Journal of Agriculture, Environmental Resources and Management
ISSN2245-1800(paper) ISSN 2245-2943(online)
6(4)1-800;**July**.2024; pp1-11

www.saerem.com

Seasonal Variations in Length-Weight Relationships and Condition Factor of *Clarias Gariepinus* and *Oreochromis Niloticus* Inhabiting Freshwater River Donga, Taraba State, Nigeria

[1]Amos, J.T., and [2] Newton Moses

[1]Department of Biological Sciences, Federal University Wukari, Taraba State, Nigeria
[2]Federal College of Horticulture, Dadin Kowa, P.M.B 108, Gombe State, Nigeria

*Corresponding Author: jummaiat@gmail.com; amostidi@fuwukari.edu.ng

ABSTRACT

Fishes and fisheries are vital globally, offering food, income, and ecological balance. Effective fishery management practices require comprehensive biological data, particularly on length-weight relationship (LWR) and condition factor (K), which are essential for assessing fish biomass, health, and environmental impacts. This study aims to evaluate LWR and K of Clarias gariepinus (C.g) and Oreochromis niloticus (O.n) in River Donga, Nigeria. Specimens were collected from four landing sites. Total length (TL) and standard length (SL) were measured, and weight recorded. LWR was analyzed using formula $W= aL^b$, transformed to Log W = Loga + bLogL. Condition factor was calculated using $K = 100W/L^3$. Data analyzed using SPSS, and results expressed as means ± SD. A total of 524 specimens were analyzed, revealing that both species generally exhibited negative allometric growth ($b < 3$). B-values among seasons ranged from 0.335 – 3.254 and 1.440 – 2.862 while K-values ranged 0.481 – 0.803 and 1.298 – 2.460 for C. g. and O. n., respectively. A negative allometric growth ($b<3$) for all O. n. and some C. g. in wet season and positive allometric growth ($b>3$) male and female C. g. in dry season. The study demonstrated that O. n. is better adapted to the River Donga ecological conditions than C. g. The negative allometric growth suggests that fish's weight gain rate is less than length increase, possibly due to environmental stressors. These findings underscore the utility of LWR and K as effective tools for monitoring fish population dynamics and health in river ecosystems. Development of conservation and management strategies to protect the fish species and their habitats. Education and awareness programs for local communities on the importance of sustainable fishing practices and environmental conservation is highly recommended.

Keywords: Allometric growth, *Clarias gariepinus,* Condition factor, Length-weight relationship, *Oreochromis niloticus*

Introduction: Fishes and fisheries play key roles globally, providing protein-rich food and feedstuff as well as income for teeming populations. Recently, reports indicate that there are declining catches due to pressures that arise from over-exploitation and environmental degradation (Zhou QiCun; Yue, and YiRong. 2010). To forestall such decline and ensure food and social security, fishery management practices employ biometrical approaches to assess biological factors of fish stock for making workable recommendations since a comprehensive knowledge of fish biology is quintessential for increased fish production. Such functional approach used to elucidate the growth pattern, history and general wellbeing of fish populations in aquaculture and the wild include the relationship between length and weight of fish as well as the condition factor (Abowei and Ezekiel, 2013).

