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Editors

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25 Fishery, stock assessment and management of the barracuda resource in India

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ABSTRACT

The annual landings of barracuda increased from 1996 t in 1969 to 14679 t in 1995. During 1985-93 on an average 8332 t was landed and it constituted 0.44% of the total marine fish catch in India. The statewise contribution was Tamilnadu 3925 t (47.7%), Kerala 2471 t (30.0%), Andhra Pradesh 457 t (5.6%), Gujarat 420 t (5.1%), Maharashtra 416 t (5.0%), Karnataka 340 t (4.1%), Pondicherry 98 t (1.2%), Orissa 71 t (0.9%) and Goa 29 t (0.4%). Four species *Sphyraena obtusata*, *S. jello*, *S. picuda* and *S. forsteri* sustained the barracuda fishery in India. The growth parameters like L_{∞} , K , t_0 ; length weight relationships and natural mortality of *S. obtusata*, *S. jello* and *S. picuda* have been calculated. The total mortality rate, fishing mortality rate generated by the trawl and drift gillnets and stock have been estimated for these three species. At present *S. obtusata* is under exploited by trawlnet and *S. jello* and *S. picuda* are exposed to high fishing pressure by drift gillnets. The production may be increased by intensifying the exploitation in the deeper waters beyond 100 m depth. Suggestions and recommendations for proper management of the fishery have been proposed.

Introduction

The barracudas (Pisces: Family Sphyraenidae) are important food and sport fishes of the tropical, subtropical and occasionally, temperate waters. These fishes are considered as commercially important resource by virtue of their good quality as delicious food fishes in India. Though some of the species in certain Indo-Pacific regions, as well as in the Caribbean, have been implicated in ciguatera (ichthyosarcotoxism), or poisoning caused by eating

freshly captured specimen and many cases of attacks on man, such instances have not been reported in India so far. Difficulties are reflected in the identification of these pike-like marine fishes and descriptions by many authors might well apply to any of the 69 nominal species described, of which about 20 species are valid and about 10 occur in Indian Ocean and adjacent seas. However, only four species constitute a regular fishery along the Indian coast.

During 1985-95, the annual catch of barracudas varied from 3116 t in 1985 to 14679 t in 1995 with an annual average catch of 9015 t constituting 0.44% of the total marine fish catch in India. But for a few accounts on the taxonomy, fishery and biology by Jones and Kumaran (1968), Virbadhra Rao (1973), Kothare (1975), Kothare and Bal (1975), DeSylva (1974), Mahadevan pillai (1981) and others virtually there is no information available on the growth, rate of exploitation and stock assessment of barracudas except the two accounts by Somavanshi (1989) and Kasim and Balasubramanian (1990). Most of these works carried out in C.M.F.R.I., and elsewhere are consolidated and the findings are reported.

Distribution

Though barracudas occur all along the Indian coasts, the abundance varies from place to place. The fishery is good along the coast of Tamilnadu, Kerala, Andhra Pradesh, Gujarat and Andamans; very poor or moderate in other maritime states. The seasonal pattern indicates that the abundance was good in shallow waters below 50 m during South West monsoon. During North East monsoon (October - December) and pre South West monsoon (January - May) the abundance was greater in deeper waters (100 - 300 m). There appears to be a distinct variation in the distribution of barracudas during day and night as they tend to congregate near the bottom of the sea during day time with a peak around noon.

Exploitation

Barracudas are being exploited by different types of crafts and gears all along the Indian coasts. Among the mechanised units, small trawlers land the bulk of the barracuda catches and *S. obtusata* is the dominant species,

whereas the drift gillnet units also land a considerable quantity of mostly large sized barracudas belonging to *S. barracuda* and *S. jello*. However, the traditional non-mechanised units such as the catamarans, plank built boats and dug out canoes also land sizable quantities of small sized barracudas from near shore waters. The gears which are effective in exploiting the barracuda resource, in the order of importance, are the trawl, drift nets, boat seines, hooks & lines and shore seines.

