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Fishery, biology and stock of the Indian mackerel *Rastrelliger kanagurta* off Mangalore-Malpe in Karnataka, India

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Abstract

The Indian mackerel, *Rastrelliger kanagurta* constitutes one of the most important marine fishery resources along Mangalore-Malpe coast. Annual average production was 9,700 t during 1997/98 to 2001/02. Since a number of gears are in operation the resource is landed throughout the year. The fishery showed a steady decline and the production was lowest during 2001/02. Environmental factors together with high exploitation levels seem to have caused the sharp decline in the catch. Growth parameters estimated were $L_\alpha = 307$ mm and $K = 1.8$/yr. Total mortality observed was 7.63 and natural mortality 2.63. The resource at present is being exploited at a level (present E = 0.66) higher than optimum ($E_{max} = 0.588$) indicating greater fishing pressure than sustainable levels. Appropriate management measures are discussed for preventing further deterioration of the stock.

Keywords : Fishery, biology, stock, Indian mackerel

Introduction

The Indian mackerel, *Rastrelliger kanagurta,* an important pelagic fish resource of India constituted 4% of the total marine fish landing during 2001/02. Mangalore and Malpe are the two major fishing harbours, which account for more than 65% of the total fish catch in Karnataka. Popularly known as the 'mackerel coast', this region contributed 5,100 t forming 5.6% of the country's total mackerel catch during the period. Several gears have been found to harvest mackerel almost throughout the year. Like any other tropical pelagic resource, mackerel also exhibited seasonal and annual fluctuations in landings. However, a steady declining trend during the last five-years is a cause of concern to the fishermen as well as the fishing industry. Some of the recent studies on the fishery, biology and stock structure of mackerel from different regions of the west coast include reports by Gopakumar *et al.* (1991), Noble *et al.* (1992), Devaraj *et al.* (1994), Prathibha *et al.* (1996, 1998), Yohannan *et al.* (1998, 2002) and Yohannan and Nair (2002). The present paper gives details of the fishery, biology, growth and stock of mackerel along the Mangalore-Malpe coast based on the investigations made during 1997/98-2001/02.

Material and methods

Weekly visits were made to the fishing harbours at Mangalore and Malpe. Data on catch in weight of mackerel, effort expended by different gears were collected. Monthly estimates were obtained by raising the estimated days catch to the number of fishing days in the month. Random samples of mackerel collected from various gears were analysed in the laboratory for biological studies. Total length (mm) and wet weight (g) of individual fish were taken. The gonads were classified into five groups and seven stages as follows: Immature (stages I and II), Developing (III and IV), Mature or Gravid (V and VI), Spent and Resting (IIb). Fishes in stage III and above were considered for the purpose of estimating length at first maturity and fishes above the length of first maturity were considered for determining the spawning season. Length frequency data grouped into 10 mm intervals were used to estimate the growth parameters of the von Bertalanffy growth equation. The L_α and K were estimated using the ELEFAN module of FiSAT (FAO-ICLARM stock assessment Tools Ver. 1.1, 1990) and t_0 was calculated using Pauly's (1979) empirical equation, Log $(-t_0)$ = -0.392-0.275 log L_α - 1.038K. The total instantaneous mortality coefficient (Z) was estimated using the length converted catch curve method (Pauly, 1983). The natural mortality coefficient (M) was estimated using Pauly's (1980) empirical formula. (T = 28.5°C in the present study) The fishing mortality coefficient (F) was derived from the relation Z = F + M. Length structured population analysis (VPA) of FiSAT was used to obtain population sizes and fishing mortalities per length class. The exploitation rate (U) was estimated from the equation U = F/Z $(1-e^{-z})$. Average standing stock (Y/F) and total annual stock of biomass (Y/U) was derived for the five-year period by taking the annual average mackerel stock.

Results

An annual average of 9,700 t of mackerel was landed along Mangalore-Malpe coast during 1997-2002. The catch showed a decreasing trend, varying from 14,900 t to 5,100 t forming 14% to 5% of the total marine fish landings. Highest catch was recorded in 1997-98 and lowest in 2001-02.

