

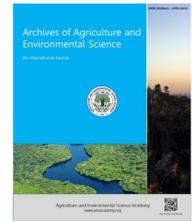


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ORIGINAL RESEARCH ARTICLE



Length-weight relationship and condition factor of *Mugil cephalus* and *Oreochromis niloticus* from a Tidal creek in the Niger Delta, Nigeria

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ABSTRACT

The aim of this study was to assess the length-weight relationship (LWR) and condition factor (K) of *Mugil cephalus* and *Oreochromis niloticus* obtained from a tidal creek in the Niger Delta Nigeria. Six samples of each species were randomly collected monthly (January - December 2015) from fisher men making a total of 144 samples. Samples were immediately taken to the laboratory in ice pack coolers for analysis. The b-values ranged from 0.913-3.172 and 1.624-3.484 while K-values ranged from 0.79-1.07 and 1.01-1.08 for *M. cephalus* and *O. niloticus* respectively. The results indicated positive and negative allometric growth patterns ($b > 3$ & $b < 3$) for the two fish species, a departure from the cub law, but *M. cephalus* exhibited isometric growth pattern ($b=3.003$) during just one month of the study period, a compliance with the cube law. Growth coefficient also had obvious inter and intra specific variation while condition factor did not but indicated wellbeing of fish samples examined. The weight of both fish showed significant difference ($P < 0.01/ P \leq 0.05$) with respect to time while R^2 values indicated strong linear relationship between length and weight. The study concluded that allometric growth pattern observed for the two fish species had both inter and intra specific variation along temporal lines. However, inter and intra specific condition of fish examined was relatively stable across study period suggesting the two different species could have responded to ecological and environmental variables similarly.

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INTRODUCTION

Evaluation of length-weight relationship (LWR) remains a veritable aspect of fish biology. LWR used in combination with fish condition factor has become very useful in aquaculture. According to Silva *et al.* (2015), mathematical models of fish growth give an objective and practical method for describing patterns of growth data and estimating fish weight at times between sampling intervals. Accurate estimations of standing biomass, and therefore, of the amount of feed that must be provided, are vital to aquaculture management. Pauly (1993) reported that length-weight relationships can be used to predict weight from length measurements made in yield assessments while Lizama *et al.* (2002) stated that knowledge of quantitative aspects such as length-weight relationship, condition factor, growth, recruitment, and mortality of fishes are important tools for understanding fish biology. The condition of a fish has been said to reflect recent physical and biological circumstances, due to strong influence by both biotic and abiotic environmental variables, and changes by interaction among feeding habits, parasitic burden and fish physiological conditions (Le Cren, 1951; Olurin and Aderibigbe, 2006). The condition factor in fish also serves as a measure of

the physiological state of fishes in relation to their welfare (Le Cren, 1951; Ighwela *et al.* (2011) and provides information when comparing two populations living in certain feeding density, climate and other conditions (Weatherly and Gills, 1987).) But, fish might show different growth patterns (isometric and allometric) due to water quality, nutrition, habitat, density, sex and time of life stages (Ali *et al.*, 2000). Thus length-weight relationship and condition factor are important parameters for assessing the health condition (Nehemia *et al.*, 2012; Mortuza and Al-Misned, 2013) and also important for understanding the life cycle of fish species and contributes to adequate management of these species and, therefore, to the maintenance of equilibrium in the ecosystem (Lizama *et al.*, 2002). Fish with negative allometric growth, are associated with poor condition, which suggests that the fish becomes more slender as it increases in weight while fishes with appropriate condition factor have isometric growth, which implies that the fish becomes relatively deeper-bodied as it increases in length (Migiro *et al.*, 2014). The condition factor of fish can also be affected by a number of factors such as stress, sex, season, availability of feeds, and other water quality parameters (Khallaf *et al.*, 2003). Hence the condition of a particular

fish is strongly related to the length and weight of the fish vis-à-vis prevailing environmental factors. Condition factor compares both inter- and intra- specific “condition”, “fatness” or wellbeing of fish from the same or contrasting habitats and a useful index for monitoring of feeding intensity, age and growth rates in fish (Oni *et al.*, 1983), which can then be used to assess the quality of the aquatic habitat of the fish. Tilapia (*Oreochromis niloticus*) and mullets (*Mugil cephalus*) are fish of very high economic and commercial value within the Niger Delta and beyond. Such fish are good source of proteins and vitamins and attracts high exploitation due to demand. The aim of this study was to examine the length weight relationship and condition factor of two fish (*Oreochromis niloticus* and *Mugil cephalus*) obtained from the same estuarine creek (Azuabie) in the Niger Delta and compare intra and inter specific condition of the fish samples.

