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Fishery and population characteristics of Indian mackerel, *Rastrelliger kanagurta* (Cuvier) at Kakinada

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ABSTRACT

Indian mackerel, *Rastrelliger kanagurta* is exploited by trawls and gillnets along Kakinada coast. Its production increased from 67 t in 1988 '99 to 3,493 t in 1997 '98. Period of peak abundance and fishery was February-March while recruitment was high during December-January. Length weight relationship showed that females were slightly heavier than males of the same size. Growth parameters, L_∞ and K were estimated as 286.3 mm and 1.89/year respectively. Natural mortality of the stock was 2.61. Total mortality varied between 4.69 and 9.29 and fishing mortality between 2.08 and 6.68. Stock varied during the period between 1,814 and 5,255 t and biomass between 268 and 902 t. Maximum sustainable yield is 2,239 t. Emax is 0.77, whereas exploitation rate varied between 0.44 and 0.72. These indicated that the resource is currently under moderate fishing pressure especially from trawls and has only marginal scope for further increase in production. Since further increase in effort by trawls would be detrimental for the resource it is recommended to reduce their effort marginally or to maintain at the present level, whereas effort by gillnets can be increased.

Introduction

The Indian mackerel, *Rastrelliger kanagurta* is a commercially important pelagic resource with wide distribution along east and west coast of India. Its contribution in the country's total marine fish production varied between 2 and 20% during 1984 '88 (Noble *et al.*, 1992). South west coast is the most productive zone as far as its fishery is concerned. However, in recent years it has emerged as a dominant fishery along the east coast also. During the last decade its landings increased steadily along the Andhra coast from 3,633 tonnes of 1985 to 25,688 in 1993 (Anon, 1995). East Godavari district alone contributed 45% of the total mackerel production from the state (Luther, 1995). However, information on the fishery and biology of mackerel from this region is scanty, as most of the investigations were confined to west coast (Yohannan, 1979; 1982; Noble, 1986; Noble *et al.*, 1992; Devaraj *et al.*, 1994 and Prathibha *et al.*, 1998). Contribution from east coast is limited to reports on the occurrence of their young ones in the catches (Rao and Basheeruddin, 1953; Appannasastry, 1969) food and feeding habits (Kuthalingam, 1956; Rao and Rao, 1957) and bionomics along Visakhapatnam coast (Rao, 1962; Luther, 1995). Present study was undertaken at a time when this resource is emerging as one of the dominant fishery along the east coast and its outcome will be useful for fishery managers and researchers.

Materials and methods

Fishing effort and fishery by trawls and gillnets and biology of *Rastrelliger kanagurta* at Kakinada were monitored during 1995-2000 at weekly intervals. Catch-effort data by trawls for 1985-'95 period were also used to study the trend in fishery over the years. Length-weight relationship was estimated following linear regression analysis as in Sparre (1986). Well-being and robustness of the fishes were assessed by studying the relative condition factor (Kn) as in Le Cren (1951). Size at first maturity was determined by probability curve method.

Growth, mortality, exploitation and recruitment pattern were estimated from monthly length frequency data of the species in the catch during 1995-2000 using ICLARM's FiSAT software (Gayanilo *et al.,* 1995). Growth and growth parameters were also estimated through integrated modal progression analysis (Pauly, 1980). Size at first capture (Lc_{50}) was estimated as in Pauly (1984) and age at zero length (t_o) as in Bertalanffy (1934).

