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MAXIMUM SUSTAINABLE YIELD OF THE ROUND HERRING, *ETRUMEUS TERES* AND SLIMY MACKEREL, *SCOMBER JAPONICUS* IN THE GULF OF SUEZ.

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Key words: Round herring; slimy mackerel; fishery statistics; surplus production models; Schaefer model; maximum sustainable yield.

ABSTRACT

Fishery statistics (catch, effort and catch per unit of fishing effort) of the round herring, *Etrumeus teres*, and slimy mackerel, *Scomber japonicus*, from the Gulf of Suez during the fishing seasons from 1989/1990 to 2001/02 were analysed. The surplus production model of Schaefer (1954 & 1957) was applied to estimate the maximum sustainable yield "MSY" and the corresponding level of fishing effort "f_{MSY}" for both species. The obtained results indicated that, the two fish stocks are overexploited and the maximum sustainable yield of them can be obtained through the reduction of fishing effort by about 47.6% for *E. teres* and 45.9% for *S. japonicus*.

INTRODUCTION

Round herring, *Etrumeus teres* (family: Clupeidae), and slimy mackerel, *Scomber japonicus* (family: Scombridae), are of great economic importance in the Gulf of Suez fisheries. They are exploited by purse-seine fishery and contributed about 25.27 and 11.05% of the total purse-seine production, respectively. Despite the economical importance of purse-seine fishery in the Gulf of Suez, where it represents about 76% of the total annual fish production from the Gulf, few studies concerning the evaluation of the status of the exploited stocks by purse - seine were published (Sanders and Kedidi, 1984; Azab *et al*., 1998; Mehanna, 1999 a&b, 2001 & 2002 and El-Gammal and Mehanna, 2001).

The present study represents an analysis of the data concerning catch, effort and catch per unit of fishing effort for the round herring, *Etrumeus teres* and slimy mackerel, *Scomber japonicus* in the Gulf of Suez as well as the estimation of the maximum sustainable yield (MSY) and the corresponding level of fishing effort (f_{MSY}) for the two species.

MATERIALS AND METHODS

Data concerning the fishing effort exerted into the purse-seine fishery represented by the number of landing as well as the round herring and slimy mackerel catches from the Gulf of Suez during the fishing seasons from 1989/90 to 2001/02 were obtained from the fisheries office of the General Authority for Fish Resources Development. Catch per unit of fishing effort is estimated as the total catch divided by the number of landing.

The surplus production model of Schaefer (1954 & 1957) was applied to calculate the maximum sustainable yield "MSY" and the corresponding level of fishing effort "f_{MSY}". The Schaefer's model expresses the yield per unit of fishing effort as a function of effort as follows:

$$Y/f = a + bf$$

where Y = catch, f = effort and a & b are constants whose values can be estimated by

least square method and the corresponding yield curve can be given by the following equation:

$$Y = af + bf^2$$

The curve has a maximum sustainable yield $MSY = -a^2 / 4b$ at an effort $f_{MSY} = -a/ 2b$.

RESULTS AND DISCUSSION

Description of the Fishery

About 84 purse-seiners are operated inside the Gulf of Suez at night using lighted dinghies. Each dinghy is equipped by about nine kerosene lamps each of about 100 watt candle power. All fishing operations cease for approximately ten days during each month when the moon is full. The nets' lengths varied between 200 to 300 m and their depths ranged from 50 to 80 m. The nets are hauled manually. The crew number on board of each ship ranged between 25 and 40 persons.

The purse-seine fishery is seasonal, generally from October to May. Since the fishing season 1996/97 and up to now, the fishing has paused each year from May to the end of September. At the beginning of each season, the fishing trip takes only three to five days duration because the fishing operation is undertaken relatively close to the landing site at Ataka. Later in the season, fishing trip takes more days, about 10 days.

