

CMFRI

bulletin 44

Part One

JUNE 1989



NATIONAL SYMPOSIUM ON RESEARCH AND DEVELOPMENT IN MARINE FISHERIES

MANDAPAM CAMP
16-18 September 1987

Papers Presented
Sessions I & II

CENTRAL MARINE FISHERIES RESEARCH INSTITUTE
(Indian Council of Agricultural Research)
P. B. No. 2704, E. R. G. Road, Cochin-682 031, India

Central Marine Fisheries Research Institute
40
YEARS
1947-1987

AN ASSESSMENT OF THE BOTTOM-TRAWL FISHERY RESOURCES OF THE NORTHEAST COAST OF INDIA

S. Reuben, G. Sudhakara Rao, G. Luther, T. Appa Rao, K. Radhakrishna,
Y. Appanna Sastry and G. Radhakrishnan
*Visakhapatnam Research Centre of Central Marine Fisheries
Research Institute, Visakhapatnam - 530 003.*

ABSTRACT

An overview of the bottom trawl fishery resources of the continental shelf of the northeast coast (lat. 15° N-21° N and long. 80° E-88° E) has been attempted based on data collected from the exploratory fishery surveys conducted by the Govt. of India fishing vessels during 1961-1985. The 'swept-area' method has been employed to estimate the standing stock, and 60% of this has been reckoned as the potential yield. The catch rates in the shelf region ranged between 1 kg/hr in square 17-33 C1 and 377 kg/hr in squares that yielded 150 kg/hr or more are distributed widely both in the inshore and offshore grounds. The potential yield estimates for the area explored varied between 0.83 t/km² in 20° N-87° E and 3.37 t/km² in 19° N-35° E.

A potential yield of 150 919 t has been estimated for the 81.684 km² area for the shelf and adjacent areas along the northeast coast with the State wise break up as: West Bengal 24 121 t, Orissa 52,065 t and Andhra Pradesh 74,733. Depth-wise potential yield in the shelf area and beyond are also given. It is pointed out that demersal fish catches off West Bengal and Orissa could be increased with increased exploitation. It is observed that sharks and skates, rays, catfishes, mackerels, threadfin breams and jacks are underexploited at present and that lizard fishes and croakers have already reached the optimum level of exploitation. Current knowledge of bottom trawl fishery resources of the shelf area of the northeast coast has been reviewed, and the factors responsible for the variations in the potential yields estimated by various authors have been discussed.

INTRODUCTION

Exploratory bottom trawling operations are being conducted by the Fishery Survey of India (FSI) since 1960 with intensive coverage along

the northeast coast of India: Off West Bengal, Orissa and Andhra Pradesh, between latitudes 15°N to 21°N and longitudes 80° E to 88°E. Different aspects of the results of these exploratory trawling operations have been reported

various authors from time to time (Naumov, 1961; Shariff, 1961; Poliakov, 1961 & 1962; Borisov, 1962; Sekharan *et al.*, 1973; Krishnamoorthi, 1973 and 1976; Josph *et al.*, 1976; Anon, 1980; Antony Raja, 1980 and Sivaparakasam, 1987). These accounts, however, were limited to short periods of time covering small areas and a few vessels, and some times to one or two specific resources. Stimulated by the results of the exploratory fishing operations, the private entrepreneurs have embarked on commercial fishing through the introduction of small sized boats using shrimp trawl with an operational range of about 35 km. Mexican type of large trawlers with cold storage facility which could make 20-30 days voyage covering vast areas have started fishing on a commercial scale in the area since 1978. With the concentration of over 100 such large trawlers, Visakhapatnam has come to stay as a very important fishing harbour in our country. Roychowk, Paradeep and Kakinada are the additional bases with facilities to operate small sized shrimp trawlers along the northeast coast. Bhavanapadu and Nizampatnam are fast emerging as minor fishing harbours along the Andhra coast.

In view of the ever increasing fishing effort being expended by the large trawlers as well as the small mechanized boats along this coast, it has become imperative to understand the present status of the bottom trawl fishery resources in order to formulate policies for proper management of the resources. The present account provides a comprehensive overview of the past 25 years, since 1961, by various vessels of the FSI in different areas of this vast region.

MATERIAL AND METHODS

This report is based on the analysis of data collected during the exploratory bottom trawling operations of the FSI vessels based at Visakhapatnam during the period 1961-1985 over an area of 81,684 km² extending from Sunderbans in the north (21°N) to Ramayapatnam in the south (15°) and projecting 20-120 km towards the continental slope (Fig. 1 & 2). In all 10 vessels were involved in exploratory fishing

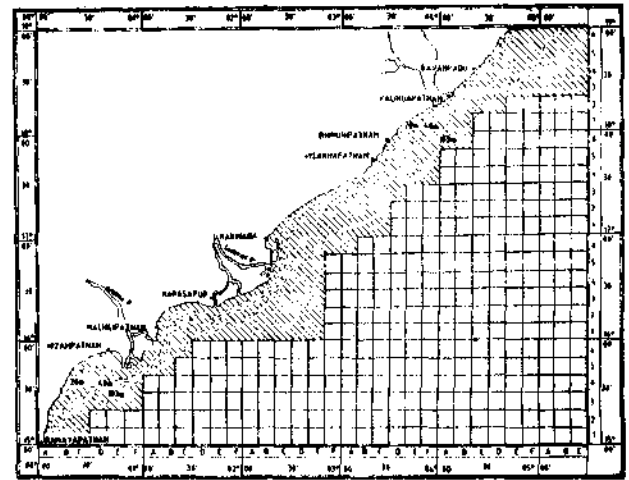


Fig 1 Areas Explored (Hatched) off Andhra Pradesh

Fig. 1 : Areas explored (hatched) off Andhra Pradesh.

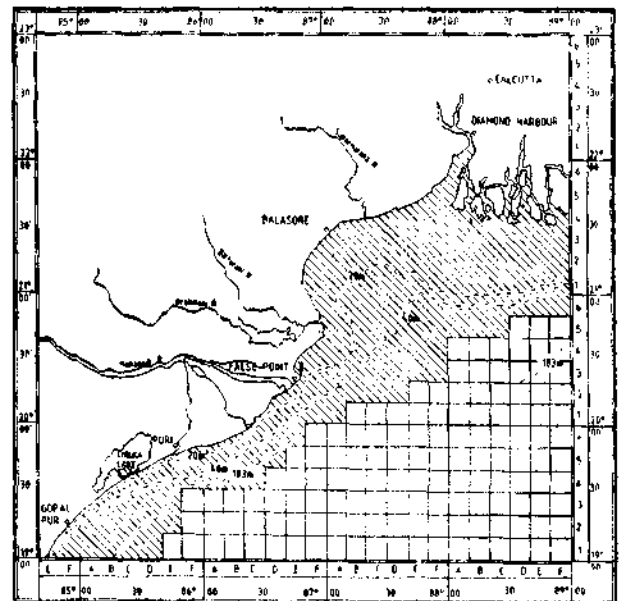


Fig 2 Areas Explored (Hatched) off Orissa and West Bengal

Fig. 2 : Areas explored (hatched) off Orissa and West Bengal.

over the period. But only 5 of them, namely, *M. T. Ashok*, *M. V. Champa*, *M. V. Meena Shodhak*, *M. V. Meena Jawahar* and *M. F. V. Matsya Shikari* are considered in the present study. The remaining five vessels, namely, *M. T. Pratap*, *M. T. Gudjon*, *M. V. Sea Horse*, *M. V. Sagar Kumari* and *M. F. V. Matsya Darshini* expended negligible effort in bottom trawling and hence not considered. The vital statistics, including the performance, of the first five vessels are presented in Table 1,

TABLE 1

Vessels and gears employed for exploratory bottom trawling off northeast coast of India

Particulars of vessel	M. T. Ashok	M. V. Champā	M. V. Meena Jawahar	M. V. Meena Shodak	M. F. V. Matsya Shikari
OAL in m	25.4	14.3	17.5	17.5	39.5
GRT	91.7	34.5	56.8	56.8	352.5
BHP (rated)	240	165	200	200	1740
Gear	Fish otter trawl	Fish otter trawl	Fish otter trawl	Fish otter trawl	Fish otter trawl
Length of head rope (m)	15	14	24	24	34
Cod-end mesh size (mm)	40	30	50	50	50
Period of operation	1961-'70	1961-'71	1973-'79	1972-'81	1980-'85
Area surveyed	16°-20°N	17°-18°N	15°-19°N	15°-19°N	15°-20°N
Hours spent in trawling	6259	6983	4366	4065	4276
Catch in t	899	687	369	303	688
Cph in kg	143.62	98.4	84.5	74.5	160.9
Fishing power	1.70	1.16	1.00	0.88	1.90

OAL = Overall length; GRT = Gross registered tonnage; BHP = Break horse power
Cph = Catch per hour of trawling.

On board the vessel, the catches were broadly categorised into six groups, namely, 1) sharks & skates 2) rays 3) catfishes 4) prawns 5) miscellaneous small and 6) miscellaneous big. The scientists of the Visakhapatnam Research Centre of C. M. F. R. I. further subdivided these groups into genera and species by collecting representative samples. In all, the following 17 major groups/species were considered for this purpose: 1) sharks & skates 2) rays, 3) catfishes, 4) mackerel, 5) ribbon-fishes, 6) silverbellies, 7) threadfin breams, 8) croakers, 9) lizard fishes, 10) drift fish, 11) whitefish, 12) grunters, 13) jacks (Carangids), 14) pomfrets, 15) goat fishes, 16) 'other perches' and 17) miscellaneous fishes (Table 2). Tunas, threadfins, seerfishes, sickle fishes, red snapper, barracudas, silver breams and such other large varieties were clubbed under 'other perches', where prawns, crabs, lobsters, cephalopods, soles, flatfishes, clupeoids etc, comprised the miscellaneous fishes.

The entire region of exploration of 81,684 km² has been subdivided into 10' x 10' squares, each of 343 sq km (18.53 x 18.53 km). These squares were designated numerically

(1-6) along the latitude and alphabetically (A-F) along the longitude. Each square is indicated by its latitude-longitude and the coordinates separated by an oblique stroke. Each ten minute square is taken as the unit grid to demarcate the abundance of the resources. Catch and catch rate (cph) are expressed in kg, and effort in hours. The data from each vessel were analysed square-wise for the entire period of operation. The effort put in by the different vessels has been standardized instead of interpreting the data vessel-wise as was done by the previous authors.

M. V. *Meena Jawahar*, among the five vessels, was taken as standard as she operated during the middle part of the period under study, and was intermediate in OAL among the vessels employed in the survey. In view of the wide variability in design, capability and efficiency of the vessels and nets, fishing power of different vessels/nets could not be standardized based on the length or horse power of the vessels. Hence, the cph of the vessels based on their catch and effort for the entire period has been taken into account to compute their relative fishing power. Thus, considering the fishing power of *M. T. Jawahar* as 1, the

relative fishing powers of *M. T. Ashok*, *M. V. Champa*, *M. V. Meena Shodhak* and *M. F. V. Matsya Shikari* was estimated as 1.70, 1.16, 0.88 and 1.90 respectively. Based on these estimates the effort put in by each vessel was standardized. For instance if *M. T. Ashok* operated in a square for 5 hours, the standard effort of this operation works out to (5 x 1.7) 8.5 hours. Likewise if *M. V. Meena Shodhak* operated for 5 hours in a square the standard effort becomes (5 x 0.88) 4.4 hours. In this

manner the entire fishing operations by different vessels in each square have been integrated to obtain the total fishing effort expended, and the catch rate arrived at. Depending on the cph values for the total trawl catches the squares were categorized as very poor (< 20 kg), poor (21-50 kg), moderate (51-100 kg), rich (101-150 kg) and very rich (> 150 kg) (Figs. 3 and 4). For individual groups of fishes, however, a lower scale was adopted eg. very poor (< 1 kg), poor (1-5 kg) moderate (6-10 kg), rich (11-20 kg) and very rich (> 20 kg).

