Growth, mortality and relative yield per recruit of Japanese scad *Decapterus maruadsi* (Temminck & Schlegel, 1842) in the Gulf of Suez, Red Sea, Egypt

Sahar F. Mehanna[1]; Magdy T. Khalil[2]; Mahmoud H. M. Ahmed[3]; Sameh B. El Kafrawy[3] and Asaar S. H. El-Sherbeny[1]

1- National Institute of Oceanography and Fisheries, Fisheries Division, Fish Population Dynamics Dept., Suez, Egypt.
2- Ain Shams University, Faculty of Science, Zoology Dept., Cairo, Egypt
3- National Authority for Remote Sensing and Space Science, Agriculture Applications, Soil and Marine Science Division, Marine Science Dept., Cairo, Egypt.
"Asar_Elsherbeny@yahoo.com", P.O. Box, 182, Suez, Egypt

ABSTRACT

The stock of Japanese scad *Decapterus maruadsi* was assessed based on 1864 specimen (combined sexes), collected from the Gulf of Suez during the fishing season 2011/2012. The growth parameters (L∞ & K) have been estimated from length frequency distribution data, and the obtained values were L∞ = 27.31 cm TL and K = 0.53/y. The instantaneous rates of total (Z), natural (M) and fishing (F) mortalities were 1.80, 0.61 and 1.19/y respectively with exploitation ratio (E) of 0.66/y which reflects an over exploitation situation. The estimated length at first capture (L_c) was 12.2 cm, while the length at first sexual maturity (L_m) was 12.3 cm. The relative yield per recruit analysis shows that the stock of *D. maruadsi* is overexploited and needs to develop a management strategy to conserve and optimize its yield.

Keywords: Growth; yield per recruit; *Decapterus maruadsi*; Gulf of Suez

INTRODUCTION

The Gulf of Suez is considered as one of the major sources of fish production in the Egyptian sector of the Red Sea as well as in Egypt. Pelagic fishes, caught by purse seine in the Gulf of Suez, represent about 67 % of the total annual fish production from the Gulf; hence they contribute to a major fishery in Egypt. They are mostly small, highly mobile, schooling fish, live in the surface and near-surface waters. The pelagic fish community in the Gulf of Suez consists of *Trachurus indicus*, *Decapterus maruadsi*, *Rastrelliger kanagurta*, *Scomber japonicus*, *Engraulis japonicus*, *Etrumeus teres* and *Sardinella gibbosa*.

Analysis of annual total Suez Gulf catch and purse seine catch landed during the last fourteen years; from the fishing season 1998/1999 to 2011/2012 revealed that both total and purse seine catches; decreased sharply through the past ten years.

Family Carangidae is considered one of the economically important families in the Gulf of Suez. This family contains more than 200 species of marine fishes, including such well-known forms as the horse mackerels, scads, jacks and pompanos. Horse mackerels in the Gulf of Suez are represented mainly by three species; Arabian scad *Trachurus indicus,* round scad *Decapterus macrosoma* and Japanese scad *D. maruadsi*. They contribute by about 77% of the purse seine catch; hence they contribute to a major fishery in Egypt (GAFRD, 2012). Despite the great importance of horse mackerels in the Egyptian Red Sea fisheries, a little is known about their dynamics (Sanders and Morgan, 1989 on *D. maruadsi*; El-Gammal *et al.*, 1995 on *T. indicus*; Mehanna, 1999a&b on *T. indicus* and *D. macrosoma*; Khalifa and Mehanna, 2005 on the management of carangid fishery in the Gulf of Suez).

The present study is aimed to estimate the basic parameters required for assessing and managing *D. maruadsi* stock in the Gulf of Suez.

MATERIALS AND METHODS

1864 specimens of *D. maruadsi* were collected from purse seine catches in the Gulf of Suez (Fig. 1), during the period from September 2011 to May 2012. Total length and total weight were measured to the nearest millimeter and 0.1 gram respectively. The length frequency distribution of all specimens of *D. maruadsi* (sexes combined) was arranged in 1.0 cm length intervals. The FiSAT II software was applied for data analysis (Gayanilo *et al.,* 1997).
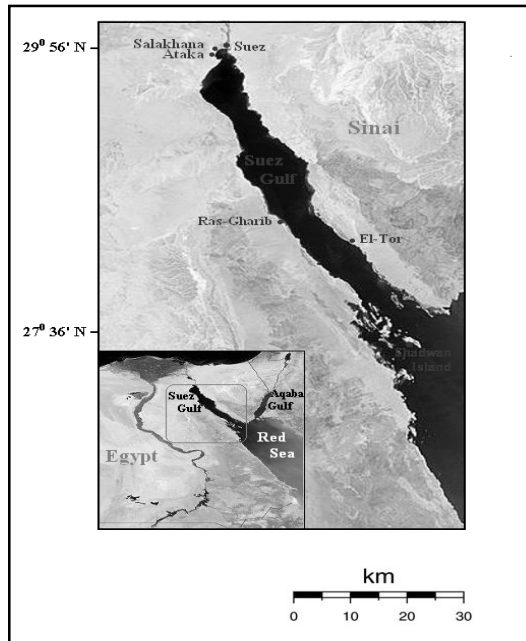

