FUDMA Journal of Agriculture and Agricultural Technology
ISSN: 2504-9496
Vol. 12 No.2, June 2026: Pp.94-100

https://doi.org/10.33003/jaat.2026.1202.10

MORPHOMETRIC CHARACTERISTICS, LENGTH-WEIGHT RELATIONSHIP AND CONDITION FACTOR OF *Coptodon zillii*, *Hepsetus odoe*, *Clarias gariepinus*, *Oreochromis niloticus*, and *Alestes nurse* IN UREJE RESERVOIR, ADO-EKITI, EKITI STATE, NIGERIA

[1]Balogun, A.T., [2]Adeyemi, S.O., [2]Akinsorotan, A.M and [2]Tope-Jegede, O.H
[1]Department of Fisheries Technology, The Federal Polytechnic Ado Ekiti, Ekiti State
[2]Department of Fisheries and Aquaculture, Federal University Oye Ekiti, Ekiti State.

ABSTRACT

This study aimed to assess the morphometric characteristics, length-weight relationship, and condition factor of fish species in Ureje Reservoir, Ado-Ekiti, Ekiti State, Nigeria. Samples of five fish species from the reservoir were collected for 24 months covering the wet and dry seasons, and the weight of each fish sample were taken monthly using top top-loading sensitive weighing balance. Their total length and standard length were taken using a meter rule calibrated in centimetres. Data obtained were subjected to descriptive statistics to determine means and standard deviations on the Statistical Package for Social Sciences (20.0). Condition Factor (K) and Length- weight Relationship were calculated. Analysis of fish morphometric revealed seasonal differences in Growth performance and condition factors. Morphometric measurements revealed seasonal variations in the studied fish species. During the dry season, *Coptodon zillii* had a mean body weight of 85.53 ± 50.64 g, total length (TL) of 16.44 ± 4.72 cm, and standard length (SL) of 13.60 ± 4.66 cm (n = 110), while *Hepsetus odoe* recorded a mean weight of 258.46 ± 46.53 g, TL of 27.20 ± 3.75 cm, and SL of 24.56 ± 3.73 cm (n = 10). In contrast, *Oreochromis niloticus* exhibited a higher condition factor in the wet season (K = 2.85) compared with the dry season, while *Clarias gariepinus* recorded K = 2.43 in the dry season. The length–weight relationships indicated negative allometric growth in most species, with *O. niloticus* showing b = 2.41 in the wet season and b = 2.17 in the dry season. Overall, the wet season produced better growth performance and condition factor, reflecting improved feeding conditions and environmental suitability.

Keywords: Allometric Growth, Morphometric measurements, Growth Pattern, Standard Length

INTRODUCTION

Fish and fish products are beneficial for protein, fatty acids, and vitamins which play a vital part in the food security and economy of the globe. Fish and its products are also helpful in uplifting human livelihood mainly in developing countries (Chan *et al*., 2019). Fish is a cheaper source of protein, vitamins, and minerals particularly in particularly in low and middle-income countries (Robinson *et al*., 2022). According to Muir (2013), eating fish on a daily basis can help with protein, vitamin, mineral, and fatty acid deficits. Its flesh provides an immediate source of omega-3 unsaturated fatty acids. Calder (2018) emphasizes the importance of these FAs for maintaining healthy living. By supplying around 50% of the food generated from animals and being an essential component of the national economy, the fish sector also contributes significantly to satisfying the nutritional demands of the country (Ogunbode *et al*., 2020; Subansighe *et al*. 2021). The fish sector contributes by promoting socioeconomic growth, alleviating poverty, and improving the livelihoods of marginalized communities (de Graaf and Garibaldi, 2014).

Reservoirs are the basic sources of raw water needed for domestic purposes, industrial, agricultural, fishery and other forms of usage. During the dry season, most rural communities in semi-arid regions, solely depend on these reservoirs as a means of survival economically and socially (Loucks and Van, 2017). These reservoirs function as a flood control system, as they temporarily store this water during peak flow, so minimizing excess surface runoff along the streams contributing downstream (Elkhrachy, 2015). Nigeria's reservoirs considerably contribute to indigenous fish production (Komolafe *et* al., 2014). In Ekiti State, reservoirs receive inflows from household wastewater and agricultural runoff, while also serving as sources of drinking water, fish production, and recreational facilities. The biology of fish in Ureje reservoirs is probably going to suffer as a result of these many human activities (Adeyemi *et al*., 2023).

