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ESTIMATION OF YIELD PER RECRUIT OF Solea solea (LINNAEUS, 1758) IN LAKE BARDAWIL, EGYPT.

By

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ABSTRACT

The total mortality coefficient "Z", natural mortality coefficient "m" and fishing mortality coefficient "F" of males, females and sexes combined of Solea solea in Lake Bardawil were estimated. The obtained results indicated that males are characterized by a higher values of "Z", "M" and "F". The yield per recruit estimates showed that the present level of fishing mortality coefficient (F = 1.054 per year) is nearly the same as the fishing mortality coefficient which produce the maximum yield per recruit. The effect of natural mortality coefficient and age at first capture on the yield per recruit were estimated and discussed.

INTRODUCTION

Lake Bardawil can be considered as one of the most important lakes in Egypt, since several fish species produced from the lake are for export. Among these fish species is Solea solea. The present study is undertaken to estimate the mortality and yield per recruit of Solea solea in order to achieve a proper management policy for the development of sole fishery in the lake.

MATERIALS AND METHODS

The present study was based upon monthly samples of Solea solea collected from Lake Bardawil during the fishing season 1987.

Otoliths were used for age determination, the Von Bertalenfy growth parameters L_∞, K, W_∞ and $t_\circ$ were estimated using the methods of Ford (1933)-Walford (1946), Gulland & Holt (1959) and Chapman (1960).

The total mortality coefficient "Z" was estimated by the following methods :-

- Analysis of catch curve based on age composition data using the methods of Chapman & Robson (1960) and Ricker (1983).

- Analysis of catch curve based on age composition data using the methods of Jones & van Zalinge (1981) and Pauly (1983).

The natural mortality coefficient "M" was calculated by the methods described by Ursin (1967). In this methods the natural mortality coefficient "M" can be calculated as a decreasing function of the body weight as follows $M = W^{-1}/3$

where M is the natural mortality coefficient per year.

The yield per recruit (Y/R) was calculated using the formula suggested by Gulland (1983) as a simple form of the model of Beverton & Holt (1957). The formula is as follows:-

$$Y/R = F\, e^{-M\,(Tc-Tr)}\; W_\infty \left[\frac{1}{Z} - \frac{3S}{Z+K} + \frac{3S^2}{Z+2K} - \frac{S^3}{Z+3K}\right]$$

where, F : the fishing mortality coefficient.

M : the natural mortality coefficient.

t_c : Mean age at first capture.

t_r : Age at recruitment.

W_∞ : Asymptotic weight.

Z : Total mortality coefficient.

K : Growth coefficient.

$t_\circ$: Theoretical age at length zero.

S : $e^{-K\,(Tc\,-\,to)}$

RESULTS AND DISCUSSION

Length - frequency distribution

The length frequency distribution of males, females and sexes combined of Solea solea collected from Lake Bardawil during the fishing season 1987 are given in (Table 1). As seen from the Table, it is obvious that the length composition of males ranged between 15.0 and 24.9 cm, while the length frequency of females varied between 15.0 and 28.9 cm.

Age composition

The age composition of Solea solea in the catch varied according to sex. The maximum age for males and females was found to be fou, six years respectively. Fishes of age 11 were the most abundant and contributed 52.83% and 52.79% for males and females, respectively (Table 2). It is also evident that both males and females are fully recruited to the fishery at age group II.

Growth parameters

The von Bertalanffy growth parameters for growth in length and in weight are given in (Table 3). The obtained results showed that females have a higher asymptotic length $L\infty$ and weight $W\infty$ than males. On the other hand males are characterized by a higher value of "K" than females, indicating a higher diminution of growth rate of males with the increase in length.

Mortality

1- Total mortality coefficient "Z"

The total mortality coefficient "Z" was estimated by the analysis of catch curve based on age composition data (Table 4) by the methods of Chapman & Robson (1960) and Ricker (1975) as well as the analysis of catch curve based on length frequency data (Table 1) by the methods of Jones and van Zalinge (1981) and Pauly (1983). The obtained estimates are the first for Solea solea in Lake Bardawil. The results indicate that males of Solea solea are characterized by relatively higher total mortality coefficient than females (Table 4). This may be attributed to differences in the behavior of males and females or that males are more vulnerable to the fishery than females of the same size.

