

**Evaluation of *Oreochromis niloticus* and *Tilapia zillii* fisheries at Aswan region,
River Nile, Egypt**

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ABSTRACT

Cichlid fish species dominating River Nile at Aswan region (namely *Oreochromis niloticus* and *Tilapia zillii*) were collected from the widespread used trammel nets. Analysis of the length-frequency using (FiSAT) computer program revealed that, the estimated the Von Bertalanffy's growth parameters were $L_{\infty} = 25.73$ cm (asymptotic length); $k = 0.73 \text{ year}^{-1}$ for *O. niloticus* and $L_{\infty} = 19.43$ cm ; $k = 1.4 \text{ year}^{-1}$ for *Tilapia zillii* . The instantaneous total mortality rate of *O. niloticus* was 3.64 and 5.60 year^{-1} for *T. zillii*. The estimated natural mortality rate was 1.44 for *O. niloticus* and 2.38 year^{-1} for the second species. The respective fishing mortality rates were 2.2 and 3.22 year^{-1} , while their estimated exploitation rates were 0.60 and 0.57 year^{-1} . The results indicated that, *O. niloticus* and *T. zillii* fisheries are overexploited. Therefore, it is recommended to decrease the fishing effort in the area of study and increase the mesh size of the inner layer of trammel nets to at least 3 cm mesh bar to secure profitable fisheries and optimum catch for the future.

Keywords: *O. niloticus*, *Tilapia zillii*, exploitation rate, River Nile, Aswan.

INTRODUCTION

The fishing industry has a relatively minor direct role in the economy of Egypt, but nevertheless, domestic fish production makes a valuable contribution to the national food supply and to the traditional way of life, in which fish eating plays an important part. Fishing industry is also important for the livelihood of over 65000 fishermen and other people employed full time in related activities (estimated at some 300000), (GAFRD, 2008).

Freshwater fish represent an essential and often irreplaceable source of high quality, and cheap animal protein. Cichlid fish species were found dominating the River Nile and inland lakes. It was found that *Oreochromis niloticus* and *Sarotherodon galilaeus* dominated the catch of Lake Nasser (Adam, 2000 and Bishai *et al.*, 2000), while *O. niloticus* and *T. zillii* were the dominant species at Rosetta branch (Mahmoud and Mazrouh, 2008 and El- Bokhty and El-Far, 2014).

Various aspects of the biology and fisheries of Cichlid species have been studied in Egypt, e.g. Abdel Azim (1974), Talaat (1979), Ishak *et al.* (1985), Bayoumi and Khalil (1988), Akel (1989), Dowidar *et al.* (1990), Abdel-Baky and El-Serafy (1990), Abdel-Aziz *et al.* (1990), El-Haweet (1991), El-Shazly (1993), Bakhoum (1994, 1995 & 2002), Essa and Faltas (1997), Abd-Alla and Talaat (2000), Khallaf *et al.* (2000), Khalifa *et al.*,(2000), Khallaf (2002), Adam (2004), Eskander (2004), Abaza (2004), Mehanna (2005), El-Bokhty (2006), El-Sayed (2006), El-Sayed and Moharram (2007), and El-Bokhty and El-Far (2014).

Due to the importance of Lake Nasser, several studies have been done, but studies on the River Nile at Aswan area were little. Therefore, the present work aims

to evaluate the status of fisheries of *Oreochromis niloticus* and *Tilapia zillii* in River Nile at Aswan region.

MATERIALS AND METHODS

The present study is a part from a scientific project, carried out by NIOF, covering the River Nile from Aswan to Alexandria during 2008-2009 entitled "An integrated scientific discipline for protection of the River Nile from pollutants and increasing fishery resources".

Sample collection was taken from the fishing boats working at four stations at Aswan region (Fig. 1) namely; Kima, Aswan city (Al-Markaz), Koum Imbo and Idfu regions during autumn season. Fishing by trammel nets in River Nile is usually carried out by small boats of the third class "Canoe-like faloukas without sails" with mean crew size 2 fishermen from the early dawn to near afternoon. Fishermen employed in fishing use exclusively floating trammel (which are commonly used at the River Nile and its tributaries).