Catch Composition

The dominant fish families and species are as follows: horse mackerel and scads (family: Carangidae) principally *Trachurus indicus, Decapterus macrosoma* and *D. maruadsi.* This group considered as the most abundant group in the catch (39.27%), followed by the round herring, *Etrumeus teres* (25.27%) (family: Clupeidae). Sardines (family: Clupeidae) principally *Sardinella gibbosa* and *S. jussieui* (11.18%) come in the third degree in the catch followed by slimy mackerel, *Scomber japonicus* (11.05%) then the indian mackerel, *Rastrelliger kanagurta* (2.98%) (family: Scombridae). In addition, the species of lesser importance or unsorted species were grouped in the "others" category.

Catch Statistics

The annual total catch of the purse-seine fishery, the round herring catch and slimy mackerel catches are shown in Figure 1. The total catch of the purse-seine fishery shows a great fluctuation from season to another with a maximum value of 26153.7 tons during the fishing season 1992/93 and a minimum value of 8531 tons during the 1998/99 fishing season with a mean of 15706.13 tons (during the period from 1989/90 to 2001/02). On the other hand, round herring, *E. teres* catch varied between 14882 tons during the fishing season 1992/93 and only 514.8 tons during the fishing season 2001/02 with a mean of 3968.46 tons. The slimy mackerel, *S. japonicus* catch fluctuated between a maximum of 5249.2 tons during the fishing season 1992/93 and a minimum of 239.5 tons during the fishing season1998/99 with a mean of 1735.6 tons.

Fishing Effort

The fishing effort represented by the number of landing varied between a minimum of 2433 during the fishing season 1989/90 and a maximum of 3312 landing during the fishing season 2000/01.

Catch Per Unit of Fishing Effort

The catch per unit of fishing effort for the round herring and slimy mackerel expressed as catch per landing are given in Figure 2.

The values of the round herring catch per unit of fishing effort varied between a maximum of 5.1 ton/landing during the 1992/93 fishing season and a minimum of 0.16 ton/landing during the 2001/02 fishing season. In respect to slimy mackerel catch per unit of fishing effort, it ranged between a maximum of 1.85 ton/landing during the fishing season 1990/91 and a minimum of 0.077 ton/landing during the fishing season 1998/99.

Surplus Production Models

In the stock assessment studies, the effort and catch per unit of fishing effort statistics are essential as they constitute the basic input for the surplus production models. Both provide indices related to the fishing mortality and the density of the exploited stock. The surplus production models allow to estimate the optimum level of effort that produces the maximum sustainable yield without affecting the long term productivity of the stock. To evaluate the effect of fishing effort expressed as the number of landing on the stocks of round herring and slimy mackerel in the Gulf of Suez, the surplus production model of Schaefer (1954 & 1957) was applied to estimate MSY and f_{MSY} of the two stocks. Also, 2/3 f_{MSY} as a target reference point has been determined. The obtained results are represented in Figures (3 and 4).

The application of Schaefer (1954) model to the round herring catch and effort data gives a maximum sustainable yield of 13291.7 tons with a corresponding effort of f_{MSY} = 1658 landing (the catch during 2001/02 is 514.8 tons). This means that the present level of fishing effort (f = 3164 landing) is higher than that produces MSY by about 47.6%. The use of 2/3 f_{MSY} criteria, which is the fishing at effort level which allow about 80% of the MSY to be harvested with a significant reduced risk, gives a sustainable yield of 11811.8 tons. To achieve this level of fishing effort (2/3 f_{MSY} = 1105 landing), the present level of fishing effort must be reduced by about 65.1% (Fig. 3). The target control is more conservative than threshold, and defines a desired rate of fishing and acceptable levels of stock biomass. So, the use of 2/3 f_{MSY} as a target reference point is safer than the use of the limiting or threshold reference point (f_{MSY}).

In respect to slimy mackerel, a maximum sustainable yield of 4441.6 tons (the catch during the fishing season 2001/02 is 326.6 tons) can be obtained at fishing effort equal to 1712 landing. This means that the present level of fishing effort should be reduced by about 45.9%.The use of 2/3 f_{MSY}, gives a sustainable yield of 3947.6 tons. To obtain this level of fishing effort, it should be reduced from 3164 to 1141 landing (63.9%).

The result based on f_{MSY} and 2/3 f_{MSY} indicated clearly that the stocks of round herring and slimy mackerel in the Gulf of Suez are in a situation of overfishing. For the rational exploitation of these two stocks the present level of the fishing effort should be reduced. It means the reduction of fish production costs with an increase in the round herring catch as well as slimy mackerel catch and consequently fish price can go down.