Natural mortality (M) was estimated from the empirical formula as in Pauly (1980), by taking the mean sea surface temperature as 29^o C and total mortality (Z) from the catch curve as in Pauly (1983). Exploitation rate (E) was estimated from the equation, E = F/Z and exploitation ratio (U) from $F/Z \times (1\ e^{Z})$ as in Beverton and Holt (1957) and Ricker (1975), where, F is the fishing mortality. Potential yield per recruit and optimum age of exploitation were computed as in Krishnankutty and Qasim (1968). Stock was computed from the relations, P = Y/U and biomass from

TABLE 1: *Mackerel catch, catch rate, their percentage contribution in total fish catch and effort by trawls at Kakinada during 1985-2000*

Period	Effort (unit)	Catch (tons)	CPUE (kg)	CPH (kg)	% in total fish catch
1985-'86	43,370	81	1.87	0.26	0.40
1986-'87	44,321	102	23.01	2.81	4.35
1987-'88	34,852	218	6.25	0.72	1.65
1988-'89	39,124	67	1.70	0.19	0.82
1989-'90	42,157	142	3.36	0.40	1.11
1990-'91	33,149	68	2.04	0.18	0.53
1991-'92	41,826	188	4.50	0.42	0.83
1992-'93	51,481	764	14.84	1.16	2.76
1993-'94	47,721	917	19.21	1.22	3.18
1994-'95	51,340	1,246	24.27	1.18	3.68
1995-'96	49,768	837	17.91	0.88	2.69
1996-'97	47,966	1,411	29.41	1.84	5.40
1997-'98	58,872	2,992	50.81	3.11	8.56
1998-'99	61,807	1181	19.11	1.20	3.48
1999-2000	57,842	1643	28.4	1.78	4.7

B=Y/F, where, Y is yield in tonnes. MSY was estimated graphically as in Corten (1974).

Results

Fishery

Mackerel fishery was supported almost exclusively by *R. kanagurta*. They were exploited by trawls and gillnets. Almost 77% of the fishery was by trawls. Catch by the gear increased steadily over the years from 67 t of 1988 ’89 to 2,992 t in 1997 ’98 (Table 1). Increasing trends have been observed in catch rates and percentage composition also. Catch rate varied between 1.7 and 50.8 kg/unit effort and 0.2 and 8.1kg/trawling hour and percentage contribution between 0.40 and 8.6%.

Trawls landed mackerel round the year with peak during December-April forming nearly 53% of the annual catch during February-March. Comparatively large proportions of spent and gravid fishes were represented in the fishery during this period. Catch rates and percentage contribution in the total catch were also high during this period. Gillnet catch varied between 276 and 787 t annually during 1995-2000 at an average catch rate of 14.0 kg/hr of fishing and 38.2 kg/unit effort. It formed 19% of the total fish catch in the gear. Peak fishery in the gear was during March-May. In April it formed nearly 64% of the catch in the gear.

Size composition in the catch

In trawls 60-275 mm fishes with 172 mm as mean size and 95-100, 135-140 and 225-230 mm as major modes supported the fishery (Fig. 1). Mean weight of the species in the catch was 55.7 g. Small fishes of less than 150 mm constituted 44.4% of the catch, 150-200 mm fishes 16.6% and above 200 mm 39%. Small fishes, below 100 mm entered in trawl catches in large numbers during March-May and in small numbers during September/October. Their size at first capture in the gear was 149.6 mm. Gillnets landed relatively large fishes of 140-270 mm size with 230-235 mm as modal class. About 95% of the catch in the gear was by adults and 92% by fishes above 200 mm.

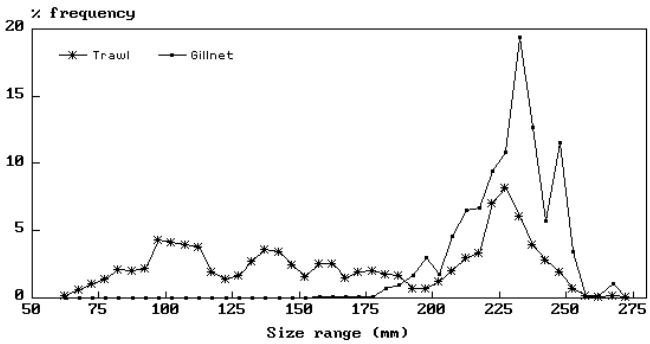

Fig 1. Annual average size frequency distribution of *Rastrelliger kanagurta* in trawls and gillnets during 1995-2000.

