Growth Patterns and Condition Factors of Some Freshwater Fish Species in Lake Erelu, Southwestern Nigeria

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Abstract

Studies on length-weight relationship of fish provide valuable information on standing stock biomass for comparative growth studies. Information on growth patterns also remains an important tool for proper exploitation and management of population of fish species. The length-weight relationship (LWR) and condition factors of four dominant fish species in Erelu Lake, Oyo, Nigeria were therefore investigated. A total of 2663 specimens were caught between July, 2013 and March, 2015 using various mesh sizes of gillnets. Weights were taken to the nearest gram and length measured to the nearest centimeter using tabletop weighing balance and wooden measuring board, respectively. The sampled population was male dominated except for Raimas senegalensis. Total length was least in R. senegalensis (14.27±1.92) and highest in Sarotherodon galilaeus (18.30±1.92), while the least weight (51.26±29.53g) and the highest weight (85.60±42.99g) were obtained in R. Senegalensis and Oreochromis niloticus, respectively. The lowest growth coefficient (b) value (1.024) was obtained for O. niloticus while the highest (2.697) was recorded for R. senegalensis. This result indicates that all the investigated fish exhibited negative allometric growth. The mean condition factors (K) of the fish species ranged between 1.241±0.43 in S. galilaeus to 1.709±0.39 in O. niloticus. The condition factors fell within the range recommended for fresh water fish species in the tropics hence, Erelu Lake is suitable for the sustainable production of all the four fish species investigated. Therefore, the environmental condition of the lake should be maintained.

Keywords: Allometric, cichlidae, fisheries management, growth pattern, inland water.

Introduction

Studies on length-weight relationship and condition factor of fish species remain the most important biological parameters that provide vital information on the growth and condition of fish species and the entire fish community which assists in the management and conservation of natural populations (Sarkar *et al*., 2009; Muchlisin *et al*., 2010). Length – Weight relationship allows for the study of the ontogenetic allometric changes in fish growth and possible effects from environmental distress. Growth parameters differ from species to species and from stock to stock within the same species depending upon the habitat conditions. According to Moutopoulos and Stergiou (2002), establishment of a relationship between weight and length is essential for the calculation of production and biomass of a fish population.

Fishes are highly important renewable natural resource both at the national and domestic sectors of the Nigerian economy (Udo *et al*., 2014). It is a major source of high quality animal protein which also provides other socio-economic values; sources of job opportunities and raw material for industrial activities as well as recreational purposes

(Yakub, 2012). However, fish are known to experience growth fluctuations due to factors such as environmental changes, change in food composition, competition within the food chain, changes in the physical and chemical properties of the aquatic medium (Adedeji and Araoye, 2005; Abowei and Davies, 2009).

Length-weight relationships provide information on species status in an environment and characterize patterns of growth (Froese, 2006; Kharat *et al*., 2008). During the last two to three decades, human interference as well as natural disturbances like climate change brought about low water level, which severely impacted the water quality as well as the distribution and abundance of the native fish fauna in many aquatic habitats (Bhat *et al*., 2010). There are indications of decline in catch of commercial important fishes qualitatively and quantitatively in both coastal and inland water bodies due to over-exploitation and environmental degradation (Jamu and Ayinla, 2003). Thus, the study of condition factor and size composition of fishes from inland waters will provide information on: the amount of stock available for the fishery, evaluation of production level, stock sizes, mortalities and status of the fish population through estimation of the average weight at a given length group as an index of growth and feeding intensity.

The Erelu Lake supports a rich biodiversity, offers livelihood and nutritional security to both artisanal fishermen and the riparian community. Falaye *et al*. (2015) reported an estimated sixteen (16) fish species belonging to eight (8) families of which six (6) species are more preponderance in the lake. However, this lake resource has been less-studied from biology, ecology and conservation point of view. Most studies on this lake resources have been limited to socio-economics (Iroko, 2003; Adewale and Ikeola, 2005; Ufoegbune *et al*., 2011). Although, Kareem *et al*. (2015) worked on length-weight relationship and condition factor of *Schilbe mystus* and *Chrysichthys nigrodigitatus* only without covering the other four dominant species. Hence, this study investigates the Length–Weight Relationship and Condition factor of *Oreochromis niloticus*, *Sarotherodon galileaus*, *Raimas senegalenis* and *Tilapia marie* in Erelu Lake, South-Western Nigeria.

