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CONTENTS

A STUDY OF THE DEMERSAL FISHERIES RESOURCES OF THE
WADGE BANK AND THE GULF OF MANNAR

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Introduction

The Wadge Bank and the Gulf of Mannar are traditionally known for their rich fishery resources. A number of surveys on the fisheries resources of these areas have been carried out in the past. Historical accounts of these resources surveys are given by Sivalingam and Medcof (1957), Chacko (1973 a), Rao (1973) and many others. Systematic surveys of fishery resources of these areas were however commenced only by 1959 when Fishery Survey of India (FSI) Bases at Cochin and Tuticorin (formerly Offshore Fishing Stations) were established. In the early years, the surveys were conducted with small and medium sized vessels upto a depth of 70-80 m. The results of these surveys are presented by Rao (1967, 1973), Pai and Pillai (1973), Tholasilingam et al (1973), Joseph et al (1976 a & b) and Joseph (1980). FSI had undertaken a detailed survey of the Wadge Bank upto a depth of 300 m with a large survey vessel during 1981 to 1983 (FSI, 1982 a & b, 1983, 1984). The Indo-Norwegian Project Bases at Cochin and Mandapam and Pelagic Fisheries Project, Cochin have also made contributions to the knowledge of fishery resources of the two regions (Rao, 1973; George et al, 1977, Oommen 1980, 1985).

Though a wealth of information on resources is available in the two areas, resource scientists and the fishing industry still lament, rightly so, that there is no adequate and relevant information. The resource surveys conducted in the Wadge Bank were at different points of time, repetitive and non-complimentary so that gaps in information still persist. The deeper waters have not been surveyed at all. It is with a view to fill in this gap in the knowledge of resources that a comparative survey of the demersal resources of the deep sea from 20 to 500 m were undertaken in the two areas by FSI with the large sophisticated survey vessel Matsya Nireekshani during October 1983 to March 1985. The results of the survey are presented in this paper.

General features of the survey

Although a large number of surveys for the demersal resources have been carried out in the Wadge Bank, they were mostly from Srilanka. The surveys were spread over a long period of time. Detailed information on many aspects of the resources were not available. The proposal to survey the Wadge Bank came at a time when the Government of Kerala made a request for a survey of the area in connection with a pre-investment appraisal of the Vizhinjam Fishing Harbour Project. Therefore, a detailed survey of the Wadge Bank demersal resources was conducted by FSI during October 1981 - April 1983. Three progress reports on the surveys were issued and a fisheries chart depicting the demersal resources of the Wadge Bank was published (FSI, op. cit.).

The Gulf of Mannar on the other hand has not been surveyed for the demersal resources of the deep water areas beyond 50-60 m. Therefore the survey of the deep water demersal resources of the area from 20-500 m was undertaken. A preliminary note on the survey is given by Somvanshi and Bhar (1984).

The survey of the Wadge Bank, which is in the nature of a monitoring survey to confirm the earlier findings and that of the Gulf of Mannar were undertaken for a period of 18 months from October 1983 to March 1985. The combined survey of the two areas would also facilitate a comparative study of the demersal resources of the two areas at the same time. A large survey vessel M.V.Matsya Nireekshani was employed for the survey and was operated from the Tuticorin Base of FSI. The photograph and the specifications of the vessel are given in Fig. 1. The vessel is a sophisticated combination trawler equipped with modern navigational and fish finding equipments and capable of conducting pelagic and demersal trawling. The
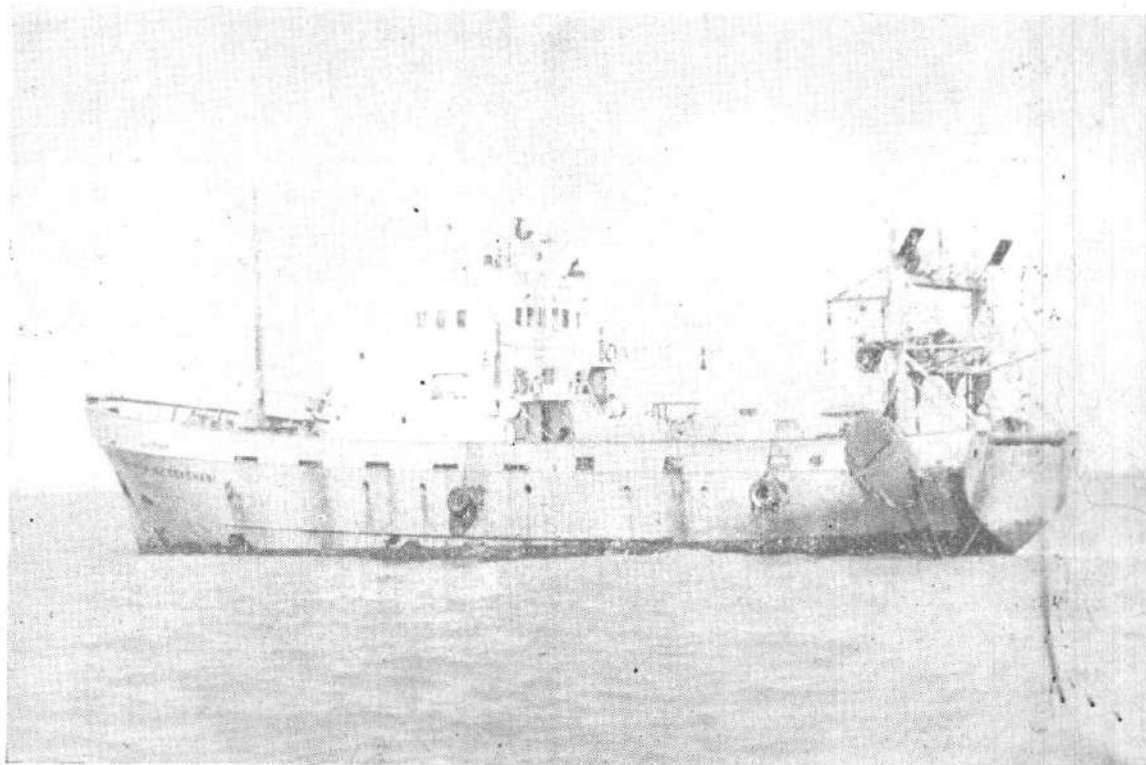
Fig. 1 FISHERY SURVEY VESSEL M. V. MATSYA NIREEKSHANI

A.	Length overall (m)	:	40.55
B.	Engine rating	:	2030 BHP at 800 rpm
C.	G R T	:	329.26
D.	Navigational equipments	:	- Satellite Navigator
			- Marine Radar
			- Radio Telephone
			- Auto Pilot
			- Gyro Compass
E.	Fish finding equipments	:	- Echo sounder
			- Sonar
			- Net recorder
F.	Fish processing and storing devices		
	- Frozen hold (-25°C)	:	75 M³
	- Cold storage (0°C)	:	235 M³
	- Flake ice plant	:	Capacity 6 tonnes/day
	- Vertical plate freezer	:	Capacity to process 10 tons of fish in 24 hours
G.	Main bunkers		
	- Fuel tank	:	180 M³
	- Fresh water	:	34 M³
H.	Endurance	:	20 days
I.	Speed	:	13 Knots
J.	Accommodation	:	24 berths

vessel operated a 34 m fish trawl as the sampling gear with oval otter doors each weighing 1355 kg. The drawing and specifications of the gear are given in Fig. 2.

The areas surveyed are presented in Fig. 3. The Wadge Bank and the Gulf of Mannar are two contrasting areas with different geography, physiography, oceanography and meteorology, the former an open sea with a vast submarine plateau while the Gulf of Mannar is a protected region with rather narrow continental shelf. More details of the areas are given elsewhere.

For the purpose of survey, the Wadge Bank area was restricted to the squares 7-77 and 8-77. The Gulf of Mannar essentially falls under the square 8-78, besides the squares 7-78, 8-79, 9-78 and 9-79. Gulf of Mannar being common to India and Srilanka, an equidistant median line separates the Exclusive Economic Zone of these two countries. The Wadge Bank which fomed the focus of traditional distant water trawl fishery of Srilanka is now entirely within the Indian Exclusive Economic Zone.

For the purpose of the survey, the continental shelf and the continental slope have been demarcated into 4 depth strata viz. 20-50 m, 50-100 m, 100-200m and 200-500 m. Cruise tracks and trawling stations were pre-planned for adequate coverage of the various depth zones and survey cruises were implemented according to this plan.

For the purpose of analysis and interpretation of the resources data, the squares 7-77 and 8-77 were combined in the case of Wadge Bank. In the case of Gulf of Mannar the squares 7-78, 8-78 and 9-78 were considered separately as well as combinedly. The results of the survey are presented in the following pages.

Physiography of the areas

As already stated elsewhere, the Wadge Bank area is an open sea area subject to monsoons and severe winds. The inshore area from 0-20 m is very narrow due to the fact that the sea bed becomes steep very near the shore. However, beyond 20 m the sea bed slopes very gradually. The result is a vast submarine plateau of a total area of about 10,000 KM2 highly suitable for trawl fishing. The sea bed is generally uneven and rocky with sea fans, sponges etc.

