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Length-weight relationships and condition factor status of fishes in Ozizza and Ndibe rivers in Afikpo, Ebonyi State, Nigeria

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Abstract

This study evaluated the length-weight relationships (LWRs) and condition factor status of fish species from Ozizza and Ndibe rivers in Afikpo North Local Government Area (LGA), Ebonyi State, Nigeria. Earlier studies in these rivers had reported concentrations of manganese and chromium that are beyond standard limits; there was therefore the need to evaluate the suitability of these rivers to support growth of fish species. Samples of fish species caught by anglers were procured at the landing sites of both rivers between the months of May and August, 2019 and used for the study. The fish species were identified using a standard guide. Thereafter, total length (TL), standard length (SL), and weight of the fish species were measured using metre rule and a sensitive weighing balance, as appropriate. The LWRs, condition status and TL-SL relationships of the fishes were calculated using standard protocols. The condition factor status of the fish species from the rivers were assessed by the Fulton condition factor (K) and relative condition factor (K_n). Three fish species were identified: *Clarias anguillaris*, *Tilapia zillii* and eel fish (*Anguilla* spp.). Only the eel fish from both rivers (2.241 – 2.289) and *C. angularis* (2.607) from Ozizza river showed negative allometric growth (< 3). The K values ranged from 0.732 to 1.793 for all other fish species. The K_n values of the fish species ranged from 0.984 to 1.00. Results suggest that factors such as size, state of maturity and environmental factors affect the LWR and K of the eel fish and *C. anguillaris* in the rivers. Further, the K_n values showed that the Ozizza and Ndibe rivers in Afikpo, Ebonyi State, Nigeria, can, at the time of the study, support the growth of the fish species found therein.

Keywords: Fish species; Length-weight relationship; Condition factor status; Growth pattern; Ozizza and Ndibe rivers, Afikpo Nigeria.

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Introduction

Fish constitute an essential human dietary component because of its high protein content (Aniagor *et al.,* 2019). Fisheries, an integral part of Nigeria's agricultural sector, contributed 1.09% of the country's gross domestic product (GDP) in the year 2020 and 0.9% in the third quarter of 2021 (Odioko and Becer, 2021). In recent years, fish has become the favourite source of animal protein in the Nigerian society because of several health reasons. This has led to increase in its demand and the flourishing of fishing business (Ahamed *et al.,* 2017). The Food and Agriculture Organization (FAO) in 2005 reported that in communities living close to rivers, uncontrolled fishing activities take place (FAO, 2005). Apart from the increase in fishing business in Afikpo Rivers, uncontrolled fishing also takes place because of their fishing festivals, the consequence of which is the plummeting of fish stocks (FAO, 2016).

Fisheries management is an aspect of fisheries that seeks among other goals to monitor the biological, ecological, environmental, social and economic factors affecting fish stock in order to adopt a strategy that fulfills the feeding requirements of societies without over-exploiting fish stock (Jisr *et al.,* 2018). In fisheries management, factors that affect fish stock are monitored using morphometric and meristic data of fish species (Mojekwu and Anumudu, 2015; Ethin *et al.,* 2019). Morphometric data of length and weight is used to describe mathematically the relationship between length and weight. The length-weight relationship (LWR) is described by the model $W=aL^b$, where W is weight, L is the length, *a* is the logarithm of the intercept and *b* is the slope; both are linear regression parameters of LWR (Nieto-Navarro *et al.,* 2010). This relationship provides information about the life history, growth pattern, general health, stock assessment and fish population dynamics. It is also useful in ascertaining the morphological characteristics of the fish, comparison of life history of fish from different regions, and as indicators of fatness, general well-being, gonad development of fish and suitability of fish environment (Jisr *et al.,* 2018).