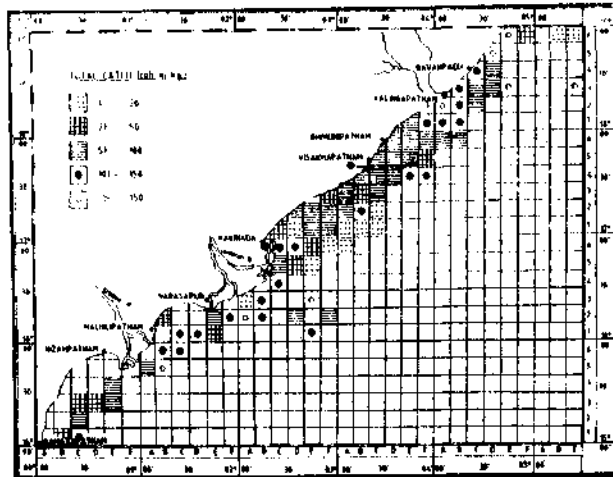


Fig 3. Distribution of catch rates in the Explored area off Andhra Pradesh.

Fig. 3: Distribution of catch rates for the total catches in the explored areas off Andhra Pradesh.

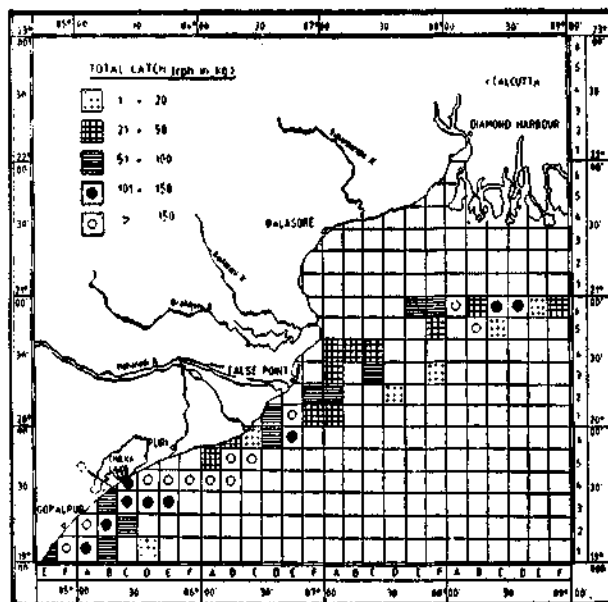


Fig 4. Distribution of catch rates in the Explored area off Orissa and West Bengal.

Fig. 4: Distribution of catch rates for the total catches in the explored areas off Orissa and West Bengal.

Data from squares, where the total effort put in was 5 hours or less have not been considered in this study.

Standing stock in each square is estimated by the 'swept area' method (Gulland, 1965). The size of the standing stock (B) is obtained from the relationship:

$$B = \frac{C/F.A}{a \cdot X_1}$$

where,

C/F = the mean catch per unit of effort (cph),

A = the area of exploitation

a = the area swept by the gear during one unit of effort (one hour)

X_1 = the proportion of fishes in the path of the net which are actually retained by the net. A value of $X_1 = 0.5$ as proposed by Pauly (1979 and 1983) for Southeast Asian waters is adopted here.

The bottom surface area (a) swept by the gear during a unit of effort is computed from the equation:

$$a = t \cdot v \cdot h \cdot X_2$$

where,

v = speed of the vessel while trawling

t = time spent for trawling

h = length of the trawl head rope

X_2 = fraction expressing the width of the area swept by the gear, which is a function of the length of the head rope (h). The value of X_2 ranging between 0.4 and 0.66 has been employed in Southeast Asian waters with 0.5 as the best compromise (Pauly 1979). Hence X_2 is taken as 0.5 in this analysis.

For computing the area swept (a) the following values have been adopted : $t =$ one hour, $v = 2.5$ km, $h = 24$ km and $x_2 = 0.5$. Thus the area swept per unit time works out to 0.06 km².

For computing standing stock (B) the values adopted are : $C/F =$ mean cph, $A =$ area of one square being 343 km², $a = 0.06$ km² and $x_1 = 0.5$.

The values of standing stock for the different $10' \times 10'$ squares surveyed have been added up and the average value for one square was obtained. Based on this, the standing stock for the corresponding $1^\circ \times 1^\circ$ area along the north east coast surveyed has been estimated. Thus the total value of standing stock for the entire region was obtained by adding values calculated for different $1^\circ \times 1^\circ$ trawled during the period under report. The terms 'square' and 'area' used in the text refer to $10' \times 10'$ squares and $1^\circ \times 1^\circ$ squares respectively.

The above procedure has been adopted to estimate the standing stock of the bottom trawl resources as a whole as well as for the individual groups. The potential yield is reckoned as 60% of the standing stock.

The catch figures of the various groups of fishes mentioned in the text as 'present landings' refer to the landings by all the craft and gear mechanised as well as artisanal.

Three depth zones viz, less than 40 m, 40m-180m and beyond 180 m are considered for the depth-wise estimation of potential yields. The latitude-longitude zones of $15^\circ-80^\circ$ to $18^\circ-85^\circ$, $19^\circ-84^\circ$ to $20^\circ-88^\circ$ and $21^\circ-86^\circ$ to $21^\circ-88^\circ$ have been considered to represent the fishing grounds off Andhra Pradesh, Orissa and West Bengal respectively for the purpose of the present analysis. The data from the explored area in the shelf have been extrapolated to the entire shelf area.

RESULTS

Effort

Effort expended by different vessels varied widely. The quantum of effort expended in different squares ranged from 1.1 trawling hrs in 19-85/A3 to 8640.4 trawling hrs in 17-83/C5.

Out of the 160 squares explored, 24 squares were fished for less than 5 hours, 18 squares for 5.1-10 hrs, 47 squares for 10.1-50 hrs, 20 squares for 50.1-100 hrs, 4 squares for 100.1-1000 hrs and 5 squares for more than 1000 hrs.

Catch rates

The catch rates for the total resource (Figs. 3 & 4) in different squares varied from 1 kg (16-82/E5, 17-83/C1) to 377 kg (20-88/B5). The categorisation of squares in terms of abundance is given below :

Very rich : 15-81/B5, 16-82/A2, E3; 18-84/A2, D5, E6; 18-85/C3; 19-84/C ; 19-85/A2, B4, D4, E4, F4; 19-86/A4, B4, B5, C5, 20-86/E1; 20-85/A6, B5.

Rich : 15-80/C1; 15-81/B6; 16-81/C1, D1, F2; 16-82/B2, B3, B6, C4, C6, D6, 17-83/B2, B5, E4, F4; 18-83/F1; 18-84/A1, B1, B2, B3, C4; 19-85/A1, B2, C3, C4, D3, E3, 19-86/E6; 20-88/C6, D6.

Moderate : 15-80/C2, E3, E4; 15-81/A5; 16-81/E2; 16-82/C5, D2, F2; 17-82/D2, E1, E2, F1, F2; 17-83/A2, A4, B4, C3, C4, C5, C6, D4, D5, D6, E5, E6, F6; 17-84/A6, B6; 18-83/E1; 18-84/C2, C3, D3, D4; 19-84/E1, 19-85/B1, B3, C2; 20-86/D1, F2; 20-87/A2, C3, E6, F6.

Poor : 15-80/B1, C3; 16-81/B2, E1; 16-82/D5, E6; 17-82/C1, F3, 17-83/B3, F5; 18-83/D1; 18-84/F6; 19-86/A5, 20-87/A1, A3, A4, B4, C4, F5.

Very poor : 16-82/A3, E5, F6; 16-83/A6; 17-83/B1, C1, C2; 18-85/B6, C6; 19-85/D1; 19-86/C6; 20-87/D2; 20-88/C5.

Standing stock and potential yield

Standing stock of trawl fishery resources varied from 1740 t in area $17^\circ-84^\circ$ to 33,067 t in area $16^\circ-82^\circ$. The potential yield for each area of 1° latitude and 1° longitude are shown in Table 2. The area surveyed in terms of km², the potential yield of the total resource as well as group wise breakup for each one degree squares are also given in this table. The potential yield varied from 1044 t in area $17^\circ-84^\circ$ to 19840 t in area $16^\circ-82^\circ$ with the total estimate as 1,50,919 t for the entire area of 81,684 sq km. However, potential yield per km² varied from

TABLE
Area-wise potential yields (t) of different

Latitude/ longitude	15-80	15-81	16-81	16-82	17-82	17-83	17-84	1883	18-84
Area in km ²	5848	2133	3882	9711	2519	7058	686	743	5760
Potential yield (t)	7831	5617	6369	19840	3157	10054	1044	1396	12318
Sharks & skates	355	419	497	637	141	386	58	101	677
Rays	203	121	658	1860	139	572	31	100	710
Catfish	551	683	1084	2495	274	2158	256	221	3411
Mackerel	163	134	128	2063	220	452	109	—	82
Ribbonfish	178	22	141	557	6	163	—	17	555
Silverbellies	631	790	248	60	61	420	138	89	365
Threadfinbreams	1254	114	143	485	171	928	7	47	282
Croakers	349	1185	1032	2450	271	1197	76	230	1997
Lizard fishes	2	—	12	89	73	260	78	23	134
Drift fishes	4	114	118	260	228	187	10	25	465
Whitfish	13	19	20	136	32	96	8	39	170
Grunters	18	88	78	548	123	214	4	133	620
Jacks	1436	663	1083	2630	384	437	47	57	755
Pomfrets	387	306	298	465	72	147	8	19	100
Goatfishes	7	25	61	346	77	424	38	54	290
Other perches	820	192	385	707	74	261	11	83	508
Miscellaneous	1440	742	891	3508	891	1752	165	158	1697

0.86 t in area 20°-87° to 3.37 t in area 19°-85°, the average estimate for the entire region surveyed being 1.85 t.

1. **Sharks & skates** : Sharks and skates represented by *Scoliodon* spp, *Carcharhinus* spp, *Sphyrna* spp, *Rhynchobatus* spp, *Rhinobatos granulatus*, *R. variegatus* and *Pristis* spp formed important components of this resource along this coast. The catches were very rich in 19-86°/B4, 20-86°/D1, 20-87°/F 6,

rich in 15°-81°/B5, 15°-81°/C6, 16°-81°/B2, 16°-82°/86, 18°-84°/D5, 19°-85°/A1, 19°-85°/C4, 19°-85°/C4, 19°-85°/F4, 19°-86°/A5, 20°-86°/E1, 20°-87°/E6 and 20°-87°/F5. In the other areas the catch was moderate, poor or very poor (Figs. 5 and 6).