The examination of length–weight relationships (LWRs) in fish species is one of the essential tools for evaluating growth patterns, condition factors, and population dynamics in fisheries management (Getso *et al*., 2017). The length–weight relationships is instrumental in fisheries science not only for estimating biomass and growth patterns but also for evaluating the ecological status of water bodies (Pinna *et al*., 2023). LWRs reveal growth patterns, indicating whether fish exhibit positive or negative allometric growth (Sharma *et al*., 2024). LWRs can indicate the health of fish populations, allowing for comparisons across different environments and conditions (Soinski *et al*., 2020). Likewise, determining the condition component allows for assessment of the ecological status of the environment in which the fish reside (Lederoun *et al*., 2022) and the assessment of the health or well-being of the fish (Lederoun et al., 2016). Morphometric studies are fundamental tools for understanding the development, growth variations, and population characteristics of fish species (Singh *et al*., 2022; Tariq *et al*., 2023). Fish morphometric analyses are crucial for understanding the biology of fishes and for figuring out how different body components relate to one another. Morphometric studies play a vital role in assessing fish development patterns, habitat conditions, overall health, feeding ecology, reproductive status, size distribution, and general condition, thereby providing insights into population structure and maintenance (Islam *et al*., 2020; Khatun *et al*., 2022). The condition factor (K) is commonly used as a physiological index to evaluate the health and general well-being of fish (Ajibare and Loto, 2022). According to Olopade *et al*. (2018), it provides insight into a range of biological and environmental influences such as physical fitness, reproductive maturity, and how suitable the habitat is for the fish's nutritional status. It essentially reflects how well-nourished a fish is, functioning as an indicator of its body fatness and energy reserves. Condition factor proves especially useful when comparing fish populations exposed to different feeding regimes, environmental conditions, or other external factors (Fafioye and Ayodele, 2018). Additionally, it is useful in evaluating aspects such as feeding frequency, age, and growth rate in fish species (Ndimele *et al*., 2010). Ureje Reservoir serves as a representative example of many small tropical freshwater reservoirs in Nigeria, which are under threat from eutrophication, climate change, and unregulated land use (Akindele *et al*., 2019). Despite the ecological and economic importance of the Ureje Reservoir, there is limited published information on the morphometric traits, length-weight relationships, and condition factors of its fish species. This gap hinders effective fisheries development and conservation efforts in the Ekiti State. This study aimed to assess the morphometric characteristics, length-weight relationship, and condition factor of fish species in Ureje Reservoir, Ado-Ekiti, Ekiti State, Nigeria.

MATERIALS AND METHODS

Study Area

The study was conducted in Ureje Reservoir (Figure 1), a small multipurpose reservoir located in Ado Ekiti, the capital of Ekiti State, Southwest Nigeria. The reservoir is geographically positioned between latitude 7°37′N and longitude 5°13′E, with an elevation of approximately 445 meters above sea level (Ayoade, 2016). Ekiti State falls within the humid tropical rainforest zone, characterized by two distinct seasons: the wet season (April to October) and the dry season (November to March). Ekiti State experiences average annual rainfall between 1,200 mm and 1,500 mm and a mean annual temperature ranging from 25°C to 28°C (Ogunbode *et al*., 2020). Ureje Reservoir was constructed primarily as a municipal water supply source for Ado Ekiti and surrounding communities. Over time, it has gained importance for fisheries, irrigation, livestock watering, flood control, and recreation (Olaleye and Akinyemi, 2018). The reservoir is fed mainly by the Ureje River, which is part of the Osun River Basin. The surrounding catchment area comprises undulating terrain with lateritic soils and a mosaic of land uses, including agriculture, urban settlements, and patches of natural vegetation (Fasakin and Ajayi, 2021). For this study, three sampling stations were selected to reflect spatial and anthropogenic variation. Station A (Upstream) is located at the primary inflow point of the Ureje River. It is characterized by relatively fast-flowing water, agricultural runoff, and riparian vegetation. Station B (Midstream) is situated centrally within the reservoir. It receives both upstream inflows and lateral runoff. The station has moderate fishing activity and intermediate depth. Station C (Downstream) is found near the dam embankment and outlet. This station has the greatest depth and calm water. It is influenced by domestic and urban discharges due to proximity to human settlements.

