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STUDIES ON PRODUCTION PER BIOMASS OF THE NILE CATFISH *SYNODONTIS SCHALL* (BLOCH - SCHNEIDER) OF THE RIVER NILE , EGYPT

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KEY WORDS: Production per biomass, Simulation analysis, Allowable biological catch, Fish population dynamics, Nile catfish.

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ABSTRACT

In the River Nile from Giza to Assuit , males of *Synodontis schall* attain their first sexual maturity at smaller size and slightly earlier age compared to females. The estimated survival rate of the population was 35% per year. The current exploitation of *S.schall* was computed to be 0.52. Simulation analysis of production per biomass (P/B) was made to evaluate changes that may occur if the fishing pressure increased or decreased. P/B ratio of juvenile *S.schall* increases with increase of the fishing effort ,while the reverse is the case for adult population. Maximum Sustainable Yield (MSY) was predicted to occur at 0.5 fishing mortality coefficient, where this level of exploitation would be expected to cause a shift toward larger sizes of fish and virtually eliminate fish in the small size-classes (immature fishes).

INTRODUCTION

The importance of the River Nile as one of the main resources of fish production in Egypt encouvaged many investigators to study the Nile fishes for a long time. Most of these previous studies were concerned with the morphology, classification, food analysis and some biological aspects (Boulenger,1907; Karam,1940; Nawar and Yoakim,1964; Gohar etal.,1972; Latif,1974; Kamel and Yoakim,1977; Abass, 1982; Hassan &EL-Dawi,1992 and Kheir,1993). However, few recent studies were focused on the stock assessment as well as fish population dynamics of some Nile fishes (Tharwat,1995; Tharwat *et al.*,1997; Tharwat and Emam,1997 and Tharwat and EL- Dawi,1997). So, the present work is a complementary part of the fishery studies on the Nile fishes regarding the production per biomass (P/B) of the common Nile catfish *Synodontis schall* under the current management strategy. Simulation analysis was also made for P/B under the different levels of fishing mortality. This study aims to evaluate the exploitation status of the fish stock and to estimate the target fishing effort which leads to the maximum sustainable yield for *S.schall* at the long run.

MATERIALS AND METHODS

During the period from January 1996 to December 1997, total samples of 746 females and 536 males of *Synodontis schall* were fished monthly using the common trammel gill nets (the mesh size of the inner layer ranged between 2.5 and 3.5 cm) in the area extending from Giza to Assuit (about 500Km) of River Nile, Egypt. Date of capture, total length(cm), total weight (g) were recorded for each fish. The fifth anterior vertebra was removed and selected as a suitable skeletal structure for age determination as *S.schall* has not scales, and its otoliths were very difficult to remove because they are covered by the hard bony cephalonuchal shield. Moreover, the vertebrae were used as the best bony structures for aging by several investigators (Appelget and Smith,1951; EL-Bolock,1972; EL-Sedfy,1978 and Kheir,1993). The constants of length-weight relationship were computed from the emperical data by applying the statistical least square method. The equation of Lee,1920 was used for back-calculations of fish lengths at the end of each year of life. Von Bertalanffy growth parameters of the mathematical model ($L\infty$,K and t_0) were estimated by using the method of Ford (1933) and Walford (1946). The natural mortality coefficient(M) was calculated with applying Pauly's formula (1980). The total mortality coefficient(Z)was extracted from the catch curve according to Pauly (1983). Biomass, production and production per biomass ratios (P/B) based on a cohort basis were computed by the method of Allen (1950 1971). Statistical analysis were performed using the analysis of variance (Stell and Torrie 1960).

RESULTS

ANALYSIS OF THE CATCH

Table (1) shows the length-weight relationship and the accumulative relative abundance for each length interval of *Synodontis schall* in the catch. The fish total length ranged between 11 - 41cm with an average of 24.4cm, and the total weight of fish ranged from 20 to 600 gm with an average of 149.6 gm. The estimated equation of the regression line between Log.length and Log. weight for 1282 specimens of combined sexes of *S.schall* can be represented by:

$$\text{Log.W} = -1.5894 + 2.7118 \text{ Log.L} \quad \text{or} \quad W = 0.0257 \cdot L^{2.7118}$$

This relation between length (L) and weight (W) has high correlation coefficient ($r = 0.998$).The results also indicated that small fish size less than 23cm T.L. or 113.1gm T.W. represented about 56% from the catch.