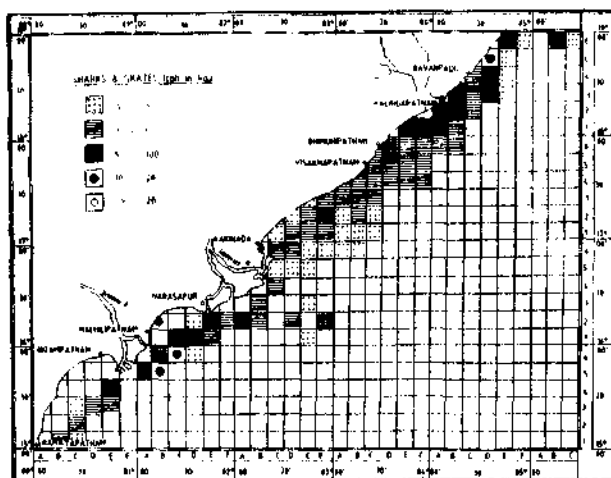


Fig. 5 : Distribution of catch rates for sharks and skates in the explored areas off Andhra Pradesh.

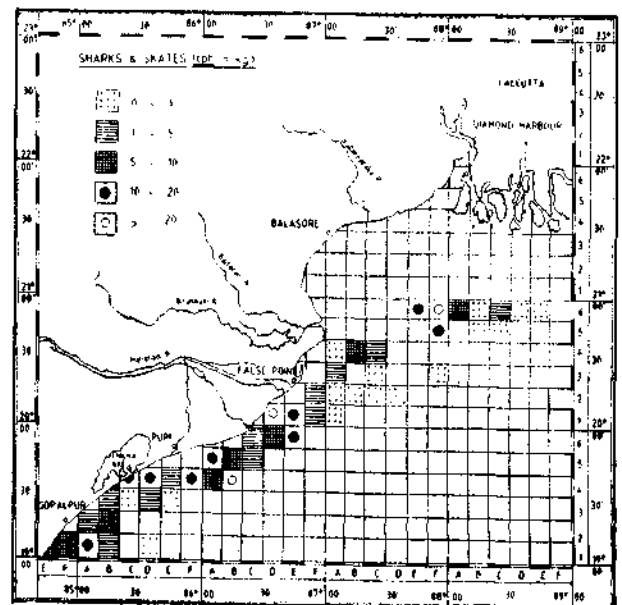


Fig. 6 : Distribution of catch rates for sharks and skates in the explored areas off Orissa and West Bengal

bottom trawl fishery resources.

18-85	19-84	19-85	19-86	20-86	20-87	20-88	11-86	21-87	21-88	Total
4116	730	5733	2879	27-28	9605	2744	686	7899	6174	81684
6607	1867	19312	9447	5987	8295	7157	1518	8511	14092	150919
260	115	759	727	802	1348	136	203	1383	268	9272
—	61	488	204	70	317	124	17	325	245	6237
5719	560	8405	890	371	636	516	94	653	1015	29992
—	—	1561	2890	—	334	1161	—	343	2286	11826
—	20	53	21	27	43	53	7	43	104	1510
—	18	630	32	173	147	—	44	151	—	4541
—	1	730	182	13	402	1032	3	413	2033	8240
44	564	1279	1035	1170	611	1075	298	628	2116	17607
—	9	21	17	14	40	—	4	41	—	817
480	5	416	237	—	26	167	—	26	329	3097
—	12	37	567	52	13	79	13	14	156	1476
—	56	505	409	22	74	36	5	76	71	3080
—	79	914	433	368	310	1718	93	318	3380	15085
—	25	194	122	389	388	56	98	398	110	3522
32	3	52	40	64	20	—	16	21	—	1570
—	115	399	164	463	820	214	118	850	423	6607
72	224	2869	1577	1989	2766	790	505	2828	1556	26440

Potential yield estimates of this group varied from 58 t in area 17°-84° to 1383 t in area 20°-87°. The potential yield for the entire area was estimated as 9272 t. As the present average annual landings is about 7362 t, a further 1910 t of sharks & skates could safely be harvested from this region.

2. Rays: Rays represented by *Dasyatis* spp, *Aetomyleus* spp, *Aetobatus* spp and *Mobula diabolus* formed an important component of

the catches. 'Very rich' grounds for rays were observed in 16°-81°/E1 and 16°-82°/B3. The catch rate was 'rich' in 16°-81°/E2, 16°-82°/B6, 16°-82°/C4, 17°-83°/F4, 18°-84°/B1 and 18°-84°/F6. In the other squares they were moderate, 'poor' or 'very poor' (Figs. 7 and 8).

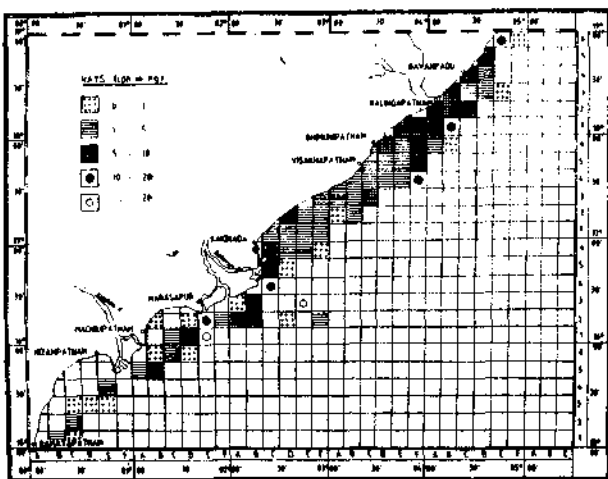


Fig. 7 : Distribution of catch rates for rays in the explored areas off Andhra Pradesh.

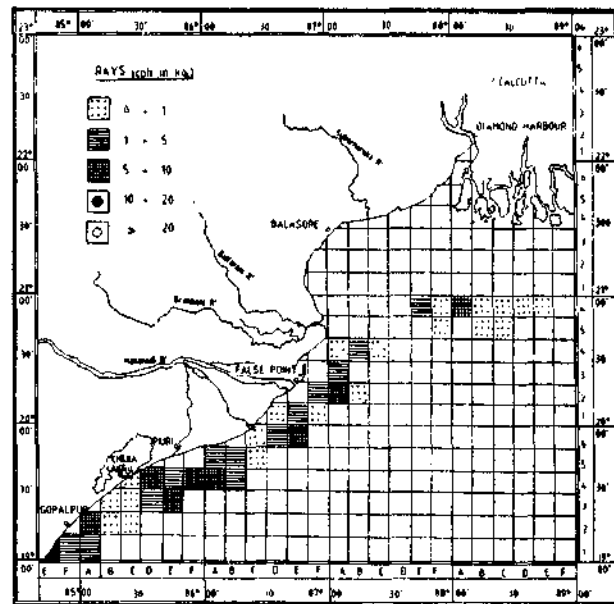


Fig. 8 : Distribution of catch rates for rays in the explored areas off Orissa and West Bengal

Potential yield for the entire region was estimated as 6237 t. It varied from 17 t in 21°-86° to 1860 t in 16°-82°. The present annual landings of rays along this coast is about 2261 t. Hence there is scope for harvesting an additional 3976 t of rays in this region.

3. **Catfishes:** Five species of catfishes viz., *Tachysurus thalassinus*, *T. tenuispinis*, *T. caelatus*, *T. dussumieri* and *Osteogeneiosus milleris* occur in the catches. Only the first two species form the bulk of the landings.

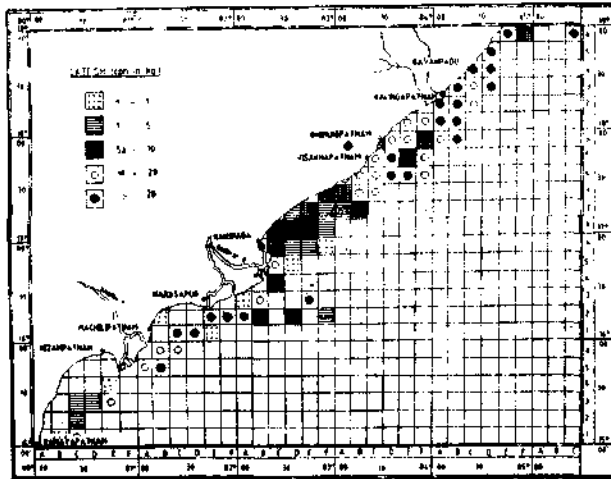


Fig. 9 : Distribution of catch rates for catfishes in the explored areas off Andhra Pradesh.

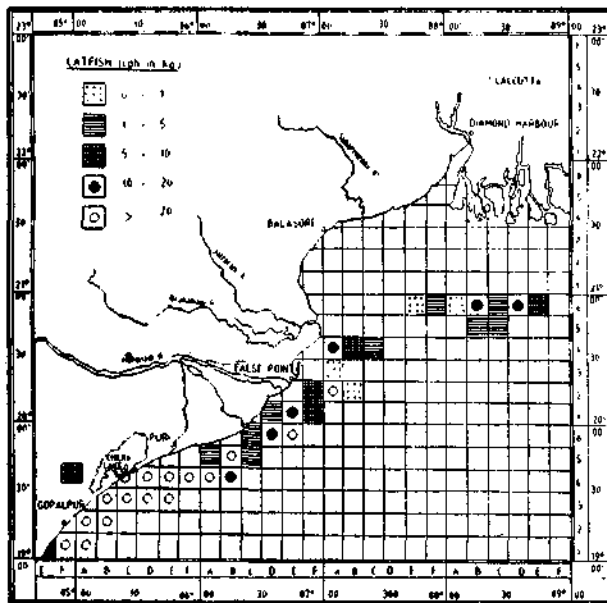


Fig 10 : Distribution of catch rates for catfishes in the explored areas off Orissa and West Bengal.

'Very rich' grounds were observed for catfishes in areas 15°-81°, 16°-81°, 16°-82°, 17°-83°, 17°-84°, 18°-84°, 19°-84°, 19°-85°, and 19°-86°. Catfish catch rates were more than 10 kg in most of squares in the general area explored (Figs. 9 and 10). Potential yield varied from 94 t in 21°-86° to 8405 t in 19°-85°. Potential yield for the entire region was estimated as 29,992 t while the present landings are only 12085 t indicating vast scope for expansion of the fishery for catfishes.

4. **Mackerel :** Mackerel are generally considered to be pelagic species. However, on many occasions, they were caught by these exploratory vessels operating bottom trawls, particularly in the northern latitudes. *Rastrelliger kanagurta* formed the major species contributing to the landings with sporadic occurrence of *R. faughni*. 'Very rich' grounds for mackerel were encountered in 16°-82°/A2, C6, E3; 17°-83°/E5, 19°-85°/A2; 19°-86°/B4, B5, C5; 20°-87°/C3 and 20°-88°/B5 while the grounds were 'rich' in 16°-82°/C5, D6; 19°-86°/A4 (Figs. 11 and 12). Potential yield varied from nil in 18°-83°, 18°-85°, 19°-84°, 20°-86° and 21°-86° to 2790 t in 19°-86°. For the entire region the potential yield was estimated as 11,826 t. The present landings along this coast are only 5065 t per annum indicating ample scope to increase the landings of mackerel. The potential yield value is in itself a gross underestimate since a sizeable portion of this resource occurs in the pelagic realm.

