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Trawl Fishery of the Mid-Shelf Region off Mangalore Coast

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ABSTRACT

Trawl fishery over the mid-shelf region off Mangalore coast was studied during 1979/80-1987/88. Details of craft and gear employed, the nature and extent of fishing ground and the changing pattern of fishing are dealt with. There was an eight-fold increase in fishing effort from 4,132 unit days in 1979-80 to a maximum of 34,758 unit days in 1984-85. The annual production rose from 527 t in 1979-80 to a maximum of 10,327 t in 1986-87, showing a twenty-fold increase. The catch rate, however, showed an increasing trend initially reaching a peak value of 299 kg in 1981-82 and declined thereafter only to register another peak of 335 kg in 1985-86. This is probably associated with the changing pattern and extension of fishing. The fishery is seasonal from November to May, with maximum production during February-March. The major resources exploited were stomatopods (24.1%), threadfin breams (14.9%), flat heads (7.1%), cephalopods (7.9%), penaeid prawns (6.8%), lizard fish (5.9%), carangids (5.5%), ribbon fish (4.8%), flat fish (3.7%) and bull's eye (3.3%). The annual and seasonal trends and biological characteristics of a few prominant species are given. The average annual value of the fishery was Rs. 42.4 million. The economics of trawl operations indicated that the average income per unit per season was Rs.3,28,631 with a net profit of Rs. 45,581. The rate of return was 21.26% and the operational cost profit ratio was 0.25. The exploitation rate of the total standing stock was estimated at 0.6 for the current period. A catchable potential yield of 15.000 t from the trawling ground was indicated. It is suggested that maintaining the fishing effort at the current level would ensure sustainable yields. Introduction of similar type of trawlers at other centres of the Indian coast would increase the demersal fish production from the mid-shelf.

INTRODUCTION

The inshore trawl fishery by small trawlers (<9.5m OAL) along the Mangalore coast has been studied by Sukumaran *et al.* (1982), Ramamurthy and Sukumaran (1984) and George *et al.* (1988) with special reference to prawns. The underexploited and unexploited resources in the deeper water of this coast have been surveyed and their potential indicated by Philip and Joseph (1988). The recent introduction of medium sized trawlers (9.75-15 m OAL) for the exploitation of larger species of prawns from relatively deeper waters has been briefly reported by Sukumaran (1985). Initially these boats made fishing trips of single night duration and later on they extended the trips to 2-3 nights for trawling in depths beyond 30m. This enabled them to reduce the fuel cost considerably. In the early eighties when catches dwindled, these trawlers resorted to fishing during the day time also and this resulted in a steep rise in effort as well as catch.

Trawl operations in deeper and distant grounds by medium trawlers being a new development, a detailed study was made on the fishery of the mid-shelf region off Mangalore coast, encompassing fish production trends, major exploited resources, economics of operation and status of the fishery.

MATERIAL AND METHODS

Data on catch and effort were collected based on bi-weekly observations of the landings of medium-sized trawl units at Bunder fish-landing jetty, Mangalore. Approximately 10% of the units landed were sampled at random on each day of observation and details on species composition and duration of absence from the port were recorded. The average species-wise catch in kg and effort in unit days were raised by the number of units landed to obtain daily effort and catch estimates. Such estimates for different observation days were pooled and raised to obtain monthly catch and effort data. In the present study, unit effort is defined as 12 hour absence from the port.

Biological details like length composition, sex ratio and gonadal maturity of a few important species were also studied during the observation days. These trawl units generally operate two types of nets, one being a shrimp trawl and another a fish trawl. Since the catch obtained by these nets are brought togther, it was not possible to record the gear-wise landings separately and hence the data were treated together. The economic aspects of the trawl operations were worked out based on the estimated landing value as well as enquiry of input costs.

The total standing stock (TSS) of the demersal resources of the midshelf was estimated by the swept area method employing the formula $\frac{c/f A}{a X_1}$

where c/f = mean catch per unit effort for the concerned period,
A= total area of the fishing ground,

a=the area swept by one unit of effort and
X_1=the proportion of fish in the path of the trawl actually retained by net.

