

Fishery, population dynamics and stock assessment of the spotted seer in gill net fishery at Veraval

SHUBHADEEP GHOSH, N. G. K. PILLAI AND H. K. DHOKIA

Veraval Regional Centre of Central Marine Fisheries Research Institute

Matsya Bhavan, Bhidiya, Veraval – 362 269, Gujarat, India

e-mail: subhadeep_1977@yahoo.com

ABSTRACT

The fishery and population characteristics of *Scomberomorus guttatus* (Bloch & Schneider) from Veraval was studied for the period 2003 – 2006. The average annual catch was 378 t, forming 14.4% of the total gill net catches at Veraval. The post-monsoon and winter seasons (September to January) were the most productive seasons in terms of catch and catch rate. The length–weight relationship showed that growth was isometric for the species. 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 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. The maximum sustainable yield was 305 t, which was lower than the average annual catch indicating over-exploitation of the species. The yield per recruit and biomass per recruit was 198.9 g and 66.9 g respectively. An increase in relative yield to 101.8% would be obtained by decreasing the present level of fishing by 20%.

Keywords: Fishery, Gill netters, Population dynamics, *Scomberomorus guttatus*, Stock assessment, Veraval.

Introduction

Gujarat being the leading seerfish producing state in India, lands roughly a quarter of the total catch of the country (Muthiah *et al.*, 2002). The annual average catch of seerfish in the state during 2002-2006 was 0.07 lakh tonnes (Mohanraj *et al.*, 2007). However, Kasim *et al.* (2002) recorded much higher average catch of 0.13 lakh tonnes during 1995-1999. The fishery assumes greater importance owing to their higher economic value. Part of the catch is consumed afresh and the remaining is frozen and exported. The fishery is dominated by the spotted seer *Scomberomorus guttatus*, the rest being constituted by the king seer *Scomberomorus commerson*, streaked seer *Scomberomorus lineolatus* and the wahoo *Acanthocybium solandri*.

There is only limited information available on the fishery and stock assessment of the spotted seer landed at Veraval (Kasim *et al.*, 2002) by gill netters. Therefore a need was felt to assess the fishery and the status of the stock so as to optimize yield through rational exploitation.

Materials and methods

Data on catch and effort expended for *S. guttatus* were collected weekly from commercial gill netters of Veraval for four years during 2003 - 2006. A total of 5,418 specimens

of *S. guttatus* in the size range of 20 to 59.9 cm, collected randomly were used for recording fork length and body weight. The length-weight relationship of *S. guttatus* was calculated as in Le Cren (1951).

Growth parameters *viz.*, asymptotic length (L_∞) and growth co-efficient (K) were estimated using the ELEFAN I module of FiSAT software and the Powell – Wetherall plot (Gayaniilo *et al.*, 1996). The length based growth performance index ϕ 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 (t_0) 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). Length structured virtual population analysis (VPA) was used to obtain fishing mortalities per length class. 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.

Total stock (P) and biomass (B) were estimated from the ratios Y/U and Y/F respectively; where Y is the annual

average yield in tonnes. Maximum sustainable yield was calculated as in Gulland (1979) for exploited fish stocks. The relative yield per recruit (Y'/R) and biomass per recruit (B'/R) at different levels of F was estimated using LFSA package (Sparre, 1987).

Results

Fishery

The average annual catch of *Scomberomorus guttatus* during 2003 – 2006 was 378 t; forming 14.4% of the total gill net catches at Veraval. Eighty five percentage of the seer fish landed at Veraval was constituted by *S. guttatus*. The annual catch fluctuated between 326 t in 2004 and 431 t in 2006 (Fig. 1). The effort expended by gill netters during the period increased from 18,616 units in 2003 to 21,661 units in 2006. The average catch rate during the period was 19.7 kg unit⁻¹. The catch rate on the contrary, exhibited a decreasing trend over the years with the lowest of 16.3 kg per unit in 2005 and the highest of 22.1 kg per unit in 2003. The contribution of *S. guttatus* to the total gill net landings and their representation in the total seer fish catch also decreased over the years.