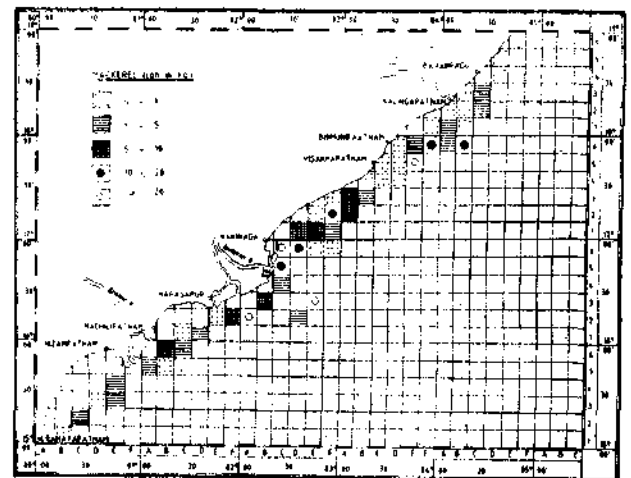


Fig 11 : Distribution for catch rates for mackerels in the explored areas off Andhra Pradesh.

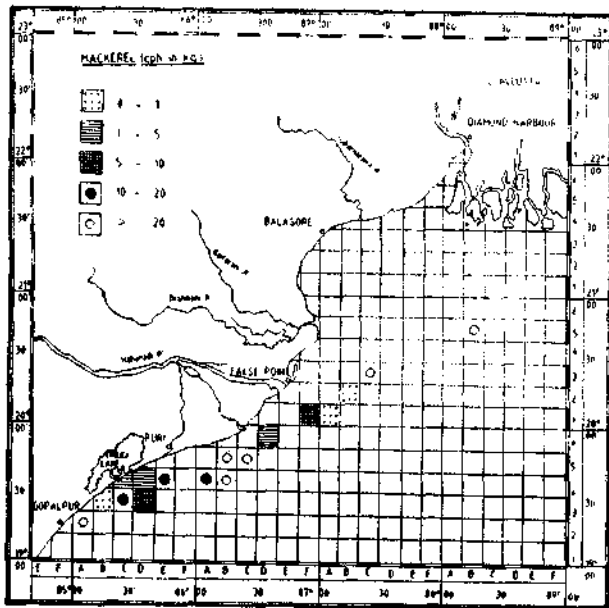


Fig. 12 : Distribution of catch rates for Mackerel in the explored area off Orissa and West Bengal.

Fig. 12 : Distribution of catch rates for mackerels in the explored areas off Orissa and West Bengal.

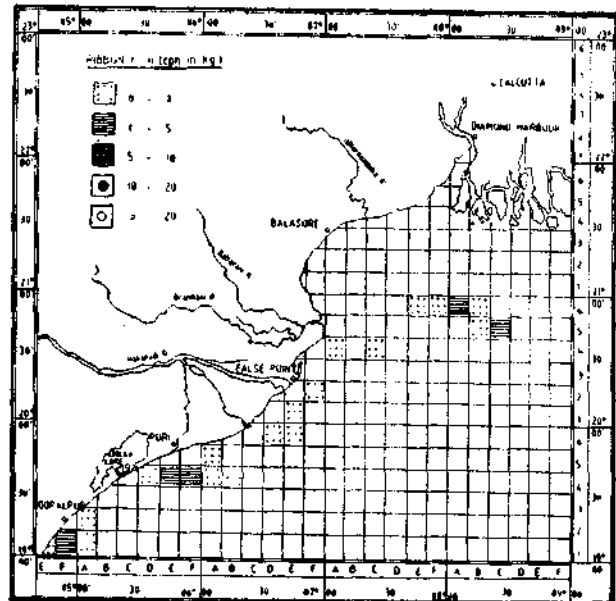


Fig. 14 : Distribution of catch rates for ribbonfishes in the explored areas off Orissa and West Bengal

5. *Ribbonfishes*: *Trichiurus lepturus* formed the major component of the ribbonfish catches with occasional occurrence of *T. russelli*, *Lepturacanthus savala*, *L. gangeticus*, *Eupleurogrammus muticus* and *E. glossodon*. Catch rates were 'poor' in most of the squares probably because of the large mesh of the codend of trawlnet and the low body depth as well as the pelagic habitat of this group. Potential yield varied from nil in 17°-84° and 18°-85° to 557 t in 16°-82° (Figs. 13 & 14).

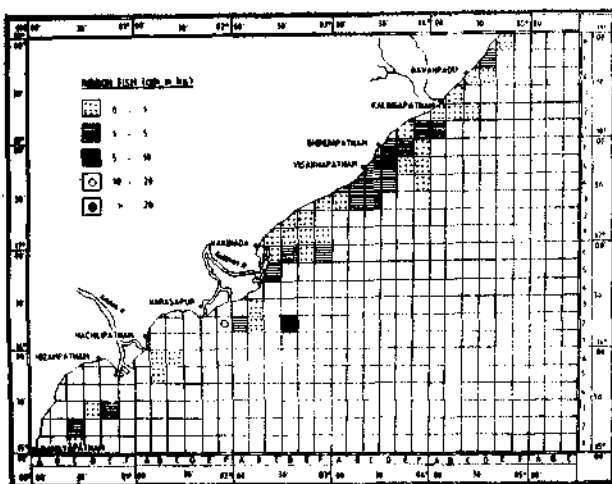


Fig. 13 : Distribution of catch rates for ribbonfishes in the explored areas off Andhra Pradesh

The potential yield for the entire region was estimated as 1510 t. The present landings are about 8545 t along this coast. The lower potential yield as compared to the actual landings may be due to the pelagic nature of this group.

6. *Silverbellies*: *Leiognathus bindus* formed the bulk of the landings and the other species represented in the catches are *L. dussumieri*, *L. leucisus*, *L. splendens*, *L. equulus*, *Secutor insidiator*, *S. ruconius* and *Gazza minut*. 'Very rich' grounds were observed in squares 15°-81°/A5, B5, 17°-83°/B5 and 19°-85°/D4, and 'rich' grounds in 15°-81°/B6, 16°-82°/C4 and 18°-84°/F2 (Figs. 15 & 16). In the other squares the catch rates were either 'moderate' or 'poor' or 'very poor'. Potential yield varied from nil in 18°-85° 20°-80° and 21°-88° to 790 t in area 15°-81°, and for the entire region it was estimated as 4541 t. It is pertinent here to mention that the nets used are of large mesh at the codend and most of the *Leiognathus species* are small in size and hence escape through the nets. The present estimate could therefore be much lower than the actual potential yield.

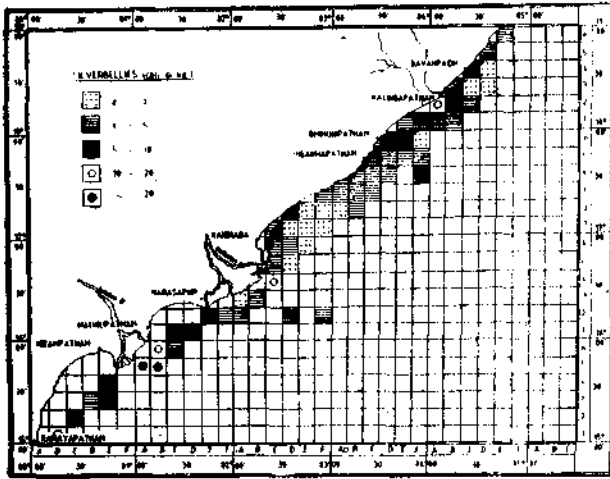


Fig. 15 : Distribution of catch rates for silverbellies in the explored areas off Andhra Pradesh.

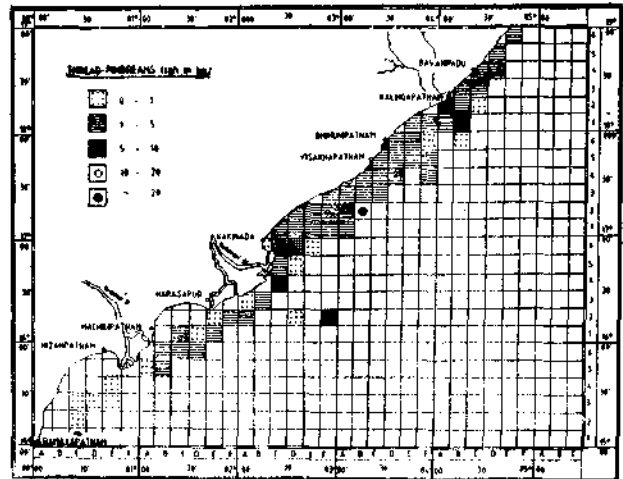


Fig. 17 : Distribution of catch rates for threadfin breams in the explored areas off Andhra Pradesh.

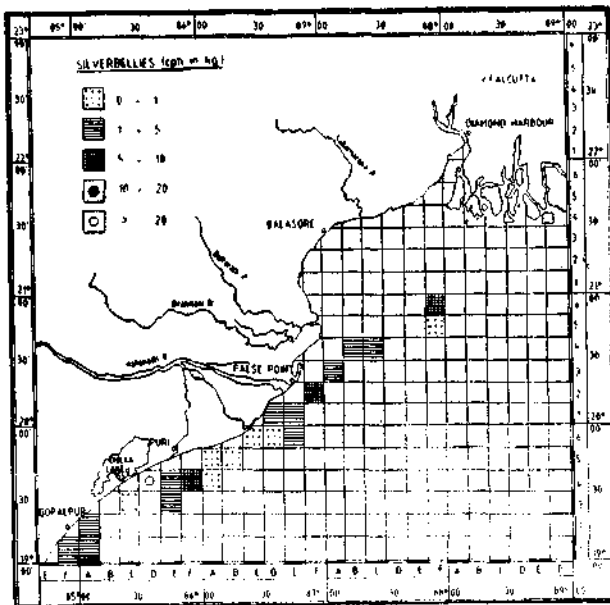


Fig. 16 : Distribution of catch rates for silverbellies in the explored areas off Orissa and West Bengal.

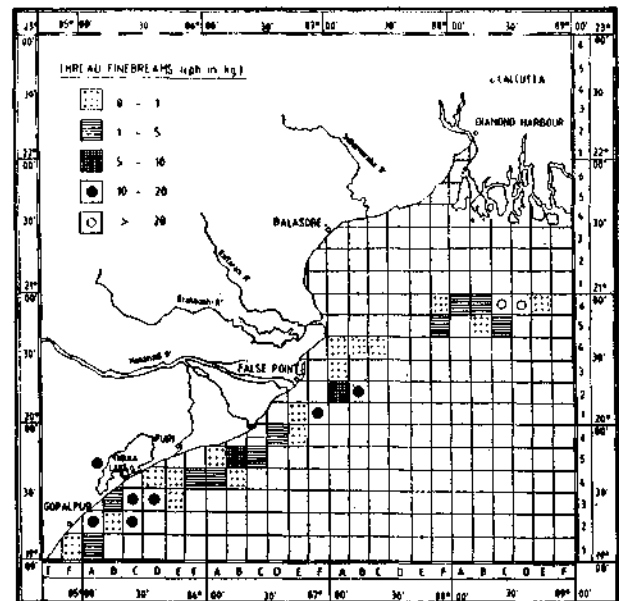


Fig. 18 : Distribution of catch rates for threadfin breams in the explored areas off Orissa and West Bengal.

