Assessment of *Oreochromis aureus* caught by different fishing techniques at Lake Borollus, Egypt.

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ABSTRACT

Evaluation of *Oreochromis aureus* caught from Lake Borollus was studied based on the length-frequency of samples collected by different fishing gears. Analysis of the data using (FiSAT) computer program returned the estimate of the von Bertalanffy's growth curve parameters as: L_∞ = 18.28 cm (total length); k = 0.87 year^{-1} (for Lokaffa), L_∞ = 19.32 cm; k = 0.41 year^{-1} (for Trammel), L_∞ = 17.19 cm; k = 0.42 year^{-1} (for Basket traps) and L_∞ = 14.55 cm, K=0.39 year^{-1} (for Al-qerba). Very narrow selection range was observed and its upper limit didn't exceed 11.53 cm in most of the investigated fishing gears except that of trammels which reached 12.11 cm. The total mortality coefficient "Z" was found to be 3.05, 1.83, 1.46, and 1.58 year^{-1} corresponding the fore-mentioned fishing methods respectively. Also, their respective natural mortality coefficient "M" was 1.67, 1.01, 1.06, and 1.06 year^{-1}. The estimated exploitation rate "E" was 0.45, 0.45, 0.28 and 0.33 respectively. Their relative yield and relative biomass per recruit analysis showed that the stock of *O. aureus* is moderately exploited and more effort could be added to reach the maximum sustainable yield and at the same time larger mesh sizes of fishing nets should be used to increase the mean lengths at first capture and also to conserve the reproducible part of *O. aureus* population.

Keywords:

INTRODUCTION

Egypt has various inland fishery resources, namely the Nile River including its irrigation canals, six northern coastal lagoons (Mariut, Edku, Borollus,Manzala, Port Fouad and Bardawil). All of these lakes, with the exception of Lake Mariut, are directly connected to the sea (El-Ganainy, 2006).

Borollus Lake is a region of outstanding importance in terms of its contribution in of fish food security. This Lake is considered as one of the important fishing areas in Egypt. The annual fish production of Borollus Lake during 2009 was found to be 53401 tons representing about 47.2% of the northern Nile Delta lakes. Tilapia species represent major category of the catch (38.81 %), followed by catfish (21.74%) and gray mullet (14.44), (GAFRD, 2009).

Tilapia species in Lake Borollus are represented by *Oreochromis niloticus, Oreochromis aureus*, *Sarotherodon galilaeus* and *Tilapia zillii*.

Fishing activity has been proposed as the first major human disturbance to coastal areas (Jackson *et al* 2001), and evidence of fishing activity going back to ancient times.

Both of the passive and active fishing gears are used in the lake Borollus. Among the passive gears are basket traps, gill nets and trammel nets, while the active gears were are mostly the dragged gears such as Lokaffa and Alqerba (Local names).

The biology of various aspects of Tilapia species have been studied by many authors e.g. Khalifa *et al*., 2000 ; Abd-Alla and Talaat, 2000; Khallaf *et al*., 2000; and

Khallaf, 2002. Fishing gears used in this study were mainly investigated by Al-Sayes, 1976, 2002 & 2005. While few studies concerning the fishing activities impacts on fish populations were carried by Ishak *et al*. (1985); El-Bokhty (2006, 2009 & 2010).

The present study is an attempted to estimate the fishing activities impacts on the dynamic parameters of *Oreochromis aureus* population in the Lake Borollus using the length frequency data in a predictive analysis. This may help in the sustainable management of Tilapaia spcies in this lake.

MATERIAL AND METHODS

Fish samples of the commercial catch of *Oreochromis aureus* were taken by various gears working at Lake Borollus was undertaken during 2002 - 2003.

These gears are traditional ones used for the last 50 years without introducing significant modifications to either their designs or fishing techniques.

Trammel net is the most common one at lake Borollus and used to catch Tilapia and grey mullet. Hanging of three walls of webbing to a single cork or lead line makes the trammel net.

