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Population dynamics parameters of Silver Pomfret *Pampus argenteus* in Iranian waters of the northern Persian Gulf and Oman Sea

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Abstract. *Parsa M, Mahmoudi Khoshdarehgi M, Nekuro A, Pouladi M. 2017. Population dynamics parameters of Silver Pomfret* Pampus argenteus *in Iranian waters of the northern Persian Gulf and Oman Sea. Biodiversitas 18: 633-638.* This research represents population dynamics parameters of *Pampus argenteus* including age, growth and mortality parameters in Iranian waters of the northern Persian Gulf and Oman Sea using length-frequency data. Fork length and total weight data collecting of *P. argenteus* were conducted from April 2014 to March 2015. A total of 1919 specimen were collected ranging from 10 to 32 cm fork length and 35 to 1075 g total weight. The mean length and weight were recorded to be 19.97±0.12 cm and 272.04±7.43 g, respectively. The relationship between fork length and total weight was determined as $W = 0.0231FL^{3.141}$ (R^2=0.9932, n= 643) and indicated that *P. argenteus* grew allometrically in the study region. The Von Bertalanffy growth function estimates were obtained as: $L\infty$ = 32.55 cm, K = 0.3 year^{-1}, t_0=-0.54 years and ϕ'= 2.5. The infinite weight of *P. argenteus* was estimated as 1301.77 g. The annual instantaneous rate of total mortality (Z) was 1.55 year^{-1}, the natural mortality (M) was 0.75 year^{-1} and the fishing mortality (F) was 0.78 year^{-1}. Furthermore, the exploitation rate (E) was calculated as 0.51. Results of the obtained exploitation rate showed that *P. argenteus* was fully exploited in the study region.

Keywords: Growth, mortality, Oman Sea, Persian Gulf, Silver Pomfret

INTRODUCTION

Silver pomfret (*Pampus argenteus* Euphrasen, 1788), belonging to family Stromateidae, is a high valued marine fish inhabiting pelagic waters (Divya et al. 2014). This species is an economically important fishery species which is widely distributed in subtropical regions along the coast of the Indo-West Pacific from the East China Sea to Southeast Asia, Indian Ocean, Persian Gulf and the North Sea (Froese and Pauly 2011; Sun et al. 2012). It is usually found over muddy bottoms in depths between 5 to 80 m and feeds on jellyfish and zooplankton (Carpenter et al. 1997). *P. argenteus* attains a maximum size of about 60 cm (Fischer and Bianchi 1984). It is fished in the waters of the Persian Gulf and Oman Sea by artisanal and local fishers who use different fishing methods and gears such as monofilament drift gillnets and trawls. *P. argenteus* is a prime, valuable and shared fish stock in the northern Persian Gulf between Kuwait and Iran. The fishery of *P. argenteus* characteristically operates in shallow waters of 3 to 10 m on muddy-sandy bottoms (AL-Husaini 2006). This species is a valuable species and has an important role in the fisheries of Iran (Parsamanesh 2001).

Knowledge of growth and mortality parameters is essential for understanding the population dynamics of different species. Various methods such as length-frequency based analyses, tagging and recapture experiments and observations of the mark on the hard parts such as scales, otoliths, spines, and vertebrates were often utilized to ascertain the age and growth of fish (Stequert et al. 1996).

Studies on *Pampus argenteus* in Iranian waters of the Persian Gulf and Oman Sea are principally focused on its biology (Salari 1996), spawning season (Amrollahi et al. 2007), feeding (Dehghani et al. 2008), heavy metals concentration (Mortazavi et al. 2013), distribution patterns (Mohammadkhani and Shirangi 2013) and genetic diversity (Bazrafshan et al. 2014). Since that there is scarce information about the population dynamics characteristics of *P. argenteus* in Iranian waters of the northern Persian Gulf and Oman Sea, therefore, this research aimed to investigate the length frequency structure, length-weight relationship, growth parameters using the length frequency-based method, mortality parameters using the length-converted catch curve and the exploitation rate of *P. argenteus* in Iranian waters of the northern Persian Gulf and Oman Sea.

MATERIALS AND METHODS

Study area and sampling sites

This research was conducted from April 2014 to March 2015 in Iranian waters of the northern Persian Gulf and Oman Sea. Using different fishing gears such as gill nets, trawls and stake nets, monthly fork length data of *P. argenteus* were collected from five major landing sites in an area extending from west to east including Bandar Lengeh (26° 31′N, 54° 51′E), Qheshm island (26° 41′N, 55° 41′E), Bandar Abbas (27° 11′N, 56° 15′E), Sirik (26° 20′N, 57° 05′E) and Jask (25° 39′N, 57° 47′E) (Figure 1).

