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GROWTH, MORTALITY AND YIELD PER RECRUIT OF GILTHEAD SEA BREAM, *SPARUS AURATA* IN BARDAWIL LAGOON, NORTH SINAI, EGYPT

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ABSTRACT

Growth, mortality and yield per recruit of Gilthead sea bream, Sparus aurata were studied from a small scale fishery of Bardawil lagoon. 2775 specimens ranged between 11.9 to 36.1 cm cm TL and varied from 22 to 651 g total weight, were collected during, 2010. The relationship between length and weight was estimated as W= 0.0248*$L^{2\prime 82Ii}$ .The study showed that there are 6 age groups have been identified by reading the scales and growth rates were calculated in the corresponding lengths for different age groups in a manner back calculation as follows 17.74, 23.25, 27.6, 31.44, 32.85 ad 34.19 at the end of the first year, the second, and sixth, respectively. Age was determined using scales reading technique for 900 individuals and the longevity of this species was found to be 6 years. Growth in length and growth in weight at the end of each year were calculated. The growth parameters of the von Bertalanffy equation were calculated as Loo = 38.04 cm, K = 0.3381 yf and to =~ 0.7933 yr, natural and fishing mortality rates were 0.8420yr", 0.4551 yr~' and 0.3869 yr'[1], respectively. The currently exploitation rate (E = 0.4595) indicates that the stock of sea bream in the Bardawil lagoon under exploited. The length at first capture L_c was estimated as 20 cm. The length ai first maturity L_m of males and females were estimated as 20.0 and 24.5 respectively.

Key Words: Age, growth, yield per recruit, Sparus aurata, Bardawil lagoon, Egypt.

INTROUDACTION

Gilthead sea bream, *Sparus aurata* is economically a very important fish species in the Bardawil lagoon and in the general Mediterranean area. Gilthead sea bream (F. Sparidae) this family can be found in a wide variety of marine habitats, from rocky to sand bottoms, at depths between 0 to 500 m, although they are usually more common at less than 150m deep (**Abecasis *et al,* 2008).** The gilthead sea bream, *Sparus aurata* is a one of the main target demersal species of the trammel gear fishery in the lagoon. About 97% of the total catch of the lagoon come from the boats using the trammel nets.

In Bardawil lagoon, *Sparus aurata* is mainly exploited by two fishing techniques; trammel nets and hand line. The previous studies on the gilthead sea bream populations in the lagoon indicated that the exploited and fishing effort may have been above optimum levels for most demersal species **(Bebars., 1986&1992: Khalifa, 1995; Salem 2004; Khalil and Mehanna, 2006; Mehanna, 2006; Salem *et al,* 2008 and Salem 2011).**

This work carried out to supplement some information about Age, growth, yield per recruit and exploitation rates of *Sparus aurata* in Bardawil lagoon that could be useful for management of this important species.

MATERIALS AND METHODS

1. Study Region:

The study was carried out in the Bardawil lagoon (Fig. l).The lagoon covers an area of 693 km^2, in an arid area in the northern part of Sinai Peninsula, Egypt. It separated from the Mediterranean Sea by along narrow sandbar that varies in width between 100 m and 1 km.

The lagoon communicates with the Mediterranean Sea water by two artificial and one natural narrow channel.

The lagoon is considered as a natural depression with a depth of 0.5-3 m.

2. Sampling:

Random samples (2775 specimens) were collected from well mixed catches during the fishing season 2010. For age determination, the scales were removed from the left side of each fish behind the tip of the pectoral fin for 900 specimens.

In the laboratory, the scales were cleaned and stored dry in envelopes for the subsequent study. Later on, scales were soaked overnight in 10% ammonia solution. 5-7 scales were placed between two glass slides, and examined by a projector with 33 x magnifications.

On the clearest scale from each batch, the total scales radiuses as well as the radius of each annulus were measured to the nearest 0.01 cm.

3. Data Analysis:

The back-calculated total length at the end of each year was determined from scale measurements using Lea's, 1910 equation as $L_x = L_p (S_x/Sp)$, where: L_x equals length of fish at age (x), L_p equals the fish length at capture, S_x equals the scale radius at annulus x and S_p equals total scale radius.

The relationship between length and weight was described by the potential equation ($W= a*L^b$, **Ricker, 1975),** where W is the total weight (g), and L is the total length (cm), a and b are constants.