Lokkafa is a sack like net some 8.0 m long fastened to a wodden frame shaped like an inverted (V): The net is funnel shaped, hanged to the side of the boat while in operation where it is laid down during sailing to drag the bottom of the fishing area.

El-Kerba net is more or less similar to Lokkafa in its fishing technique although smaller in size where a triangle frame having a sharp iron base forming the base of the triangle.

Basket traps used at lake Borollus are of the non return basket type. A typical trap has one hoop horizontally elliptical. To attain good catch these traps are set usually among aquatic vegetations.

The length frequency distributions of *O. aureus* were analyzed using the appropriate routines and subroutines of the "FiSAT" computer program (Gayanilo *et al.*, 1997). An estimate of the asymptotic length (L_∞) and the growth coefficient (K) were obtained by the method of Wetherall (1986). The parameters were then used as seed values in ELEFAN I routine (Pauly, 1984 a &b) for estimating the best combination of L_∞ and K.

The instantaneous rate of total mortality (Z) was derived from the length converted catch curve method described by Pauly (1983). The instantaneous rate of natural mortality (M) was computed from the empirical equation of Pauly (1983) considering the mean annual temperature of the lake as 22°C (Alsayes *et al* 2007).

The instantaneous rate of fishing mortality (F) was extracted as F=Z–M. The exploitation ratio was calculated as E = F/Z. The length at first capture "L_c" was determined from the catch curve according to Pauly (1984a & b).

The relative yield per recruit $(Y/R)'$ and relative biomass per recruit $(B/R)'$ were estimated by using the model of Beverton and Holt (1966) as modified by Pauly and Soriano (1986) and incorporated in the FiSat software package as follows;

$$(Y/R)' = E\, U^{M/K} [1 - (3U/1+m) + (3U^2/1+2m) - (U^3/1+3m)]$$

$$(B/R)' = (Y/R)' / F$$

Where $(Y/R)'$ is the relative yield per recruit,

$(B/R)'$ is the relative biomass per recruit,

M is the natural mortality coefficient,

F is the fishing mortality coefficient,

K is the growth parameter,

E is the exploitation rate or the fraction of deaths caused by fishing,

$m = (1-E)/ (M/K) = K/Z$, and $U = 1 – (L_c / L\infty)$

RESULTS AND DISCUSSION

Lake fishery characteristics

The total annual catch of Tilapia from Lake Borollus during the period 2000-2009 (GAFRD, 2009) fluctuated between a minimum catch of 51768 ton in 2000 and a maximum catch of 59785 ton in 2002 with an average of 55207 ton showing a tendency of oscillation with a decreasing trend (Table 1 & Fig. 1).

Table 1: Total annual fish catch landed from Lake Borollus during 2000 – 2009.

Year	Total Catch(ton)
2000	51768
2001	59200
2002	59785
2003	55500
2004	55000
2005	53909
2006	52956
2007	58291
2008	52260
2009	53401
Av. Catch	55207

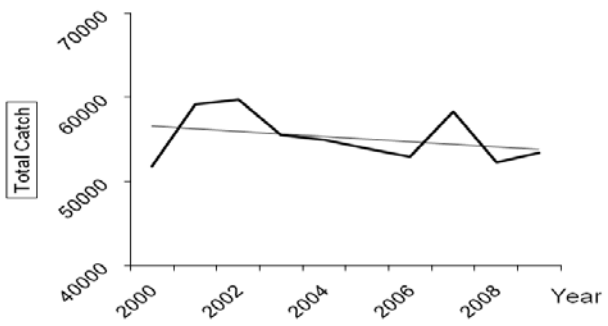


Fig. 1: Total annual fish catch of Lake Borollus during 2000 – 2009.