7. *Threadfin breams: Nemipterus japonicus* and *N. mesoprion* constituted the bulk of the threadfin bream landings while *N. delegeae* and *N. tolu* were observed rarely. 'Very rich' grounds for *Nemipterus spp* were found in 15°-80°/C1, 17°-83°/B2, 20°-88°/C6 and 20°-88°/B6 and 'rich' grounds in 17°-83°/A4; 19°-8°/B4, C2, C3, D3, 20°-85°/F1, 20°-87°/B2, (Figs. 17 and 18). Potential yield varied from nil in 18°-85° to 2033 t in 21°-88° with the total estimate for the entire region at 8240 t. Present landings of threadfin breams along this coast are only

2348 t per annum and another 5892 t can be safely harvested from these grounds.

8. *Croakers*: Although about 20 species of this group were observed in the catches, only *Pseudosciaena aneus*, *P. bleekeri*, *P. axillaris*, *P. sina*, *P. diacanthus*, *Johnius caruttii*, *J. maculata*, *Sciaena dussumieri* and *Atrorhynchus nibe* were observed in commercial proportions. Very rich grounds for sciaenids were observed in 15°-81°/A4, B5, C6; 16°-81°/C2, F2; 16°-82°/A2, B3, C5, 17°-83°/F, 18°-84°/A2, C4, E6, 19°-84°/F1;

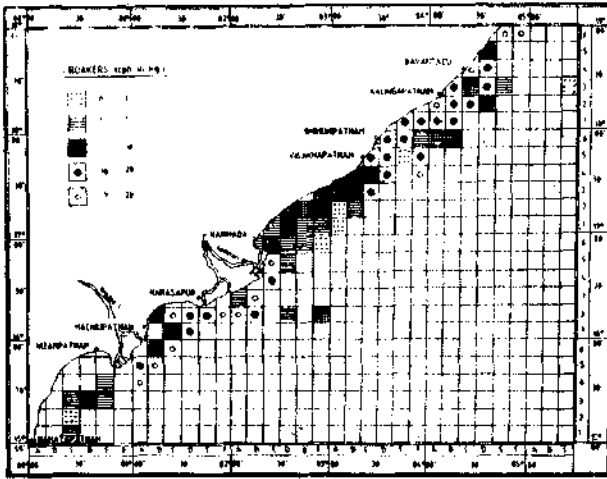


Fig 19 : Distribution of catch rates for croakers in the explored area off Andhra Pradesh.

Fig. 19 : Distribution of catch rates for croakers in the explored areas off Andhra Pradesh.

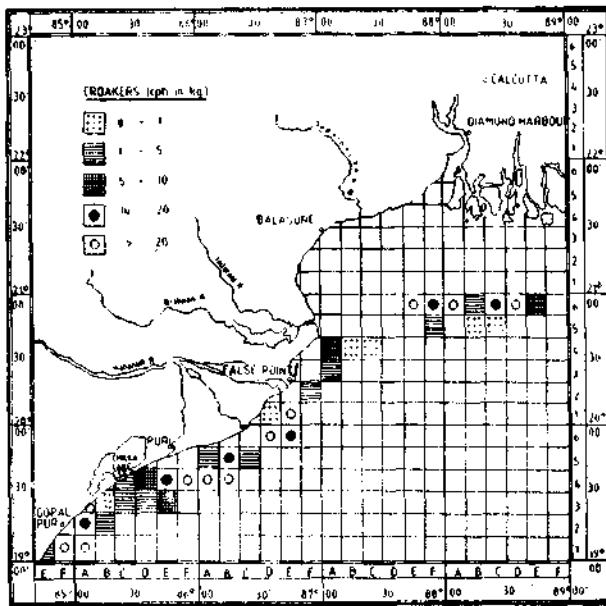


Fig 20 : Distribution of Catch rates for Croakers in the Explored area off Orissa and West Bengal.

Fig. 20 : Distribution of catch rates for croakers in the explored areas off Orissa and West Bengal.

19°-85°/A3, F4; 19°-86°/A4, B4, D6; 20°86°/E1; 20° 87°/E6, 20°-88°/A6 and D6. 'Rich' 'moderate' 'poor' and 'very poor' grounds are represented in Figs. 19 and 20. Potential yield varied from 44 t in 18°-85° to 2450 t in 16°-82° with the total for the entire region estimated as 17607 t. Present landings of sciaenids in this region are about 16,965 t per annum indicating that the resource has almost reached the optimum level of exploitation.

9. *Lizardfishes* : *Saurida tumbil*, *S. undosquamis* and *S. gracilis* constituted the bulk of the landings with occasional occurrence of *S. longimanus*. *Saurida* spp form only a small fraction of the trawler catches. Maximum cph of 9.0 kg was observed 17°-83°/B5. In most of the grounds the cph was less than 1 kg (Figs. 21 & 22). Potential yield varied from nil in 15°-81°, 18°-85°, 20°-88° and 21°-88° to 260 t in 17°-83°, and for the entire region it has been calculated as 817 t while the present landings are about

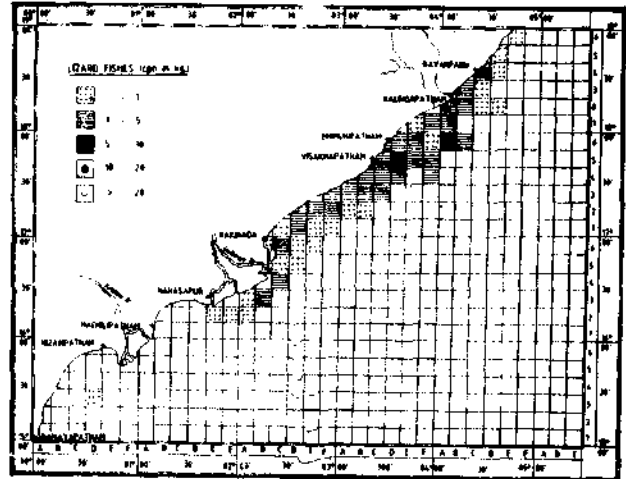


Fig. 21 : Distribution of catch rates for lizardfishes in the explored areas off Andhra Pradesh.

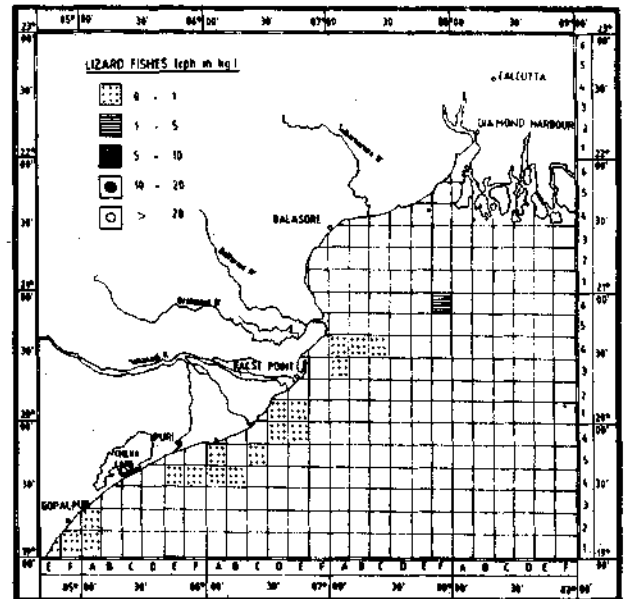


Fig. 22 : Distribution of catch rates for lizardfishes in the explored areas off Orissa and West Bengal.

1141 t. It would appear that the stocks are being fished beyond their potential.

10. *Driftfish*: *Psenes indicus* is the only species of driftfish caught along this coast. 'Very rich' grounds for the species were observed in 19°-86°/C5, 'rich' grounds in 17°-82°/E1, 18°-84°/C3, 19°-85°/A/2 and 20°-88°/A6 and 'moderately rich' grounds in 15°-81°/B5, 16°-82°/C6, 18°-8°/B2, C4, D3, 19-85/B2, C3 and C4 (Figs. 23 & 24). In the other areas either the grounds are 'poor' or 'very poor'. Potential yield varied from nil in 20°-86° and

21°-86° to 480 t in 18°-85° with the estimated total for the entire region being at 3097 t. The annual landings of this species are about 500 t along this coast indicating scope for five fold increase in the landings.

11. *Whitefish*: 'Very rich' grounds for the whitefish *Lactarius lactarius* were observed only in 19°-86°/A4 and 'rich' grounds in 18°-84°/B1, B2, 19°-06°/B5 and 20°-88°/C6 (Figs. 25 & 26). Potential yield from nil in 18°-85° to 567 t in 19°-86° with the total being estimated at 1476 t Presently about 890 t of *L. lactarius* is being

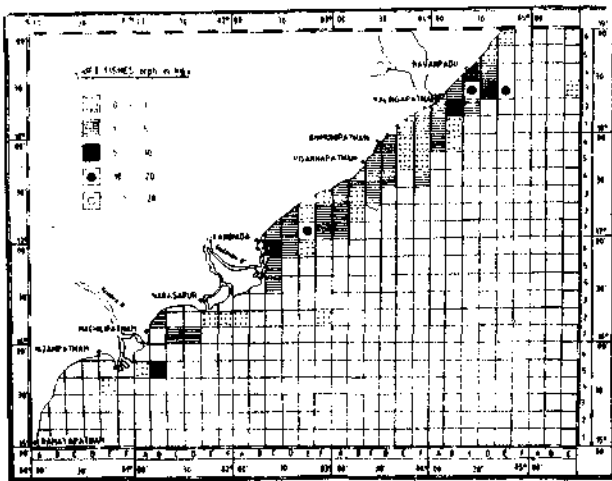


Fig. 23 : Distribution of catch rates for driftfish in the explored areas off Andhra Pradesh.

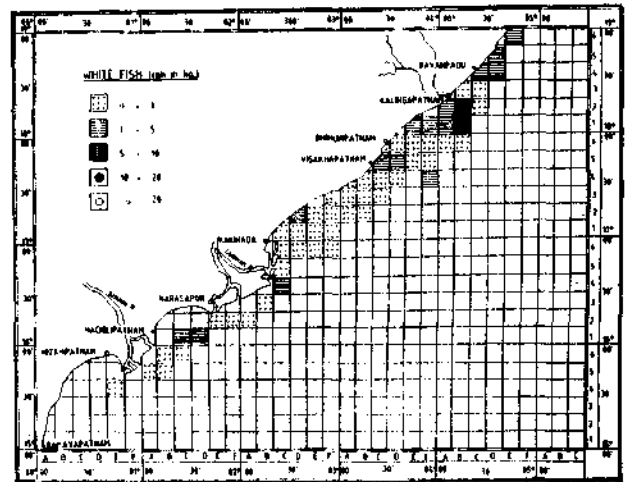


Fig. 25 : Distribution of catch rates for whitefish in the explored areas off Andhra Pradesh.