Annual barracuda production in some of the important landing centres are 137 to 435 t in Madras at the catch rate of 3.4 kg/unit of small mechanised trawlers; at Tuticorin it was 612 t at the catch rate of 17.1 kg/unit of trawler and 122 t at the catch rate of 6.9 kg/unit of drift gill net and at Cochin 290 t were landed at the catch rate of 6.2 Kg/unit of trawler during 1987-89. In all these three important landing centres *S. obtusata* formed 85.5%, 69.5% and 84.0% at Madras, Tuticorin and Cochin respectively in trawl net landings. Of late since 1980's, the introduction of large sized trawlers and high opening trawl net by the Bay of Bengal Programme and also venturing of the fishermen into deeper waters beyond 100 m in search of new resources have resulted in increased landing of barracudas.

Resource characteristics

The all India annual landings of barracudas increased from 1996 t in 1969 to 14679t in 1995 with cyclic fluctuation every 4 or 5 years. The lowest catch of 1271t was recorded in 1971 which constituted 0.11% of the total catch and the highest of 14679 t was observed in 1995 which formed 0.65% of the total landings. During 1985-95 the barracuda landings varied from 3116 t in 1985 to 14679 t in 1995 with an average catch of 9015 t which formed 0.44% of the total catch and the annual percentage composition of barracudas in total marine fish catch varied from 0.21% in 1985 to 0.65% in 1995 (Fig.1). The statewise average catch of barracudas during 1985-93 was Tamilnadu 3925 t; Kerala 2476 t; Andhra Pradesh 457 t, Gujarat 420 t; Maharashtra 416 t; Karnataka 340 t; Pondicherry 98 t; Orissa 71 t; Goa 29 and West Bengal nil (Table 1). The statewise percentage contribution of barracuda was Tamilnadu 47.7%, Kerala 30.0%, Andhra Pradesh 5.6%, Gujarat 5.1%, Maharashtra 5.0%, Karnataka 4.1%, Pondicherry 1.2%, Orissa 0.9% and Goa 0.4% (Table1).

Fishery, stock assessment and management of the barracuda resource in India

Table 1. Production of barracudas in different maritime States in India during 1985-'93.

| Year | Orissa | Andhra Pradesh | Tamil Nadu | Pondi-cherry | Kerala | Karna-Goa taka | Mahara-shtra | Gujarat | Total | |
|------------|--------|----------------|------------|--------------|--------|----------------|--------------|---------|-------|--------|
| 1985 | 39 | 429 | 1309 | 79 | 898 | 93 | 27 | 146 | 96 | 3116 |
| 1986 | 93 | 321 | 2125 | 19 | 1313 | 150 | 88 | 69 | 26 | 4204 |
| 1987 | 337 | 503 | 3131 | 42 | 929 | 173 | 1 | 85 | 38 | 5239 |
| 1988 | 8 | 397 | 3595 | 285 | 1886 | 647 | 0 | 135 | 222 | 7175 |
| 1989 | 4 | 455 | 4253 | 54 | 2144 | 543 | 0 | 349 | 633 | 8435 |
| 1990 | 70 | 788 | 4694 | 162 | 3842 | 299 | 0 | 232 | 487 | 10574 |
| 1991 | 36 | 336 | 5660 | 46 | 4211 | 463 | 56 | 803 | 1211 | 12822 |
| 1992 | 28 | 474 | 5121 | 79 | 4046 | 452 | 43 | 965 | 640 | 11848 |
| 1993 | 24 | 406 | 5438 | 117 | 3018 | 244 | 42 | 958 | 425 | 10672 |
| Average | 71.0 | 456.6 | 3925.1 | 98.1 | 2476.3 | 340.4 | 28.6 | 415.8 | 419.8 | 8231.7 |
| Percentage | 0.9 | 5.5 | 47.7 | 1.2 | 30.1 | 4.1 | 0.3 | 5.1 | 5.1 | |

Species composition

Four species, *Sphyraena obtusata*, *S. barracuda*, *S. jello* and *S. forsteri* constitute the barracuda fishery in India, though more number of species occur in Indian waters. The size composition of these species varied from 10 - 44 cm in *S. obtusata*, 17.5 - 152.5 cm in *S. jello* 15 - 230 cm in *S. picuda* and 15 - 35 cm in *S. forsteri*. The average percentage composition in trawl fisheries was estimated to be *S. obtusata* (70.5%), *S. picuda* (14.5%), *S. jello* (10.0%) and *S. forsteri* (5.5%) and in drift gillnet fishery *S. jello* (78.0%), *S. picuda* (20.0%), *S. obtusata* (1.8%) and *S. forsteri* (0.2%).