Tilapia fish formed the majority of fish catch from the lake (38.81 %) followed by catfish (21.74 %) while the mullets represented only 14.44 % in year 2009. Recently, the decline in the landed catch of tilapia fish was in parallel with an increase of both catfish, mullets and other groups. Hence, the lake total fish catch seems nearly steady with slightly decrease during the last few years, (GAFRD, 2009). Unfortunately, the species constituents of tilapia fish were not identified by GAFRD estimates. It was found that *Oreochromis aureus* and *Oreochromis niloticus* dominated the catch of most of the fishing methods in the lake in numerical order, while *O. niloticus* dominated by weight over the others (Al-Sayes, 2005).

Mortality estimates

Estimation of different mortality parameters were used to characterize the state of various fish populations and as input variables for bio-demographic models like those of Beverton and Holt (1957) and Pet *et al.* (1996). These models are applied to predict consequences of management measures, like changes in effort and mesh size, on the yield. The estimated vital population parameters of *O. aureus* are summarized in Table (2).

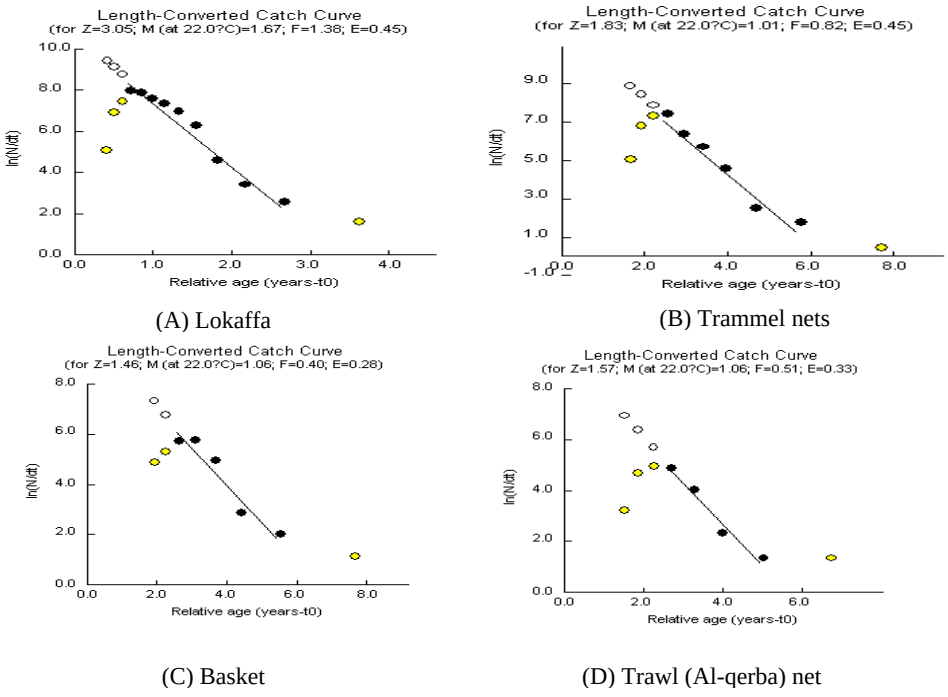
Mortality Rates

An estimate of the total mortality coefficient (Z) for *O. aureus* from the descending portion of catch curve (Fig. 2, a-e) was found to be 3.05, 1.83, 1.46, and 1.58 y^{-1} corresponding to Lokaffa net, Trammel net, Basket traps & Al-Qerba net. The values of Z for *O. aureus* by these fishing gears are closely similar except that corresponding to the fish caught by lokkafa nets, which may return to the higher effort exerted by such nets leading to over estimation and (or) population and locality differences compared with other gears and (or) zonal variations which may lead to variations in the population of *O. aureus*. The mean value of Z (1.98 y^{-1}) was found less than that recorded by Ishak *et al*. (1985) (2.626 y^{-1}). Also, this value is lower than that estimated by Dowidar *et al*. (1990) (2.2 y^{-1}) for Lake Manzalah. Meanwhile, the natural mortality (M) of *O. aureus* as determined from Pauly's equation (1980) was computed as 1.67, 1.01, 1.06, and 1.06 y^{-1} for the respective fishing gears.

