

Original Research Paper

## Estimation of Length-Weight Relationship and Condition Factor of Two Dominant Fish Species in Obafemi Awolowo University Teaching and Research Farm Reservoir, Ile-Ife, Nigeria

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### Abstract

This study examined the length-weight relationships (LWR) and condition factors (K) of two dominant fish species: *Coptodon zillii* (Gervais, 1848) and *Sarotherodon galilaeus* (Linnaeus, 1758) in Obafemi Awolowo University Teaching and Research Farm Reservoir. This reservoir contains various fish species, providing an essential source of animal protein for the O.A.U. community and its immediate environment. The aim was to provide preliminary insights into the health status of the fish species in this reservoir, which is crucial for evaluating the long-term sustainability of its fishery resources. A total of 138 fish specimens were collected from the site between November 2022 and January 2023. The total length of the fish samples ranged between 17.3cm to 27.6 cm for *C. zillii* and 18.3 cm to 28 cm for *S. galilaeus* while their weight ranged between 126.00g to 436.69 g and 138.05g to 480.00 g for *C. zillii* and *S. galilaeus* respectively. Parameters of the length-weight relationship were estimated and the growth pattern (regression coefficient), (b), ranged between  $2.652 \pm 0.16$  and  $2.721 \pm 0.05$  for both *C. zillii* and *S. galilaeus* respectively. The two species exhibited a negative allometric growth pattern as “b” values were less than 3. The weight-length relationship had a positive correlation coefficient, (r) of 0.89 and 0.97, while the coefficient of determination, ( $r^2$ ), was 0.79 and 0.94 for *C. zillii* and *S. galilaeus* respectively. The condition factor, (k) of 2.206 was recorded in *C. zillii* and 2.338 in *S. galilaeus*. This indicated that the fish species were in good condition and thriving well in the reservoir of study. The study, therefore, recommended effective management of the reservoir in order to sustain its valuable fishery resources.

**Keywords:** Allometric growth, Condition factor, *Coptodon zillii*, Regression coefficient, *Sarotherodon galilaeus*

### Introduction

*Coptodon zillii* (Gervais, 1848) and *Sarotherodon galilaeus* (Linnaeus, 1758) are freshwater fishes belonging to the Cichlidae family, generally called Tilapia. They are native to several parts of Africa and are widely distributed in other parts of the world where they have been introduced. In Africa, the native range of *C. zillii* spans the northern half of the continent, extending across tropical West and Central Africa; including the coastal regions of southern Morocco and the Senegal River to the central Congo River basin. In northeastern Africa, *C. zillii* is widely distributed throughout much of the Nile basin, from the Nile Delta in northern Egypt to Lake Albert in the DR Congo–Uganda region, as well as Lake Turkana in Ethiopia–Kenya (Clavero *et al.*, 2017). *S. galilaeus* is native to Africa and the Middle East but has also become widely distributed in Europe and parts of the Americas. It has been introduced to several Asian countries, including Japan and China, for aquaculture purposes (Froese and Pauly, 2014). Both species thrive in diverse habitats, including lakes, reservoirs, rivers, and brackish waters. Their efficient gill structures enable them to tolerate low oxygen levels, while their ability to endure changes in salinity and temperature makes them highly adaptable to various aquatic

environments. Their rapid growth, adaptability, and high reproductive rates have made them popular for aquaculture systems (Gophen, 2018). *C. zillii* and *S. galilaeus* are highly valued due to their nutritious taste and numerous economic importance.

Organisms typically increase in length and weight as they develop. In fish, the key factors influencing growth include availability of food, competition for the same food resource, water, temperature, oxygen levels, and other water quality parameters. Growth in length and weight is a fundamental aspect of an animal's life, and understanding the relationship between these two traits is essential for both practical applications and scientific research (Kimberley *et al.*, 2003). Understanding the Length-weight relationship of any fish species is a prerequisite for studying its population structure and stock assessment (Le Cren, 1951). The length-weight relationship is crucial for fisheries biologists, as it provides a mathematical link between the two variables, allowing for the calculation of an unknown variable when the other is known. This relationship is known as the “cube law” which states that the weight of an organism varies as the cube of its length. Deviations from the expected cubic relationship between length and weight can occur due to environmental conditions and the physiological state of the animal.