The obtained results are in a good agreement with the findings of Sanders and Kedidi (1984). They concluded that, the stocks exploited by purse-seiners in the Gulf of Suez are fully exploited and any additional effort to the purse-seine fishery will be associated with an annual decrease in the catch.

Mehanna (1999 a&b), 2001 & 2002) estimated the yield per recruit of *Decapterus macrosoma, Trachurus indicus, Rastrelliger kanagurta* and *Scomber japonicus* in the Gulf of Suez, and came to the conclusion that, these fish stocks were overexploited. She also found that, the maximum yield per recruit can be obtained by reducing the fishing mortality which is related to the fishing effort by about 38%, 33%, 51% and 50% for *D. macrosoma, T. indicus, R. kanagurta* and *S. japonicus* respectively.

El-Gammal and Mehanna (2001) estimated the maximum sustainable yield and the corresponding level of fishing effort for total purse - seine catch based on the surplus production models of Schaefer (1954) and Fox (1970). They found that the fish stocks exploited by the purse-seine fishery in the Gulf of Suez during the period from 1987/88 to 1998/99 are overexploited and to obtain the maximum sustainable yield, the present level of fishing effort should be reduced.

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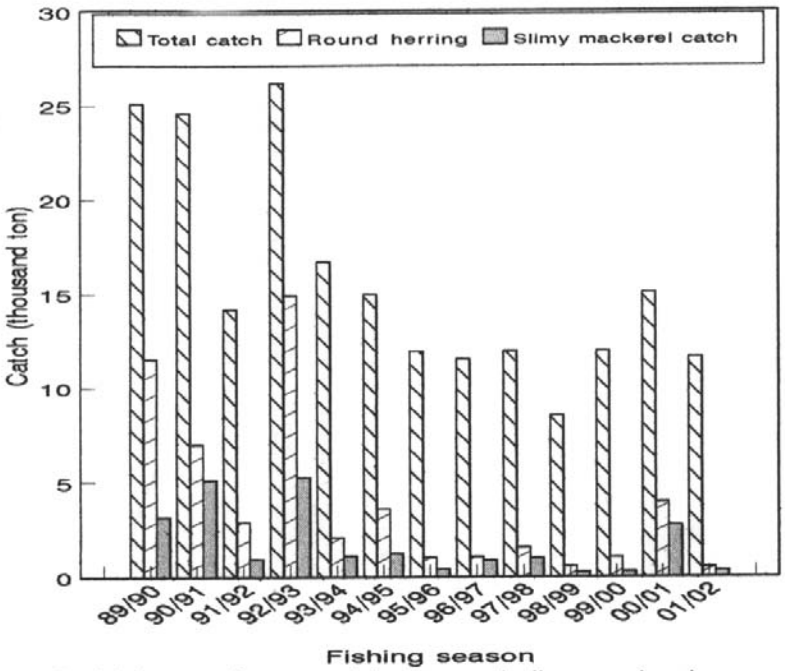

Fig.(1).Purse-seine, round herring and slimy mackerel catches from the Gulf of Suez.