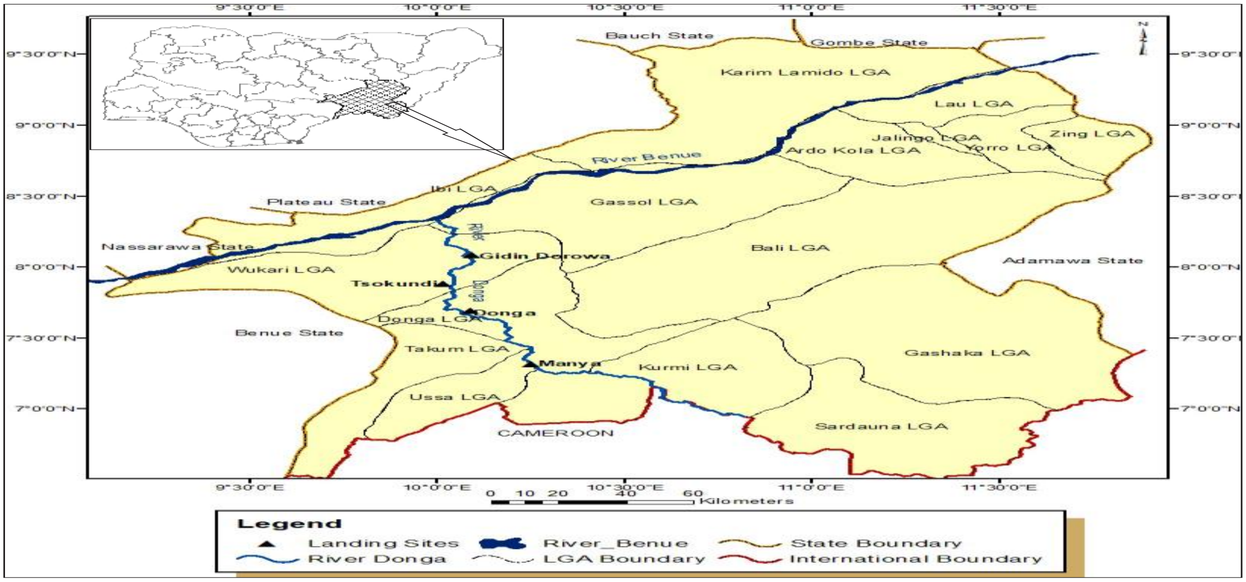
Length-Weight Relationship (LWR) is an important estimate for the assessment of fish biomass, taxonomy as well as environmental impacts and habitat dynamics critical for fish survival (Kalu, K. M Umeham, S. N and Okereke, F, 2007; Zargar, U. R., Yousuf, B. M. and Dilafroza, J. 2012). This growth index, which is based on the power relationship, helps to establish mathematical relationship between length and weight of fish, explains the growth patterns in the wild and evaluates differences between populations and species from different geographical locations (Lalrinsanga, 2012). Fishes are said to exhibit isomeric growth when length increases in equal proportions with body weight for constant specific gravity with the regression co-efficient for isomeric growth being 3 while values greater or less than 3 indicate allometric growth.

The condition factor, K, is an expression that describes the relative wellbeing of fish as influenced by age, gender, season as well as their physiological maturity (Anyanwu, 2007; Golam and Fahad, 2013). Otherwise known as the coefficient of body condition, K is an excellent indicator of not only the health status of the fish but also the impacts of recent physicochemical and biological conditions that influence the aquatic ecology (Kumar, A., Jitender, K. J. and Hemendra, K. V. 2017; Nehemia, A., Maganira, J. D. and Rumisha, C. 2012). Condition factor is based on isometric growth pattern which assumes that the shape of the fish does not vary with regards to growth and explains morphometric variations in terms of the cube law. This approach unearths vital information about the effects of seasonal and habitat variations as well as structural and functional dynamics of fish populations since higher values for K denote better wellness of the fish (Anderson, O. R. and Neumann, R. M. 1996). Alhassan, E. H., Abobi, S. M., Mensah, S. and Boti, F. (2014) argued that an index ranging between 1 and 1.2 indicates that the fish is doing well while an index of 1.4 suggests that the fish is near spawning.

According to Kalu *et al*. (2007), Clarias and tilapia-type species are possibly the most predominant groups of fish in Nigerian freshwater. Clarias is a fish genus found in the family Clariidae. In Nigeria, ten Clarias species are common of which *C. gariepinus* is the most predominant (Olaosebikan and Raji, 2013). *Oreochromis niloticus*, is a staple fish species important in Nigerian diets. The importance of these two species in the cuisines of different cultures in Nigeria makes the study of their LWR and condition factor a worthwhile venture. The aim of the present work was to determine the status of *Oreochromis niloticus* and *Clarias gariepinus* while the objectives was to assess the length-weight relationship and condition factor of *Clarias gariepinus* and *Oreochromis niloticus* in River Donga. This study was limited to ascertaining the status of *Oreochromis niloticus* and *Clarias gariepinus* in River Donga, Taraba State, Nigeria.