Length in mm	Total Length in m
400	8
400	6
400	10
400	5
200	10
100	10
80	8
80

34

51

AB
WIRE 16φ
46
IN IB 56
150
IN 4B
46
118
100
200
IN 4B
134
268
IN 4B
148
180
IN 3B 60
60

WIRE 22 φ DISCS
φ 8 PA
46 AB
AB
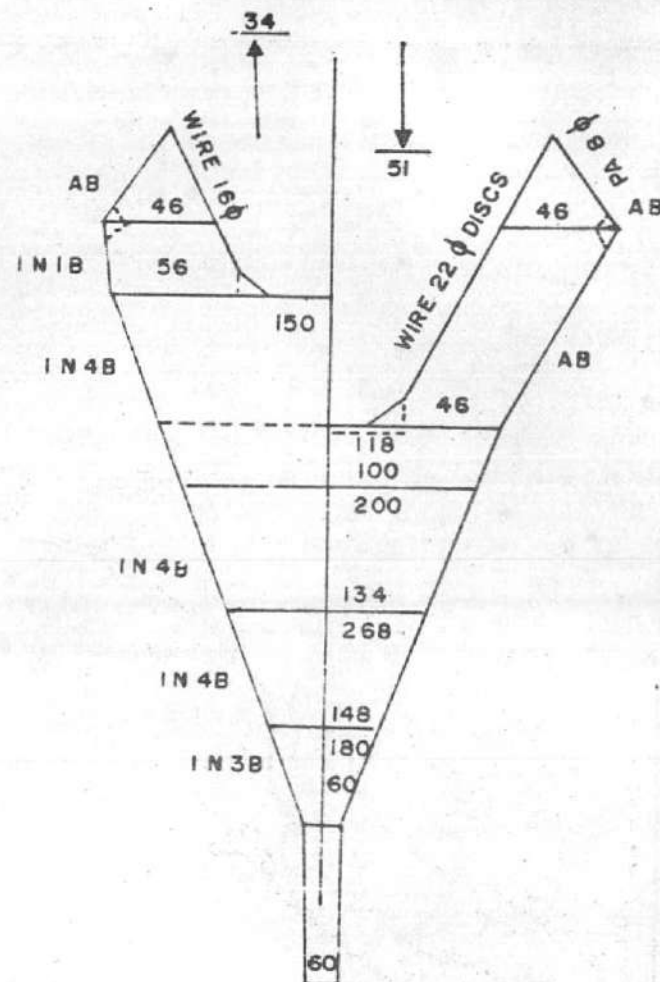
Number ※	Twine NR
20	210 / 240
15	/ 240
43
37½	/ 240
13½	/ 240
50	/ 132
100	/ 126
100	/ 108

Fig. 2. Specifications and design of the sampling gear

Fig.3. Chart showing the areas and depth contours surveyed

The Gulf of Mannar on the other hand presents a different picture. The inshore area from 0-20 m is much wider and almost equal to the area between 20-200 m. This impl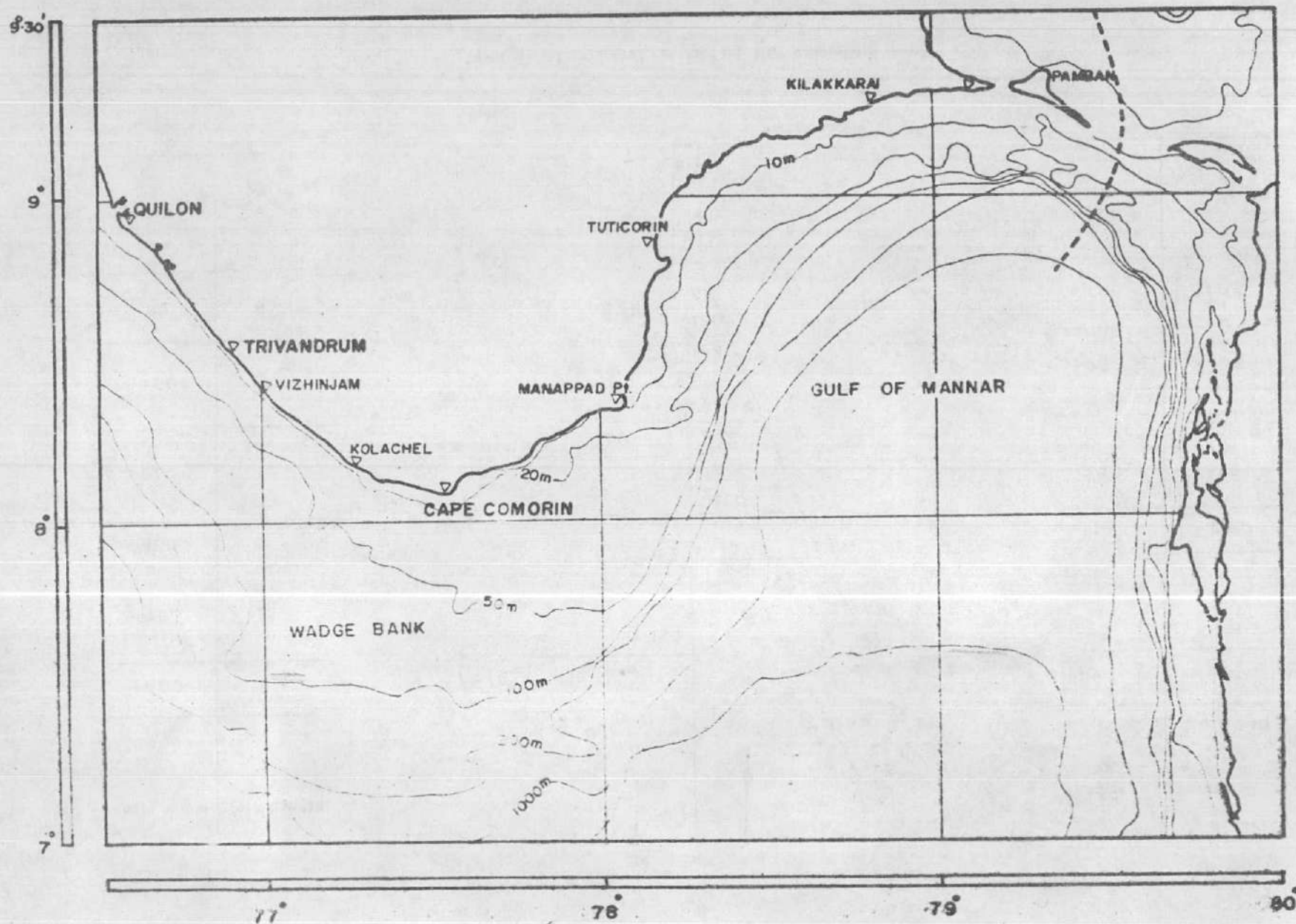ies that the sea bed slopes gradually nearer the shore and becomes steep after 50-60 m. The shallow inshore area on the northern side is generally bordered by coral reefs. The area is generally rocky with patches of sandy and muddy grounds.

The depth and distance configuration of the sea bed of the two areas which is an important criterion in the selection of fishing vessels, is presented in Figs. 4 & 5. It will be seen from this that the Wadge Bank is a vast flat ground extending upto a distance of 70 miles south of Vizhinjam and a little over 50 miles south of Cape Comorin. These two places could be the nearest bases of operation for the exploitation of Wadge Bank resources. The Gulf of Mannar on the other hand presents a flat ground upto a distance of 40-50 miles. South of Pamban pass the shelf extends upto 15 miles and when it becomes very steep. East of Tuticorin the grounds are flat upto about 25 miles and thereafter it slopes upto a distance of 40 miles. South of Manappad the grounds are flat and extend upto a distance of 40 miles forming very good trawling ground and thereafter the shelf becomes very steep. Tuticorin, Manappad and Mandapam could be the bases of operation for the exploitation of Gulf of Mannar resources.

The expanse of different depth strata of the two areas are given in Table I and VI.