Another essential component in fisheries management is fish condition factor, which is a measure of the physical health of a population of fish based on the fish's relative plumpness or fatness (Ogle, 2016). The condition factor of fish is widely used to understand survival, reproduction, maturity and health of fish, and often, it can be used as a good indicator of water quality or general health of fish populations, which inhabit specific habitat or ecosystem (Ridanovic *et al.,* 2015). The condition of fish can be affected by factors related with length, selection sampling and other long-term features such as environment, food supply and degree of parasitism. In view of these factors, the condition of fish can be analyzed with the aim of measuring the condition factor (K) of a fish in relation to a hypothetical fish, which exhibits isometric growth. It can also be used to measure the deviation of a fish from the average weight in order to assess the suitability of a specific water environment for growth of fish; this is called relative condition factor K_n (Mojekwu and Anumudu 2015; Ethin *et al.,* 2019).

Studies on LWR and condition factor have been well documented for many tropical freshwater fishes in Nigeria. However, there is no published report on the LWR and condition factor of fish species caught from Afikpo rivers in Ebonyi State, Nigeria. Furthermore, Nwani *et al.* (2010) reported that the concentrations of manganese and chromium in Afikpo rivers were beyond the World Health Organization (WHO) limits. The report suggested that fish species in Afikpo rivers may possibly suffer manganese and chromium toxicity, which may be detrimental to their growth and overall health. The aim of this study was, therefore, to determine the length-width relationships, condition factor and relative condition factor of fish species in Ozizza and Ndibe rivers in Afikpo Ebonyi State Nigeria, and thus assess the suitability of these waters to support fish growth.

Materials and Methods

Study area and Period: The study was carried out in the two rivers in Afikpo North Local Government Area (LGA), Ebonyi State, Nigeria: Ozizza river (Latitude 5˚30̍ N and Longitude 7˚40̍ E) and Ndibe river (Latitude 5˚ 40̍ N and Longitude 7˚35̍ N) (Nwani *et al.,* 2010). Ozizza and Ndibe are large towns in Afikpo North LGA (Latitude 5˚53̍ 35̎ N and Longitude 7˚56̍ 14̎ E). The study was done between May and August, 2019.

Fish collection and Biometrics: Samples of fish species from Ozizza and Ndibe rivers were procured from local fishermen as soon as they brought their fish to landing sites of the rivers. Fishing is a major economic activity in Ozizza and Ndibe communities. The fishes were identified using a field guide to Nigerian freshwater fishes (Olaosebikan and Raji, 1998). Total length (TL) and standard length (SL) [measured in cm], and weight (Wt.), in g were measured using a metre rule, measuring board and a sensitive weighing balance, respectively.

Length-Weight Relationship (LWR): The log transformation formula of Le Cren was used to establish LWRs (LeCren, 1951). Using the linear regression of the log transformed equation: log (W) = log (a) + b log (L), the parameters "a" and "b" were calculated, with 'a' representing the intercept and 'b' the slope of the relationship. The 95% Confidence Limits (95% CL) of b were calculated using the equation CL= b ± (1.96 × SE) where SE is the standard error of b. The degree of relationship between the variables was computed by the coefficient of determination (R^2) (Abobi, 2015).

Condition Factor: The fish condition factor was estimated using Fulton's condition index K; K = $100W/L^3$, where W= weight and L= length. The relative condition factor (K_n) of the fishes was also assessed. K_n is defined as Wo/Wc, where Wo is the observed weight, and Wc is the calculated weight. Good growth condition of the fish is deduced when $K_n \geq 1$, while the fish is in poor growth condition compared to an average fish of the same length when $K_n < 1$ (Jisr *et al.,* 2018).

Statistical analysis: The IBM SPSS statistics software, version 20 was used to analyze data. Simple regression was done. In order to verify if the estimated b was significantly different from 3, the student t-test was employed. Level of significance was accepted at $p < 0.05$.

Results

Fish species collected and their Biometrics: Seventy-two fish samples comprising three fish species (12 each) were procured from the local anglers at landing sites of Ozizza and Ndibe Rivers. The fish species were identified as *Clarias anguillaris* (Family: Clariidae), *Tilapia zillii* (Family: Cichilidae), and *Anguilla* spp. (Family: Anguilla) [Figure 1]. This is the first scientific report of *Anguilla* spp. (also called eel fish) at the landing sites of Ozizza and Ndibe rivers in Afikpo North LGA, Ebonyi State, Nigeria. The TL of *C. anguillaris* ranged from 23.1 to 36.1 cm while the weights were between 131.5 to 385.8g for the two rivers. *T. zillii* procured from the two rivers had maximum length and weight of 18.9 cm and 120.7 g, respectively. *Anguilla* had a minimum and maximum TL of 7.5 cm and 38.3 cm respectively while the weight ranged from 6.9 g to 328.6 g (Table 1).