The calculated weight at the end of each year was estimated by applying length-weight equation. The von Bertalanfry growth equation (VBGE): L_t = La> (1- e"^{k} $^{(t"}$ V was used to describe growth in size, where L_t is the length at age t, Loo the asymptotic length, K the body growth coefficient and to the hypothetical age at which a fish would have zero length.

The values of Leo and K were estimated by plotting L, vs L_t+i using the Ford, 1933 - Walford, 1946 plot, while to was estimated by Gulland and Holt plot, 1959. For comparison of the growth parameters with previous studies, the growth performance index was calculated from the given by **Munro and Pauly, 1983** as <£>' = *Ln K + 2Ln U.* To estimate the instantaneous rate of total mortality (Z) using Jakson 1939 The instantaneous rate of natural mortality (M) was obtained by **Alverson and Camey(1975).**

The fishing mortality (F) was estimated by subtracting the value of natural mortality from the total mortality as F = Z - M, while the exploitation rate E = F/Z.

The length at first maturity *(L_m)* was determined by examination of gonads to determine the sex and the stage of maturity, where 50% of fish reach their sexual maturity was estimated by fitting the maturation curve between the percentage maturities offish corresponding to each length class interval. Then L_m was estimated as the point on the X-axis corresponding to 50% point on the Y-axis.

The probability of capture was

estimated from length-converted catch curve, using the running average technique to determine L50 **(Pauly, 1984b).** The method of **Gulland, 1969** was used to predict the yield per recruit as follows: Y' / $_{R}$ = p * $_{e}$ M(Tc-Tr) * $_{W(X}$* ^ $_{(1/Z}$j _ ($_{3S/Z+K}$) + (3S2/Z+ZK) - (S3/Z+3K)]

Where: S = e-$^{k(Tc\_T0)}$ K , tO = Von Bertalanfy growth parameter, Tc is age at first capture, Tr is age at recruitment, Wcc is asymptotic body weight, F is fishing mortality, M is a natural mortality and Z = F+M, is a total mortality.

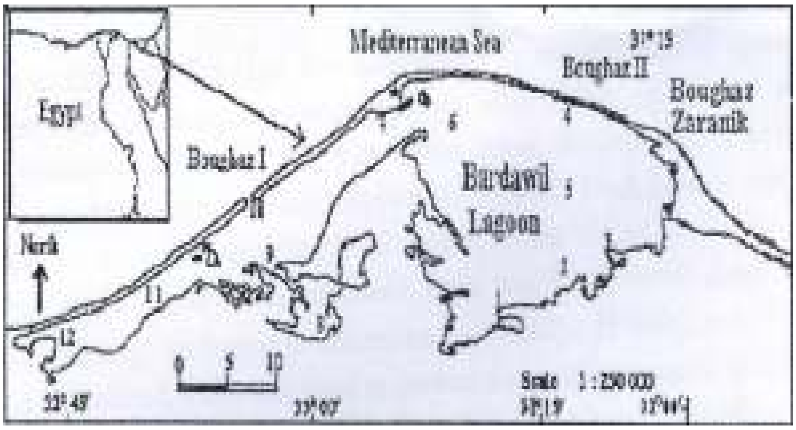

Fig. (1): The Bardawil lagoon

RESULTS AND DESICCATION

1. Age and growth

Scales reading for 900 individuals showed six age classes of *Spams aurata* in Bardawil lagoon during the fishing season 2010.

The percentage occurrence of these groups as 17.9, 29.3, 30.7, 15.3, 3.4, 1.9 and 1.4% for 0, 1, 2, 3, 4, 5 and 6 age groups respectively. This indicated that, the dominate of the young fish (0, 1 and 2-group fish, illegal size) while the age group five and six the least age groups in the catch (1.9 and 1.4 %).

The maximum estimated age (6 years) for *S. aurata* in Bardawil lagoon was recorded by Khalifa, 1995. Age groups and growth in length (average back - calculation lengths) were identified for *S. aurata* as 17.74, 23.25, 27.60, 31.44, 32.85 and 34.19 cm for ages 1st, 2nd, 3rd, 4^{lh}, 5th and 6th years respectively. The growth rate of *S. aurata* is particularly high during the first year of life, especially in this study.

After the first year, the annual growth rate drops rapidly. Table (1): summarized the back-calculated lengths of the present study compared with the other studies for the same species The observe total length ranged from 11.9 to 36.1 cm and the observed total weight varied from 100 to 651 g.

