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Research Paper

Length-weight Relationship and Condition Factor of Fish species in Imo River, Rivers State, Nigeria

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Abstract
A 12-month (April 2021-March 2022) study period was used to examine the length-weight relationship and condition factor of several fish species in the Imo River. 13 different fish species were caught during this period in Kono (Station 1) and Opuoko (station 2) respectively. The fishes were taken to the laboratory where their total lengths (cm) and body weights (g) were measured using a measuring tape and an electronic digital scale with the model number TH-901. The length-weight relationship showed that all fish species in the two stations had negative Allometry (b<3) and the condition factor value showed that four species were in poor condition. Sardinella maderensis (K=0.78 ±0.15) in Opuoko (Station 2), Chrysichthys nigrodigitatus (K=0.90 ± 0.14, K=0.88 ±0.13), Ethmalosa fimbriata (K=0.87 ± 0.23, K=0.90 ±0.24) and Polydactylus quadrifilis (K=0.57 ±0.09, K =0.58 ±0.07) in Kono and Opuoko respectively. The mean condition factor values of the fishes harvested at the two stations showed a significant difference (p<0.05) across species. In conclusion, the Imo River features a wide variety of fish species in abundance. Although certain commercially significant species were discovered to be in poor health condition, it's vital to monitor the river's environmental conditions in order to safeguard and conserve the fish species found in the river system.
Keywords: *Negative Allometry, Condition Factor, Stock Assessment, Length-Weight, Imo River*

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I. INTRODUCTION

Fish is a significant source of animal protein, accounting for 20% of all animal protein (Seiyaboh *et al.*, 2016). They also include other crucial nutrients that body needs, making them one of the least expensive sources of extremely nutritious protein (Adaka*et al.*, 2015). Fish can be caught in the wild or in concrete and earthen ponds (Ogbe *et al.*, 2019). Length-Weight Relationship of fish can reveal essential details about their habitat as well as important hints about climatic and environmental changes and shifts in human subsistence practices. Evaluation of Length-Weight relationship(LWR) is a crucial component of fish ecology (Moslen and Miebaka, 2017). The length-weight ratio of fish varies depending on the conditions of life in the aquatic environment, according to Bashir *et al*. (1993). The relationship between length and weight can alter during life cycle events including transformation, growth, and the beginning of maturity, much like other morphometric parameters might (Le Cren, 1951). In fishery science, the study of length-weight is crucial since it helps to comprehend the general health and growth patterns of a fish population. Fish body length and body weight are two helpful empirical variables in stock evaluation, population ecology, community, and ecosystem ecological studies (Giarrizzo *et al.*, 2015). Length-Weight relationships can be used to create yield equations, estimate the quantity of fish landed, and compare population over time and place (Beverton and Holt, 1957). The mathematical parameters describing the relationship between fish length and weight provide additional details on how an individual's weight varies in relation to their length (Ndiaye *et al.*, 2015).

Condition factor reflects variance and offers information on the physiological state and welfare of fish (Olanrewaju *et al.*, 2017). The condition factor is an index that illustrates how biotic and abiotic factors interact to affect the physiological state of fishes. The condition factor (K) is used in fisheries to compare the 'condition' health of the fish (Alex and Adeyemo, 2021). Fish health in aquatic environments can be impacted by a variety of factors, including lack of food, predation, competition, intense fishing, changes in physico-chemical parameters, spawning and pollution (Abowei, 2009). Tropical inland waters, such as the Imo River, have a vast diversity of fish species and are important to the economy of Rivers State and Nigeria. Olaosebikan andRaji (2013) reports that there are 316 fish species in Nigeria's inland waters, with 50 families represented. The majority of these species are endangered (Ciruna *et al.,* 2004) thus prompting our investigation into the length-weight relationship and condition factors of fish species in the Imo River, Rivers State, in an effort to provide details on their growth pattern and wellbeing.

