A STUDY ON CATCH ASSESSMENT IN THE NORTHERN PART OF JEBEL AULIA RESERVOIR

BY

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Abstract

The study was executed in the northern part of Jebel Aulia reservoir from the dam to Ed Dobasi , during the period (February 2001 to January 2002) , showed that the fishing pressure at Jebel Aulia is relatively intense given into account that the total annual yield is 115,732 kg anf the maximum sustainable yield is 90706 kg , whereas the fishing pressure at Geteina is on the optimum level as the maximum sustainable yield (MSY) is 1,925,454 kg. And the total annual yield is 1,617,648 kg , and Geteina is more productive than Jebel Aulia.

During the study 41 species belonging to 24 genera and 13 families were recorded in Jebel Aulia, whereas in Geteina 37 species belonging to 22 genera and 13 families were recorded.

During this study Tilapias represented by *Oreochromis niloticus* dominated the catch at both sites. Nonetheless it is over fished.

During this study, reduction of fish size is conspicuous (0.25 – 0.56 kg).

During this study some genera like *Protopterus, Tetradon, Mormyrops, Petrocephalus, Chrysichthys and Malapetrus* were recorded in few numbers.

الخلاصة

أوضحت الدراسة أن مجهود الصيد في جبل أولياء عالي إذا أخذنا في الإعتبار أن الإنتاج الكلي السنوي يبلغ 115.732كجم بينما الإنتاج المستدام يبلغ 90.706كجم . بينما جهد الصيد في القطينة في مستوى مقارب للجهد العاليإذ أن الإنتاج الكلي السنوي في القطينة يبلغ 1.617.648 كجم في حين أن الإنتاج المستدام يبلغ 1.925.454 كجم والقطينة ذات إنتاجية أكبر من جبل أولياء.

أثناء هذه الدراسة تم رصد 41 نوعاً تنتمي إلى 24 جنس و13 عائلة في جبل أولياء بينما تم رصد 37 نوع تنتمي إلى 22 جنس و13 عائلة في القطينة.

أثناء هذه الدراسة كان البلطي هو النوع السائد علي الأسماك ممثلاً في البلطي النيلي في الموقعين. برغم هذا نجد أنه مستنزف بمجهود صيد عالي.

أثناء هذه الدراسة سجلت بعض الأجناس

Malapterus , chrysichthy , وكذلك Petrocephalus , Mormyrops , Tetraodon , Prottopterus,

بكميات قليلة.

أثناء هذه الدراسة تلاحظ قلة حجم الأسماك المصطادة (0.25 – 0.56 كجم)

Dedication

To he who taught me a letter,

to my parents and friends

Acknowledgment

I gratefully acknowledge My supervisor Dr Zuheir Nour Eldayem Mahmoud . I would like to thank the Fisheries Research Center administration for availing the laboratory equipment. I appreciate the hospitality of Mr Imad Mohamed Abdalla.
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CHAPTER ONE: INTRODUCTION

The river Nile is the longest river in the world. Its basin, has an area of 2.9×10^6 km^2 extending from latitude 4˚ south to latitude 31˚ N and covering the whole of Uganda and flows in the Mediterranean sea stretching over a distance of 6695 km (Ibrahim and Babiker, 1984). The Nile basin is divided into five sub basins. These are the White Nile, the Sobat the Blue Nile, the Atbra and the Main Nile. The White Nile subbasin has a catchment area of 378000 km^2, its source is Lake Victoria, the second largest fresh water lake in the world (69000 km^2).

The Nile basin has an extensive fresh water resources covering an estimated area of 7.5×10^6 ha. The area available for commercial production of fish is about 1×10^6 ha (Ibrahim and Babiker ,1984). Jebel Aulia reservoir is located 45 km south of Khartoum. The dam was constructed in 1937. It is 377 m above sea level. The reservoir surface area ranges from 600 to 1500 km^2. The maximum depth is 12 m but it generally ranges from 2.3 to 6 m, with a volume of 3.5 km^3 (Welcomme, 1972). (Khalid and Hannel 1990) stated that the reservoir has a mean depth of 2.3 m, a capacity of 3.5 km^3 with a surface area of 1246 km^2 and the maximum width in the vicinity of the dam is between 6 and 7 km. The reservoir's level starts to drop in February and continues until the end of May, but it attains its maximum level in September. The amplitude of water level movement is 6 m (Khalid and Hannel , 1990).

The reservoir is the main source of fresh water fishes for Khartoum State. various estimates of fish production were made. There is a paucity of information regarding the fishery of Jebel Aulia reservoir as reliable statistics does not exist. Henderson (1975) stated a range from 7000 to 8100 tons year with a potential yield of 15000 tons (corresponding to 100 kg ha, yr). The FAO (1982) stated an annual yield of 8216 tons. Kapetsky

and Peter (1984) calculated an annual yield of 55 kg/ha for the period 1981 – 1982. Abdel Rahman (1985) estimated the maximum sustainable yield (MSY) to range from 7363 to 8600 tons/yr ; Saeed et al.,(1993) estimated the annual productivity to be 8216 tons, and Elbashir (1995) (in Arabic) suggested 15000 tons/year. Jebel Aulia reservoir plays a vital role in supplying fresh and chilled fish to Khartoum State, and cured fish for many parts of the Sudan. The reservoir fisheries support financially many households in Jebel Aulia and White Nile State along the White Nile Stretch. In order to assure continuity of a sustainable fish stock; Lucrative fishery activities; proper exploitation and management of the reservoir fisheries resources, provision of scientific advice for sustainable exploitation, information about fish species and fishery of the reservoir are vital.

Objectives:

This study on fisheries of the northern part of Jebel Aulia reservoir has the following objectives:

- Estimation of abundance and composition of fish species.
- Estimation of seasonality of species.
- Estimation of catch per unit effort (CPUE), effort, maximum sustainable yield (MSY) and optimum effort (OE).
- Determination of length frequency, of age, assessment of total mortality, (Z), natural mortality (M) and fishing mortality (F) of *Oreochromis. niloticus* and *Sarotherodon galilaeus* to detect their exploitation ratio.

CHAPTER TWO:LITERATURE REVIEW

Various studies have been carried out on the fishes of the Nile in general and composition of fish species in particular.Proper exploitation and management of fishery resources require basic knowledge of species prevailing in the water body, their abundance and biology.

Fish species in Jebel Aulia reservoir:

Information regarding the species present in the White Nile was given by various investigators. The taxonomy and characteristics of fishes of the Nile were compiled by Boulenger (1907); Pekkola (1918); Sandon (1950); AmirThalingham and Khalifa (1965); Abu Giediri (1984) and Bailey (1994); Giris (1948) has recorded 18 families and 62 species from the swamps and southern tributaries of the White Nile. Sandon (1950) recorded 108 species in the White Nile. (Hammerton, 1972) reported that the fish fauna of the Nile includes at least 54 genera and over 300 species. Adam (1977) reported that the commercial catch of fish at the vicinity of Jebel Aulia reservoir consist of ten families. These are, *Mormyridae, Characidae, Cyprinidae, Bagridae, Claridae, Mochocidae, Schilbeidae, Centropomidae, Cichlidae and Citharinidae* Hamza (1981) concluded that the fish population in the White Nile showed a decrease both in number of species and fish size and reported 33 species belonging to 10 families. Abu Gideiri (1984) recorded 52 fish species in Jebel Aulia reservoir. Abdel Rahman (1985) reported catches to consist of 54 fish species, 28 genera belonging to 14 families. Hickley and Bailey (1986) surveyed the fish in the Sudd region and recorded 62 species. Elbashir (1995) (in Arabic) recorded 20 species from fish landing at Khartoum. He pointed out that the source of these species is Jebel Aulia Lake. Alist of fish species encountered by various authors was given in Appendix 1 and the systematic based on Bailey(1994) was given in Appendix 2.

Catch composition

Investigations of catch composition in Jebel Aulia area were carried out by various authors. Ponadelko, *et.al.* (1964) studied the catch composition of some fishes caught by beach seining operations; one wall set net and trammel net and reinforced gill nets. They found that, the average daily catch in kg for the beach seining operation at a 3 hectare fished area (10 km below dam) is ranging from 5 kg for *Lates niloticus* to 35 kg for *Alestes*. The average daily catch for one wall set nets range from 6.1 kg for the net with 50-mm mesh size to 9.4 kg for the net with 30-mm mesh size. For the reinforced set nets (Stretched) the average catch in kg is 18.8 for a net with 55-mm mesh size.

