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Fishery, biology and population dynamics of the Indo-Pacific king mackerel, *Scomberomorus guttatus* (Bloch & Schneider, 1801) exploited in India

Prathibha Rohit* and Shubhadeep Ghosh
***Research Centre of Central Marine Fisheries Research Institute**
Indian Council of Agricultural Research (ICAR)
Post Box No. 255, Hoige Bazar, Dakshina Kannada District,
Karnataka State India, Pin: 575001
Email: rohitprathi@yahoo.co.in

Abstract

Scomberomorus guttatus known popularly as the spotted seer and known worldwide as the Indo-Pacific king mackerel is a preferred table fish in India. The family Scombridae is represented by four species viz. *S.commerson* (62.0%), *S.guttatus* (37.7%), *S. lineolatus (*0.1%) and *Acanthocybium solandri* (0.2%) in India and it comprised 1.6% of the total marine fish catch of the country. Exploitation is mainly by gillnets and the hooks and line. *S.guttatus* is represented in the capture fishery of all the coastal states of India with high catches along West Bengal, Andhra Pradesh, Gujarat and Maharashtra. The annual catch of *S.guttatus* during 2007-2011 ranged between 15,225 t and 23,796 t with an average catch of 19,712 t. The post-monsoon and winter seasons (September to January) were the most productive seasons in terms of catch and catch rate. The fork length of *S.guttatus* landed by gillnets ranged between 20 cm and 60 cm with the mean length at 42.2 cm. The estimated length-relationship was: log W = -1.8181362 + 2.888425 log L, (r = 0.985). Gut contents mainly consisted of fishes (mackerel, sardines, ribbonfish) and *Acetes* sp. The von Bertalanffy growth equation was: $L_t = 61.27\ [1 - e^{-1.4\ (t + 0.0046)}]$ and length attained at the end of 1 and 2 years were 46.3 cm and 57.6 cm respectively. The growth performance index was 3.721 and longevity was 2.138 years. Recruitment pattern was unimodal with peak recruitment from February - July and the length at first capture was estimated 21.1 cm. The natural mortality, fishing mortality and total mortality were 1.79, 2.92 and 4.71, respectively and exploitation ratio was 0.62.

Introduction:

The seerfishes comprising of four species along the Indian coast forms a fishery seasonally in all the coastal states of the country. The fishery, distribution, biology and growth of dominant seerfish species from India have been reported earlier by Krishnamoorthy (1958), Devraj (1977,1981, 1987), Naik *et al*. (1998), Muthiah *et al*. (2002), Kasim *et al*. (2002), Mohanraj *et al*. (2007) and Ghosh *et al*. (2009, 2011). The Indo-Pacific king mackerel, *Scomberomorous guttatus* is one among the four seerfishes fished all along the Indian coast and contributes 37.7% of the catch. The other seerfish species exploited are *S.commerson* forming 62%, *S.lineolatus* (0.1%) and *Acanthocybium solandri* (0.2%). This paper gives details of the fishery biology and population dynamics of the spotter seer *Scomberomorus gutatus* exploited along the Indian coast.

Material and method:

Data on catch, effort expended and length frequency distribution for *S.guttatus* was collected on a weekly basis from major fish landing Centres during 2007-2011.The estimated statewise production for the period was obtained from the Fishery Resource Assessment Division of the Central Marine Fisheries Research Institute. A total of 9,613 specimens of *S. guttatus* in the size range of 20 to 60 cm, collected randomly were used for recording fork length and body weight. The length-weight relationship was calculated as in Le Cren (1951). Stomachs were preserved and the contents analysed for the food contents. Growth parameters *viz*., asymptotic length ($L\infty$) and growth co-efficient (K) were estimated using the ELEFAN I module of FiSAT software and the Powell-Wetherall plot (Gayanilo *et al*., 1996). The length based growth performance index Ø was calculated from L_∞ and K as in Pauly and Munro (1984). The probability of capture and size at first capture (L_c) were estimated as in Pauly (1984) and the age at zero length (t0) from Pauly's (1979) empirical equation. Longevity was estimated from $t_{max} = 3/K + t_0$ (Pauly, 1983a).