The length - weight relationship Fig. (2) was described by the power equation as:

W= 0.0248*L^{2,89},the negative allometry was established as the value of (b < 3).

The differences in length-weight relationship might be interpreted as being due to differences in growth and morphometry between regions **(Barnabe,**

Table (1): The length at the end of life year of *S. aurata* given by different authors

Region	sex	Age years	N	Total length at the end of life year 1	2	3	4	5	6	References
Bardawill lagoon	M	1--2	106	16.39	18.85					**Bebars. 1986**
seasons 1985/86	F	1--3	148	16.97	2(i.15	22.7				
Bardawill lagoon, season 1986	M+F	1--3	—	19.5	23.67	26.89				**Ameran, 1992**
Bardawill lagoon, Season, 1986	M+F	1--6	—	19.36	23.67	26.29	28.39		32. 16	**Khalifa. 1995**
Bardawill lagoon season 2000	M+F	1--5	1826	19.36	23.83	28 45	31.54	32.84		**Salem, 2004**
Bardawill lagoon season 2001	M+F	1--5	1835	20.2	25.2	27.6	29.8	32.3		
Port Said	M+F	1--4	1714	21.26	27.8	32.25	34.3			**Mehanna. 2007**
Bardawill lagoon, season, 2008	M+F	1--4	3483	22.82	27.09	30.03	31.5			**Salem, 2010**
Bardawill lagoon	M+F	1--4	3262	2338	27.51	30.21	32.15			**Salem, 2011**

1976) and it is a practical index of the condition of fish, and varies over the year according to factors such as food availability, feeding rate, gonad development and spawning period **(Bagenal and Tech, 1978).**
Growth parameters of von Bertalanffy were calculated as Loo= 38.04 cm, K = 0.34 year"^{1} and to = -0.793 year and the obtained equation was *L, = 38.04*(l-e o.34 (tu 793)^* **Mcllwain *et al.*, 2005** mentioned that the differences in growth parameters due to age, sex, maturity and sampling period for the same species. The value of growth performance index (<£>'*)* was calculated as 6.19.

The results showed a low growth performance index than in the previous studies, may be due to the lower value of A Constant of length-weight relationship and growth parameters for 5. *aurata* in Bardawil lagoon were summarized in Table. (2).

2. Length at first maturity *(L_m)*

The length at first maturity was estimated at 20.0 and 24.5 cm for male and female respectively (Fig. 3,4).

This result is close to that of Salem, 2004, 2011, for male while the length at first maturity is higher in this study, who observed that, the value of L_m for *S. aurata* in the same lagoon as 20.6 and 22.5 cm for male and female respectively.

Anna *et al,* 2005 recorded that, in the Mediterranean Sea, the species is becoming mature at smaller lengths compared to the other regions.

3. Mortalities and exploitation rate:

Total mortality (Z) was estimated as 0.842 yr^{-1}, while natural mortality (M) was estimated as 0.455 yr^{-1} and the fishing mortality rate.

We find that the high natural mortality may be due to the presence of fishing craft shrimp (Alklsh) that destroy the very large

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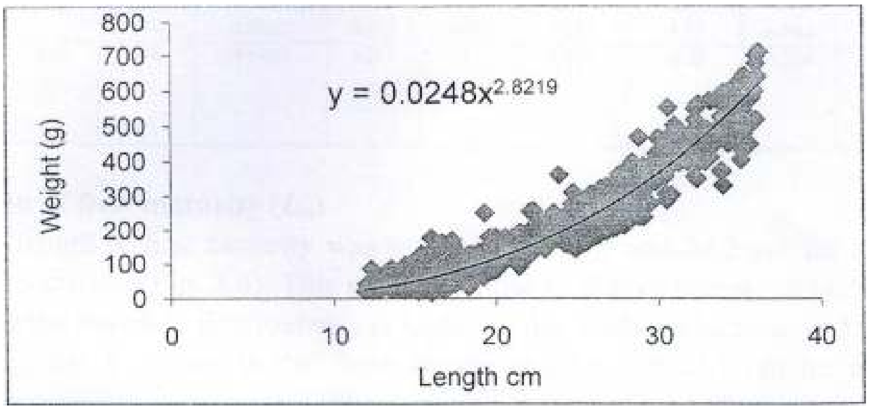

Fig.(2): Length - weight relationship of 5. *aurata* in Bardawil lagoon.

amounts of fish sea bream fry. These results indicated that, the natural mortality is increasing from year to year. This may be due to two factors:

1-shrimp trawl fishing, where the mortality of by catch either direct by capture the bream fmgerlings (very small mesh of the trawls used in this fishery) or indirect by accumulated the granules of clay and fine sand on gill lamellae of fingerlings (this method kill many fingerling of these species by increasing of turbidity in water).