Materials and Methods

Study Area

Erelu Lake (Figure 1) with a surface area of 161.07 ha is located in Oyo town, North of Ibadan, the capital city of Oyo State, Nigeria. The main body of the lake lies about 6.4 km from the centre of Oyo town between Latitudes 7º53'0" - 7°55'30" N and Longitudes 3°53'30" - 3°56'0" E. It was formed by a dam constructed across Awon River along Oyo-Iseyin axis in 1961 (Ufoegbune *et al*., 2011). The lake is fed by the several tributaries which include Isuwin, Oroki, Ogbagba, Oloro, Elesin, Awon and Abata.

The reservoir sustains a thriving artisanal fisheries industry and serves as a source of water for domestic and industrial use as well as transportation. This reservoir is rich in diverse fish resources among which *O. niloticus*, *S. galileaus*, *R. senegalenis* and *T. marie* forms part of the dominant stock (Falaye *et al*., 2015). Erelu Lake is located in a tropical derived savannah climate with two clearly marked seasons of wet between April and October, and dry between November and March.

Fish Sampling

The lake was spatially stratified into lower, middle and upper zones based on geographical locations and logistical characteristic (Southwood and Henderson, 2000). Fish specimens were collected monthly from July, 2013 to March, 2015, using fleet of graded gill nets (38.1, 50.8, 63.5, 76.2, 88.9, 101.6 and 127.0 mm). Nets were simultaneously set in late afternoon (18:00 – 20:00 h) and retrieved the next morning from 06:00 –08:00hour. Identification of fish specimen was done using the procedures of Reed *et al*. (1967), Idodo-Umeh (2003) and Olaosebikan and Raji (2013). Specimens were sorted and stored in coolers containing ice and transported to the wet laboratory, Department of Aquaculture and Fisheries Management, University of Ibadan for further analysis.

Length-weight Relationships: Length of the fishes were measured and weighed in fresh condition to the nearest 0.1cm and 0.1g, respectively using wooden measuring board and tabletop weighing balance. The length-weight relationship was estimated using the formula $W=aL^b$ (Lecren, 1951; Pauly, 1983) where W = Weight of the fish, L = Length of the fish and 'a' = Constant (Intercept) and 'b" = Allometric growth coefficient (slope). After logarithmic transformation, the relationship was linearly represented as Log W=Loga+bLogL