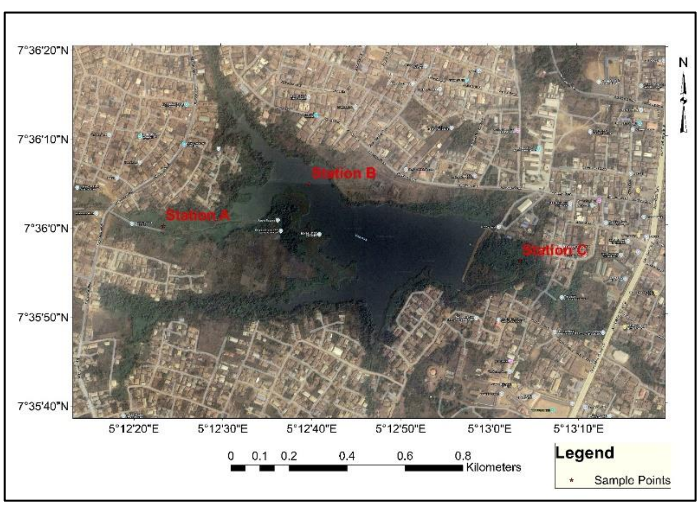

Figure 1: Map of Ureje Reservoir

Collection and identification of Fishes

Samples of fish from the reservoir were collected. Gill nets with a twine diameter of 0.16 mm were deployed monthly to capture a representative range of fish sizes. The fine mesh improves capture efficiency and reduces visibility, ensuring reliable sampling across different seasons. The assistance of artisanal fishermen was employed to capture fish for this study. Fish samples were identified according to Adesulu and Syndenham (2007) and Olaosebikan and Raji (2013).

Fish Measurement

The weight of each fish samples were taken using top loading sensitive weighing balance (Model no: BL10001) to the nearest 0.01g. Also, their total and standard length were taken to the nearest 0.01cm using a meter rule calibrated in centimetres. The Total Length (TL) of each fish were measured from the tip of the anterior part of the mouth to the extremity of caudal fin while the standard length was measured as the distance from the snout to the caudal peduncle.

Data Analysis

Data obtained were subjected to descriptive statistics (means and standard deviations were used to determine morphometric characteristics) on the Statistical Package for Social Sciences (20.0). The variations were tested at P=0.05. Significant means were separated using Duncan's Multiple Range Test (Duncan, 1955). Descriptive analysis was used to present tables and figures while Condition Factor (K) and Length- weight Relationship was calculated as follow:

Determination of Condition Factor (K)

The formula of calculating the 'K' is given as described in the equation proposed by Pauly, (1984).

$$K = \frac{100W}{L^3}$$

Where: K = Condition factor

W = Weight of fish in grams

L = Length of fish in centimeters

Determination of Length- weight Relationship

The relationship between the length (L) and weight (W) of fish will beestimated by the equation

$$W = aL^b$$ (Loto *et al.*, 2021)

And will be logarithmically transformed into

$$logW = loga + blogL$$

Where W = weight of fish in grams,

L = total length of fish in centimeters,

a = constant of proportionality and

b = allometry coefficient.

The parameters "a" and "b" were estimated by method of least squares regression using the log transformed data.

RESULTS

The morphometric measurements of five fish species collected from Ureje Reservoir during the dry and wet seasons are presented in Table 1. The species assessed were *Coptodon zillii*, *Hepsesus odoe*, *Clarias gariepinus*, *Oreochromis niloticus*, and *Alestes nurse*. During the dry season, *C. zillii* had a mean body weight of 85.53 ± 50.64 g, TL of 16.44 ± 4.72 cm, and SL of 13.60 ± 4.66 cm (n=110). *H. odoe* had weight of 258.46 ± 46.53 g, with a TL of 27.20 ± 3.75 cm and SL of 24.56 ± 3.73 cm (n=10). *Clarias gariepinus* showed mean weight of 202.09 ± 139.52 g (n=56). *O. niloticus* recorded the lowest mean weight (53.23 ± 37.40 g, n=166). *Alestes nurse* had the highest measurements overall in the dry season (BW: 325.16 ± 35.30 g; TL: 34.10 ± 1.56 cm; SL: 30.80 ± 3.25 cm), though sample size was small (n=2).

