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Fisheries biology of the haffara bream *Rhabdosaragus haffara* (Family: Sparidae) in Suez Bay, Egypt.

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ABSTRACT

Family Sparidae is considered as one of the most commercial families of the small scale fishery of Suez bay. A Total of 800 specimens of *Rhabdosaragus haffara* were collected from the Suez bay landing site, El-salakhana, during the fishing season 2018-2019. The length-weight relationship equation is $W=0.014L^{3.02}$ indicating an isometric growth. Age was determined by reading otoliths and revealed that the population has five age groups. The Von Bertlanffy equation was as follow; L_t **= 27 (1-e$^{-0.43(t+0.27)}$).** Length at first capture L_C= 13.0cm. The growth performance index (Φ) was estimated as 2.49. Total mortality was estimated to be Z=1.7, natural mortality is M=0.65, fishing mortality F= 1.05, and Exploitation rate is E= 0.62.The target and limit biological reference points are: F_{Opt}=0.32 year^{-1} and F_{Limit} = 0.43 year^{-1}. Exploitation rate, F_{Opt}, and F_{Limit} indicated that the stock of *R. haffara* in Suez bay is overexploited and threatened.

INTRODUCTION

Family Sparidae has a wide distribution in the tropical and temperate areas in western Indian Ocean, the Arabian Gulf, Red Sea and the Gulf of Suez (Froese & Pauly, 2013 ; Lidour and Beech, 2019; Ahmed and El ganainy, 2000). It inhabits a wide range of habitats such as shallow water, coral reef ecosystem, sandy and muddy bottoms. It is a carnivorous fish feeds on benthic invertebrate (Sommer *et al,* 1996). Family Sparidae is represented in small scale fishery (trammel and gill nets) operating in the gulf of Suez and Suez bay by seven species, the most dominant one of them is *R. haffara* (Osman *et al,* 2020). *R. haffara* is Lessepsian migrant species from the Red Sea to the Mediterranean Sea through Suez Canal (Golani, 1998). The most dominant species of the family in the Mediterranean Sea is *Boops boops* (Abdel Rahman, 2003). Despite its important as edible and commercial fish in the Egyptian fisheries, the fisheries management studies conducted on this species are very scarce. Ahmed and El ganainy (2000) were reporting the ageing parameters and population dynamics in the Gulf of Suez. Elboraay (2004) studied its reproductive biology and hermaphroditism. Ahmed and El mor (2006) reported that family Sparidae constitutes 44.66% of the total catch of beach seine in el Malaha lake. As well, El darawany (2015) studied its ageing and mortality parameters in Lake Timsah. Finally, Osman *et al* (2020) studied the reproductive biology of *R. haffara* in Suez Bay.

The biological parameters such as age, growth rate and mortality should be studied to achieve a proper fishery management and consequently protect the stock from the overexploitation. So the present study aims to estimate the biological parameters for *R. haffara* in the Suez bay for stock management.

MATERIALS AND METHODS

Samples of *R. haffara* were collected monthly from the local landing site on Suez bay (El-salakhana) (Fig. 1) from September 2018 to April 2019. A Total of 800 samples were collected. Total length of fishes was measured to the nearest mm and total weight was measured to the nearest gm.

The samples were dissected for sex determination and otolith extraction. Otoliths of about 260 specimens were carefully removed, cleaned, dried and immersed in 5 % HCL and examined on a dark background with reflected light using binocular microscope at 25x magnification.

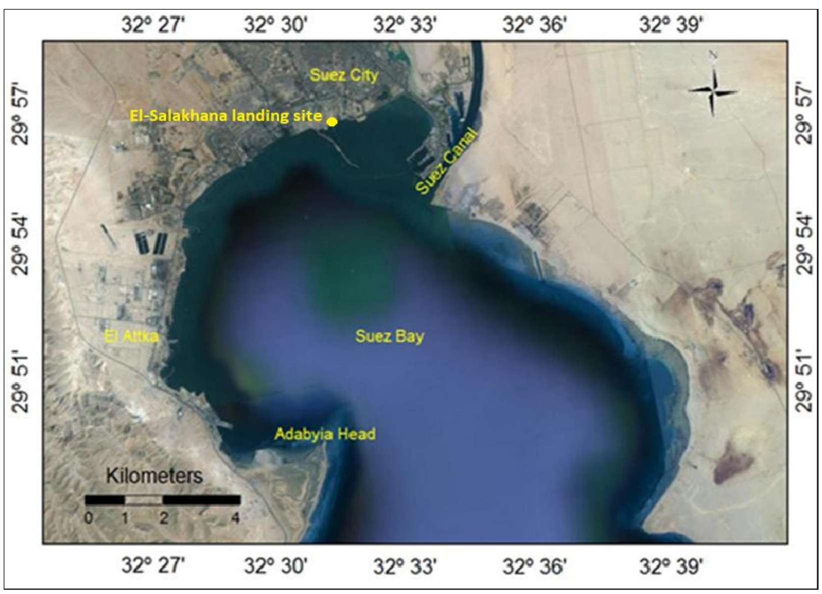

Fig.1: A map of the study area and the landing site.