Adam (1975) investigated the relationship between populations of plankton and fish in Jebel Aulia reservoir and recorded that the density of plankton proportionally affect fish composition and diversity in Jebel Aulia reservoir. Ali (1975) conducted a study on gill net selectivity and fish populations in Jebel Aulia reservoir and recorded 15 families comprising 36 species in Jebel Aulia reservoir. Henderson (1975) studied the fisheries of the reservoirs of central Sudan which has a surface area of (3000 km^2). The area includes Sinnar reservoir, Khashm elgerba and Jebel Aulia reservoir. He reported that at Jebel Aulia reservoir, seines and gill nets are the principal gear, but cast nets are also common and the commercial catches from Jebel Aulia reservoir is dominated by the family *Mormyridae* which constituted 23.7% of the catch followed by *Mochokidae* (23.5%) and the least family is *Citharinidae* which contributes 2.8% to the total catch.

Elobeid (1995) studied the influence of water hyacinth on the distribution of fishes in Jebel Aulia. She stated that changes in fish abundance after hyacinth infestation is according to the creation of food patterns that favour herbivores, omnivores and carnivores respectively.

Peak and fishing effort

Abdel Rahman (1985) conducted a study on stock assessment in Jebel Aulia reservoir, and reported that, no direct over fishing could be proved, although exploitation levels reached the maximum allowable level. Kawai (1994) studied the fishing effort and fishing intensity in the northern part of Jebel Aulia reservoir, and concluded that intensive fishing is being practiced in the area.

Biological aspects

Alkholy, *et.al*., (1973) studied the growth and survival rate of *Lates niloticus* in Jebel Aulia reservoir and concluded that about 22% of *Lates niloticus* survive per year after 3 years of ages. Bishai (1975) studied the biology of *Bagridae* family in Jebel Aulia reservoir and reported that, both species of *Bagrus bayad* and *Bagrus docmak* are predacious-feeding on insects, molhuscs and fish.

Abdel Rahman (1978) studied the growth, food, feeding habits and reproduction of some cyprinid fishes in Jebel Aulia reservoir. Her findings indicated that the *Barbus bynni* begins to mature at age 4 with a minimum standard length of 32.0 cm. Bishai (1980) executed a study on age, growth and maturation of *Lates niloticus* in Jebel Aulia reservoir. Abdel Rahman Elmoghraby (1984) investigated the reproductive biology of *Barbus bynni* in Jebel Aulia reservoir. Babiker (1984) studied the breeding and sex structure of populations of *Tilapia nilotica* and *Labeo niloticus* in Jebel Aulia Dam area of the White Nile. He found that *L. niloticus* starts breeding from mid July to December, while *Oreochromis niloticus* has two peaks of spawning corresponding with early and late flooding. Tahir (1994) investigated the age and growth, feeding habits and reproduction of *Oreochromis niloticus* in Jebel Aulia Dam. He

reported that, maturity at size is ranging from 11.5-13.0 cm and the sex ratio of males to females is 1.095:1 to 2:1 , respectively.

Salih (2000) studied the growth and reproduction *of Oreochromis niloticus* and *Sarotherodon galilaeus* from three different environments (Lake Nubia, White Nile (Khor Elgassir), Elmarabe and fish ponds in Elshagara). He found that the total length and standard length relationships were linear in both species in the three studied sites, and their regression were highly significant (P = 0.001). Salih, also noted that statistical analysis of standard length and total weight relationship were curvilinear for both species in the three sites and their regressions were highly significant (p=0.001) and (r=0.986) for *O. niloticus* and (r = 0.981) for *S. galilaeus*.

Since the end of the eighties of the last century , and up to the present time it is reported that fishing pressure has continued and stocks have further got depleted in diversity and size especially in the northern part of Jebel Aulia reservoir. In order to verify that, the present work is undertaken.

CHAPTER THREE :MATERIAL AND METHODS

3-1 The Study area

The Jebel Aulia dam was constructed in 1937 to provide water storage for Egypt. The dam has a total length of 5 km comprising 1.7 km of masonry and 3.3 km of rock fill embankment. There is a navigation lock and fish ladder towards the east bank of the White Nile. At full storage capacity Jebel Aulia reservoir stretches for over 600 km, from the Jebel Aulia southward to Jelhak (Fig.a and b). The study area extends 150 km in length from the dam site to Ed Dobasi, in the northern part of White Nile state and it was divided into two fishing sites. Site I, which extends from the dam site to 25 km southwards, is the main landing site at the vicinity of the dam.

Site II, extending for 125 km from Elmansorab to Ed Dobasi in the northern part of White Nile state and has its main landing site at Elgeteina.

3-2 Fisheries

The study commenced in February 2001 and terminated in January 2002. The study was conducted at two landing sites. Site I, Jebel Aulia station at the vicinity of the dam up to25 km, and site 2,Elgetina up to Ed Doobasi which extends 125 Km from the end of site 1). Sampling took place thrice a month. During each time the catch from randomly chosen boats was studied .The study included recording the total weight of fish by species ,the type of boat, number of fishermen and type of gear used .The number of fishes studied was

11305. Identification of fish species followed Sandon(1950), Abu Gideiri (1984) and Bailey (1994).

3-3 Biological Investigation

3-3-1 Length Frequency Recording

Length data of *O. niloticus* and *S. galilaeus* from randomly chosen boats was generated . The total length and standard length of each species was measured to the nearest 0.1 cm using a measuring board. The weight was recorded to 0.1g using a spring balance.

3-3-2 Aging

Aging was based on the scale methods. Between 5 to 10 scales were removed from the left side immediately posterior to the termination of the dorsal fin and 2-3 rows above the lateral line. The scales were kept in envelopes with information of date, month, locality, species, standard length (cm), total length (cm), total body weight (gms) and sex. Scales were dipped into 25% NH_4 OH for 12 hours for calrity purpose, then rinsed in water and cleaned by wiping and read under a binocular microscope

3-3-3 Length – Weight Relationship of the Fishes

The study of length weight relationship was based on the mathematical formula suggested by LeCren(1951),Lagler(1956), Beverton and Holt(1966), Richer(1975), Gulland (1983), and Sparre *et.al.,* (1989).The type of the formula is $W = a L^b$, where

W = total weight (gm)

L = standard length (cm)

a= intercept and b = slope

3-3-4 Age – Length Keys

Age – length keys were formulated following Gulland and Rosenberg, (1992) the proportion of each age group within each length group is calculated as

$P_{ij} = n_{ij} / n . j$

Where P_{ij} = proportion of fish aged in the sample of fsh in length group for which ages were determined.

n_{ij} = number of fish at age I in that sample .

n.j= total number of fish in the sample of length group (see Appendix 9- 16)

3-3-5 Mortality Rates:

The total mortality(Z) is calculated using the standard age-based catch – curve of Ricker (1958), in which the natural logarithm of the numbers in each age group is plotted against age in the form Y=a-bX. The result should be descending right hand limit which is linear, with slope (changed sign) Z.

Natural mortality (M) is calculated by adopting (Pauly, 1978, 1980,1984) empirical formula.

$\text{Log}_{10} M = - 0.0066 – 0.279 \log_{10} L \text{ in } f + 0.6543 \log_{10} k + 0.4634 \log_{10} T$

Where M= natural mortality

T = mean environmental temperature

L_{inf} = total length in cm.

Thus fishing mortality (F) is obtained as follows. $F = Z – M$

Where Z= total mortality

Exploitation ratio (E R) = $\frac{F}{}$

$$F + M$$

L_{inf} and K are calculated using the ford – walford plot in which L (t + Δt) is plotted against L (t)

$K = - \ln b / \Delta t$

$L_{inf} = a /(1-b)$

3-3-6 Statistical analysis

Statistical analysis was made by the excel using a personal computer and the programs suggested by Abramson (1971), Green(1973),Bazigos(1974) and Welcomme and Bagborg (1977).

CHAPTER FOUR: RESULTS

4-1 Main features of catch at the two Sites.

The total weight of the catch landed in Jebel Aulia was115732 kg (Table 1), while at Geteina it was 1617648 kg (Table 2). Geteina was more productive than Jebel Aulia throughout the year (Table,1 and 2, Fig. 1).

4-1-1 Seasonality of species in the two sites:

The maximum production in Jebel Aulia was in April. Where as, September was the least productive month (Table 1, Fig. 1). At Geteina March was the most productive month, while, June was the least productive month (Table 2, Fig. 1).

4-1-2 Peaks of occurrence

Three distinct peaks of occurrence were observed at each site. These were during April, July and December at Jebel Aulia (Table 1, Fig. 1) and during March July and October at Geteina (Table 2,Fig. 1).

4-1-3 Number of species encountered :

The maximum number of species encountered at Jebel Aulia was 26 in June, while, the least was 13 species in August (Table 1). In Geteina the maximum number of recorded species was in April (23 species) where as, September records showed only seven species (Table 2).

4-1-4 Abundance of species at the two sites:

At Jebel Aulia site, 41 species belonging to 24 genera and 13 families were encountered (Tables 1, 3 and 4). At geteina 37 species belonging to 22 genera and 13 families were encountered (Table 2, 3 and 5).

Oreochromis niloticus dominated the catch at Jebel Aulia as it accounted for 24.9% of the total catch. Some fish species were encountered in few months like, *Petrocephalus bane*, *Labeo coubie* and *Mormyrops anguilloid*. On the other hand *Hydrocyrus forskalli* was encountered over 9 months.

