI figures for 1982-84 taken

Penaeid prawns

Annual landing in Orissa and West Bengal is 1381 tonnes and 9733 tonnes respectively. From the standing stock estimate of 10,000-13,000 tonnes by Sudarsan (1977), MSY in the Sandheads area is calculated as 5750. The annual average quantity of prawns taken from the area by deepsea trawlers and landed at Visakhapatnam is about 4615 tonnes (1984-86). No data is available on the catch by the mini-trawlers. A Technical Committee which recently examined the factual position of production of prawns has indicated the MSY of penaeid prawns from the Sandheads as 6500 tonnes. Assuming the share of mini-trawler to be about 25-30% of catch from Sandheads it could be seen that the current production is more or less at the MSY level. Assuming further that the current landing of prawns from the coastal belt of the respective states is also roughly near the MSY level and taking into account of the estimated MSY of 6,500 tonnes from the Sandheads, aggregate MSY of penaeid prawns from the Orissa-West Bengal coast is calculated as 17600 tonnes; 4700 tonnes from the Orissa coast and 12900 tonnes from the West Bengal coast.

Non-penaeid prawns

Survey data is not available on distribution and abundance of non-penaeid prawns. However as a first approximation based on the current landings, the MSY is placed at 6,800 tonnes; 2400 tonnes from Orissa coast and 4400 tonnes from West Bengal coast.

Other crustaceans

Other crustaceans consisting of lobsters, crabs and stomatopods are estimated to support an MSY of 500 tonnes per annum; 300 tonnes and 200 tonnes respectively from Orissa and West Bengal coast. These estimates are again based on current production.

7.3. Cephalopod resources

Based on the trawl survey results and following the same methodology as in case of demersal finfishes MSY is estimated as 500 tonnes from shelf waters off Orissa and 100 tonnes off West Bengal. The inshore areas within 50m contour will yield 87% of the estimated potential along Orissa coast and 98% in the West Bengal shelf. It may however be stated that as the cephalopods, particularly squids, will not be fully vulnerable to bottom trawl gear the estimate could be marginally on lower side.

7.4. Pelagic resources

The major components are hilsa, lesser sadines, anchovies, wolf herring, Bombay duck (in West Bengal), ribbon fish, seer fish and mackerel (in Orissa). As stated earlier based on current landings, pelagics form about 41% of total resources along Orissa and West Bengal coast. Applying this proportion and duly considering the pelagic species appearing in demersal catches, MSY of resources from the pelagic realm upto 200m depth along Orissa-West Bengal coast is estimated as 71,600 tonnes; 40,300 tonnes from Orissa coast and 31,300 tonnes from West Bengal coast.

7.5. Summary of MSY estimated

The summary of MSY estimate of fishery resources along Orissa-West Bengal coast from the continental shelf upto 200m depth is given in Table 36. The shelf can sustain annual yield of 2.447 lakh tonnes; 1.256 lakh tonnes from Orissa coast and 1.191 lakh tonnes from West Bengal coast. It should, however be stated that in view of the absence of survey data and inadequacy of landing statistics the assessment of non-penaeid prawns should be considered only as prefatory.

Table 36. MSY estimate of fishery resources along Orissa-West Bengal coast

('000 tonnes)

Resource	Orissa	West Bengal	Total
Demersal finfishes	77.4	70.2	147.6
Crustaceans			
- Penaeid prawns	4.7	12.9	17.6
- Non-penaeid prawns	2.4	4.4	6.8
- Other crustaceans	0.3	0.2	0.5
Cephalopods	0.5	0.1	0.6
Pelagic resources	40.3	31.3	71.6
TOTAL	125.6	119.1	244.7

7.6. Earlier estimates of MSY

Fishery potential of Orissa coast has been studied earlier by several authors based on primary production, current yield and exploratory surveys (Table 37). The estimates vary from 48,140 tonnes (Antony Raja, 1986) to 7,35,000 tonnes (George **et al.**, 1977).

Table 37. Estimates of MSY of fishery resources in the continental shelf along Orissa coast

('000 tonnes)

Author	Method	Estimated MSY	Remarks
Cushing, 1971	Primary production	139.4 & 314.5	Computed by Antony Raja (1986) at 9% & 13.5% conversion rates respectively.
George **et al.**, 1977	Primary production	735.0	-
Indian Institute of Foreign Trade, 1970	Primary Production	100.0 to 120.0	Demersal only
Jones & Banerjee, 1973	Primary production	208.0	-
Joseph, 1985	Exploratory survey	204.0	Demersal (computed)
Krishnamoorthi, 1976	Exploratory survey	143.0	Demersal (computed)
Mishra **et al.**, 1973		120.0	-
Antony Raja, 1974	Primary production	208.0	-
Antony Raja, 1980	Primary production	253.0	-
Antony Raja, 1986	Exploratory survey	48.1	-
Roy, 1981		120.0	For EEZ off Orissa
Scariah **et al.**, 1987	Maximum contribution approach	100.0	Calculated 75.462 Assumed 100
West, 1973	Primary production	117.0	-
Sivaprakasam and Joseph, 1986	Exploratory survey	98.8	Demersal only
Present study	Exploratory survey	125.6	-

There has been considerable difference in the extent of area taken by different authors, mainly due to subjective demarcation of the shelf boundary. Also some of the authors have taken the shelf area upto 100fm while others have covered upto 200m depth. Among the different estimates, the MSY of 48,140 tonnes based on exploratory data has been critically examined by Sivaprakasam and Joseph (1986) and found that the methodology and computation erred on several counts which resulted in the lower estimate. The potential of 98,795 tonnes demersal resources by Sivaprakasam and Joseph (op.ct.) is marginally on higher side compared to the present estimate which is 85,300 tonnes for all demersal stocks together. This is mainly due to the difference in extent of area considered in two studies. As the present study is based on additional data inputs this estimate can be considered as more refined.