Materials and Methods: Study Area**:** Donga River is located on latitude 8^0 19’00” N and longitude 9^0 58’00” E of the equator and at an elevation of 113 metres above sea level (https//geographic.org). The river rises from the Mambilla Plateau in Northeast Nigeria, forms part of the international border between Nigeria and Cameroon and flows northwest to eventually merge with the Benue River as attribute in Nigeria. The Donga watershed is 20,000 square kilometres (7,700sq mi) in area and at its peak, near the Benue River delivers 1,800 cubic meters

(64,000cu ft) of water per second. The river is often brownish in colour during wet season and clear during dry season as such the surrounding communities use the water for several purposes which include drinking, irrigation, fishing, laundry, bathing and transportation**.** The coordinates of the landing sites are for this study include: Dorowa 8° 2′ 49.66″ N and 8° 5′ 47.203″E; Tsokundi 10° 1′ 54.206″ N and 7° 51′ 10.67″E; Donga, 7° 39′ 17.117″ N and 10° 5′ 3.156″E; Manya 7° 16′ 28.261″ N and 10° 15′ 29.695″E as indicated by black triangles on Figure 1.



Source: Digitized from Google Earth and Taraba State Political Map of Diva GIS.

Figure 1: Map of River Donga Showing the Study Areas

Experimental Design:

A 16-month study (March 2018 - September 2019) was conducted to investigate the biology of freshwater fish species. Monthly collections of specimens were made, and fish were transported to the laboratory in chilled containers to prevent degradation. Species identification was performed using the Field Guide to Nigerian Freshwater Fishes (Olaosebikan & Raji, 2013), ensuring accurate classification.

Monthly assessments of fish biology were conducted, and data were recorded accordingly. Measurements included:

- Total length (TL): distance from snout to caudal fin tip (cm)
- Standard length (SL): distance from fish mouth to hidden base of tail fin rays (cm)
- Weight: measured in grams using an electronic balance
- Condition factor: calculated and recorded

These measurements were taken to the nearest 0.1 cm using a meter rule, ensuring precision and accuracy in the research findings.

Length-Weight Relationship was estimated using the mathematical expression

$W = aL^b$ which was transformed to the logarithm form Log W = loga + $_b$logL, where W is the body weight of fish in grams (g), L is the standard length of fish in centimetres (cm), 'a' is the constant that describes the regression constant and 'b' is the slope of the regression line that describes the pattern of growth or coefficient of allometry.

The condition factor (K) for individual fish for each month were calculated using the formula K = described by Pauly (1983) as adopted by Ja'afaru and Tashara (2009) where K is the condition factor, L is the total length in centimetres and W is the body weight of fish in grams.

Data Analysis

Morphometric data collected from the fish were analysed using the statistical package SPSS version 23 (1BM, 2015). Results were expressed as means ± SD. The length-weight relationships were assessed using regression analysis. The parameters 'a' and 'b' were obtained using the linear regression of Log transformed data and the plots were done using Microsoft Excel (2013).

Results: A total of 524 fish specimens comprising of 231 *Clarias gariepinus* and 293 *Oreochromis niloticus* individual fishes were obtained from artisanal fishers from four different landing sites along the banks of Donga River during the study period. Table 1a presents data on the length-weight relationship and condition factor for both species during the dry season of 2018. For this season, estimates showed negative allometric growth patterns (b < 3) for both species. *C. gariepinus* recorded the higher mean length and weight as well as regression constant than *O. niloticus* which had a relatively higher growth coefficient (b-value) of 2.215 and R^2-value of 0.992. Combined *O. niloticus* recorded the higher K-value of 2.122 as compared to the 0.482 recorded by *C. gariepinus* during this period. The correlation coefficients r, for *C. gariepinus* ($r = 0.801$; $p < 0.001$) and *O. niloticus* ($r = 0.996$; $p < 0.001$) were positive and closer to unity. When the two species were separated according to their sexes for this season, male *C. gariepinus* recorded the highest mean length and weight while male *O. niloticus* recorded the lowest mean and length. There were significant linear correlations between weights and lengths in all fishes except for male *C. gariepinus* whose correlation coefficient was not significant ($r = 0.263$; $p > 0.05$). Although both fish species had negative allometric growth pattern (b < 3) ranging between 0.335 for male *C. gariepinus* and 2.571 for male *O. niloticus*, coefficients of determination varied between 0.069 and 0.991 for male *C. gariepinus* and female *O. niloticus* individuals respectively. The low R^2 value recorded by male *C. gariepinus* indicated that only about 7% of the variation in the weight of that species was determined by their length. Condition factor K varied from 0.481 for female Clarias to 2.460 in male *O. niloticus*.