In the wet season, *C. zillii* showed slightly reduced BW (78.02 ± 47.75 g) but increased TL (18.06 ± 8.10 cm) and SL (14.22 ± 3.17 cm) with a higher sample size (n=128). *H. odoe* decreased in weight (161.00 ± 124.21 g), TL (22.15 ± 8.00 cm), and SL (20.20 ± 7.90 cm) despite an increased sample size (n=15). *Clarias gariepinus* increased in BW to 242.92 ± 109.94 g and SL to 20.88 ± 7.39 cm but showed marginal increase in TL (22.87 ± 7.48 cm; n=23). *O. niloticus* showed marked increases in BW (99.70 ± 63.04 g), TL (16.52 ± 3.74 cm), and SL (13.40 ± 3.86 cm), suggesting improved condition during the wet season. For *Alestes*, a large drop in BW and length was observed (BW: 114.26 ± 119.52 g; TL: 21.04 ± 7.26 cm; SL: 17.20 ± 7.71 cm; n=10).

Table 1: Morphometric Characteristics of Five Fish Species Collected from Ureje Reservoir

Species	Parameter	*C. zillii*	*H. odoe*	*C.gariepinus*	*O. niloticus*	*Alestes nurse*
	BW (g)	85.53±50.64[b]	258.46±46.53[c]	202.09±139.52[c]	53.23±37.40[a]	325.16±35.30[d]
Dry	TL (cm)	16.44±4.72[b]	27.20±3.75[c]	22.61±7.93[c]	14.56±4.39[a]	34.10±1.56[d]
Season	SL(cm)	13.60±4.66[b]	24.56±3.73[d]	18.48±7.06[c]	11.74±3.87[a]	30.80±3.25[e]
	n	110	10	56	166	2
	BW (g)	78.02±47.75[a]	161.00±124.21[d]	242.92±109.94[e]	99.70±63.04[b]	114.26±119.52[c]
Wet	TL (cm)	18.06±8.10[b]	22.15±8.00[c]	22.87±7.48[c]	16.52±3.74[a]	21.04±7.26[c]
Season	SL(cm)	14.22±3.17[a]	20.20±7.90[b]	20.88±7.39[b]	13.40±3.86[a]	17.20±7.71[ab]
	n	128	15	23	116	10

BW: Body weight; TL; Total length; SL: Standard length; n: Sample number

The length–weight relationship (LWR) and condition factor (K) of five fish species (*Coptodon zillii*, *Hepsesus odoe*, *Clarias gariepinus*, *Oreochromis niloticus*, and *Alestes nurse*) in Ureje Reservoir were assessed during the dry and wet seasons and presented in Table 2. In *Coptodon zillii*, the exponent b was 1.94 in the dry season and 1.18 in the wet season, with corresponding condition factors of 1.92 and 1.32, respectively indicating negative allometric growth. The coefficient of determination (R^2) was moderate in the dry season (0.60) and low in the wet season (0.34). This suggests a fair to weak correlation between length and weight, particularly during the wet season. *Hepsesus odoe* showed strong correlations in both seasons, with R^2 values of 0.99 (dry) and 0.93 (wet). The b-values were 1.28 and 2.35, respectively (indicating negative allometric growth), while the condition factor was slightly higher in the wet season (K = 1.48) compared to the dry season (K = 1.28).

In *Clarias gariepinus*, the length–weight exponent decreased slightly from 1.66 in the dry season to 1.54 in the wet season (indicating negative allometric growth). However, the condition factor increased from 1.75 to 2.03, and the correlation coefficient also improved from 0.47 to 0.66. *Oreochromis niloticus* recorded relatively high b-values in both seasons (2.38 and 2.41), with strong correlations (R^2 = 0.88 and 0.85). The condition factor was higher in the wet season (K = 2.21) compared to the dry season (K = 1.72), indicating better physiological condition during the rainy season. For *Alestes nurse*, only two specimens were captured during the dry season, showing a perfect correlation (R^2 = 1.00) with b = 2.30 and K = 0.82. In the wet season, more individuals were sampled (n = 10), with a b-value of 3.00 indicating isometric growth, R^2 = 0.97, and an improved condition factor (K = 1.23).