Survey efforts

The areas of different depth strata, sampling effort in terms of trawling hours and the intensity of sampling in each depth strata in respect of the Wadge Bank and the Gulf of Mannar are presented in Table I. It will be seen from the table that in the case of Wadge Bank, the 3 depth strata 20-50 m, 50-100 m and 100-200 m are more or less of same extent thereby indicating the flatness of the shelf and suitability for trawling. This area, as already stated, had earlier been surveyed and nearly 1000 hours of trawling were done. In the present survey, about 500 hours have been spent in sampling, more effort closer to the shore and vice versa. The area actually swept in fishing and its percentage in the total area of the depth strata are also given as a measure of intensity of sampling.
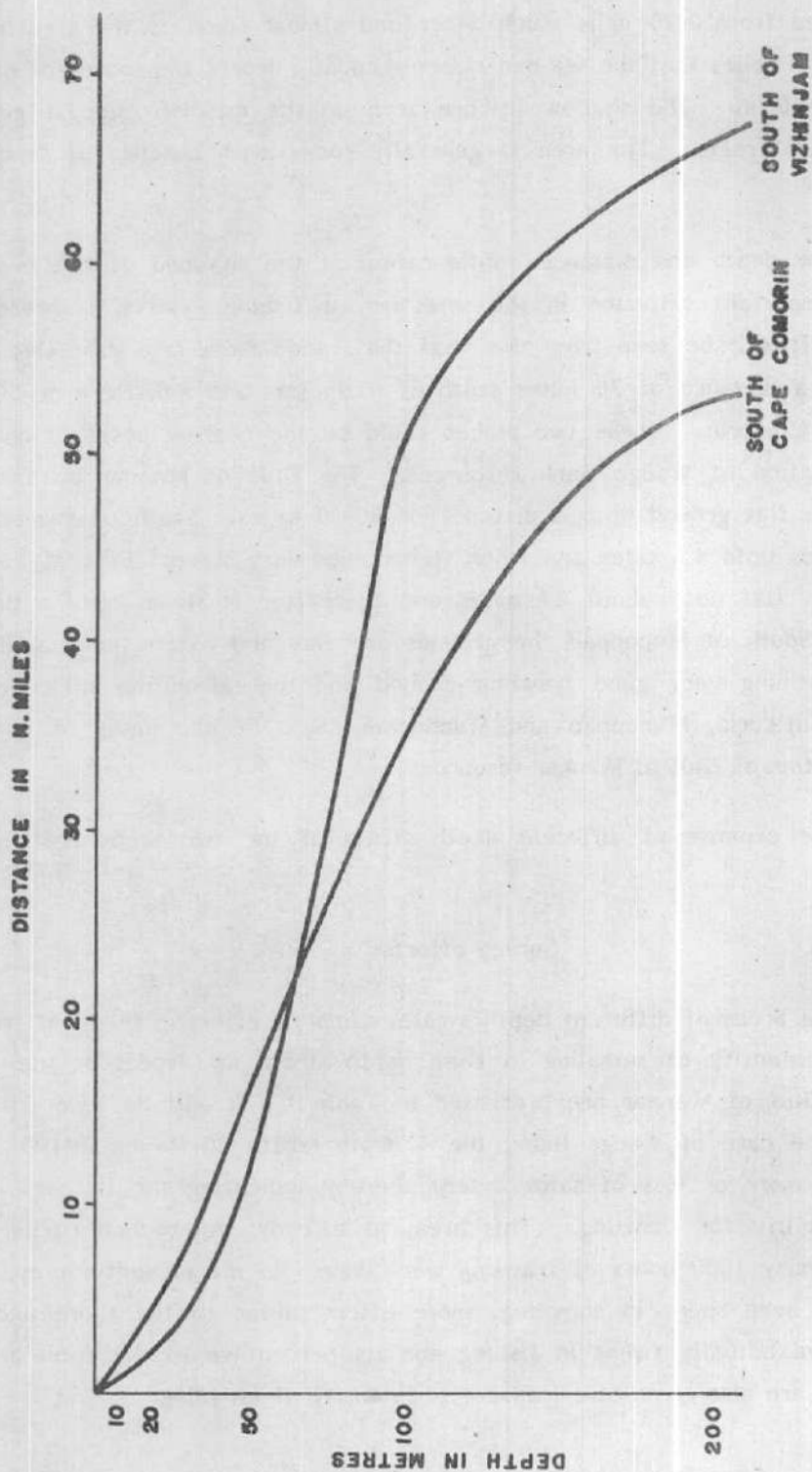
Fig.4. Depth and distance configuration of the Wadge Bank
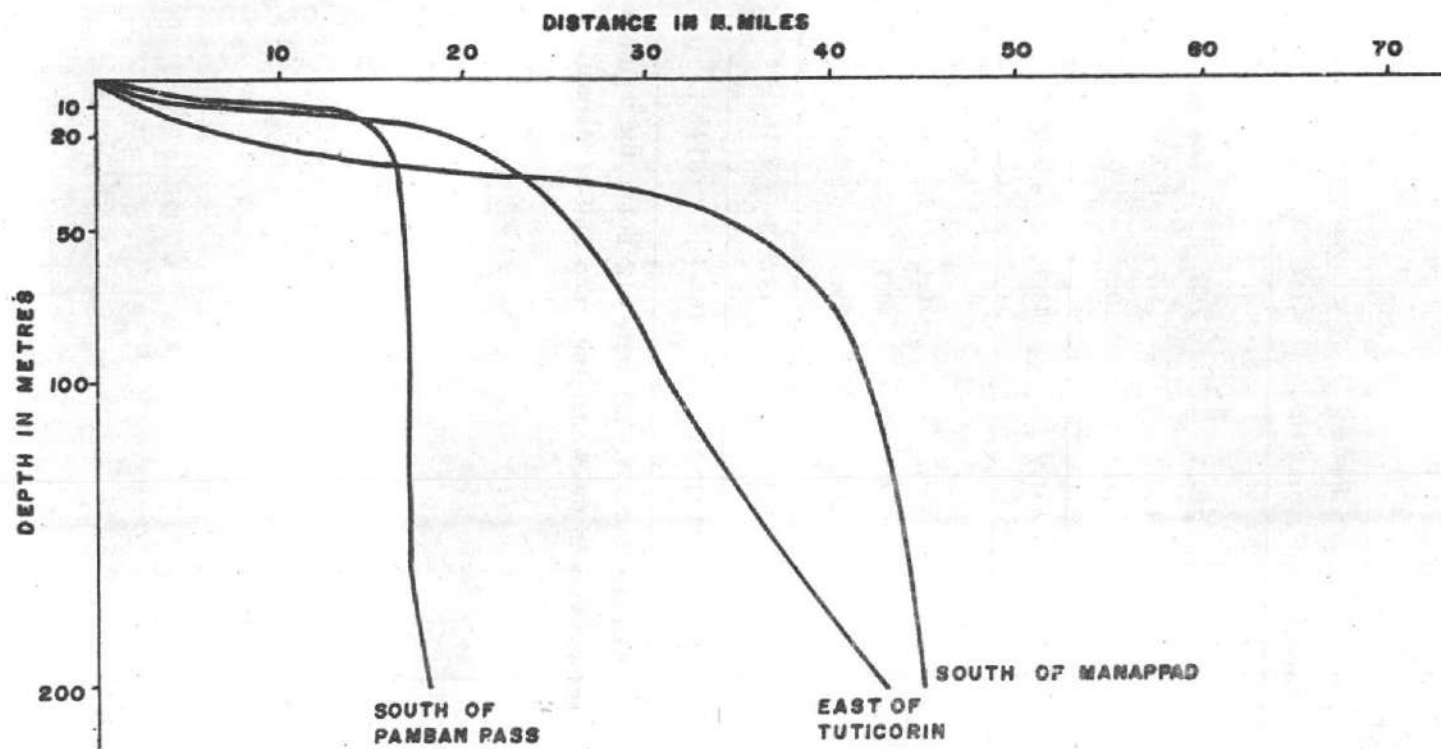
Fig.5. Depth and distance configuration of the Gulf of Mannar

Table I: Depth strata, area, sampling effort, area sampled and sampling
intensity in the Wadge Bank and Gulf of Mannar

Region/Depth strata m	Area Km2	Sampling effort Hrs.	Area sampled	
			Km2	%
Wadge Bank				
20-50	3541	240.5	21.2	0.60
50-100	3831	132.7	11.7	0.30
100-200	2926	118.7	10.5	0.36
Sub total	10298	491.9	43.4	0.42
Gulf of Mannar				
20-50	2738	795.0	70.1	2.56
50-100	917	5.5	0.5	0.05
100-200	1743	615.1	54.3	3.11
Sub total	5398	1415.6	124.9	2.31
Total	15,696	1907.5	168.3	1.07

N.B: An effort of 104.1 hrs and 559.9 hrs were also put in the depth strata
200-500 m respectively in the Wadge Bank and Gulf of Mannar.

In the case of Gulf of Mannar, the survey is a new endeavour and intensity of sampling also was high. The area of each depth stratum given will show that the shelf is shallow and flat nearer to the coast. It is rather narrow in the depth stratum 50-100 m and again broader in the depth 100-200 m. The stratum 50-100 m was very rough with corals and rocks and as a result not amenable for trawling. Hence the poor effort in this stratum. More effort was spent in 20-50m for the reason already stated. Good efforts were also put in 100-200 m and 200-500m.

In both the areas, good efforts were put in the continental slope from 200-500 m for the first time in the history of the resources survey in these areas.

Results of survey

The data collected during the survey have been analysed region-wise i.e separately for the Wadge Bank and the Gulf of Mannar. In the case of Wadge Bank, the data pertain to the squares 7-77 and 8-77. As the area falling under the square 8-77 is small, the two squares were pooled together. The data were analysed separately for each depth stratum i.e 20-50 m, 50-100 m, 100-200 m and 200-500m. The data were also analysed month-wise to study the seasonal variation in the distribution and abundance of various fish categories.

In the case of Gulf of Mannar, the data were analysed squarewise for the three squares viz. 7-78, 8-78 and 9-78. The area falling under the squares 7-78 and 9-78 was small and major portion falls under the square 8-78. The data were again analysed separately for different depth strata as mentioned in the case of Wadge Bank. The data were also analysed month-wise separately for each square as well as combinedly for the whole area to study the seasonal variation in the distribution and abundance of demersal resources.

Species composition

The important fish categories and their species composition are furnished below.

Perches Lutianus argentimaculatus, L.malabaricus,

L.lineolatus, L.rivulatus

Pristipomoides typus,

Aprion virescens

Epinephelus diacanthus, E.tauvina

	Promicrops lanceolatus
	Lethrinus ornatus, L.nebulosus
	L.miniatus
	Pomadasys hasta, P.maculatus
	Plectorhynchus pictus
	Scolopsis vosmeri, S.bimaculatus
	Gaterin cinctus
Carangids	Caranx ignobilis, C.Kalla
	Seriola sp.
	Chorinemus lysan
	Decapterus dayi
	Rachycentron canadus
Pomfrets	Pampus argenteus, P.sinensis
	Formio niger
Barracuda	Sphyraena obtusata, S.picuda, S.Jello
Cat fish	Tachysurus spp.
	Osteogeneiosus sp.
Nemipterids	Nemipterus japonicus, N.mesoprion
Lizard fish	Saurida tumbil
	Trachinocephalus myops
Balistids	Odonus niger
	Balistis maculatus
Drift fish	Psenes indicus
Bulls eye	Priacanthus hamrur
Silver belly	Leiognathus spp.
	Secutor spp.
Mackerel	Rastrelliger kanagurta
Moon fish	Drepane punctata
Ribbon fish	Trichiurus spp.
Clupeids	Sardinella albella, S.fimbriata
	Thrissocles spp.
Sharks	Carcharias spp.
	Rhynchobatus sp.

Rays	Aetobatus spp.
	Gymnura sp.
Crabs	Portunus spp.
Cephalopods	Loligo duvauceli
	Sepioteuthis arctipinnis
	Sepia pharaonis, S.aculeata
	Sepiella inermis
Deep sea Prawns	Parapandalus spinipes
	Aristeus semidentatus
	Heterocarpus wood-masoni, H.gibbosus
	Penaeopsis rectacuta
	Plesionika martia
	Solenocera hextii
Deep sea Lobsters	Puerulus sewelli
Deep sea Fish	Chlorophthalmus sp.
	Emmelichthys nitidens
Other fishes	Sciaenids, Upeneids, Seer fish

The relative abundance and percentage composition in the two areas are discussed elsewhere. However, it may be mentioned that Clupeids, Sciaenids and Moon fish which occured in the Gulf of Mannar in appreciable quantities were conspicuously absent or negligible in the Wadge Bank. Seer fish, Sciaenids, Upeneids and deep sea Prawns/lobsters which occured in small quantities (0.1 to 0.9%) are not shown separately and are included under "Other fishes".

Relative abundance in various areas

In the case of Wadge Bank, the total catch/hr of all fish for the whole period was 98.6 kg/hr of trawling. The catch/hr of various species are given in Table II. It will be seen that the perches yielded the highest catch/hr of 19.8 Kg followed by the balistids (file fishes, leather jackets, 19.2 Kg), Nemipterus(17.7Kg),

Table II: Relative abundance (Kg/hr) and percentage composition of various species of Wadge Bank and Gulf of Mannar.