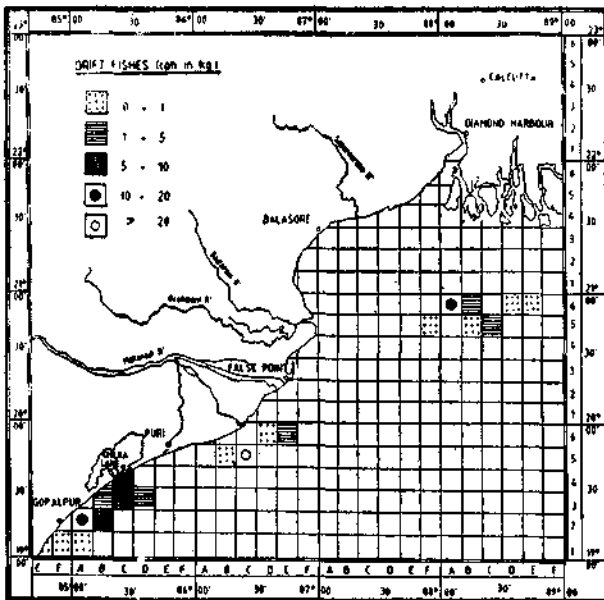


Fig. 24 : Distribution of catch rates for driftfish in the explored areas off Orissa and West Bengal.

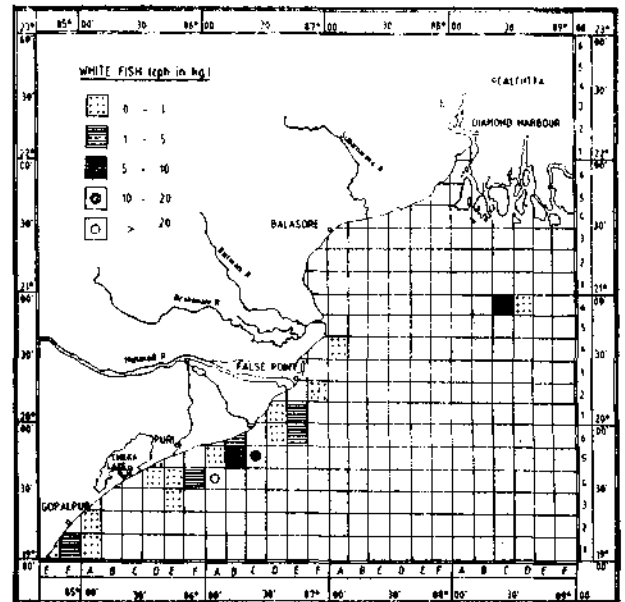


Fig. 26 : Distribution of catch rates for whitefish in the explored areas off Orissa and West Bengal.

landed annually along this coast showing that there is a harvestable supply of 586 t.

12. *Grunters*: *Pomadasys hasta* is the major species of the grunTERS in the landings. *P. maculatus* was also observed in considerable quantities. 'Very rich' grounds were observed only in 16°-82°/B6, 18°-84°/A2 and 19°-86°/B4 were rich (Figs. 27 & 28). Potential yield varied from nil in 18°-65° to 620 t in 18°-84° with an estimated total for the entire region of 3080t. Since data for the present landings of this group are not available separately, it is not possible to state whether the group is over or underfished.

Jacks: Although about 20 species of carangids comprising trevallys, scads, horse mackerel, king fishes, etc., were observed in the catches, only three species viz, *Carangoides malabaricus*, *Decapterus russelli* and *Megalaspis cordyla* contribute to the bulk of the landings. Very rich grounds for carangids were observed in 15°-80°/E3, 16°-81°/C1, D1, F2, 16°-82°/A4, B2, 18°-84°/B2, 19°-85°/C4, 20°-88°/A6 and B5, while the grounds in 15°-80°/C2, C3, E4, 15°-81°/B5, B6, C6, 16-81 A2, C2, E2, 16°-82°/

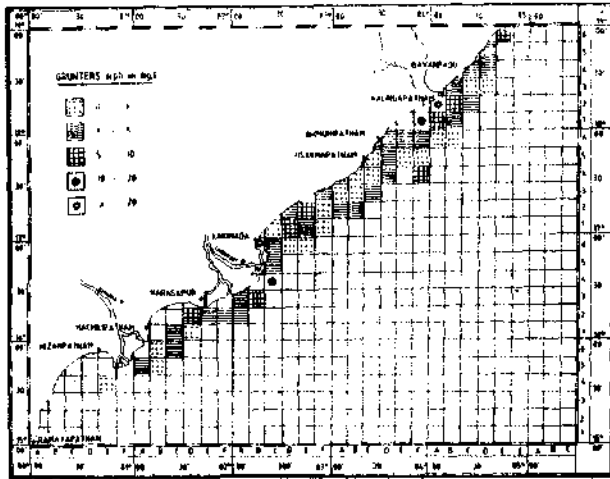


Fig. 27 : Distribution of catch rates for grunTERS in the explored areas off Andhra Pradesh.

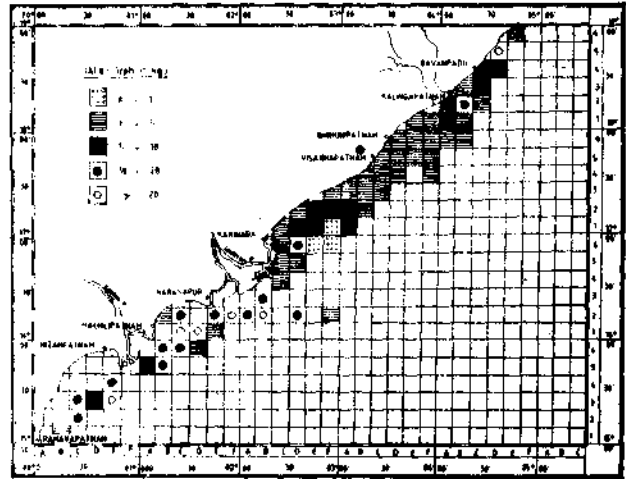


Fig. 29 : Distribution of catch rates for jacks in the explored areas off Andhra Pradesh.

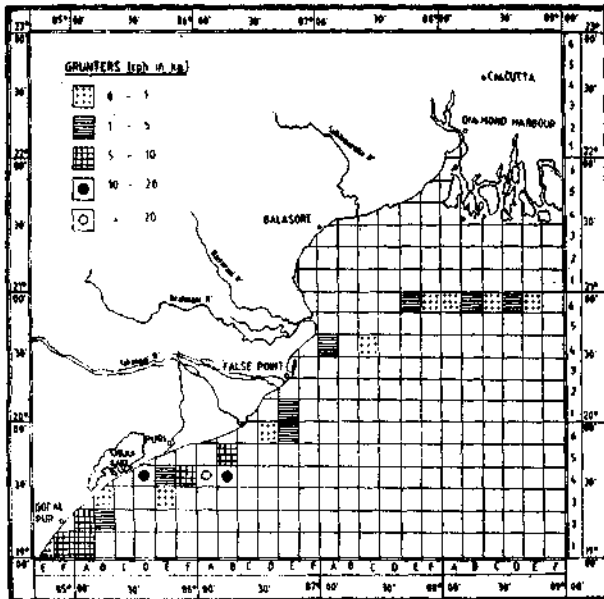


Fig. 28 : Distribution of catch rates for grunTERS in the explored areas off Orissa and West Bengal.

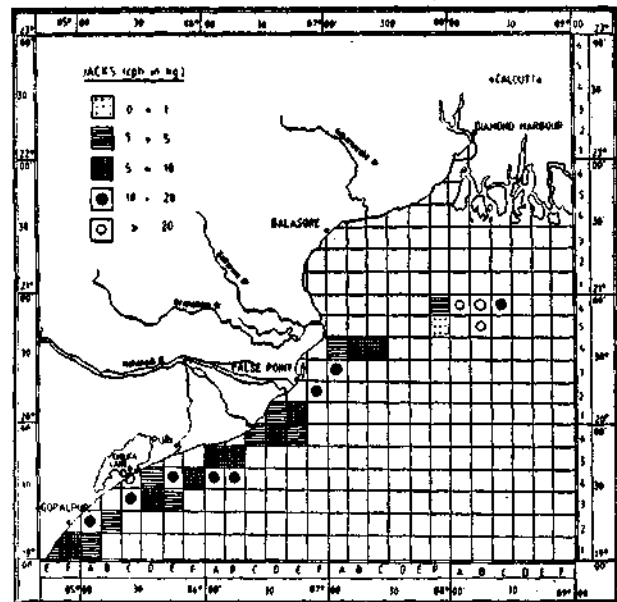


Fig. 30 : Distribution of catch rates for jacks in the explored areas off Orissa and West Bengal.

A2, B3, D2, D6, 17°-83°/B5, 18°-84°/B2, 19°-85°/A2, C3, E4, 19°-86°/A4, B4, 20°-86°/F2, 20°-87°/F2, 20°-87°/A3 and 20°-88°/C6 were 'rich' in this resource (Figs. 29 and 30). Potential yields varied from nil in 18°-05° to 3380 t in 21°-88° with the estimated total for the region at 15085 t. Presently about 5413 t of carangids are being harvested, indicating a harvestable surplus of 9672 t.

14. *Pomfrets* : *Pampus argenteus* and *Formio niger* are the main species with occasional occurrence of *P. chinensis*. 'Very rich' grounds for pomfrets were observed only in 15°-80°/E4 while the grounds in 16°-81°/C1, 20°-86°/E1

and 20°-87°/E4 were 'rich' in this resource (Figs. 31 and 32). Potential yield varied from nil in 18°-85° and 17°-84° to 465 t in 16°-82° with the estimated total for the area being at 3522 t. The annual landings along this coast are about 12370 t. Since pomfrets are columnar in habitat, bottom trawl may not be the effective gear to capture this resource. The present analysis only helps to know the relative abundance of pomfrets in different squares rather than their potential yield.

15. *Goatfishes* : *Upeneus sulphureus* and *U. vittatus* are the dominant species. Grounds were very rich for this group only in 17°-83°/C6

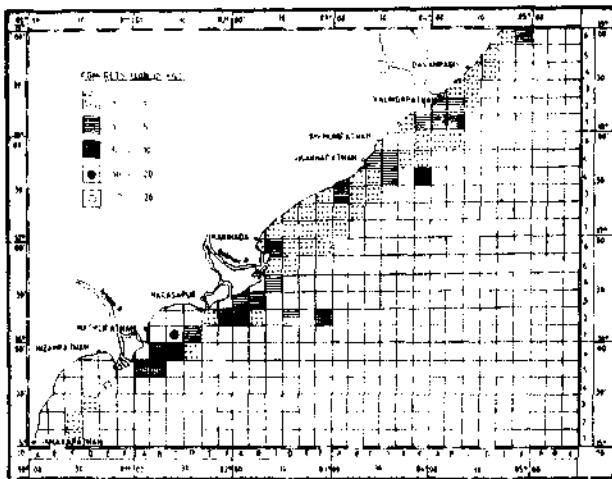


Fig. 31 : Distribution of catch rates for pomfrets in the explored areas for Andhra Pradesh.