II. MATERIALS AND METHOD

2.1 Description of Study Area

The investigation was carried out in Khana Local Government Area of Rivers State at Kono (Station 1) and Opuoko (Station 2) along the Imo river. Accessibility and the availability of various fish species influenced the selection of sampling locations. Oyigbo in the North, Opobo in the South, Andoni and Gokana in the West, and Ikot-Abasi in the East form the boundaries of the sampling sites. The sampling sites in the villages of Kono and Opuoko are along the Imo River. The main aquatic vegetation near the stations is Nypa palm, a species of palm that is unique to the Imo River basin. The vegetation along the creeks consists of *Avicennia germinas, Conocarpus erectus* and *Languncularia racemosa,* and mangrove *Rhizophora mangle, R. harrisonii, R. racemosa, Avicennia*. Aside from fishing, people also use the estuary for transportation and settlements. The alternating wet and dry season give the climate its character. April through October is the rainy season, but November through March which is the dry season, sees intermittent precipitation (NMA, 2008). Mud flats sediments are present at both high and low tide in the water course, however the tidal ranges change from month to month.

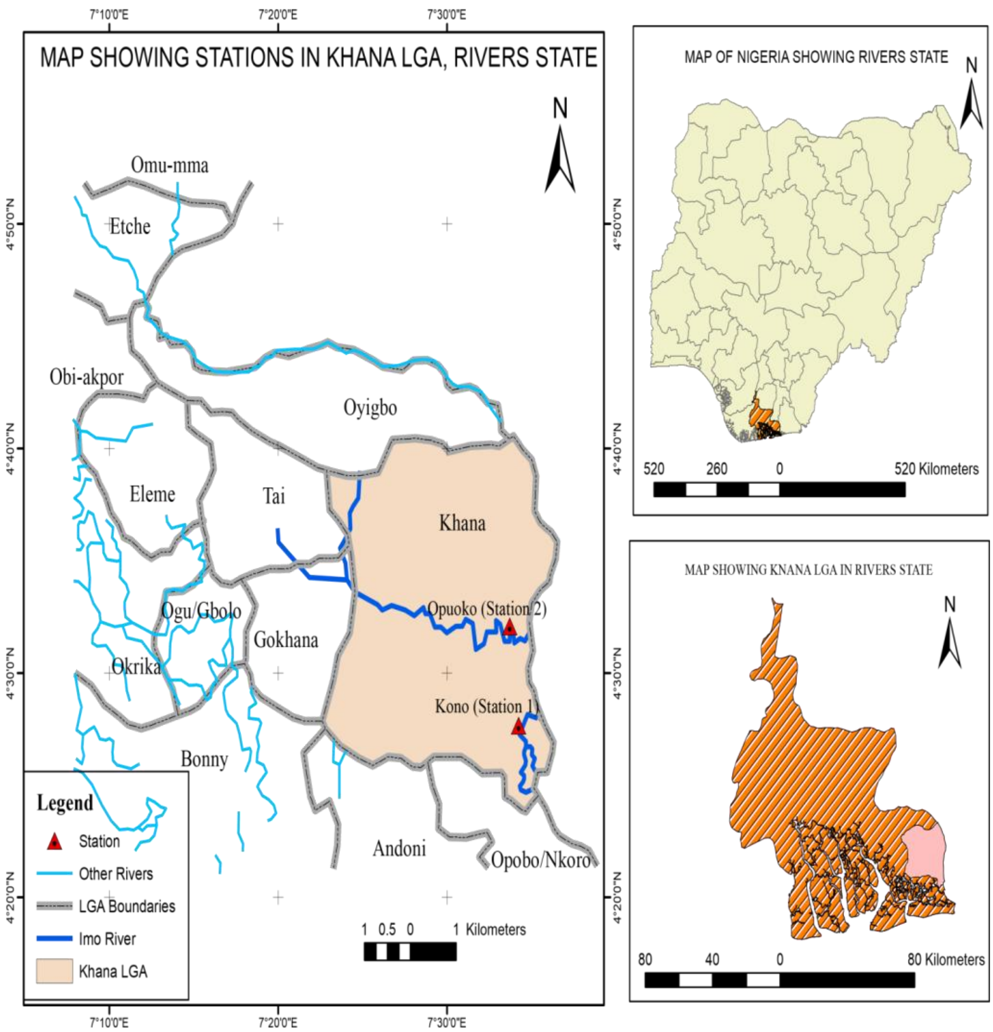

Fig. 1: Map showing the sampling stations in Imo River Estuary

2.2 Fish Harvest and Identification

Fish samples of different species were sampled over the course of a year (April 2021- March 2022) at Kono (station 1) and Opuoko (station 2) along the Imo River. The fish were caught with the assistance of artisanal fishermen using both active and passive gears like; gill net, trammel net, single hook and line, long hook and line, wire and basket traps. The specimens were immediately transported to the department of Animal and Environmental Biology Laboratory at Rivers State University for identification after being stored in a cooler with proper labelling and ice. When the fish specimens from each sampled stations arrived at the laboratory, they were identified to species level using fish identification references such as; Reed *et al.* (1967), Skelton (1993), Idodo-Umeh (2003).