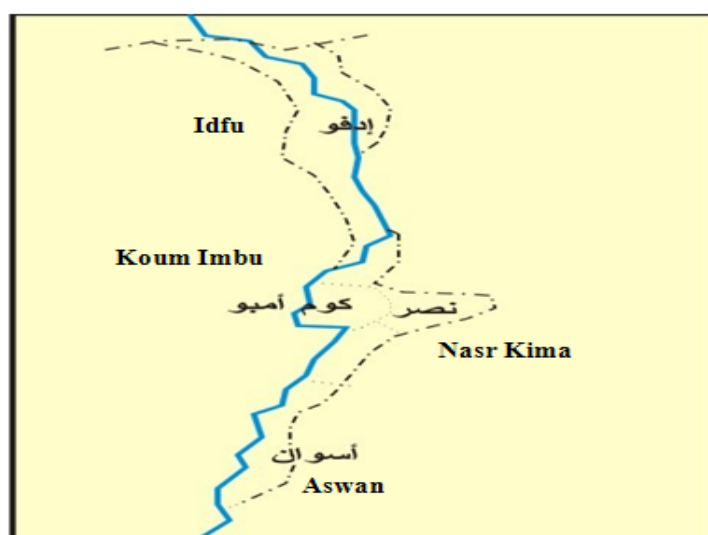


Fig. 1: Location map of Aswan Governorate, Egypt

At the laboratory, fish samples were sorted into species level and for each species was sized to the nearest cm and weighed to the nearest gram.

The length frequency distributions 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 (1980) considering the mean annual water temperature 25°C (Elewa and Latif, 1988). The instantaneous rate of fishing mortality (F) was extracted as $F = Z - M$. The exploitation rate 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) 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

Catch characteristics

A total number of 1168 fish were collected from the catch of trammel nets working at four stations from River Nile at Aswan. It was found that *O. niloticus* represented the majority of catch composition by more than 88 % of numerical abundance and the rest proportion was *T. zillii*. *O. niloticus* ranged in total length from 13.5 cm to 24.5 cm and showing a modal length at 15.5 cm at most of the stations. While, *T. zillii* ranged between 12.5 cm and 18.5 cm in total length exhibiting a modal length of 14.5 cm (Fig. 2).

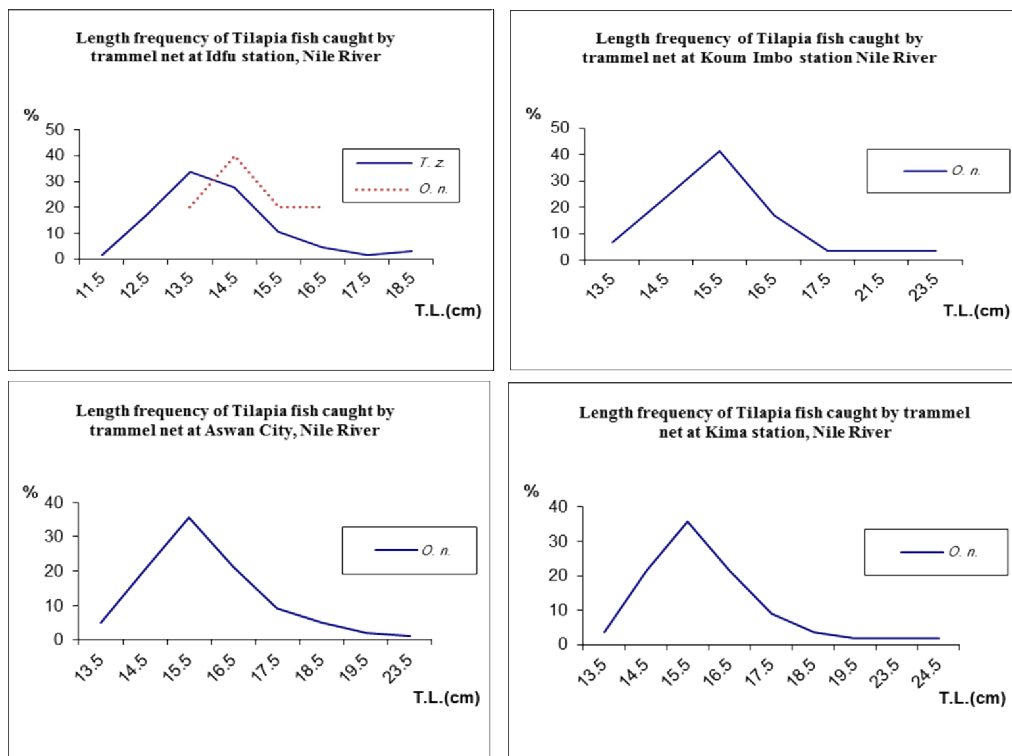


Fig. 2: Length frequency distributions of tilapia fish sampled from four stations at Aswan Governorate (2008).