The value of X_1 was taken as 0.5 as suggested by Pauly (1983). The area swept by the trawl in one unit of effort was computed from the formula: $a=t.v.h.X_2$ where t = time spent in trawling (6.6 hr. per unit day),
v = speed of trawl while fishing (average speed 1.8 knots),
h = length of head rope of trawl (here, the average lengths of head rope of both shrimp and fish trawl was taken, i.e., 25.6m) and
X_2 = effective width of the net divided by the head rope length (0.4 was taken as the realistic value).

An attempt was made to estimate the maximum sustaniable yield (MSY)/maximum catchable potential by using the Schaefer model (Pauly, 1983) and the Relative Response model (Alagaraja, 1984) respectively. The potential yield (Py ≃ MSY) was also derived by employing Gulland's model (Py = M x 0.5 x Bv) as suggested by Pauly (1983).

Results and Discussion

The fishing ground in the mid-shelf region off Mangalore exploited by medium-sized trawlers from Malpe in the north to Nileshwar in the south between 30m and 70 m isobath covering an area of 1,540 sq nmi (Fig. 1). The bottom is mostly sandy to muddy and beyond 65 m depth, it is rocky. The fishing season usually commences in the middle of November and extends upto the end of May.

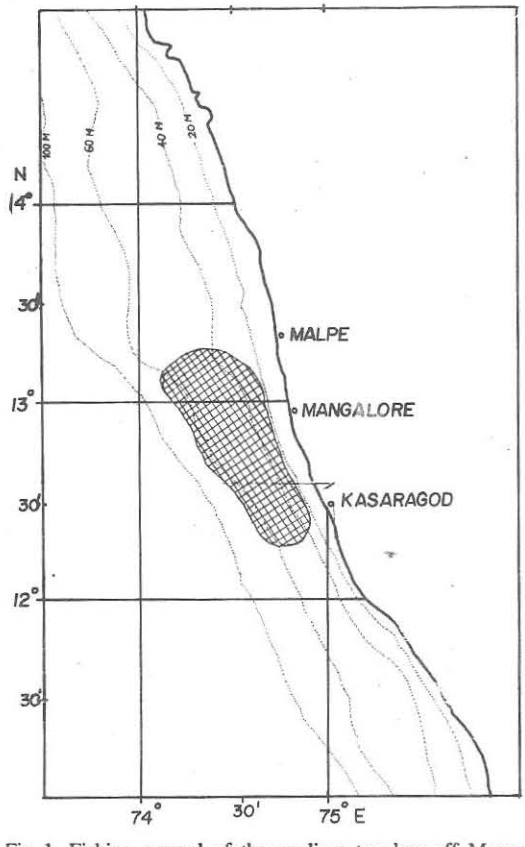


Fig 1. Fishing ground of the medium trawlers off Mangalore

Table 1. Specifications of the craft and gear deployed for the fishery in the midshelf region off Mangalore

A.	**Craft**		
1.	Overall length (OAL)	9.75-15.0m	
2.	Beam	4.1-4.4m	
3.	Draught	1.6-1.9m	
4.	Speed (Cruising)	4-6 knots	
5.	Endurance	Upto 4 days	
6.	Gross tonnage	13-24	
7.	Material used	Wild jack wood	
8.	Type of construction	Carvel planking	
9.	Type of engine	Mostly Ruston Mk. I & II and Leyland 370 & 400	
10.	Horse power	53-102	
11.	Winches	Twin drum, mechanically operated	
12.	Number of crew	5-8	
13.	Fish hold capacity	4-11m^3 (also 2-4 FRP tanks with ice)	
14.	Life of the boat	15-20 years.	
B.	**Gear**		
1.	Type of net	Shrimp trawl	Fish trawl
2.	Length of head rope	16-28m	25-32m
3.	Mesh size (cod end)	25-28mm	30-40mm
4.	Net material	75mm synthetic twine	
5.	Otter board	Rectangular, 65-85 kg	