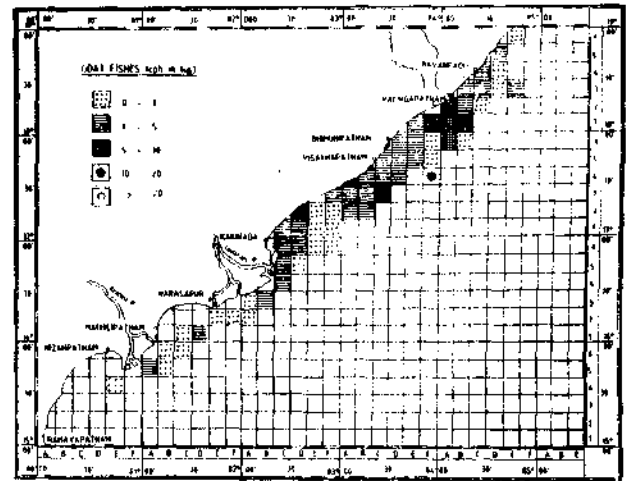


Fig. 33 : Distribution of catch rates for goatfishes in the explored areas off Andhra Pradesh.

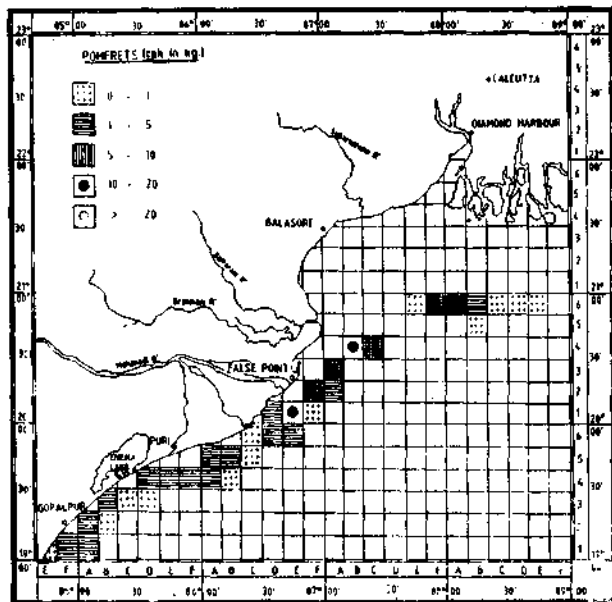


Fig. 32 : Distribution of catch rates for pomfrets in the explored areas off Orissa and West Bengal

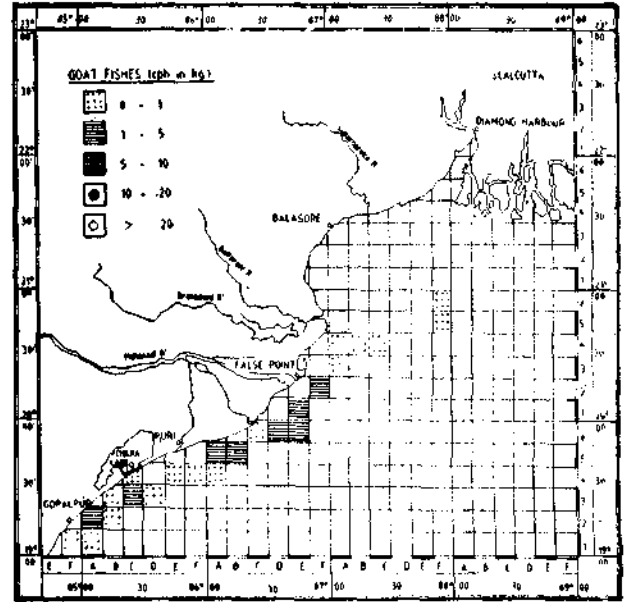


Fig. 34 : Distribution of catch rates for goatfishes in the explored areas off Orissa and West Bengal

and F4, while they were 'moderate', 'poor' or 'very poor' in most of the squares (Figs. 33 and 34). Potential yield varied from nil in 20°-88° and 21°-88° to 424 t in 17°-83° with the total for the entire region estimated as 1570 t. As the present landings of goatfishes are about 985 t the harvestable surplus is 585 t.

16. Other perches: Groups of fishes (belonging to different taxa) that do not contribute to the landings in considerable quantities individually are clubbed under this category. They are rock cods, snappers, pigface-brems, Threadfins, Seerfishes, bill fishes, barracudas, silver brems, sickle fishes, humpheads etc. 'Very rich' grounds for such miscellaneous big fishes were observed in squares 16-82/B6, 18°-84°/D5, and 20°-88°/A6, while 'rich' grounds were observed in 15°-80°/B1, E4, 16°-81°/C1, 18°-84°/E6, 19°-84°/E1, 19°-85°/D4 20°-86°/D1, E1, F2 and 20°-87°/A3 (Figs. 35 and 36). Potential yield varied from nil in 18°-85° to 850 t in 21-87 with the total for the entire region estimated as 6607 t.

17. Miscellaneous fishes: Prawns, lobsters crabs, cephalopods, clupeoids, flat fishes are the main components of this group. Potential yield of this group varied from 72 t in 18°-85° to 3508 t in 16°-82° with the total for the entire area being estimated at 26440 t. However, the estimates of potential yield of this group based on the fish trawl catches may not be valid since many of these varieties pass through the nets used by these vessels because of the big codend mesh size. Further, groups like clupeoids and cephalopods are pelagic in habitat,

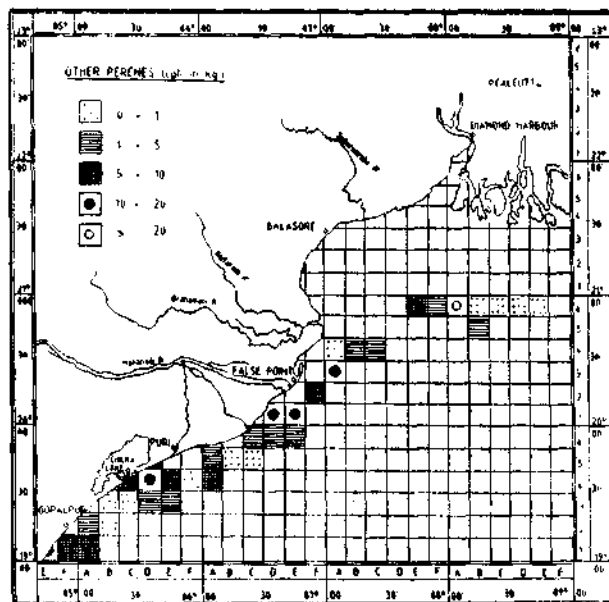


Fig 36. Distribution of catch rates for 'Other perches' in the explored areas off Orissa and West Bengal.

STATE-WISE AND DEPTHWISE DISTRIBUTION OF RESOURCES

The present account is based on bottom trawling covering 80%, 75.4% and 86.5% of the shelf area off West Bengal, Orissa and Andhra Pradesh respectively in addition to around 1200 km² off Orissa and 16,269 km² off Andhra Pradesh explored beyond the continental shelf.

In shallow waters upto 40 m of the entire region, the potential yield is 1.72 t/km² between 40 m - 180 m it is 1.94 t/km² and beyond 180 m it is 1.90 t/km². Off Andhra Pradesh the potential yield is more or less uniform in the three depth zones, whereas off Orissa it increases with increase in depth (Table 3). The high figure of 3.98 t/km² beyond the Orissa shelf could be an artifact resulting from scanty sampling.

The potential yield of demersal fishes on the continental shelf (upto 180 m) off the upper east coast is estimated at 145,502 t. Of this, the share of West Bengal is 29,312 t, Orissa-62,675 t and Andhra Pradesh-53,515 t (Table 4) Waters beyond the shelf were fairly well explored off Andhra Pradesh and to a much less extent off Orissa.

In the entire region surveyed five areas of good fishing grounds were encountered. These are; 1) 15° N-81° E, off Machilipatnam (2.60 t/km²), 2) 16° N-82° E off Kakinada (2.03 t/km²),

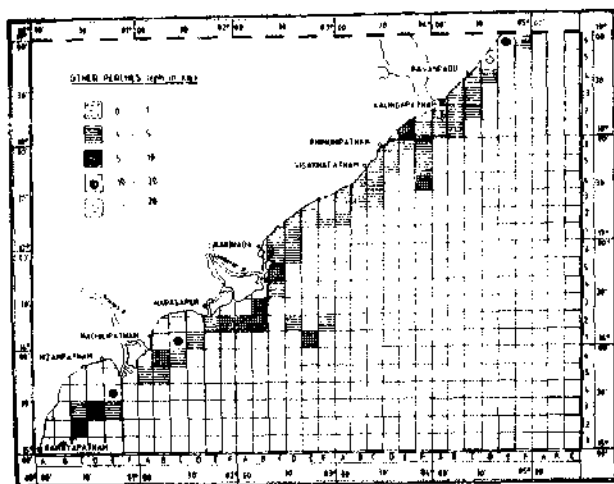


Fig. 35 : Distribution of catch rates for 'Other perches' in the explored areas off Andhra Pradesh

TABLE 3
State-wise and depth-wise distribution of potential yields of bottom trawl fishery resources in the areas explored

* State	< 40 m depth			40-180 m depth			> 180 m depth			Total area		
	Area explored (km ²)	Potential yield (t)	Potential yield/km ² (t)	Area explored (km ²)	Potential yield (t)	Potential yield/km ² (t)	Area explored (km ²)	Potential yield (t)	Potential yield, km ² (t)	Area explored (km ²)	Potential yield (t)	Potential yield/km ² (t)
Andhra Pradesh	10347	17487	1.69	15890	28753	1.81	16259	28492	1.75	42506	74733	1.76
Orissa	11438	19535	1.71	11781	27752	2.36	1200	4778	3.98	24419	52065	2.13
West Bengal	9814	17035	1.77	5146	7086	1.38	—	—	—	14759	24121	1.63
Total	31399	54057	1.72	32816	63591	1.94	17469	33270	1.90	81684	150919	1.85

* Distribution of latitude/longitude squares :

Andhra Pradesh : 15-80, 15-81, 16-81, 16-82, 17-82, 17-83, 17-84, 18-83, 18-84, 18-85.

Orissa : 19-84, 19-85, 19-82, 20-86, 20-87, 20-88, 21-86, 21-87, 21-88.

West Bengal : 21-86, 21-87, 21-88.