Knowledge of the condition factor (K), a derivative of the length-weight relationship is essential in fishery management as it provides insights into key biological aspects such as overall health, feeding intensity, age at first maturity, and the onset of spawning (Le Cren 1951). The condition factor (K) reflects the relative fatness of a fish, with higher values of "K" generally indicating a healthier and better-conditioned fish. This factor is used to evaluate the "condition" of a fish by analyzing the relationship between its weight and length, which is influenced by both biotic and abiotic factors. (Froese, 2006). Studying the condition factor is crucial for understanding the life cycle of fish species, aiding in their proper management and, consequently, supporting the maintenance of balance in the ecosystem. Several studies have documented the length-weight relationship and condition factor of populations of different fish species. For example, Nehemia *et al.* (2012) described the length-weight relationship and condition factor of *Tilapia zillii* and *Oreochromis urolepis urolepis* raised in seawater and freshwater ponds. They found that both species exhibited negative allometric growth in freshwater ponds and positive allometric growth in seawater ponds. They also reported condition factors (K) with values less than 1 for both *T. zillii* and *O. urolepis urolepis* in seawater ponds while a value greater than 1 was reported for *T. zillii* in freshwater pond.

Seiyaboh *et al.* (2016) reported the length-weight relationship and condition factor of five fish Species from Kolo Creek, Niger Delta. The results indicated that four of the five fish species exhibited negative allometric growth across both climatic regimes. The condition factor of *Oreochromis niloticus* in Lake Nasser, Egypt was evaluated by Bayoumy *et al.* (2017), the authors found significant differences in the condition factor values across seasons, with the highest values recorded during the reproductive period. Similarly, Ola-Oladimeji *et al.* (2020) estimated the length-weight relationship and condition factor of *Clarias gariepinus* and *Parachanna obscura* at Egbe Dam in Ekiti State, Nigeria. They found that the species exhibited negative allometric growth ( $b < 3$ ) and their condition factor was less than 1, indicating that the fish species were not in good condition in the study area.

In this study, the length-weight relationship and condition factor (K) of two dominant fish species; *Coptodon zillii* and *Sarotherodon galilaeus*, in the Obafemi Awolowo University Teaching and Research Farm reservoir was estimated in order to provide data that can inform management decisions supporting the long-term health and sustainability of these fish populations.

## Materials and Methods

### Study Area

Samples were collected from the Obafemi Awolowo University Teaching and Research Farm Reservoir. This reservoir is located within the premises of Obafemi Awolowo University (latitude 70 33' 0"N and longitude 40 34' 0"E), a renowned Nigerian tertiary institution situated in Ile-Ife, Osun State, Nigeria (Adeboye *et al.*, 2017). The reservoir serves as a critical component of the university's teaching and research farm, which aims to facilitate practical education and innovative agricultural research. It was impounded between March and July 1967 primarily for agricultural purposes, such as irrigation and fish farming, through the regular stocking of the lake with various fish species. The fish species in the lake

survive on the natural food materials supplied through the two inlets (tributaries) and the abundance of plankton life (Aduwo and Adeniyi, 2019)

### Collection of Samples

A total of 138 fish were collected from the reservoir, comprising 77 *Coptodon zillii* and 61 *Sarotherodon galilaeus*. The samples were collected between November 2022 and January 2023. All collected samples were transported to the fish culture laboratory for analysis. The fishes were identified using identification keys prepared by Paugy *et al.* (2003)

### Length-Weight Measurements

The following morphological traits were measured on each specimen: Total Length (TL), Standard Length (SL), and Weight (W). The total length and standard length were measured to the nearest 0.1cm using a digital vernier caliper (Kynup) while the weight was determined on an electronic scale (Mettler P1210) to the nearest 0.01g. The total length was measured as the distance from the snout to the tip of the caudal fin, while the standard length was measured from the snout to the caudal peduncle

### Determination of Length-Weight Relationship

The length-weight relationship was determined using the allometric growth formula, as applied by Ricker (1973), in the form of  $W = aL^b$  where:

(W) stands for body weight (g), (L) stands for total length (cm), (a)- Intercept on the length axis,

Y- Intercept (when X = 0.0), (b)- Regression coefficient.