Length-weight relationships of the fish species: Linear regressions of length-weight of fish species of in the Afikpo rivers were significant ($p < 0.05$). The coefficient of determination (R^2) for LWRs for fish species from the different rivers at Afikpo was high and ranged from 0.901 to 0.996. The parameter *b* ranged from 2.241 to 3.093 in Ozizza river and 2.289 to 3.180 in Ndibe river. For the two rivers, *Anguilla* had the lowest *b* value while *T. zilliii* had the highest *b* value. For *Anguilla* from the two rivers and *C. anguillaris* from Ozizza river, the *b* value was significantly ($p < 0.05$) less than 3, indicating negative allometric LWR. The other fish species (*C. anguillaris* and *T. zillii* from Ndibe river, and *T. zillii* from Ozizza river) had *b value* significantly ($p < 0.05$) greater than 3, indicating positive allometric growth (Table 1).

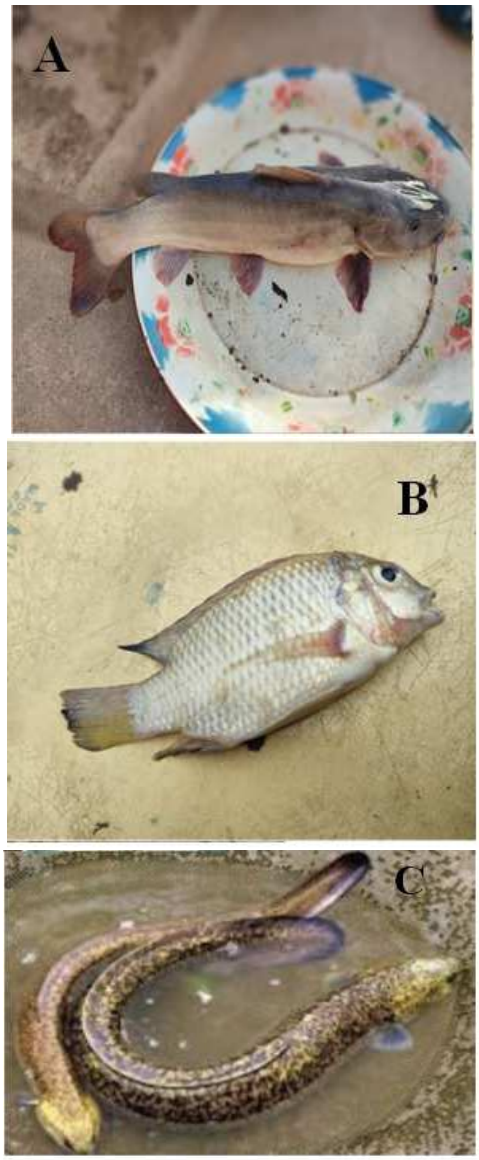

Figure 1. Fish species caught at Ozizza and Ndibe rivers in Afikpo, Ebonyi State, Nigeria. A – *Clarias anguillaris;* B – *Tilapia zillii*, and C – *Anguilla* spp. (Molted eel)

Condition and Relative Condition Factors: The Fulton condition factor (K) ranged from 0.59 to 1.07 for *C. anguillaris*, 1.45 to 2.07 for *T. zillii* and 0.58 to 2.07 for *Anguilla* (Table 2). Generally, the mean K of fish species was higher for fish species procured from Ozizza river than Ndibe river (Table 2). The relative condition factor (K_n) of the fish species were approximately or exactly 1 for both rivers (Table 3).

Total length – Standard length relationships: For all the fish species, the total length – standard length regressions were significant ($p < 0.0001$), with R^2 values ranging from 0.955 to 0.999 (Table 4).