TABLE 4
State-wise projections of bottom trawl fishery resources upto 180 m depth

States	Area explored within 80 m (km ²)	Potential yield (t) in explored area	Total area Within 180 m depth (km ²)	Potential yield (t) extrapolated for the total area	Present demersal fish landings (t)	Remarks (Present yield vs. Potential yield)
Andhra Pradesh	26,237	46,240	30,365	53,515	57,433	Exceeds potential yield
Orissa	23,219	47,287	30,775	62,675	24,595	Far below the potential yield
West Bengal	14,759	24,121	17,935	29,312	14,113	Far below the potential yield
All states	64,215	117,648	79,075	145,502	96,141	

TABLE 5
Potential yields (t) vs present landings (t) in the three states

Group	Andhra Pradesh		Orissa		West Bengal		All three states	
	Potential yield from the area	Present demersal landings	from the explored area	Present demersal landings	Potential yield from the explored area	Present demersal landings	Potential yield from the explored area	Present demersal landings from the explored area
Sharks & skates	3531	5347	3887	1564	1854	451	9272	7362
Rays	4386	1671	1264	285	587	305	6237	2261
Catfishes	16852	3143	11378	4680	1762	4262	29992	12085
Mackerels	3351	4228	5846	824	2629	13	11826	5065
Ribbon fishes	1139	5816	217	919	154	2011	1510	8545
Silverbellies	3346	5334	1000	705	195	65	4541	6104
Threadfin breams	3431	1741	2360	607	2449	—	8240	2348
Croakers	8831	7487	5734	7676	3042	1802	17607	16985
Lizard fishes	671	995	101	250	45	—	817	1141
Drift fish	1891	500	851	—	355	—	3097	500
White fish	633	858	760	31	183	—	1476	890
Grunters	1826	—	1102	—	152	—	3060	—
Jacks	7472	4434	3822	771	3791	208	15065	5413
Pomfrets	1742	3974	11747	4134	606	4262	3522	12370
Goatfishes	1354	822	179	163	37	—	1570	985
Other perches	3041	11284	2175	1986	1391	734	6607	14004
Miscellaneous	11336	—	10215	—	4889	—	26440	—
Total Potential yield	74733	—	52065	—	24121	—	150919	—
Present demersal landings	—	77433	—	24595	—	14113	—	96141
Present pelagic landings	—	72241	—	21393	—	17412	—	111049
Total fish landings (P & D)	—	129674	—	45988	—	31525	—	207187

- 3) 18° N-84° E off Kalingapatnam (2.14 t/km²)
 4) 19° N-85° E off Chilka Lake (3.37 t/km²)
 and 5) 20° N-88° Hooghly river (2.61 t/km²)

Potential yields in relation to the present landings in respect of the 16 groups of fishes in the three states are presented in Table 5.

GENERAL REMARKS

Potential yields of bottom trawl fishery resources based on exploratory surveys are presented. Analysis of data covers a time span of 25 years (1961-1985), a geographical area of 81,684 sq. km within 15°N-21°N and 80°E-88°E upto depths of 350 m. and the operations of 5 of the 10 trawlers deployed for the survey. The potential yield for the entire area is estimated as 1,50,919 t, i. e., 1.85 t/km². In the seven latitude zones from 15° to 21°N the yield is distributed as 1.60 t, 1.93 t, 1.40 t, 1.90 t, 3.30 t, 1.40 t and 1.60 t per km² respectively. Thus the 19°N (off Orissa) emerges as very rich. The depth-wise analysis also shows that offshore waters off Orissa are rich with an yield of 3.9 t/km².

While relating the potential yield values obtained in this analysis to the present commercial landings it should be borne in mind that the commercial fishing is mostly within the 50m depth. Fishes small in size (e. g., silverbellies), low in body depth (e. g., ribbon fishes), less in girth (e. g., lizardfishes) tend to escape through the large meshes of the exploratory trawl nets, and thus not netted effectively. Sharks being active and fast swimmers can avoid capture by the trawl nets. Thus these exploratory surveys would naturally lead to the under-estimation of stocks of these groups. The survey employed fish trawl and not shrimp trawl. Hence, prawns do not figure in these surveys.

Certain groups like ribbonfishes, whitefish, jacks, (carangids), pomfrets and even mackerel which normally occur in the column or even at the surface, nonetheless, contributed to a substantial proportion of the exploratory trawl landings. These fishes are more vulnerable to and are regularly harvested by traditional gear. Potential yields of these groups based on exploratory bottom trawl surveys alone would

therefore be under-estimates. The regular and constant contribution of mackerels and jacks to the trawl landings in depths upto 180 m speak of their abundance in offshore grounds, presently beyond the reach of the traditional fishery. The present landings of the above fishes fall short of the potential yields which are in themselves under-estimates. Obviously, the actual stock are far in surplus and there is, therefore, considerable scope to expand these fisheries.

On the other hand, the present total landings too are under-estimated to the tune of at least 43,000 t, these being the fish discarded at sea by the large trawlers engaged in shrimp fishery. The fish are discarded due to shortage of cold storage space claimed by the high-value prawns.

The potential yields are more or less uniformly distributed in the three depth zones (< 40 m, 40-180 m and > 180 m) off Andhra Pradesh. Off Orissa, however, the yield increases with increasing depth. West Bengal waters are mostly shallow with average potential yields. Of the three states Orissa with its wide continental shelf holds promise for expansion of fishery in future.

The potential yields estimated in the present analysis differ considerably with those of previous workers. Mitra (1973) estimated the potential yield of the Andhra-Orissa coast upto 40 fathoms (FSI operations from Visakhapatnam Base) as 1.47 t/km² (5.1 t/square nautical mile). This is relatively a low estimate. Joseph *et al.* (1976) arrived at a standing stock of 244,432 for an area of 56,635 km² i. e., 4.32 t/km² (Table XI and XII of Joseph *et al.*, 1976). Although these authors have given potential yields also, their standing stock figures may be taken as potential yields as they did not consider the escapement factor of 0.5 as rightly pointed out by Antony Raja (1980). Krishnamoorthi (1976) also estimated potential yields for individual years for the 10 year period 1961-70 and arrived at a cumulative potential yield of 251,209.45 t for all the 10 years. He too did not consider the escapement factor (0.5). Antony Raja (1980) failed to notice that Krishnamoorthi's cumulative potential yield

value was for all the ten years and reckoned it as the potential yield.

Hence, Joseph *et al.* (1970) alone could be considered for comparison with the present analysis. Their high value of 4.32 t/km², as compared to the present value of 1.85t/km² is due to the facts that;

- 1) the area covered by Joseph *et al.*, being upto 40 fathoms, is more fertile and less in extent as compared to the area upto 180 m of the present study,
- 2) they have considered 17.5 m trawlers and *M. T. Ashok* as the standard whereas in the present study, the effort has been standardized in respect of all the five vessels considered,
- 3) Joseph *et al.* (1970) reckoned the trawling speed as 2 knots instead of 2 to 3 knots as mentioned in the log sheets of *M. T. Ashok*.
- 4) They had assumed that *M. T. Ashok* operated a 24 m otter trawl whereas the net actually used in the vessel was a 15 m otter trawl (Vide log sheets of *M. T. Ashok*).
- 5) they have not considered the escape-ment factor of 0.5, and 6) for calculating the swept area they have taken the entire length of the head rope, whereas only 50% of the head rope length is generally taken to be area effectively swept for stock assessment purpose.

Sivaprakasam (1987) in his assessment of demersal fishery resources of Indian waters, points out that along Andhra and Orissa coasts mackerel abound in the 70-200 m depths. He has given the distribution of the dominant groups of fishes in the different depth zones upto 500 m. The present analysis broadly confirms his findings particularly respecting the abundance of mackerel and columnar fishes in the offshore waters.

Finally, the present analysis brings out the following salient points: 1) presently non-demersal groups like mackerel and jacks, that contribute to the bottom trawl fisheries, also are exploited by the traditional sector much below

their potential and a good scope exists to harvest the surplus stocks, particularly in waters, beyond 40 m depth; 2) the typical demersal resources, like lizardfishes and sciaenids are being exploited to the optimum level with marginal surplus leaving no scope for future expansion; and 3) in the order of richness of bottom trawl fishery resources along the north-east coast of India, Orissa ranks first followed by Andhra Pradesh and West Bengal.

ACKNOWLEDGEMENTS

The authors express their heartfelt appreciation to the Fishery Survey of India for furnishing the fishing log sheets relating to their Visakhapatnam base. They thank Dr. B. Krishnamoorthi who supervised consolidation of the data for the period 1961-1979. The late Dr. K. V. Sekharan, and the late Shri V. Ramamohana Rao, Dr. K. V. Subba Rao, Shri M. S. Muthu and Shri P. Mojumdar have contributed much in consolidating the data. While further processing the above data for the present account considerable technical assistance was received from S, Shri M. V. Somaraju, B. Narayana Rao, K. Narayana Rao, J. B. Varma, M. S. Sumithrudu and M. Prasada Rao. The authors owe a debt of gratitude to all of them. They express their sincere thanks to Dr P.S.B R. James, Director, CMFRI, for the keen interest and encouragement given for this study. They also thank Shri C Mukundan, Head of Demersal Fishery Division of CMFRI, for reviewing the manuscript

REFERENCES

- ANONYMOUS, 1980. Industrial fisheries off Visakhapatnam coast based on exploratory surveys during 1972-1978. *Mar. Fish. Infor. Serv. T & E Ser. No. 15*: 1-15.
- ANTONY RAJA, B. T. 1930. Current knowledge of fisheries resources in the shelf area of the Bay of Bengal. BOBP/WP/8: 23 pp.
- BORISOV, N.T. 1962. Report to the Government of India on experimental and exploratory fishing in the Bay of Bengal. *FAO, EPTA Report No. 1466*.

- GULLAND, J. A. 1965. Manual of methods for fish stock assessment Part I. Fish population analysis. *FAO Fish. Tech. pap.* (40) Rev. 1 : 1-68.
- JOSEPH, K.M, N RADHAKRISHNAN, ANTONY JOSEPH AND K. P. PHILIP. 1976. Results of demersal fisheries resources survey along the east coast of India 1959-74. *Govt. of India Bulletin of the exploratory project. No. 5* : 53 pp
- KRISHNAMOORTHY, B. 1973. An assessment of *Nemipterus* fishery off Andhra Orissa coasts based on exploratory fishing. *Proc. Symp. Living Resources of the Seas around India.* 495-516.
- KRISHNAMOORTHY, B. 1976 An assessment of the demersal fishery resources off the Andhra-Orissa coast based on exploratory trawling. *Indian J. Fish.* 21 (2) : 557-565.
- MITRA, G. N. 1973. Method of estimation of fish abundance in the Indian seas and steps to be taken for management of the commercial fisheries. *Proc. Symp. on living resources of the seas around India* : 145-154.
- NAUMOV, M. V. 1961. A survey of the fishery resources of the Bay of Bengal. *FAO EPTA Report No.* 1393.
- PAULY, D. 1979. Theory and management of tropical multispecies stocks ; a review with emphasis on the southeast Asia demersal fisheries. *ICLARM Stud. Rev.* 1 : 35 pp.
- PAULY, D. 1983. Some simple methods for the assessment of tropical fish stocks. *FAO, Fish. Tech. Pap No.* : 234 ; 51 pp.
- POLIAKOV, M. P. 1961. Interim report to the Government of India on experimental and exploratory trawling in the Bay of Bengal in 1960-1961. *FAO Rome* ; pp 23.
- POLIAKOV, M. P. 1962. Report to the Govt. of India on exploratory trawling in the Bay of Bengal *FAO EPTA Report No.* 1573.
- SEKHARAN, K. V, M. S. MUTHU. K. VENKATA SUBBA RAO, V. RAMAMOHANA RAO P. MOJUMDER AND S. REUBEN. 1973. Exploratory trawling on the continental shelf along the North-Western part of the Bay of Bengal. *Proc. Symp. On living resources of the seas around India* : 280-337.
- SHARIFF, A. T. 1961. A survey of the off shore demersal fisheries of Andhra Orissa coasts, 1960. *In: Souvenir Fisheries of Gujarat*, PP 46-54.
- SIVAPRAKASAM, T. E. 1937. Demersal fishery resources of the Indian exclusive economic zone. *Fishing Chimes*, 3 (3) : 49-461