2-Predators by the cormorant birds where it visit the lagoon in the critical seasons for the seabream fingerlings. The increasing of natural mortality from year to year linked with increasing of effort by shrimp trawl fishing and the fishing activity in most areas is mainly directed to juveniles on their nursery grounds according to the local fishermen. The higher natural mortality (.455 year-1) in this study versus previous study indicates the stock of sea bream under abnormal position. These results are consistent with those results obtained from **Salem *et al* 2008**. (F) was 0.387 year-1.

From these results, the current exploitation rate *(E = 45.95 %)* shows under exploited stock and safe according to **Gulland, 1971),** who suggested that the optimum exploitation rate for any fish stock is about 0.5 at F=M and more recent, **(Pauly, 1987)** proposed a lower optimum F that equal to 0.4 M and (**Patterson, 1992**) reported that an exploitation rate of about 0.4 is safe for the stock.

4. Length at first capture *(L_c)*

The length at first capture (The length at which 50% of fishes retained by the gear is the mean selection length, *Lc)* was estimated to be 20 cm, (Fig 5). In this study, the value of L_c was equal of the length at first sexual maturity *(L_m)* for male (20.0cm) and smallest length at first sexual maturity for the female (24.5 cm). From our results, the most of bream catch in Bardawil lagoon were below the length at first sexual maturity (immature fish), which must be having a chance to spawn 2-3 times before capture according to **(Grandcourt *et al.,* 2005)**.

5. The relative yield-per-recruit (Y7R) and biomass per-recruit (B/R):

The formula of **Gulland (1969)** was used for the calculation of yield per recruit, as follows: *T /'* R = F e $^{(\sim M (Tc - Tr)]}$ Woo [(1/Z) - (3S/(Z+K)) + ((3S^2)/(Z+2K)) -((S^J) /(Z+3K))] The input parameters used in the calculation were as follows in Table (5). As shown from the figure (6) there were clear that the curves starts at the origin where the yield per recruit was zero when the fishing mortality was zero.

Table (2): Constant of length weight relationship and the growth parameters of *S. aurata* in Bardawill lagoon.

Regions	Age (years)	N	Constants of length-weight relationship and growth parameters						References
Egypt			a	b	Loo	K	to	<P'	
Bardawil lagoon	1-4	3262	0.025	2.813	36	0.39	1.68	0.22	**Salem, 2011**
	1-6		0.014	2.98	38	0.34	0.96	.	**Khalifa, 1995**
	1-5	1537	0.013	3.035	38.5	0.297	1.08	-	**Tharwate/tf/., 1998**
	1-4	1835	0.014	3.017	35.2	0.58	0.74	6.58	**Salem. 2004**
Port said	1-4	1714	0.012	3.028	38	0.5	-0.6	-	**Mehanna, 2007**
	1-4	1947	0.027	2.79	32.7	0.81	-	6.76 5	**Salem *etai.* 2008**
	1-4	3483	0.030	2.76	34.2	0.48	0.78	6.33	**Salem. 2010**
Other regions									
Thau (France)	1-4	713	0.0226	2.SS(>	62	0.221	-0.077	6.745	**Lasserre & Labourge. 1974.**
Ebro (Spain)	1-7	611	$112*10^7$	3.055	62.1	0.171	-0.63	6.494	**Suau and Lopez, 1976**
Mima (Croatia)	1-12	314	0.0112	3.052	59.8	0.153	-1.71	6.303	**Kraljevic and Duleic. 1997**
Mellah Lagoon (Algeria)	1-7	370	0.0129	3.067	55.3	0.513	-0.28	7.359	**Chaoui,e/a/.,2006**