Table 1b presents the length-weight relationship and condition factor data for *C. gariepinus* and *O. niloticus* during the 2019 dry season. The results show that: *C. gariepinus* had higher mean lengths and weights, but lower condition factors compared to *O. niloticus*. All regression lines exhibited negative intercepts, indicating a strong correlation between length and weight. High R-values (0.953-0.966) suggest that at least 95% of the weight variations in both species can be attributed to their lengths. *C. gariepinus* displayed positive allometric growth (b > 3), whereas *O. niloticus* exhibited negative allometric growth (b < 3). Male and female *O. niloticus* had superior mean condition factors (1.340 and 1.332, respectively) compared to their *C. gariepinus* counterparts during this season. These findings highlight the differences in growth patterns and condition factors between the two species during the 2019 dry season.

Table 2a presents data on the length-weight relationship and condition factor for the fish species for the wet season of 2017. For combined sexes, *C. gariepinus* had a higher mean length and weight although the growth index (b-value) and K-values of both species were comparable. *O. niloticus* recorded a much higher condition factor of 1.702 to the 0.764 recorded by *C. gariepinus*. For the separated sexes in this season, female *C. gariepinus* had a higher mean length and weight but the lowest R-value of 0.471. The intercepts for all regression were negative except for *O. niloticus* which was marginally positive. Although the growth index for both species were negatively allometric (b < 3), *O. niloticus* male had the highest mean condition factor (1.748) while female *C. gariepinus* had the lowest mean K-value of 0.719. Female *O. niloticus* recorded the highest R^2- value (0.733) while female *C. gariepinus* recorded the lowest for this value (0.471).

Table 2b presents data on the length-weight relationship and condition factor for both species for the wet season of 2018. For the combined sexes, *C. gariepinus* recorded higher mean lengths while *O. niloticus* had the higher mean weight. All regressions lines were intercepted by the negative axis. For separated sexes, R^2-values were relatively high and comparable for the two species ranging from 0.627 for male *C. gariepinus* to 0.881 for females of the same species. Both species showed a negative allometric growth pattern, b < 2, ranging between 2.852 for female *C. gariepinus* and 1.560 for male *O. niloticus*. This trend was however reversed for condition factor with male *O. niloticus* recording the highest K value of 1.436 while male *C. gariepinus* recorded the lowest condition factor of 0.457 for this season.

Table 1a: Length - Weight Relationship of *Clarias gariepinus* and *Oreochromis niloticus for* Dry Season, 2018

Species	Sex	N	r	Length Mean ± SD	Weight Mean ± SD	a	B	R^2	K
C. gariepinus	Female	16	0.619**	1.480 ± 0.004	2.115 ± 0.002	1.586	0.357	0.383	0.481 ± 0.011
C. gariepinus	Male	9	0.263^{ns}	1.519 ± 0.005	2.240 ± 0.007	1.731	0.335	0.069	0.484 ± 0.021
C. gariepinus	Combined	25	0.801**	1.494 ± 0.005	2.160 ± 0.013	-0.848	2.013	0.641	0.482 ± 0.009
O. niloticus	Female	27	0.996**	1.197 ± 0.019	1.899 ± 0.004	-0.75	2.214	0.991	2.059 ± 0.071
O. niloticus	Male	5	0.992**	1.104 ± 0.014	1.696 ± 0.036	-1.143	2.571	0.985	2.460 ± 0.062
O. niloticus	Combined	32	0.996**	1.183 ± 0.017	1.868 ± 0.038	-0.752	2.215	0.992	2.122 ± 0.066

Table 1b: Length - Weight Relationship of *C. gariepinus* and *O. niloticus* for Dry Season, 2019