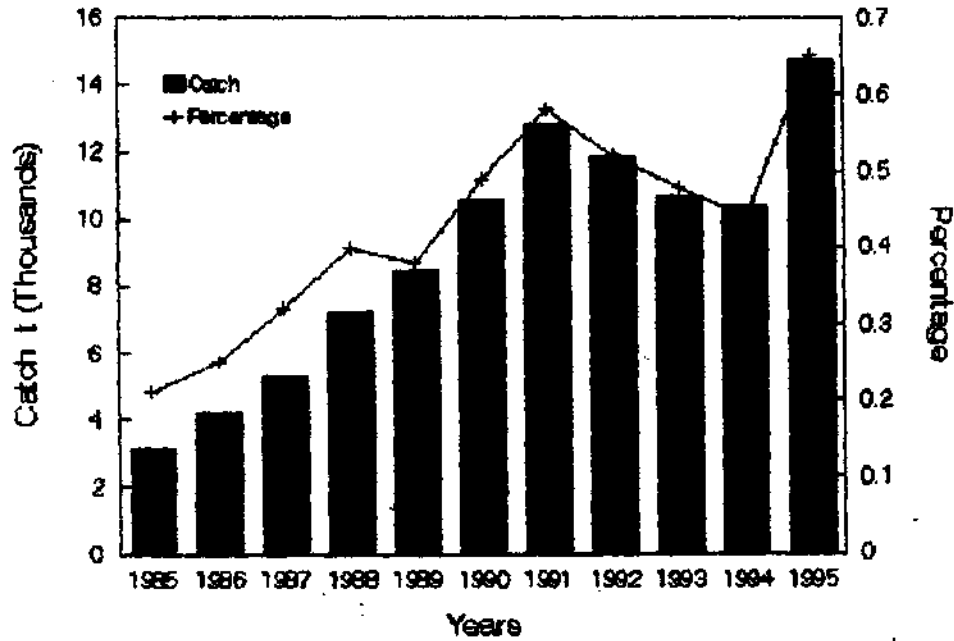


Fig. 1. Barracuda production and its percentage composition in total fish catch in India during 1985-'95.

Age and Growth

The growth parameters have been estimated from the length frequency data to be L_{∞} 470.0 mm, K 1.0364/yr and t_0 -0.009 yr for *S. obtusata* and this species attains a fork length of 1929, 305.0, 371.7, 411.5 and 435.1 mm when it is 0.5, 1.0, 1.5, 2.0 and 2.5 years old. The growth parameters of *S. jello* have been estimated to be L_{∞} 1680 mm, K 0.396/yr and t_0 -0.0448 yr and it attains a fork length of 529.0, 905.5, 1158.7, 1329.2, 1444.0 and 1521.0 mm in 1,2,3,4,5 and 6 years respectively. The growth parameters of *S. picuda* have been estimated to be L_{∞} 1521 mm, K 0.3266/yr and t_0 -0.1085 yr and it attains a fork length of 384.2, 701.0, 929.4, 1094.3, 1213.2 and 1298.9 mm in 1,2,3,4,5 and 6 years respectively.

Spawning season

Barracudas breed more than once in a year during October - February and June - August. The spawning occurs in deep waters at the edge of the

continental shelf and the eggs drift inshore, where they develop in mangroves, seagrass beds, or other sheltered nursery areas. The young ones, in due course, move offshore to coral reefs and become semi-migratory in the deeper waters. The food of juveniles consist of small bony fish, young fish, copepods, pteropods, cirrepede larvae, lamellibranch and gastropod larvae and polyzoans. The minimum size at maturity of *S. obtusata* is 18 cm and fecundity vary from 30,000 to 1,00,000. The recruitment of *S. obtusata* is recorded from March to July and that of *S. barracuda* and *S. jello* a pronounced one in April and a less prominent one in September, October and Novemeber.

Length-weight relationship

The length-weight relationship of these three species have been studied from the data on the fork length in mm and wet weight in g and it is expressed as per the following equations.

$$S. obtusata = \text{Log } W = -3.7274 + 2.3815 \text{ Log } L$$

$$S. jello = \text{Log } W = -4.2667 + 2.6229 \text{ Log } L$$

$$S. picuda = \text{Log } W = -4.5434 + 2.7385 \text{ Log } L.$$

Based on the equations the W_{∞} of these species have been estimated to be *S. obtusata* 433 g, *S. jello* 15.594 kg and *S. picuda* 14.82 kg.