The details of craft and gear employed are given in Table 1. At present, about 150 medium trawlers, majority of them having an OAL of 10.5, operate from this centre. Besides these, about 25 purse seine-cum-trawl boats are also deployed during the lean purse seine season, for trawling. Generally, these units leave the base around 1700 hr and reach the fishing ground in about 2 hr. They operate shrimp trawl exclusively during night and the relatively larger fish trawl during day. On an average, each unit makes 3 hauls during night and 3 hauls during day, each haul lasting 2.2 hr. The trawling speed varies from 1.75 to 2 knots, the fish trawl being generally towed

Table 2. Estimated catch, fishing effort and catch rate by medium trawlers

Fishing season	Catch (tonnes)	Effort (unit days)	Catch per unit effort (tonnes)
1979-80	527	4132	0.128
1980-81	416	1704	0.244
1981-82	2011	6727	0.299
1982-83	3403	13914	0.245
1983-84	4827	23487	0.206
1984-85	7665	34758	0.221
1985-86	9122	27238	0.335
1986-87	10327	30836	0.334
1987-88	6955	22738	0.306
Average	5028	18393	0.273

at higher speeds. The boats return to the port the following morning or after 1 1/2 or 2 1/2 days fishing. On an average, these units operate around 190 days during a fishing season.

Production trends

The annual landings were the lowest (416 tonnes) during 1980-81 fishing season (Table 2). Therafter, the landings increased reaching a maximum of 10,327 t in 1986-87. Within 8 seasons, from 1979-80 to 1986-87, the catch increased by 9,800 t. However, in 1987-88, the landings decreased by 3,372 t due to decrease in fishing effort. Like catch, the fishing effort also registered a steep increase over the years, from a minimum of 1,704 unit days in 1980-81 to 34,758 unit days in 1984-85. But, it showed 35% decrease by 1987-88. The catch per unit of effort (CPUE), after registering a relatively high value of 0.299 t in 1981-82 fell to 0.206 t in 1983-84 and thereafter increased to a maximum of 0.355 t in 1985-86. In the following year the CPUE appeared to have stabilized, but then decreased marginally in 1987-88 (0.306 t). The cyclical increasing trend in catch rates appears to be associated with the extension of the exploitation to virgin areas over the fishing ground made possible by the changing pattern of the fishing operations from single day to 2-3 days duration. The average annual catch, effort and CPUE during the period were 5028 t, 18,393 unit days and 0.273 t respectively.

Maximum production was obtained during January-March and minimum in November. A similar trend was also observed for fishing effort. The CPUE values fluctuated between 0.236 t and 0.298 t from November to April and showed a maximum of 0.402 t in May. (Fig. 3)

Major groups/species

The annual trend in yield of major groups/species studied over the 6 fishing seasons is depicted in Fig. 4.

Stomatopods: This group was the most dominant component of the fishery (24.1%). The yield showed an increasing trend from a minimum of 838 t in 1982-83 to

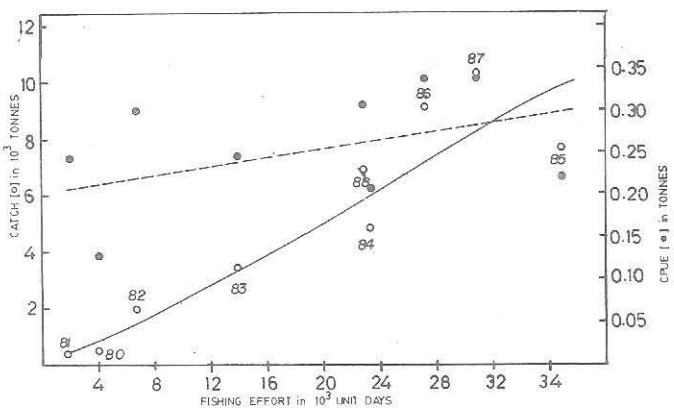


Fig. 2. Relationship between fishing effort, catch and CPUE of the medium trawlers

Table 3. Economic evaluation of medium trawlers (11m OAL) based on the level of production, input and output prices during 1987-88

A.	Initial investment (cost of craft, nets and accessories)	Rs. 5,20,000
B.	Fixed costs (including interest on loan, insurance premium and depreciation)	Rs. 1,01,000
C.	Operational costs (including cost of fuel, ice, labour, auction, maintenance and port charges)	Rs. 1,82,050
D.	Total cost (B+C)	Rs. 2,83,050
E.	Average income/unit/year	Rs. 3,28,631
F.	Net income/year (E-D)	Rs. 45,581
G.	Rate of return (%)	21.26
H.	Operational cost profit ratio	0.25