The length-weight relationships were determined according to the allometric equation (Sparre *et al*., 1989): $\mathbf{W = aL^b}$,

W is the total body weight (g), L is the total length (cm), a and b are constants.

The relationship between length and girth was estimated using equation:

$$T_G = a + b \times TL$$

Where Ĝ is the observed girth, L is the observed length and a and b are the intercept and regression coefficient (slope) respectively (Santos et al., 2006).

Fulton's condition factor (*K*) was estimated from the relationship *K=100W/L3*

where W is Total Weight in gram, L is Total length in cm and the factor 100 is used to bring K close to unity (Le Cren, 1951; Froese, 2006).

Growth was expressed by the von Bertalanffy equation:

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

Von Bertalanffy growth parameters, such as the asymptotic length (L_∞) and the growth coefficient (K) were estimated by the methods of Chapman (1961) and Prager *et al.*, (1989)

The growth performance index (Φ) was estimated according to (Pauly and Munro, 1984):

$$\Phi = \log K + 2 \log L_\infty$$

Where, K and L_∞ are Von Bertalanffy parameters.

Total mortality coefficient "Z" was estimated using the method of Pauly (1983).

Natural mortality was estimated according to king (1995) as follows:

$$M = -\ln(0.01)/t_{max}$$

Where: M: is the natural mortality

T_{max}: is the maximum age

The biological reference point (BRP's), Fishing mortality rate with target (F_{opt}) and fishing mortality limit (F_{limit}) were calculated using the two formulas described by Patterson (1992), as follow:

$$F_{opt} = 0.5M$$

$$F_{limit} = 2/3M.$$

Fishing mortality coefficient (F) was estimated by subtracting the value of natural mortality coefficient (M) from the value of total mortality coefficient (Z) as follow:

$$F = Z - M$$

Length at first capture (L_c) was obtained by plotting the curve for probability of capture by length (Pauly, 1984).

RESULTS

Length -weight and length-girth relationships:

The total length of samples ranged from 10.2 to 25.4 cm with an average length 16.0 cm and total weight is ranged from 17.3gm to 251.0gm with an average weight 69.7gm. The girth of fish varied between 7.1 and 15.9 cm, The length weight relationship equation was estimated to be $W=0.014L^{3.02}$ as b= 3.02 (Fig. 2). While the length girth relationships formula was assessed to be G=0.706TL- 0.225 (Fig. 2). The coefficients of determination (r^2) of the LGR regressions was recorded to be 0.92 this revealed that the growth of the *R. haffara* is isometric.