Mortality and exploitation rates

The natural mortality rates (M), estimated for these three species from their life span (T_{max}) as per Sekharan (1974), are 1.3 for *S. obtusata*, 0.6 for *S. jello* and 0.5 for *S. picuda*. The average total mortality rates (Z) estimated by the catch curve method (Pauly, 1984) are 3.65 for *S. obtusata* in trawl net, 1.82 for *S. jello* and 3.01 for *S. picuda* in drift gillnet during 1986-88. The fishing mortality rate (F) is estimated to be 2.35 for *S. obtusata* in trawl net, 1.23 for *S. jello* and 2.51 for *S. picuda* in drift gillnet. The exploitation rate (U) is estimated to be 0.65 for *S. obtusata* in trawl net, 0.5 for *S. jello* and 0.66 for *S. picuda* in drift gillnet.

Yield per recruit

Yield per recruit of *S. obtusata*, *S. jello* and *S. picuda* was estimated as per Beverton and Holt (1957), simplified by Ricker (1958) by using the growth

parameters, mortality rates, age at recruitment and age at first capture as input data. The age at first capture obtained from the length converted catch curve as per Pauly (1984) is 0.25, 0.254 and 0.27 yr for *S. obtusata*, *S. jello* and *S. picuda* respectively and the age at first capture 0.54, 0.65 and 0.76 yr for *S. obtusata*, *S. jello* and *S. picuda* respectively. The estimates of yield per recruit obtained for the prevailing M/K ratio 1.25 for *S. obtusata* are given in Fig.2. The yield increases with increase in F to a certain level and then it tends to decline thereafter. The F max which can produce the highest yield of 35.44 g is 2.25. The average F obtained during 1987-88 was 2.35 which is marginally higher than the F max which can produce the yield max. The yield per recruit estimates obtained for *S. jello* for the prevailing M/K ratio 1.52 are given in Fig 3. The F max which can produce the yield max of 671.4 g was 0.5 and it was much lower than the average F (1.02) generated by the gillnet during 1987-88. The estimates of yield per recruit obtained for the M/K ratio 1.53 for *S. picuda* are given in Fig.4. The F max which can produce the yield

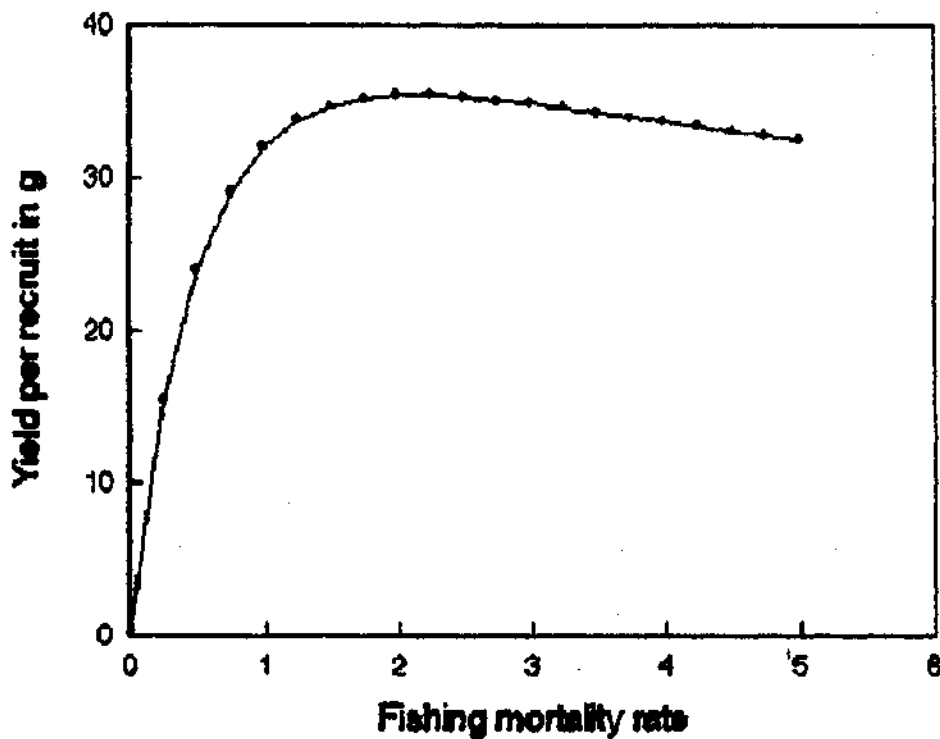


Fig. 2. Estimates of yield per recruit for *S. obtusata* at different fishing mortality rates.