The length frequency distribution curves (Fig. 2) of fish caught by trammel nets revealed uni-modal asymmetrical curves positively skewed at the right hand side due to entanglement effect for large sized fishes.

Von Bertalanffy's growth parameters were estimated as $L_{\infty} = 25.73$ cm (asymptotic length); $k = 0.73$ year⁻¹ for *O. niloticus* and $L_{\infty} = 19.43$ cm ; $k = 1.4$ year⁻¹ for *Tilapia zillii*.

Mortality

The annual instantaneous rate of total mortality (Z) for *O. niloticus* as estimated from the length converted catch curve was 3.64 (Fig. 3). The solid line shows the regression equation fitted to data for length converted catch curve. The lengths for small ages (left hand side) showing ascending line were excluded as those don't represent fully exploited groups. The last two length groups (right hand side) were also excluded due to insufficient number of individuals represented.

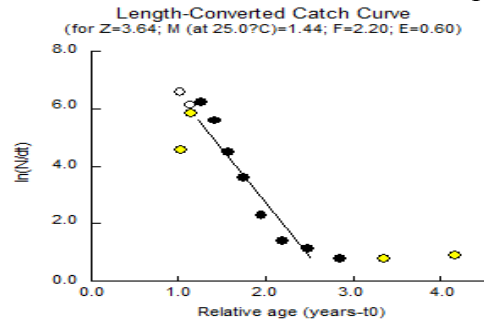


Fig. 3: Length converted catch curve of *O. niloticus*, Aswan, River Nile

The annual instantaneous rate of natural mortality (M) derived from the Pauly's empirical formula was 1.44. The average water temperature (used in the formula) was used as 25°C according to Elewa and Latif (1988) and in the mean time as an average between 24 °C (El-Shahat, 2000) and 26 °C (Bishai *et al.*, 2000). The calculated annual instantaneous rate of fishing mortality (F) was 2.20. The current exploitation (E) was estimated as 0.60 indicating a state of over exploitation (Table 1).

Table 1: Mortality and exploitation rates of *O. niloticus* and *T. zillii* caught from Aswan region, River Nile.

species	L_{∞}	K	Z	M	F	Input parameters		E_{current}
						M/K	L_c / L_{∞}	
<i>O. niloticus</i>	25.73	0.73	3.64	1.44	2.20	1.973	0.548	0.60
<i>T. zillii</i>	19.43	1.40	5.60	2.38	3.22	1.700	0.690	0.57

The total mortality coefficient (Z) of *T. zillii* was estimated as 5.60 y⁻¹. While its natural mortality rate (M) was computed as 2.38y⁻¹ and the fishing mortality rate was 3.22 y⁻¹ (Fig. 4).

The exploitation rate (E) was found to be 0.57 y⁻¹ as shown at Table (1).

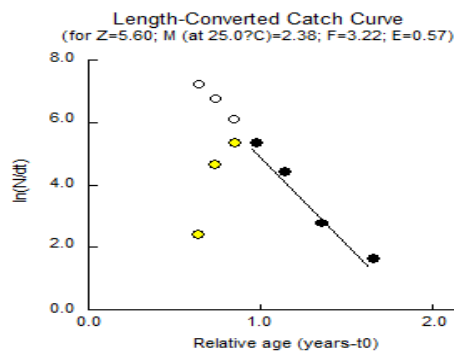


Fig. 4: Length converted catch curve of *T. zillii*, Aswan, River Nile

Probability of capture

From the length converted catch curve, extrapolation of a regression line drawn was used to approximate the probability of capture for each length group which was then used to estimate the selection (probability) parameters based on the extrapolated points (Gayani *et al.* 1997). The probability of capture was plotted using the running average technique to estimate the selection parameters. The length at first capture (L_c) at which 50% of the fish that become vulnerable to capture was estimated to be 14.11 cm and 13.41 cm, for *O. niloticus* and *T. zillii*, respectively (Table 2 & Figs. 5 & 6).