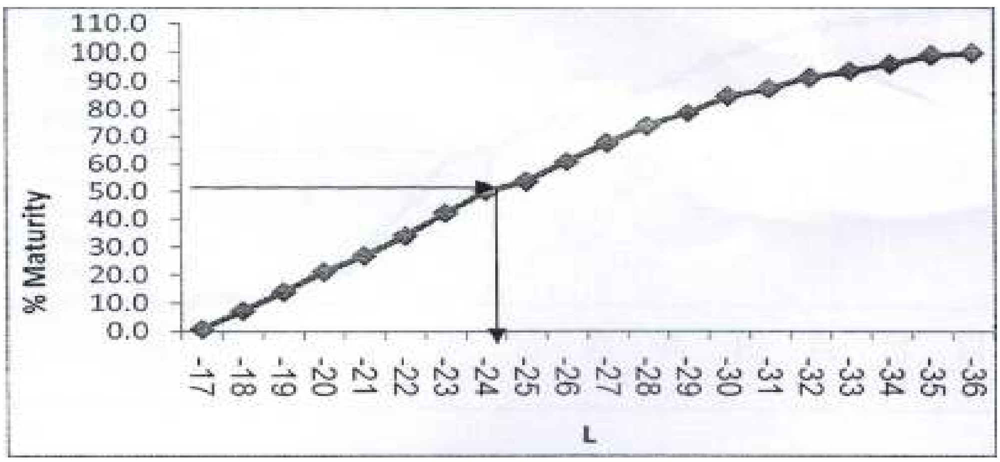

Fig (3): Length at first maturity for males of S. *aurata* in Bardawill lagoon 2010.

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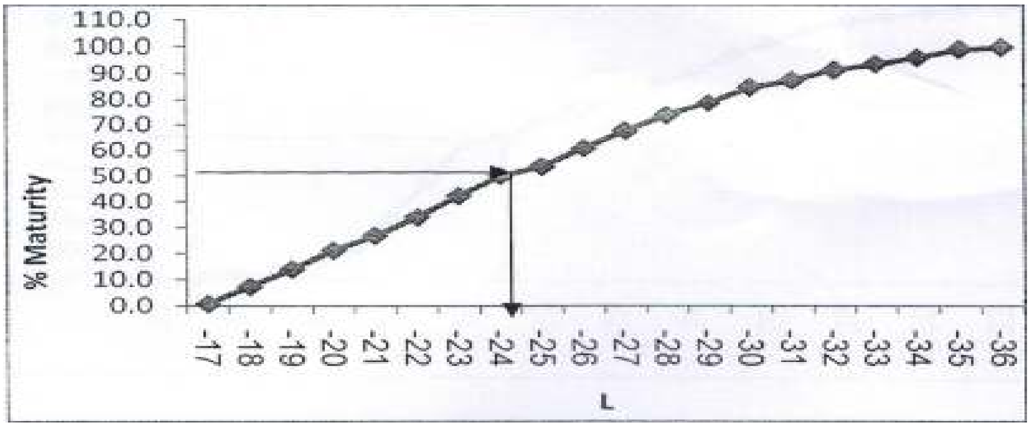

Fig (4): Length at first maturity for females of *S. aurata* in Bardawill lagoon 2010.

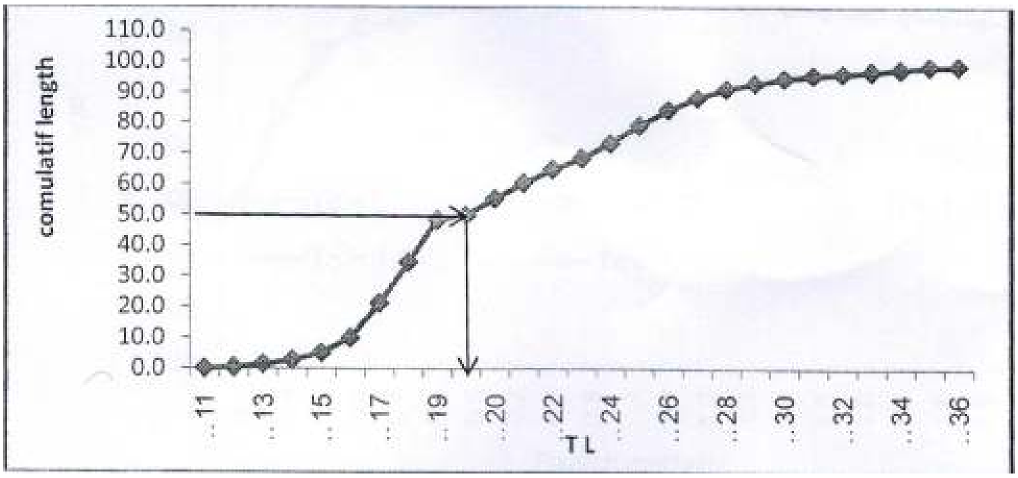

Fig (5): Length at frist capture of *Sparus aurata* in Bardawill lagoon 2010.