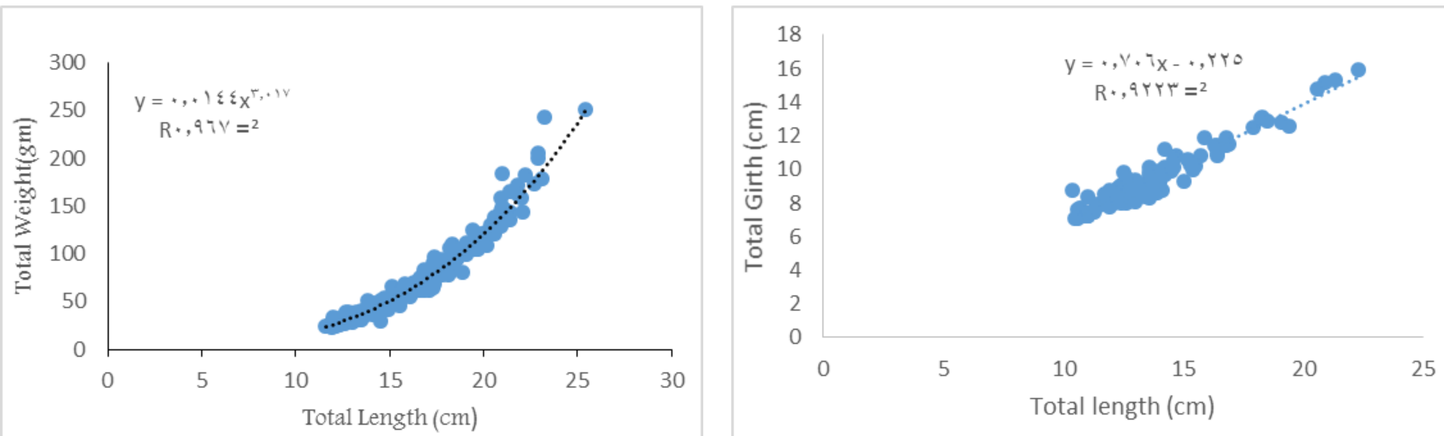

Fig. 2: Length-weight and length girth relationship for *R. haffara* in Suez bay.

Condition factor:

In the current study, the condition factor (K) of *R. haffara* showed monthly fluctuation (fig. 3). The highest value was recorded during March and September, just before and after spawning season. Whereas, the lowest value was recorded during January.

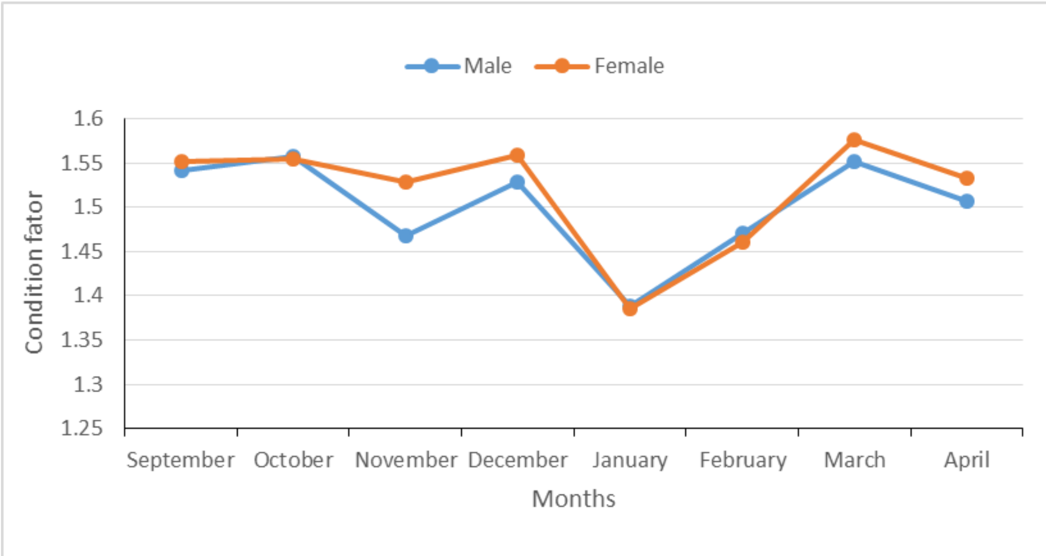

Fig. 3: The monthly absolute condition factor for male and female *R. haffara* in Suez Bay.

Growth in Length:

Reading the otolith of about 250 samples of *R. haffara* revealed that its population in Suez bay has five age groups samples attain 12.2, 16.7, 19.9, 22.3 and 23.5 cm total length at the end of 1^{st}, 2^{nd}, 3^{rd}, 4^{th} and 5^{th} year of life span (table 1). The mean length at age indicated rapid growth in the 1^{st} year of life with fish attaining almost 40% of its maximum size, whereas in the following years the rate of growth slows down (fig. 4).

Table.1: The mean, minimum and maximum length at different age groups for *R. haffara* from the Suez bay.

Age group	Mean length	Minimum length	maximum length	No	SE	SD
1	12.2	10	13.7	65	0.12	1.04
2	16.7	14	17.9	64	0.11	0.94
3	19.9	17	21.2	69	0.09	0.79
4	22.3	21	24.0	39	0.18	1.01
5	23.5	23	25.4	13	0.25	0.8

Theoretical growth in length:

The values of von Bertalanffy constants "L_∞ and K" estimated by the methods of Chapman (1961) and Prager *et al.*, (1989) for *R. haffara* are given in Table (2) and the growth curve describes the observed length at age is shown in Figure (5).