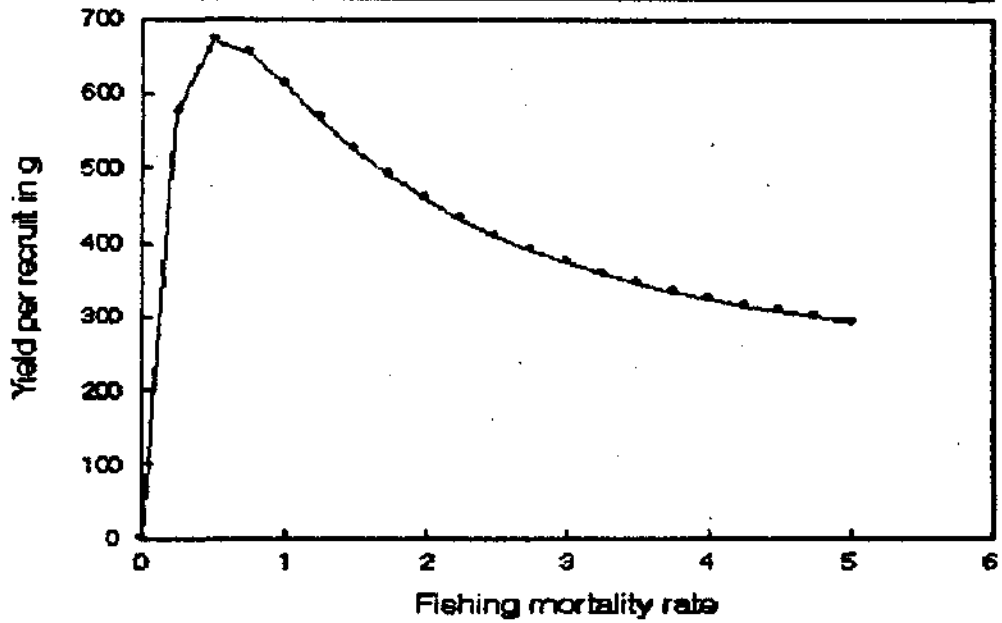


Fig. 3. Estimates of yield per recruit for *S. jello* at different fishing mortality rates.

