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Population biology and assessment of Deep flounder *(Pseudorhombus elevatus* ogilby, 1912) in northwest of Persian Gulf (Khuzestan Coastal Waters, Iran)

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ABSTRACT: Length composition data of Deep flounder (Pseudorhombus elevatus) landed between April 2009 to March 2011 in Coastal Waters of Iran (Persian Gulf), were monthly used to estimate the Population biology and assessment of the stock. The growth parameters of von Bertalanffy equation were as, L_∞: 42 cm and K: 1 per year and t_0: -0.14 year, **Φ'**: 3.24 respectively. The estimated valve of total mortality, natural mortality, fishing mortality and Exploitation ratio were Z: 4.65, M: 1.5, F: 3.15, E 0.68, respectively. Relative yield per recruitment (Y'/R):0.031, relative biomass per recruitment, (B'/R):0.11, for Deep flounder stock was calculated. The results in this study showed exploitation ratio Deep flounder stock is over fishing and deceases of exploitation ratio is proposed.

***Keywords*:** Pseudorhombus elevatus, Population biology, assessment, Persian Gulf.

INTRODUCTION

The Persian Gulf is a semi-closed water body connected to the Oman Sea through Strait of Hormuz in which is restricted to 56km at its narrowest point. The maximum width is 640 km with the average depth of 35m (Reynolds, 1993). The Persian Gulf is in the subtropical zone lying almost entirely between the latitudes of 24° and 30°N and longitudes of 49° to 61° 25′E.

The Deep flounder, *Pseudorhombus elevatus* (ogilby, 1912), is a member of the family Paralichthyidae and is widely distributed throughout the Indo-West Pacific, from the Red Sea and East Africa to Japan and New Caledonia (Fischer and Bianchi, 1984; Carpenter *et al*.,1997). Adults are found in shallow coastal waters and the diet of this species consists of bottom-living animals. Consequently it is exploited throughout its range with a variety of gears, including trawls (Fischer and Bianchi, 1984). This species has a gonochoristic reproductive mode and spawning occurs annually with one clear seasonal peak during April to June (Hashemi *et al*., 2011).

Many of the demersal fish populations in the Persian Gulf have been heavily exploited and fishing effort may be above optimum levels for some species (Hashemi and valinassab, 2011). The lack of appropriate data on most stocks underscores the need to assess the regions fisheries resources. Nowadays, sustainable development and sustainable yield are essential factors in all different fields dealing with “production” such as fishing and fishery industry. To attain this aim is necessary to rationally manage marine resources for long-term sustainable and successful exploitation (Jennings et al., 2001). For this to be achieved it is essential to collect biological data and monitor the resources. The present study was undertaken to estimate the key parameters of stock assessment and population dynamics of *P.elevatus* such as asymptotic length(L∞), growth coefficient(K),Tzero(to),total mortality(Z),natural mortality(M),fishing mortality(F),exploitation rate (E),relative yield per recruit(Y'/R) and relative biomass per recruit(B'/R).This information is necessary in formulating management and conservation policies fishery development in Iran.

MATERIALS AND METHODS

Length-frequency data of *P. elevatus* were collected monthly from the commercial catches in landing sites of Abadan and Hendigan , from April 2009 to March 2011(Fig.1). Random sampling was done to the nearest cm fork length (L_F) using a measuring board.

The data were then pooled monthly from different landing sites and subsequently grouped into classes of 2 centimeter intervals. The data were analyzed using FiSAT II (FAO-ICLARM Stock Assessment Tools) as explained in details by Gayanilo Jr . *etal*. (1996).

Growth was calculated by fitting the von Bertalanffy growth function to length frequency data. The von Bertalanffy growth equation is defined as follows (Sparre and Venema, 1998):

$L_t=L_\infty [(1-\exp(-K(t-t_0))]$

Where L_t is length at time t, L_∞ the asymptotic length, K the growth coefficient and t_0 is the hypothetical time at which length is equal to zero.

The t_0 value estimated using the empirical equation (Pauly, 1979).

$Log_{10}(-t_0) = -0.3922 - 0.2752 Log_{10}L_\infty - 1.038 Log_{10}K$

The fitting of the best growth curve was based on the ELEFAN I programm (Pauly and David, 1981), which allows the fitted curve through the maximum number of peaks of the length-frequency distribution. With the help of the best growth curve, growth constant (K) and asymptotic length (L∞) were estimated.