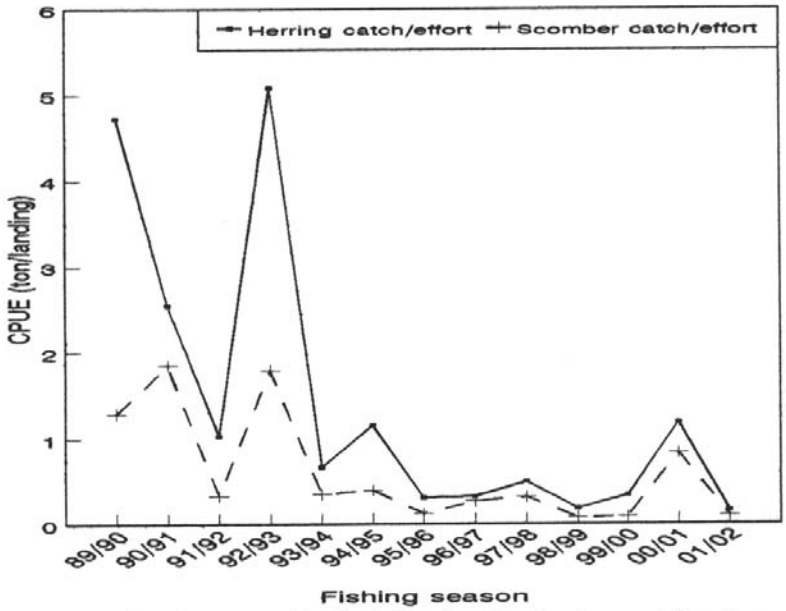

Fig.(2).Catch per unit effort (ton/landing) of round herring and slimy mackerel from the Gulf of Suez.

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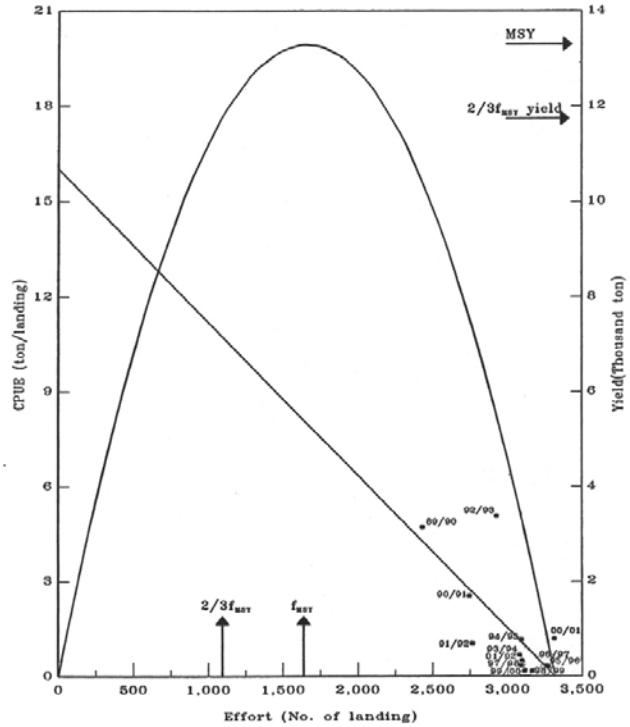

Fig.(3). Maximum sustainable yield(MSY) and the corresponding level of fishing effort (f_{MSY}) of round herring in the Gulf of Suez using the model of Schaefer(1954).

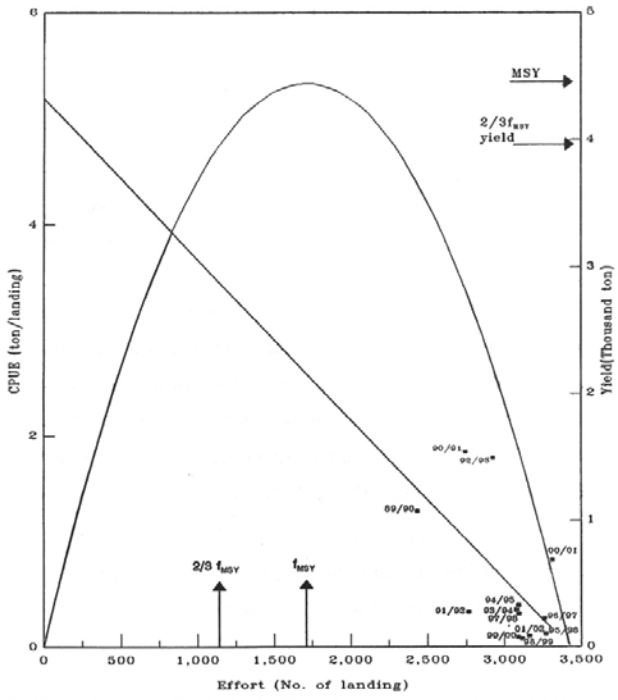

Fig.(4). Maximum sustainable yield(MSY) and the corresponding level of fishing effort (f_{MSY}) of slimy mackerel in the Gulf of Suez using the model of Schaefer(1954).