The LWR equation was then transformed into a linear form:

$\log W = \log(a) + b(\log L)$ .

The log-transformed length-weight relationship was calculated using linear regression analysis, and scatter plots of length and weight were created (Datta *et al.*, 2013).

### Determination of Condition Factor

Fulton's condition factor (K) was determined using the expression:  $K = 100 \left( \frac{W}{L^3} \right)$

Where K = Condition factor,

W = Weight (g),

L = Total length (cm), and 3 = the cubic relationship between length and weight.

### Data Analysis

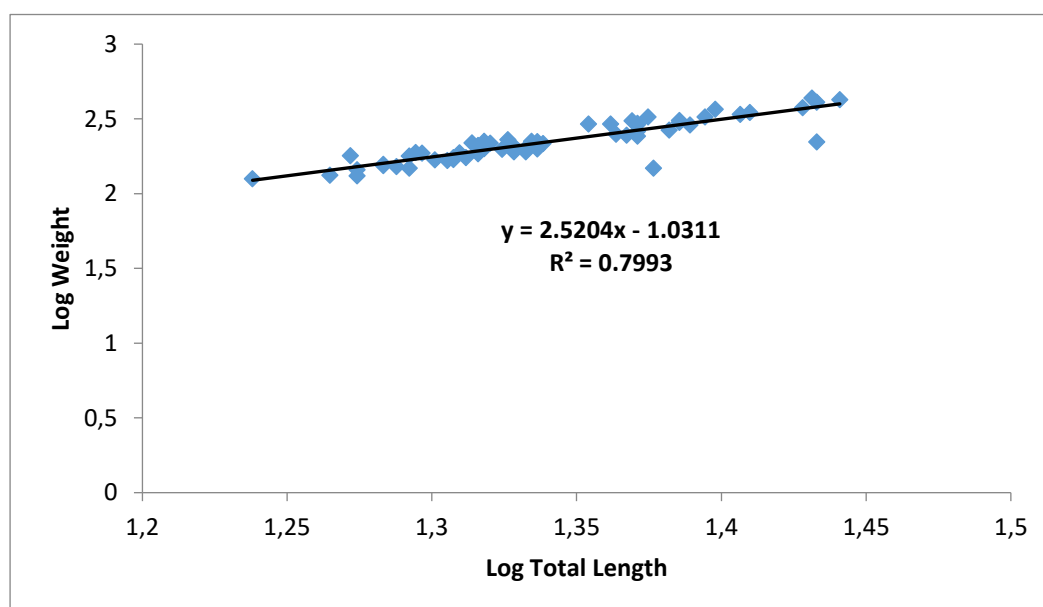
The data was analyzed using descriptive statistics and regression analysis on Microsoft Office Excel.

## Results

A total of seventy-seven (77) individuals of *C. zillii* and sixty (60) *S. galilaeus* were recorded. The total length (cm) of *C. zillii* specimens ranged between 17.3cm and 27.6 cm with a mean value of 21.98cm while the weight ranged from 126.00g to 436.69 g with an average of 234.91g. *S. galilaeus* specimens had total lengths that ranged between 18.3 cm and 28.0cm with a mean value of 23.5 cm and their weight ranged from 138.05g to 480.00g, with an average of 303.42g (Table 1). Of the two species, *S. galilaeus* had the higher mean total length and body weight. The Weight-length relationship of the two fish species is presented in Table 2 and Figures 1 and 2. *C. zillii* and *S. galilaeus* had weight-length relationships of  $y = 2.5204x - 1.0311$  and  $y = 2.721x - 1.2753$  respectively. The regression coefficient (b) for the two fish species from the reservoir was less than 3 in value. The correlation coefficient, r, (0.96) was the highest in *S. galilaeus*, while *C. zillii* had (0.89). The mean condition factor (K) for *C. zillii* was 2.21 while that of *S. galilaeus* was 2.34 (Table 2).

