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ESTIMATION OF TOTAL MORTALITY RATES AND VIRTUAL POPULATION ANALYSIS OF *EPINEPHELUS TAUVINA* FROM ARABIAN GULF QATAR

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ABSTRACT

Mortality rates and virtual population analysis of *Epinephelus tauvina* from Arabian Gulf off Qatar were computed using data on age, length and catch. Total mortality was found to be 0.57 per year; the natural mortality 0.17 per year while the fishing mortality was 0.4 per year. VPA showed a decrease of population number and increase in the fishing mortality with age and length. There was an increase in the catch up to the length group (63 cm) after that it decreased with increase of the fish size. The biomass was also increased with length up to length group (59cm) and then decreased with length.

1. INTRODUCTION

Groupers (Family Serranidae) are a major component of fish landing in the Arabian Gulf region, with extremely high market value (El-sayed, 1992 El-sayed and Abdel-Bary, 1999; Grandcourt *et al.*, 2005). They are generally long-lived, with slow growth rates and low natural mortality rates (Grandcourt *et al.*, 2005). Seven species of groupers, namely; *Epinephelus tauvina*, *E. areolatus*, *E. chloristigma*, *E. jayakari*, *E. latifasciatus*, *E. malabaricus* and *E. bleekeri* have been recorded in the Arabian Gulf waters (El-Sayed and Abdel-Bary, 1999). However, only three species (*E. tauvina*, *E. chloristigma* and *E. jayakari*) are commercially represented in Qatari fish landing (El-Sayed, 1992. In the mean time, *E. tauvina* is, by far, the most dominant species of groupers in the Arabian Gulf and Indian Ocean (Kuronuma and Abe, 1982).

However, only few studies considered the mortality rates and virtual population analysis (VPA) of the grouper (*E. tauvina*) from the Arabian Gulf waters (Mathews and Samuel, 1987; Lee and Al-Baz, 1989; Grandcourt *et al.*, 2005). Moreover, no studies have been conducted on the population structure of *E. tauvina* in Qatari waters.

The aim of the present study was to estimate the mortality rates of grouper (*E. tauvina*) from the Arabian Gulf waters off Qatar using catch curve analysis and to study the population structure and cohort dynamics by virtual population analysis (VPA).

2. MATERIALS AND METHODS

Fish samples (863 specimens) of the grassy grouper *Epinephelus tauvina*, caught from Arabian Gulf in Qatar were taken from the commercial catch. Age and length composition analysis were made for the samples and then raised to the total landed catch.

2. 1. MORTALITY RATES

2. 1. 1. Total mortality

The total mortality coefficient was determined according to the following methods:

1- Analysis of catch curve based on age composition data. This was done according to Beverton and Holt (1956)

2. 1. 2. Natural mortality

Natural mortality was computed using the equation of Pauly (1980)

$\ln M = -0.0152 - 0.279 \ln L_\infty + 0.6543 \ln K + 0.463 \ln T$

T is the mean annual temperature in °C of the water from which fish were caught. The mean temperature in Arabian Gulf is about 25 ºC (Hazek, N. M., 1996)

2. 2. VIRTUAL POUPLATION ANALYSIS

Age structured VPA was done according to Pope (1972) using the software, FISAT II (Gayanilo *et al.*, 1995).

Length structured VPA was done according to Jones (1984) using FISAT software (Gayanilo *et al*., 1995).

3. RESULTS

3. 1. MORTALITY RATES

The catch curve as obtained in the present study is shown in Figure 1. Here the age composition of the total fish catch (Table 1) was used. The descending part of the curve starting from the beginning of age group VII was then used in the regression analysis (Fig. 1) to estimate the total mortality coefficient, which was found to be 0.57 per year.

Natural mortality according to Pauly equation (1980) for *E. tauvina* in Arabian Gulf was found to be 0.17 per year. The fishing mortality was therefore 0.4 per year

3. 2. VIRTUAL POPULATION ANALYSIS

3. 2. 1. Age structure VPA (Pope, 1972)

Age structured VPA obtained from the age composition data (Table 1) are graphically represented in Figure (2). The figure clarify that fishing mortality increases as the fishes increase in age. Exposure to this sequence of fishing mortality together with natural mortality (0.17 per year) caused a decrease in the population from age group 0 to age group XII. It also appears that after age group VI the catch of *E. tauvina* decreases with the increase of fishing mortality as it progresses in age. We can also notice that fishing mortality reached its highest value at age group VIII.

