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Estimating Growth and Mortality Parameters of Narrow-Barred Spanish Mackerel (*Scomberomorus commerson*) in the Iranian Waters of the Persian Gulf and Oman Sea

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Abstract

Scombermorus commerson is one of the most important and commercial species in the Persian Gulf and Oman Sea. In order to adopt the responsible fishing patterns, it was necessary to estimate population dynamic parameters. Samples were collected randomly from five major traditional fish-landing sites in Chabahar, Jask, Bandar Abbas, Bandar Lengeh and Parsian in the north of the Persian Gulf and Oman Sea from October 2005 to September 2007. The average length of fork was 79.20 ±26.05 cm. The growth parameters of L_∞ and K were 175.26 (cm) and 0.45 (1/ year), respectively. Growth performance index (ǿ) was 4.1. Total mortality, natural mortality, fishing mortality and exploitation rate were 1.98, 0.5, 1.48 (1/year) and 0.74, respectively.

Keywords: *Scombermorus commerson , Growth &mortality parameters ,Length frequency , Persian Gulf, Oman Sea.*

1. Introduction

The Narrow- barred Spanish mackerel (*Scomberomorus commerson*) (Lacepe`de, 1800) belongs to the family Scombridae under the order Perciformes. It is an epipelagic predator distributed widely in the Indo-Pacific waters from the Red Sea and South Africa to the Southeast Asia, in the north to China and Japan and south to Australia (Randall, 1995). Narrow- barred Spanish mackerel commonly known as kingfish is a highly valued pelagic fish caught seasonally along the Iranian waters of the Persian Gulf and Oman Sea. The peak season of the fishing is between October and June. This seasonality is linked with the occurrence of a migratory movement of this species from the Arabian Sea towards the Persian Gulf in September and in the opposite direction around April (FAO, 1989).

Small juveniles up to 10 cm fork length live in creeks, estuaries and sheltered mud flats during the early wet season (McPherson, 1981). Large adults may be solitary, whereas juveniles and young kingfish occur in small schools (Collette, 2001). It reaches a maximum size of 240 cm fork length and maximum weight of 70.0 kg (McPherson, 1992). Ageing studies of this species in Western Australia suggest that it has longevity of 22 years (Mackie et al., 2003).

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The *S. commerson* catch in the southern waters of Iran fluctuated from 3939 metric tons in 1997 to 8778 metric tons in 2006 or 6% of the total production of large pelagic fishes. Most artisanal fleets use drift gillnets with mesh size of 95 and 120 mm for fishing *S. commerson* (Kaymaram et al., 2010).

Some studies on population dynamics and biological characteristics of *S. commerson* were carried out by Dudley et al., (1992), Edwards et al. (1985), Pillai *et al.* (1993),Taghavi Motlagh and Ghodrati Shojaei, 2009 and Kaymaram et al., (2010) in the Persian Gulf and Oman Sea.

This study was conducted to provide useful data on population dynamic parameters of *S. commerson* in the Persian Gulf and Oman Sea as the basis for the management and sustainable exploitation.

2. Material and Methods

Length frequency data was collected randomly from five traditional fish-landing sites: Chabahar, Jask, Bandar Abbas, Bandar Lengeh and Parsian in the north of the Persian Gulf and Oman Sea (Figure 1), from October 2005 to September 2007.

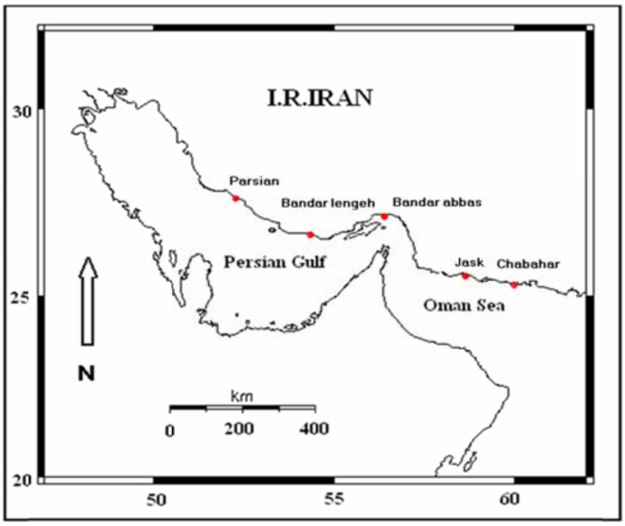

Fig. 1: Landing sites for sampling of *S. commerson* in the Persian Gulf and Oman Sea

The fishes were measured to the nearest cm (fork length). The length frequencies were grouped in 3 cm intervals (Gayanilo et al., 1996). The total sample size was 1995 speciemen.

The Von Bretalanffy growth equation was used for length infinity estimation:

$L_t= L_\infty$ [1-exp (-K (t-t_0))] (Sparre and Venema, 1998).

Growth parameters (K, L_∞) and total mortality (Z) were estimated by FiSAT II software (FAO-ICLARM STOCK ASSESSMENT TOOLS) (Gayanilo *et al.*, 1996) with using Shepherd and length- converted catch curve methods.