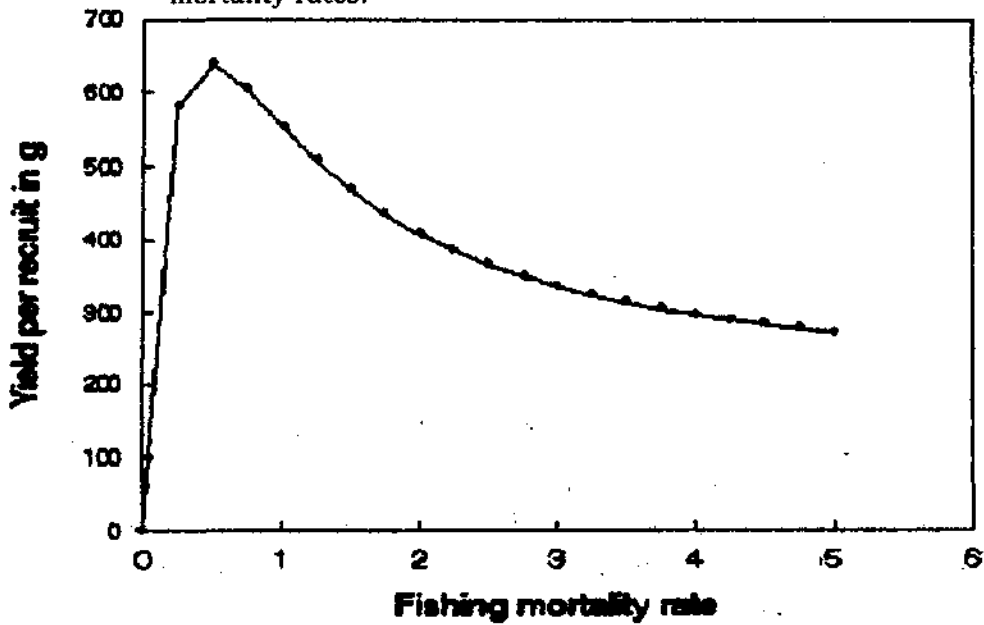


Fig. 4. Estimates of yield per recruit for *S. picuda* at different fishing mortality rates.

max of 639.5 g was 0.5 and the average F (2.51) generated by the gillnets during 1987-88 was much higher than the F max. These results indicate that *S. obtusata* is exposed to a marginally higher fishing pressure by trawl net whereas the *S. jello* and *S. picuda* are exposed to higher fishing pressure by the drift gillnet.

Stock assessment

Studies on the population parameters such as the growth factors, total, natural and fishing mortality coefficients, exploitation rates and yield per recruitment of *S. obtusata* indicate that the present effort input by trawlers is marginally higher than the optimum effort which can generate the highest yield from the stock of *S. obtusata*. There is no scope for further increase in the effort of trawlers to increase the production of this species. The average standing stock is estimated to be 343.2 t and average annual stock 1032.7 t at Tuticorin in Gulf of Mannar.

The country's annual average stock of *S. obtusata* was estimated to be 5730t in 1987 and 7848 t in 1988, of *S. jello* to be 2710t in 1987 and 1516t in 1988 and of *S. picuda* to be 1746t in 1987 and 1129t in 1988.

The gearwise $fmsy$, MSY , biomass msy , yield and biomass obtained by Thompson and Bell (1934) long term forecast analysis for *S. obtusata*, *S. jello* and *S. picuda* exploited by trawl and drift gillnets during 1987-88 are given in Table 2. The yield at different F factors and the mean biomass obtained from the Thompson and Bell long term forecast analysis for *S. obtusata* are given in Fig 5 and the MSY 5765t is indicated at F factor 1.2, for *S. jello* in Fig 6 wherein the MSY 2782t is indicated at F factor 0.8 and for *S. picuda* in Fig 7 wherein the MSY 2163t is indicated at F factor 0.4. As seen from the $fmsy$, *S. obtusata* was underfished by 20% lower effort input than the effort which can produce the MSY during 1987 and 1988 whereas, *S. jello* and *S. picuda* were exposed to 20 and 60% higher effort expenditure respectively during 1987-88. Kasim and Balasubramanian (1990) have also observed a similar under exploitation with regards to *S. obtusata* by trawl net off Tuticorin.

Table 2. Gearwise fmsy, MSY, biomass msy, yield and biomass for *S. obtusata*, *S. jello* and *S. picuda* exploited in India during 1987-'88.

| Species/ Gear | Year | fmsy (F factor) | MSY (t) | Biomass msy(t) | Yield (t) | Biomass (t) |
|--------------------|------|--------------------|------------|-------------------|--------------|----------------|
| <i>S. obtusata</i> | 1987 | 1.2 | 5765 | 3088 | 5730 | 3486 |
| Trawl net | 1988 | 1.2 | 7900 | 4233 | 7848 | 4777 |
| <i>S. jello</i> | 1987 | 0.8 | 2782 | 3538 | 2710 | 2784 |
| Drift gillnet | 1988 | 0.8 | 1557 | 1988 | 1516 | 1565 |
| <i>S. picuda</i> | 1987 | 0.4 | 2103 | 2627 | 1746 | 1140 |
| Drift gillnet | 1988 | 0.4 | 1329 | 1631 | 1129 | 739 |