3. 2. 2. Length structured VPA (Jones, 1984)

The results of length structured VPA are graphically illustrated in Figures (3a and b). It appears that fishing mortality in general increases with length. On the other hand, the population number decreases with length. A parallel decrease in catch (Fig. 3b) with length was observed concomitant with an increase in fishing mortality (Fig. 3a) after length group, 63 cm. Concerning the stock biomass a direct decrease with length occurs after length group, 59 cm by the increase of the fishing mortality. These data show that fishing mortality reaches higher values in bigger individuals than in smaller ones. At small length groups the fishing mortality is very low. Figure (3b) shows that the fishing mortality at maximum catch and biomass of the population were 0.26 and 0.15 per year respectively, which are much lower than the current fishing mortality (0.4 per year). It should be noted that the highest fishing mortality (0.84 per year) to which the population is exposed occurs at length group 95 cm.

Table (1): Age composition data for *Epinephelus tauvina* from Arabian Gulf, Qatar.

Age groups (years)	Total landed catch (numbers)
0	4184
1	7322
2	9414
3	10460
4	31379
5	49161
6	66943
7	58575
8	54391
9	39747
10	23012
11	5230
12	4184

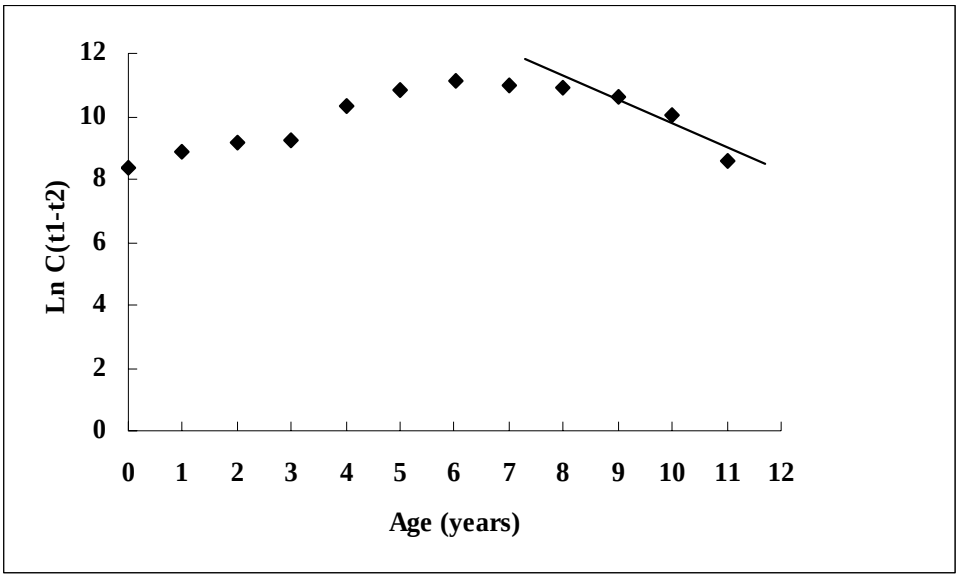

Fig. (1): Catch curve based on age composition data of the total landing for *Epinephelus tauvina* from Arabian Gulf, Qatar.