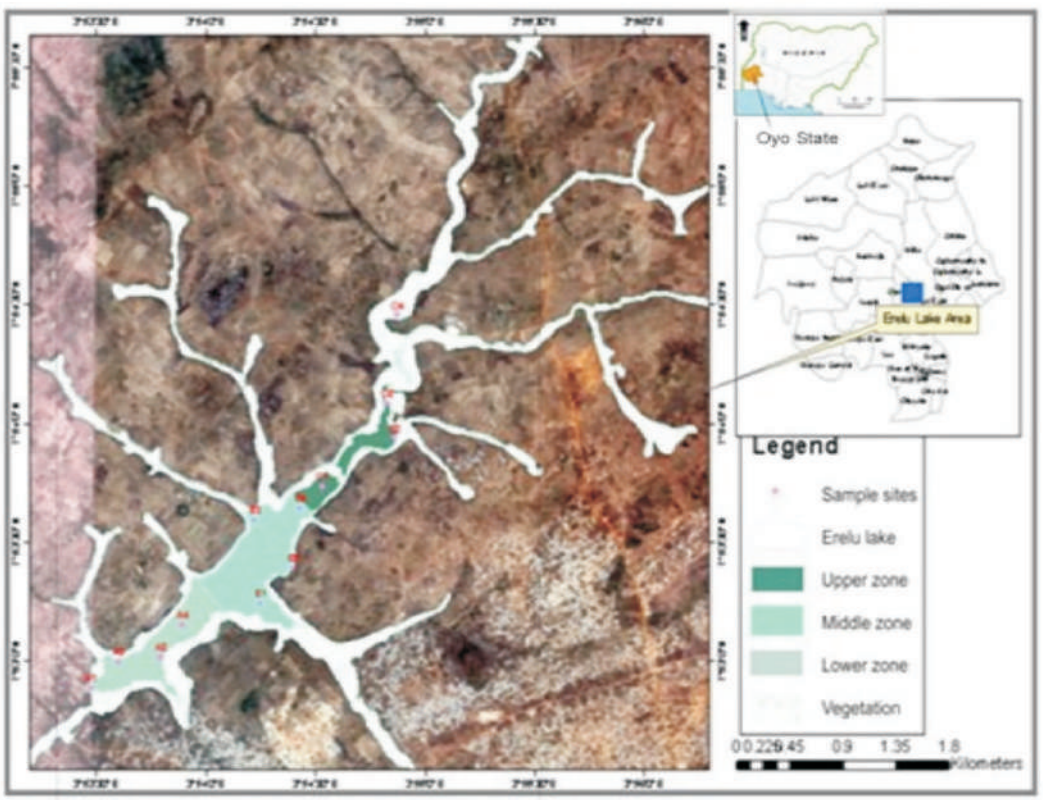

Figure 1. Map of Erelu Lake, Oyo, Nigeria

(Hile, 1936). The constants 'a' and 'b' in the above equation were estimated using the least square method (Zar, 1999). The linear equation was fitted separately for both sexes. The correlation coefficient, r^2 and 'b' were calculated using standard statistical procedures.

Condition factor was used to assess the stoutness of the fish, Ponderal index or condition factor was evaluated by Fulton's formula $K = 100W/L^3$ (Richter, 1973) where K = Condition factor, W = Whole body weight and L = Standard length.

Statistical analysis

All statistical analyses, including descriptive statistics of data were done using Statistical Package for Social Sciences (SPSS, version 17) and Microsoft Office Excel software.

Results

The sample size for the study was 2663 individuals comprises of *Oreochromis niloticus*, *Raimas senegalensis*, *Sarotherodon galileaus* and Tilapia *marie* with 893, 668, 595, and 507 respectively (Figure 2). The result revealed that sampled population was male dominated except for *R. senegalensis*. The highest individual obtained was *O. niloticus* (893) with 452 males and 441 females while *T. marie* which was the least (507) individual contributed 335 males and 172 females. However, *R. senegalensis* had 668 specimens comprising 350 females and 318 males. This result therefore indicates that there are more males than females in all sampled species except *R. senegalensis*.

The results of the weight differences among the sampled size are presented in Figure 3. The weight range obtained for *O. niloticus*, *S. galilaeus*, *R. senegalensis* and *T. marie* were 21.3-452.5 g, 15.7-208.6 g, 11.7-199.6 g and 12.5-250.0 g, respectively while the mean weights were 85.60±42.99 g, 72.36±34.94 g, 51.26±29.53 g and 63.66±36.78 g, respectively (Table 1).

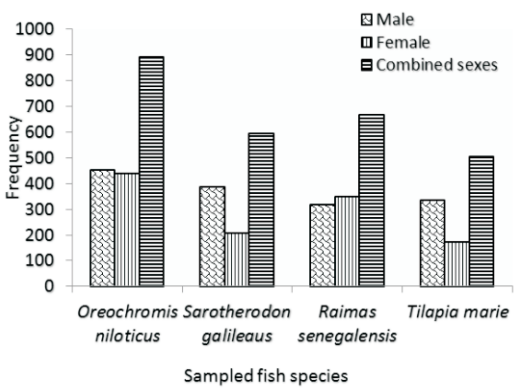

Figure 2: Sample size and sex composition for the four fish species from Erelu Lake

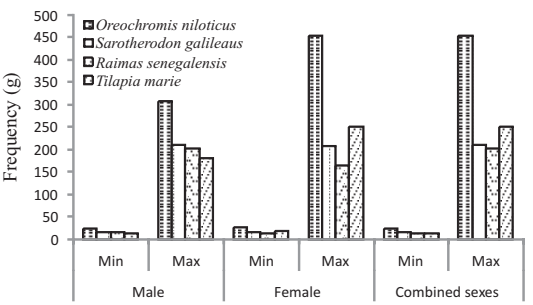

Figure 3: Range in body weight for the four fish species sampled during the study period. (*CS* combined sexes, *Min* minimum, *Max* maximum, *g* grams).

Table 1: Mean body weight of four fish species sampled in Erelu Lake, Oyo Nigeria during the study period.