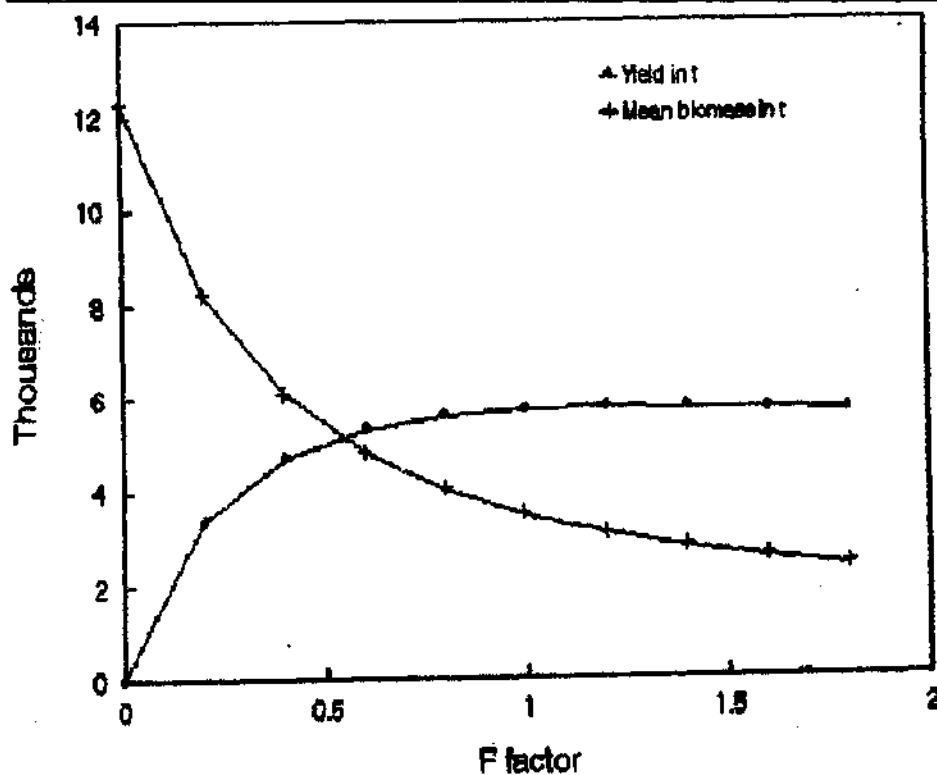


Fig. 5. Estimates of yield and mean biomass for *S. obtusata* by Thompson and Bell analysis.

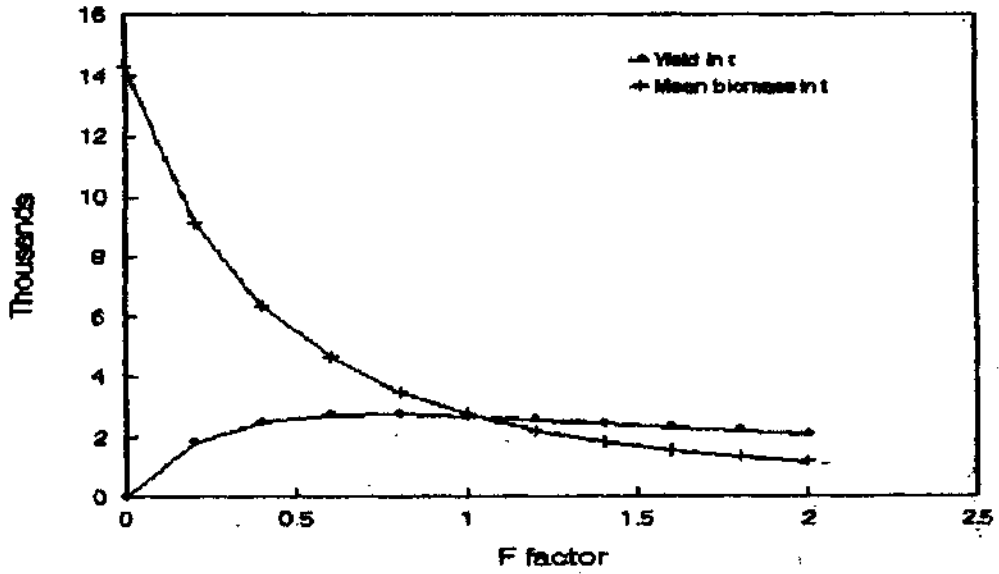


Fig. 6. Estimates of yield and mean biomass for *S. jello* by Thompson and Bell analysis.