Species	Sex	N	R	Length Mean ± SD	Weight Mean ± SD	a	B	R^2	K
C. gariepinus	Female	12	0.964**	1.475 ± 0.819	2.108 ± 0.799	-2.692	3.254	0.964	0.488 ± 0.023
C. gariepinus	Male	45	0.983**	1.395 ± 0.017	1.892 ± 0.055	-2.632	3.243	0.966	0.518 ± 0.013
C. gariepinus	Combined	57	0.981**	1.412 ± 0.015	1.938 ± 0.048	-2.575	3.197	0.961	0.511 ± 0.011
O. niloticus	Female	59	0.977**	1.239 ± 0.017	1.828 ± 0.046	-1.381	2.591	0.954	1.332 ± 0.045
O. niloticus	Male	25	0.977**	1.288 ± 0.022	1.983 ± 0.064	-1.702	2.862	0.954	1.340 ± 0.044
O. niloticus	Combined	84	0.976**	1.253 ± 0.014	1.874 ± 0.038	-1.466	2.665	0.953	1.334 ± 0.034

Table 2a: Length - Weight Relationship of *Clarias gariepinus* and *Oreochromis nilotus* for Wet Season, 2018

Species	Sex	N	R	Length Mean ± SD	Weight Mean ± SD	A	B	R^2	K
C. gariepinus	Female	38	0.686**	1.413± 0.009	2.072 ± 0.030	-0.899	2.103	0.471	0.719 ± 0.039

C. gariepinus	Male	44	0.853**	1.365 ± 0.019	1.929 ± 0.043	-0.647	1.887	0.727	0.803 ± 0.102
C. gariepinus	Combined	82	0.821**	1.397 ± 0.012	1.995 ± 0.028	-0.748	1.977	0.675	0.764 ± 0.058
O. niloticus	Female	61	0.856**	1.222 ± 0.146	1.857 ± 0.035	-0.637	2.041	0.733	1.669 ± 0.695
O. niloticus	Male	43	0.735**	1.177 ± 0.011	1.745 ± 0.021	0.051	1.440	0.540	1.748 ± 0.087
O. niloticus	Combined	104	0.839**	1.203 ± 0.010	1.811 ± 0.023	-0.517	1.935	0.705	1.702 ± 0.054

Table 2b: Length - Weight Relationship of *C. gariepinus* and *O. niloticus* Wet Season, 2019

Species	Sex	N	R	Length Mean ± SD	Weight Mean ± SD	A	B	R^2	K
C. gariepinus	Female	24	0.938**	1.412 ± 0.014	1.913 ± 0.041	-2.111	2.851	0.881	0.481 ± 0.017
C. gariepinus	Male	43	0.791**	1.439 ± 0.007	1.969 ± 0.218	-1.691	2.544	0.626	0.457 ± 0.015
C. gariepinus	Combined	67	0.872**	1.429 ± 0.007	1.949 ± 0.020	-1.873	2.674	0.760	0.466 ± 0.011
O. niloticus	Female	41	0.855**	1.291 ± 0.010	1.976 ± 0.026	-0.807	2.156	0.732	1.298 ± 0.044
O. niloticus	Male	32	0.882**	1.281 ± 0.022	1.961 ± 0.039	-0.038	1.560	0.777	1.436 ± 0.097
O. niloticus	Combined	73	0.861**	1.287 ± 0.011	1.969 ± 0.022	-0.023	1.712	0.742	1.358 ± 0.049