Table (1): Length frequency distribution of Solea solea collected from Lake Bradawil during the fishing season 1987.

Length Groups	Males		Females		Sexes combined	
	No.	%	No.	%	No.	%
15.0-15.9	5	2.36	2	0.39	7	0.96
16.0-16.9	7	3.30	5	0.96	12	1.64
17.0-17.9	6	2.83	10	1.93	16	2.19
18.0-18.9	16	7.55	10	1.93	26	3.56
19.0-19.9	16	7.55	25	4.81	41	5.61
20.0-20.9	31	14.62	68	13.10	99	13.54
12.0-12.9	52	24.53	105	20.23	157	21.48
22.0-22.9	43	20.28	108	20.81	151	20.66
23.0-23.9	20	9.43	76	14.64	96	13.13
24.0-24.9	16	7.55	55	10.60	69	9.44
25.0-25.9	---	---	33	6.36	35	4.78
26.0-26.9	---	---	14	2.70	14	1.92
27.0-27.9	---	---	5	0.96	5	0.68
28.0-28.9	---	---	3	0.58	3	0.41
Total	212	100	519	100	731	100

Table (2): Age composition of Solea solea collected from Lake Bardawil during the fishing season 1978.

Age Group	Males		Females		Sexes combined	
	No.	%	No.	%	No.	%
0	2	0.34	1	0.20	3	0.41
I	48	22.64	74	14.26	122	16.70
II	112	52.83	274	52.79	386	52.80
III	40	18.87	100	19.27	140	19.15
IV	10	4.72	50	9.63	60	8.21
V	--	--	15	2.89	15	2.05
VI	--	--	5	0.96	5	0.68
Total	212	100	519	100	731	100

Table (3): The Von Bertalanffy growth parameters for Solea solea collected from Lake Bardawil during the fishing season 1987.

		L_∞	K	t_0	W_∞
Ford-Walford	Males	26.29	0.497	-1.143	161.37
	females	30.22	0.330	-1.529	263.36
	Sexes - cobmined	30.04	0.336	-1.519	254.03
Gulland & Holt	Males	26.29	0.487	-1.217	161.37
	Females	30.22	0.323	-1.636	263.36
	Sexes - cobmined	30.05	0.333	-1.559	254.29
Chapman	Males	26.31	0.495	-1.148	161.75
	Females	30.22	0,323	-1.636	263.36
	Sexes - cobmined	30.06	0.336	-1.509	254.55

Table (4): Estimated total mortality coefficient "Z" of Solea solea collected from Lake Bardawil during the fishing season 1987 (values per year).

Method	Males	Females	Sexes combined
Chapman & Robson (1960)	1.440	1.283	1.322
Ricker (1975)	1.208	0.990	1.093
Jones & Van Zalinge (1981)	1.356	1.284	1.327
Pauly (1983)	1.374	1.215	1.323
Mean	1.345	1.193	1.266

Table (5): Natural mortality and fishing mortality coefficients of Solea solea collected from Bardawil during the fishing season 1987 (values per year).

	Males	Females	Sexes combined
Natural mortality coefficient "M"	0.235	0.210	0.212
Fishing mortality coefficient "F"	1.110	1.983	1.054

2- Natural mortality coefficient "M"

The natural mortality coefficient "M" was calculated by the method described by Ursin (1967) for the North Sea Plaice. In this method the natural mortality coefficient is a simple decreasing function of the body weight as follows :-

$$M = W^{-1/3}$$

where M : is the natural mortality coefficient (per year)
and W : is the total weight in gram.

The estimated natural mortality coefficient of the males, females and sexes combined of Solea solea from Lake Bardawil are given in (Table 5). The obtained results showed that the natural mortality coefficient "M" of males is higher than that of females (M = 0.235 per year for males and 0.210 per year for females).