Table 4. Estimated standing stock, yield and exploitation rate during different fishing seasons

Fishing season	TSS (tonnes)	Yield (tonnes)	Exploitation rate
1979-80	5789	527	0.10
1980-81	11051	416	0.04
1981-82	13543	2011	0.15
1982-83	11097	3403	0.31
1983-84	9331	4827	0.52
1984-85	10010	7665	0.77
1985-86	15174	9122	0.60
1986-87	15128	10327	0.68
1987-88	13860	6955	0.50
Average	11666	5028	0.43

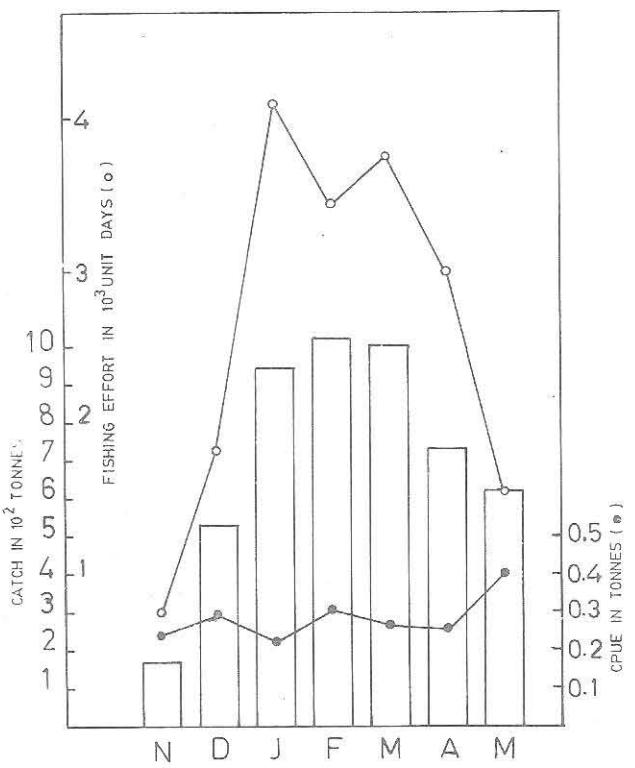


Fig. 3. Trends in the average monthly yield, effort and catch rate of the medium trawlers

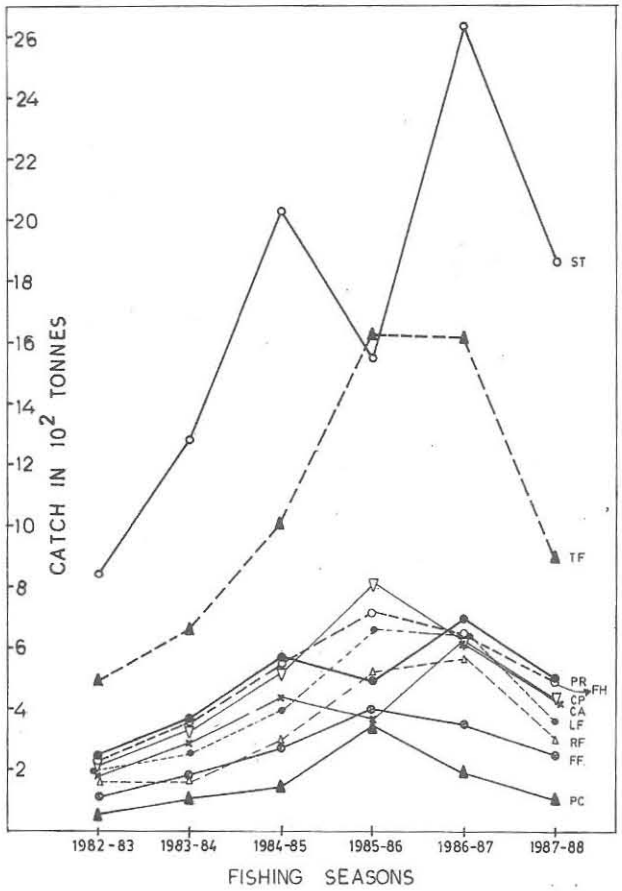


Fig. 4. Seasonal trends in yield of major exploited resources/groups (ST-stomatopods, TP-threadfin breams, Pr-prawns, FH-flat heads, CP-cephaloponds, CA-carangids, LF-lizard fish, RF-ribbon fish, FF-flat fish and PC-*Priacanthus* sp.)