Region	Wadge Bank		Gulf of Mannar	
Fishing effort(hrs)	596.0		1975.5	
Species	CPH	%	CPH	%
Sharks & Skates	2.4	2.4	2.5	1.9
Rays	4.7	4.8	10.0	7.5
Barracuda	1.9	1.9	16.8	12.6
Cat fish	0.3	0.3	3.6	2.7
Perches	19.8	20.1	24.8	18.7
Pomfrets	0.1	0.1	2.7	2.0
Caranx	5.0	5.1	8.8	6.6
Decapterus	9.0	9.1	2.9	2.2
Psenes indicus	0.3	0.3	2.0	1.5
Nemipterus	17.7	17.9	4.0	3.0
Priacanthus	3.0	3.0	1.8	1.4
Lizard fish	1.8	1.8	0.7	0.5
Balistoids	19.2	19.2	1.1	0.8
Silver belly	0.1	0.1	9.4	7.1
Clupeids	-	-	2.4	1.8
Mackerel	0.6	0.6	1.1	0.8
Moon fish	-	-	2.3	1.7
Ribbon fish	0.1	0.1	1.3	1.0
Crabs	2.3	2.3	20.8	15.6
Squids & Cuttle fish	1.9	1.9	2.1	1.7
Others	8.9	9.0	11.8	8.9
All fish	98.6	100.0	133.0	100.0

Decapterus (9 Kg), Carangids (5 Kg), Priacanthus (3 Kg), Rays (4.7 Kg), Sharks (2.4Kg) and other categories in smaller quantities.

In the case of Gulf of Mannar, the total catch/hr of all fish was 133Kg for the whole area for the whole period. It was 154.2 Kg in the square 7-78, 110.8Kg in 8-78 and 296.3 Kg in 9-78. The high catch/hr in areas 7-78 and 9-78 can be attributed to the fact that the depth range fished in these areas was 20-50 m while the depth range fished in 8-78 was from 20-500 m.

Species-wise, for the Gulf of Mannar as a whole, the Perches yielded highest catch/hr of 24.8 Kg followed by Crabs (20.8 Kg), Barracuda (16.8 Kg), Rays (10 Kg), Silver belly (9.4 Kg), Carangids (8.8 Kg), Nemipterus (4 Kg), Cat fish(3.6Kg), Decapterus (2.9 Kg), Pomfrets (2.7 Kg) and other categories in smaller quantities.

All the three areas in the Gulf of Mannar yielded high catch rates for Perches. The square 9-78 yielded the highest catch rate of 92.1 Kg followed by 7-78 (44.4 Kg) and 8-78 (16 Kg). Balistids occured only in 7-78 with a catch rate of 22.4 Kg. Mackerel and Rays also occurred in substantital quantity with a catch/hr of 12.1 and 22.1 Kg/hr respectively.

The square 8-78 was remarkable for Crabs with a catch/hr of 24.4 Kg. Further Barracuda yielded a high catch rate of 16.5 Kg while it was 7 Kg/hr in other areas.

The square 9-78 yielded high catch rate for Silver belly (67.9 Kg). This area was also rich for Cat fish (24.0 Kg), Pomfrets (22.5 Kg), Clupeids (15.3 Kg), Moon fish (10.1 Kg) and Carangids (10.0 Kg).

Relative abundance in various depth strata

The relative abundance and distribution of various fish categories in the Wadge Bank and the Gulf of Mannar are presented separately in Tables III and IV and Fig.6.

In the Wadge Bank, the highest catch rate for all fish was 136.1 Kg/hr in the depth range 100-200 m followed by 20-50 m (122.3 Kg/hr), 50-100 m (83.5Kg/hr) and 200-500 m (17.8 Kg/hr). The continental slope from 200-500 m yielded very poor catch including miscellaneous varieties. Perches showed a declining trend in

Table III: Relative abundance (Kg/hr) and percentage composition of various species in different depth strata of Wadge Bank

Area	7-77 & 8-77 combined							
Depth strata (m)	20-50		50-100		100-200		200-500	
Fishing effort(Hrs)	240.5		132.7		118.7		104.1	
Species	CPH	%	CPH	%	CPH	%	CPH	%
Sharks & Skates	3.4	2.8	1.3	1.5	1.4	1.0	2.5	14.0
Rays	7.6	6.2	5.1	6.1	2.6	1.9	-	-
Barracuda	4.5	3.7	0.2	0.2	-	-	-	-
Cat fish	0.7	0.6	-	-	-	-	-	-
Perches	33.9	27.7	20.4	24.4	7.6	5.6	-	-
Pomfrets	0.2	0.1	-	-	-	-	-	-
Caranx	8.1	6.6	4.0	4.8	4.4	3.2	-	-
Decapterus	6.9	5.6	7.3	8.7	23.5	17.3	-	-
Psenes indicus	-	-	-	-	-	-	-	-
Nemipterus	9.4	7.7	2.5	3.0	66.7	49.0	-	-
Priacanthus	1.7	1.4	1.7	2.0	8.9	6.5	1.1	6.2
Lizard fish	2.5	2.0	1.2	1.4	2.6	1.9	-	-
Balistoids	29.6	24.2	32.6	39.0	-	-	-	-
Silver belly	0.2	0.1	0.1	0.1	-	-	-	-
Clupeids	-	-	-	-	-	-	-	-
Mackerel	0.8	0.6	1.2	1.4	-	-	-	-
Moon fish	-	-	-	-	-	-	-	-
Ribbon fish	-	-	-	-	-	-	-	-
Crabs	-	-	-	-	11.6	8.5	-	-
Squids & Cuttle fish	3.1	2.5	2.1	2.5	1.4	1.0	-	-
Others	9.7	7.9	3.8	4.5	5.5	4.0	14.2	79.8
All fish	122.3	100	83.5	100	136.1	100	17.8	100

Table IV: Relative abundance (Kg/hr) and percentage composition of various species in different depth strata of Gulf of Mannar

Area	7-78		8-78								9-78	
Depth strata(m)	20-50		20-50		50-100		100-200		200-500		20-50	
Fishing effort(Hrs)	100.0		491.0		5.5		615.1		559.9		204.0	
Species	CPH	%	CPH	%	CPH	%	CPH	%	CPH	%	CPH	%
Sharks & skates	5.5	3.6	2.2	1.4	0.9	8.3	4.3	2.4	-	-	3.0	1.0
Rays	22.1	14.3	21.6	14.0	-	-	7.1	4.1	-	-	13.5	4.5
Barracuda	7.0	4.5	3.9	2.5	-	-	47.3	27.0	-	-	7.0	2.4
Cat fish	1.7	1.1	3.9	2.5	-	-	0.3	0.2	-	-	24.0	8.1
Perches	44.4	28.8	51.6	33.3	-	-	0.4	0.2	-	-	92.1	31.1
Pomfrets	0.1	0.0	1.5	1.0	-	-	-	-	-	-	22.5	7.6
Caranx	9.1	5.4	24.0	15.5	-	-	4.3	2.4	-	-	10.0	3.4
Decapterus	2.8	1.8	5.4	3.5	-	-	4.5	2.6	0.2	3.1	-	-
Psenes indicus	-	-	-	-	-	-	6.2	3.5	-	-	-	-
Nemipterus	7.4	2.8	2.7	1.7	0.9	8.3	9.5	5.4	0.2	3.1	-	-
Priacanthus	-	-	-	-	-	-	4.9	2.8	1.0	15.6	-	-
Lizard fish	1.7	1.1	1.2	0.8	-	-	1.0	0.6	-	-	-	-
Balistoids	22.4	14.5	-	-	-	-	-	-	-	-	-	-
Silver belly	0.4	0.3	7.5	4.8	-	-	1.9	1.1	-	-	67.9	22.9
Clupeids	-	-	3.3	2.1	-	-	-	-	-	-	15.3	5.1
Mackerel	12.1	7.8	1.1	0.7	-	-	0.2	0.1	-	-	1.3	0.4
Moon fish	-	-	5.1	3.3	-	-	-	-	-	-	10.1	3.4
Ribbon fish	-	-	-	-	-	-	4.3	2.4	0.1	1.6	-	-
Crabs	-	-	-	-	-	-	66.9	38.2	-	-	-	-
Squids & Cuttle fish	1.7	1.1	1.2	0.8	4.5	41.7	5.1	2.9	-	-	0.1	0.0
Others	15.8	10.2	18.3	11.8	4.5	41.7	7.1	4.0	4.9	76.5	29.5	9.9
All fish	154.2	100	154.5	100	10.8	100	175.3	100	6.4	100	296.3	100

240

225

WADGE BANK

200

GULF OF MANNAR

175

154·2 154·5

296·3

175·3

150

CATCH (Kg) PER HOUR

136·1

125

122·3

100

83·5

75

50

25

17·8

10·8

6·4

0

7°8'/20-50   7°/50-100   7°/100-200   7°/200-500   7°/20-50   8°/20-50   8°/50-100   8°/100-200   8°/200-500   9°/20-50