MATERIALS AND METHODS

Study area: The study area is an estuarine creek (Azuabie creek) in the upper reaches of the Bonny estuary in the Niger Delta, Nigeria (Figure 1). The creek has rich fishery resource and is habitat to Tilapia and Mullet, however, impact of human activities is becoming a serious threat the fishery resources of the area. The study area is located on the eastern flank of Port Harcourt city and catches from this area greatly compliments protein demands of city dwellers.

Collection of fish samples: Fresh samples were collected directly from the fishermen on a monthly basis for twelve months (January to December 2015). Six samples were collected for each species of fish per month making a total of 144 samples during the study. The samples were immediately transported in ice pack coolers to the laboratory for analysis.

Laboratory analysis: Excess water from fish body was removed using filter paper before weighing to ensure accuracy (Anderson and Gutreuter, 1985). Total length and weight of fish samples were measured to the nearest 0.1 cm and 0.1 g, respectively. Calibrated meter rule was used to measure fish length while weight of sample was determined with an electronic weighing balance (model- P1203).

Length-weight relationship and condition factor: The Length-Weight relationship was evaluated using the equation $W = aL^b$ (Pauly, 1983). Where W = Fish weight (g), L = Fish length (cm), a = intercept (rate of change of weight with length), b = slope (weight at unit length). Log-transforming the equation ($\log a + b \log L = \log \text{weight} + b \log \text{Length}$) was done to determine ‘a’ and ‘b’. If “b” = 3 then growth is isometric, if not the growth is allometric (>3 = positive allometric growth, <3 = negative allometric growth).

The condition factor of the fish was evaluated from the mean weight and length of the six replicate specimens using the equation, $K = W / aL^b$

Where by K = condition factor; W = fish weight (g); L = Fish total length (cm); b = the value obtained from the length-weight equation.

The exponent ‘b’ value that is equal to 3 was not used to calculate the ‘K’ value because Bolger and Connolly (1989) had stated that it is not a real representation of the length-weight relationship for greater majority of fish species, hence the ‘b’ value was obtained from the estimated length-weight relationship equation ($W = aL^b$) as suggested by Lima-Junior *et al.* (2002). The length-weight relationship and condition factor were calculated irrespective of fish sexes and size.

Statistical analysis: Analysis of variance (ANOVA) using

General linear model was applied to $\log(x+1)$ transformed length and weight data to detect temporal significant differences. Tukey test was used for mean separation while t-Test was used to determine significant difference between coefficient of growth as well as condition factor between the two fish species examined. Ms Excel and Minitab 16 were the software packages used.

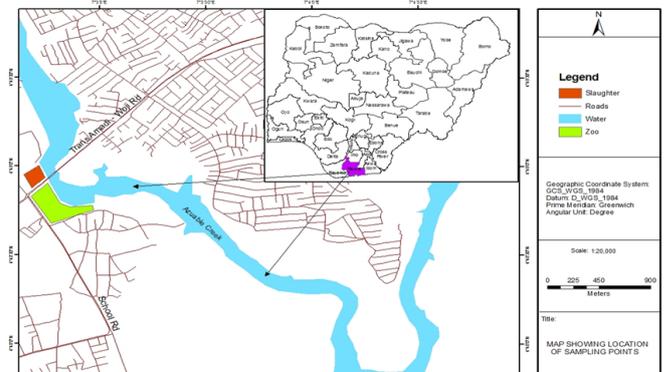


Figure 1. Study site where fish samples were collected (© IOSR 2017).