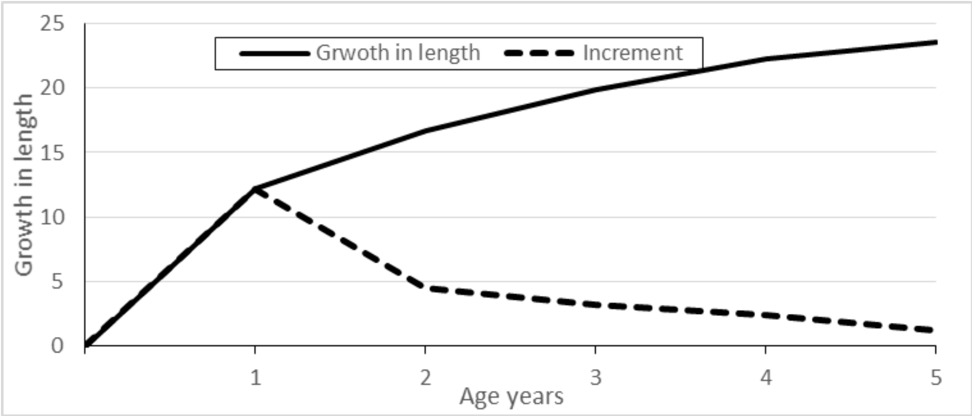

Fig.4: The growth in length and its increment for *R. haffara* in Suez bay.

Table (2). The Von Bertalanffy growth parameters for *R. haffara* by applying two methods.

Method / constants	Chapman (1961)	Prager *et al*., (1989)
L∞	26.8	27.0
K	0.38	0.43
T_0	-0.58	-0.27
Φ	2.43	2.49

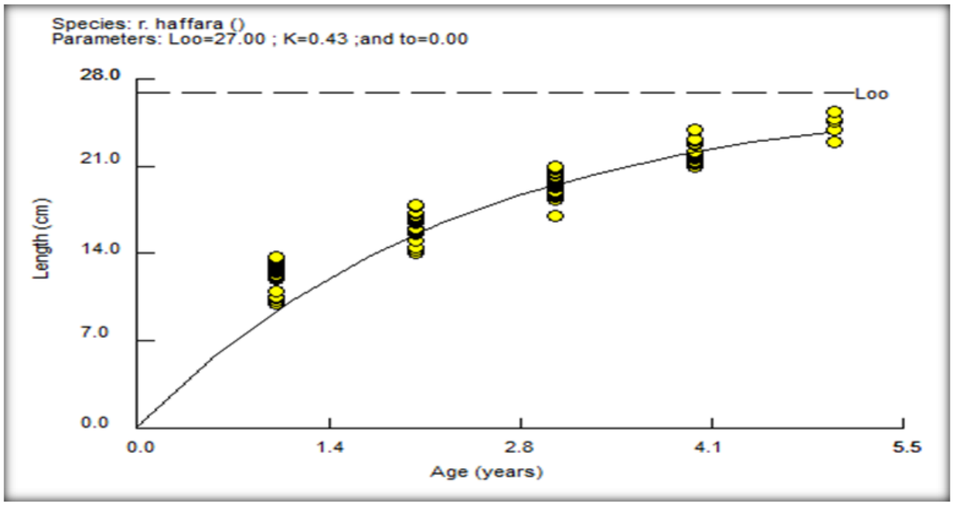

Fig. 5: The growth curve for *R. haffara* in Suez bay.

Length at first capture L_C:

The length at which 50% of the population is represented in the catch (L_c) was estimated to be 13.0cm (Fig. 6).

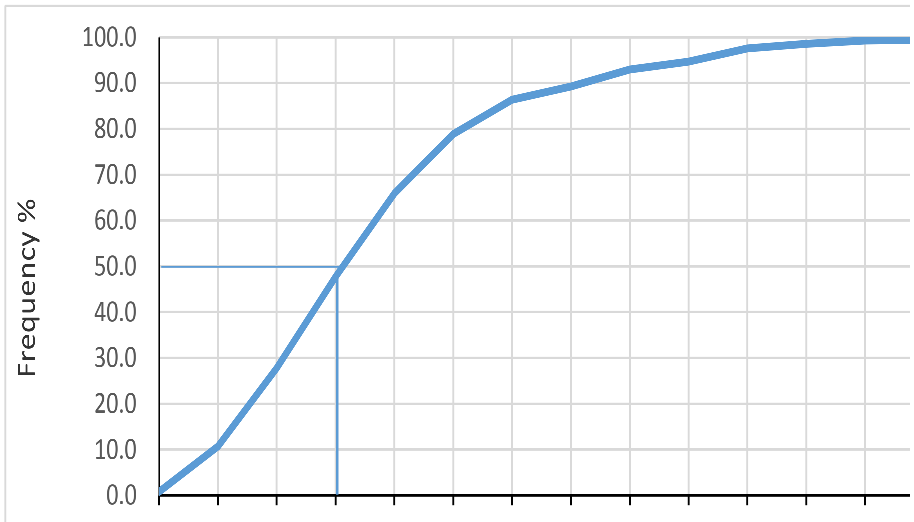

Fig. 6: Length at first capture for *R. haffara* in Suez Bay

Mortalities, exploitation rate;