Table (5): Input parameters used in the calculation yield per recruit for *S. aurata* in Bardawill lagoon, 2010.

The parameters	Season 2010
Length infinity Lcc	38.04
Weight infinity W<x>	714.3
Growth constant K	0.3381
Natural mortality M	0.4551
Fishing mortality F	0.3869
Total mortality 2	0.8420
Mean age at recruitment Tr	0.3161
Mean age at first capture Tc	1.4127
Mean length at first capture Lc (cm)	20.00
Mean length at recruitment Lr (cm)	11.9
Theoretical age at length zero To	-0.7933
Mean length $L^{\%}$	21.59
Exploitation rate E	0.46
L_c- =	25.2000

Then the yield per recruit increased rapidly as the fishing mortality increased and a maximum value of yield per recruit was reached, after which the yield per recruit decreased with further increasing in fishing mortality.

Table (6) also showed that the present fishing mortality (F = 0.38 and age at first capture (Tc = 1.41) gave a yield of 61.89 gram per recruit.

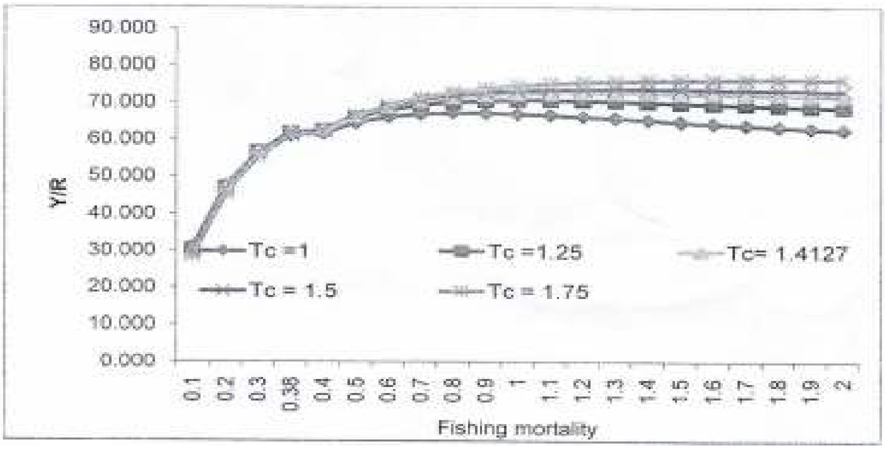

Fig (6): Y/R of S. aurata during 2010 a function of different fishing mortality and age at the first capture.

Table (6): Yield per recruit (Y / R) of *S. aurata* during 2010 a function of different fishing mortality and age at the first capture.

F	T_c=l	T_CH.25	T_c=1.4127	T_c=1.5	T_t=1.75
0.1	30.928	30.352	29.857	29.556	28.569
0.2	47.330	47.006	46.559	46.248	45.106
0.3	56.427	56.646	56.452	56.245	55.291
0.38	61.056	61.812	61.897	61.817	61.139
0.4	61.579	62.418	62.546	62.486	61.855
0.5	64.487	65.939	66.399	66.496	66.232
0.6	66.071	68.094	68.873	69.123	69.229
0.7	66.850	69.394	70.468	70.861	71.321
0.8	67.133	70.144	71.487	72.013	72.804
0.9	67.107	70.537	72.123	72.769	73.864
1	66.888	70.692	72.498	73.253	74.627
1.1	66.551	70.689	72.693	73.547	75.175
1.2	66.143	70.581	72.764	73.708	75.568
1.3	65.697	70.404	72.749	73.775	75.846
1.4	65.232	70.182	72.673	73.773	76.039
1.5	64.763	69.931	72.556	73.724	76.167
1.6	64.298	69.665	72.411	73.640	76.246
1.7	63.842	69.389	72.246	73.533	76.288
1.8	63.400	69.112	72.070	73.409	76.302
1.9	62.973	68.835	71.887	73.274	76.295
2	62.562	68.563	71.701	73.132	76.271

The results in season 2010 indicated that the maximum yield per recruit was obtained with a fishing mortality coefficient F = 1.75. It was also evident the increase of present fishing mortality coefficient (F = 0.38) to F_{max} (F -1.8) would be associated with negligible increase in the yield per recruit (73.30 - 61.89 =11.41). This means that increase of fishing mortality coefficient by about 17.56%.