3- Fishing mortality coefficient "F"

The fishing mortality coefficient "F" was estimated directly by subtracting the values of the natural mortality coefficient "M" from the mean value of the total mortality coefficient "Z" as shown in (Table 5).

4- Yield per recruit (Y/R).

The yield per recruit was calculated using the analytical model of Beverton and Holt (1957). The fixed input parameters used in the calculation were :-

W_∞ = 250.03 gram.

K = 0.336 per year.

t_0 = - 1.519 year.

t_r = 0.6 year.

t_c = 2.11 year.

To evaluate the effect of fishing mortality coefficient "F" on the yield per recruit of Solea solea in Lake Bardawil during the fishing season 1987, the yield per recruit was calculated using the present level of natural mortality coefficient (M = 0.21210, and age at first capture (t_c = 2.11 year). The results indicated that, the maximum yield per recruit (70.16 gm.) was obtained with a fishing mortality coefficient of (F = 1.0)).

This means that, the present level of fishing mortality (F = 1.054) is nearly the same as the fishing mortality which produced the maximum yield per recruit. It is also evident that, the increase of fishing mortality above the present level will be associated with a decrease in the yield per recruit (Table 6).

To evaluate the effect of changing age at first capture (t_o), which is closely related to the estimation of the optimum mesh size, on yield per recruit, values of the yield per recruit were calculated using t_c = 1 & 3 and the present level of t_c (t_c = 2.11). The results of these calculations are given in (Table 6). The obtained results indicate that, for present level of fishing mortality coefficient, the decrease of age at first capture from t_c = 2.11 to t_c = 1.0 will be associated with a decrease in the yield per recruit (from 70.15 to 58.22 gm.), while the increase in age at first capture from 2.11 to 3.0 will be associated with a noticeable increase in the yield per recruit from 70.16 to 72.13 gm. (Table 6).

Table (6): Yield per recruit (gm) of Solea solea collected from Lake Bardawil during the fishing season 1987 as a function of fishing coefficient and mean age at first capture.

F	Y \ R		
	Tc = 1.00	Tc = 2.11*	Tc = 0.300
0.5	81.78	67.67	66.85
1.0	58.62	70.16	72.13
*1.054	58.22	70.15	72.34
1.5	55.40	69.73	73.26
2.0	54.16	69.09	73.57
2.5	51.59	68.53	73.64
3.0	50.43	68.88	73.63
3.5	49.56	67.71	73.60
4.0	48.88	67.40	73.56
4.5	48.33	67.15	73.51
5.0	47.88	66.94	73.47

* **The present level of the fishing mortality coefficient. and mean age at first capture.**

To study the effect of changing natural mortality "M" on the yield per recruit of Solea solea, the yield per recruit was calculated in which M = 0.1 & 0.3 and the present level of M (M = 0.212) and the results are given in (Table 7). As shown from the Table it is obvious that, at the present level of fishing mortality coefficient from M = 0.212 to m = 0.1 will be associated with an increase in the yield per recruit from 70.16 to 93.48 gm. and the increase of the natural mortality coefficient from M = 0.212 to M = 0.30 will be associated with a decrease in the yield per recruit from 70.16 to 56.48 gm.

Table (7): Yield per recruit (gm) of Solea solea collected from Lake Bardawil during the fishing season 1987 as a function of fishing and natural mortality coefficients.

F	Y \ R		
	M = 0.10	M = 0.212*	M = 0.300
0.5	99.43	67.67	51.20
1.0	93.48	70.16	56.45
*1.054	92.94	70.15	56.66
1.5	89.43	69.73	57.58
2.0	86.85	69.09	57.86
2.5	85.11	68.53	57.89
3.0	83.86	68.88	57.85
3.5	82.93	67.71	57.78
4.0	82.20	67.40	57.70
4.5	81.62	67.15	57.64
5.0	81.15	66.94	57.57

* The present level of the fishing mortality coefficient, and natural mortality coefficient.

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