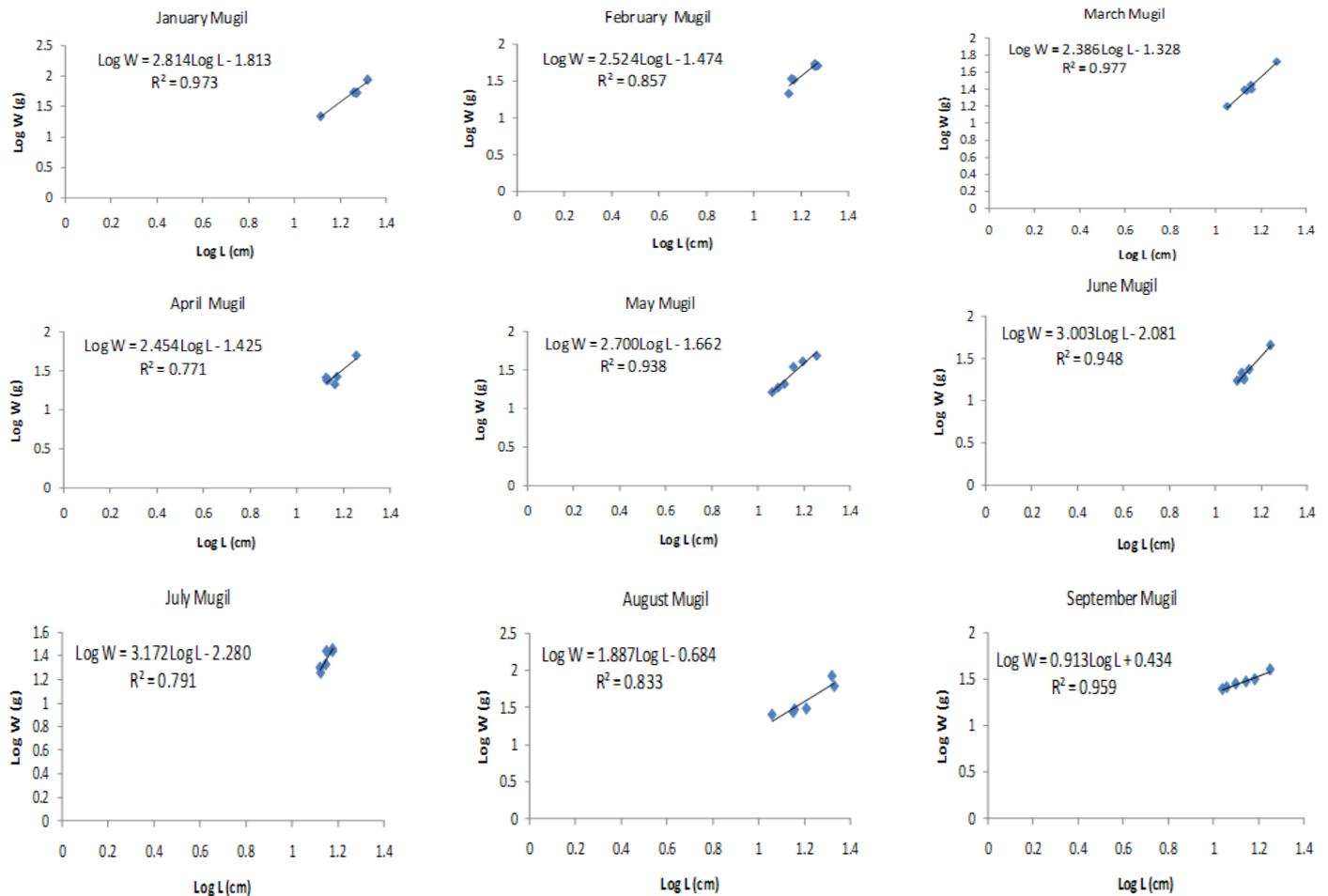
RESULTS AND DISCUSSION

The regression of weight on length of fish samples examined on a temporal basis is given in Figures 2 and 3 for *Mugil cephalus* and *Oreochromis niloticus*, respectively. Temporal trends of b and K -values for both fish is also shown in Fig. 4 while the ANOVA extract with F and P -values is given on Table 1. The growth coefficient (b -value) for *M. cephalus* ranged from 0.913 in September to 3.172 in July showing isometric, positive and negative allometric growth patterns. The b -value for *O. niloticus* ranged from 1.624 in August to 3.484 in February indicating positive and negative allometric growth styles. The b -values for both fish showed temporal variations while the K -values of the fish showed relative stability across the period of study and indicated that both fish were in good condition. Analysis of variance (ANOVA) for weight values of *M. cephalus* was significantly different ($P < 0.01$) while those of length was not ($P > 0.05$) across the period of the study. Post hoc analysis using Tukey test showed that the significance difference in weight occurred thus: January > August = February = November = December = October = September = May = April = March > July = June. Similarly ANOVA for the weight values of *O. niloticus* showed significant difference ($p \leq 0.05$) while those of length did not ($P > 0.05$) but pair wise comparison could not detect where actual difference occurred for weight of *O. niloticus*. Comparison of b -values of both fish using t-Test showed no significant difference ($P > 0.05$) likewise for K -values of both species. The LWR for the two fish species examined was linear and also strongly related as indicated by the R^2 values in the regression equation.

There were variations in the growth patterns of both *M. cephalus* and *O. niloticus* examined across the period of study. Both species exhibited positive and negative allometric growth patterns but isometric growth was only observed in *M. cephalus* during the month of June while the only positive growth pattern for the same species was just in the following month of July. This study found the two fish species not to fulfill the cube law ($b < 3$ & $b > 3$) however, *M. cephalus* seemed to comply with the cube law ($b = 3.003$) during the month of June only. During the month of June, this study found that *Mugilids* retained their body shape and specific gravity in view of isometric growth as suggested by Lagler (1952) and

Wootton (1998) but the remaining period of the study had the *Mugilids* depart from isometric growth which according to Le Cren (1951) could be due to environmental factors or condition of the fish. The observed isometry in this study accords with the findings of Muchlisin *et al.* (2017) who also reported isometric growth with b-value of 3.04 for snapper (*Lutjanus russellii*). The coefficient of growth (b-values) obtained in this study corroborates the findings of Moslen and Uyovbukerhi (2017) in a study of four fish species from commercial landings in Port Harcourt with the following observations; *Mugil* sp. (2.2 - 3.2), *Sardinella* sp. (2.4 - 2.8), *Tilapia* sp. (0.9 - 2.0) and *Arius* sp. (1.5 - 3.1). In another study of four *Mugilids* Zubia *et al.