AGE AND GROWTH

The longivety of *S.schall* attained 5 years at the investigated area of the River Nile, mean back- calculated lengths and weights at the end of each year of its life span are shown in Table 2. The highest increment in length (15cm) occurs during the first year, while the highest increment in weight (107g) occurs through the fourth year of life (Table 2). The annual increment revealed two patterns of growth with age, the first is a gradual decrease of the growth in length with age, while the second is a gradual increase of the growth in weight with age. On the other hand, the age frequency distribution of *S.schall* in the catch indicated that the harvested fishes that belong to the young-age groups I and II constituted about 56% of the total catch. Age group III which included about 50% of mature fishes (age at first sexual maturity) represented 35.1% of the population. However, all mature fishes that belong to older age groups IV and V constituted only 8.9% of the population.

SIZE AND AGE AT FIRST SEXUAL MATURITY

Investigation of the maturity stages of the ovaries and testes for each specimen of *S.schall* during all months of the year revealed that males

attained their first sexual maturity slightly earlier than females. The length at first sexual maturity (L_{m50}) was 26 cm for males and 28 cm for females (Fig. 1). These lengths correspond to age at first sexual maturity (t_{m50}) of 2.66 and 3.00 years for males and females, respectively.

MORTALITY AND EXPLOITATION RATIO

The estimated total mortality coefficient (Z) of *S.schall* from the catch curve was 1.06 per year (Fig. 2). That means, the rate of total mortality equals to 65% and the survival rate is 35% in the population. However, the calculated values for both natural and fishing mortality coefficients were 0.51 and 0.55, respectively. Consequently, the current exploitation ratio of fish stock represented 0.52 yearly. The present results may indicate that there a slightly overfishing occurs for the population of *S. schall* in the River Nile from Giza to Assuit under the current fishery exploitation.

PRODUCTION PER BIOMASS (P/B)

Simulation analysis of production and biomass of *S.schall* that inhabits the River Nile was made for the five age groups under the range of fishing mortality(F) from 0.35 to 0.75. Production per biomass (P/B) was computed for both young-age groups O^+ , I^+ and II^+ representing the immature fish population (Juvenile stock) and the old-age groups III^+ and IV^+ including all mature fishes (spawning stock). The results in Table 3 showed that P/B ratios for both Juvenile and spawning stocks under the current fishing mortality (F=0.55) were 1.29 and 0.92, respectively. While, in the case of using the target fishing mortality of 0.5 the P/B ratio of spawning population can be raised to 1.00 instead of 0.92 and relatively lowered to 1.23 for Juvenile. It was also obvious that P/B values of spawning population were decreased gradually from 1.10 to 0.51 with the increase of fishing mortality from 0.35 to 0.75 (Table 3). Inversely, the values of P/B for the Juvenile were increased gradually from 1.12 to 1.56 by increasing thefishing pressure. In general, Juvenile population of *S.schall* exhibits high annual P/B ratios than the adult fishes, which may be due to extremely efficient food utilization (high specific growth rates).

DISCUSSION AND CONCLUSIONS

In the present study, production per biomass (P/B) of the Nile catfish *S. schall* was separately investigated for both of young and old age groups.The high P/B ratios correspond to more abundant young ages, while low P/B ratios correspond to more abundant old ages. On the other hand, the result of simulation analysis indicated that the P/B ratio of *S. schall* increased with increasing of fishing pressure for Juvenile population, while an inverse picture was observed for adult population, i.e. increasing fishing pressure lowered P/B ratio of the adult stock. Similar relationship was observed for some species in the River Nile; e.g. *Oreochromis aurea*, *O.galilaeus*, and *Tilapia zillii* (Tharwat,1995), and *O. niloticus* (Tharwat et al. 1997).

Among 18 estimates of annual P/B (average,1.2) for brown trout in a Wisconsin stream, Brynildson and Brynildson(1984) reported high ratios of 2.2 - 3.3 in 4 years when age-groups 0 and 1 were strong ,and ratios of 0.4 and 0.8 in 2 years when age- groups 0 and 1 were weak.

The P/B ratio has been summerized in several reviews (Mortensen 1977; Waters 1977; Mann and Penczak 1986). Most of these studies suggest a fairly consistent annual P/B of about 1.0--1.5 for stream resident trout populations. However, important differences among species have been reported recently. For example, Waters etal.(1990) found different P/B ratios among three species of stream trout. These different P/B ratios were inversely related to age structure of the populations. A population of Juvenile rainbow trout had two or three age-groups and an annual P/B of 2.2 population of brook trout with four age groups had an annual P/B of 1.7, and a population of brown trout with six age-groups had an annual P/B of 0.9. Waters (1992) estimated the annual P/B ratios for three species of trout populations, their values were 2.0 for anadromous rainbow with 2 or 3 years, about 1.5 for brook trout with 4 years, and about 1.0 for brown trout with 5—8 years. From the above mentioned information it can be concluded that:

- The strength of different age-groups within a given species may affect the P/B ratio. Strong young age -groups raise the ratio, whereas weak young age groups lower the ratio.
- The annual P/B ratios varied with the number of age-groups in the population.