In Genteina the catch was dominated by *Oreochromis-niloticus*. It accounted for 47% of the total catch, followed by *Bagrus, Synodontis* and *Clarias* species respectively. *Schilbe intermedius* and *Schilbe uranoscopus* were the least encountered species. Six species encountered in Jebel Aulia site were not found in Geteina.These were,*Mormyrus cashive, Mormyrus kannume, Hyperopisus bebe, Brycinus nurse, Brycinus macrolepidotus* and *Petrocephalus bane*. On other hand *Hydrocynus vittatus* and *Brachysynodontis batensoda* species were encountered from Geteina site only.

4-2Genera Occurrence at the two sites

Genera wise at Jebal Aulia site, *Oreochroims* dominated the catch (24.9%) .followed by *Synodontis* (14.8%), *Bagrus,*(12.1%) *Labeo* (10.5%) and *Hydrocynus* (7.95%) (Table 3) while, the least encountered genus is *Petrocephalus* (0.02%). In Geteina site *Oreochroims* dominated the catch, it amounted to 47% of the total

catch followed by *Bagrus* (11%), *Synodontis* (11%) and *Clarias* (7 %)

(Table 3). Genera like *Hypropisus, Brycins* and *Petrocephelus* were absent from Geteina.

4-3 Occurrence of families at the two sites:

In Jebel Aulia, Cyprinidae, Bagridae and Mochochidae were encountered throughout the year (Table 4). These in addition to Cichhidae constituted 73% of the catch (Table 4). While in Geteina, Cichlidae, Cypriridae and Bagridae and Mochochidae were encountered throughout the year and they constituted 84% of the total catch (Table 5). The family Cichhidae dominated the catch .It constituted 27% of the catch in Jebel Aulia and 48% in Geteina (Table,4 and 5 respectively). In both sites, 9 families were not encountered during August, (Table 4 and 5). The maximum number of families encountered was 10 during June, December and January at Jebel Aulia (Table 4) where as, 11 families were encountered in Geteina during May (Table 5). The least encountered family during the study was Protopteridae. It was encountered in January at Jebel Aulia (Table 4) and during February and April in Geteina (Table 5)

.

4-4 Occurrence of Commercial species:

The occurrence of commercial fish species on bases of popularity and preference at both sites was given in Table 6

4-4-1 *Lates nilotcus*

Lates niloticus constituted 1.5% and 3% of the total catch at Jebel Aulia and Geteina, respectively (Tables1, 2 and 6). April was the most productive month at Geteina where as, July was the least

productive month (Fig. 2). In Jebel Aulia site July was the most productive month, where as, January was the least productive month. This species was not encountered during February, April, May, June, November and December.

4-4-2 *Bagrus bagrus:*

Bagrus bagrus contributed 11.4% to the total catch in Jebel Aulia and 6.41% in Geteina . In Jebel Aulia April was the most productive month and October the least one. In Geteina the most productive month was April and the least one was September (Fig. 3) *Bagrus bagrus* was not encountered during July, August and September in Jebel Aulia and June, August and October in Geteina, (Tables 1, 2 and 6).

4-4-3 *Oreochromis niloticus*:

Oreochromis niloticus recorded 24.92% in Jebel Aulia and 47% of the total catch in Geteina. It occurred throughout the year at both sites, except during August at Jebel Aulia (Tables 1, 2 and 6). Three peaks of occurrence were observed at Geteina.These were during March, October and May. In Jebel Aulia, a single peak of occurrence was noticed during December (Fig. 4).

4.4.4 Labeo niloticus:

In Jebel Aulia *Lates niloticus* constituted 9.3% of the total catch while in Geteina it amounted to 4.41% (Tables 1, 2 and 6). *Labeo niloticus* was encountered throughout the year at both sites except

during November in Geteina. Three peaks occurrence were observed in Geteina. These were July, February and January. In Jebel Aulia, a high peak occurred in March and a low one at September (Fig. 5).

4-4-5 *Auchenoglanis occidentalis*

The fillets of this species started to gain popularity in Khartoum fish markets. The species accounted for 2.89% of the total catch at Jebel Aulia and 3.94% in Geteina. May, June, August and September represent its peaks of occurrence in Geteina where as, in Jebel Aulia, the months that represent peaks of occurrence were, May , October and December (Fig. 6,Tables 1, 2 and 6).

4-4-6 *Synodontis schall*

Synodontis schall was encountered throughout the year in both sites, and constituted 11.09% and 8.86% of the total catch in Jebel Aulia and Geteina respectively (Tables 1, 2 and6).

March, May, June and August, represent peaks of abundance at Geteina. While July and August are the peaks at Jebel Aulia (Fig. 7).

4-4-7 *Clarias gariepinus:*

Clarias gariepinus contributed 3.65% and 6.8 of the total catch in Jebel Aulia and Geteina respectively (Tables 1, 2 and6). The species was encountered in 9 months in Jebel Aulia and in 8 months at Geteina. April was the most productive month in Jebel Aulia, where as, February was the most productive month in Geteina (Fig. 8).

4-4-8 *Hydrocyrus forskalli*:

This species contributed 7.6% of the total catch in Jebel Aulia and 1.8% of the total catch in Geteina .It was encountered in 9 months at Jebel Aulia and in 7 months in Geteina. One peak of abundance was recorded for Geteina and that was in April. In Jebel Aulia two peaks of occurrence were observed at March, and November (Fig.9, Tables 1, 2 and 6).

4.5 Occurrence of the family Cichlidae:

At both sites, the family Cichlidae dominated the catch (Table 4 and 5) it contributed 48% in Geteina and 27% of the total catch in Jebel Aulia. In the two sites, *Oreochromis. niloticus* dominated the Cichhidae and consequently the catch of the species (Tables 1 and 2). It amounted to 24.92% and 47% in Jebel Aulia and Geteina respectively *S. galilaeus* proportion of the total Cichhidae catch was 0.67% at Jebel Aulia and 0.86% in Geteina. While *Tilapia zilli* at Jebel Aulia was 1.14% and in Geteina 0.25% (Table 1 and 2, Figs. 10 and 11).

4.6 Description of fishery in the two sites:

The number of operating boasts in Jebel Aulia is 35 boats and one sharog. These were operated by 178 full time fishermen using 121 gill nets, 13 lines, 11 beach senies 22 silka nets, 3 cast nets and 8 trammel nets (Table 7). The ratio of boats of Geteina to Jebel Aulia is 12:1, the number of fishers and gears used is 10 times that

of Jebel Aulia (Table 7). Partime and occasional fishermen were absent in

Jebel Aulia. In Geteina, cast net is absent.The distance sampled in Geteina is (125 km) which is 5 times that of Jebel Aulia.

The highest productive gear in Jebel Aulia is the silka net with a mean catch per day of 3.78% kg (Table 8 a) and the least was the cast net with an average catch per day of 1.89 kg. In Geteina the highest productive gear was Trammel net with a mean catch per day of 7.5 kg while the long lines is the least productive gear with a daily average catch of 1.45 kg. (Table 8 b).

Comparison between catch per unit effort (CPUE) per day in kg between Jebel Aulia and Geteina, showed that the yield in Geteina is higher than that of Jebel Aulia.

CPUE by boat = 10.53 kg at Geteina and 8.81 Kg at Jebel Aulia
CPUE by fisher = 2.48 kg at Geteina and 1.78 Kg at Jebel Aulia
CPUE by net = 2.38 Kg at Geteina and 1.78 Kg at Jebel Aulia.

4.7 Stock assessment in the two sites:

The total annual yield of Jebel Aulia is 115732 kg and in Geteina 1617648 kg.(Table 1 and 2 respectively) The catch per unit effort was calculated at low water, rising flood and falling water regimes in the study area. The regression of catch per unit effort (CPUE) and effort in boat days yielded, a significant correlation at Jebel Aulia ($p > 0.05$) and very highly significant correlation ($p < 0.001$) at Geteina (Table 9). Based on the regression constants (a and b) the maximum sustainable yield for Jebel Aulia, was found to be 90706 kg and for Geteina 1925454 kg. The optimum effort was found to be 1739 boat days for Jebel Aulia and 21940 boat days for Geteina (Table 9).

4-8 Some biological studies of some Cichlids:

4-8-1 Relationship between standard length and total length:

Analysis of standard and total length relationship revealed very highly significant ($p < 0.001$) correlation with respect to sex, species at each fishing site (Table 10,Appendix 1-8, Fig. 12 – 19). The Tabulated

$r = 0.597$ at 25 Df is by far lower than any of the calculated r (Table 10). Therefore, either the standard length or the total length can be used with very high reliability in describing the growth in each species at each site. No significant difference ($p > 0.05$) were detected between the r value of the various species with respect to the sex or locality.