Table 2: Length–Weight Relationship (LWR) and Condition Factor (K) Of Five Fish Species in Ureje Reservoir

Species	Dry Season					Wet Season				
	a	B	R^2	K	n	A	B	R^2	K	n
C. zillii	-1.14	1.94	0.60	1.92	110	0.85	1.18	0.34	1.32	128
H. odoe	1.31	1.28	0.99	1.28	10	-2.39	2.35	0.93	1.48	15
C. gariepinus	-0.03	1.66	0.47	1.75	56	0.59	1.54	0.66	2.03	23
O. niloticus	-2.55	2.38	0.88	1.72	166	-2.26	2.41	0.85	2.21	116
A. nurse	1.26	2.30	1.00	0.82	2	-4.70	3.00	0.97	1.23	10

a = constant of proportionality; b = allometry coefficient; R^2 = correlation coefficient; K = condition factor; n = Sample number

DISCUSSION

The results indicate species-specific and seasonal variations in morphometric characteristics. *C. zillii* and *O. niloticus*, both cichlids, showed relatively higher standard lengths during the wet season, suggesting better growth conditions likely due to increased food availability and spawning activities. *H. odoe*, a pelagic predator, showed notable reduction in body size metrics during the wet season, potentially due to reproductive stress or increased competition and movement across habitats. The increase in *C. gariepinus* BW and SL suggests a favorable feeding regime or physiological adaptation during this period. Notably, the wide standard deviations, particularly for catfish and *H. odoe*, imply size heterogeneity within populations, possibly due to mixed age classes, differential growth rates, or hybridization in cultured species. *A. nurse* data are insufficient because catch rates were low during the dry season. This low capture rate is likely due to seasonal movements: individuals commonly move into adjoining river channels, deeper reservoir zones, or floodplain habitats in response to reduced inflow, altered depth and habitat conditions, and seasonal feeding/spawning behaviour. Consequently, the observed reduction in size metrics during the wet season may reflect either this migratory behaviour or sampling bias associated with seasonal changes in fish distribution.

The observed morphometric variations align with previous studies showing that seasonal changes significantly influence fish growth, condition, and reproductive status (Fagade, 1979; King, 1996). The wet season, associated with higher primary productivity and food availability, generally supports increased growth and better condition factor in many freshwater fish species (Ayoade et al., 2006). *Oreochromis niloticus* and *C. zillii*, both known to breed during the rainy season, showed signs of improved condition (higher TL and SL), consistent with studies by Offem et al. (2007), who observed similar trends in some reservoirs in the Cross River, Nigeria. *C. gariepinus* with higher BW in the wet season, may reflect both enhanced feeding and gonadal development. However, the decline in sizes of *H. odoe* during the wet season contradicts the general growth pattern and may be explained by ontogenetic migration into floodplains, tributary channels, or littoral nursery habitats where smaller juveniles dominate the population (Ekwu and Sikoki, 2006). The large standard deviations observed in body weight and length for catfish and *H. odoe* indicate high variability within the sampled populations. Future studies should incorporate size-class distribution and condition factor analysis to provide deeper insights into their population dynamics. The decline in *A. nurse* size during the wet season, though based on limited data, could be due to migratory behavior or habitat shift, as *A. nurse* are known to move into floodplains during rainy seasons (Lévêque *et al*., 1992). Thus, it can be suggested that seasonal variation significantly affects the morphometric characteristics of fish species in Ureje Reservoir, reflecting ecological responses to hydrological and climatic factors. The findings established the importance of integrating seasonal and species-specific traits into fisheries management and conservation planning.

The coefficient of determination R^2 was generally high for most species, especially *H. odoe*, *O. niloticus*, and *A. nurse*, suggesting a strong correlation between length and weight. Lower values observed in *C. zillii* and *C. gariepinus* may indicate greater size variability or sampling inconsistencies. The length–weight relationship (LWR) provides insight into the growth pattern of fish. In Ureje Reservoir, most species exhibited negative allometric growth ($b < 3$), meaning they gained weight at a slower rate compared to their length. This growth pattern is common in natural populations where seasonal variations in food availability, reproductive activity, and environmental stresses affect energy allocation (Loto *et al.,* 2021). The negative allometry observed suggests that, at certain times of the year, fish may be diverting energy to reproduction rather than somatic growth, or experiencing limited food resources (Ayoade *et al*., 2006). In contrast, the condition factor (K) reflects the health, wellbeing, and ecological suitability of the environment. Higher K values, as observed in *O. niloticus* and *C. gariepinus* during the wet season, indicate favorable feeding conditions, sufficient nutrient availability, and supportive environmental conditions, making the reservoir suitable for sustaining these species.