2.3 Measurement and Calculation of Length/Weight Relationship/Condition Factor

A digital electronic scale with the model number TH-901 was used to weigh fish samples of the various species that were caught in Kono and Opuoko respectively to the nearest 0.1g. Using a measuring tape with accuracy to the nearest 0.1mm, the total length of the fish samples was recorded.

The length-weight relationship was computed from the formula described by Bagenal and Tesch (1978) and Pauly (1984). Thus: $W = aL^b$

Where: W = Weight of fish

L = Total length of fish

b = Exponent (or regression coefficient).

a = Constant (or regression intercept)

The above equation was converted to log transformation as follows:

$\mathrm{Log}_{10} W = a + b \mathrm{Log}_{10} L$

Where W=body weight of the fish (g)

L= total body length of the fish (cm)

a and b = values estimated by regression formula

a = Intercept at Y and X

b = Slope or regression coefficient

Following data linearization, each species' b allometric constant was determined to be either isometric, If b= 3; positive allometric, if b >3; and negative allometric, if b<3.

The Condition Factor (K), was used to assess the relative well-being of the fish and calculated as follow:

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

Where K = Condition factor

K= Fulton's Condition Factor

W = Observed weight of the fish (g)

L = Observed total length of the fish (cm)

2.4 Statistical Analysis

Microsoft Excel was used to compile the data from this study, calculate the condition factor, and create a scatter plot showing the length-weight relationships of the fish samples. The Anova ($p<0.05$) and Turkey tests were done using Minitab version 16 software

III. RESULTS

The results from this study revealed that the growth exponent (b) for fish species harvested in Kono varied from 0.38 (*Polydactylus quadrifilis*) to 2.56 (*Ethmalosa fimbriata*). Generally, all the fishes exhibited negative allometry since the slope (b) deviated significantly (b<3) from isometry (3). The coefficient of determination (r^2) between length-weight of fish species harvested in Kono varied from 0.332 (P*olydactylus quadrifilis*) to 0.900 (*Caranx hippos*) (Table 1). Similarly, the growth exponent (b) for fish specimens in Opuoko landing site differed significantly (b<3) from isometry (3). They all exhibited negative allometry; their values ranged from 0.37 (*Pomadasys jubelini*) to 2.80 (*Chrysichthys nigrodigitatus*). Coefficient of determination (r^2) between length-weight of fish species harvested in Opuoko varied from 0.292 (*Pomadasys jubelini*) to 0.840 (*Chrysichthys nigrodigitatus*) (Table 2). The mean condition factor of fish species in Kono landing site ranged from 0.57 (*Polydactylus quadrifilis*) to 3.65 (*Pellonula vorax*). Majority of the fish species where in good physiological condition except for *Chrysichthys nigrodigitatus* (K = 0.90), *Ethmalosa fimbriata* (K = 0.87), *Liza falcipinnis* (K = 0.75), *Polydactylus quadrifilis* (K = 0.57) and *Sardinella maderensis* (K = 0.77) that were in poor condition (Table 1).

In Opuoko, the condition factor of fish species ranged between 0.58 (*Polydactylus quadrifilis*) and 2.02 (*Liza falcipinnis*). Four species; *P. quadrifilis* (K = 0.57), *S. maderensis* (K = 0.78), *C. nigrodigitatus* (K = 0.88) and *E. fimbriata* (K = 0.90) had K value (<1) indicating poor condition while the other species were in good condition (K>1) (Table 2). There was significant variability (p<0.05) noted in the mean condition factor values of fish species across stations.