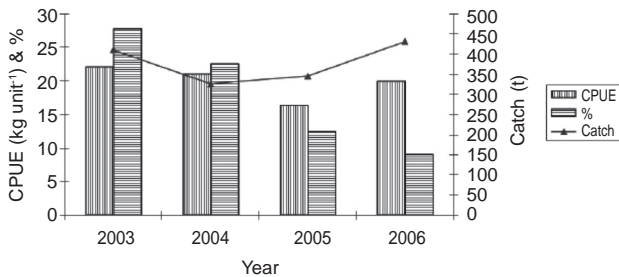


Fig. 1. Annual catch of *S. guttatus* by gill netters at Veraval

Seasonal abundance

The spotted seer supported the fishery round the year with post-monsoon and winter season (September to January) being the most productive in terms of catch and catch rate (Fig. 2). This could be attributed to the increase in the operational units of gill netters during this season. The average monthly catch and catch rate was highest in October (106 t and 35.26 kg per unit) and lowest in June (0.04 t and 0.08 kg per unit). Similarly, the average month-wise contribution of *S. guttatus* to the total gill net landings was maximum in October (36.3%) and minimum in June (0.1%).

Length composition

The mean length of *S. guttatus* varied widely between 41.4 cm in 2005 and 43.92 cm in 2003. The higher mean lengths were recorded during September to March and the lower during April, May and August (Fig. 3).

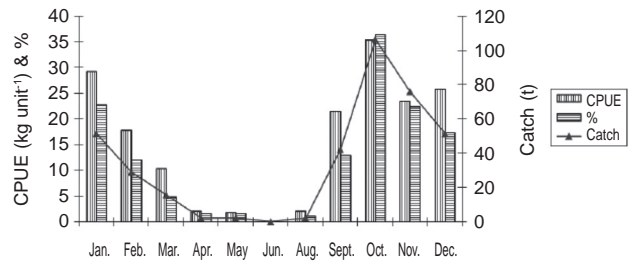


Fig. 2. Seasonal abundance of *S. guttatus* at Veraval

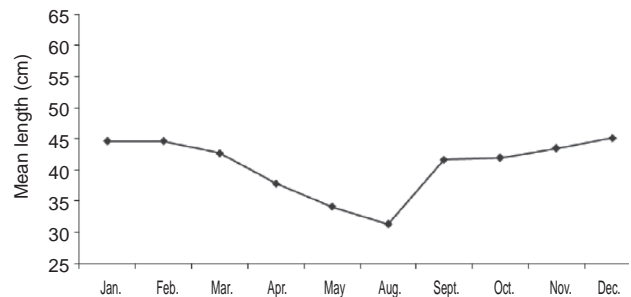


Fig. 3. Average monthly mean length of *S. guttatus* landed by gill netters at Veraval

Length-weight relationship

The length-weight relationship was estimated using 339 length-weight measurements. The estimated relationship was: $\log W = -1.8181362 + 2.888425 \log L$ ($r = 0.985$) (Fig. 4)

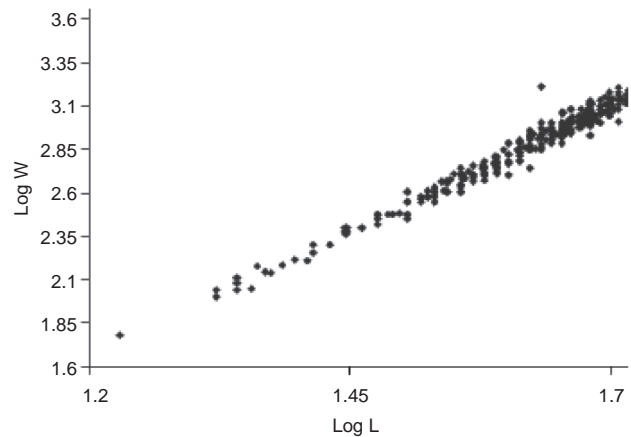


Fig. 4. Length-weight relationship of spotted seer landed at Veraval

Growth

The estimates of the growth parameters L_{α} and K obtained through ELEFAN I were 61.27 cm and 1.4 per year, which was more or less close to the value (L_{α} - 60.19 cm) obtained from the Powell – Wetherall plot. The growth performance index ϕ 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:

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

The relationship showed that they grew to 46.3 cm and 57.6 cm at the end of 1 and 2 year respectively. Their longevity was estimated as 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.

Recruitment pattern

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.

Mortality, exploitation and VPA

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 over-exploitation of this species.

Virtual population analysis indicated that main loss in the stock up to 30.9 cm size was due to natural causes. Fishes became more vulnerable to the gear after this size and mortality due to fishing increased and eventually outnumbered the natural losses from 40.9 cm onwards. The maximum fishing mortality of 3.53 was recorded at size of 56.9 cm.

Estimation of stock and MSY

The annual total stock, biomass and MSY of *S. guttatus* were estimated at 616 t, 130 t and 305 t, respectively.