Conversely, lower K values, such as those recorded for *Alestes* in the dry season, may point to stress, poor food resources, or suboptimal habitat conditions, suggesting that some species are less adapted to the reservoir's seasonal fluctuations (Offem *et al*., 2007). The LWR and CF indicate that Ureje Reservoir can support diverse fish species, but environmental and seasonal factors strongly influence growth and wellbeing. Species like *O. niloticus* and *C. gariepinus* appear well adapted to the reservoir's productivity cycles, while others, like *Alestes*, may be more vulnerable to seasonal resource limitations (Kolding *et al*., 2008). This highlights the importance of sustainable management to maintain ecosystem balance and fish stock health. The seasonal variation in both b and K values aligns with earlier findings that fish growth patterns and condition are influenced by hydrological regimes, food availability, and habitat quality (Fagade, 1979; King, 1996). Additionally, anthropogenic stressors such as fishing pressure and pollution could influence growth and condition (Ighwela *et al*., 2011). Overall, the data suggest that fish health and growth patterns in Ureje Reservoir are species- and season-dependent, with important implications for fisheries management, stock assessment, and conservation planning.

CONCLUSION AND RECOMMENDATION

The findings of this study revealed clear seasonal and species-specific differences in fish morphometrics, with most species exhibiting negative allometric growth patterns and variable condition factors, reflecting the influence of environmental fluctuations on growth performance, wellbeing, and the overall suitability of Ureje Reservoir to sustain diverse fish populations. Cichlids (*Coptodon zillii* and *Oreochromis niloticus*) showed improved growth during the wet season, *C. gariepinus* also demonstrated increased body weight during this period, while *Hepsetus odoe* displayed reduced size, possibly due to stress or juvenile dominance in samples. Most species exhibited negative allometric growth, with condition factor values varying by species and season. Therefore it is recommended that fisheries management strategies must consider the observed seasonal and species-specific variations in growth, condition factor, and population dynamics. Enhanced biological monitoring during both wet and dry seasons is necessary to fully capture ecological responses and inform adaptive management.

REFERENCES

Adesulu, E.A. and Syndenham, D.H.J. 2007. *The Freshwater Fish and Fisheries of Nigeria*. Macmillan Nigeria Publishers Ltd, Nigeria, 397pp.

Adeyemi, S. O., Bankole, N. O., and Adikwu, I. A. (2023). Length-Weight Relationship and Condition Factor of *Oreochromis niloticus* (Linnaeus, 1758) in Selected Tropical Reservoirs of Ekiti State, Southwest Nigeria. *Journal of Fisheries and Environment*, 11(4), 707–719. http://dx.doi.org/10.18006/2023.11(4).707.719

Ajibare, A. O., and Loto, O. O. (2022). Length-weight relationship and condition factor of *Sarotherodon melanotheron* and *Tilapia Guineensis* in Lagos Lagoon, Nigeria. *Agrosearch*, 21(1and2), 57-66.

Ayoade, A. A., Fagade, S. O., and Adebisi, A. A. (2006). Dynamics of limnological features of two man-made lakes in relation to fish production. *African Journal of Biotechnology*, *5*(10), 1013–1021.

Ayoade, J. O. (2016). *Introduction to climatology for the tropics* (2nd ed.). Ibadan: Spectrum Books.

Calder, P. C. (2019). Conference on 'The future of animal products in the human diet: health and environmental concerns' Plenary Lecture 3 n-3 PUFA and health: fact, fiction and the future Very long-chain n-3 fatty acids and human health: fact, fiction and the future. *Proceedings of the Nutrition Society*, 77, 52-72.

Chan, P. (2019). Challenges of fish for food security in Africa. *Global Food Security*, (20), 17.

De Graaf, G., and Garibaldi, L. (2014). The value of African fisheries. *FAO Fisheries and Aquaculture Circular*, No. 1093. FAO, Rome, pp. 76.

Ekwu, A. O., and Sikoki, F. D. (2006). Species composition and distribution of the Ichthyofauna of Onyoma River, Niger Delta, Nigeria. *Journal of Applied Sciences and Environmental Management*, *10*(3), 97–99.

Elkhrachy, I. (2015). Flash flood hazard mapping using satellite images and GIS tools: A case study of Najran city, Kingdom of Saudi Arabia (KSA). *The Egyptian Journal of Remote Sensing and Space Sciences,* 18(2), 261–278. https://doi.org/10.1016/j.ejrs.2015.06.007

Fafioye, O. O., and Ayodele, O. P. (2018). Length–weight relationship and condition factor of four commercial fish species of Oyan Lake, Nigeria. *Examines in Marine Biology and Oceanography,* *2*(4), 227–230. https://doi.org/10.31031/EIMBO.2018.02.000543

Fagade, S. O. (1979). Observation on the biology of two species of *Tilapia* from the Lagos Lagoon, Nigeria. *Bulletin de l'Institut Francais d'Afrique Noire*, *41*, 627–658.