a maximum of 2,637 t in 1986-87. Peak abundance was observed during December-January and in May (Fig. 5). *Oratosquilla nepa* was the only species represented in the fishing and its length ranged from 45 to 115 mm with a single dominant mode at 65 mm (Fig. 6). The size at first maturity for females was at 95 mm. Females generally outnumbered males. The spawning period extended from December to October with peaks during March-June and September-October.

Threadfin breams: This group formed 14.9% of the average annual production. The catch showed an upward trend from a minimum of 485 t in 1982-83 to a maximum of 1.627 t in 1985-86. Maximum abundance of threadfin breams was observed in May (Fig. 5). *Nemipterus japonicus* was the principal species (73%) and its length ranged from 65 to 285 mm with dominant modes at 115mm and 185 mm (Fig. 6). Females were in excess of males. Size at first maturity in females was at 145 mm. Peak breeding was during December-February.

Flatheads: Of the total annual catch, 7.1% was contributed by this group. A minimum yield of 234 t was obtained

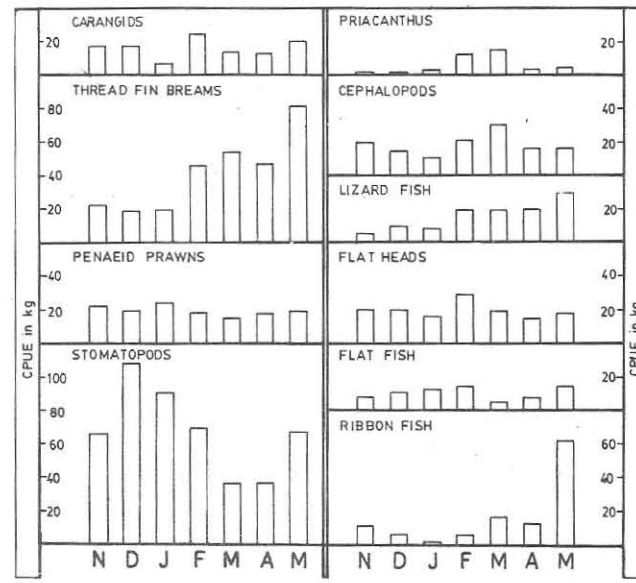


Fig. 5. Average monthly abundance (CPUE) of major exploited resources

in 1982-83 and a maximum of 716 t in 1985-86. February was the peak period of abundance (Fig. 5).

Cephalopods: This group constituted 7% of the annual average trawl landings. The minimum and the maximum yields were 244 t and 807 t in 1982-83 and 1985-86 respectively. Peak abundance was in March (Fig. 5). The squid, *Loligo duvaucelii* was the dominant species (80%) with size range of 45-285 mm. A single dominant mode was observed at 95 mm and the size at first maturity in females was at 105 mm (Fig. 6). Females were in excess of males and the breeding season was continuous with a peak during March-May.

Penaeid prawns : This group formed 6.8% of the annual average catch. The minimum and the maximum catches were 248 t in 1982-83 and 698 t in 1986-87 respectively. The catch rates were uniform in all the months, except in January when slightly higher rate was recorded (Fig. 5). *Matapenaeus monoceros* accounted for the bulk of prawn catch (92%). It's size ranged from 85 to 185 mm with a dominant mode at 115 mm (Fig. 6). Females were more abundant than males. The size at first maturity was at 120 mm for females. The peak breeding was during February-April.