Yield per recruit

The yield and biomass per recruit and yield and biomass curves showed that the maximum yield and yield per recruit could be obtained by decreasing the present level of fishing by 20% (Fig. 5 and 6). The maximum yield and yield per recruit obtained at 80% of the present fishing effort is 385.0 t and 198.9 g, whereas at the present level of fishing, it is 378 t and 195.4 g. The biomass and biomass per recruit achieved at 80% of the present effort is 164.8 t and 85.1 g, respectively but with the present rate, the biomass and biomass per recruit is a low 130 t and 66.9 g. The relative yield would be 101.8% at the reduced effort. However since at 80% of the present level of fishing the increase in yield would be only a slender 1.8%, no reduction in effort was prescribed.

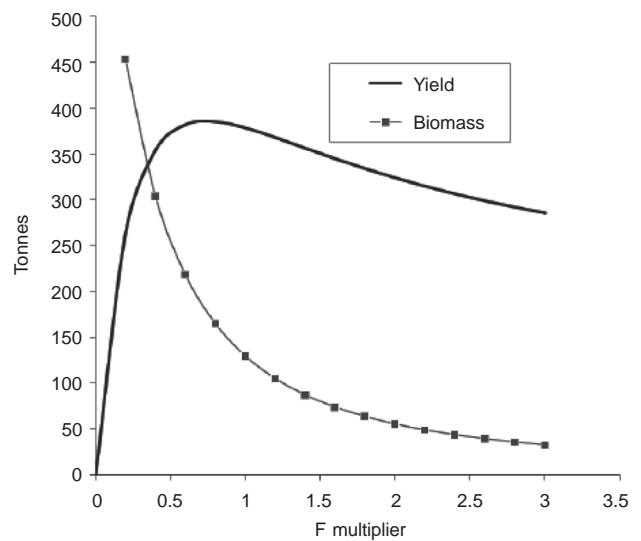


Fig. 5. Yield and biomass of *S. guttatus* for different multiples of F

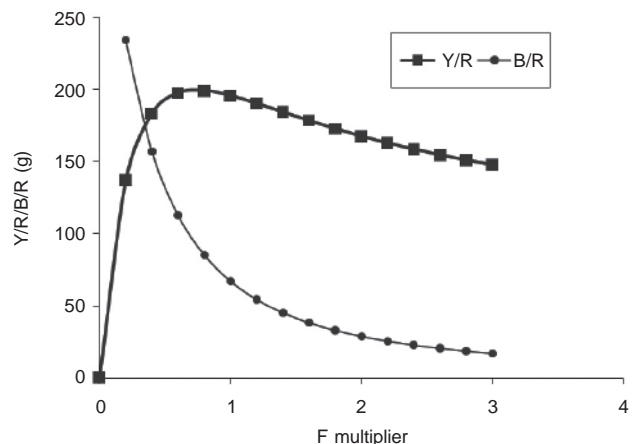


Fig. 6. Yield per recruit and biomass per recruit of *S. guttatus* for different multiples of F

Discussion

Though there was a marginal increase in catch of spotted seerfish in 2006 from that of 2003, the catch rate and its percentage contribution in gill net landings decreased over the same period. This marginal increase in catch could be attributed to the increased fishing effort in this period. In recent years, increased abundance of coastal tunas and king seer has resulted in fishermen increasing the mesh size of surface drift gill nets from 85–90 mm to 110–115 mm which might have contributed to the decrease in catch rate.

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 58 cm, which further supports

the fact that there has been an increase in the mesh size of surface drift gill nets resulting in less exploitation of juveniles in recent years. The length-weight relationship showed that *S. guttatus* exhibited isometric growth. Similar exponent values of 2.86 and 2.82 for spotted seer were recorded by Devaraj (1981) and Naik *et al.* (1998).

The L_{α} recorded in this study (61.27 cm) is similar to 65 cm recorded by Kasim *et al.* (2002) from Veraval and Mangalore. However the same authors recorded much higher L_{α} values of 75.2 cm and 75.5 cm along the east coast at Chennai and Kakinada respectively. This lower value of L_{α} could be because of reduction in average size due to increased exploitation of this species. 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.

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.

The present exploitation ratio being more than the E_{\max} and the annual average catch higher than the MSY is an indication of intensive fishing of this species. Decreasing the present level of fishing by 20% would result in optimum yield and biomass per recruit. However since at the reduced effort the increase in yield would be only a slender 1.8%, no reduction in effort was prescribed. It is therefore concluded that the resource at present is marginally over-exploited above the optimum without warranting any immediate management measures.

Acknowledgements

The authors express their gratitude to Dr. G. Syda Rao, Director, CMFRI; Dr. G. Mohanraj, former SIC, VRC of CMFRI; Dr. E. M. Abdussamad, Senior Scientist, CMFRI and Dr. P. K. Asokan, Senior Scientist, VRC of CMFRI.