**Table 1.** Range and mean values of the total length and body weight of *C. zillii* and *S. galilaeus* collected from Obafemi Awolowo University Teaching and Research Farm Reservoir.

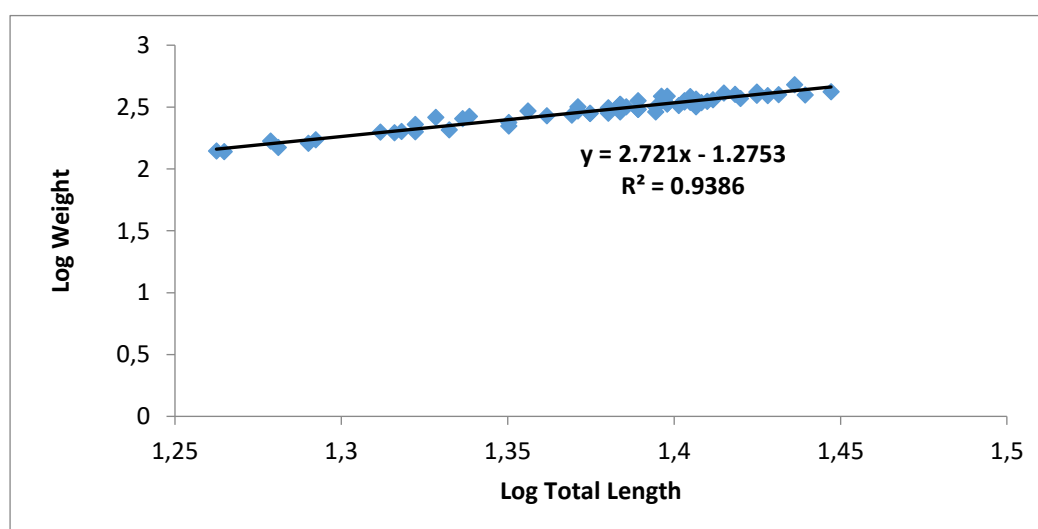
| Fish Species                  | Total Length (cm) |        | Body Weight (g)   |         |
|-------------------------------|-------------------|--------|-------------------|---------|
|                               | Range             | Mean   | Range             | Mean    |
| <i>Coptodon zillii</i>        | 17.3cm - 27.6cm   | 22.0cm | 126.00g – 436.69g | 234.91g |
| <i>Sarotherodon galilaeus</i> | 18.3cm – 28.0cm   | 23.5cm | 138.05g – 480.00g | 303.42g |



**Fig.1.** Weight-length relationship and regression expression of *Coptodon zillii*  
\* $R^2$  = coefficient of determination

**Table 2:** Length-weight relationship and condition factor of *C. zillii* and *S. galilaeus* collected from Obafemi Awolowo University Teaching and Research Farm Reservoir

| Fish Species                  | Number Sampled | Condition Factor (K) | Regression Coefficient (b) | Correlation Coefficient (R) | Growth Type |
|-------------------------------|----------------|----------------------|----------------------------|-----------------------------|-------------|
| <i>Coptodon zillii</i>        | 77             | 2.206                | 2.520                      | 0.89                        | -A          |
| <i>Sarotherodon galilaeus</i> | 60             | 2.338                | 2.721                      | 0.97                        | -A          |



**Fig.2.** Weight-length relationship and regression expression of *Sarotherodon galilaeus*  
\* $R^2$  = coefficient of determination