Gear-wise contribution to mackerel fishery

Among the various gears, the seines (purseseine and boat seine) were the most efficient, landing 85% of the total catch (Fig.1). During 1997-2002, purseseine landed an annual average catch of 7,600 t forming 83% of the catch (all gears) and 98% of the catch made by seines. Nearly 65% of the catch was from 11-20m, followed by 34% from 21-40m. Beyond 40m the contribution was only less than 1%. The boat seine (*Ranibale* or *Kotibale)* operated only during the monsoon months (June to August) at depth upto 20 m landing an annual average of 117 t and 38t respectively. This formed less than 2% of catch made by all gears. The trawl landings showed an increasing trend over the years and landed 13% of the total mackerel catch (Fig.1). Among the single-day trawl (SDT) and multi-day trawl (MDT), the latter landed considerable quantities of mackerel (annual average catch 1,157 t) as bycatch throughout the fishing season. The catch formed 13% of the total

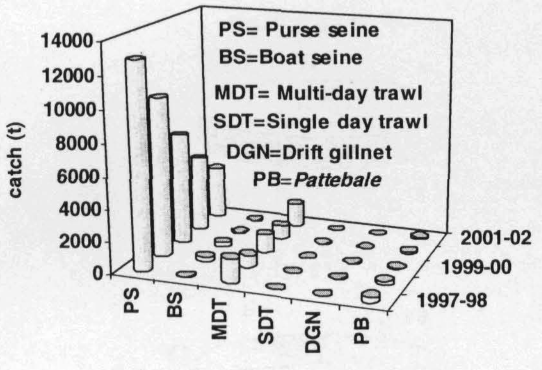

Fig. 1. *Annual mackerel landings (t) by different gears along Mangalore- Malpe coast*

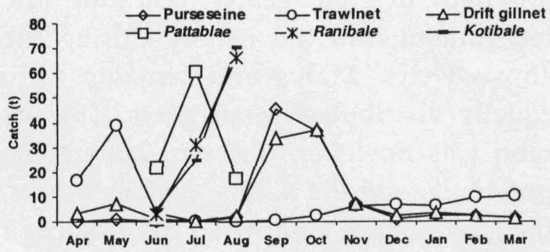

Fig.2. *Average monthwise production (%) of mackerel in different gears*

catch (all gears) and 99% of the catch made by both type of trawl. Landings by SDT was occasional with the annual average catch (14 t) comprising < 1% of the catch by all gears. Though trawlers operate in a wide range (12-500 m), mackerel was generally caught at depth ranging from 20-70 m. Landings by gillnets (drift gillnets and *Pattabale*) were seasonal and on an average contributed 2% of total catch by all gears. The drift gillnets contributed 0.3% of the total catch. Depth of operation ranged from 28-80 m. The *pattabale*, an encircling gillnet, is operated only during the monsoon months. It targets only large sized fish and contributed 1.9% of the total mackerel landed by all gears.

Period of peak production

The general period of peak production by all gears together was during September-October (Fig.2). This trend is a true reflection of the landings by purse seine and gillnet. In trawl, the peak was in April-May and lowest in August. In *Pattabale* maximum catch was in June, and the boat seine in August.

Length distribution

Gearwise length distribution revealed that the length range was wide in purseseine and trawl. It was 55-295mm in the former and 55-280mm in the latter. Small fishes were more prominent in purseseine catch during February, April and September The mean length ranged from 176 mm to 211 mm. In trawl, smaller fishes in the length range of 55 to 150 mm were observed during September-October and January-March. The mean length ranged from 177 mm to 195 mm. Drift gillnet landed only large sized mackerel of length 155 mm to 285 mm, with mean length varying from 212 mm to 236 mm. In *pattabale,* the length ranged from 185 mm to 285 mm and the mean length from 245 mm to 250 mm. In *Ranibale* and *Kotibale* the size ranged from 110 - 260 mm and 125 - 265mm respectively.