4-8-2 Length Weight relationship

The standard length and total weight were plot against each other for males and females of both species (*O. niloticus* and *S. galiaeus*) from both sites (fig. 20 to 27). Logarithmatic transformation of the data revealed insignificant correlation ($p > 0.05$) between total weight and standard length in females *S. galilaeus*_from both sites. Calculated r ranged between 0.364 and 0.503 which is less than tablated $r = 0.597$ at $DF = 25$ (Table 11,appendix 1-8). For the rest of measurements, very highly significant ($p < 0.001$) correlation were noticed (Table 11).The growth of both species is allometric as the calculated b ranged from 0.529 to 3.723 and no value approached the isometric norm of 3.00 (Table 11).

4-8-3 Determination of growth parameters, mortality rates and rate of exploitation (ER) in the two sites:

Based on the numbers of each species at the corresponding age (appendix 9to 16). The total mortality(Z) was calculated and the Z value was higher in Geteina species as compared to Jebel Aulia species. (Table 14a). The K and L infinity values (Table 13), and the Z values (Table 14a and Table 14b) were utilized to calculate (M) natural mortality,(F) fishing mortality (Table 14b). From these parameters .the exploitation ratio was calculated (Table 14b). Its highest value was 0.71 for *O. niloticus*, and the least was 0.54 for *S. galilaeus,* both from Jebel Aulia area.

CHAPTER FIVE: DISCUSSION

5. The reservoir fisheries

5.1. Hydrology and morphometry

Jebel Aulia, 377 m above sea level, has a surface area ranging from 600 to 1500 km^2 (Welcomme, 1972), while the lake's length extends up to 500 km and its maximum width in the vicinity of the dam is between 6 and 7 km (Khalid and Hannel, 1990). The amplitude is between minimum water level (end of April) and maximum water level (September) is about 6 m (Khalid and Hannel, 1990). According to (Khalid and Hannel 1990), the surface area and Jebel Aulia reservoir ranges from 600 to 1500 km^2 . As regard to Welcomme (1986) equation (Catch kg = 3.83 × area). The catch would be 2298-5745 tons/year. Based on his world wide constant, the catch would range from 3276 to 8190 tons/year. The present study showed that the catch from the northern part of reservoir was 1,733.38 tons.

Welcomme (1972) related the number of species (N) to the basin area (A) as: N = 0.449 A. Based on this the capacity is between 269-674 species.

5.1.1. Description of the fishery in the two sites

Full time, part time and occasional fishers are practicing fishing in Geteina with the use of boats (Morkab and Sharok). While at Jebel Aulia only full time fishermen are practicing fishing activities. The principal type of Gears in use are (silka, seines and gill nets). They did not change much over the years, and this is in agreement with the findings of

Henderson (1975), who reported that seine and gill nets are the principal gears in use.

Welcomme (1975) estimated that, the number of fishers and boats operating in the Lake as 1500 and 550 respectively. After a decade, the numbers were found to be 1594 and 544 respectively (FAO, 1982; Kapetsky, 1986). The findings of the present work indicated an increase in the number of full time fishers to 1965 and an increase in the number of boats to 457.It worth mentioning that t, the previous findings were for the whole reservoir.

5.2. Species composition and seasonality of species

5.2.1. In Jebel Aulia

During this study 41 species belonging to 24 genera and 13 families were encountered in Jebel Aulia (Tables. 1, 3 and 6). Sandon (1950) recorded 23 families comprising 105 species from the White Nile. In Jebel Aulia reservoir, Ali (1975) recorded 15 families represented by 36 species and Adam (1977) recorded 48 species belonging to 14 families in Kosti area. Hamza (1981) in her work in the northern part of the White Nile recorded 33 species belonging to ten families. Abdel Rahman (1985,1989) recorded 53 species belonging to 14 families. It is clear that the number of species , the relative abundance of genera and family is decreasing (Tables 1, 3 , 4 and 6 and Appindix 19).

Genera wise, the diversity is changing (Table. 3) with *Oreochromis niloticus* shared a figure up from 1.76% (Khalid 1981) to 24.92% (the present study). In Abdel Rahman work (1984), she found that, the relative abundance of *Oreochromis* is 4.6, *Sarotherodon* is 3.5% and the *Tilapia* is 1.3%. In the present study *Oreocromis* comprises 24.92%, *Sarotherodon* comprises 0.67% and *Tilapia* 1.14% .The fact that Nile Bulti species are more abundant could be attributed to its early attainment

of maturity at small size. Tahir (1994) reported maturity at size ranging from 11.5 to 13.0 cm standard length.

Babiker and Ibrahim (1979) reported the smallest female was 9.0 cm long and male 11.2 cm long and they were still in their first year of age .

Familywise, from 1977 some families like (*Citharinidae*) disappeared over time, some like *Distichodontidae* and *Mormyridae* are in decline abundance wise; others like *Cyprinidae*, *Bagridae* and *Mochocidae* are having more or less similar percentage of occurrence. The family *Cichlidae* recorded a higher percentage of occurrence over time, (Appendix 2 0).

5.2.2: Species composition and seasonality in Geteina.

During this study 37 species belonging to 22 genera and 13 families were recorded in Geteina. In earlier survey of Abdel Rahman (1985) recorded 53 species belonging to 14 families. This is an indication of decrease in species diversity. The number of families in Geteina is equal to that in Jebel Aulia, but some genera like *Hypropisus, Brycinus* and *Petrocephalus* were not encountered in Geteina, and some species like (*Petrocephalus bane*, *Brycinus nurse*, *Brycinus macrolepidotus, Mormyrus cashive* and *Mormyrus kannume*) were not encountered in Geteina.

During this study, Nile Bulti dominated the catch *Oreochromis niloticus* comprised 46.95% of the total catch in Geteina followed by *Sarotherodon galilaeus* 0.86% and *Tilapia zilli* 0.26%. At both site, the weight of fish ranged from 0.25 to 0.56 kg at Jebel Aulia and 0.25 to 0.36 kg in Geteina. Long lines tend to capture large size fish 0.56 kg in Jebel Aulia and 1.29 kg in Geteina. However, large proportion of the catch is composed of undersized and illegal caught fish, which is likely due to

illegal fishing gears. Tables 1 and 2 indicated clearly discrepancy in species abundance throughout the year at both sites. Fish in the two sites were abundant during the low water, before and after the flood. This indicated that, hydrological regime has got its effect on fishes abundance and distribution. Seasonality of species recorded by Ali (1975), Hamza (1981) and Abdel Rahman (1985), was explained on basis of the same argument. Current speed and wind velocity which probably drive fish from the main stream towards the shelters of the bank, also plays a role in abundance and seasonality of fish species (Abdel Rahman, 1989).

5.3. Biological data on Nile Bulti from the two sites.

5.3.1. Length weight relationship.

Regression analysis of total weight versus standard-length of *Oreochromis niloticus* species from Jebel Aulia revealed that, the growth is allometric for both males and females with b-value ranging from 1.969 to 2.366.

Abdel Rahman (1985) reported b = 2.92 for males and 3.02 for females (isometric). Abdalla (1996) reported allometric growth with b = 3.214 for males and 3.2823 for females. Salih (2000) recorded, b = 2.6988 and 2.428 for males and females respectively. In Geteina, the regression coefficient (b) was 3.402 for males and 3.7226 for females *Oreochromis niloticus* indicating allometry. Length weight relationship for *Sarotherodon galilaeus* revealed an allometric growth for males in the two sites with b = 2.751 and 2.767 for Jebel Aulia and Geteina respectively and the value for the females is 0.41 and 0.539 which revealed allometric growth. Salih (2000) recorded allometric growth for *Sartherodon galilaeus* from Khor Jassir as 2.627 and 2.3905, for males and females, respectively.

5.4. Stock assessment

The present study showed that, the total annual yield at Jebel Aulia is 115,732 kg and the maximum sustainable yield is 90,706 kg, and this show that the fishing pressure is intense. Thus, the annual fishing effort should be decreased in Jebel Aulia by at least 25 tons to be within the estimated range of MSY. This necessitates reduction of the number of boats from 36 to 28, full time fishermen, from 178 to 139 and fishing gears from 178 to 139.

In Geteina, the MSY (1,925,454 kg) is about 16% higher than the current annual yield of 1,617,648 kg. Consequently, the executed effort can be in creased by increase in number of boats to 500, fisher to 2127, and the number of gears to 2216. In case of Jebel Aulia as well as Geteina, the figures given above were based on those of Table 7 and the calculated catch per unit effort given in 4. 6 (description of fishery in the two sites). As far as fishing effort is concerned the catch per unit effort in Geteina surmounted that of Jebel Aulia 10.5 kg for Geteina and 8.81 for Jebel Aulia. By fisher 2.4 for Geteina and 1.78 kg per day for Jebel Aulia. Catch per unit effort by net in Geteina is 2.3 kg and in Jebel Aulia 1.78 kg per day.