The growth performance (**Φ'**) of Deep flounder population in terms of length growth was computed using the index of Pauly and Munro (1984).

$\Phi' = Log_{10} K + 2 Log_{10}L_\infty$

The annual instantaneous rate of total mortality (*Z*) was obtained using length converted catch curves adapted to incorporate seasonal growth patterns (Gayanilo and Pauly, 1997).Pooled length frequency samples were converted into relative age frequency distribution using parameters of the von Bertalanffy growth function.

The annual instantaneous rate of natural mortality (*M*) was estimated by the empirical equation derived by Pauly's empirical relationship (Pauly,1980).

$Log_{10}M = 0.0066 - 0.279 Log_{10} L_\infty + 0.6543 Log_{10} K + 0.4634 Log_{10} T$

Where L_∞ is expressed in cm and T, the mean annual environmental water temperature in ºC. Here it is 25C. Fishing mortality (F) was obtained by subtracting M from Z and exploitation rate (E) was obtained from F/Z.

A selectivity curve was generated using least squares linear regression fitted to the ascending data points from a plot of the probability of capture against size, which was used to derive values of the sizes at capture at probabilities of 0.5 (*L*50) and the size at which fish were fully recruited to the fishery (*L*100).

Relative yield per recruit (Y'/R) and relative biomass per recruit (B'/R) values as a function of E were determined from the estimated growth parameters and probability of capture by length (Sparre and Venema,1998).

RESULTS AND DISCUSSION

Length frequency distribution:

The total lengths of 369 fish were in 110 to 410 mm range size (Table 1), using a meter scale (2±mm). Major and minor range length fishery supporting in the 250-270 and 390-410 mm range respectively. Length frequency percentage groups of *P. elevatus* during April 2009 to March 2011 are presented in Fig 2.

Growth Studies:

Growth parameters of von Bertalanffy growth formula for *P. elevatus* were as follows: L∞ = 42cm and K = 1 yr^{-1} (Fig 2). For these estimates through ELEFAN I the response surface (Rn) was 0.178 for the curve. The growth curves produced with those parameters are shown over its restructured length distribution in fig3. The Φ' and t_0 was found to be 3.24 and -0.14 year respectively.

Mortality estimate:

The mortality rates M and Z computed were 1.5 and 4.65 respectively. Figure 4 represents the catch curve utilized in the estimation of Z. The darkened circles were used in calculating the value of Z through the least square linear regression. The blank circles represent the points either not fully recruited or very close to L∞. Good fit to the descending right hand limits of the catch curve was considered. The fishing mortality rate (F) was taken by subtracting M from Z and was found to be 3.15 yr^{-1}.

Exploitation rate

The rate of exploitation (E) was estimated as 0.68. The higher value of E is indicated over fishing during that period. This assumption is based on Gulland (1971). He stated that suitable yield is optimized when F=M i.e., when E is more than 0.50, the stock is generally considered to be over fished.

Yield per recruit and biomass per recruit

Values of the sizes where the probability of capture was 50% (L_{50}) and 100% (L_{100}) were 21.30 and 28.5cm (TL), respectively. Fish were recruited to the fishery at a mean size of L_{50} = 21.30 cm.
Value Lc/ L∞ and M/K were 0.51 and 1.5 respectively (Fig 5). Relative yield per recruitment (Y'/R):0.031, relative biomass per recruitment, (B'/R):0.11, for Deep flounder stock was calculated.

Discussion:

The values of L∞ and K were calculated as 42cm and 1 ($year^{-1}$). L∞ and K of Deep flounder were calculated in Kuwait waters for both male and female, L∞(44) and K(0.16). These parameters reported in Khuzestan by Mohamadi and Khodadadi, 2007 (41.9 , 0.2) for *Euryglossa orientalis*.