Natural mortality (M) was calculated by Pauly's empirical formula (Pauly, 1980) and total mortality (Z) from length converted catch curve (Pauly, 1983b). Exploitation ratio was estimated from the equation, E = F/Z and exploitation rate from U = F/Z*(1-e-z); where, F is the fishing mortality rate.

Results

Fishery:

The annual catch of seerfish in India ranged from 41,983 to 60,801 t with an average catch of 52,254 t during 2007-201. Highest and lowest catch was during 2010 respectively. *S.guttatus* catch during the same period ranged from 15,225 t to 23,796 t with an average catch of 19,712 t. The year 2008 recorded the highest catch and the 2011 the lowest catch (Fig. 1). West Bengal followed by Maharashtra, Andhra Pradesh and Gujarat were the most productive states and *S.guttatus* formed 46.7 to 99.6 % of the total seerfish catch (Fig.2).

Exploitation the spotted seer is by a variety of gears with gillnets being the most dominant gear along both the coasts. This gear contributed 65% of the total *S.guttatus* catch followed by hooks and lines (10.8%), which is more popular along the east coast. The trawls have emerged as a major gear in recent years and they especially land juvenile seerfish. Trawls contributed 10.1%. The rest of the catch was landed by a number of indigenous gears (shoreseines, boatseines, small monofilament gill, trammel nets, longlines, surface trolling, etc,). *S.guttatus* formed a fishery throughout the year with the post-monsoon and winter months (September-January) being the most productive period.

Length composition

The fork length of *S.guttatus* landed by gillnets ranged between 20 cm and 60 cm with the mean length at 42.2 cm. The mean length varied widely between 41.4 cm and 43.92 cm. Higher mean lengths were recorded during September to March and the lower during April, May and August.

Food and feeding:

Teleosts formed the major food item in the stomachs of S.guttatus examined. Food consisted mainly of sardines (*Sardinella* spp., *Dussumerei* sp.), small mackerel (*Rastrelliger* spp), scads (*Decapterus* spp), ribbonfish (*Trichiurus* spp) and anchovies (*Stolephorus* sp.). Anchovies, scads and sardines were observed in the gut in almost all the months of observation. Other telosts observed occasionally in the gut included smallpelagics viz. *Thryssa* sp. *Pellona* sp., and Chirocentrus sp. *Leiognathids, Percoids* and *Upeneus* sp., were observed in the diet rarely. Crustaceasns formed the second important food item in the gut. These mainly included *Acetus* sp., Megalopa larva, penaeid prawns and Alima larvae.

Length-weight relationship

The length-weight relationship was estimated using 669 length-weight measurements. Separate estimates were made for males and females. However, comparison of slopes and of the elevations of males and females gave F-values that were not significant at 1% and 5% levels. Hence the length-weight data were pooled and the pooled length-weight estimated relationship was: log W = -1.8181362 + 2.888425 log L (r = 0.985) Growth was allometric where the weight increase was slower than 3; relative to the increase in length (Fig 3).

Growth:

The growth parameters in the von Bertalanffy equation were estimated. The L_∞ and K obtained through ELEFAN I were 61.27 cm and 1.4 per year respectively. Powell and Wetherall plot too gave a similar value for L_∞ (60.19 cm). The growth performance index Ø was 3.721 and t_0 was calculated at -0.0046 years. The length at first capture (L_c) was 21.05 cm, which corresponded to an age (t_c) of 0.296 year. The von Bertalanffy growth equation was:

$$Lt = 61.27\ [1 - e^{-1.4\ (t + 0.0046)}]$$

The fish attained a fork length of 46.3 cm and 57.6 cm at the end of 1 and 2 year respectively. Longevity estimated was 2.14 years. The fishery was dominated by fishes of 0 year and 1 year classes. The asymptotic weight (W_∞) estimated from the length-weight relationship was 2209 g.

A unimodal recruitment pattern was observed with young ones being recruited into the fishery for most months of the year. The peak recruitment was in the months from February to July and this pulse produced on an average 92.44% of the recruits. The smallest length of recruitment was 20.95 cm.