Sample species	Weight (g)		
	Male	Female	Combined sexes
Oreochromis niloticus	56.43±22.31	93.74±39.10	85.60±42.99
Sarotherodon galileaus	69.15±28.18	74.43±31.70	72.36±34.94
Raimas senegalensis	57.19±41.39	39. 47±15.30	51.26±29.53
Tilapia marie	46.11±33.24	78.20±18.44	63.66±36.78

The length frequency distributions of the samples for the study are shown in Table 2 and 3. The standard length varied between 9.0-30.2cm in *O. niloticus*, 7.4-26.3cm in *S. galileaus*, 9.1-21.8 in *R. senegalensis* and 8.3-21.7 in *T. marie* while the mean standard lengths were 13.30±2.83cm, 14.56±1.71cm, 11.84±1.55cm and 13.61±2.05cm for *O. niloticus*, *S. galilaeus*, *R. senegalensis* and *T. marie* respectively. Similarly, total lengths followed the same trend of standard lengths as shown in Table 2. The total length of larger specimen (*O. niloticus*) ranged from 12.0 – 35.5cm, followed by *S. galilaeus* (9.8-29.4cm) while *R. senegalensis had the least* from 10.0 – 25.0cm. However, *S. galilaeus* gave the highest mean total length (18.30±1.92 cm) while *R. senegalensis* had the least.

Table 2: Ranges in Standard length and Total length for four species studied.

Species	Standard Length (cm)						Total Length (cm)					
	Male		Female		CS		Male		Female		CS	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
O. niloticus	10.2	25.8	9.0	30.2	9.0	30.2	12.8	30.5	12.0	35.5	12.0	35.5
S. galileaus	7.4	26.3	8.2	26.3	7.4	26.3	8.5	29.4	9.8	30.8	9.8	29.4
R. senegalensis	10.2	21.8	9.1	18.9	9.1	21.8	11.8	25.0	10.0	22.4	10.0	25.0
T. marie	8.3	17.7	10.2	21.7	8.3	21.7	9.6	21.5	12.4	26.2	9.6	26.2

CS = combined sexes, *Min* = minimum, *Max* = maximum

Table 3: Mean standard lengths and total lengths for the four fish species sampled during the study period.

Sampled species	Standard Length (cm)			Total Length (cm)		
	Male	Female	CS	Male	Female	CS
Oreochromis niloticus	13.07±2.33	14.89±2.16	13.3±2.83	17.65±2.13	19.13±2.25	16.84±1.15
Sarotherodon galileaus	9.68±2.67	16.88±1.72	14.56±1.71	13.74±1.25	21.95±2.82	18.30±1.92
Raimas senegalensis	9.08±1.53	13.17±1.50	11.84±1.55	12.26±2.11	16.59±3.18	14.27±1.92
Tilapia marie	12.72±1.82	14.33±2.02	13.61±2.05	15.82±1.30	18.21±1.40	16.94±2.10

CS = combined sexes, *SEM* = standard error of mean

Estimates of *a* and *b* for the length-weight relationship, the coefficient of the regression (r^2), and mean standard error are tabulated in Table 4. The calculated linear regression indicates significant differences between the slopes of the L-W relationship among species. Figures 4 showed the regression graph of the four fishes studied. For all four species the scatter of points along the regression line was sturdy and this can be backed up by the relatively low values of coefficient of determination (r^2). The regression coefficient *b* values varied between 1.024 for *male S. galileaus* and 2.697 for *female R. senegalensis*.

Although, these results suggest that all species showed negative allometric growth and that the fish do not grow in proportion to the length but the increase in weight occurs with much smaller increments with increase in the length of the fish. However, the correlation coefficients for all species were similar; 0.94 for *O. niloticus*, 0.96 for *S. galileaus*, 0.92 for *R. senegalensis* and 0.95 for *T. marie*. This is a clear indication that strong correlation exist between the length and the weight of all the species.