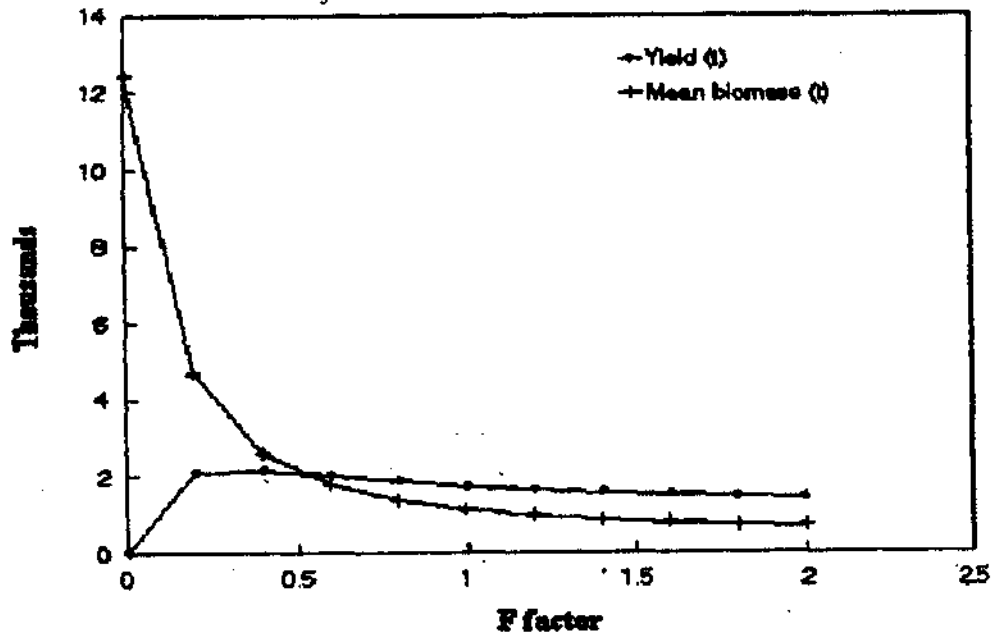


Fig. 7. Estimates of yield and mean biomass for *S. picuda* by Thompson and Bell analysis.

Potential for further exploitation

Barracuda is one of the most promising marine fishery resource for fruitful exploitation. Fishery surveys by FSI vessels and FORV Sagar Sampada of DOD in areas beyond the conventional fishing grounds i.e., beyond 100 m depth indicate the occurrence of barracuda resource in good abundance along both the coasts of India. This resource may be exploited effectively by extending the area of exploitation from the conventional shallow waters to further deeper water, i.e., beyond 100m depth in trawlable areas. In the areas of coral reef and rocky bottom the drift gill net and hooks & lines are the most effective gears specially in catching larger species like *S. picuda* and *S. jello*. However, bottom trawling operations in deeper waters during day time and operations of drift gill nets during night time will be ideal for effective exploitation of this resource.

Utilization and marketing

At present the entire catch is sold in fresh condition in the local markets in India. The prospects for export of this resource is not yet explored mainly because of non availability of sufficient quantities of large specimens. The marginal quantity of larger specimens which are landed in nearly spoiled condition are being salt cured. Economically, the larger specimens fetch a good return for the fishermen as they are priced next to seer fish. The smaller barracudas *S. obtusata* and *S. forsteri* also fetch a good return for the fishermen by virtue of their quantum of landing. The smaller species are auctioned at the rate of Rs. 10 - 25/kg and the larger species fetch Rs. 25 - 45/kg in the landing centres.

Recommendations and suggestions

Studies so far conducted on population dynamics and stock assessment of barracudas in Indian waters indicate that *S. obtusata* is being under exploited (Kasim and Balasubramanian, 1990; Somavanshi, 1989) and *S. jello* and *S. picuda* are exposed to higher fishing pressure. The fishery surveys conducted by the FSI and DOD vessels have indicated the good abundance of this resource may be intensified beyond this depth by bottom trawlers during day time and drift gill nets and hooks & line during day time and drift gill nets and hooks & line during night time to increase the production. Shallow coastal waters, back waters and lagoons with abundant sea weeds and man-

grove vegetations are the nursery grounds for the young ones of barracudas also and the protection of the nursery grounds is of prime importance to ensure a continued good strength of recruitment into the population to sustain the fishery. The resource has to be monitored continuously to assess the nature of exploitation so as to provide the required information for proper regulation of the fishery.

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