To investigate the variation in yield per recruit with changing of age at first capture T_c, which was closely related to the estimation of the optimum mesh size, in season 2010 the yield per recruit of £ *aurata* was calculated using T_c = 1.0, 1.25, 1.5 and 1.75 with the present age at first capture (T_c - 1.41) and the results are given in table (6) and graphically represented by fig. (6). The results indicated that the maximum yield per recruit increased when the age at first capture increased.

This means that increase of age at first capture can be associated with increase of the maximum yield per recruit in spite of increasing of the fishing mortality (Table. 6).

CONCLUSION

It may not be easy to achieve a balance between the low voltage and the social and economic needs of fishermen, but the application of the optimum mesh size may be not difficult in terms of increased Tc to 1.75 years, which achieved the highest yield in the current fishing effort.

Recommendation:

We can recommend that, the current effort of *S. aurata* should be stabilized and if possible should be reduced. Attempts should be made to increase the length at first capture from 20 cm. to 25 cm. (change of current to optimum mesh size) to help escapement of immature fish that in turn may help recoup the fishery in subsequent years.

If this is not carried out immediately, there is a possibility of damage to the *S.aurata* fishery in near future.

Must stop the use of shrimp fishing craft trawel (Alklsh) in Lake Bardawil because they destroy the very large numbers of sea bream fingerlings Fish.

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الملخص العربي

النمو والنفوق والإمداد لأسماك الدنيس ببحيرة البردويل ،شمال سيناء مصر

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٥. مركز بحوث الأحياء المائية بالعباسية

تم إجراء هذا البحث فى بحيرة البردويل لعمل دراسة على مخزون أسماك الدنيس *Sparus aurata* ووضع خطة علمية عملية لإدارة مصيد هذه الاسماك ببحيرة البردويل. تم تجميع ٢٧٧٥ عينة فى الفترة من أبريل حتى ديسمبر خلال موسم الصيد ٢٠١٠. قيست اطوال العينات من ١١,٩ الى ٣٦,١ سم مقابل الاوزان من ٢٢ الى ٦٥٠جم، وكانت العلاقة بين الطول والوزن من خلال المعادلة التالية حساب $W=0.0248*L^{2.8219}$. وأوضحت الدراسة أن ٦ مجموعات عمرية بالبحيرة تم تحديدها عن طريق قراءة القشور وحسبت معدلات النمو فى الاطوال المقابلة للمجموعات العمرية المختلفة بطريقة الحساب الرجعى على النحو التالي ١٧,٧٤، ٢٣,٢٥، ٢٧,٦، ٣١,٤٤، ٣٢,٨٥، و٣٤,١٩ سم عند نهاية السنة الأولى، الثانية، الثالثة، الرابعة، الخامسة، السادسة على الترتيب. قيم معاملات النمو لفون بيرتلانفى كانت كالتالي: الطول عند ما لا نهاية = ٣٨,٠٤سم، معامل النمو=٠,٣٣٨١/ سنة والعمر الصفري= -٠,٨٤٢٠ ، النفوق الطبيعي =٠,٤٥٥١. النفوق بالصيد= ٠,٣٨٦٩/ سنة ومعدل الاستغلال = ٠,٤٥٩٥ وأظهرت النتائج أن الطول عند بداية النضج الجنسي كالتالي :٢٠سم و٢٤,٥سم للذكور والاناث على الترتيب وكان الطول عند بداية الصيد ٢٠سم عند عمر ١,٤سنة. ويتضح من الدراسة أن هناك صيد جائر للأسماك صغيرة الحجم ولذلك يجب رفع الطول عند بداية الصيد الى ٢٥سم حتى يزيد عن الطول عند بداية النضج الجنسي ٢٤,٥ (يتم ذلك باستخدام فتحات شباك أكبر من الحالية) وكذلك يجب وقف الصيد بحرفة كلسة الجمبري فى بحيرة البردويل التي تدمر كميات كبيرة من إصبعيات أسماك الدنيس.

الكلمات الاسترشادية: النمو ، النفوق ، الإمداد، أسماك الدنيس، بحيرة البردويل، الصيد الجائر.

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