Fig. 1: A map of the Gulf of Suez showing the main four fishing harbors along it Salakhana, Ataka, Ras Gharib and El-Tor.

Length - weight relationship was determined by using the equation $W = aL^b$ (Beckman, 1948 and Le Cren, 1951); Where W is the total weight (g), L is the total length (cm), a and b are constants whose values were estimated by the least square method.

Growth parameters "L∞ and K" were estimated by using the methods of Powell (1979) - Wetherall (1986) and ELEFAN I (Pauly, 1987). The reliability of these growth parameters was tested by Phi-prime "Ø'" computed from the equation derived by Pauly and Munro (1984) as $Ø' = Log_{10} K + 2 Log_{10} L_\infty$.

Total mortality coefficient "Z" was calculated by two methods; Jones and Van Zalinge (1981) and Pauly (1983) methods. Natural mortality coefficient "M" was estimated by two methods; Ursin's method (1967) as $M = W^{-1/3}$ and Pauly's empirical equation (1980) as $logM = - 0.0066 - 0.279 logL_\infty + 0.6543 LogK + 0.4634 logT$, Where T = average annual temperature of the stock's habitat in °C. Fishing mortality coefficient "F" was estimated as $F = Z - M$. The exploitation ratio "E" was estimated by the formula suggested by Gulland (1971) through the relation $E = F / Z$.

Critical lengths; length at recruitment L_r, length at first capture L_c and length at first sexual maturity L_m were determined. L_r is considered as the smallest fish in the catch; L_c (the length at which 50% of the fish retained in the gear) was estimated by

the analysis of catch curve using the method of Pauly (1984), while L_r was estimated by fitting the percentage maturity against mid lengths. L_m was estimated as the point on X-axis corresponding to 50% point on Y-axis.

Relative yield per recruit (Y/R)' was estimated using the model of Beverton and Holt (1966) as modified by Pauly and Soriano (1986) and incorporated in the FiSAT software package as follows: $(Y/R)' = E\ U^{M/K} [1 - (3U/1+m) + (3U^2/1+2m) - (U^3/1+3m)]$

Where: $m = (1-E)/(M/K) = (K/Z)$ and $U = 1 - (Lc/L\infty)$.

RESULTS AND DISCUSSION

Length – Weight Relationship

The measurements of total length and total weight of 1864 specimens of *D. maruadsi* were used to estimate the length-weight relationship (Fig. 2). The total length ranged between 7.3 and 25.1 cm, while the total weight varied from 4.4 and 141.7 g. The obtained equation was found to be: $W = 0.013TL^{2.903}$ (r = 0.983) indicating an isometric growth. This result is in agreement with the only previous work on this species of Sanders and Morgan (1989) who gave b = 3.03 in the Gulf of Suez.
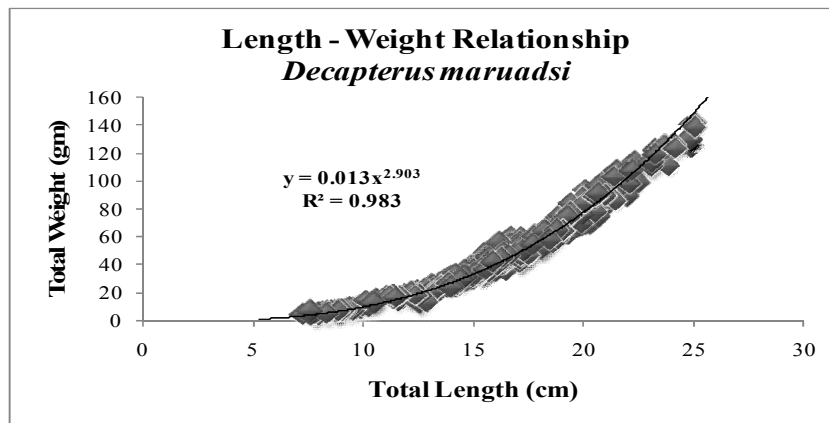