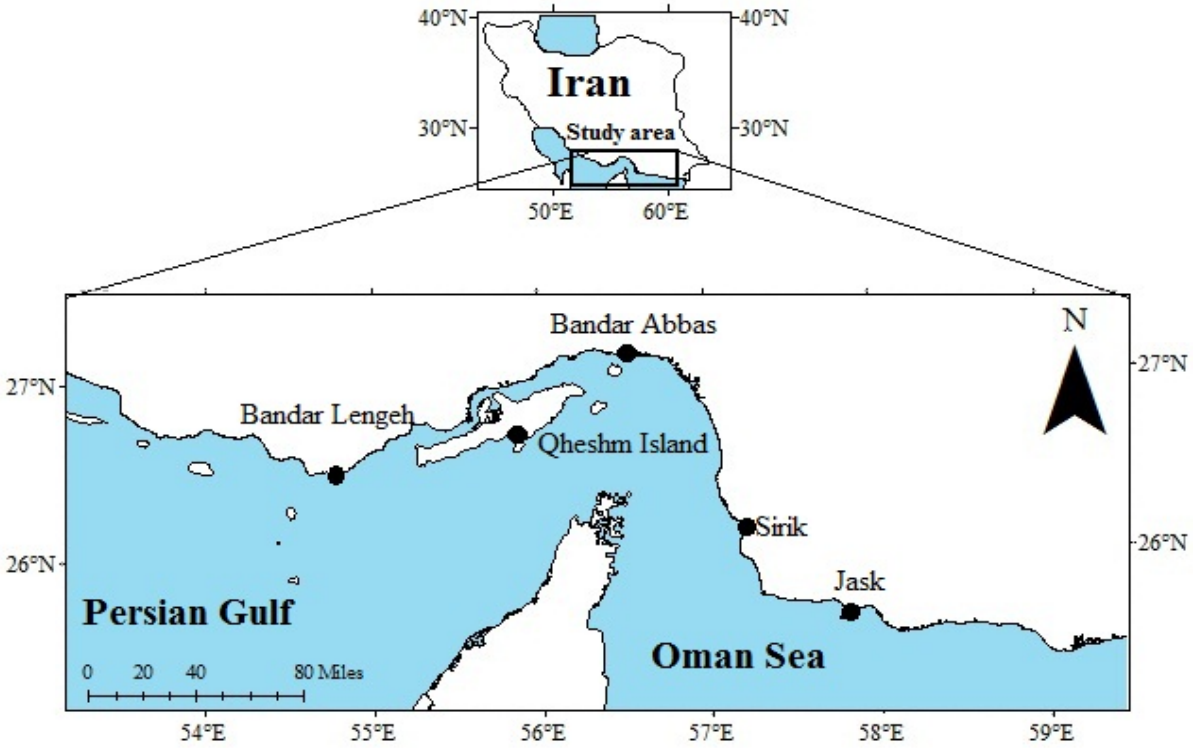

Figure 1. Map of study area along the Iranian waters of the northern Persian Gulf and Oman Sea showing the sampling sites of *P. argenteus*

Procedures

Length frequency and length-weight relationship

Fork length (FL) of all specimens was measured to the nearest 1 cm and total weight (TW) of 643 specimens was measured to the nearest 1 g. The relationship between length and weight was estimated using the equation $TW= aFL^b$ (Jones 2002), where a is a coefficient related to body form, and b is an exponent isometric growth when equal to 3. The parameters a and b were estimated by linear regression on the transformed equation: log W = log a + b log L (Koutrakis and Tsikliras 2003). The best regression parameters (a and b) were obtained by minimizing the residuals errors by the least square residuals method (Haddon 2011). Student's t-test was applied to verify whether the declivity of regression (constant "b") presented a significant difference of 3, indicating the type of growth: isometric (b=3.0), positive allometric (b>3.0) or negative allometric (b<3.0).