* (2014) observed that *Liza melinoptera* and *Valamugil speigleri* showed negative allometric growth ($b < 3.0$), while *M. cephalus* and *Liza macrolepis* indicated positive allometric growth with b-values greater than ideal value ($b = 3.0$). Oribhabor *et al.* (2009) also reported isometric growth for *Sarotherodon melanotheron* in the Niger Delta which is at variance with the findings of this study. However, findings of this study also agrees with Khawar *et al.* (2015) who found significant relationship between length and weight in their studies of *Mugil incilus*. About 66.6% of the study period showed *Oreochromis niloticus* generally had higher growth coefficients (b-values) compared to *M. cephalus* obtained from the same environment. This implied that the two species examined did not have exactly the same growth pattern even though they were affected by similar environmental factors. In other words intra and inter specific growth pattern was observed in the two species studied due mainly to biological factors and individual fish condition and habit. The generally high b-values obtained in this study conforms with those of Wootton (1998) and Abowei (2010) in their respective studies and revealed that the present condition of *M. cephalus*

and *O. niloticus* in the study area was more suitable for feeding and optimum growth of fish (Zubia *et al.*, 2014). Oribhabor *et al.* (2011) in a study of different fish species in the Niger Delta also reported b-values (0.97 - 5.67) and R^2 (0.22-0.99) within the range of the results observed in the current study. The coefficient of determination R^2 values obtained in this study also corroborate that (0.93) noticed by Shahabuddin, (2015) and those (0.60 - 0.98) recorded by Christina *et al.* (2016) suggesting strong length weight relationships. The condition factor (K) of a fish reflects physical and biological circumstances and fluctuations by interaction among feeding conditions, parasitic infections and physiological factors (Le Cren, 1951). Condition factor of the two species examined was almost the same suggesting very minimal intra and inter specific condition for the two fish species. The reason is that irrespective of the inter and intra species differences both species responded almost the same way to the environmental and ecological factors contributing greatly to the minimal difference between the condition factors of the two fish even when they are different species. The K-values obtained suggested that both fish species examined were in good condition during the study period. The result of this study agrees with the findings of the following studies; Khawar *et al.* (2015 who reported negative allometric growth ($b < 3$) and good condition for *Muil incilus* over a one year study, Moslen and Uyovbukerhi, (2017) who reported good condition ($K = 1.0 - 1.06$) of four fish species in Port Harcourt attributed to favourable ecological conditions for such commercially important fish species around Port Harcourt. Dan-Kishiya, (2013) found k-values of 1.06 - 2.02 while Muchlisin *et al.* (2017) reported ($K = 2.49 - 3.01$) and Datta *et al.* (2013) reported that condition factor further indicates the changes in food reserves and therefore an indicator of the general fish condition.