References

- Beverton, R. J. H. and Holt, S. J. 1956. A review of method for estimating mortality rates in exploited fish population, with special reference to source of bias in catch sampling. *Rapp. P. – V. Reun. CIEM*, 140: 67-83.
- Beverton, R. J. H. and Holt, S. J. 1959. A review of the lifespans and mortality rates of fish in nature and their relation to growth and other physiological characteristics. In: Wolsenholmy, G. E. W. and O'Connor, M. (Eds.), *Ciba Foundation Colloquia on ageing*, 5: 142-180.
- Devaraj, M. 1981. Age and growth of three species of seerfishes *Scomberomorus commerson*, *S. guttatus* and *S. lineolatus*. *Indian J. Fish.*, 28: 104-127.
- Devaraj, M. 1987. Maturity, spawning and fecundity of the spotted seer, *Scomberomorus guttatus*, in the Gulf of Mannar and Palk Bay. *Indian J. Fish.*, 34(1): 48-77.
- Gayanilo, F. C. Jr., Sparre, P. and Pauly, D. 1996. The FAO-ICLARM Stock Assessment Tools (FiSAT) User's Guide. *FAO computerized information series (Fisheries)*. Rome, FAO, 126 pp.
- Gulland, J. A. 1979. *Report of the FAO/UNDP workshop on the fishery resources of the Western Indian Ocean – South Equator*. FAO, Rome, 10FC/DEV/79/ 45: 1-37.
- Kasim, H. M., Muthiah, C., Pillai, N. G. K., Yohannan, T. M., Manojkumar, B., Said Koya, K. P., Balasubramaniam, T. S., Bhatt, U. S., Elayathu, M. N. K., Manimaran, C. and Dhokia, H. K. 2002. Stock assessment of seerfishes in the Indian seas. In: Pillai, N. G. K., Menon, N. G., Pillai, P. P. and Ganga, U. (Eds.), *Management of Scombroid Fisheries*, Central Marine Fisheries Research Institute, Cochin, p. 108-124.
- Le Cren, E. D. 1951. The length-weight relationship and seasonal cycle in gonad weight and condition in the perch *Perca fluviatilis*. *J. Anim. Ecol.*, 20: 201-219.
- Mohanraj, G., Nair, K. V. S., Asokan, P. K. and Ghosh, S. 2007. Status of marine fisheries in Gujarat with strategies for sustainable and responsible fisheries. *Book of Abstracts, 8th Asian Fisheries Forum*, Central Marine Fisheries Research Institute, India, 85 pp.
- Muthiah, C., Kasim, H. M., Pillai, N. G. K., Yohannan, T. M., Manojkumar, B., Said Koya, K. P., Bhatt, U. S., Balasubramaniam, T. S., Elayathu, M. N. K., Manimaran, C., Dhokia, H. K. and Somaraju, M. V. 2002. Status of exploitation of seerfishes in the Indian seas. In: Pillai, N. G. K., Menon, N. G., Pillai, P. P. and Ganga, U. (Eds.), *Management of Scombroid Fisheries*, Central Marine Fisheries Research Institute, Cochin, p. 33-48.
- Naik, S. K., Tiburtius, A. and Bhalkar, S. R. 1998. Biology of the seerfish landed by exploratory trawlers. *Indian J. Fish.*, 45(1): 35-41.
- Pauly, D. 1979. Theory and management of tropical multi-species stocks. A review with emphasis on the south-east Asian demersal fisheries. *ICLARM Studies and Reviews* 1: 35 pp.

- Pauly, D. 1980. On the interrelationships between natural mortality, growth parameters and mean environmental temperature in 175 fish stocks. *L. Cons. Ciem.*, 39 (2): 175-192.
- Pauly, D. 1983a. Some simple methods for the assessment of tropical fish stocks. *FAO Fish. Tech. Pap.*, 243: 52 pp.
- Pauly, D. 1983b. Length converted catch curves. A powerful tool for fisheries research in tropics (Part-1). *ICLARM Fishbyte*, 1(2): 9-13.
- Pauly, D. 1984. Length converted catch curves. A powerful tool for fisheries research in tropics (Part-II). *ICLARM Fishbyte*, 2 (1): 13-14.
- Pauly, D. and Munro, J. L. 1984. Once more, on the composition of growth in fish and invertebrates. *Fishbyte*, 2 (1): 21.
- Sparre, P. 1987. Computer programming for fish stock assessment. Length based fish stock assessment (LFSA) for Apple computers. *FAO Fish. Tech. Pap.*, 101 (Suppl: 2), 217 pp.