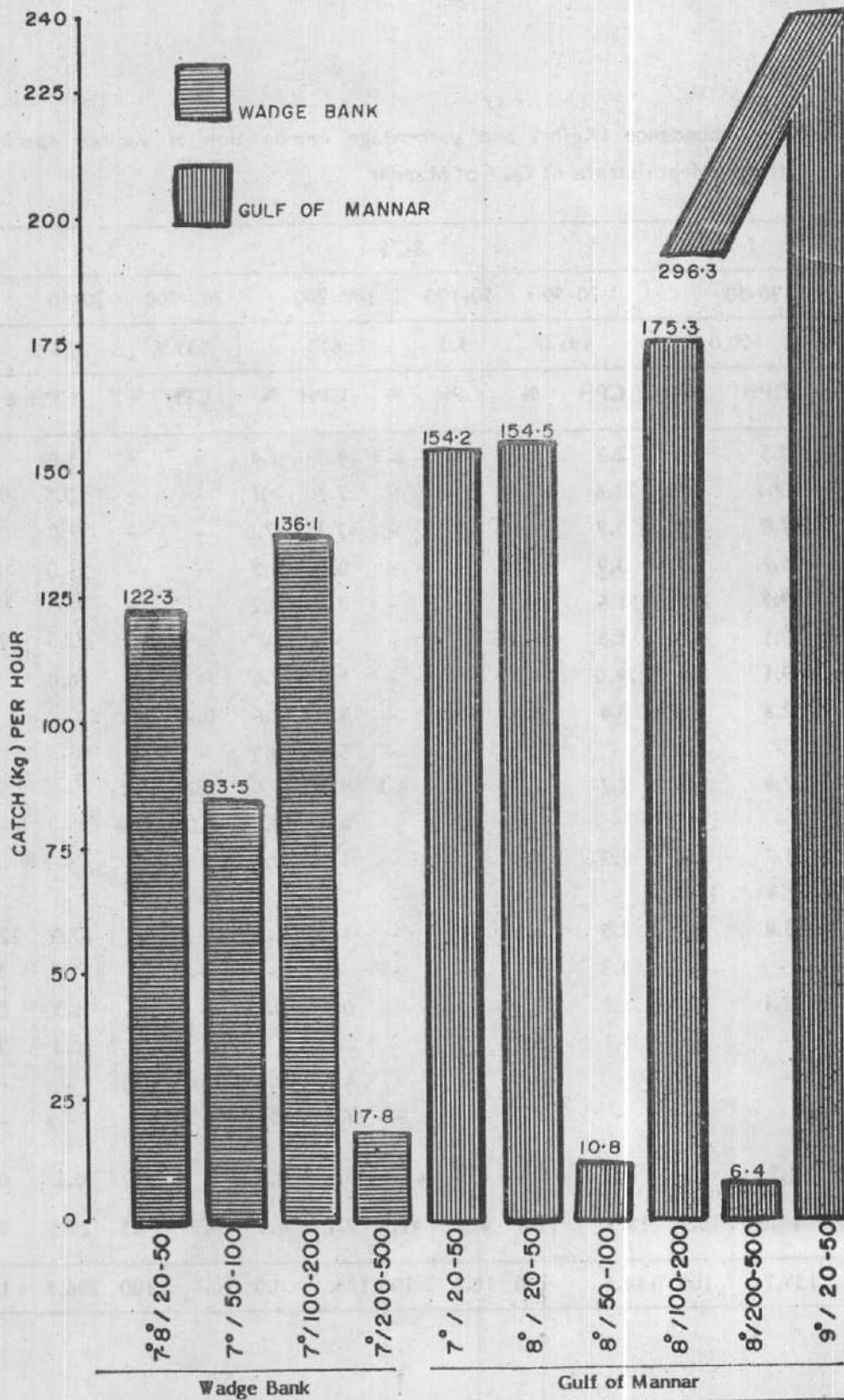Wadge Bank   Gulf of Mannar

Fig. 6.   Relative abundance (Kg/hr) of All Fish in different squares/depths in the Wadge Bank and the Gulf of Mannar

catch rate with increasing depth while Decapterus, Nemipterus, Priacanthus etc. showed a reverse trend. Balistids were abundant from 20-100 m and absent in deeper waters. Most of the categories otherwise showed a declining catch rate with increasing depths.

In the Gulf of Mannar the data were analysed depth-wise separately for the three squares and were also combined. The depth range 20-50 m yielded a highest catch rate of 296.3 Kg/hr in the square 9-78 followed by the depth range 100-200 m in the square 8-78 (175.3 Kg). The depth range 20-50 m in the square 7-78 as well as 8-78 yielded the same catch rate of 154 Kg/hr. The depth range 50-100 m in the square 8-78 was not adequately fished due to rocky grounds and it yielded a very low catch rate. The depth range 200-500 m in the same area also yielded low catch rates.

The combined depth-wise data for the Gulf of Mannar (not presented here) show that the depth range 20-50 and 100-200 m yielded a high and almost equal catch rate of 190.5 and 175.3 Kg/hr. Noteworthy among other observations are high catch rate of Barracuda in the depth 100-200 m (47.3 Kg), Perches in the depth 20-50 m (61.1 Kg), Crabs (66.9 Kg/hr) and the deep sea fishes, drift fish (6.2 Kg/hr), Nemipterus (9.5 Kg/hr), Priacanthus (4.8 Kg/hr) etc. occurred in the depth range 100-200 m.

Seasonal variation

The month-wise analysis of the data was done separately for the Wadge Bank and the Gulf of Mannar for various categories of fishes to study the seasonal variation in their abundance. The data were also analysed separately for various squares as indicated earlier. These data are voluminous and hence not presented here. However, the seasonal variation in the abundance of all fish in the two areas are presented in Fig. 7.

In Wadge Bank the highest catch rate was obtained during January, February (147.4 and 149.6 Kg) and the lowest catch rate was in July. From the figure it will be seen that the catch rates steadily increase from August upto February and thereafter starts declining steadily with the exception of June. Therefore the fishing season can be said to start from October and last till March. Perches occur throughout the year with high catch rates.

CATCH(Kg)PER HOUR

75·4
137·4

41·3
103·5

106·5
46·9

7·9
157·1

90·6
148·0

62·0
75·6

103·0
157·0

109·5
100·7

135·7
180·0

147·4
147·6

149·6
140·6

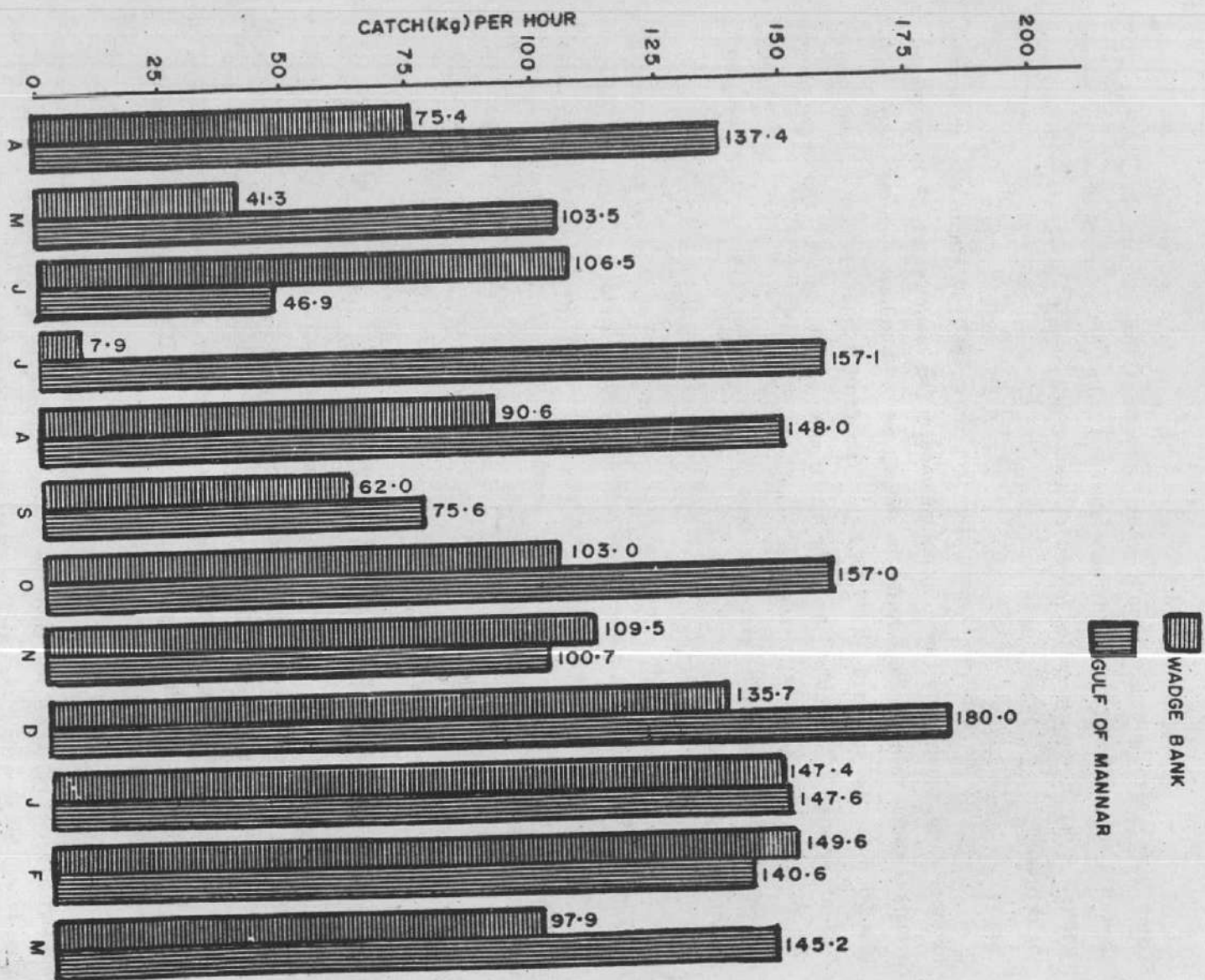97·9
145·2

WADGE BANK

GULF OF MANNAR

Fig. 7. Seasonal variation in the relative abundance (Kg/hr) of All Fish in the Wadge Bank and the Gulf of Mannar

:20:

In the Gulf of Mannar the highest catch rates were obtained during December (180 Kg) followed by July and October (157 Kg). The catch rates were lowest in June (46.9 Kg) and September (75.6 Kg).

The predominance of various categories of fishes in different areas/ depth ranges and different seasons are presented in Table V.

Percentage composition

The percentage composition of various fish categories in the Wadge Bank and Gulf of Mannar are presnted in Table II and Fig.8. This information is also given for each area/depth range in respect of the Wadge Bank and the Gulf of Mannar in Tables III and IV.