Sex and maturity

The indeterminate (7%), pre-adult (40%) and adult fishes (53%) supported the fishery (Fig.3). Indeterminates formed less than 10% (all gears) indicating low recruitment into the fishery during the above years. Males and females were equally distributed in all gears. The sex ratio was however, different among the pre-adults and the adults. Among adults, the gravid stage comprised 54% followed by the resting stage 21%. The spent and developing stages formed 13% and 11% respectively.

In purseseine, pre-adults and adults comprised 56% and 42% against 18% and 68% in trawl, and 25% and 75% in gillnet respectively. Females dominated in purse seine compared to males in trawl. Gravid fishes formed 38% the in the former, 62% in the latter and 45% in gillnet. The *Pattabale* catch consisted only of adults with a dominance of males. In *ranibale,* the pre-adults and adults formed 64% and 27% respectively. The *kotibale* consisted of only pre-adults (38%) and adults (62%). Males dominated both the groups. The gravid fishes formed 84% (Fig.4).

Size at first maturity

The minimum size at maturity was determined as 180mm when more than 50% of fish (all gears pooled) were found to be mature. It was 190mm in purse seine and *Ranibale.*, 180mm in trawl and *Kotibale.*, 160mm in gill net., and 180mm in *Pattabale.*

Spawning season

Spawning in mackerel was prolonged with gravid gonads observed throughout the year. However, peaks in spawning were confined to a few months in the

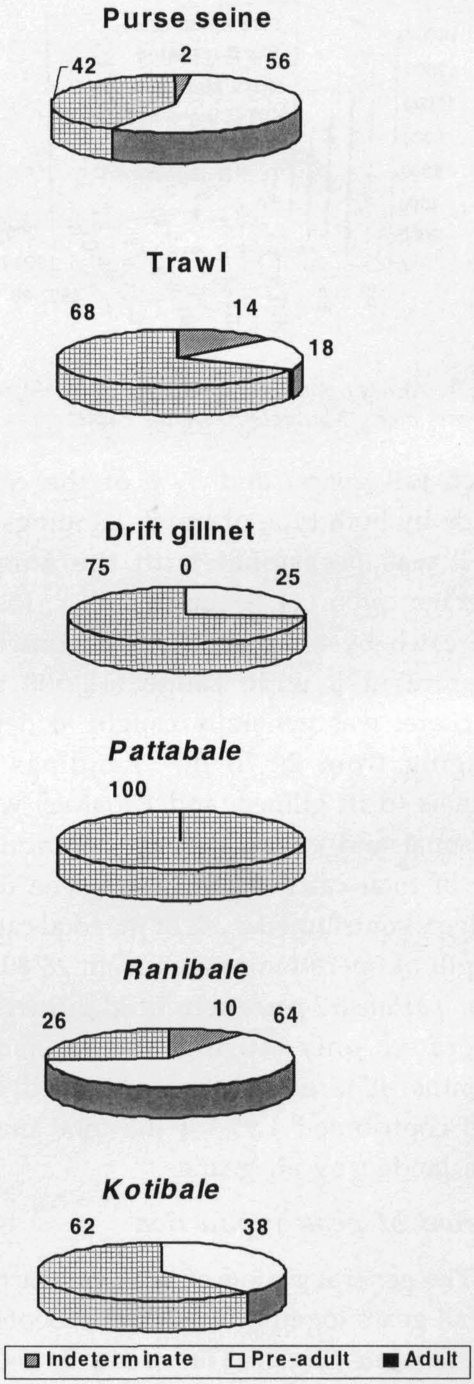

Fig. 3. *Contribution of indeterminate, pre-adult and adult mackerel to the fishery at Mangalore-Malpe*

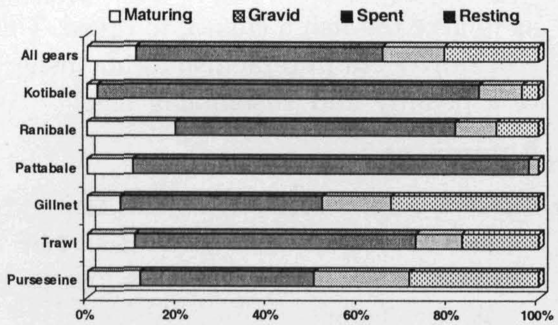

Fig.4. *Gearwise distribution of gonad maturity stages in adult mackerel (pooled for 1997/98-2001-02)*

year, a major peak during June-August and a minor one during March-April.