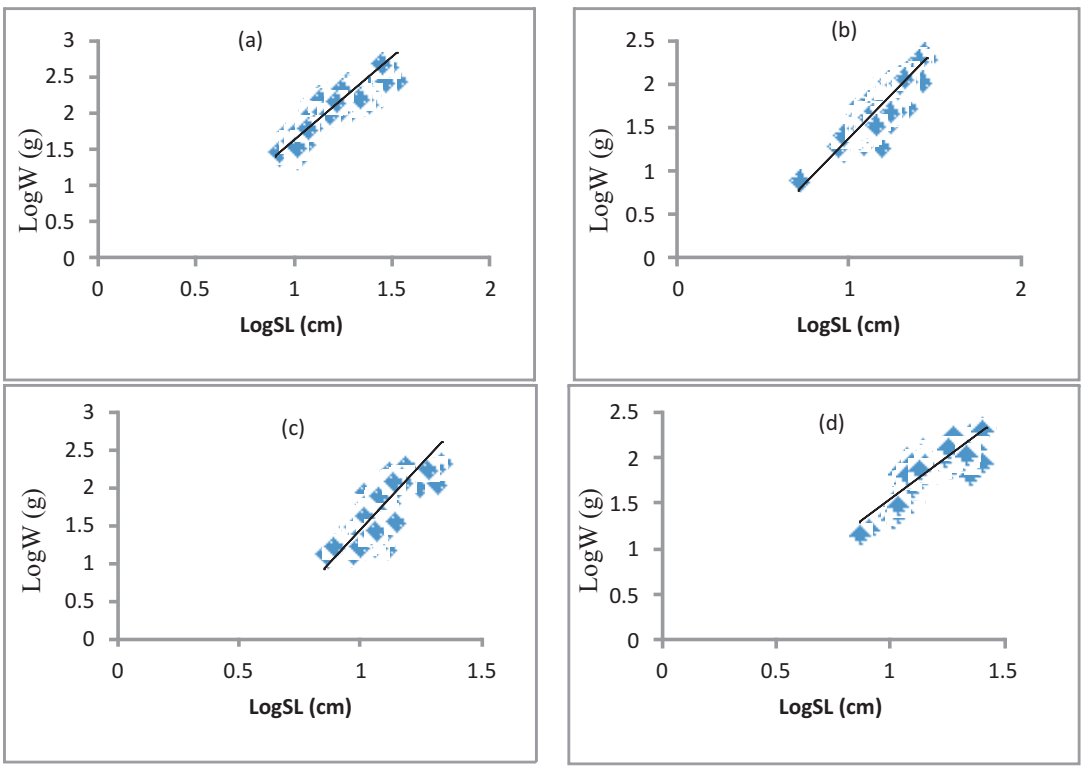

Figure 4: Length-weight relationships of fish samples (combined sexes) in Erelu Lake (a – d). *Legend*: *a = Oreochromis niloticus*; *b = Sarotherodon galilaeus*; *c = Raimas senegalensis* and *d = Tilapia marie*.

Table 4: Regression Coefficient for Length-weight relationship of the four fish species used for the study

Species	Sex	a	b	r^2	SEM
	M	0.5613	1.6513	0.8901	19.3611
O. niloticus	F	0.3480	2.0182	0.9214	21.5072
	CS	0.3712	1.9204	0.9440	22.6865
	M	0.8167	1.0238	0.8173	18.5477
S. galileaus	F	0.9234	1.3627	0.9102	15.3619
	CS	0.9983	1.4673	0.9566	16.7409
	M	0.0271	2.5219	0.9153	17.1335
R. senegalensis	F	0.0288	2.6971	0.8425	16.3517
	CS	0.0393	2.6845	0.9186	16.8957
	M	0.7945	2.3077	0.9381	13.5912
T. marie	F	0.8292	2.2684	0.9146	12.9885
	CS	0.8417	2.3115	0.9450	13.6082

M= male; F= female; CS= combined sex; a= intercept; b= slope; r^2= coefficient of determination; SEM= standard error of the mean.

The condition index value ranged from 0.558 – 3.280 for *O. niloticus*, 0.225 – 3.183 for *S. galileaus*, 0.392 - 3.761 for *R. senegalensis* and 0 .598 - 4.742 for *T. marie* (Table 5). Meanwhile, the mean condition factor (combined sexes) calculated for *O. niloticus was* 1.709±0.39 while *S. galilaeaus*, *R. senegalensis* and *T. marie* had 1.241±0.43, 1.649±0.51 and 1.375±0.52, respectively. The results showed significant differences between the condition factors of male and female of *the fish species studied* ($p<0.05$).

Discussion

The family cichlidae were the most abundant in the catches and were represented by *O. niloticus, S. galilaeaus* and *T. marie*. This implies that the family Cichlidae predominates the fish stock in the reservoir. This finding is similar to report of Ayoade and Ikulala (2007) in Eleyele lake, Offem *et al*. (2009) in Cross River, Edward (2013) in Egbe reservoir and Olopade and Rufai (2014) in Oyan dam. The sex composition of the four species investigated revealed preponderance of males over females

Table 5: Condition factor for the four fish species sampled in Erelu Lake, Oyo Nigeria