Discussion

This study has shown that fish species brought to landing site of the Ozizza and Ndibe rivers by anglers were *Clarias anguillaris, Tilapai zillii* and the eel fish (*Anguilla* spp.). This is the first report of eel fish collected from these rivers in Afikpo North LGA, Ebonyi State, Nigeria. With the exception of *Anguilla* spp. (eel fish), all fish species recorded in this study have been reported in Afikpo rivers. The eel fish are carnivorous, long-living fish species that spend most of their life as young eels in fresh water, but return to the sea to breed (FAO, 2009). This suggests that the eel fish recorded in this study were young eel fish that migrated to fresh water to feed and were caught by the anglers during fishing.

The *C. anguillaris* from the Ozizza river had a negative allometric growth while the one from Ndibe river had positive allometric growth. The *T. zillii* from both rivers showed positive allometric growth but the eel fish from both rivers had negative allometric growth. For eel fish, the *b* has been described to vary according to seasons. It has been reported that eels are relatively fat during dry season because they can easily hunt their natural food due to shallow depth of water; giving them positive allometric growth during dry season. The eels however present negative allometric growth during the rainy season because of their inability to hunt their prey (Pangerang *et al.,* 2018). This explains the negative allometric growth of the eel fish procured in this study as the study was conducted during the rainy season.

It has been established that growth process can differ in the same species dwelling in different locations, influenced by numerous biotic (e.g. competition and predation) and abiotic factors such as food availability, temperature, and physicochemical variable of the environment

(Jisr *et al*., 2018). Therefore, the difference in allometric growth pattern of *C. anguillaris* procured from the two rivers in Afikpo North LGA may have been influenced by varied factors playing out in the different rivers. The *T. zillii* in this study presented positive allometric growth in both rivers. According to Gusau *et al.,* (2021), positive growth patterns indicate the ability of the fish to adapt and colonize its ecological niche in the water body where it is found. Therefore, the positive allometric growth of *T. zillii* from both rivers in this study suggests they had no significant physical and biological disturbance and are able to adapt to their environment.

Table 1. The length-width relationship (LWR) of fish species caught in Ozizza and Ndibe rivers in Afikpo, Ebonyi State, Nigeria. [SEM – Standard error of mean; CI – Confidence interval]

Rivers	Ozizza river			Ndibe river		
Fish species	*Clarias anguillaris*	*Tilapia zillii*	*Anguilla spp.*	*Clarias angullaris*	*Tilapia zillii*	*Anguilla spp.*
Sample size (n)	12	12	12	12	12	12
Length range (cm)	23.1 – 36.1	7.5 – 18.9	7.5 – 38.3	25.8 – 36.0	7.5 – 18.9	13.4 – 38.3
Weight range (g)	131.5 – 385.8	6.6 – 120.7	6.9 – 328.6	141.1 – 385.8	6.6 – 120.7	17.1 – 328
Constant (a)	0.034	0.014	0.092	0.061	0.012	0.076
Slope (b)	2.607	3.093	2.241	3.108	3.180	2.289
SEM (b)	0.167	0.060	0.146	0.327	0.091	0.192
CI (b)	2.28 – 2.98	2.98 – 3.21	1.95 – 2.53	2.47 – 3.75	3.00 – 3.36	1.91 – 2.67
R^2	0.961	0.996	0.959	0.901	0.992	0.934
T-test significance	0.001	0.003	0.000	0.003	0.018	0.00
Growth pattern	Negative allometry	Positive allometry	Negative allometry	Positive allometry	Positive allometry	Negative allometry

Table 2: The Fulton condition factor (K) of fish species caught in Ozizza and Ndibe rivers in Afikpo, Ebonyi State, Nigeria. [K – Fulton condition factor; SEM – Standard error of mean]

Rivers	Ozizza river			Ndibe river		
Fish species	*Clarias anguillaris*	*Tilapia zillii*	*Anguilla spp.*	*Clarias anguillaris*	*Tilapia zillii*	*Anguilla spp.*
Mean K	0.909	1.712	0.947	0.817	1.793	0.732
Min. – Max. K	0.80 – 1.07	1.45 – 1.98	0.58 – 2.07	0.59 – 0.92	1.45 – 2.07	0.58 – 2.06
SEM of K	0.027	0.042	0.172	0.221	0.060	0.121

Table 3: The relative condition factor (K_n) of fish species caught in Ozizza and Ndibe rivers in Afikpo, Ebonyi State, Nigeria. [K_n – Relative condition factor; SEM – Standard error of mean.]