Considering the two areas, the Wadge Bank demersal resources are dominated by Perches (20.1%), Balistids (19.2%) and Nemipterus (17.9%). Among other important categories are Decapterus (9.1%) and Carangids (5.1%). Other categories occurred in smaller quantities.
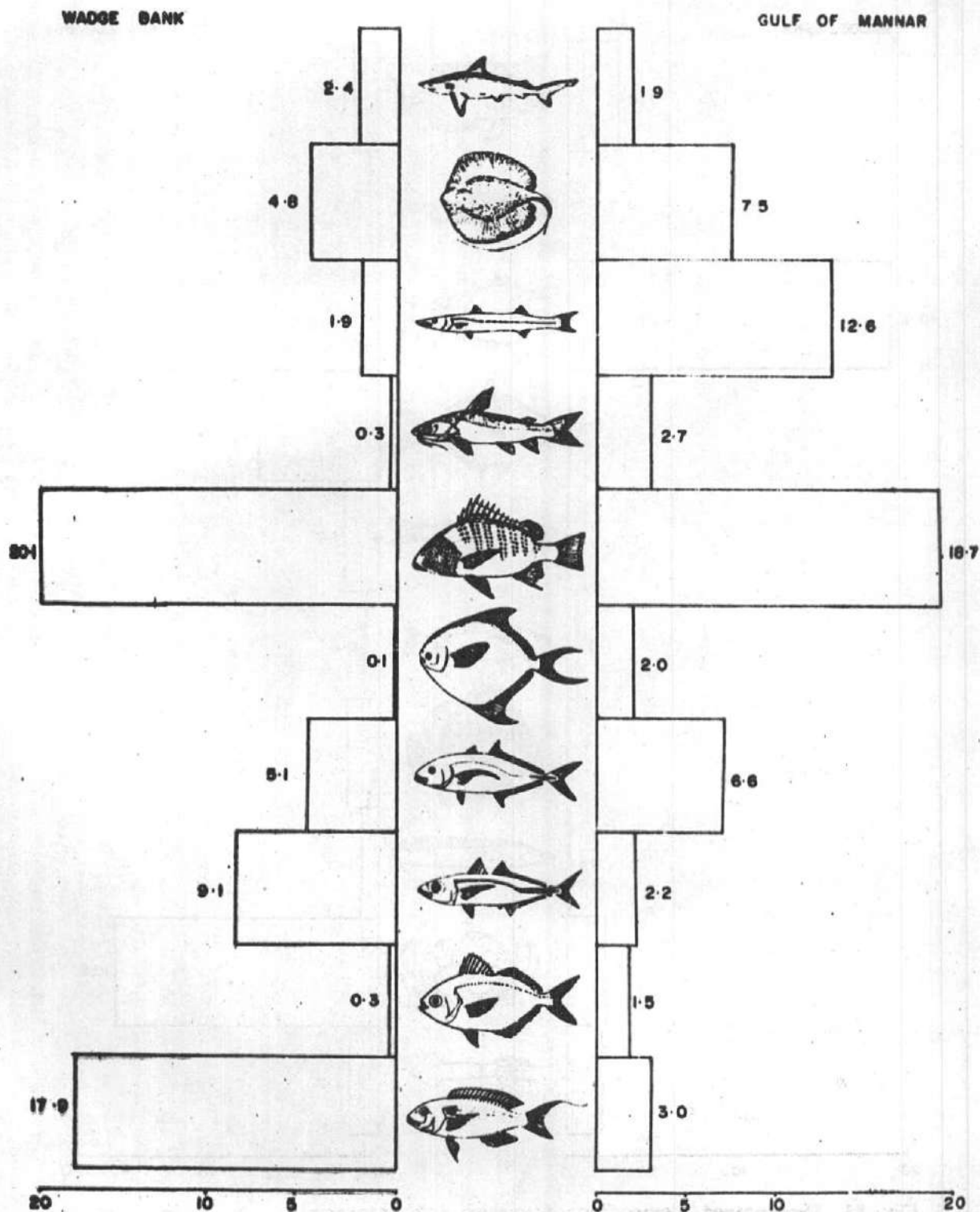
The Gulf of Mannar resources were dominated by Perches (18.7%), Crabs (15.6%) and Barracuda (12.6%). Among other important categories are Carangids (6.6%), Silver belly (7.1%), Nemipterus (3%), Cat fish (2.7%) and Pomfrets (2%).

Considering each depth range in the Wadge Bank, it may be stated that the depth ranges 20-50 and 50-100 m present more or less similar composition and the catches were dominated by Perches, Balistids etc. The depth range 200-500m presented only Sharks (14%), Priacanthus (6.2%) and the remaining miscellaneous varieties of low quality. The catch rate was also poor in this depth range. The depth range 100-200 m was dominated by Nemipterus (49%), Decapterus (17.3%), Priacanthus (6.5%) and Crabs (8.5%).

In the Gulf of Mannar, the depth range 20-50 m within the squares 7-78 and 8-78 present a similar picture dominated by Perches and Elasmobranchs. Balistids were available only in 7-78 and Mackerels were more (7.8%) in this area. In square 8-78 a high percentage of Carangids (15.5%) was observed in depth range 20-50 m. The depth range 50-100 m could not be fished adequately and the catch rate and composition were also poor. The depth range 100-200 m present a high percentage of Barracuda (27%) and Crabs (38.2%). The depth range 200-500 m present

Table V Predominance of various species in different areas/depth (m) and seasons with catch (kg) per hour (in brackets) in Wadge Bank and Gulf of Mannar

Region	Wadge Bank		Gulf of Mannar	
Species	Depth (CPH)	Months (CPH)	Depth (CPH)	Months (CPH)
Sharks & Skates	20-50 (3.4)	Oct. (8.5)	7°/20-50 (5.5)	Oct. (7.3)
Rays	20-50 (7.6)	Apr. (37.5)	7°/20-50 (22.1) 8°/20-50 (21.6)	July (26.6) Oct. (26.1)
Barracuda	20-50 (4.5)	June (14.6)	8°/100-200 (47.3)	Apr. (33.2) Dec. (38.6)
Cat fish	20-50 (0.7)	June (1.8)	9°/20-50 (24.0)	Feb. (11.4) July (9.3)
Perches	20-50 (33.9)	Nov. (34.3)	9°/20-50 (92.1)	May, July, Oct., Dec. (35 to 37)
Pomfrets	Negligible	Negligible	9°/20-50 (22.5)	Jan. (7.2) Nov. (6.9)
Caranx	20-50 (8.1)	June (14.4) Sept.(14.1)	8°/20-50 (24.0)	July (58.4)
Decapterus	100-200 (23.5)	Aug. (24.7)	8°/20-50 (5.4)	Aug. (23.8)
Psenes	Negligible	Negligible	8°/20-50 (6.2)	Apr. (5.5) Oct. (4.5)
Nemipterus	100-200 (66.7)	Jan. (34.4) Feb. (76.4)	7°/20-50 (7.4) 8°/100-200 (9.5)	Oct. (16.5)
Priacanthus	100-200 (8.9)	Dec. (12.8)	8°/100-200 (4.9)	Oct. (11.2)
Lizard fish	20-50 (2.5) 100-200 (2.6)	Oct. (9.9)	7°/20-50 (1.7)	Aug. (6.2)
Silver belly	Negligible	Negligible	9°/20-50 (67.9)	Apr. (35.9)
Balisteids	20-50 (29.6) 50-100 (32.6)	Dec. (60.2) Jan. (79.3)	7°/20-50 (22.4)	Dec. (8.5)
Clupeids	Absent	Absent	9°/20-50 (15.3)	Apr. (12.5) May (15.3)
Mackerel	Negligible	Negligible	7°/20-50 (12.1)	Sept. (13.4)
Moon fish	Absent	Absent	9°/20-50 (10.1)	July (9.5) Aug. (12.5)
Ribbon fish	Negligible	Negligible	8°/100-200 (4.3)	Jan. (10.2)
Crabs	100-200 (11.6)	Mar. (12.5)	8°/100-200 (66.9)	Dec - March (40.8, 50.3, 28.3, 49.7)
Squids & Cuttle fish	20-50 (3.1)	Sept. (5.0)	8°/50-100 (4.5) 100-200 (5.1)	Oct. (8.9)