Sampled species	Male			Female			Combined sexes		
	Min	Max	Mean±SD	Min	Max	Mean±SD	Min	Max	Mean±SD
O. niloticus	0.56	2.57	1.33±0.43	0.58	3.28	1.54±0.49	0.56	3.28	1.71± 0.39
S. alileaus	0.39	3.18	1.64±0.61	0 .22	2.87	1.15±0.74	0 .23	3.18	1.24±0.43
R. senegalensis	0.67	3.43	1.89±0.80	0.39	3.76	1.76±1.03	0.39	3.76	1.65± 0.51
T. marie	0.70	4.74	2.16±1.25	0 .59	4.55	1.95±0.89	0 .59	4.74	1.38±0.52

except for *R. senegalensis* which was dominated by females. The male to female (♂:♀) ratio were 1:1.02,1:1.87, 1:1.95 and 0.91:1 for *O. niloticus*, *S. galilaeus*, *T. marie* and *R. senegalensis* respectively. This result agreed with the work of Offem *et al*. (2009) who found a sex ratio of 2:1 (♂:♀) in *Tilapia marie* from a tropical flood river in Southeast, Nigeria. The same authors however, documented sex ratio of 1:1 for *O. niloticus* and *Sarotherodon galilaeus*. Also, Offem *et al*. (2007) reported similar skewed sex ratio of 1:0.97 (♂:♀) for *O. niloticus* in Cross River, Nigeria. Contrarily, Dan-Kishiya (2013) reported skewed sex ratio of 1:1.95 and 1:1.26 (♂:♀) for *Tilapia marie* and *Oreochromis niloticus* in Lower Usuma Reservoir Abuja, Nigeria.

The length and weight data of the four fish species were (12.26±2.11 – 21.95±2.25cm) and (46.11±33.24– 93.74±39.10g) respectively. The mean size of fish caught indicate that under natural conditions, fish attain commercial sizes in Erelu Lake. The regression exponent in Length-Weight relationship of males and females of the four fish species varied between 1.0238 and 2.6971. The *b* value obtained for *R.senegalensis* and *T. marie* was close to 3 (b≥ 3.0). The result inferred that change in length is disproportional to the change in the weight of the fish studied. The value of *b* (Combined sexes) was1.92 for *O. niloticus*, 1.46 for *S. galilaeus,* 2.68 for *R. senegalensis* and 2.31 for *T. marie.* These values therefore, indicate negative allometric growth for all the species studied. However, females showed greater 'b' values than males in all the species except *T. marie* where males recorded higher exponential value than females. According to Tesch (1971), values of *b* usually fluctuates between 2 and 4 while Hile (1936) opined that in majority of cases was not found equal to 3. LeCren (1951) pointed out that the variation in *b* value wellbeing is due to environmental factors, season, food availability, sex, life stage and other physiological factors. The length-weight relationship obtained in this study is comparable with the previous work by Kareem *et al*. (2015) in Erelu Lake. The authors reported negative allometric growth for *Schilbe mystus* (2.58) and *Chryschythys nigrogiditatus (*1.98). Similar departure from cube law has also been observed by King (1996), Anibeze (2000), Ekelemu and Samuel (2006), Ibrahim *et al*. (2008), Offem *et al*. (2009), Bala *et al*. (2009), Imam *et al*. (2010) and Obasohan *et al*. (2012). The correlation coefficient r^2 obtained in this study varied between 0.8173 and 0.9566 which reflects strong association between length and weight. This implies that as the length of the fish increases, the weight also increases though not in the same proportion. Ekelemu and Samuel (2006) and Alex *et al*. (2012) also reported positive correlation in their studies.

The mean condition factors for all species was greater than 1 with *K* values ranging from 1.241 (±0.43) for *S. galilaeus* to 1.709 (±0.39) for *O. niloticus*. Moreover, the higher *K* value for *O. niloticus* could be due to abundance of its feed in the reservoir. Generally, the values of condition factor obtained from this study showed that all the fish species were in good state of wellbeing. The results are in agreement with previous studies on different fish species from various water bodies as reported by Lawal *et al*. (2010) in Epe Lagoon, Imam *et al*. (2010) in Wasai Reservoir, Ikongbeh *et al*. (2012) in Lake Akata, Ibrahim *et al.* (2012) in Kontagora Reservoir, Dan-Kishiya (2013) in Lower Usuma Reservoir and Kareem *et al*. (2015) in Lake Erelu.

Conclusion

The four fish species investigated varied in length and weights hence the difference in length and weight relationship. Also, the composition of sexes which was mostly dominated by male indicated that the reservoir was good breeding ground for the fish as the ratio allowed for good pairing. All the species enjoyed a very good state of well-being in the Lake. The environmental condition of the lake should be maintained if it could not be improved upon to guarantee sustainable fish production.

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