Table 2: Estimated sizes at 25, 50 and 75 % probability of capture of *O. niloticus* and *T. zillii* at Aswan region

Species	<i>O. niloticus</i>	<i>T. zillii</i>
L_{25} (cm)	13.31	12.65
L_{50} (cm)	14.11	13.41
L_{75} (cm)	14.91	14.25

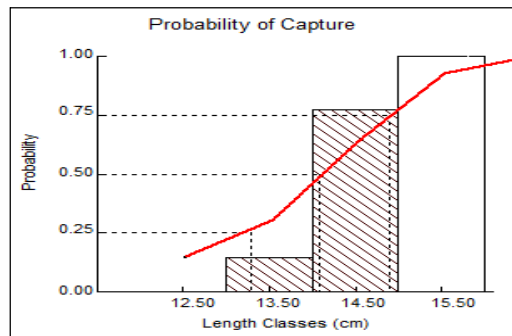


Fig. 5: Probability of length at first capture for *O. niloticus*, River Nile, Aswan

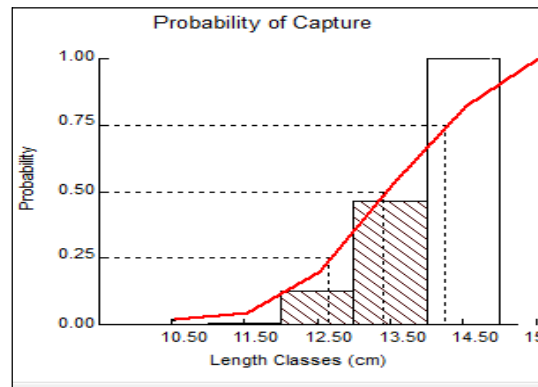


Fig. 6: Probability of length at first capture for *T. zillii*, River Nile, Aswan

A narrow selection range ($L_{75} - L_{25}$) was found to be 1.6 cm for both of the two species. Fish were fully recruited to the fishery (L_{100}) at sizes of 15.71 cm and 15.04 cm for the two species respectively.

Yield per Recruit

The relative yield-per-recruit (Y'/R) of *O. niloticus* was determined as a function of L_c / L_{∞} and M / K (Table 3 and Fig. 7). The current exploitation ($E = 0.60$) of population obtained by trammel nets was lower than the maximum allowable limit based on yield-per-recruit calculation ($E_{max} = 0.877$), which leads to the maximum sustainable yield (MSY), and at the same time the current exploitation was lower than the optimum exploitation rate ($E_{opt} = 0.757$).

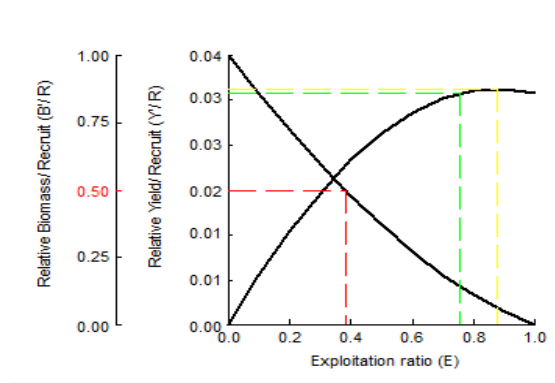


Fig. 7: Relative yield per recruit (Y/R)' and biomass per recruit (B/R)' of *O. niloticus*, River Nile, Aswan

On the other hand, the current exploitation rate of *T. zillii* ($E = 0.57$) was also lower than the maximum limit ($E_{\max} = 0.749$) and lower than the optimum rate ($E_{\text{opt}} = 0.657$) (Table 3 and Fig.8).

Table 3: Relative exploitation parameters for *O. niloticus* and *T. zillii* caught at Aswan region.

Exploitation parameter	Species	
	<i>O. niloticus</i>	<i>T. zillii</i>
$E_{10(\text{opt.})}$	0.757	0.657
E_{50}	0.381	0.396
E_{\max}	0.877	0.749

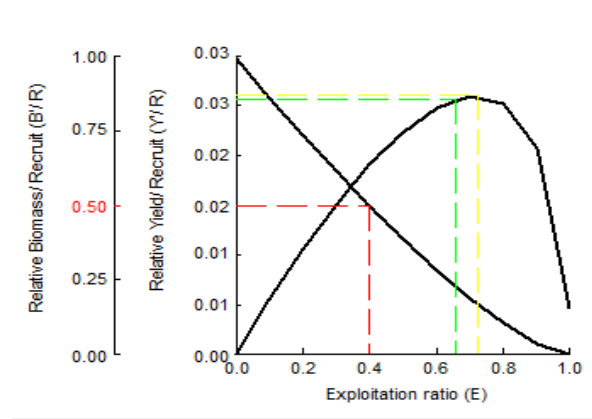


Fig. 8: Relative yield per recruit (Y/R)' and biomass per recruit (B/R)' of *T. zillii*, River Nile, Aswan.