Fasakin, E. A., and Ajayi, B. D. (2021). Reservoirs and aquatic ecosystems in Nigeria: Current state and sustainable management options. *Nigerian Journal of Environmental Science and Technology*, *5*(1), 45–58.

Froese, R. (2006). Cube law, condition factor and weight–length relationships: History, meta-analysis and recommendations. *Journal of Applied Ichthyology*, *22*(4), 241–253. https://doi.org/10.1111/j.1439-0426.2006.00805.x

Garcia, S. M., and Rosenberg, A. A. (2010). Food security and marine capture fisheries: characteristics, trends, drivers and future perspectives. Philosophical Transactions of the Royal Society B: *Biological Sciences*, 365(1554), 2869-2880.

Getso, B.U., Abdullahi, J.M., and Yola, I.A. (2017). Length-weight relationship and condition factor of *Clarias gariepinus* and *Oreochromis niloticus* of Wudil River, Kano, Nigeria. *Agro-Science*, 16:1–4. doi: 10.4314/as.v16i1.1.

Ighwela, K. A., Ahmed, A. B., and Abol-Munafi, A. B. (2011). Condition factor as an indicator of growth and feeding intensity of *Nile tilapia fingerlings (Oreochromis niloticus)* fed formulated diet containing maltose. *American-Eurasian Journal of Agricultural and Environmental Sciences*, *11*(4), 559–563.

Islam, M. A., Mawa, Z., Hossain, M. Y., Rahman, M. A., Hasana, M. R., Khatun, D., Chowdhury, A. A., Rahman, O., Rahman, M. A., Tanjin, S., Hassan, U. H., and Ohtomi, J. (2020). Morphometric and meristic characteristics of spotted snakehead *Channa punctata* (Bloch, 1793) in a wetland ecosystem (NW Bangladesh) using multi-linear dimensions. *Indian Journal of Geo-Marine Sciences*, 49(8), 1442–1446. Retrieved October 6, 2021, from http://nopr.niscair.res.in/bitstream/123…

Khatun, D., Hossain, M. Y., Hossain, M. F., and Mawa, Z. (2022). Population parameters of a freshwater clupeid, *Corica soborna* (Hamilton, 1822) from the Ganges River, northwestern Bangladesh. *Pakistan Journal of Zoology, 54*(3), 1279–1290. https://doi.org/10.17582/journal.pjz/20191208161233

King, R. P. (1996). Biodiversity of freshwater fishes of the Niger Delta. In: *Proceedings of the Conference on the Sustainable Utilization of Aquatic Resources of Nigeria*. NIFER, New Bussa.

Kolding, J., Haug, L., and Mkumbo, O. (2008). Does lake ecosystem size matter? The role of capture fisheries in the Great Lakes and implications for management. *Lakes and Reservoirs: Research and Management*, *13*(2), 143–154.

Lederoun, D., Ahouanganon, V. H., Dagnidé, R. A., Vandewalle, P., and Lalèyè, P. (2022). Evaluation of length–weight and length–length relationships of some of the most abundant commercial fishes from the Couffo River basin (Benin, West Africa). *Fisheries and Aquatic Life*, *30*(2), 63–73. https://doi.org/10.2478/aopf-2022-0006

Lederoun, D., Lalèyè, P.A., Vreven, E.J., and Vandewalle, P. (2016). Length-weight and length-length relationships and condition factors of 30 actinopterygian fish from the Mono basin (Benin and Togo, West Africa). *Cybium*, 40(4): 267-274.

Lévêque, C., Paugy, D., and Teugels, G. G. (1992). *Faune des poissons d'eaux douces et saumâtres de l'Afrique de l'Ouest*. Tome 1. Paris: ORSTOM.

Loucks, D. P., and van Beek, E. (2017). Water Resource Systems Planning and Management: An Introduction to Methods, Models, and Applications (2nd ed.). *Springer International Publishing*. https://doi.org/10.1007/978-3-319-44234-1

Muir, A. M., Hansen, M. J., Bronte, C. R., and Krueger, C. C. (2016). If Arctic charr Salvelinus alpinus is 'the most diverse vertebrate', what is the lake charr Salvelinus namaycush?. *Fish and Fisheries*, 17(4), 1194-1207.