The length converted catch curves (fig. 7, 8) showed that total mortality (Z) is 1.7/yr., natural mortality is 0.65/yr. and fishing mortality is 1.05/yr. The target and limit biological reference points were: $F_{Opt} = 0.32$ year^{-1} and $F_{Limit} = 0.43$ year^{-1}. Exploitation rate is E= 0.62. Exploitation rate shows that the stock is overexploited as well as F_{Opt} and F_{Limit} rates are lower than the fishing mortality F, suggesting the overexploitation of the stock.

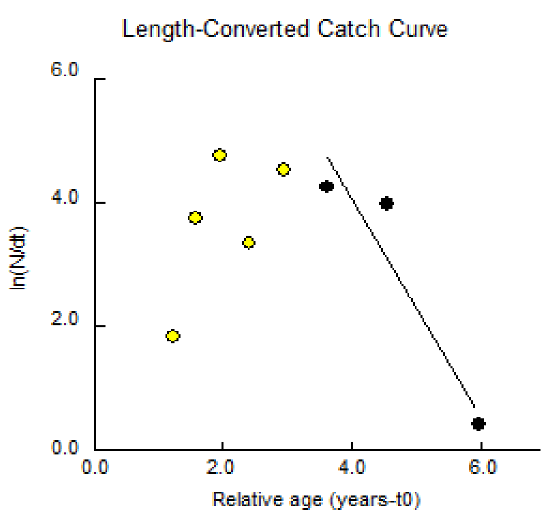

Fig. 7: Length converted catch curve with total mortality indication.

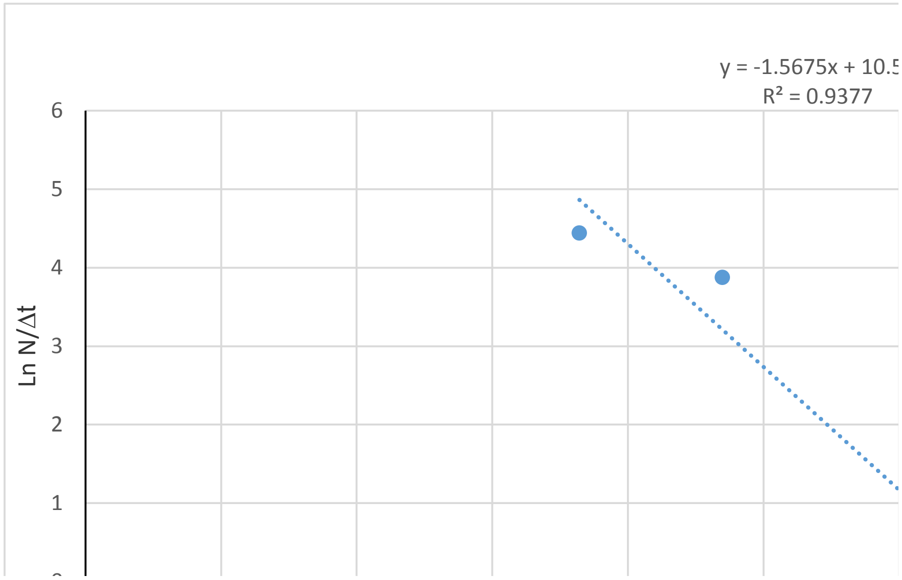

Fig. 8: The total mortality coefficient for *R. haffara* in Suez Bay

DISCUSSION

Family Sparidae is one of the most commercial families of the small scale fishery of Suez bay. There were scarce of fisheries and biological studies on *R. haffara* on the Suez bay. Mehanna, 2001 studied *R. haffara* growth and mortality in Suez Bay, Ahmed and El Ganainy, 2000 reported its population dynamics in the Gulf of Suez, Elboray, 2004 studied the reproductive biology *R haffara* male in Suez Bay and Osman *et al*, 2020 investigated the characteristic of reproductive biology of *R. haffara* in Suez Bay.