The earlier estimates of fishery potential in the shelf area off West Bengal (Table 38) are in the range of 60,000 tonnes (Philipose **et al.**, 1987) to 2,60,000 tonnes (George **et al.**, 1977). The MSY of 1,19,100 tonnes estimated here is the first assessment based on exploratory surveys.

Table 38. Estimates of MSY of fishery resources in the continental shelf along West Bengal coast

Author	Method	Estimated MSY ('000 tonnes)	Remarks
George **et al.**, 1977	Primary production	266.0	-
Jones and Banerjee, 1973	Primary production	160.0	-
Philipose **et al.**, 1987	Maximum contribution approach	60.0	Does not include the Sandheads
Present study	Exploratory survey	119.1	-

8. ADDITIONAL HARVESTABLE YIELD

Based on the MSY estimates made herein and the current production it is estimated that an additional yield of 53,400 tonnes fish per annum can be harvested from the continental shelf along Orissa coast (Table 39). The demersal component would be 35,800 tonnes of which 33,700 tonnes will come from within 100m depth.

Table 39. Estimated additional harvestable yield from Orissa-West Bengal coast

('000 tonnes)

State	Resource	MSY	Current * yield	Additional harvestable yield
Orissa	Demersal	85.3	49.5	35.8
	Pelagic	40.3	22.7	17.6
	TOTAL	125.6	72.2	53.4
West Bengal	Demersal	87.8	45.1	42.7
	Pelagic	31.3	20.1	11.2
	TOTAL	119.1	65.2	53.9

*Includes by-catches of deepsea shrimp trawlers

The shelf area along West Bengal will be able to sustain an additional harvestable yield of 53,900 tonnes; 42,700 tonnes from demersal sector and 11,200 tonnes from pelagic sector. It is significant that unlike in the case of Orissa coast the 100-200m depth zone along West Bengal coast is rich in resources and will be able to sustain an annual yield of 20,200 tonnes.

9. DEVELOPMENT PROSPECTS

(i) There is scope for increasing marine fish landing from the continental shelf along the Orissa coast by about 70% of the current production. Towards increasing production from the presently exploited zone, Scariah **et al.** (1987) has suggested addition of 160 trawling boats, 140 gill net boats and 1700 non-mechanised craft. The major stocks available for further exploitation in the demersal sector are elasmobranchs, catfish, sciaenids, mackerel, silver belly, perches and pomfret. Horse mackerel and sardines will substantially contribute to the pelagic fishery. While considering the inputs needed to exploit the deepsea resources (beyond 50 m depth) it is significant that about 90% of the demersal resources are in 50-100 m depth belt (see Table 34). The development strategy therefore has to target in tapping the resources from this zone for which intermediate size stern trawlers of 15-20m OAL are considered suitable. Considering the operational capability of such vessels and the size of fish stock available, about 45 vessels are suggested for introduction along the Orissa coast.

(ii) The marine fish production from the shelf area off West Bengal can be augmented by about 80% of the current yield. Additional input for optimum exploitation from the present fishing zone has been suggested by Philipose **et al.** (1987) as 80 mechanised boats and 150 non-mechanised craft. Unlike in Orissa coast where the outer shelf is relatively narrow and resultantly resources are limited, the grounds beyond 100m depth contour along West Bengal coast are very extensive and can sustain an annual yield of about 11400 tonnes of demersal fish. The major species components are mackerel, Bulls eye, Carangids and Indian drift fish. The development strategy for exploitation of demersal resources would therefore involve deployment of stern trawlers suitable for fishing in 50-200 m depth. 30 vessels of 15-25 m OAL are suggested.

(iii) Considering the large proportion of mackerel in demersal catches in deeper waters (66% in 100-200 m depth) off-bottom trawling with specialised gear would be a very successful fishing method particularly along West Bengal coast.

(iv) The deepsea trawlers exploiting shrimp stocks along the Orissa-West Bengal coast are mostly based at Visakhapatnam. Infrastructure facilities for berthing, maintenance, processing, storage and such ancillary activities conducive for operating the larger vessels from Orissa and West Bengal should be developed. Basing of vessels at harbours relatively nearer, with requisite facilities, would enable reduction of running costs and increase fishing time and thus improving overall profitability of operations.

(v) Efforts should be made to utilise the by-catch of 30,000-40,000 tonnes fin fish per annum discarded by shrimp trawlers along the Orissa-West Bengal coast. A scheme involving a few vessels to collect this catch at sea and establishing appropriate storage, processing and marketing network could be considered. The low value species can also form the raw material for production of value added fish products.

(vi) Precise information on availability and distribution of tunas and allied species in the EEZ along Orissa-West Bengal coast are not available. However, considering the general availability of tunas and bill fishes in Bay of Bengal, development opportunities are promising.

Fishery Survey of India will undertake survey of tuna resources in upper Bay of Bengal during the VIIIth Plan enabling to identify the prospects in precise terms.

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