Ndimele, P. E., Kumolu-Johnson, C. A., Aladetohun, N. F., and Ayorinde, O. A. (2010). Length-weight relationship, condition factor and dietary composition of *Sarotherodon melanotheron*, Ruppell, 1852 (Pisces: Cichlidae) in Ologe Lagoon, Lagos, *Nigeria. Agriculture and Biology Journal of North America, 1, 584-590.*

Offem, B. O., Ayotunde, E. O., Ikpi, G. U., Ochang, S. N., and Ada, F. B. (2007). Fisheries and some aspects of the biology of *Sarotherodon galilaeus*, *Tilapia zillii*, and *Tilapia mariae* (Cichlidae) in the Cross River, Nigeria. *Journal of Fisheries International*, *2*(2), 69–73.

Ogunbode, C. A., Ojo, A. S., and Fadare, A. A. (2020). Climate variability and water resources in Ekiti State, Nigeria. *Journal of Geography and Environment*, *8*(1), 22–30.

Olaleye, V. F., and Akinyemi, A. A. (2018). Water use potential of Ureje Reservoir: An assessment of ecosystem services. *Nigerian Journal of Hydrology*, *10*(2), 66–73.

Olaosebikan, B.D. and Raji, A. 2013. Field guide to Nigerian Freshwater Fishes (Revised Edition), Remi Thomas Press, New Bussa, 241pp.

Olopade, O.A., Dienye, H.E., Jimba, B., Bamidele, N. A., and Taiwo, I. O. (2018). Length–weight relationship and condition factor of *Guinean Tilapia*, *Coptodon guineensis* (Günther, 1862) from the New Calabar River and Buguma Creek, Nigeria. *Punjab University Journal of Zoology*, 33(1), 42-46. DOI: http:dx.doi.org/10.17582/pujz/2018.33.1.42.46

Pauly, D. (1984). Fish population dynamics in tropical waters: a manual for use with programmable calculators. *ICLARM Studies and Revision*, 8: 1 – 325.

Pinna, M., Zangaro, F., Saccomanno, B., Scalone, C., Bozzeda, F., Fanini, L., and Specchia, V. (2023). An Overview of Ecological Indicators of Fish to Evaluate the Anthropogenic Pressures in Aquatic Ecosystems: From Traditional to Innovative DNA-Based Approaches. *Water*, *15*(5), 949. https://doi.org/10.3390/w15050949

Sharma, J., Minare, A., Vyas, V., and Garg, R. K. (2024). Length-weight relationships (LWRs) revealing the impacts of multiple conditions factors for sustainable fisheries of four small indigenous fish species inhabiting in wetlands of Bhopal, M.P., India. *Ecology, Environment and Conservation, 30*(04), 1680–1684.

Singh, A. P., Saxena, J., Srivastava, R. K., Trivedi, S. P., and Ratn, A. (2022). Comparative analysis of morphometrics of fish species from river Ganga and Gomti of Uttar Pradesh (India). *International Journal of Fisheries and Aquatic Studies*, 10(5), 119–123. https://doi.org/10.22271/fish.2022.v10.i5b.2735

Soinski, T. A., Costa, M. S., Brambilla, E. M., and Smith, W. S. (2020). Length-weight relationship for two fish species from Ipanema National Forest, São Paulo state, Brazil. *Revista Colombiana de Ciencia Animal – RECIA*, 12(2), e749. https://doi.org/10.24188/RECI A.V12.N2.2020.749.

Subasinghe, R., Siriwardena, S.N., Byrd, K., and Chan, C.Y. (2021). Nigeria fish futures. Aquaculture in Nigeria: Increasing Income, Diversifying Diets and Empowering Women. Report of the scoping study, Penang, Malaysia: *World Fish. Program Report*: 2021-16. Retrieved from https://hdl.handle.net/20.500.12348/4951.

Tariq, S., Shah, T. H., Bhat, F. A., Abubakr, A., Bhat, B. A., Bhat, T., Malik, R., and Chashoo, H. F. (2023). Biometric Assessment of Cyprinus carpio var. Communis from Anchar Lake of Kashmir Valley. *International Journal of Enviornment and Climate Change*, 13(10), 874–880. https://doi.org/10.9734/ijecc/2023/v13i102730

Weatherley, A. H., and Gill, H. S. (1987). *The biology of fish growth*. Academic Press