Growth and age:

Growth parameter, L∞ and K were 286.3 mm and 1.89/yr respectively and t_o was-0.0023 year.

$$L_t = 286.3 \times [1 \quad e^{-1.89 (t + 0.0023)}].$$

The calculated lengths were 168, 234, 262 and 275 mm by the end of 6, 12, 18 and 24 months respectively after birth.

The age corresponding to size at first capture was 4.8 month, whereas optimum age of exploitation was 8.3 months. This suggested necessity of formulation and implementation of measures to increase their size and age at first capture and to reduce fishing pressure for sustaining stock and increasing yield.

Sexual maturity

The fish attained sexual maturity and spawn during the first year. Their size at first maturity was 182.4 mm for males and 184.7 mm for females. Age at this size was 6.5 months. However, fully matured fishes with ripe gonads were observed in the population from 173 mm onwards.

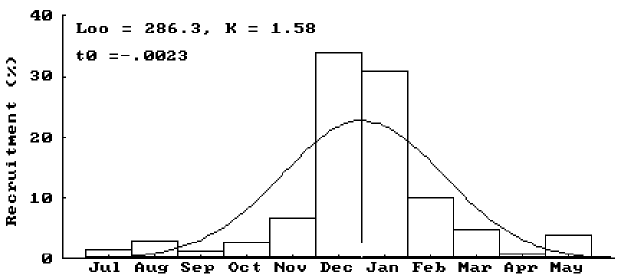

Fig 2. Recruitment pattern of *Rastrelliger kanagurta* along Kakinada region.

Spawning and recruitment pattern

Recruitment pattern (Fig.2) and presence of young ones in the catch showed that they spawned almost round the year with peak during December-January accounting 67% of the total spawning activity. Recruits from the December-January brood entered the fishery during March-April.

Length-weight relationship

Length-weight relationship for males, females and unsorted fishes were computed separately and the regression equations are given below.

Male	Log W = -5.54817 + 3.23919 * Log L
Female	Log W = -5.41674 + 3.18733 * Log L
Unsorted fishes	Log W = -5.91862 + 3.40179 * Log L

These relationship shows that females are heavier than males of the same size. Analysis of covariance shows that males and females differ significantly ($P < 0.05$) in their length-weight relationship (F: 4.26; *df*. 1, 1106).

Condition factor (Kn)

Relative condition factor (Kn) fluctuated during different season (Fig. 3). Kn value increased steadily from September and remained high till January. It declined sharply there after below 1.0 during February-May. The seasonal variations are attributed to progressive gonadal maturation and subsequent spawning during December-January.

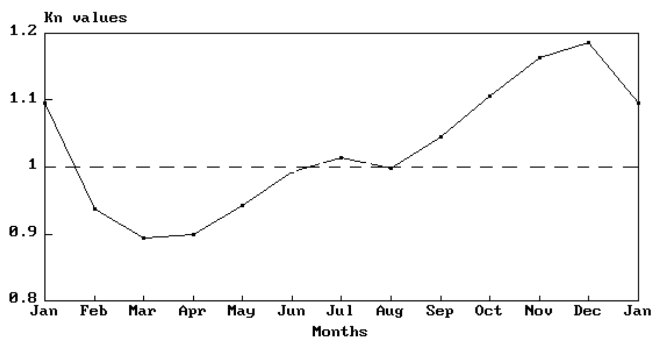

Fig 3. Seasonal fluctuation in the condition factor (Kn) of *Rastrelliger kanagurta* at Kakinada.