Growth parameters

Fork length frequency data was used to calculate the von Bertalanffy growth rate (k) and the asymptotic length ($L\infty$) using the ELEFAN I menu from FiSAT software (Pauly 1984; Gayanilo et al. 1994). The best value of growth parameter (K) for the given value of $L\infty$ was identified by Shepherd's method. The von Bertalanffy growth function was fitted to the data using the following formula (Sparre and Venema 1998):

$$Lt = L\infty (1 - \exp (- K (t - t0)))$$

Where Lt is the length at age t, $L\infty$ is the asymptotic length and t0 represents the theoretical age at length zero. The growth performance index (ϕ') was calculated using the following formulae (Pauly and Munro 1984):

$$\phi' = \log K + 2 \log L\infty$$

The t0 parameter calculated using the proposed empirical equation (Pauly 1983)

$$\text{Log10 } (-t0) = -0.392 - 0.275 \text{Log10} L\infty - 1.038K$$

The following formulae were used to determine the age-weight relationship and $w\infty$ (Haddon 2011):

$$\hat{w}_t = w_\infty \left[1 - e^{-k[t - t_0]}\right]^b$$

Where $w\infty$ is the calculated infinite weight and b is the regression coefficient derived from length-weight relationship equation. Data analysis was done by Microsoft Excel, FiSAT Program, and SPSS 19 software.

Mortality parameters and Exploitation rate (E)

The length-converted catch curve was utilized for the calculation of the instantaneous annual mortality rate (Z)

(Pauly 1983). The natural mortality (M) was calculated by Pauly's empirical equation:

$$\log M = 0.1228 - 0.192 \log L\infty + 0.7485 \log k + 0.2391 \log T$$

Where: T = the mean annual temperature (in °C), which is assumed to reflect the sea surface temperature in the survey area (Pauly 1984). In this study, the mean annual temperature of sea surface was considered as 27 °C (Ebrahimi, 2006).

Fishing mortality calculated by subtracting the natural mortality from the instantaneous annual mortality (F = Z – M) (Appeldoom 1984). The exploitation rate (E) was calculated using the following formulae (Gulland 1985):

$$E = F / Z$$

RESULTS AND DISCUSSION

This study has investigated the population dynamics parameters of *P. argenteus* as one of the most important fish species in the Iranian waters of the northern Persian Gulf and Oman Sea. The length-frequency based analysis is used widespread, particularly in the tropical and subtropical regions. This method becomes important when other aging methods are either not possible or very expensive (Wang and Ellis 2005). According to Zhu et al. (2011), the study of growth using length-frequency data analysis has long been the most frequently used method.

Gulland and Rosenberg (1992) noted that a sample of 50-150 fish/ month and an annual sample of 1000-1500 fish provide the most reliable image on the biological condition of a specific species. In order to have a most reliable understanding on the population dynamics parameters of *P. argenteus*, sampling was done in five landing sites and covered 12 months (160 fish/ month).

Figure 2 shows the fork length frequency distribution of *P. argenteus* in the study area and the biometric data including sample size, minimum, maximum and mean length and weight are presented in Table 1. Fork length of 1919 specimens was ranged between 10 to 32 cm and the total weight was ranged between 35 to 1075 g. The mean fork length and total weight were obtained as 19.97±0.12 cm and 272.04±7.43 g, respectively.

The fork length frequency distribution of *P. argenteus* showed that the minority of catch was in 30 to 32 cm length class (0.46%), and the majority of catch ranged between 22 to 24 cm length class (about 17%).

The length range and maximum weight of *P. argenteus* from Khuzestan Province (northwest the Persian Gulf) have been calculated previously as 95 to 312 mm and 1191 g, respectively (Amrollahi et al. 2011), that is in agreement with our findings. Mohammadkhani and Shirangi (2013) reported the length frequency range of *P. argenteus* as 15-35 cm fork length.

Length-weight relationship estimates are very helpful in fishery management and stock assessment models (Barría et al. 2014), and has been widely used in the environmental monitoring programs such as calculation of fish weight at a certain length, conversion of an equation of growth in weight (Yoon et al. 2013; Oliveira et al. 2014). The relationship between fork length and total weight of *P. argenteus* is given in Figure 3. The relationship between fork length and total weight was determined to be $W = 0.0231FL^{3.141}$ (R^2=0.9932, n= 643). The b value for many fish species was found between 2.5 and 4 and a value close to 3 indicates that the fish grows isometrically (Biswass 1993). Based on obtained b=3.141 (b>3), we determined a positive allometry growth model for *P. argenteus* (P<0.05).