Lizard fish: On an average, 5.9% of the total catch was formed by this group. A minimum yield of 190 t was observed in 1982-83 and a maximum of 661 t in 1985-86. Maximum abundance of this group was observed in May (Fig. 5). *Saurida tumbil* formed 82% of the lizard fish catch and its size ranged from 135 to 415 mm with multiplicity of modes and a dominant mode at 235 mm (Fig. 6). The size at first maturity in females was at 225

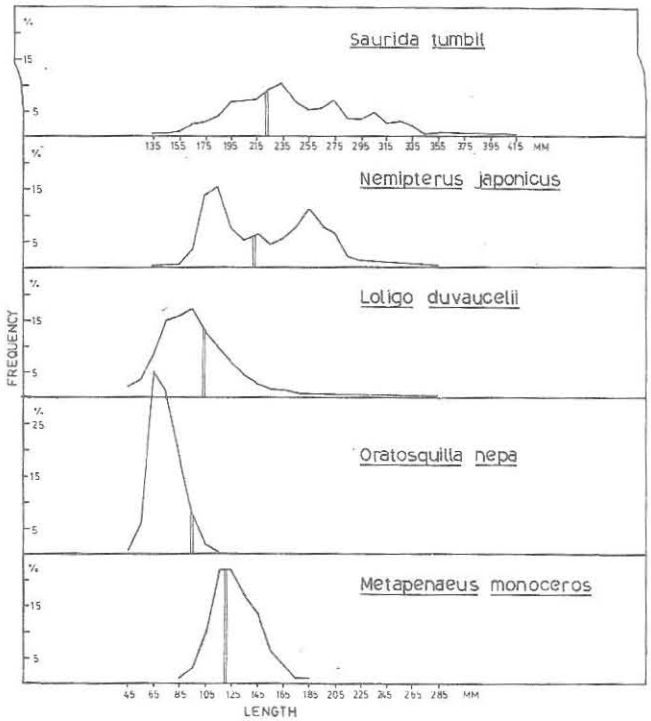


Fig. 6. Annual size composition of the major exploited species (vertical lines indicate size at fist maturity of females)

mm. Females outnumbered males and peak breeding was during November-January.

Carangids: They formed 5.5% of the annual average catch with minimum and maximum yields of 194 t and 631 t in 1982-83 and 1986-87 respectively. Peak abundance was in February (Fig . 5).

Ribbon fish: This group constituted 4.8% in the average total landings. The minimum and the maximum yields were 167 t and 574 t in 1983-84 and 1986-87 respectively. Maximum abundance was in May (Fig. 5).

Flat fish: Forming 3.7% of the average annual landings, this group had a minimum landing of 112 t in 1982-83 and a maximum of 396 t in 1985-86. Peak abundance was in February and May (Fig. 5).

Bull's eye: This deep sea resource comprising *Priacanthus* sp. contributed to 2.3% of the annual average landings. A minimum yield of 61 t and a maximum of 357 t were observed in 1982-83 and 1982-83 and 1985-86 respectively. Maximum abundance of this species was observed in March (Fig. 5).

Besides the above mentioned major groups, minor groups consisting of sciaenids, crabs, perches, pomfrets, catfish, anchovies, sharks and rays, *Lactarius* sp. and silver bellies contributed to 17.9% of the trawl landings.

The earlier studies indicated that the trawl fisheries of inshore and mid-shelf areas are not competing for the same component resources, except for stomatopods, carangids and cephalopods (Sukumaran, 1985). This is mainly because the grounds exploited by these two fisheries do not overlap.

Studies on the size distribution and size at first maturity of a few dominant species exploited by the medium trawlers showed that in most cases larger individuals above the size at first maturity are being exploited. This is a healthy situation from the point of recruitment.