In order to compare results of this study with other studies, the growth performance index (ǿ) was estimated as follows:

ǿ = Log (K) + 2 Log (L_∞) (Pauly and Munro, 1984)

Natural mortality coefficient (M) was calculated with the equation of Pauly (1980) (multiplied by 0.8). Since, pelagic species are considered schooling migratory fish (Pillai et al., 1993) following equation was used:

Log M= 0.0066-0.279 Log L_∞ + 0.6543 Log K+ 0.4634 Log T

Where T is the mean temperature of surface water, (270 C) (Kaymaram et al., 2010).

3. Results

A total of 1995 specimens were collected (Figure 2) ranging in size from 20 to 164 cm. The mean fork length of *S. commerson* was estimated as 79.20±26.05 cm , with the highest abundance in 8o-83 cm length range (Figure 2).

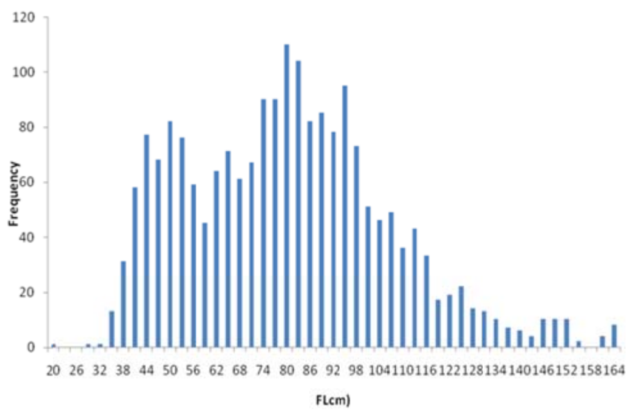

Fig. 2: Fork length frequency of *S. commerson* in the Persian Gulf and Oman Sea

The K-scan technique indicated an L_∞ of 175.26cm FL and a K value of 0.45 $year^{-1}$ for the original data set (Figures 3 and 4). The growth performance index (ǿ) was estimated as 4.1.

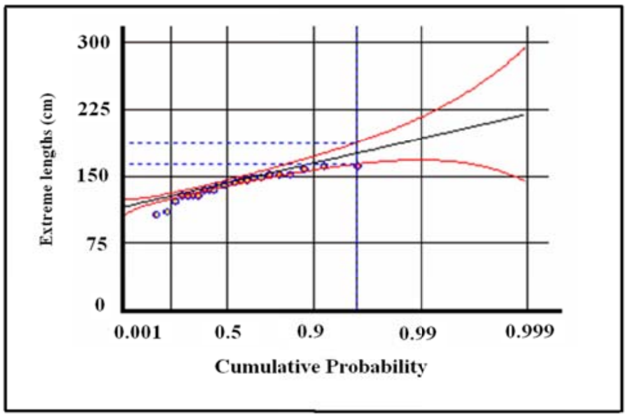

Fig. 3: Cumulative probability graph for estimation Lmax of *S.commerson*

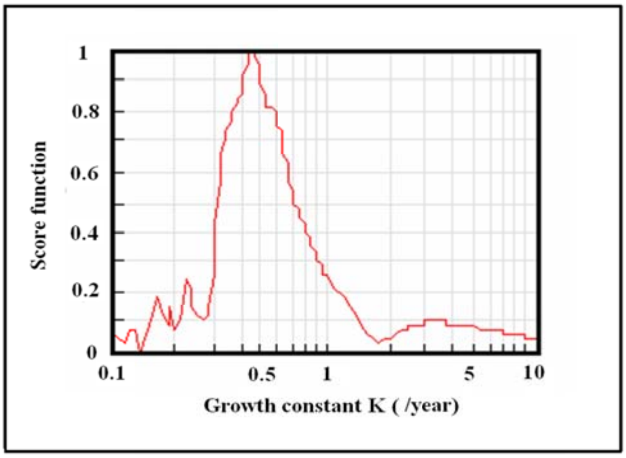

Fig. 4: K-Scan values curve by Shepherd's method and best fitting for *S. commerson*

Total mortality coefficients from length-converted catch curve indicated an annual estimate of 1.83 $year^{-1}$ (Figure 5).

Fig.5. Length-converted catch curve of *S. commerson* in the Persian Gulf and Oman Sea (Z=1.83/year)

The natural mortality coefficient, M, was estimated at 0.5 (Multiplied 0.8). The fishing mortality (F) and exploitation rate (E) were 1.48 $year^{-1}$ and 0.74, respectively. Recruitment pattern graph showed that *S. commerson* had the highest recruitment in August,, September and October in decreasing order, respectively (Figure 6).