WADGE BANK

GULF OF MANNAR

2·4

1 9

4·8

7 5

1·9

12·6

0·3

2·7

80·1

18·7

0·1

2·0

5·1

6·6

9·1

2·2

0·3

1·5

17·9

3·0

20   10   5   0   0   5   10   20

WADGE BANK

GULF OF MANNAR

3·0   1·4

1·8   0·5

19·2   0·8

0·1   7·1

1·8

1·6   0·8

1·7

0·1   1·0

2·3   15·6

1·9   1·7

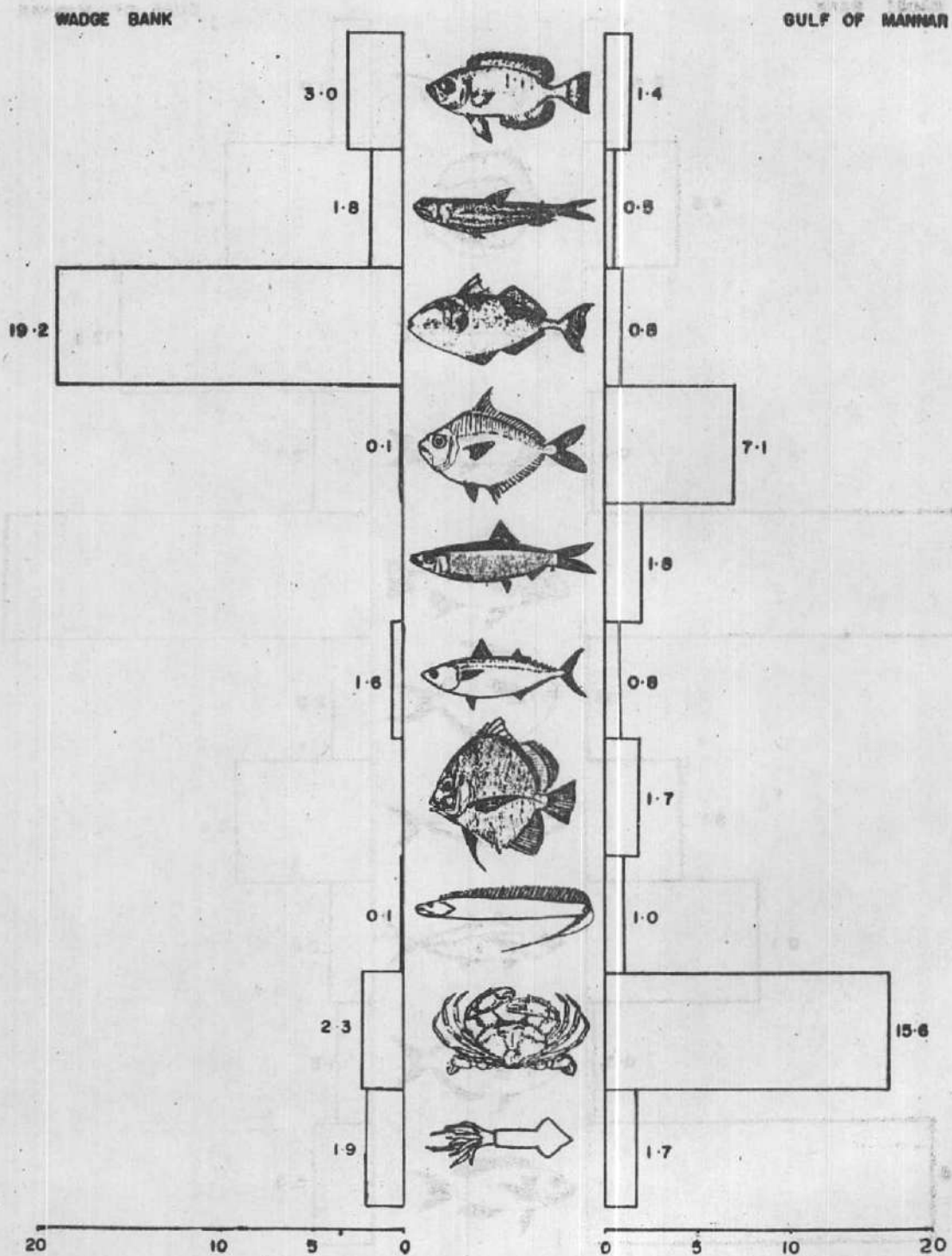20   10   5   0   0   5   10   20

Fig. 8.   Percentage Composition of various fish categories in the Wadge Bank and
the Gulf of Mannar, Fish categories are in the same order as in Table II

a poor catch rate and composition, miscellaneous low quality fish forming the bulk (76.5%) and other varieties being Priacanthus (15.6%), Nemipterus (3.1%) and Deca-pterus (3.1%).

In area 9-78 the bulk of the catch was formed by Perches (71.1%) and Silver bellies (22.9%). Other important categories were Cat fish (8.1%), Pomfrets (7.6%), Clupeids (5.1%), Moon fish and Carangids (3.4% each).

The catches in general contained low percentage of miscellaneous low quality fish and high percentage of quality fish. Squids and Cuttle fish which are of export value occurred in all the depth ranges.

Biomass and potential yield

The total biomass of demersal resources in the Wadge Bank and the Gulf of Mannar within the depth range 20-200 m have been worked out using the swept area method. For this purpose, the area of various depth ranges in each square were measured. The catch/hr using the 34 m fish trawl were taken separately for each depth range. This represents the relative abundance of the demersal resources. The area swept in 1 hour was worked out taking a trawling speed of 3.5 knots and the horizontal spread of net as 40% as observed in the case of similar nets in flume tank tests. The biomass and absolute abundance per KM2 was worked out taking the catchability co-efficient of the net as 40% based on some experiments and also considering the large mesh size in the cod-end (80 mm) as well as other portions (400 mm). The total biomass or standing stock in each depth range was worked out based on the area in Km2 and absolute abundance per Km2. The details of the biomass estimates for Wadge Bank and Gulf of Mannar are presented in Table VI.

It will be seen from the Fig. 3 that the Wadge Bank actually extends over the areas 7-76, 6-76, 7-77, 8-77, 7-78 and 8-78. However, most of the trawlable areas of Wadge Bank are found in the areas 7-77 and 8-77 and our study is also restricted to these areas. The total biomass in the Wadge Bank in the depth range 20-200 m in the squares 7-77 and 8-77 works out to 38,663 t.

The total biomass in the Gulf of Mannar in the depth range 20-200m works out to 24,114 t.

Table VI Biomass in the depth strata 20-200 m of Wadge Bank and Gulf of Mannar

Area	Depth strata m	Area Km2	Catch per hour kg	Biomass per Km2 kg	Total Biomass t
WADGE BANK					
8-77	20-50	1496	146.3	4146.3	6202.9
	50-100	280	93.7	2655.5	743.5
7-77	20-50	2045	146.3	4146.3	8479.2
	50-100	3551	93.7	2655.5	9429.7
	100-200	2926	166.5	4718.8	13807.2
Sub total	20-200	10298	-	3754.4	38662.5
GULF OF MANNAR					
7-78	20-50	417	145.6	4126.4	1720.7
	50-100	265	93.7*	2655.5	703.7
	100-200	206	175.3**	4968.2	1023.0
8-78	20-50	2075	157.0	4449.5	9232.7
	50-100	598	93.7*	2655.5	1588.0
	100-200	1373	175.3	4968.2	6821.3
8-79	100-200	164	175.3**	4968.2	814.8
9-78	20-50	128	296.3	8397.4	1074.9
	50-100	15	93.7*	2655.5	39.8
9-79	20-50	118	296.3***	8397.4	990.9
	50-100	39	93.7*	2655.5	103.6
Sub total	20-200	5398	-	4467.2	24113.8

* Because of poor sampling effort, CPH of Wadge Bank taken

** Because of absence of sampling effort, CPH of 8-78 taken

*** Because of absence of sampling effort, CPH of 9-78 taken

The annual maximum potential yield in the two regions were worked out using the modified first-approximation method of Gulland. The original method refers to virgin resources and the modified methods applies to exploited resources which also takes into account the current production besides biomass of exploited stocks. The mortality rate has been taken as 1 and the maximum yield at 50%. In the case of the Wadge Bank and the Gulf of Mannar, data on the current production of demersal resources are not readily available. However, based on the district-wise production figures given by Chacko (1973) for the year 1976-77 and the production and composition data on demersal catches (57%) for the year 1981-82 and also taking into account the fact that the present study pertain to the depth range 20-200 m the current production was estimated at approximately 15,000 t and 10,000t respectively for Wadge Bank and the Gulf of Mannar in the depth range 20-200m. Accordingly the annual maximum yield has been worked out at 26,832 t for Wadge Bank and 17,057 t for Gulf of Mannar in the depth range 20-500 m. The total biomass and the potential yield per Km2 works out to 3.754 t and 2.606 t respectively for Wadge Bank and 4.467 t and 3.160 t respectively for Gulf of Mannar.

Taking into account the current production of demersal, an additional annual yields of about 12,000 t and 7,000 t of demersals are possible in Wadge Bank and Gulf of Mannar respectively in the depth range 20-200 m.

Wadge Bank survey during October 1981 - December 1982

As started earlier, a comprehensive survey of the demersal resources of the Wadge Bank was carried out earlier during October 1981 to April 1983 and based on the results, a demersal fishery chart was also prepared for this area (FSI, 1984). In this survey, the area of operation covered also areas surrounding the Wadge Bank proper (7-77 and 7-78) and the depth range was limited to 20-300 m. The area-wise and depth-wise results of part of this survey from October 1981 to December 1982 are summarised in Table VII and VIII.

A comparison of the catch rates obtained for major categories in the two surveys reveals that the Balistids which generally occurred in large quantity, were perhaps included in miscellaneous fishes and that Cephalopods were obtained in large quantity in the earlier survey. Also, better catch rates were obtained on the whole for all fishes including the Nemipterids, Rays, Cat fish, Perches, Carangids and Lizard fish. This could be attributed to the fact that the earlier survey covered

Table VII   Relative abundance (Kg/hour) of various species in different areas
of Wadge Bank and adjacent areas surveyed during October 1981
to December 1982

Areas	7-76	7-77	7-78	8-76	8-77	8-78	9-76
Fishing effort (Hrs)	74.17	523.0	12.25	278.5	45.67	47.00	9.25
Sharks & Skates	0.6	2.6	1.2	1.3	0.2	2.2	4.5
Rays	12.5	14.9	26.1	22.9	29.9	82.3	13.9
Barracuda	0.2	1.0	-	-	-	-	-
Cat fish	-	6.4	-	34.4	1.0	0.9	10.4
Perches	2.0	59.4	34.3	9.4	25.2	19.5	2.2
Caranx	7.4	11.1	0.4	32.0	29.3	6.8	6.8
Nemipterus	69.2	35.1	0.3	30.3	1.7	6.2	11.9
Lizard fish	15.0	5.6	-	27.6	-	3.9	13.1
Mackerel	-	0.5	-	1.3	0.1	-	6.3
Flat fish	-	0.2	-	0.1	-	0.1	-
Crustaceans	1.4	-	0.2	0.1	-	-	-
Cephalopods	2.1	18.3	2.5	16.6	5.1	37.4	7.3
Others	1.7	10.4	4.7	16.4	11.0	17.3	3.7
All fish	112.0	165.7	69.6	192.1	103.6	176.7	100.2

Table VIII   Relative abundance (Kg/hour) of various species in different depth strata of Wadge Bank and adjacent areas surveyed during October 1981 to December 1982

Depth strata (m)	20-50	50-100	100-200	200-300
Fishing effort (hrs)	587.83	227.75	171.0	3.33
Sharks & Skates	1.7	3.8	0.4	-
Ray	23.8	21.9	9.6	-
Barracuda	0.9	-	0.1	-
Cat fish	15.5	15.6	2.1	-
Perches	54.6	17.4	2.7	-
Caranx	22.0	10.0	8.6	-
Nemipterus	14.2	18.5	115.6	4.5
Lizard fish	13.9	8.3	11.4	12.0
Mackerel	0.8	0.5	0.4	-
Flat fish	0.2	0.1	0.1	-
Crustaceans	-	0.1	0.6	-
Cephalopods	23.9	8.0	2.4	-
Others	13.1	12.8	5.0	1.5
All fish	185.3	117.9	159.2	18.2

many areas other than Wadge Bank proper and also operations were limited to 20-300 m.

Survey of the Wadge Bank and the Gulf of Mannar
by 17.5 m vessels during the years 1971-1980

While the present study throws light on the demersal resources of the two areas as surveyed by a large survey vessel in the depth rangee 20-500 m, the picture regarding the resources of inshore waters from 0-80 m are provided by the survey conducted by FSI with the 17.5 m vessels during the years 1971-80. The results are published in the Bulletins of FSI. Joseph (1976 a & b,1980) consolidated the information available in this regard upto 1975 and 1980.