Mohammadkhani and Shirangi (2013) reported the length-weight relationship of *P. argenteus* as $W = 0.0091FL^{3.3641}$ (R^2= 0.9415) in Oman Sea, indicating a perfect allometric growth pattern that is agreement with the results of our research. Various factors such as sexual dimorphism (Artigues et al. 2003), period of year and stage of maturity (Weatherley and Gill 1987), water quality or food availability on fish growth (Mommsen 1998) and sampling procedure (sample size and length range) (Ecoutin and Abaret 2003) can affect b values and Length-weight relationships of fish species.

The growth curve for *P. argenteus* is shown in Figure 4. Using ELEFAN I method in FiSAT software, the Von Bertalanffy growth parameters were calculated as L_∞ = 32.55 cm, t_0 = -0.54 year, ϕ'= 2.5. The k value was 0.3 $year^{-1}$. Growth comparison of fish based on K or L∞ parameters is misleading (Pauly 1984), and some authors (Pauly and Munro 1984) have proposed overall growth performances (ϕ') based on the two parameters L∞ and K, because these are correlated and produced by growth rates that are constantly changing with time and size. Figure 5 shows the relationship between age and weight of *P. argenteus* in the study area. The infinite weight of *P. argenteus* was estimated as 1301.77 g.

The L∞ estimated in present research for *P. argenteus* is higher than the estimates given by some previous research (Dwiponggo et al. 1986; Mustafa 1993), lower than other research (Parsamanash et al. 2003; Salari 1996; Mohamed 2008; Lee et al. 1992), but completely similar to findings of Morgan (1985) in Waters of Kuwait (L∞=32.5 cm). Amrollahi et al. (2011) estimated the L∞ of *P. argenteus* as 33.9 cm during one year in the northern Persian Gulf that is relatively comparable with the obtained L∞ in the present study.

Differences in the growth parameters estimated in other researchers are due to the data used for different analytical methods were obtained by different fishing methods such as gill nets, hooks and lines, purse seines and trawls (Pillai et al. 2002). Taghavi Motlagh et al. (2010) stated that different values of L∞ and k might be associated with sampling error, variation in fishing intensity or environmental conditions. Moreover, slight differences in growth patterns can be the results of differences in genetic structure, differences in temperature, density of food and diseases (Wootton 1998). Age frequency distribution of *P. argenteus* is shown in Figure 6. Age composition was included of 10 age groups (from year 1 to 10) and mean age was 2.97±0.03. Age 3 was the largest age group and constituted 24.67% of the total sampled specimen.

Table 1. Biometric data of *P. argenteus* in the study area

Biometric parameter	Number	Min.	Max.	Mean±S.E
Fork length (cm)	1919	10	32	19.97±0.12
Total weight(g)	643	35	1075	272.04±7.43