- The P/B ratios of young age-groups were higher than P/B of old age groups.
- The percentage of immature fish in the catch constituted about 74% of the total number.
- The fishery of *S.schall* in the River Nile from Giza to Assuit is relatively overexploited under the current total mortality rate of 65% which lead to lower the mean fish size in the catch as a result of high fishing pressure and gear selectivity.

On the basis of the present results it is recommonded that fishing mortality (F) must be lowered from 0.55 to 0.50 to reach the optimum exploitation of fishery resources as well as maximum allowable catch of the River Nile catfish *S.schall* on the long run.

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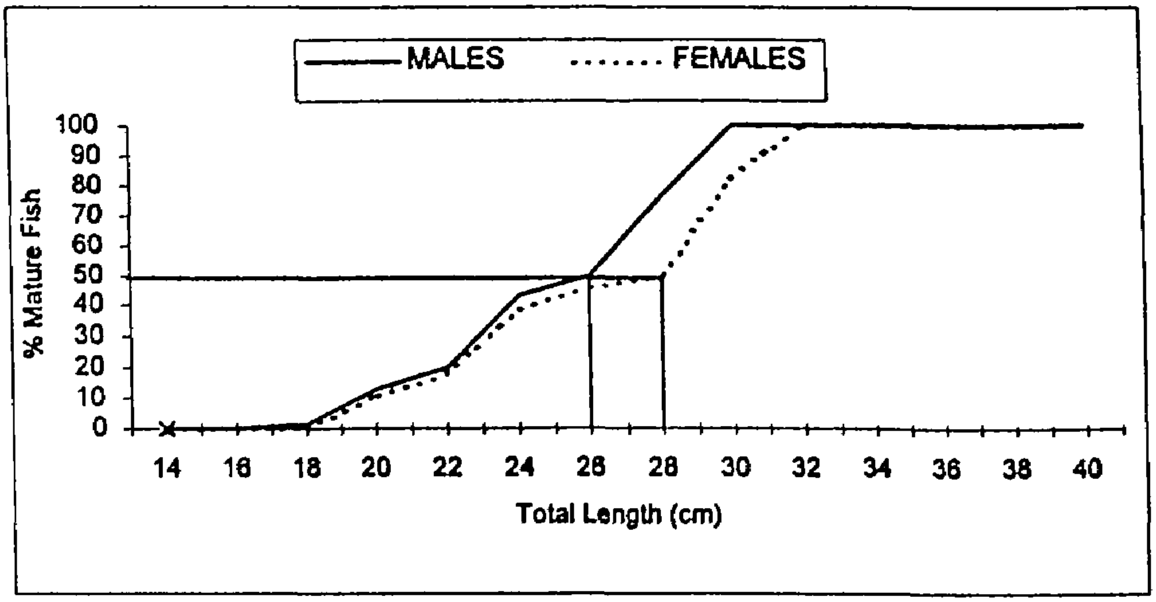

Fig (1): The percentage of mature males and females of *S. schall* in the successive length groups to estimate the size at first sexual maturity (L_{m50}).

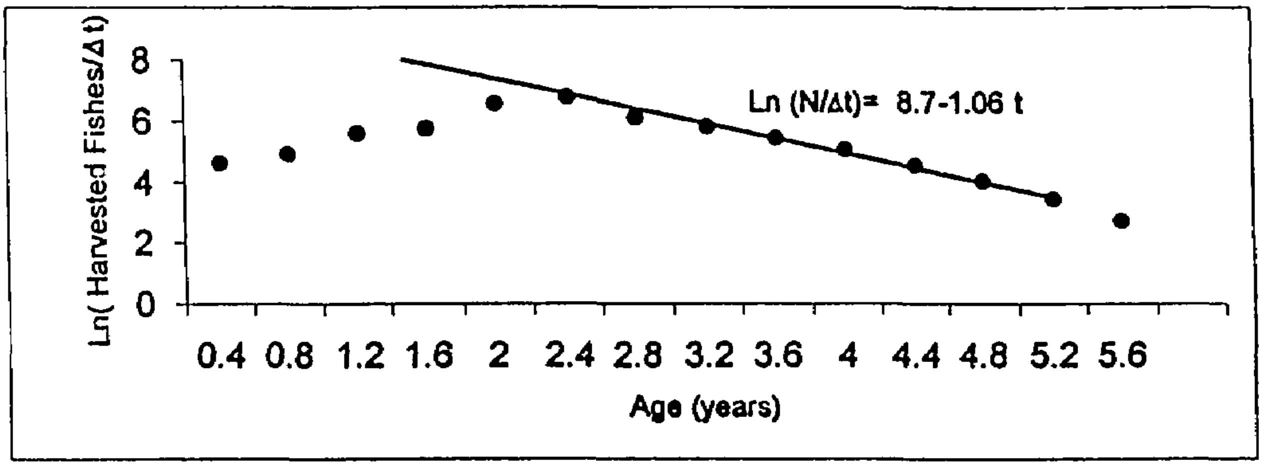

Fig (2): Catch curve based on fish length converted to relative age for estimation of total mortality coefficient (Z) of *Synodontis schall.*

Table (1): Mean individual size of *S.schall* distributed with its relative abundance in the catch.