Table 2: Estimated vital population parameters for *Oreochromis niloticus* caught by different fishing gears, at Lake Borollus during (2000-2003).

Method	L_∞	K	Z	R^2 (Z)	M	F	E
Lokkafa	18.28	0.87	3.05	0.9657	1.67	1.38	0.45
Trammel	19.32	0.41	1.83	0.9660	1.01	0.82	0.45
B. traps	17.19	0.42	1.46	0.9340	1.06	0.40	0.28
AlQerba	14.55	0.39	1.57	0.9701	1.06	0.51	0.33

Z: estimated from length converted catch curve, F = Z – M, E = F/ Z
R^2 (Z): determination coefficient of Z.



(A) Lokaffa (B) Trammel nets

(C) Basket (D) Trawl (Al-qerba) net

Fig. (2 A - D): Length converted catch curves of *O. aureus* caught by different fishing methods at Lake Borollus during (2002-2003).

The fishing mortality (F) is simply defined as the fraction of the average population taken by fishing. It was computed as 1.38 , 0.82 , 0.40 , and 0.51 y^{-1}

corresponding to the fishing methods in respective order (Table, 2) the differences between these rates could be attributed to the differences between the fishing gears (Dalzell, 1996) as some may catch a wide variety of sizes and species, while others (such as gill and trammel nets) may be very size selective taking only a relatively narrow ranges of lengths depending on the size of the mesh (Acosta. 1994) these findings indicated that *O. aureus* is subjected to moderate fishing mortality rates.

Exploitation Rate

The exploitation rates (E) of *O. aureus* were determined by using the formula of Gulland (1971) and were found to be 0.45, 0.45, 0.28 and 0.33 corresponding to the fore-mentioned fishing gears respectively. According to Gulland (1971), who suggested that in an optimally exploited stock, fishing mortality should be about equal to natural mortality, resulting in a fixed E_{opt} = 0.50. Thus, it was found that the stock of *O. aureus* is under the optimum level (E= 0.50).

Probability of capture and selection ranges

The length at first capture is strongly correlated with the mesh size of the net used. It was estimated as a component of the length-converted catch curve analysis. L_{50} values at which 50% of the fish that become vulnerable to capture were estimated to be 7.64, 11.24, 10.7 and 8.34 cm for *O. aureus* caught by lokaffa net, trammel net, basket traps and Al-Qerba net respectively. Shawky (1999) indicated the sizes of males and females of *O. quraeus* to attain their first maturity were 11.8 cm and 12.00 cm respectively. This means that *O. aureus* is caught before being given the chance to grow even to their first size at maturing by most of these fishing methods except those caught by trammel which shows slight higher length which can be returned to the much wider meshes of such nets. (Table 3 & Fig. 3).

Table 3: Probability of capture and selection ranges of *O. niloticus* caught by different fishing gears at Lake Borollus (2000-2003).

Fishing Method	L_{25} (cm)	L_{50} (cm)	L_{75} (cm)	Range (cm)
Lokaffa	6.86	7.64	8.48	1.62
Trammel	10.45	11.24	12.11	1.66
B. Traps	9.93	10.7	11.53	1.6
Al-Qerba	7.57	8.34	9.23	1.66