Figures 2. Contd.

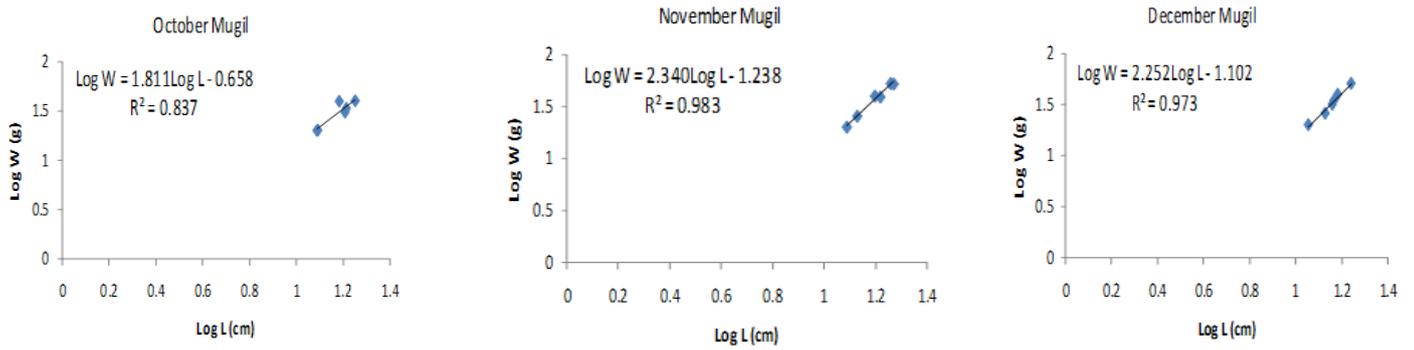


Figure 2. Scatter plots and regression equations for *M. cephalus* during the study periods.