Fig. 2: Length – Weight Relationship of Japanese scad *Decapterus maruadsi*

Growth Parameters & Growth Performance Index

The values of von Bertalanffy constants "L_∞ and K" estimated by the methods of Powell (1979) - Wetherall (1986) and ELEFAN I (Pauly, 1987) for *D. maruadsi*, are showed in Fig. 3. It is clear that there is a good agreement between the values of the two applied methods. So, the values obtained by Powell - Wetherall were chosen for subsequent calculations. The obtained values of L_∞ & K for *D. maruadsi* were 27.31 cm and 0.53/year, respectively and the computed value of Ø' was 2.60. Sanders and Morgan (1989) had calculated the values of L_∞ and K as 25 cm and 0.41/y, respectively for the same species in the Gulf of Sue
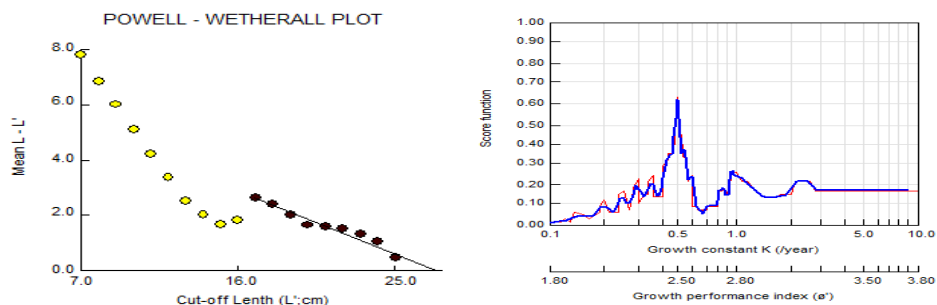

Fig. 3: Powell – Wetherall and ELEFAN I plots of Japanese scad *Decapterus maruadsi*

Mortality and Exploitation Rates

Total mortality coefficient (Z), estimated from two methods; Jones and Van Zalinge (1981) and Pauly (1983) were found to be 1.74 and 1.86/y, respectively (Fig. 4) with a mean value of 1.80/y. The mean value of natural mortality coefficient (M) was 0.61/year, correspondingly the value of fishing mortality coefficient (F) was 1.19/y. The estimated exploitation ratio (E) was 0.66/year, which seemed to be higher than the optimum level of exploitation (E = 0.5), this is based on the assumption that a stock is optimally exploited at E = 0.5 when F equals M (Gulland, 1971). So, this high value of "E" indicating that the stock of *D. maruadsi* is overexploited. Sanders and Morgan (1989) had estimated the values of Z, M, F and E for the same species in the Suez Gulf as 2.3, 0.7, 1.6 and 0.7/y, respectively.
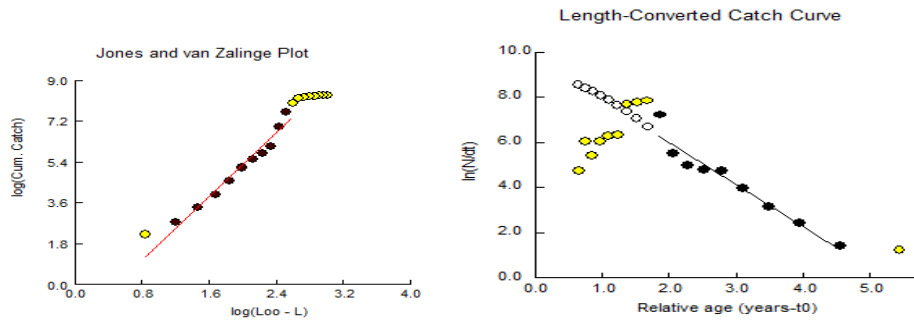

Fig. 4: Cumulative catch curve and Length converted catch curve of Japanese scad *Decapterus maruadsi*