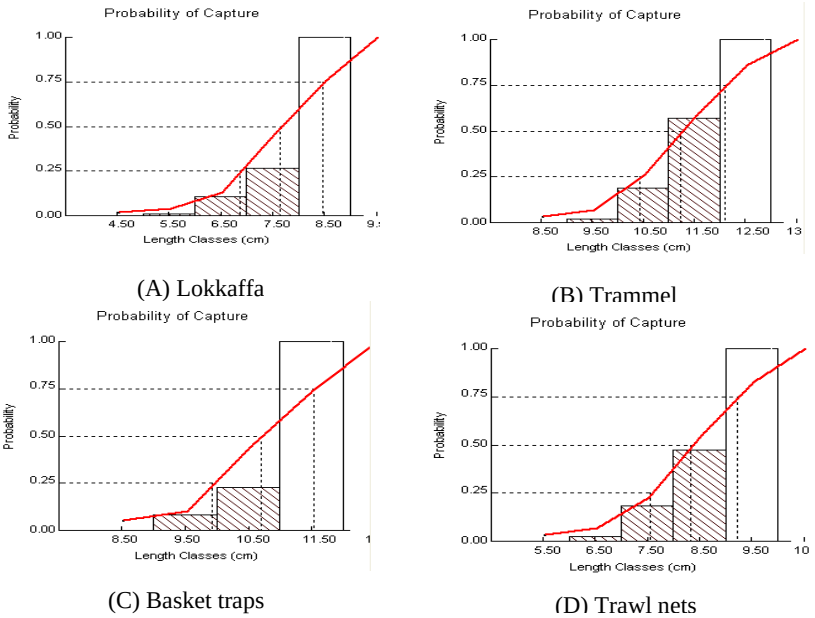
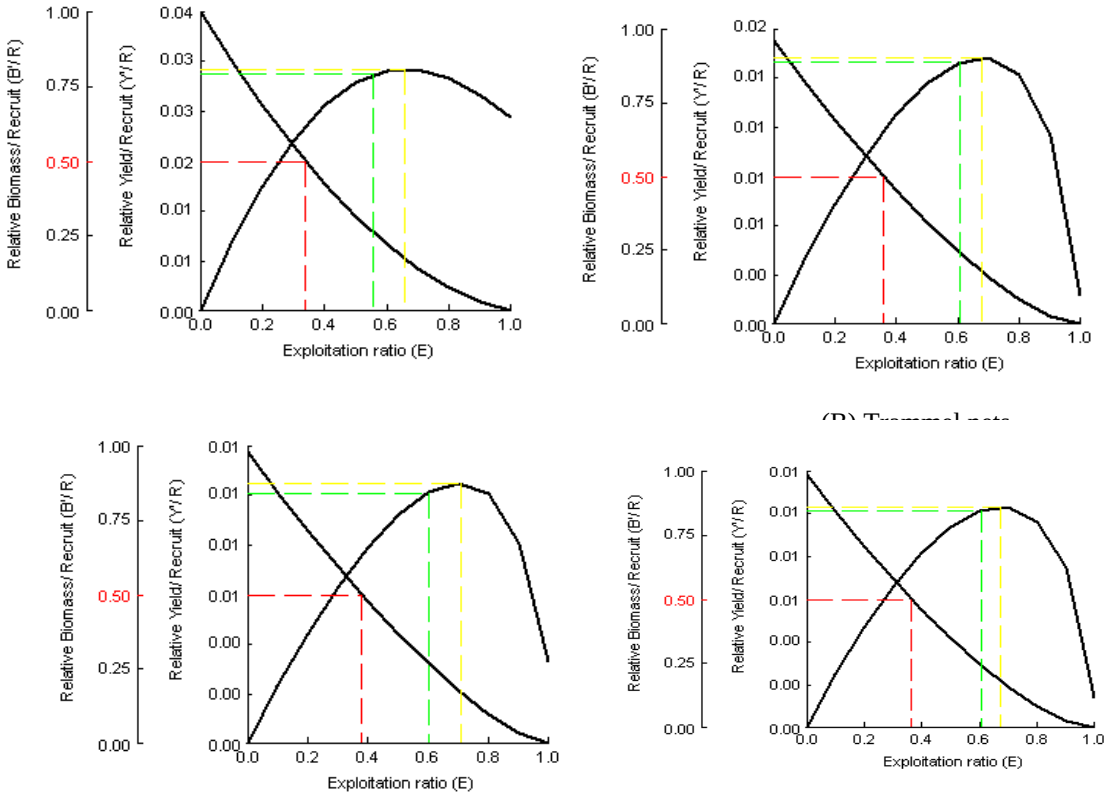


Fig. (3 A-D): Probability of capture of *O. aureus* corresponding to different fishing methods at Lake Borollus during (2002-2003).