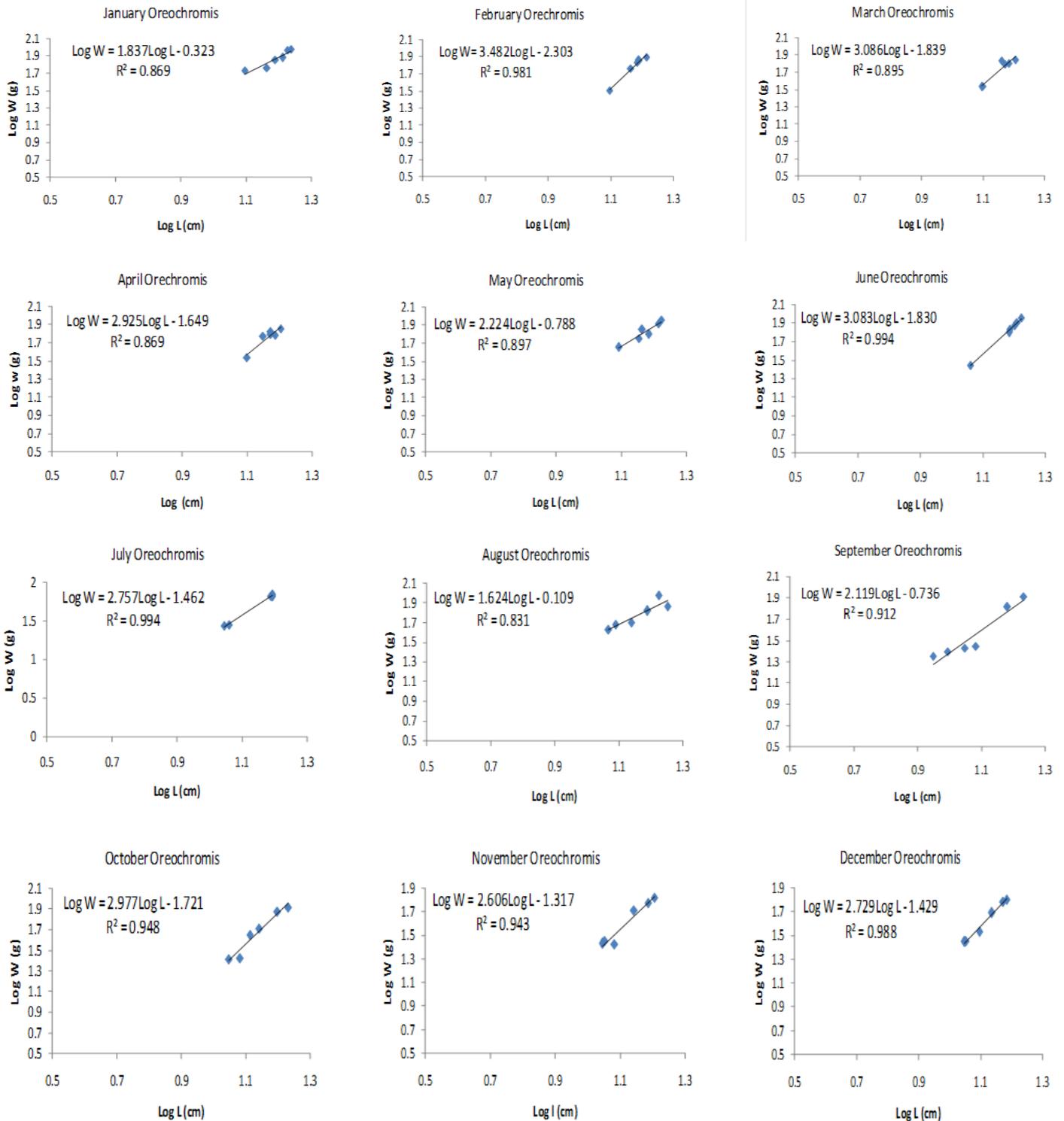


Figure 3. Scatter plots and regression equations for *O. niloticus* during the study periods.

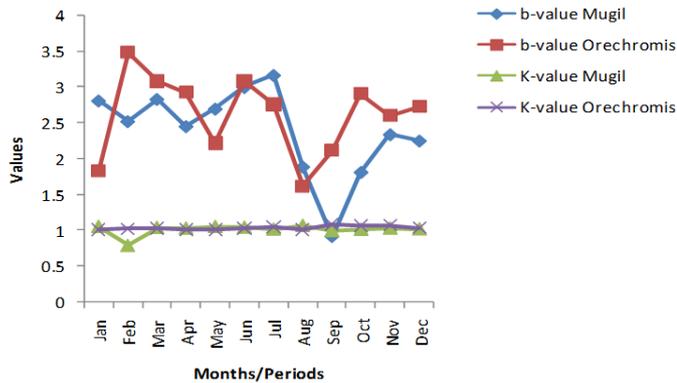


Figure 4. Temporal trends in the b-values and K-values of fish samples examined.

Conclusions

This study concluded that *M. cephalus* and *O. niloticus* observed over a period of one year in a tidal creek in the Niger Delta exhibited negative and positive allometric growth factors with strong length weight relationship. However, only *M. cephalus* showed isometric growth for only one month. Inter and intra specific LWR was obvious but inter and intra specific condition was very minimal due to biological, ecological and environmental factors prevailing in the study creek. The findings of this study also adds to the existing knowledge of biology of the these two species and serve as further guide to prospective aquaculture development in view of the high demand for such fish species of commercial and economic importance.

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Table 1. ANOVA summary with F and P-values.

	F-values	P-values
<i>M. cephalus</i>		
Length	1.79	0.075
Weight	2.72	0.007*
<i>O. niloticus</i>		
Length	1.4	0.197
Weight	1.95	0.05*

* Significant

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