**p<0.01; ns = not significant (p>0.05)

Discussion: Length-weight relationships unearth vital information on the structural and functional dynamics of fish populations. Temporal variations were observed in the length-weight relationship for *Clarias gariepinus* and *Oreochromis niloticus* in the four seasons of the two years of this study. Although there were consistently higher mean lengths observed for *C. gariepinus*, mean weights for both species generally followed the same trend except for the wet season of 2019 where this trend was reversed. This reversal of trend as well as the temporal fluctuations in the mean weights observed for the species between seasons suggests intra-specific variations among the fish which may have impacted on the estimates of fish morphometric traits. The generally positive and high correlations among the species suggest a linear relationship between weights and lengths and indicate that weights of fish in River Donga increased as lengths increased. The estimated high correlation coefficient also suggests that the linear model employed for the analysis was reliable as well as fit for the data in this study. The positive but low coefficient of correlation between length and weight recorded by male *C. gariepinus* for the dry season of the 2018 indicated that growth was not linear and that the increase in weight was not matched by the increase in length. Although *C. gariepinus* recorded lower R^2 values in dry (male and female) and wet (female) season of 2018, the relatively high coefficient of determination observed for most of the fish populations in this study suggests strong length-weight relationship. It also implied that increase in weight of fish was determined to a great extent by an increase in weight. However, the low R^2 value earlier mentioned may have resulted from low sample size.

In this study, the two fish species did not conform to the cube law which specified that an ideal fish must have an isometric growth pattern with the b-value equalling 3.00. For both fish species, the negative allometric coefficient observed, except for *C. gariepinus* in the dry season of 2019 and the total duration, suggest that the rate of weight gain was less than length increase. The negative allometric growth posted by both species implied that the fishes became thinner as they grew as highlighted by Migiro *et al.*, 2014. This corroborated the position of King (1996) who reported that most Nigerian freshwater fish exhibit negative allometric growth pattern. This confirms that the results from this study are valid and are comparable to results from earlier studies on freshwater fishes. It is possible that overfishing and trophic potential in River Donga may have contributed to this body shape index. This concurs with the position of Asmamaw *et al*. (2019) who reported that illegal fishing, wrong mesh size and anthropogenic activities can give rise to negative allometric growth pattern of fish in a water body such as River Donga. The positive allometric growth pattern exhibited by male and female *C. gariepinus* for dry season of 2019 and the study duration, which were close to isometric, indicated that the rate of increase in weight of the fishes was almost directly proportional to length increase. This closeness to the cube law also suggests that the conditions of the river at those times were favourable for the isometric growth of this species. Although mostly allometric in pattern, fluctuating trends for b-values within and between the two species suggest intra and inter-specific variations in the ability of these fishes to adapt and utilise resources in the River under different conditions. Variations in the Length-Weight relationship may have resulted from gear selectivity, differences in sex and season, time of collection as well as the sample size as earlier reported by Oboh and Olowo (2016).

The consistently low mean condition factor (K < 1) for *Clarias gariepinus* in both seasons and years suggested that this species was generally in poor condition. Although, Edah *et al.* (2010) explained that condition factor is mainly influenced by sex, season, age and maturity, the low K-value recorded by *C. gariepinus* across seasons, year, and sex indicated that other habitat factors at play may have led to the elongated and undernourished fish as reported by Alhassan *et al*. (2014). The higher condition factor observed for *Oreochromis niloticus* species across sex, season and year suggest that this species was in better conditions and therefore better fitted to the ecology of River Donga than *Clarias gariepinus*. This corroborated the findings of Oboh and Olowo (2016) who recommended that the optimum range for the K-value for freshwater fish should be between 1 and 2. The seasonal trends in K-value suggest that both rain-fed and dry conditions in the two years impacted better on the wellness of *O. niloticus* than *C. gariepinus*. *O. niloticus* seem to be better adapted to the changing condition in River Donga which corroborates the position of Datta *et al.* (2013) who stressed the importance of the K-factor as an indicator of the ability of a fish to cope with changes in food reserves. This good condition factor may have stemmed from the fact that *O. niloticus* is a sturdy omnivore who feeds on phytoplankton, zooplankton and even debris and has high conversion efficiency of its feeds (Vicente and Fonseca-Alves, 2013). The declining and fluctuating K-value for *O. niloticus* and *C. gariepinus* respectively over the study period seems to indicate that both species responded differently to varying biotic and abiotic environmental stress. This agrees with the position of Kumar *et al*. (2017) who emphasized that condition factor is strongly influenced by environmental factors and can be used as an index to access the status of the aquatic ecosystem due to physicochemical changes. This finding contradicts Moslen and Miebaka (2017) who posited that different fish species can still respond in the same manner to ecological signals despite inter and intra-specific variations. It is possible that declining and fluctuating condition factors for both fish species as observed in this study may have been due to differential response of each fish species to cyclical anthropogenic activities such as agro-chemical application as well as run-off from surrounding farmlands.