TOTAL LENGTH (cm)	FREQ.	CATCH %	OBSERVED WEIGHT (gm) MEAN + S.D.	CALCULATED WEIGHT (gm)
11---13	24	1.87	21.4 ± 2.58	21.7
13---15	36	2.81	33.0 ± 4.12	33
15---17	72	5.61	47.9 ± 5.74	47.4
17---19	91	7.10	65.8 ± 5.82	65.3
19---21	210	16.38	88.4 ± 6.45	86.9
21---23	286	22.31	113.1 ± 6.70	112.5
23---25	152	11.86	141.7 ± 7.52	142.4
25---27	129	10.06	175.4 ± 7.63	176.9
27---29	98	7.64	217.1 ± 8.30	216.3
29---31	70	5.46	261.5 ± 9.74	260.8
31---33	46	3.59	308.6 ± 10.52	310.7
33---35	31	2.42	365.1 ± 11.12	366.2
35---37	20	1.56	425.1 ± 12.97	427.6
37---39	11	0.86	496.6 ± 14.50	495.2
39---41	6	0.47	570.2 ± 15.16	569.1
TOTAL	1282	100		

Table (2): Age frequency, mean back-calculated total lengths (T.L.) and weights (T.W.) and the percentage of annual increment of *S. schall* at the end of each year of life.

AGE (year)	CATCH COMPOSITION		MEAN FISH SIZE		ANNUAL INCREMENT		%INCREMENT	
	FREQ.	%	T.L.(cm)	T.W.(gm)	T.L.(cm)	T.W.(gm)	T.L.	T.W.
I	132	10.3	15.0	39.6	15.0	39.6	41.7	9.3
II	586	45.7	21.9	110.5	6.9	70.9	19.2	16.7
III	450	35.1	28.0	215.0	6.1	104.5	16.9	24.6
IV	77	6.0	32.5	322.0	4.5	107.0	12.5	25.2
V	37	2.9	36.0	424.8	3.5	102.8	9.7	24.2
TOTAL	1282	100.0			36.0	424.8	100.0	100.0

Table (3): Simulation analysis of production per biomass (P/B) for Juvenile and adult stocks of *S. schall* under different levels of fishing mortality.

FISHING MORTALITY (F / YEAR)	PRODUCTION PER BIOMASS (P/B)	
	JUVENILE	ADULT
0.35	1.12	1.10
0.40	1.15	1.08
0.45	1.17	1.05
0.50	**1.23**	**1.00**
0.55	**1.29**	**0.92**
0.60	1.35	0.83
0.65	1.41	0.70
0.70	1.49	0.62
0.75	1.56	0.51

دراسات على الانتاج بالنسبة لمخزون أسماك الشال فى نهر النيل بمصر

عادل أحمد ثروت

قسم الانتاج الحيوانى- كلية الزراعة -جامعة القاهرة.

فى الدراسة الحالية وجد أن ذكور أسماك الشال تصل إلى بداية النضج الجنسى عند حجم وعمر مبكراً قليلاً عن الإناث. وإن معدل البقاء المقدر للعشيرة هو ٣٥٪ سنوياً. وأن الاستغلال الحالى لأسماك الشال يعادل ٠,٥٢.

إستخدم تحليل نظام المحاكاة للإنتاج بالنسبة للمخزون وذلك لتقييم التغيرات التى قد تحدث عند زيادة أو خفض جهد الصيد وقد تبين أن نسب الإنتاج بالنسبة لمخزون أسماك الشال الصغيرة (الغير ناضجة جنسياً) زادت مع زيادة جهد الصيد بينما حدث تناقص فى الإنتاج بالنسبة لمخزون الأسماك الكبيرة (الناضجة جنسياً) مع زيادة جهد الصيد.

ومن الدراسة تبين أن أقصى محصول سمكى يمكن الحصول عليه بدون استنزاف للمخزون السمكى يكون عند معامل صيد قدره (٠,٥) حيث أن هذا المستوى من الإستغلال يعمل على زيادة الإنتاج السمكى من الأسماك الأكبر حجماً ويقلل من صيد الأسماك الصغيرة الحجم التى لم تصل إلى بداية النضج الجنسى.