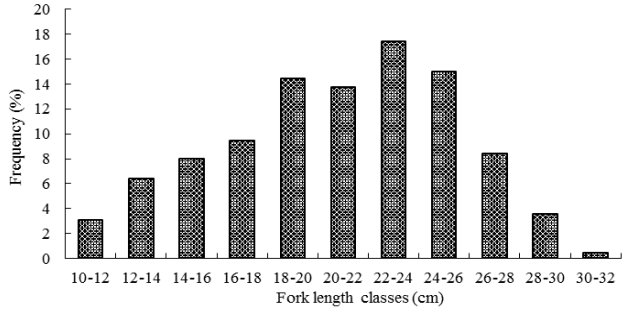

Figure 2. Fork length frequency distribution of *P. argenteus* in study area

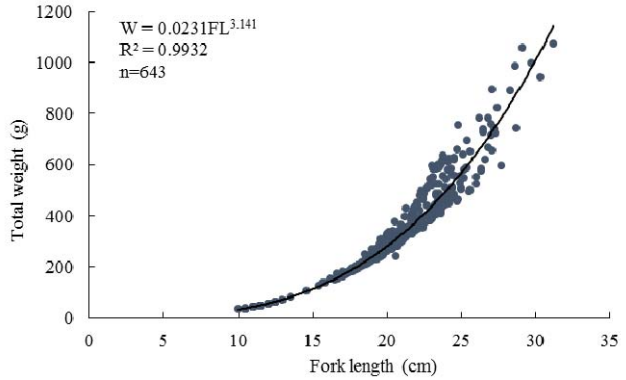

Figure 3. Length-weight relationship of *P. argenteus* in study area

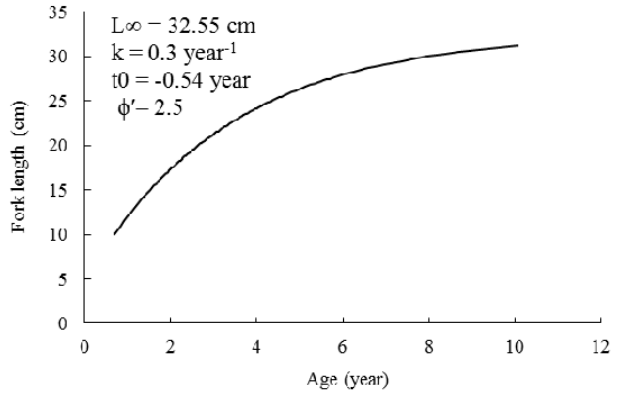

Figure 4. Growth curve of *P. argenteus* in study area

Figure 5. Relationship between age and weight of *P. argenteus* in study area

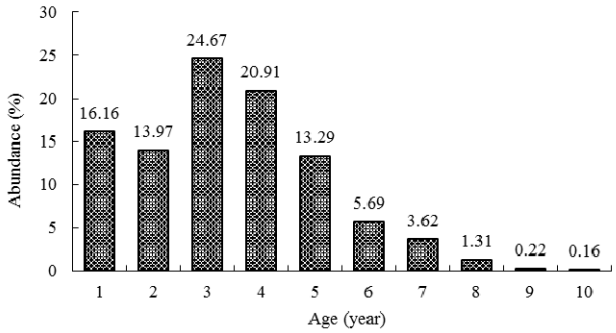

Figure 6. Age frequency distribution of *P. argenteus* in study area

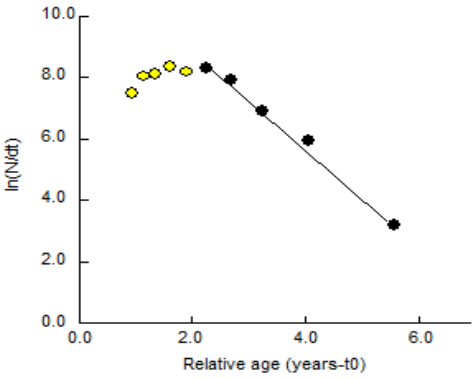

Figure 7. Length-converted catch curve of *P. argenteus* in study area

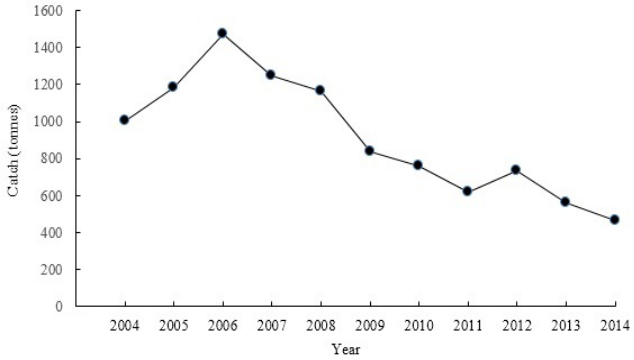

Figure 8. Trends in catch amount of *P. argenteus* in study area, northern Persian Gulf and Oman Sea

The length-converted catch curve of *P. argenteus* is shown in Figure 7. The estimated rates of total mortality (Z) and natural mortality rate (M) were 1.55 year^{-1} and 0.75 year^{-1}, respectively. The fishing mortality (F) was 0.78 year^{-1}. The exploitation rate (E) was calculated as 0.51. The exploitation rate for the population of *P. argenteus* (E=0.51) in the present study was high. It is stated that in an optimally exploited stock, fishing mortality should be equal to natural mortality, resulting in an exploitation rate of 0.50 (Guland 1985). Moreover, it is declared that the fishing rate satisfying optimal E level of 0.5 tended to reduce fish stock abundance and E should be maintained at 0.4 for optimal exploitation of those stocks (Patterson 1992).

It is declared that *P. argenteus* is one of the most important commercial species account for a very small proportion of the total catch in the Persian Gulf and Oman Sea (Valinassab et al. 2006). The decrease of *P. argenteus* catch amount due to overexploitation suggest that fishing was affecting community structure of this valuable species (Figure 8). The calculated exploitation rate suggests that the population of *P. argenteus* in Iranian waters of the northern Persian Gulf and Oman Sea is being overexploited and overfished at a higher level than the optimum and a better management policy is necessary for this area.

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