The mortality rates M, F and Z computed were 1.79, 2.92 and 4.71, respectively. The exploitation rate was 0.614 and exploitation ratio was 0.62. E_{max} is 0.544 which is smaller than present exploitation, indicating overexploitation of this species.

Discussion

Catch of seerfish exhibited annual fluctuation with a declining trend. The year 2011 recorded higher catch as compared to the previous year but total seerfish catch as well as the catch of *S.guttatus* over the study period showed a declining trend. Pelagic resources

are known to exhibit seasonal, annual and decadal fluctuations and (Muthiah *et al.*, (2000) and Kasim *et al*., (2002). Muthiah *et al*. (2002) recorded lengths of spotted seer ranging from 16 to 62 cm at Veraval. In the present study, the range was from 20 to 60 cm. The reason for not obtaining smaller fishes may be due to the use of gillnets with larger mesh size Ghosh (2009). The length-weight relationship showed that *S. guttatus* exhibited isometric growth. Similar exponent values for spotted seer were recorded by Devaraj (1981), Naik *et al*. (1998), Abdurahiman *et al*. (2004) and Dutta *et al*. (2012).

The food mainly consisted of fishes followed by crustraceans. Earlier studies carried out by Vijayaraghavan (1955), Rao (1962) and Devraj (1977) have also observed good feeding condition with a dominance of teleost fishes as the major food item.

The L_∞ recorded in this study is similar to the values obtained by Ghosh *et al*. (2009) and comparable to pooled value estimated by Kasim *et al*. (2002) though the authors got higher values of L_∞ from Veraval and Mangalore. Higher L_∞ values of 75.2 cm and 75.5 cm along the east coast at Chennai and Kakinada respectively was reported. This lower value of L_∞ could be because of reduction in average size due to increased exploitation of this species as already suggested by Kasim *et al*., 2002. The growth coefficient of 1.4 per year recorded was also similar to 1.6 reported from Veraval by Kasim *et al*. (2002). The life span of spotted seer observed in the present study is 2-3 years similar to that reported by Devaraj (1987) from Palk Bay and Gulf of Mannar and Ghosh *et al*. from Veraval (2009).

Beverton and Holt (1956) pointed out that the natural mortality coefficient of a fish is directly related to the growth coefficient (K) and inversely related to the asymptotic length (L_∞) and the life span. Accordingly *S. guttatus* which had higher growth coefficient of 1.4 per year and shorter lifespan of 2.14 years was found to have relatively higher natural mortality coefficient of 1.79 per year. The M/K ratio obtained in the present study was well within the normal range of 1- 2.5, as suggested by Beverton and Holt (1959). As a rule the Z/K ratio of 1.0 is considered as growth dominated and if it is more than 2, then it is mortality dominated. In the present study, it was more than 3, which showed that the fishery of *S. guttatus* was mortality dominated. Kasim *et al.* (2002) and Ghosh *et al*. (2009) observed a similar pattern along the northwest region and at Veraval in particular. The exploitation ratio indicated higher level of exploitation in the present study. The

results in the present study indicated that *S.guttatus* at present is exploited above the optimum desired level and requires detailed study of the stock to come up with suitable management measures to maintain the stock at healthy levels.