5.5. Determination of Exploitation ratio.

The investigations during this study revealed that K = 0.1/yr for *Oreochromis niloticus* from Jeble Aulia, with L_{inf} of 44.07 cm. Abdel Rahman (1985) recorded L_{inf} of 70.5 cm Khalid and Hannel (1990) established the following parameters:

K =0.2949/yr

L_{inf} = 450 mm

The exploitation ratio of *O. niloticus* during this study is 0.71 and for *S. galilaeus* is 0.54, indicating that *S. galilaeus* is on the verge of optimum exploitation on and *O. niloticus* was over fished. Though Abdel Rahman (1985) reported that Oreochromis and Sarothrodon, could withstand further exploitation.

In Geteina the exploitation ratio (ER) is 0.59 for *O. niloticus* and 0.68 for *S. galilaeus*, indicating over fishing. The study conducted by Hamza (1981) stated that overfishing is one of the major problems in the White Nile because continuous fishing is being carried out during most of the year. The study conducted by Abdel Rahman (1985) in the vicinity of the Dam (up to 10 km) indicated that no direct over fishing can be proved, though the exploitation reached the maximum allowable level. Exploitation ratios of indicated species are higher, and there is a decrease in species diversity. Further studies over time are needed to detect the rate of fishing to total mortality for the viable fish species of the White Nile. Kawai (1994) affirmed a continual decline yield and fish genera in the northern part of Jebel Aulia reservoir.

In this study, though Nile Bulti dominated the catch in the northern part of the reservoir, it is over fished. The domination could be attributed to the cause that *Oreochromis niloticus* exhibits a fractional type of spawning and ripe females produce batches of ripe eggs at different times of the year, (Abdel Rahman, 1985). Besides, the ripe of the both sexes at small length and in their O + age.

The growth pattern of *Cichlidae* has changed over years, and the evidence for that, is decrease in $L\infty$ over time, scarcity of large fish species. Given into account that *Oreochromis niloticus* could reach a length of 55 cm (Mahdi, *et al*., 1974).

CHAPTER SIX : Conclusions and Recommendations

A . Conclusions

1. Decline in species diversity and reduction of fish size (0.25-0.56 kg) at capture is noticed in the study area, and continual decrease in production and number of fish species in the two sites .The majority of the catch in the two sites is composed of undersized fish.
2. Reduction in fish production came as a result of the use of illegal gears.
3. Variation in fish stock abundance is linked to the degree of variability in the hydrological regime, and water level affect the efficiency of fishing.
4. Three distinct peaks of occurrence were observed (March-April, July, November-December), and Geteina is more productive than Jebel Aulia throughout the year.
5. The most abundant genera were *Oreochromis, Synodontis, Bagrus, Labeo, Clarias*. Some genera like *Peotopterus, Tetradon, Mormyrops, Petrocephalus, Chrysichthys* and *Malapterus* were recorded in few numbers.
6. Length weight relationship revealed allometric growth for both sexes of *Oreochromis niloticus* and *Sarotherodon galilaeus* in Jebel Aulia and Geteina.
7. Growth pattern of *Cichlidae* has changed over years, and the evidence for that , is decrease in $L\infty$ overtime , and scarcity of large fish species.

B. Recommendations

1. Management of the area could be attained through addressing fishery problems in the area (Biological and Socioeconomic).
2. Gear control should be enforced at both levels. Gear supply and permission (prohibition of beach seining operations at low water levels).
3. Catch quota limitation through reduction of the number of fishing licenses and prohibition of undersized fish by enforcement of penalty measures.
4. Pretension of fishing activities on Khors and flooded areas in the breeding season.
5. Control of fishers permits and restrictions on the movement of fishermen during the flood.
6. Improvement of fish handling and post harvest activities.
7. A more detailed biological study of *Tilapias* and other viable fish in the White Nile is needed to scrutinize the appropriate characteristics of the stock.
8. A more accurate catch and effort statistics is required from various landing sites on the banks of the Nile, for precise assessment of stocks.
9. For proper exploitation of the reservoir, and to attain a healthy fishery, recruitment and growth, intensity of fishing should be controlled.
10. The annual fishing effort in Jebel Aulia should be decreased by at least 25 tons to be within the estimated range of MSY.

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Appendix 1 Fish species recorded from Jebel Aulia and White Nile by various authors

Fish species	**Boulenger (1907)**	**Sandon (1950)**	**Adam (1977)**	**Hamza (1981)**	**Abe Gideiri (1984)**	**Bailey (1988)**
Lates niloticus	✓	✓	✓	✓	✓	✓
Bagrus docmak	✓	✓	✓	✓	✓	✓
Bagrus bayad	✓	✓	✓	✓	✓	✓
Auchenoglans biscutatus	✓	✓	✓	✓	✓	✓
Auchenoglans occidentalis	✓	✓	+	✓	✓	✓
Clarotes laticeps	✓	✓	✓	✓	✓	✓
Chrysichthys auratus	✓	✓	✓	✓	✓	✓
Tilapia zillii	✓	✓	+	✓	✓	✓
Oreochromis niloticus	✓	✓	✓	✓	✓	✓
Sarotherodon galilaeus	✓	✓	✓	✓	✓	✓
Hydrocynus brevis	✓	✓	✓	✓	+	✓
Hydrocynus vittatus	✓	✓	✓	✓	+	✓
Hydrocynus forskalli	✓	✓	✓	✓	✓	✓
Brycinus macrolepidotus	✓	✓	✓	✓	✓	✓
Brycinus nurse	✓	✓	+	+	+	✓
Alestes dentex	✓	✓	✓	✓	✓	✓
A.lestes baremoze	✓	✓	✓	✓	✓	✓
Protopterus aethiopicus	✓	✓	✓	✓	+	✓
Polypterus sengalus	✓	✓	✓	✓	✓	✓
Polypterus endecheri	✓	✓	+	+	+	✓
Polypterus bichir	✓	✓	✓	✓	✓	✓
Hetrotis niloticus	✓	✓	+	+	✓	✓
Mormyrus hasselquestui	✓	✓	✓	✓	✓	✓
Mormyrus kannume	✓	✓	✓	✓	✓	✓
Mormyrus niloticus	✓	✓	+	+	+	✓
Mormyrus cashive	✓	✓	✓	✓	✓	✓
Hypropisus bebe	✓	✓	✓	✓	✓	✓
Mormyrops anguilloides	✓	✓	+	+	✓	✓
Petrocephalus bane	✓	✓	✓	✓	✓	✓
Xenomystus nigri	✓	✓	+	+	+	+
Brienomyrus niger	✓	✓	+	+	+	+

Appindix 1 Continued

Marcusims cyprinoides	✓	✓	+	+	✓	✓
Gymnarchus niloticus	✓	✓	+	+	✓	✓
Distichodus breuipinnius	✓	✓	+	+	✓	✓
Distichodus engycephalus	✓	✓	+	+	✓	✓
Distichodus niloticus	✓	✓	✓	✓	✓	✓
Distichodus rostratus	✓	✓	+	+	✓	✓
Citharinus citharus	✓	✓	✓	✓	✓	✓
Citharinus latus	✓	✓	+	+	✓	✓
Barbus binni	✓	✓	✓	✓	✓	✓
Barbus sligmatopygus	✓	✓	+	+	✓	✓
Labeo niloticus	✓	✓	✓	✓	✓	✓
Labeo horie	✓	✓	✓	✓	✓	✓
Labeo coubie	✓	✓	+	+	✓	✓
Labeo forskalli	✓	✓	+	+	✓	✓
Schilbi mystus	✓	✓	✓	✓	✓	✓
Schilbi intermedius	✓	✓	+	✓	✓	✓
Schilbi uranoscopus	✓	✓	✓	✓	✓	✓
Clarias gariepinus	✓	✓	✓	✓	✓	✓
Clarias anguillaris	✓	✓	+	+	✓	✓
Clarias werneri	✓	✓	+	+	✓	✓
Clarias engelseeri	✓	✓	+	+	✓	✓
Heterobranchus bidrsalis	✓	✓	+	+	✓	✓
Heterobranchus longiflis	✓	✓	+	+	✓	✓
Malapterus electricus	✓	✓	+	+	✓	✓
Synodontis schall	✓	✓	✓	✓	✓	✓
Synodontis serratus	✓	✓	✓	✓	✓	✓
Synodontis frontosus	✓	✓	+	+	✓	✓
Synodontis caudovitatus	✓	✓	+	+	✓	✓
Hemi synodontis membranaceus	✓	✓	+	+	✓	✓
Brachysynodontis betensoda	✓	✓	✓	+	✓	✓
Tetraodon. Fahaka	✓	✓	✓	✓	✓	✓

N.B.

✓= recorded species .

+ = unrecorded species .