The selection range fluctuated between 6.86 cm and 8.48 cm total length for *O. aureus* caught by lokkafa nets, while it ranged between 10.45 cm and 12.11 cm for that caught by the trammel net. Also, the lower limits of selection ranges were 9.93 and 7.57 cm for basket traps and Al-Qerba net respectively. While the upper limit didn't exceed 11.53 cm (in case of basket traps). Consequently, very narrow selection range was observed between these values which were nearly similar. (Table 3).

Relative yield per recruit (Y/R)' and relative biomass per recruit (B/R)

As shown in Figure (4,a-e) for the level of exploitation rate (0.45) was lower than that producing the maximum relative yield per recruit (0.66) by about 20% for *O. aureus* caught by Lokaffa method. Similarly the exploitation rates corresponding to the other different fishing methods were lower than that producing the maximum relative yield per recruit.



(C) Basket traps (D) Trawl net

Fig. (4 A-D): Relative yield per recruit (Y/R)' and biomass per recruit (B/R)' of *O. aureus*, corresponding to different gears at Lake Borollus during (2002-2003)

The exploitation rates ($E_{0.1}$, which the increase in relative yield per recruit is one tenth of its value) were found also higher than that estimated from the catch curves. Therefore, additional efforts could be used to reach it and at the same time, larger mesh sized nets should be used in manufacturing the different gears so as to increase the mean catchable lengths and to conserve the reproducible part or the growing part of the population.

CONCLUSION

The present results indicated that the stock of *O. aureus* caught by different fishing gears in Lake Borollus could be considered as under exploited. For fishery management of this resource, the fishing pressure should be maintained at the present level of exploitation. The use of illegal mesh sizes and other destructive fishing methods need to be urgently addressed by the authorities concerned as well as raising the mesh sizes of nets used to increase the lower limits of selection ranges corresponding to each fishing gear and also to keep breeding and saving stock biomass of that species.

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ARABIC SUMMARY

تقييم البلطي الحساني الناتج من حرف الصيد المختلفة من بحيرة البرلس – مصر

عبده عبد الله السايس و العزب العزب بدر البختى و تامر البيطار و عفيفى ابراهيم
معمل شباك وطرق الصيد - المعهد القومي لعلوم البحار و المصايد بالإسكندريه – مصر

تم تقييم البلطي الحساني الناتج باستخدام حرف الصيد المختلفة في بحيرة البرلس عن طريق استخدام برنامج FiSAT . وقد وجد أن أقصى طول (افتراضي) للبلطي الحسانى ١٩,٣٢ سم باستخدام شباك الدابه وأقل طول (افتراضي) مقابل لشبكة القربة (١٤,٥٥ سم). كما وجد أن الحد الأقصى (ل٧٥) للمدى الإختيارى للشبكة لم يتعدى ١١,٥٣ سم إلا في شباك الدابة (ثلاثية الطبقات). كما وجد أن معدل النفوق الكلى تراوح بين ١,٤٦ – ٣,٠٥ كذلك معدلات الاستغلال والتي اختلفت من شبكه لأخرى و التي أظهرت أن البلطي الحسانى يقع حول الحد المسموح به (٠,٥) أو أقل. لذلك وجب استخدام شباك ذات عيون كبيرة لرفع متوسط الأطوال عند أول حد لصيد البلطي الحسانى و ذلك للمحافظة على المخزون السمكي خاصة الجزء الحيوي المتجدد لهذا النوع.