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Figures

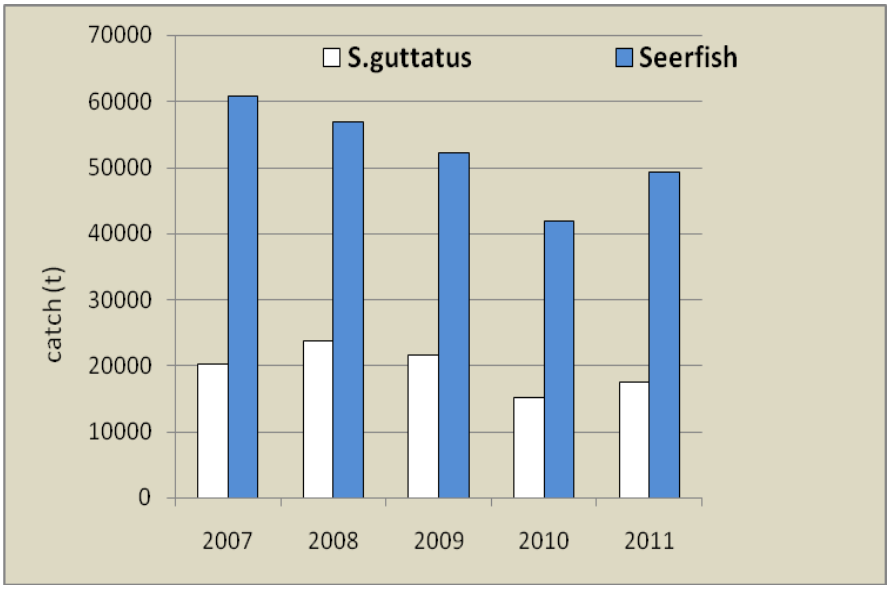

Fig.1. Annual seerfish and *S.guttatus* landings in India during 2007-2011.

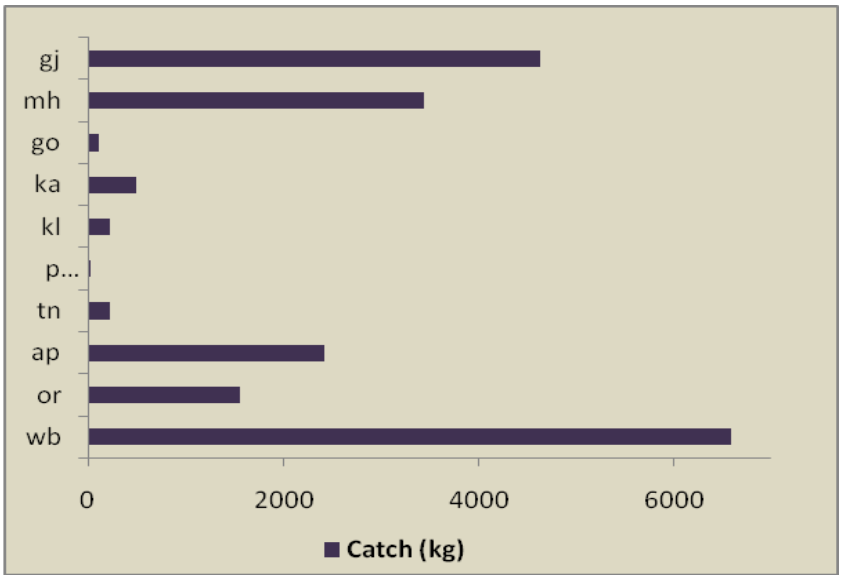

Fig.2. Average annual estimated landing *S.guttatus* in different maritime states of India

(*gj-Gujarat, mh-Maharashtra, go-Goa, ka-Karnataka, kl-Kerala,p-Puducherry, tn-Tamilnadu, ap-Andhra Pradesh, or-Orissa, wb-West Bengal*)

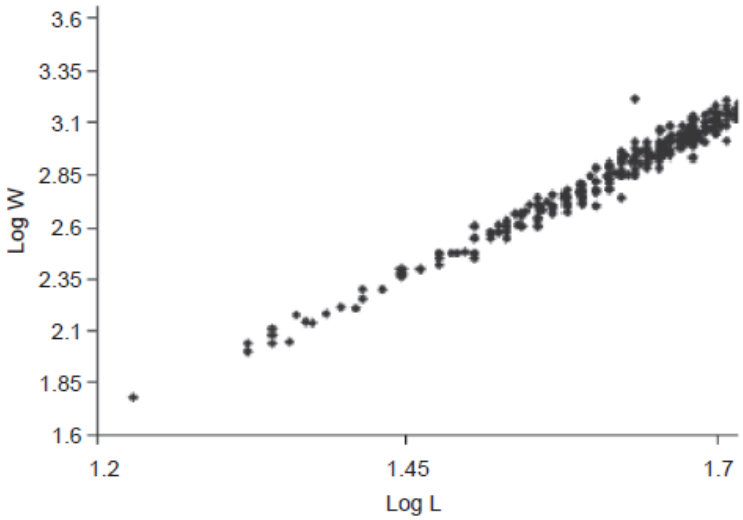

Fig. 3. Length-weight relationship of *S.guttatus*