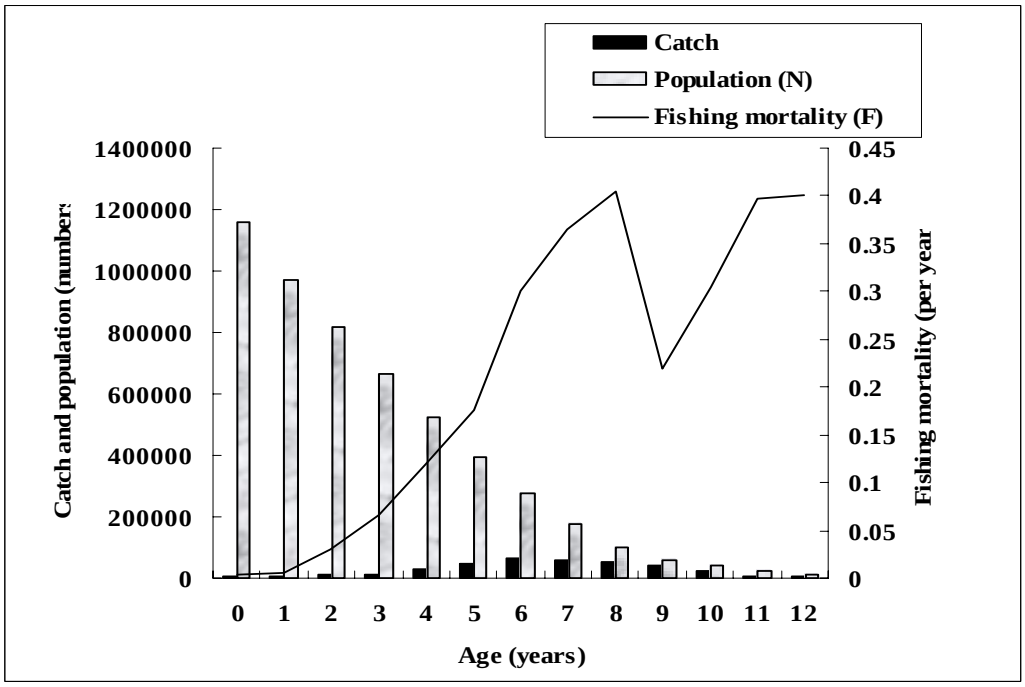

Fig. (2): Results of age structured VPA for *Epinephelus tauvina* from Arabian Gulf, Qatar.

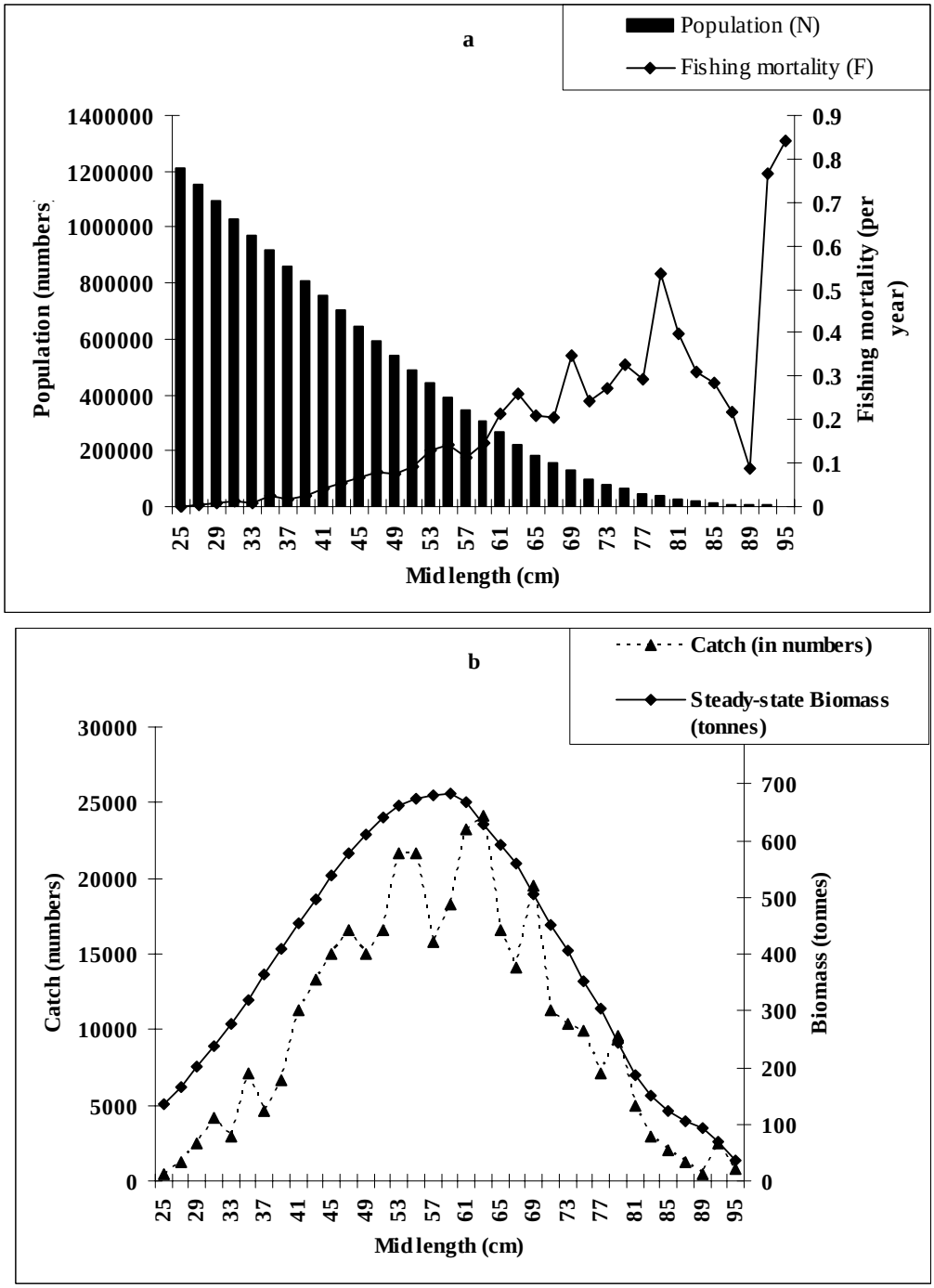

Fig. (3): Results of length structured VPA for *Epinephelus tauvina* from Arabian Gulf, Qatar.