A comparison of the percentage composition of catches as obtained by the survey of the two classes of vessels in the Wadge Bank are furnished below.

Depth(m)	Joseph (1980)				Present study			
	0-20	20-40	40-60	60-80	20-50	50-100	100-200	200-500
Elasmobranchs	52.3	22.6	34.3	-	9.0	7.7	2.9	14.0
Perches	15.8	13.5	12.0	-	27.7	24.4	5.6	-
Cat fish	9.0	7.9	2.4	51.3	0.6	-	-	-
Nemipterus	-	2.6	9.5	-	7.7	7.0	49.0	-
Ribbon fish	-	0.9	-	-	-	-	-	-
Lizard fish	-	1.1	1.2	6.2	2.0	1.4	1.9	-
Other quality fish	13.5	7.4	1.6	1.5	11.0	6.4	3.2	-
Prawns	0.1	1.5	1.2	-	-	-	-	-
Others	9.3	42.5	37.8	41.0	42.0	53.1	37.4	86.0

It will be observed that the Elasmobranchs and Cat fish formed a high percentage in the inshore waters while Perches, Nemipterus etc. formed a high percentage in the offshore and deep sea waters.

The picture presented by the two classes of vessels in the Gulf of Mannar are presented below.

Depth(m)	Joseph(1980)				Present study			
	0-20	20-40	40-60	60-80	20-50	50-100	100-200	200-500
Elasmobranchs	25.7	27.4	17.0	19.5	11.8	8.3	6.4	-
Cat fish	0.4	0.4	1.6	-	4.6	-	0.2	-
Carangids	1.7	1.3	0.3	-	9.8	-	2.4	-
Barracuda	0.1	0.1	-	-	2.7	-	27.0	-
Perches	30.7	42.1	31.0	5.7	32.1	-	0.2	-
Upeneoids	0.1	-	-	-	0.4	-	0.3	-
Sciaenids	1.8	1.4	2.3	-	1.3	-	-	3.1
Prawns	0.2	0.5	-	-	-	-	-	-
Others	39.3	26.8	47.8	74.8	37.3	91.7	63.5	96.9

It will be observed that the Eiasmobranchs and Perches formed a high percentage in the inshore waters. Barracuda were more in the deeper waters.

The estimates of total biomass and potential yield were estimated by Joseph et al (1976 a & b) and Joseph (1980) for the south-west coast and lower east coast besides other regions based on the survey by 17.5 m vessels. Antony Raja (1980) commented that Joseph et al did not appear to have correctly calculated the "swept area" and that their estimates would require revision. However, based on Joseph et al (op.cit.), estimates of biomass and potential yield for 0-70 m were computed for the Wadge Bank and the Gulf of Mannar and presented elsewhere in the paper.

Discussion

The Wadge Bank and Gulf of Mannar are traditionally known for rich resources with a high percentage of quality fishes. Antony Raja (1980) commented that these are two areas where we have a wealth of information, and a comparative study of the resource assessment of these areas will be a rewarding experience. However, it should be stated that though a number of surveys have provided inform-ation on various aspects of the pelagic and demersal resources, it cannot be said

to provide a total picture of the resources. As well designed resources survey covering all aspects of the resources including biological aspects and environmental factors is called for.

The Wadge Bank is mainly situated in the squares 7-77 and 7-78 with a total shelf area of about 10,300 Km2. Many authors have taken the surrounding areas also and put the total area as 12 - 13,000 Km2. However in the present study the area has been worked out as 10,300 Km2 and the study was restricted to the squares 7-77 and 8-77. The inshore area is very steep and the shelf within 20 m depth is negligible. The shelf beyond 20 m upto 500 m provide a vast submarine plateau suitable for extensive trawling. As a matter of fact these banks are compared to some of the best-known trawl grounds like Dogger Banks of the North sea. The Wadge Bank has been exploited for a very long time by Srilanka. The traditional distant water trawl fishery of Ceylon Fisheries Corporation was dependent on this area. Several foreign nations like Taiwan, South Korea, Thailand and USSR have been fishing in this area. However, with the declaration of the 200 miles EEZ, fishing by foreign nations have been stopped thereby reducing the fishing pressure on these resources.

The Gulf of Mannar is also known for rich resources both pelagic and demersal. The Gulf presents a contrasting bottom topography in that the inshore shelf area is rather broad and support some of the best known demersal fishery. The areas off Manappad (7-78, 8-78) support a rich demersal fishery including shrimps. The area off Tuticorin are rich in Perches, Carangids, Barracuda and other quality fishes. The squares 9-78 and 9-79 are highly productive grounds for Silver belly (91%), Pomfrets, Lactarius and Prawns (Rao 1973). The pelagic resources mainly include Elasmobranchs and Perches. The gill net and hook and line experiments conducted by FSI have shown the availability of these resources (Rao 1973). The deep sea trawling conducted by Integrated Fisheries Project and Pelagic Fisheries Project have revealed availability of deep sea prawns and deep sea lobsters in the continental slope at a depth of 300-400 m (Oommen 1980, 1985) and of pelagic resources mainly Anchovies and Lesser sardines in this area (George et al, 1977).

The catch rates and percentage composition of the various species vary in the different surveys due to several reasons. When the survey is well designed with adequate sampling effort in the various depth ranges and spread over fairly a long period, it will give a most reliable picture. Fish resource being a dynamic resource which varies at all times, the more the number of hauls and number of hours, the more reliable is the information. Thus we find that the catch rates and composition are markedly different in the earlier survey by Matsya Nireekshani (FSI, 1984) and the present survey by the same vessel in the Wadge Bank. The Fishery Chart of Wadge Bank shows more or less increasing catch rates with increasing depth. When the data are analysed square-wise and within the square depth-wise, the results are still more conflicting. Thus in the earlier survey the average catch rate for the whole period was about 140 Kg/hr while present survey it was only 98.6Kg/hr. The catch rate in the depth range 100-200 m and above 200 m were 500-525 Kg/hr and 200-220 Kg/hr respectively in the area 7-77 while in the present survey it was only 136.1 and 17.8 Kg/hr respectively. On detailed examination of the data of earlier survey, it was found the high catch rates were mainly due to occurrence of Nemipterus in very large quantities in this area in the depth range 100-125 f in February and June. The number of hauls and fishing hours in this depth range were comparatively less and hence the high figures. However the Fishery Chart for the Wadge Bank provides comprehensive information on resources.

The estimates of total biomass and the annual potential yield for the two areas have been made by a number of authors which are summarised below.

Authority	Method	Area/ depth	Biomass t	Potential yield t
Wadge Bank				
Shomura (1971)	Swept area	Whole area	-	7800
Antony Raja (1980) based on Mendis(1965)	Swept area	Whole area	-	8400
George (1977) based on Cushing (1971)	Tertiary production	Whole area	1,80,000	87750
PFP (George et al 1977)	Acoustic survey	Whole area	73,000	-
Estimated from Joseph et al (1976 a)	Swept area	0-73 m (7289 Km2)	18,193	10916
Present study	Swept area	20-200 m (10298 Km2)	38,663	26832

Authority	Method	Area/depth	Biomass t	Potential yield t
Gulf of Mannar				
PFP (George et al 1977)	Acoustic survey	Whole area	83,000	-
Estimated from Joseph et al (1976b)	Swept area	0-73 m (14050 Km2)	54,868	32921
Present study	Swept area	20-200 m (5398 Km2)	24,114	17057

It will be observed that the estimates varied to a high degree. While the accuracy of the various estimates are open for discussion, they definitely give an idea of the size of resources available and what part of it can be exploited. The information is useful in planning the fishery development of these areas. While the Wadge Bank is entirely available for exploitation for our own purpose, the Gulf of Mannar area has been truncated due to sharing of the area and the fish stocks by Srilanka and our country since 1976. As the various parameters taken for resources estimation are presented in the paper, the estimates can be refined if found necessary. It is felt that the biomass and potential yield estimated are reasonable and development schemes could be taken up for exploiting these surplus demersal resources. As stated elsewhere, about 12000 t and 7000 t of surplus resources of demersal fishes with a high percentage of quality fishes like Perches, Carangids, Barracuda etc. are available for exploitation.

It is lamentable that there is no organised large scale fishing for finfish as compared to the shrimps. This is due to the fact that there is practically no internal market for fishes and the export market for finfish is also limited except for Tunas, Bill fishes, Pomfrets, Spanish Mackerel etc. The resources available for exploitation in the areas of present study, are large perches including Snappers, Groupers, Emperors, Grunters, Carangids, Barracudas etc. which are esteemed table varieties of high market value. Whether this will be able to support deep sea trawling financially is a question which should be examined with care. Optimum size and power of vessels required for exploiting a particular resources depend, besides other factors, on the distance, depth, productivity of the grounds and cost of production per tonne (Roy Choudhury, 1973). While the fishing grounds are comparatively nearer to the port in the Gulf of Mannar, they are quite far in the case

of Wadge Bank. Depth of operation is quite high. It appears from experience that vessels of the size of 15-20 m with a horse power of 300-500 will be required for exploiting the deep sea demersal resources of the Wadge Bank. The offshore demersal resources of the Gulf of Mannar upto 75-100 m can however be effectively exploited with vessels of about 15 m with a horse power of 200-300.

About 25 trawlers could be introduced for the Wadge Bank and about 15 trawlers in the Gulf of Mannar based on deep water demersal resources alone. Trawling combined with passive methods like fishing with gill nets, bottom long lines, hook and lines, traps etc. will be highly successful in the exploitation of these resources.

While FSI has been able to meet the information needs of the fishing industry to a great extent as far as the resources information is concerned, information on technical and economic feasibility of different craft-gear combinations for different resources are not available. There are no institutions for undertaking this studies. Institutes under the public system cannot be expected to undertake such studies and they can at the best only make projections based on approximations and uncertainties. Such studies should be undertaken as projects by chartering vessels on contract basis with the best commercial fisherman and liberal incentive terms. Such a study will be rewarding in providing information on the maximum catch possibilities and economic feasibility.

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