Appendix 19 .Relative abundance of different genera of fish in Jebel Aulia

Dam. 1964-2002

Genera	Soviet expedition (1964)	Hamza (1981)	Abdel Rahman (1984)	Present study (2001-2002)
Synodontis	25-27	28.75	10.4	14.79
Labeo	4-5	8.61	8.9	10.53
Hydrocyon	4-5	14.88	12.3	7.95
Alestes	8-9	5.97	10.1	6.22
Bagrus	-	4.34	5.9	12.10
Auchenoglanis	-	2	1.7	4.03
Chrysichthys	-	0.48	6.8	1.94
Distichodus	7-8	7.62	3.9	0.32
Citharіuns	9-11	3.27	0.3	0
Eutropius	5-6	3.37	4.6	0
Schilbe	5-6	2.03	4.7	2.58
Barbus	-	4.51	3.2	2.55
Mormyrus	6-7	5.76	1.68	2.02
Mormyrops	-	-	0.5	0.04
Peterocephalus	-	0.05	0.5	0.02
Gnathonemus	5-6	0.74	0.98	0
Hyperopisus	4-5	3.23	0.95	0.10
Lates	1-2	1.86	2.5	1.46
Heterotus	2-3	-	-	0
Clarias	-	0.78	3.75	4.07
Tilapia	-	1.76	9.4	26.70

N.B. the Genera *Tilapia* in the present study is for comparative study .

TABLE 7. Some Fishery parameters at Jebel Aulia and Geteina

Parameter	Jebel Aulia	Geteina	Ratio
Boats			
Sharog	1	100	1 : 100
Morkab	35	321	1 : 9.2
Fishermen			
Fulltime	178	1170	1 : 6.6
Partime	0	381	-
Occasional	0	236	-
Fishing gears			
Gill nets	121	387	1 : 3.2
Beach seine	11	491	1 : 44.6
Silka	22	417	1 : 32.5
Cast net	3	0	3 :0
Trammel net	8	32	1 : 4
Long line	13	241	1 : 18.5

Table 3.Genera percentages in Jebel Aulia and Geteina

Generic name	Jebel Aulia		Geteina	
	Weight (Kg)	%	Weight (Kg)	%
Lates	1699	1.5	47397	3
Bagrus	14004	12.1	182794	11
Oreochromis	28817	24.92	759486	47
Sarotherodon	810	0.7	13912	1
Tilapia	1319	1.1	4044	0.3
Hydrocynus	9189	7.95	33647	2
Labeo	12187	10.5	86544	5
Auchenoglanis	4664	4.03	70529	4
Distichodus	370	0.32	11324	1
Mormyrus	2338	2.02	1284	0.1
Hypropisus	116	0.1	0	0
Synodontis	17128	14.8	170177	11
Brachysynodontis	0	0	12941	0.8
Hemisynodontis	12	0.01	1618	0.1
Clarias	4710	4.07	111618	7
Barbus	2951	2.6	51441	3
Alestes	7198	6.2	4853	0.3
Brycinus	856	0.7	0	0
Malapterus	810	0.7	6471	0.4
Schillbe	2986	2.6	11324	0.7
Chrysichthys	2245	1.9	9706	0.6
Petrocephalus	23	0.02	0	0
Mormyrops	46	0.04	11324	0.7
Tetradon	520	0.45	10529	0.6
Protopterus	741	0.6	4853	0.3
Total	115740	100	1617825	100

Table 9. Regression analysis of the type Y=a+bX, where Y= catch per unit effort, X=effort in boat days, a and b are constants.

Jebel Aulia		Geteina	
Y	**X**	**Y**	**X**
11.18[1]	**3204**	**37.469[1]**	**37469**
8.68[2]	**3312**	**38.732[2]**	**38732**
4.67[3]	**3312**	**38.732[3]**	**38732**
10.77[4]	**3312**	**11.04[4]**	**38732**
Y = 104.33 – 0.03X		Y = 175.5 – 0.004X	
r = - 0.530 , p>0.05		**r = 0.890, p<0.001**	

1=Low water; 2= Rising water; 3= Flood; 4= Falling water

Table 10. The relationship between standard length (Y) and the total length (X) in some Cichlids folllowing the equation Y=a+bX, where a and b are constants.

Species	**Sex**	Regression equation	**r**	**P**
Jebel Aulia				
O. niloticus	M	**Y = -0.26 + 0.851X**	**0.996**	**P<0.001**
O. niloticus	**F**	**Y = -0.16 + 0.831X**	**0.995**	**P<0.001**
S. galilaeus	**M**	**Y = -0.86 + 0.86X**	**0.994**	**P<0.001**
S. galilaeus	**F**	**Y = -1.55 + 0.883X**	**0.996**	**P<0.001**
Geteina				
O. niloticus	**M**	**Y = -1.51 + 0.902X**	**0.965**	**P<0.001**
O. niloticus	**F**	**Y = 2.144 + 0.724X**	**0.993**	**P<0.001**
S. galilaeus	**M**	**Y = -1.40 + 0.887X**	**0.994**	**P<0.001**
S. galilaeus	**F**	**Y = -1.54 + 0.885X**	**0.991**	**P<0.001**

Table 11. The relationship between transformed total weight (log W) and the standard length (log L) in some Cichlids folllowing the equation log W=a+blogL, where a and b are constants.

Species	Sex	Regression equation	r	p
Jebel Aulia				
O. niloticus	**M**	**LogW = -0.202 + 1.969logL**	**0.788**	**P<0.001**
O. niloticus	**F**	**LogW = -0.710 + 2.366logL**	**0.831**	**P<0.001**
S. galilaeus	**M**	**LogW = -1.110 + 2.751logL**	**0.930**	**P<0.001**
S. galilaeus	**F**	**LogW = 0.979 +0.890logL**	**0.364**	**P<0.05**
Geteina				
O. niloticus	M	**LogW = -2.050 + 3.402logL**	**0.968**	**P<0.001**
O. niloticus	**F**	**LogW = -2.013+ 3.723logL**	**0.676**	**P<0.001**
S. galilaeus	**M**	**LogW = -1.150 + 2.767logL**	**0.964**	**P<0.001**
S. galilaeus	**F**	**LogW = -1.589 + 0.529logL**	**0.503**	**P<0.05**

Table 12. Ford–Walford plot values for *Oreochromis niloticus* and *Sarotherodon galilaeus* for both sites

t	LT	LT+ΔT	LT	LT+ΔT	LT	LT+ΔT	LT	LT+ΔT
	Jebel Aulia				**Geteina**			
	O. niloticus		**S. galilaeus**		***O. niloticus***		**S. galilaeus**	
0+	**7**	**17**	**15**	**19**	**10**	**17**	**15**	**19**
1	**17**	**20**	**19**	**20**	**17**	**20**	**19**	**20**
1+	**20**	**22**	**20**	**21**	**-**	**-**	**20**	**21**
2	**22**	**24**	**21**	**23**	**20**	**22**	**21**	**24**
2+	**24**	**27**	**24**	**26**	**-**	**-**	**24**	**25**
3	**30**	**36**	**26**	**28**	**22**	**30**	**25**	**27**
3+	**36**	**38**	**28**	**30**	**30**	**32**	**27**	**29**

Table13. Regression of Ford-Walford plot values

Species	Locality	Regression equasion	r	p
O.niloticus	**Jebel Aulia**	**(LT+DT) =8.092+0.816(LT)**	**0.951**	**P<0.001**
O.niloticus	**Geteina**	**(LT+DT) =7.992+0.819(LT)**	**0.919**	**P<0.05**
S.galilaeus	**Jebel Aulia**	**(LT+DT) =3.653+0.924(LT)**	**0.975**	**P<0.001**
S.galilaeus	**Geteina**	**(LT+DT) =4.596+0.88(LT)**	**0.960**	**P<0.001**

Table 14 a. Determination of total mortality(Z) for *O.niloticus* and *S. galilaeus* from Jebel Aulia and Geteina

Age	No.	Ln	No.	Ln	No.	Ln	No.	Ln
	Jebel Aulia				Geteina			
	O.niloticus		***S.galilaeus***		***O.niloticus***		***S.galilaeus***	
O+	**7**	**1.946**	**143**	**4.963**	**22**	**3.091**	**279**	**4.304**
1	**1281**	**7.155**	**1497**	**7.311**	**1348**	**7.445**	**1030**	**7.135**
2	**1578**	**7.364**	**991**	**6.899**	**883**	**6.215**	**1022**	**6.904**
3	**417**	**6.033**	**528**	**6.269**	**69**	**4.489**	**186**	**5.252**
4	**24**	**3.178**	**-**	**-**	**-**	**-**	**-**	**-**
Slope	**-1.33**		**-0.52**		**-1.48**		**-0.94**	
Z	**1.33**		**0.52**		**1.48**		**0.94**	

Table 14 b. Determination of exploitaion ratio for Jebel Aulia and Geteina

Mortality	**Jebel Aulia**		**Geteina**	
	O. niloticus	***S. galilaeus***	***O. niloticus***	***S. galilaeus***
Total mortality, Z	**1.33**	**0.52**	**1.48**	**0.94**
Natural mortality, M	**0.39**	**0.24**	**0.61**	**0.30**
Fishing mortality, F	**0.94**	**0.28**	**0.868**	**0.64**
Exploitation ratio, ER	**0.71**	**0.54**	**0.59**	**0.68**