Rivers	Ozizza river			Ndibe river		
Fish species	*Clarias anguillaris*	*Tilapia zillii*	*Anguilla spp.*	*Clarias anguillaris*	*Tilapia zillii*	*Anguilla spp.*
Mean K_n	1.00	0.987	0.999	0.988	0.984	1.00
Min. – Max. K_n	0.97 – 1.02	0.92 – 1 .05	0.83 – 1.14	0.94 – 1.01	0.91 – 1.04	0.84 – 1.16
SEM of K_n	0.005	0.009	0.023	0.006	0.010	0.020

Table 4: Total length (TL) – Standard length (SL) relationships of fish species caught in Ozizza and Ndibe rivers in Afikpo, Ebonyi State, Nigeria, based on the equation SL = a + bTL.

Rivers	Ozizza river			Ndibe river		
Fish species	*Clarias anguillaris*	*Tilapia zillii*	*Anguilla spp.*	*Clarias anguillaris*	*Tilapia zillii*	*Anguilla spp.*
Constant (a)	- 2.514	- 0.675	- 0.467	- 1.045	- 0.683	- 0.393
Slope (b)	0.906	0.868	0.864	0.851	0.868	0.861
R^2	0.978	0.998	0.999	0.955	0.997	0.998

The *C. anguillaris* and the eel fish from both rivers had K values < 1 while *T. zillii* had K values > 1. Fulton condition factor (K) values less than 1 indicate that the fish is not in good physiological condition, and may also be probably due to factors such as sex, age, state of maturity, size, state of stomach fullness, sampling methods and environmental conditions (Famoofo and Abdul, 2020). The eel fish procured in this study were young eel fish. Therefore, the K values < 1 obtained for the eel fish could be attributed to their size, state of maturity and other environmental factors. However, the K values of the eel fish obtained in this study were higher than values (0.12 – 0.24) reported by Simon (2007) for *A. anguilla* in River Harvel system, Germany, and by Cumaranatunga *et al.* (1997) for *A. bicolor* (0.19 to 0.24) and *A. nebulosa* (0.16 to 0.20) in a river system of southern Sri Lanka. The K values < 1 also obtained for *C. anguillaris* suggest the effect of interaction factors in their environment. The K values for *C. anguillaris* obtained in this study were less than values reported in Ogbei stream, Anambra State, Nigeria by Ibemenuga, (2017) and N'Dri *et al.* (2020) in Lake Bayo, Cote D'Ivoire, where K values of 1.00 and 1.02 to 1.10 were obtained for this fish species, respectively. Although the K values of *T. zillii* in this study were > 1, which indicate a good physiological condition for the fish, the K values were lower than the K values (2.06 to 2.08) reported by Negassa and Getahun (2003) for the same fish species in Lake Zwai, Ethiopia.

The K_n values of all fish species from both rivers was approximately 1. The suitability of fish environment to support their overall fitness is when K_n values are equal to or close to 1. The K_n values obtained in this study for all fish species suggest that although the rivers were reported by Nwani *et al.* (2010) to have concentrations of manganese and chromium beyond standard limits, the river environment can suitably support the growth of fishes found therein at this period of the study.

Conclusion

The LWR relationship of fish species from Ozizza and Ndibe rivers in Afikpo North LGA indicate that except for *T. zillii,* most fish species from these rivers exhibit negative allometric growth and have Fulton condition factor values < 1. The eel fish was also reported for the first time at landing sites of these two rivers in Afikpo North LGA, Ebonyi State. The condition of the rivers is suitable for growth of fish species found therein at the time of this study.

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Conflict of Interest

The authors of this paper report no conflict of interest.

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