Length-weight relationship

Mackerel exhibited linear growth and the values (both sexes) for the different parameters in the formula $W= aL^b$ (W= weight of mackerel in gram and L = Total length of fish in cm) was, a= 0.004457 and b = 3.29.

Growth and stock structure

The values estimated for the five year period showed that mackerel can attain a maximum average total length (L_α) of 307 mm with a K value of 1.8/yr. Mortality parameters estimated were Z= 7.63, M = 2.6, F = 5.0. Exploitation ratio was 0.66. The present annual average yield (9,717 t) is higher than the MSY (7,414 t). The relative yield per recruit analysis showed an E_{max} at 0.59 against the present E of 0.7 indicating that the stock is under greater fishing pressure than the sustainable level warranting reduction in fishing effort.

Price structure

The wholesale price per kilogram of mackerel along Mangalore-Malpe coast ranged from Rs. 15/- to Rs. 50/-. The annual value of mackerel catch ranged from Rs. 15.8 crores to Rs. 27.3 crores during the study period. The price of this fish over the years has gradually increased. However, its contribution to the total revenue generated by all marine fishes landed showed a decline due to decrease in the mackerel landings. The revenue generated by the mackerel in purseseine decreased from Rs. 23.3 crores to Rs. 10.0 crores.

Discussion

Mackerel is the most favourite food fish of Karnataka and the success of its fishery determines the marine fishery scenario of the state. Annual and seasonal fluctuations in catch are an inherent feature of the fishery. Improvement in operating efficiency of the different gears and introduction of multi-day trawl along the Mangalore-Malpe coast resulted in higher mackerel catches during the early 90's. The introduction of multi-day trawl further enhanced mackerel catch (Prathibha *et al.*, 1998). However, during the present study period, the fishery has shown a steady declining trend.

The difference in the size at first maturity observed in fish caught in different gears is mostly due to the effect of environment on the biology of the fish. Yohannan and Nair (2002) have reported reduction in growth rate of mackerel when it moves to deeper waters. The trawls generally harvest mackerel from deeper waters and the smaller size at first maturity observed in the present study supports the observations made by the earlier workers.

As revealed in the present study spawning was very intense during June-August (monsoon months) when more than 80% fishes had gravid gonads. Among the different indigenous gears operating during the monsoon period, the *Pattabale* targets only large sized mackerel. Most of the fishes (87%) are in a state of active spawning (Fig.4). The *kotibale* and the *ranibale* operated during the monsoon months also trap fishes which are in an active state of spawning. The percentage of gravid fishes to the total catch was above 60% in purseseine whenever they were operated in late August. Large scale exploitation of spawners during the peak spawning period is bound to have a deleterious impact on recruitment and fishery in the subsequent years. This coupled with poor upwelling along the coast will affect the fishery in general (Yohannan and Abdurahiman, 1998). Furthermore, the study has shown that the present level of exploitation (E= 0.7) to be higher than the optimum (E_{max} = 0.6). These two reasons together have contributed to the declining catch trends. It is, therefore, suggested that measures be taken to reduce the fishing pressure so as to bring the catch to MSY levels. Further, the exploitation of gravid mackerel during the peak breeding season especially by gears like *Pattabale* must be strictly restricted either by reducing the number of units operating or limit the catch during the monsoon months so as to give the fish a chance to breed. This will slowly aid in replenishing the fishery to a healthy and sustainable level.

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