Table 8a. Monthly average catch for different gears in Jebel Aulia

Net Type	Beachseine nets								Trammelnets		Silkanet		Castnet	
	Gerrara				Umsurra		Bebe		Mushesha		Silka		Cast	
Twine size	210/12		210/15		210/12		210/4		210/46,210/6		Monofil		210/6	
Mesh size	70 mm		70 mm		40 mm		40 mm		40 to120 mm		100 mm		40 mm	
Month	Fish													
	No.	**W**	*No.*	**Wt**	*No.*	**W**	*No.*	**W**	*No.*	**W**	*No.*	**W.**	*No.*	**W**
Feb.	0	0	0	0	0	0	9435	2621	0	0	4788	1915.2	2271.5	437
March	0	0	0	0	7936	2480	14123	2435	0	0	25916	4983.8	0	0
April	0	0	6636	2141	0	0	14663	3216	0	0	817.5	291.9	4919	1265
May	0	0	0	0	0	0	9818	2282	18095	3971	5836.5	2161.6	0	0
June	0	0	0	0	0	0	8018	1909	0	0	1740	600	0	0
July	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aug.	0	0	0	0	0	0	0	0	21334	5766	0	0	0	0
Sept.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Octob.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nov.	0	0	0	0	0	0	0	0	0	0	10080	3360	0	0
Decemb.	0	0	0	0	0	0	0	0	0	0	31124	12449.6	1339	372
Jan.	10323	3441	0	0	0	0	0	0	0	0	11509	4603.5	0	0
Total	10323	3441	6636	2141	7936	2480	56057	12463	39429	9737	91811	30365.6	8529.5	2074

Table 8a. continued

Net Type	Gillnets				Long lines					
	Bebe		Omkubuk		Sareema		Gigo		Sareema	
Twinesize	210/4		210/36		Hook size 8		Hook size <7		Hook size 8	
Meshsize	40 mm		120 mm							
Month	Fish									
	No.	W	No.	W	*No.*	W	*No.*	W	*No.*	W
Feb.	1976	470	0	0	1201	1579	3203	642	0	0
March	11442	3269	0	0	351	789	0	0	0	0
April	0	0	0	0	14505	7297	0	0	0	0
May	0	0	0	0	4625	2312	0	0	0	0
June	11218	2387	0	0	0	0	6218	2073	0	0
July	35943	8767	0	0	3028	2294	0	0	0	0
Aug.	0	0	0	0	990	806	0	0	0	0

Sept.	**3404**	**724**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Octob.	**25275**	**7152**	**0**	**0**	**0**	**0**	**0**	**0**	**716**	**1023**
Nov.	**23160**	**5340**	**0**	**0**	**1260**	**840**	**0**	**0**	**0**	**0**
Decemb.	**3330**	**1110**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Jan.	**9765**	**2441**	**698**	**233**	**1350**	**1488**	**0**	**0**	**0**	**0**
Total	**125513**	**31660**	**698**	**233**	**27310**	**17405**	**9421**	**2715**	**716**	**1023**

Table 8b. Monthly average catch for different gears in Geteina

Net Type	**Beach seine nets**			**Trammel net**	**Silka net**
	Gerrara	**Umsurra**	**Bebe**	**Mushesha**	**Silka**
Twine size	**210/12**	**210/15**	**210/4**	**210/46, 210/6**	**Monofilament**
Mesh size	**70 mm**	**40 mm**	**40 mm**	**40 to 120 mm**	**100 mm**
Month	Fish				

	No.	W	*No.*	W	*No.*	W	*No.*	W	*No.*	W
Feb.	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**146743**	**46438**
March	**609208**	**148587**	**0**	**0**	**0**	**0**	**0**	**0**	**106111**	**32155**
April	**0**	**0**	**23740**	**8186**	**570572**	**139164**	**21284**	**19881**	**36485**	**14033**
May	**32126**	**13359**	**87764**	**22586**	**99472**	**34301**	**0**	**0**	**42667**	**17067**
June	**82834**	**27628**	**0**	**0**	**0**	**0**	**0**	**0**	**117037**	**33865**
July	**0**	**0**	**0**	**0**	**0**	**0**	**237177**	**67764**	**103537**	**43503**
Aug.	**0**	**0**	**0**	**0**	**299992**	**50123**	**0**	**0**	**38937**	**29790**
Sept.	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Octob.	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**147024**	**50698**
Nov.	**0**	**0**	**0**	**0**	**210652**	**51379**	**0**	**0**	**136596**	**54858**
Decemb.	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**374920**	**104144**
Jan.	**41288**	**12386**	**0**	**0**	**0**	**0**	**0**	**0**	**129422**	**61630**
Total	**765456**	**201960**	**91504**	**30772**	**1180688**	**274967**	**25846**	**87645**	**1379476**	**488181**

Table 8 b. continued.

Net Type	Gillnets				Long lines		Silka net	
	Bebe Morkab		Bebe Sharoag		Long lines		Silka Sharog	
Twine size	210/4		210/4				Monofilament	
Mesh size	40 mm		40 mm		Hooksize 8		100 mm	
Month	Fish							
	No.	W	No.	W	*No.*	W	*No.*	W
Feb.	262804	73821	0	0	36222	46438	0	0
March	39339	11239	0	0	0	0	0	0
April	0	0	0	0	5731	8186	0	0
May	0	0	0	0	4802	11712	0	0
June	0	0	0	0	13893	21050	0	0
July	0	0	0	0	9100	9203	0	0
Aug.	0	0	0	0	0	0	34046	9457
Sept.	0	0	122231	36487	0	0	158443	67711
Octob.	503804	95761	0	0	0	0	0	0
Nov.	0	0	0	0	16840	21050	0	0
Decemb.	178836	47062	0	0	0	0	0	0
Jan.	78129	36853	0	0	12634	10272	63626	27794
Total	1062911	264737	12231	36487	99222	127911	256115	104962

Table 1. Percentage occurrence of species in Jebel Aulia(by weight kg)

Species	Feb.	March	April	May	June	July	August	Sept.	Octob.	Nov.	Dece.	Jan.	Total	%
L. niloticus	0	45.1	0	0	0	992	558	34	47	0	0	23	1699	1.47
B. bagrus	1290	789	3503	2262	1440	0	0	0	670	720	744	1790	13208	11.4
B.docmac	34	451	292	0	0	0	0	0	0	0	25	0	801	0.7
O. niloticus	2903	2649	535	875	545	620	0	4	1349	3360	10416	5580	28836	24.92
T. zilli	101	0	1168	50	0	0	0	0	0	0	0	0	1319	1.14
S. galilaeus	130	56	97	0	55	0	0	0	93	0	248	93	772	0.67
H. brevis	0	0	0	0	0	0	0	0	186	120	0	93	399	0.34
H. forskalli	135	2255	535	955	76	0	0	0	1395	2520	285	651	8807	7.61
L.niloticus	639	1457	1751	905	1635	434	1736	81	605	480	682	465	10669	9.39
L. horie	0	124	97	50	109	124	310	26	0	0	0	186	1026	0.89
L. coubie	23	0	0	0	0	0	0	0	0	0	0	0	23	0.02
L. forskalli	0	0	0	0	0	0	62	17	0	0	0	0	79	0.07
A. biscutatus	0	0	49	151	55	62	124	17	884	0	0	0	1341	1.16
A. occidentalis	135	0	341	704	218	285	310	60	674	60	558	0	3344	2.89
D. niloticus	0	0	0	0	109	0	0	17	0	0	248	0	374	0.32
M. caschive	672	0	0	0	164	868	0	0	0	0	0	0	1703	1.47
M. kannume	34	0	0	0	218	372	0	0	0	0	0	0	624	0.54
M. hasselquistii	0	0	0	30	0	0	0	0	0	0	0	0	30	0.03
H. bebe	0	0	0	50	55	0	0	0	19	0	0	0	123	0.11
M. anguilloid	0	0	0	50	0	0	0	0	0	0	0	0	50	0.04
S. schall	558	1127	584	1207	982	4464	1488	171	558	960	248	488	12835	11.09
S. serratus	67	112	49	0	55	558	248	69	279	0	0	0	1436	1.24
S. frontosus	336	225	146	0	55	682	124	69	186	0	0	93	1916	1.66
S. caudovitatus	0	0	0	101	0	372	62	69	279	60	0	0	942	0.81
H. membrana	0	0	0	0	0	06	0	9	0	0	0	0	9	0.01