Mortality and exploitation rate

Natural mortality of the species was 2.61. Total mortality during the period was 6.43 and fishing mortality 3.82. Their Emax was 0.77, whereas, exploitation rate was 0.594. This indicated that the resource is under

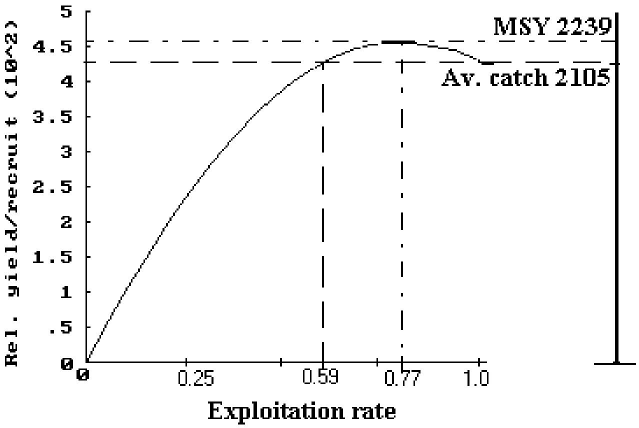

Fig 4. Yield per recruit at different levels of exploitation levels and maximum sustainable yield of *Rastrelliger kanagurta* along Kakinada coast.

moderate fishing pressure along the region.

MSY, stock, yield per recruit and biomass

Average catch of mackerel during the period was 2,105 t and maximum sustainable yield (MSY) was 2,239 t (Fig. 4). Their stock varied from 1814 to 5255t with a mean of 3,550 t; while the biomass ranged from 268 to 902 t with a mean of 551t. The present study indicated marginal scope for further increase in production. Maximum yield per recruit was 21.6 g and potential yield per recruit was 18 g.

Discussion

Mackerel fishery registered steady growth till 1997. This increase can be attributed partly to increased effort and partly to extension of fishing to deeper waters, where abundance of the resource is relatively high as evidenced from their large catch rates and increased contribution to the total fish production during late nineties. Variations observed in the seasonal pattern of fishery by trawls and gillnets may be due to differences in the fishing grounds, depth of operation of the gears and variation in vertical distribution of the species in the sea with respect to prevailing environmental conditions.

Indian mackerel grows fast in Kakinada area than that reported from Visakhapatnam area (Luther, 1995). This may probably be due to the prevalence of productive condition prevailed along the east Godavari coast due to Godavari river discharge. Estimates of growth parameters by earlier workers differ from the present estimates. However, the L∞ estimates, 281.7 by Prathibha *et al*., (1998) from west coast is very close to the present estimate than other estimates from west (Yohannan, 1979; Noble, 1986; Devaraj *et al*., 1994) and east coast (Luther, 1995). Similarly their estimates of growth coefficient (K) also vary widely from that of the present estimate. As opined by Devaraj *et al.* (1994), these variations could be due to spatial and annual variation in the growth of the fishes. It may also occur due to varying combinations of size groups in the length frequency data used for study.

Mainly zero year group constituted trawl catch (82%). Since pre-adults represented 51.1% of the total catch, the present fishing pattern may not permit large proportion of them to spawn at-least once in their life. Owing to their early maturity though there is no immediate danger on recruitment and stock, further increase in fishing pressure by trawls may result in growth over fishing. If fishes were allowed to grow for few more months than at present, production could be increased considerably from the same stock. A rough projection based on the pooled length frequency data and length-weight relationship indicates that the production will increase by nearly 57%, if their minimum size and age at harvest is increased to 200 mm and 7.7 months.

Total mortality and exploitation rate indicated moderate fishing pressure on the stock. Average exploitation rate though small, is close to E_{max} indicating only limited scope for increased production from the present grounds. It is prudent to regulate the fishery at a much lower level than the optimum exploitation level. Stock assessment suggested that under the present fishing conditions further increase in trawl effort might not be healthy for the stock. On the other hand gillnets are more ideal for mackerel exploitation, as catch was constituted by adults and so an increase in the gillnet effort may be encouraged.

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