Differences between L∞ and K is influenced by ecological characteristics, population size and gene frequency of species considering their habitat and regarding natural selection, appear different adaptation patterns were seen their life (Adams, 1980). L∞ and K amounts have reverse correlation and with decrement L∞, amount of K increases and vice versa (Sparre and Venema, 1998). Differences in growth rates between regions indicated a stock separation (Devaraj, 1981) which has, in some cases, supported a genetic difference (Begg and Sellin, 1998).
Φ' was estimated 3.24, and 2.49 reported in others researches in Kuwait waters. In general, the correlated parametric values adjust themselves to provide a similar growth pattern represented by Φ' (Sparre and Venema, 1998). Age at zero length (t_0) was as -0.14 year. With negative t_0 values, juveniles grew more quickly than the predicted growth curve for adults, and with positive t_0 values, juveniles grew more slowly (Sparre and Venema, 1998).

In this study exploitation coefficient was more than 0.5 and fishing mortality was more than natural mortality. In Khuzestan area (Iran) for *Euryglossa orientalis* M, F and Z were 0.67, 0.58 and 1.19 respectively (Mohamadi and Khodadadi, 2007). This result clearly indicates growth over fishing for both species and, in combination with the results of the yield-per-recruit analyses, demonstrates that effort reductions are also required in the fishery because target reference points cannot be achieved by modification of the gear-selectivity characteristics alone.

Reliable estimate of M can only be obtained for an unexploited stock (Al-Hosni and Siddeek, 1999). Errors in estimates of the natural mortality rates (*M*) from the empirically derived formula of Pauly (1980) may have occurred as the relationship has tended to overestimate *M*, especially for slow growing species (Russ *et al*., 1998).

The relative biomass per recruit of *P. elevatus* at the estimated fishing mortality rates was particularly low at less than 30% of unexploited levels. If the critical spawning stock biomass is between 20% and 50% of the unexploited levels, as suggested by King (2007), recruitment over fishing is likely to be occurring for this species.
Because the size at first capture was smaller than the size at which yield per recruit would be maximized (21.3 cm) and mean size at first sexual maturity (237 mm) for *P. elevates* (Hashemi *etal*., 2011), an increase in the mesh size for the trap fishery should be considered by management authorities especially given the high rate of juvenile retention for this species.

At the existing exploitation rate and size at first capture *P. elevate,* is being growth over-fished, where the fishing mortality is in excess of that which is required to maximize the yield per recruit. An increase in the mean size at first capture to that which would maximize yield per recruit was predicted to increase yields and the standing stock biomass by an order of magnitude. Furthermore, because of the increase in sustainable yields at this mean size at first capture, the stock would not be growth over-fished at the existing rate of fishing mortality.

These results are important for fisheries management authorities as they suggest that the resource is overexploited and in addition to a revision of mesh size regulations, a substantial reduction in fishing effort would also be required if management objectives are to be achieved. Patterson (1992) observed that the fishing rate satisfying optimal E level of 0.5 tended to reduce pelagic fish stock abundance, and hence, the former author suggested that E should be maintained at 0.4 for optimal exploitation of those stocks.

Life history characteristics can be used to classify the vulnerability of a species to fishing pressure and the level of productivity within a population (Musick, 1999). The growth, mortality estimates derived here suggest that *P. elevatus* has a high resilience to exploitation (Hashemi *etal*.,2011).

Table 1. Average values (±S.D.) of size corresponding of Deep flounder in Khuzestan Coastal Waters (2009-11)

Month	N	MeanW ±S.D (g)	Min – max	MeanTL ±S.D (mm)	Min– max
January	44	135±183	41-518	54±245	165-370
February	26	133±224	73-507	41±260	198-335
March	46	132±201	42-827	41±256	171-396
April	25	141±338	112-629	40±306	225-380
May	23	169±315	128-581	54±300	222-375
July	63	135±287	110-693	39±285	205-375
August	35	60±96	14-785	63±180	115-415
September	9	88±250	162-378	26±272	245-312
October	31	151±310	77-532	56±293	190-380
November	27	86±237	93-345	31±273	210-305
December	33	128±208	85-479	44±258	202-342
Average	-	238±150	14-827	264±57	115-415

Figure1. Location of two landing sites of Deep flounder in Khuzestan Coastal Waters (Iran)