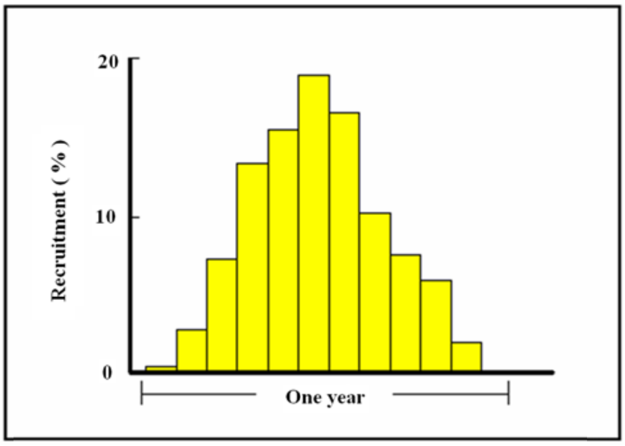

Fig. 6: Recruitment pattern graph of *S. commerson* in the Persian Gulf and Oman Sea

4. Discussion

The values of L_∞ and K were calculated as 175.26 cm and 0.45 $year^{-1}$. Length- frequency analyses using various methods produced a wide range of growth parameter estimates for the same data set, and lead to conflicting management decisions (Dudley et al., 1992).

For *S. commerson*, differences in growth rates between regions indicated stock separations (Devries and Grimes, 1997) which have, in some cases, supported a genetic difference (Begg and Sellin, 1998). In general, the correlated parametric values adjust themselves to provide a similar growth pattern represented by ǿ (Sparre and Venema, 1998). Notably, the ǿ values estimated for North Persian Gulf and Oman Sea stock were comparable to those for other studies of *S. commerson* in the Indian Ocean, suggesting a similar growth pattern in the region. It is, however, interesting to note that growth parameter estimates in Al-Hosni and Siddeek, 1999, giving (ǿ) value 4.1, deviate from the pattern of values 3.6-3.8 (Sumpton & O'Neil, 2004; Edwards et al.,1985).

Although the difference in the growth parameters estimated by earlier authors may be due to the fact that the data used for different analytical methods, were obtained by different gears such as drift gillnets, hooks and lines, troll and trawls (Pillai et al., 1993). More generally, data from neighboring countries which cover the stock migration route may be combined to discern the modal progression of cohorts and hence, derive reliable growth parameter estimates. This emphasizes the need for joint assessment of the shared stock *S. commerson* is one of the fastest- growing fish. Present study showed that *S. commerson* grows very fast in the first 2 years. Life history of *S. commerson* stocks in Oman Sea is comprised of two distinct phases. The first phase is distinguished by extremely rapid growth from the larva stage to 18 months of age. The second phase can be described as the period when growth decelerated considerably. The start of the second phase coincides with the time, at which kingfish reaches age at first reproduction (Claereboudt *et al.*, 2005). This fast growth strategy during the early stage is most vulnerable state to predation, and is typical of large –prey species like *S. commerson* (Begg and sellin, 1998).

Total mortality, natural mortality and fishing mortality were estimated 1.98, 0.5 and 1.48 year^{-1}, respectively. The data set for estimating Z by the length converted catch curve method should satisfy the primary assumption that the stock is in equilibrium (Al-Hosni and Siddeek, 1999). In a declining stock, this assumption may have been violated because of a declining trend in recruitment tends to under estimate Z by some percentage of decline (Al-Hosni and Siddeek, 1999).

Reliable estimate of M can only be obtained for an unexploited stock (Al-Hosni and Siddeek, 1999). In this case, it is equal to Z. Separating M and F from Z in a heavily exploited stock, was a difficult task. Since M is linked with the longevity and the latter to the growth coefficient K, the M/K ratio is found to be constant among closely related species and sometimes within the similar taxonomic groups (Beverton and Holt, 1959). The M/K ratio usually ranges between 1 and 2.5 (Beverton and Holt, 1959). In the present study, the M/K ratio for *S.commerson* was calculated 1.1.

Excessive fishing and inappropriate effort data prevented the use of the total mortality effort relation to estimate M. Therefore, methods based on life history and environmental parameters were used (Pauly equation). Exploitation rate in this study was 0.74. Patterson (1992) observed that the fishing rate satisfying Gulland's optimal E level of 0.5 tended to reduce pelagic fish stock abundance, and hence, suggested that E should be maintained at 0.4 for optimal exploitation of those stocks. Accordingly our estimation, the North Persian Gulf and Oman Sea *S. commerson* stock appears to have been highly exploited during the study period.

Our study showed that *S. commerson* had the highest recruitment in August. Tropical species are known to have recruitment all through the year (Sparre and Venema, 1998). Recruitment of pelagic fishes fluctuates widely in response to both fishing and environmental effects (King, 2005).

Future joint studies and researches should address the issue of migration, particularly during the reproduction season between northern and southern coasts of the Persian Gulf (Hoolihan *et al.*, 2006), in order to improve the current understanding and obtain more reliable indicators for management.

5. Conclusions

It is necessary to immediately impose fishing regulation on the stock, through gradually increasing of the mesh size of the gears or by restricting fishing for certain seasons or declaring fish sanctuaries in certain areas, especially in spawning grounds to protect not only *S. commerson,* but also Scombridae family. Further studies on S. commerson should be conducted in collaboration with countries bordering the Persian Gulf, Oman Sea and Arabian Sea.

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