## Discussion

The study of the length-weight relationship of fish is paramount in studying the growth, gonadal development, and general well-being of fish populations. It is also useful for comparing the life history and developmental patterns of fish from different habitats (Nagesh *et al.*, 2004). Basheer *et al.* (1993) opined that the length-weight relationship of fish varies depending upon the condition of life in the aquatic environment. Information on the length-weight relationship also plays a critical role in modeling aquatic ecosystems (Petrakis *et al.*, 1995). The regression coefficient (b) values in length-weight relationships define the growth pattern of fish species. When "b" equals 3, the growth is considered isometric, meaning the fish becomes proportionally more robust as its length increases (King, 1996). Conversely, when "b" significantly deviates from 3, the growth is allometric, which could be positive or negative. Positive allometric growth refers to the fish becoming proportionally heavier as its length increases while negative allometry indicates that the fish becomes thinner as its length increases. The "b" in the length-weight relationship is ideally constant at 3 for a fish living under perfect conditions. However, as a fish progresses through different life stages, the simple "cube law" which states that an organism's weight is roughly proportional to the cube of its linear dimension no longer consistently applies, leading to variations in the equilibrium constant and deviations in the fish's growth pattern. This study revealed that *C. zillii* and *S. galilaeus* from the study area did not adhere to the cube law, with the exponent "b" measured at 2.652 and 2.721 for the two species, respectively, indicating negative allometric growth ( $b < 3$ ). This is consistent with the findings of Ola-Oladimeji *et al.* (2020) who reported negative allometric growth patterns in two dominant fish species; *C. gariepinus* and *P. obscura* from Egbe Dam in Ekiti State, Nigeria. Similarly, King (1996) reported a negative allometric growth pattern in several fish species in Nigerian freshwaters. Bolaji *et al.* (2011) also reported negative allometry in the studies done on *P. obscura* from Igwu and Itu Rivers wetlands as the weight of the fish increased at a lesser rate than the cube of the body length. In contrast to the findings of this study, a positive isometric growth pattern was observed in *Papyrocranus afer*, from the Oramiri-Ukwa River, as reported by Adaka *et al.* (2015). In this study, the correlation coefficient, r, was highest (0.97) in *S. galilaeus*, while *C. zillii* had (0.89). The calculation of correlation showed that there was a strong positive relationship between the total length and weight in the studied fish species ranging from 0.89 to 0.97. The regression model quantified the percentage of data variability for the length and weight of *C. zillii* and *S. galilaeus* as indicated by the coefficient of determination ( $R^2$ ). The analysis revealed that 79.93% and 93.86% of the variation were explained in the two fish species respectively, suggesting a strong relationship between the length and weight of the two fish species. The condition factor (K) which provides information about the well-being of the fishes in their habitat showed that the two fish species (*C. zillii* and *S. galilaeus*) examined in this study were in good condition as their "K" value was greater than 1. Both species had a high mean condition factor (2.206 and 2.338), suggesting that the environmental factors in the study area favoured the growth and well-being of the fish. This also indicates that the fish are in good health, with sufficient food availability contributing to a robust body condition relative to their length. The fish can be said to be thriving optimally. This is similar to the findings of Ola-Oladimeji *et al.* (2022) who reported "K" values above 1.0 for *Oreochromis niloticus* from two different reservoirs in Ekiti state and concluded that the two reservoirs were suitable for the growth and survival of *O. niloticus*.

Several parameters including environmental factors, feeding condition, stress, age, season, sex, and the physiological condition of the fish, etc. can affect the fish condition and parameters of the length-weight relationship (Ama-Abasi, 2007; Yem *et al.*, 2007; Adeyemi *et al.*, 2009). In this study, the length-weight relationship was found to be linear conforming to the general formula that describes the relationship between the length and weight of fish. This suggests that the conditions in the study area are optimal, thus contributing to the consistent growth in the weight and length of the fish species.

## Conclusion

The length-weight relationship of the two species, *Coptodon zillii* and *Sarotherodon galilaeus*, slightly deviated from the isometric growth pattern and did not follow the cube law. The two fish species exhibited negative allometric growth. The condition factor 'K' value was above the ideal value and indicated that the species were in good conditions in their natural habitats. The study therefore recommended that the Obafemi Awolowo University Teaching and Research Farm Reservoir should be effectively managed to sustain its fishery resources

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## Author's Contributions

Oladimeji Tofunmi Elizabeth conceived the study, supervised field and laboratory work, and wrote the manuscript.

Babatunde Oluwasegun Samuel conducted laboratory work and analysis; and provided laboratory resources.

Aregbesola Omolola Comfort reviewed and edited the manuscript

Ola-Oladimeji Majolagbe Desola reviewed and edited the manuscript

## Ethics

Standard ethical considerations were followed for the fish used for this study.

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