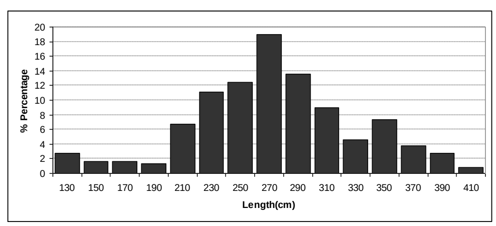

Figure 2. Percentage frequency length of P. elevatus in Coastal Waters of Iran during 2009-11

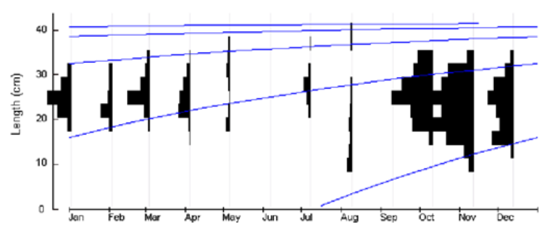

Figure 3. Growth curve of P. elevatus from Iran by ELEFAN I superimposed on the restructured length-frequency diagram (L∞ = 42 cm and K = 1 yr-1)

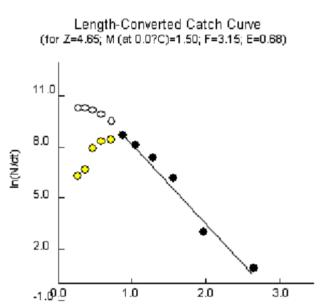

Figure 4. Length converted catch curve of P. elevatus during 2009-11

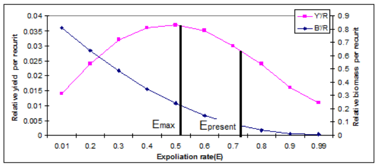

Figure 5. Relative yield-per-recruit and Relative biomass-per-recruit showing the existing exploitation rate (E) P. elevates during 2009-11

CONCULSION

Considering E, Y'/R and B'/R values it can be concluded that: catch rate and fishing mortality are more than maximum sustainable yield of Deep flounder they must be decreased. Any increase in the existing fishing level/exploitation will most likely result in a reduction in the yield per recruit and thereby hamper the optimum level. It is necessary to impose immediate fishing regulation on the stock and this can be done by gradual increasing the mesh size of the gears or by restricting fishing for certain seasons or declaring fish sanctuaries in certain areas, especially in spawning areas and spawning time.

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REFERENCES

Adams,P., 1980. Life history Pattern in marine fishes and their consequences for fisheries management. Fish Bull,78(1).

Al-Hosni, A.H. and Siddeek, S.M. 1999. Growth and mortality of the narrow barred Spanish Mackerel, Scomberomorus commerson (Lacepede), in Omani waters. Fish. Man. Ecol., 6: 145-160.

Beverton, R.J.H and S.J. Holt., 1957. On the dynamics of exploited fish populations. fishery Investigation Series, London 19: 533.

Carpenter, E., Krupp, F., Jones, D., and U, Zajonz. 1997. FAO species identification sheets for fishery Purposes. The living marine resource of Kuwait, Eastern Saudi Arabia, Bahrain, Qatar, and the United Arab Emirates. FAO. Rome. 293 p.

Devaraj, M. 1981. Age and growth of three species of seerfishes Scomberomorus commerson, S. guttatus and S. lineolatus. Indian J. Fish., 28(1/2): 104-127.

Gayanilo, J r . F.C., P. Soriano and D. P auly. 1996. The FAO-ICLARM Stock Assessment Tools(FiSAT) User s gu ide. FAO Compu t er ised In format ion Ser ies (F ish er ies), No. 8. Rome, FAO, 266p.

Gayanilo Jr., F.C., Pauly, D., 1997. FAO—ICLARM stock assessment tools. Reference manual. ICLARM International Centre for Living Aquatic Resources Management. Food and Agricultural Organisation of the United Nations. Rome, 1997, 262 pp.

Gulland, J.A., 1971.The fish resources of the ocean.west byfleet survey. Fishing News books Ltd.,for FAO:255 p.Revised edition of FAO Fish.Tech.pap.(97):425p.

Gulland, J.A., 1979. Report of FAO/IOP workshop on the fishery resources of the western Indian Ocean South of the Equator. Rome, FAO, IOFC/DEV/79/45: 1-37.