Critical Lengths

The obtained value of L_r for *D. maruadsi* was 7.3 cm, while the value of L_c was 12.2 cm, whereas the value of L_m was 12.3 cm (Fig. 5). From results, it is clear that the estimated value of L_c was lower than the estimated L_m, which was an evidence of over-fishing that prevent them from spawning at least once before being fished.
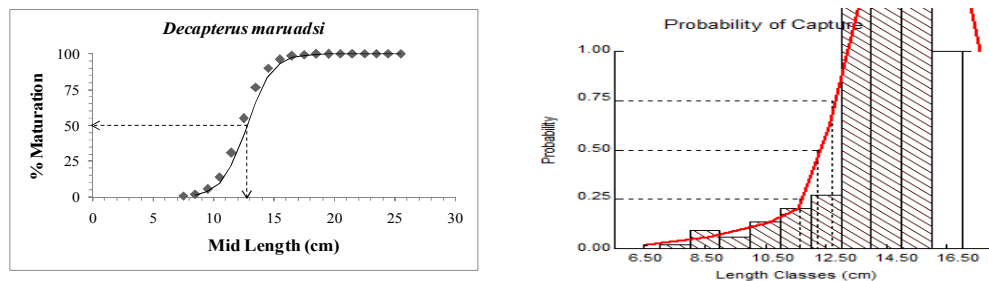

Fig. 5: Lengths at first maturity and at first capture for Japanese scad *Decapterus maruadsi*

Relative Yield per Recruit

The exploitation level which will result in a reduction of the unexploited biomass by 50% "$E_{0.5}$", and the exploitation level which give the maximum relative yield per recruit "E_{max}" for *D. maruadsi* were estimated from the plot of Relative Yield per Recruit (Y'/R) against E that showed in Figure (6). The estimated values of $E_{0.5}$ and E_{max} were 0.35 and 0.63, respectively and both values were found to be lower than the value of current exploitation rate (0.66 /year).
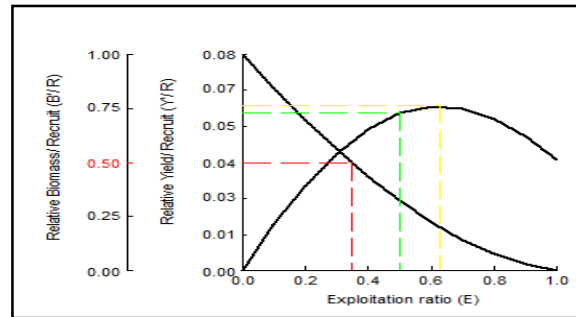
Fig. 6: Relative yield per recruit curve of Japanese scad *Decapterus maruadsi*

In conclusion, it is clear from results that; not only, the investigated fish species *D. maruadsi* is undergo high values of exploitation rates, where it has "E" higher than 0.5, but also exceeded the values of $E_{0.5}$. For management purpose, the current exploitation rate of investigated pelagic fish species *D. maruadsi* should be reduced from 0.66 to 0.35 to maintain a sufficient spawning biomass.

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ARABIC SUMMARY

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تعييـــــن معامـــلات النــمو، الوفيــات و الإنتــــاج لكل وحدة جيل لأسماك الباغة المبرومة فى خليج السويس، البحر الأحمر ، مصـــر

سحر فهمى مهنا¹ ــ مجدى توفيق خليل²ــمحمود حسين³ ــ سامح الكفراوى³
آسار صلاح الشربينى¹
١ـ المعهد القومى لعلوم البحار والمصايد، فرع خليجى السويس والعقبة، مصر
٢ـ قسم علم الحيوان، كلية العلوم، جامعة عين شمس القاهرة، مصر
٣ـ الهيئة القومية للإستشعار عن بُعد وعلوم الفضاء

تم تقييم مخزون سمكة "الباغة المبرومة" من خلال تحليل ١٨٦٤ عينة (الجنسين معا)، تم تجميعهم من خليج السويس خلال موسم الصيد سبتمبر ٢٠١١ وحتى مايو ٢٠١٢. وقد إعتمدت هذه الدراسه على تعيين معاملات النمو، فَوجد أن أقصى طول نظرى (L∞) لهذا النوع هو ٢٧,٣١ سم وأن معامل النمو (k) هو ٠.٥٣ لكل عام.

تم حساب معدلات النفوق الكلى والطبيعى والناتج عن عمليات الصيد ووجدت كالتالى: ٠,٨٠ و ٠,٦١ و ١,١٩ لكل عام على التوالى بالإضافة إلى تقدير معدل الإستغلال وهو ٠.٦٦ لكل عام. كما تم حساب الطول عند أول مصيد (١٢,١٢سم) والطول عند أول نضوج جنسى (١٢,٣ سم). وبتحليل معدل الإنتاج لكل جيل من سمكة الباغة المبرومة فى خليج السويس بإستخدام نموذج بيفرتون وهولت، وجد استغلال عالى لهذا النوع، مما يتطلب تبنى استراتيجية لتنظيم هذا المصيد وذلك لضمان المحافظة عليه وتنمية إنتاجه.

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