4. DISCUSSION

The total mortality rate (Z) (based on catch curve of age composition data) of *E. tauvina* in the present study was 0.57 per year. This rate is lower than that of other groupers in other geographical areas. For example, Grandcourt *et al.* (2005) reported that the total mortality of *E. coioides* in the southern Arabian Gulf ranged from 0.79 to 1.17 per year. These differences may be attributed to the differences in fishing pressure, natural mortality due to natural causes such as ageing, diseases, or environmental conditions. These results may suggest that *E. tauvina* in Qatari waters are not under heavy fishing pressure and also that changes in environmental conditions are severe.

The natural mortality of *E. tauvina* in the present study was 0.17 per year. This value appears close to natural mortality for *E. coioides* from the southern Arabian Gulf (0.19 per year) as recorded by Grandcourt *et al*. (2005). Once again, this result may reflect the minimal effect of natural causes on natural mortality of *E. tauvina* in Qatari waters.

As far as fishing mortality is concerned, the present study showed that *E. tauvina* in Qatari waters are subjected to a moderate fishing mortality (0.4 per year). However, this fishing mortality is higher than natural mortality. This sounds normal because this fish species is among the most economically important species in the Arabian Gulf region, and, therefore is a target species by fishermen in the region. Similarly *E. coioides*, another economically important species, has also been reported to suffer from fishing mortality ranging from 0.57 to 0.98 per year (0.78 per year in average) in the Southern Arabian Gulf (Grandcourt *et al*., 2005).

Age structured VPA of *E. tauvina* showed an increase in fishing mortality, and a decrease in population number, with increasing fish age. After age group VI, the catch decreased with the increase of fishing mortality, as ages increased.

The length structured VPA showed an increase in fishing mortality and a decrease in the population number with the increase in fish length. The stock biomass increased with the increase in fish length up to 59 cm and fishing mortality up to 0.15 per year, and then decreased afterwards. This may have been due to that these fish are not fully exploited below this length. Therefore, the growth of the fish and the recruitment to the stock could compensate the loss in biomass due to fishing operations and natural deaths (Sparre and Venema, 1998). Above this length, fishing mortality may have the major effect on the stock biomass, causing a loss that exceeds the addition to the stock by recruitment or growth (Sparre and Venema, 1998). The decrease in growth rate with increasing fish length may have been another reason.

It is clear from the above discussion that the biomass can reach a maximum value at a certain fish length and fishing mortality. Increasing fishing mortality with the length also caused an increase in the catch until certain length (63 cm) and fishing mortality (0.26 per year), after which they decreased again. This is presumably because of the fact that the negative effect of fishing mortality on the fish stock exceeded positive effect of recruitment and growth. Accordingly the catch as a part of that stock is affected and decreased with the fishing pressure at higher fish sizes.

Similar observations have been reported by other authors who applied VPA on the data for other species in different locations. Abdallah and El-Haweet (2000) found that both catch and stock biomass of *Sardina pilchardus* and *S. aurita* increased with decreasing the values of fishing mortality and exploitation rate from 1997 to 1998. Similar results have been reported on pike perch, *Stizostedion lucioperca* L. (Lehtonen, 1983), Baltic herring and Sprat (Parmanne and

Sjöblom, 1988), *Osmerus eperlanus* (Hudd, 1985) and *Boops boops* (Abdel Barr, 2003).

VPA in the present study indicated that fishing mortality values of *E. tauvina* in Arabian Gulf waters off Qatar are higher among large sizes than among smaller sizes, supporting the idea that there is size selection of that species. The fishing mortality at maximum population catch and biomass are much lower than the current fishing mortality (0.4 per year), which occurs at the largest fish length in the catch (97 cm) and the highest fishing mortality (0.84 per year) that occurs at length group 95 cm. This suggests that the fishing operations may target the largest lengths, beginning with the length group 63 cm, which is larger than the length at first maturity 52 cm (El-Sayed and Abdel-Bary, 1999). At this length, VPA analysis showed that the fish was exposed to fishing mortality 0.2 per year, which is lower than the current terminal fishing mortality (0.4 per year).

The present study suggests that it might be better to reduce the fishing pressure although the current rate of fishing mortality is moderate. This is likely to lead to the conservation of grouper and maintain the equilibrium between the loss and gain in their stock biomass.

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