Hashemi, S. A. R., Mohammadi, G. Safikhani, H. and Kashi, M. 2009. Population dynamics and stock assessment of Hilsa shad and Tenualosa ilisha in Khuzestan Province coast (northwest of Persian Gulf). The 6th Scientific Conference of Fisheries Resources, 3-4 March 2009, Basrah, p. 121 (abstract).

Hashemi, S. A. R., S.A. Taghavimotlagh and G.R.Eskandary, 2011. To determine the ecological relationship amongst economic fishes within the Persian Gulf waters. South of Iran aquaculture fishery research center,Ahwaz.Iran.33 p. In Farsi.

Hashemi, S. A. R and Valinassab, T. 2011. Stock assessment of demersal resources in the West northern Of Persian Gulf waters. World Journal of Fish and Marine Sciences. , 3(6): 480-485.

Fischer, W., and G. Bianchi. 1984. FAO species identification sheets for fishery purposes. Vol. II: 257 p. Prepared and printed with the support .Western Indian Ocean (Fishing Area, 51). Of the Danish International Development A genic(DANIDA). FAO. Rome.

Kedidi, S.M., Fita, N.I. and Abdulhadi, A. 1993. Population dynamics of the King Seerfish Scomberomorous commerson along the Saudi Arabian Gulf Coast, IPTP Collective, 8: 76-87.

Mohammadi G.H., gholami R., Alvi A., Moghamesi S., Ofipor M., 2005.Study of some biological characteristics of economical fishes (Tiger tooth Croacher, Silver pomfert, Yellow fin sea bream, Hilsa shad,
Indo-pacific king mackerel, Narrow-barred Spanish,…) in the coastal waters of the Persian Gulf South of Iran aquaculture fishery research center,Ahwaz.Iran.124p.
Mohammadi, G. and M, Khodadadi. 2007. Growth and Mortality and Exploitation Parameters of Euryglossa orientalis (Bloch and Schneider,1801) in Khuzestan Province coast, northwest the Persian Gulf. Iranian Journal of Fisheries Sciences. 9(2) : 315-326. (In press).
Musick, J. A. 1999. Criteria to define extinction risk in marine fishes. Fisheries, 24(12): 6-14.

Parsamansh,A.Shalbaf,M.Eskandari,Gh.Kash,M.,2003.Survy fish stock assessment in Khozestan privence, South of Iran aquaculture fishery research center,Ahwaz.Iran.69p.
Patterson, K. 1992. Fisheries for small pelagic species: an empirical approach to management targets. Reviews in Fish Biology and Fisheries, 2: 321-338.
Pauly,D., 1979.Gill size and temperature as governing factors in fish growth: a generalization of von Bertalanffys growth formula.Berichte aus dem institute fuer meereskunde,63,Kiel university,Kiel.
Pauly, D. 1980. On the inter-relationships between natural mortality, growth performance and mean environmental temperature in 175 fish stock. Journal du Conseil 39(3):175-192.
Pauly, D. and N. David., 1981. ELEFAN-I a basic program for the objective extraction of growth parameters from Length frequency data. Meeresforschung/Rep.Mar. Res.28(4):205-211.
Pauly, D. and J.L. Munro., 1984. Once more, on the composition of growth in fish and in vertebrates. Fishbyte 2 (1): 21.
Pauly, D., and Soriano, M. L. 1986. Some practical extensions to Beverton and Holt's relative-yield-per-recruit model. In The First Asian Fisheries Forum, pp. 491e496. Ed. by J. L. Maclean, L. B. Dizon, and L. V. Hosillo. Asian Fisheries Society, Manila. 727 pp.
Ricker, W.E. 1975. Computation and interpretation of biological statistics of fish populations. Bull. Fish. Res. Bd. Canada, 191: 382pp.
Russ, G.R., Lou, D.C., Higgs, J.B., Ferreira, B.P., 1998. Mortality rate of a cohort of the coral trout, Plectropomus leopardus, in zones of the Great Barrier Reef Marine Park closed to fishing. J. Mar. Freshwat. Res. 49, 505–511.
Sparre, P. and Venema, S.C. 1998. Introduction to tropical fish stock assessment, FAO Fisheries technical paper, Roma, 450 pp.