Table 2. continued

C. gariepinus	**52391**	**1891**	**16372**	**11712**	**14472**	**7529**	**0**	**0**	**0**	**3189**	**0**	**2417**	**109975**	**6.8**
C. anguillaris	**2381**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2381**	**0.15**
B. binni	**1191**	**1891**	**2924**	**0**	**0**	**837**	**473**	**0**	**0**	**0**	**0**	**0**	**7315**	**0.45**
B. stigmatopyg	**2381**	**22697**	**2924**	**5856**	**2631**	**5856**	**1891**	**0**	**0**	**0**	**0**	**0**	**44237**	**2.73**
T. fahaka	**0**	**0**	**4678**	**2510**	**0**	**335**	**0**	**0**	**1637**	**732**	**0**	**602**	**10529**	**0.65**
A. dentex	**1191**	**0**	**0**	**1673**	**0**	**0**	**0**	**0**	**0**	**0**	**659**	**0**	**4799**	**0.3**
A. baremose	**0**	**0**	**0**	**1673**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1673**	**0.1**
M. electricus	**0**	**0**	**0**	**0**	**0**	**2008**	**0**	**0**	**0**	**637**	**2637**	**1208**	**6491**	**0.4**
P. ethiopicus	**3572**	**0**	**1169**	**0**	**0**	**0**	**0**	**0**	**837**	**0**	**0**	**0**	**5578**	**0.34**
S. mystus	**1191**	**946**	**4093**	**1171**	**2631**	**0**	**0**	**351**	**0**	**0**	**0**	**0**	**10383**	**0.64**
S. intermedius	**0**	**0**	**585**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**585**	**0.04**
S. uranoscopus	**0**	**0**	**585**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**585**	**0.04**
C. aurtus	**2381**	**0**	**2924**	**0**	**0**	**502**	**0**	**0**	**0**	**574**	**3955**	**0**	**10335**	**0.64**
Total	**166696**	**191982**	**189449**	**99053**	**82543**	**120471**	**89371**	**104197**	**146459**	**127286**	**151206**	**148935**	**1617648**	**100**

Table 2. Percentage occurrence of species in Geteina (by weight kg)

Species	Feb.	March	April	May	June	July	August	Sept.	Octob	Nov.	Dece.	Jan.	Total	%
L. niloticus	8930	0	11694	1673	7894	1339	0	0	7918	2232	3955	1813	47448	2.93
B. bagrus	16670	5674	24558	6693	0	10039	0	1403	0	22326	6591	9667	103622	6.41
B.docmac	0	0	0	0	0	837	0	0	0	78459	0	0	79296	4.9
O. niloticus	53582	124836	52625	14222	6578	57726	26480	87007	112941	638	108099	114800	759534	47
T. zilli	0	0	0	0	0	0	946	0	1840	1276	0	0	4062	0.25
S. galilaeus	1786	0	585	0	0	0	0	1403	5020	0	2637	2417	13847	0.86
H. brevis	0	0	2924	0	0	0	0	0	0	0	0	0	2924	0.12
H. vittatus	0	0	1169	0	0	0	0	0	0	0	0	0	1169	0.07
H. forskalli	1191	567	18711	2510	0	4183	0	0	0	0	1318	1208	29689	1.84
L.niloticus	8335	6998	5263	2510	2290	17569	4729	1403	2510	0	7910	11782	71298	4.41
L. horie	0	1891	585	0	2631	837	946	0	0	2551	923	1208	11572	0.72
L. coubie	0	0	0	0	0	0	0	0	0	3189	0	0	3189	0.2
L. forskalli	0	0	5847	0	0	0	0	0	335	0	0	0	919	0.06
A. biscutatus	2381	946	0	837	0	0	1891	0	837	0	0	0	6891	0.43
A. occidentalis	595	1891	7017	10876	10525	5020	10403	9122	0	5741	1977	602	63769	3.94
D. niloticus	3572	0	0	837	0	0	0	0	0	0	1318	0	5727	0.35
M. hasselquestii	0	0	0	0	0	0	0	0	0	0	1318	0	1318	0.08
M. anguilloid	0	0	10525	1673	0	0	0	0	0	0	0	0	12198	0.75
S. schall	1191	19860	5263	26771	26313	5856	37829	3508	8366	3189	3955	1208	143309	8.86
S. serratus	595	0	0	1673	1316	0	1891	0	2510	638	1318	0	9941	0.61
S. frontosus	0	1891	0	3346	5263	0	0	0	0	0	1318	0	11819	0.73
S. caudovitatus	1191	0	0	837	0	0	946	0	837	0	1318	0	5128	0.32
H.membrana	0	0	0	0	0	0	946	0	0	638	0	0	1584	0.1
B.synodontis	0	0	11694	0	0	0	0	0	837	0	0	0	12531	0.78

Table 1. continued

C. gariepinus	**101**	**0**	**2432**	**452**	**109**	**62**	**0**	**0**	**93**	**120**	**62**	**791**	**4222**	**3.65**
C. anguillaris	**0**	**0**	**0**	**503**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**503**	**0.43**
B. binni	**0**	**0**	**0**	**226**	**55**	**868**	**372**	**0**	**0**	**60**	**0**	**0**	**1581**	**1.37**
B. stigmatopyg	**101**	**0**	**0**	**25**	**0**	**248**	**930**	**51**	**0**	**0**	**0**	**0**	**1379**	**1.19**
T. fahaka	**202**	**0**	**195**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**124**	**0**	**520**	**0.45**
A. dentex	**0**	**1015**	**389**	**50**	**22**	**0**	**0**	**0**	**93**	**120**	**0**	**0**	**1689**	**1.46**
A. baremose	**0**	**2818**	**681**	**804**	**65**	**0**	**0**	**0**	**465**	**600**	**0**	**93**	**5527**	**4.78**
B. nurse	**0**	**0**	**292**	**50**	**55**	**0**	**0**	**0**	**0**	**0**	**25**	**0**	**422**	**0.36**
B. macrolepidotus	**0**	**0**	**395**	**50**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**445**	**0.38**
M. electricus	**0**	**225**	**0**	**402**	**55**	**0**	**0**	**26**	**0**	**0**	**62**	**93**	**863**	**0.75**
P. ethiopicus	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**744**	**744**	**0.64**
S. mystus	**0**	**90**	**0**	**422**	**382**	**25**	**248**	**4**	**140**	**240**	**87**	**651**	**2289**	**1.98**
S. intermedius	**0**	**0**	**0**	**50**	**55**	**0**	**0**	**0**	**0**	**60**	**0**	**93**	**258**	**0.22**
S. uranoscopus	**202**	**0**	**0**	**0**	**55**	**0**	**0**	**0**	**0**	**60**	**0**	**140**	**456**	**0.39**
C. aurtus	**0**	**519**	**681**	**302**	**327**	**25**	**0**	**0**	**140**	**0**	**118**	**140**	**2250**	**1.94**
P. bane	**0**	**0**	**0**	**0**	**22**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**22**	**0.02**
Total	**7660**	**13957**	**14210**	**10727**	**6969**	**11061**	**6572**	**724**	**8175**	**9540**	**13931**	**12206**	**115732**	**100**

Table 6. Occurrence of commercial fish species in Jebel Aulia and Geteina.

Site*	*Species*	Feb.	March	April	May	June	July	Aug.	Sept.	Octob.	Nov.	Dec.	Jan.	Total
JA	*L. niloticus*	0	45	0	0	0	992	558	34	47	0	0	23	1699
GE	L. niloticus	8930	0	11694	1673	7894	1339	0	0	7918	2233	3955	1813	47448
JA	B. bagrus	1290	789	3503	2262	1440	0	0	0	670	720	744	1790	13208
GE	B. bagrus	16670	5674	24558	6693	0	10039	0	1403	0	22326	6591	9667	103622
JA	*O. niloticus*	2903	2649	535	875	545	620	0	4	1349	3360	10416	5580	28836
GE	*O. niloticus*	53582	124836	52625	14222	6578	57726	26480	87007	112941	638	108099	114800	759534
JA	*L. niloticus*	639	1457	1751	905	1635	434	1736	81	605	480	682	465	10869
GE	L. niloticus	8335	6998	5263	2510	2290	17569	4729	1403	2510	0	7910	11782	71298
JA	*A. occidentalis*	135	0	341	704	218	285	310	60	674	60	558	0	3344
GE	A. occidentalis	595	1891	7017	10876	10525	5020	10403	9122	0	5741	1977	602	63769
JA	*S. schall*	558	1127	584	1207	982	4464	1488	171	558	960	248	488	12835
GE	S. schall	1191	19860	5263	26771	26313	5856	37829	3508	8366	3189	3955	1208	143309
JA	C. gariepinus	101	0	2432	452	109	62	0	0	93	120	62	790	4222
GE	C. gariepinus	52391	1891	16372	11712	14472	7529	0	0	0	3189	0	2417	109975
JA	H. forskallii	135	2255	535	955	76	0	0	0	1395	2520	285	651	8807
GE	*H. forskallii*	1191	567	18711	2510	0	4183	0	0	0	0	1318	1208	29689

- JA = Jebel Aulia, GE= Geteina