DISCUSSION

It was found that only the two species *Oreochromis niloticus* and *Tilapia zillii* dominated the catch of the trammel nets at Aswan region. This may return to the method of fishing and the design characteristics of surface catching trammels and (or) to the lowered fish diversity which is a good indicator of a stressed ecosystem (Leveque, 1995) and it was commonly agreed that the higher the fish diversity, the more stable the fish community (Albarat and Lae, 2003; Emmanuel and Onyema, 2007).

The modal length of *O. niloticus* was larger where wider inner layers (2.9 - 3.0 cm mesh bar) are used in the construction of trammel nets at Kima, Aswan city and

Koum Imbu. While that of *T. zillii* was lower due to smaller mesh sizes used in trammel nets (2.7 – 2.8 cm) at Idfu (Fig. 3).

Similar studies revealed that *O. niloticus* and *T. zillii* dominated the catch by more than 51 % and 36 % respectively at Rosetta branch of River Nile at Kafr El-Zaiat and Desouq (Hatem and Mazrouh, 2008).

Estimation of growth and mortality parameters are used as input variables for bio-demographic models to characterize the state of various fish populations. Growth parameter (K) as estimated from length frequency analysis (ELEFAN I) was 0.73 y^{-1} for *O. niloticus* and 1.4 y^{-1} for *T. zillii*. These values were higher than those estimated by Hatem and Mazrouh (2008) at Rosetta branch and may return to a manifestation of the observations that similar species experience different growth rates in different habitats (Lowe - McConnell, 1982).

The estimated total mortality coefficients (Z) as well as both of the natural mortality (M) and fishing mortality (F) coefficients for *O. niloticus* and *T. zillii*, were higher than those estimated by Hatem and Mazrouh (2008) at Rosetta branch of the River Nile indicating that the two species are subjected to high mortality levels. Beverton and Holt (1956) pointed out that the natural mortality coefficient is directly related to the growth coefficient (K) and inversely related to the asymptotic length (L_{∞}) and the life span longevity. Hence, *T. zillii* exhibiting higher growth rate (1.4) and lower asymptotic length (19.43 cm) undergoes higher natural mortality ($M = 2.38 \text{ y}^{-1}$). The reverse is true for *O. niloticus*.

The current exploitation rates (E) were found to be 0.60 as in case of *O. niloticus* and 0.57 for *T. zillii*. According to Gulland (1971) the fishing mortality should equal to the natural mortality resulting in a fixed and optimal exploitation rate (0.50) to reach and ensure a sustainable yield. Therefore, it is worth mentioning that the fishing mortality which reflects the fishing effort far exceeds the natural mortality rate for the both species.

As suggested by Beverton and Holt (1959), The M/K ratios obtained in the present study were well within the normal range of 1 – 2.5. As a rule the Z/K ratio of 1.0 is considered as growth dominated and if it is more than 2, then it is mortality dominated (Al-Qishawe *et al.*, 2014). In the present study, it was equal 4.986 and 4.0 for the two species studied respectively, which showed that the fishery of *O. niloticus* and *T. zillii* was mortality dominated.

In Lake Nasser, Khalifa *et al.* (2000) found that the exploitation rate of *O. niloticus* equals to 0.80 and as a result the species was heavily exploited.

Length at first capture (L_c) was estimated to be 14.11 and 13.41 cm, for *O. niloticus* and *T. zillii*, respectively. The differences can be attributed to the differences of the mesh sizes of nets used where wider meshes were used for *O. niloticus* catching trammels while smaller meshes were observed for those of *T. zillii*. However, the same narrow selection range was observed due to different varieties according to several characteristics of net and fish (Fujimori and Tokai, 2001).