Investigation into the effects of anthropogenic activities such as overfishing, agro-chemical application, and run-off from surrounding farmlands on the fish populations. Development of conservation and management strategies to protect the fish species and their habitats. Education and awareness programs for local communities on the importance of sustainable fishing practices and environmental conservation. Collaboration with stakeholders to address the issues of gear selectivity, differences in sex and season, time of collection, and sample size. Further study on the feeding habits and conversion efficiency of *O. niloticus* to understand its adaptability to changing conditions. Investigation into the potential impacts of climate change on the fish populations and their habitats.By addressing these recommendations, we can gain a better understanding of the complex relationships between fish populations, their habitats, and environmental factors, and work towards sustainable management and conservation of these vital resources.

Conclusion: In conclusion, this study provides valuable insights into the seasonal dynamics of LWR and condition factors of *C. gariepinus* and *O. niloticus* in River Donga. Despite variations in growth patterns and condition factors, both species exhibit reliable correlations between length and weight. These findings therefore confirmed length-weight relationship and condition factor as useful methods in evaluating growth and well-being of fish in a river ecosystem. It contributes to our understanding of fish population dynamics and can inform sustainable fisheries management practices in the region.

Acknowledgements: I am deeply grateful to Prof. Ja'afaru Ali and Prof. K.A. Abubakar for their invaluable guidance throughout this study. Special thanks to Mr. Samaila Yohanna Abibauki for his expertise in examining fish species samples and coordinating research assistance during sample collection. I also extend my appreciation to Mr. Agbu Raymond Audu for his assistance in fish species identification.

REFERENCES

Abowei, J. F. N. and Ezekiel, E. N. (2013). The length-weight relationship and condition factor of *C. nigrodigitatus* (Lacepede 1800) from Amassoma River flood plain. *Scienta Agriculture*, 3(2): 30-37.

Alhassan, E. H., Abobi, S. M., Mensah, S. and Boti, F. (2014). The spawning pattern, length-weight relationship and condition factor of Elephant Fish, *Mormyrus rume* from the Bontanga reservoir, Ghana. *International Journal of Fisheries and Aquaculture*, 3(15): 263-270

Anderson, O. R. and Neumann, R. M. (1996). Length, weight and associated structural indices. In: Nielsen LA, Johnson DL. (Eds.). *Fisheries techniques.* American Fish Society, Bethesda, pp. 447-482.

Anyanwu, P. E., Okoro, B. C., Anyanwu, A. O., Matanmi, M. A., Ebonwu, B. I., Ayabu-Cookey, I. K., Hamzat, M. B, Ihumekpen, F., Afolabi, S. E. (2007). Length–Weight relationship, condition factor and sex ratio of African mud catfish (*Clarias gariepinus*) reared in indoor water recirculation system tanks. *Research Journal of Biological Sciences*, 2(7): 780-783.

Asmamaw, B., Beyene, B., Tessema, M. and Assefa, A. (2019). Length-weight relationships and condition factor of Nile tilapia, *Oreochromis niloticus* (Linnaeus, 1758) (Cichlidae) in Koka Reservoir, Ethiopia. *International Journal of Fisheries and Aquatic Research*, 4(1): 47 – 51.

Datta, S. N., Kaur, V. I., Dhawan, A. and Jassal, G. (2013). Estimation of length-weight relationship and condition factor of spotted snakehead Channa punctata (Bloch) under different feeding regimes. *SpringerPlus*, 2:436.

Edah, B.A., Akande, A.O., Ayo-Olalusi, C. and Olusola, A. (2010): Computed the wet weight-dry weight relationship of *Oreochromis niloticus* (Tilapia). *International Journal of Food Safety*, 12: 109-116.

Golam, M and Fahad, A.A (2013). Length-Weight, Condition factor and sex ratio of Nile Tilapia, O. *niloticus* in Wadi Hanifah, Riyadh, Saudi Arabia. World of Journal of Zoology 8(1); 106-109.