Length weight relationship is an essential biological parameter needed to describe the suitability of environment for fish and plays an important role in fishery management (Soliman, 2005). From the present study *R. haffara* in the Suez bay have isometric growth. El Abdelhady (2007) reported that *R. haffara* have a positive allometric growth in the Arabian Gulf. Our results agreed with El drawany (2015), who recorded that *R. haffara* in Lake Timsah has an isometric growth. However, Mehanna, (2001) in Suez bay and Ahmed and El Ganainy (2000) in the Gulf of Suez reported that *R. haffara* has a negative allometric growth. Data length-girth relationships are important information in the management of fisheries (Jasper & Evenson, 2006). Data of length-girth, as well as other parameters such as fish behavior, fishing techniques, gear construction, gear and gear dimensions affect the size selectivity of gill nets (Stergiou & Karpouzi, 2003). Finally, results of length-girth relationship of the selected species in this investigation is particularly useful for set net fisheries management in the Suez Bay.

The condition factor is studied to assess the wellbeing state of fish during its life span (Osman, 2016). This study revealed that *R. haffara* is in wellbeing state during spring after spawning and it is more exhausted during winter, as Osman *et al*, (2020) reported that the peak of the spawning season for *R. haffara* in Suez bay is during winter, this implies that *R. haffara* is more exhausted during its spawning season.

R. haffara population in Suez bay contain five age groups, Mehanna (2001) reported that the population of *R. hffara* has only four age groups. Also Ahmed and El Ganainy (2000) recorded that the *R. hffara* has three age groups. This may be attributed to their use of smaller samples than those used in the current study. El darwany (2015) found that the population of *R. hffara* has four age groups and his samples attain 12.37, 16.39, 19.31 and 21.40 cm total length at the end of 1^{st}, 2^{nd}, 3^{rd} and 4^{th} year of life span these values are very close to the first four age groups in our results.

Length at first capture for *R. haffara* population the Suez bay is 13 cm, According to Osman *et al*, (2020), Length at first maturity (L_m) for *R. haffara* in the Suez bay was estimated to be 12.7cm. For proper fisheries management L_c should be more than L_m by at least 2.0cm. This indicates that the *R. haffara* stock in Suez bay is overexploited.

Pooled length frequency samples were converted into relative age-frequency distributions by using parameters of the von Bertalanffy growth function. The natural logarithm of the number of fish in each relative age group divided by the change in relative age was plotted against the relative age, and *Z* was estimated from the descending slope of the best fitting line with least squares linear regression, the points used was that represent the ages that fully recruited to the fishery. total mortality (Z) is 1.7/yr., natural mortality is 0.65/yr. and fishing mortality is 1.05/yr compared with last studies in table 3..

The target and limit biological reference points were: $F_{Opt} = 0.32$ year^{-1} and $F_{Limit} = 0.43$ year^{-1}. Exploitation rate is E= 0.62. Exploitation rate shows that the stock is overexploited as well as F_{Opt} and F_{Limit} rates are lower than the fishing mortality F, suggesting the overexploitation of the stock which is the same situation for many fish stocks in the Red Sea and the Gulf of Suez which already overexploited (El Ganainy *et al*, 2018; Osman *et al*, 2019; and Amin *et al*, 2019). The exploitation rate value is E= 0.62. These results agreed with Mehanna (2001).

Table 3: Natural mortality, Fishing mortality, Total mortality and Exploitation rate of *R. haffara* in Suez bay.

Study area	Natural Mortality (M)	Fishing mortality (F)	Total mortality (Z)	Exploitation rate (E)	Reference
Suez bay	0.65	1.05	1.70	0.62	Present study
Suez bay	0.29	0. 90	1.19	0.76	Mehanna, 2001
Gulf of Suez	1.35	1.10	2.45	0.45	Ahmed and El Ganainy,2000
Lake Timsah	0.40	0.93	1.33	0.70	El darwany ,2015

CONCLUSION

The results of the current study revealed that the stock of haffara sea bream *Rhabdosaragus haffara* is overexploited and there is a risk on the sustainability of this resource because of the use of the traditional set nets that need further improvement. It is suggested that further management regulations is required to decrease fishing effort through reducing the number of fishing trips and improving the gear specifications (such as mesh size) to catch larger fish so as to conserve the productivity and the sustainability of the stock. For a perfect management of this important multispecies resource in this area, more studies should be conducted on the other species that caught by using these passive nets in Suez bay.

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