Several values of length at first capture (L_c) ranging from 12 cm to 17 cm were run against optimum and maximum exploitation rates to find out the length at which maximum relative per recruit (Y'/R) could be obtained. The results revealed that the (Y'/R) gradually increased within L_c increase up to the length 15 cm at which the maximum (Y'/R) could be achieved. However, the levels dropped down with any further increase in L_c beyond 15 cm indicating that this length is the optimum length at first capture to maintain the sustainable exploitation of *O. niloticus* in Aswan area. Similarly, L_c value for *T. zillii* was found at 13 cm where maximum yield/recruit was

reached and remained stable till the length 15 cm and afterwards decreased with further increasing in L_c values.

Raising L_c values to 15 cm will lead to gaining an extra-weight as reported by Hatem and Mazrouh (2008) that the maximum annual increments in weight were observed at (such length) the end of the third year of life for *O. niloticus*.

As obvious from Relative yield per recruit (Y/R) and relative biomass per recruit (B/R) Figures 4 and 5, it is evident that the optimum exploitation level ($E_{opt.} = 0.757$) as well as the maximum one ($E_{max.} = 0.877$) are higher than the current exploitation rate ($E = 0.60$) of *O. niloticus*. The same trend was observed for *T. zillii* where its current exploitation level (0.57) is smaller than both the optimum ($E_{opt.} = 0.657$) and the maximum value ($E_{max.} = 0.749$). At the same time, they exceeded the optimum value (0.50) as suggested by Gulland (19971). Therefore, the recent fishing effort should be reduced. On the other hand, the fishing nets especially trammel nets should be kept at mesh size 30 mm mesh bar for the inner net to attain sizes of 15 cm as an optimum size.

CONCLUSION

Results indicated that the stock of *O. niloticus* and *T. zillii* at Aswan region are overexploited. Although the current exploitation rate is lower than the optimum one for the both species, they exhibit a mortality dominated status due to the removal of pre - spawner fishes. Therefore, it is very important to raise the mesh sizes of the inner layer of trammel nets to at least 3 cm mesh bar to cope with catching an optimum size of 15 cm for both of *O. niloticus* and *T. zillii* for getting the maximum yield per recruit and to spawn at least once during their lifespan at the area of study. This will affectively reduces the risk of a stock collapse by a long-term increase of the spawning stock size of tilapia fish and substantially support the sustainable exploitation of these fishes.

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ARABIC SUMMARY

تقييم مصايد البلطي النيلي و البلطي الأخضر الناتج من منطقة أسوان - نهر النيل - مصر

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- ١- معمل شباك وطرق الصيد- المعهد القومي لعلوم البحار و المصايد بالإسكندرية - مصر
٢- معمل بيولوجيا الأسماك - المعهد القومي لعلوم البحار و المصايد بالإسكندرية - مصر

تم دراسة اسماك البلطي السائدة في منطقة أسوان - نهر النيل الناتجة من الصيد التجاري ضمن دراسته قام بها المعهد عام ٢٠٠٨ - ٢٠٠٩.

اظهر التحليل النوعي لمصيد أسماك البلطي ان البلطي النيلي هو الأكثر تواجدا يليه البلطي الأخضر و باستخدام برنامج FiSAT وجد أن أقصى طول (افتراضي) مقارب للبلطي النيلي ٢٥,٧٣ سم و معامل النمو ٠,٧٣ و كذلك أقصى طول للبلطي الأخضر ١٩,٤٣ سم و معامل النمو ١,٤. كما وجد أن الحد الأوسط (L) للمدى الإختياري لم يتعد ١٤,١١ سم للبلطي النيلي و ١٣,٤١ سم. كما وجد أن معدل النفوق الكلي تراوح بين ٣,٦٤ للبلطي النيلي و ٥,٦٠ للبلطي الأخضر. كذلك معدلات الاستغلال والتي تعدت الحد المسموح به (٥٠) ، فبلغت ٠,٦٠ في حالة البلطي النيلي و ٠,٥٧ للبلطي الأخضر لذلك وجب المحافظه على النوعين السابقين بتقليل جهد الصيد في تلك المنطقه الهامه من نهر النيل و زيادة سعة عيون الطبقة الداخليه لتصل على الأقل ٣ سم طول الساعد لشباك الدابه ثلاثية الطبقات المنتشرة في نهر النيل لرفع متوسط الطول الإختياري ليصل ١٥ سم على الأقل و ذلك للحصول على انتاجيه مستدامه و للمحافظة على المخزون السمكي لهما.