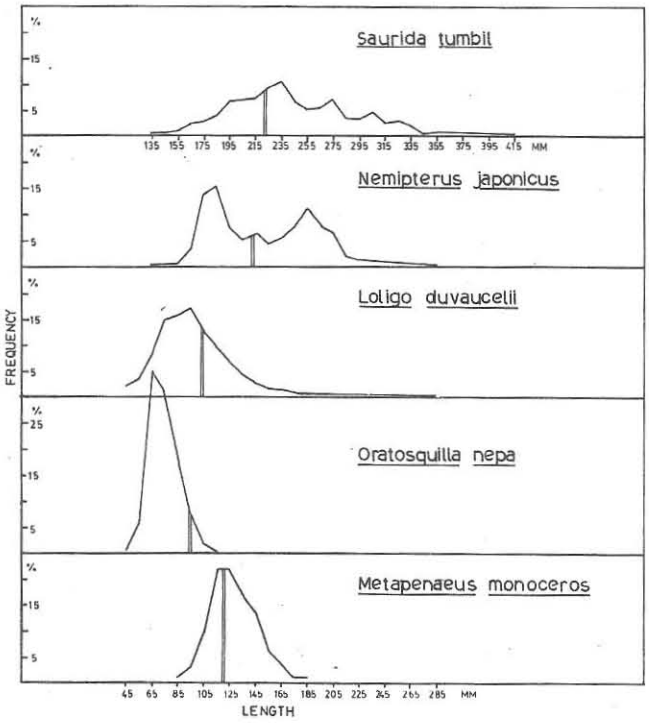
Economic evaluation of the fishery

Based on the average price of different category of fishes, the seasonal catch value was estimated for 1982-83 to 1987-88 period. The value was the lowest during 1982-83 (Rs. 18.67 million) and the highest during 1986-87 (Rs. 58.71 million) with an average annual value of Rs. 42.38 million. Prawns accounted for 48.4% of the value, although they formed only 6.8% of the average annual catch. On the basis of production and input and output costs during 1987-88, the economics of trawl operations have been evaluated (Table 3). Apart from an initial investment of Rs. 5,20,000 towards purchase of craft, gear and accessories, a sum of Rs. 2,83,000 was incurred as fixed and operational costs. The average income per unit per season was Rs. 2,28,631, the computed net profit being Rs. 45,571. Economic indicators like rate of return and operational cost-profit ratio were estimated to be 21.26% and 0.25 respectively.

The economic evaluation of the fishery revealed its profitability with an annual net return of approximately 9% of the initial investment. In an earlier study on the average cost of production and revenue realised by trawl boats at Mangalore, a low profit of Rs. 4,240/- for a similar trawler was indicated (Rao, 1983). The changing pattern of fishery has probably resulted in increased profits as revealed by the present study. The recent trend in the diversion of some of the purse seiners to trawling, during the lean purse seine season, denotes the profitability of this type of venture as advacated earlier by Jayaraj (1979).

Total standing stock and catchable potential yield

The total standing stock (TSS) of the fishing ground during different fishing seasons are given in Table 4 along with the corresponding yield. Since there has been an expansion of fishing ground as well as changes in the fishing pattern over the years, the estimates of standing stock for the last 3 seasons (1985-86 to 1987-88) was realistic may give an average TSS of 14,721 t with an exploitation rate of 0.6. Following Gulland's model, potential yield for the trawling ground was 7,400 t. However, production from the trawl fishery far exceeded this limit during 3 seasons, though strangely, the catch rate did not show a declining trend. From this, it would appear that the above estimate of potential yield is an under estimate.



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The trend in the relationship between catch, CPUE and effort (Fig. 2) was unsuitable for fitting the Schaefer's model for estimating MSY. By using the Relative Response Model, the catchable potential yield (C_∞) was estimated to be 17,000 t and the relationship could be expressed by the equation:

$$C_{t+1} = 1774.3+0.90\ C_t,\quad r = 0.93$$

Considering the standard error, the catchable potential yield may be safely taken as 15,000 t. This appears to be a more realistic estimate of the potential yield.

The current catch at Mangalore is around 11,200 t (1988-89) at the present level of fishing effort. To obtain potential yields from the present fishing ground the fishing effort has to be increased by 50% from the present level. Since trawlers stationed at Malpe (60 km north of Mangalore) are also fishing in the northern part of the present fishing ground and exploiting annually about 11,500 t of fish, there is no scope for further increase in the trawler fleet strength at Mangalore (175 boats). Hence, it is suggested that maintaining the fishing effort at the current level over the present fishing ground would ensure sustainable yields. Introduction of similar type of trawlers at other centres of the indian coast for the exploitation of the demersal resources of the mid-shelf would greatly enhance fish production.

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