IBM Corp. Released 2015. IBM SPSS Statistics for Windows, Version 23.0. Armonk, New York: IBM Corp.

Ja'afaru, A and Tashara, A.T (2009). Some aspect of the biology of *Achenoglandis occidentalis* from River Benue at Yola, Adamawa State, Nig. *Nigerian Journal of Tropical Agriculture*, 11:296-304.

Kalu, K. M Umeham, S. N and Okereke, F. (2007). Length – Weight relationship and condition factor of *Clarias gariepinus* and *Tilapia zilli* in Lake Alauand Monguno hatchery, Borno State, Nigeria. *Animal Research International*, 4(1): 635 – 638. NO.11

King, R. P. (1996). Length-Weight Relationships of Nigerian freshwater fishes. Fishbyte, NAGA, The ICLARM Quarterly, 19(3): 49-52.

Kumar, A., Jitender, K. J. and Hemendra, K. V. (2017) Length-Weight Relationship and Relative Condition Factor of *Clarius batrachus* (Linnaeus, 1758) from Gaurmati Fish Farm, Kawardha, Chhattisgarh, India. *International Journal of Current Microbiology and Applied Science*, 6(12):1425-1431.

Lalrinsanga, P. L., Bindu R., Pillai, G. P., Swagatika, M., Namita, K. N., Sovan S. (2012). Length-Weight relationship and condition factor of giant freshwater prawn *Macrobrachium rosenbergii* (De Man, 1879) based on developmental Stages, culture stages and Sex. *Turkish Journal of Fisheries and Aquatic Sciences 12:* 917-924

Microsoft Office (Excel) Professional Plus 2013.Microsoft Corporation.

Migiro, K.E., Ogello, EO. and Munguti, J.M. (2014). The length- weight relationship and condition factor of Nile Tilapia (Oreochromis niloticus L.) Broodstock at Kegati Aquaculture Research Station, Kisii, Kenya. *International Journal of Advanced Research,* 2(5):777-782.

Moslen, M. and Miebaka, C.A. (2017) Length-weight relationship and condition factor of Mugil cephalus and Oreochromis niloticus from a Tidal creek in the Niger Delta, Nigeria. *Archives of Agriculture and Environmental Science*, 2(4): 287-292

Nehemia, A., Maganira, J. D. and Rumisha, C. (2012). Length-weight relationship and condition factor of tilapia species grown in marine and fresh water ponds. *Agriculture and Biology Journal of North America,* 3:117-124.

Oboh, I. P and Olowo, U. C. (2016) Length-Weight Relationship, Condition Factor (K) and Sex Ratio of Four Fish Species from River Sihiko, Edo State, Nigeria. *Nigerian Journal of Fisheries* 13(1,2) 1058-1068

Olaosebikan, B. D and Raji, A. (2013). *Field guide to Nigerian Freshwater fishes*. Revised Edition. Federal College of Freshwater fisheries Technology, New Bussa, Nigeria, 144pp.

Pauly, D. (1983). *Some Simple methods for the assessment of tropical stocks*. FAO Fisheries Technical Paper, 234:52.

Vicente, I. S. T. and Fonseca-Alves, C. E. (2013). Impact of introduced nile tilapia (*Oreochromis niloticus*) on non-native aquatic ecosystems. *Pakistan Journal of Biological Sciences*, 16(3): 121 – 126.

River Donga: Nigeria. National Geospatial-Intelligence Agency, Bethesda, MD, USA https://geographic.org/geographic_names/name.php?uni=2791253&fid=4339&c=nigeria. Accessed 23rd January, 2018.

Zargar, U. R., Yousuf, B. M. and Dilafroza, J. (2012). Length-weight relationship of the Crucian carp, Carassiuscarrassuis in relation to water quality, sex and season in some lenthic water bodies of Kashmir Himlayas. *Turkish Journal of Fisheries and Aquatic Science*, 12: 683 - 689.

Zhou QiCun; Yue, YiRong, 2010. Effect of replacing soybean meal with canola meal on growth, feed utilization and haematological indices of juvenile hybrid tilapia, *Oreochromis niloticus* **Oreochromis aureus*. *Aquaculture Resources*, 41 (7): 982-990. NO.24