Table 1: Length-Weight Relationship and Condition factor of Fish species in Kono

Species	a	b	K ± S.D	R^2	Growth Pattern
Caranx hippos	-0.441	1.647	1.34^{f} ± 0.30	0.900	Negative Allometry
Chrysichthys nigrodigitatus	-1.348	2.503	0.90^{i} ± 0.14	0.836	Negative Allometry
Ethmalosa fimbriata	-1.544	2.599	0.87^{j} ± 0.23	0.601	Negative Allometry
Gerres nigri	+0.417	0.715	1.10^{g} ± 0.28	0.821	Negative Allometry
Liza falcipinnis	-0.345	1.604	0.75^{k} ± 0.13	0.721	Negative Allometry
Lutjanus dentatus	-0.202	1.724	1.80^{c} ± 0.35	0.723	Negative Allometry
Lutjanus goreensis	+0.220	1.271	1.60^{d} ± 0.44	0.642	Negative Allometry
Monodactylus sebae	-0.628	2.069	2.43^{b} ± 0.70	0.845	Negative Allometry
Pellonula vorax	-0.423	2.025	3.65^{a} ± 0.98	0.783	Negative Allometry
Polydactylus quadrifilis	+1.077	0.381	0.57^{m} ±0.09	0.332	Negative Allometry
Pomadasys jubelini	+1.245	0.421	1.48^{e} ± 0.35	0.368	Negative Allometry
Pseudotolithus elongatus	-0.026	1.352	1.09^{h} ± 0.27	0.471	Negative Allometry
Sardinella maderensis	-0.109	1.149	0.77^{l} ± 0.14	0.709	Negative Allometry

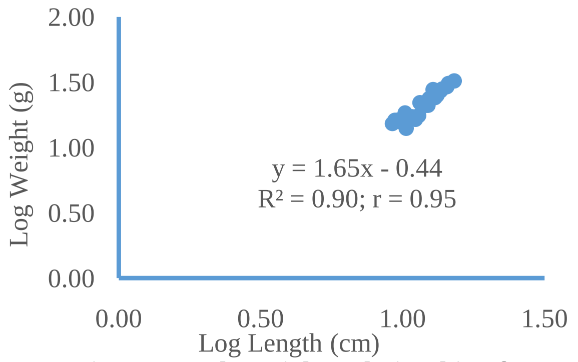

Fig. 1: Length-Weight Relationship of *Caranx hippos* (n=23) in Kono Landing Site

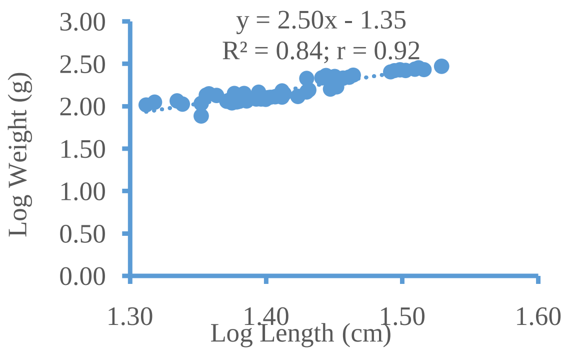

Fig. 2: Length-Weight Relationship of *Chrysichthys nigrodigitatus* (n=53) in Kono Landing Site

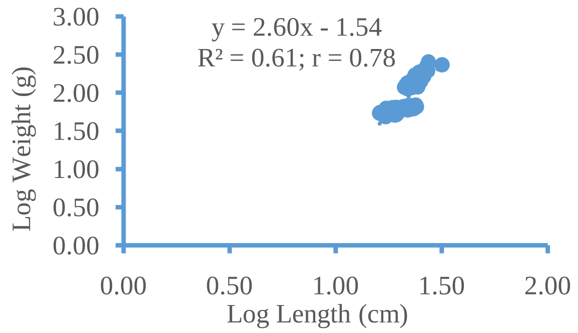

Fig. 3: Length-Weight Relationship of *Ethmalosa fimbriata* (n=174) in Kono Landing Site

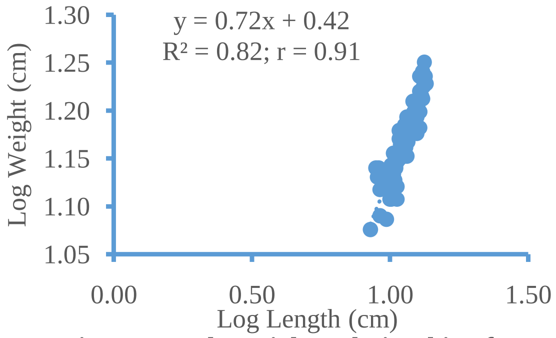

Fig. 4: Length-Weight Relationship of *Gerres nigri* (n=86) in Kono Landing Site

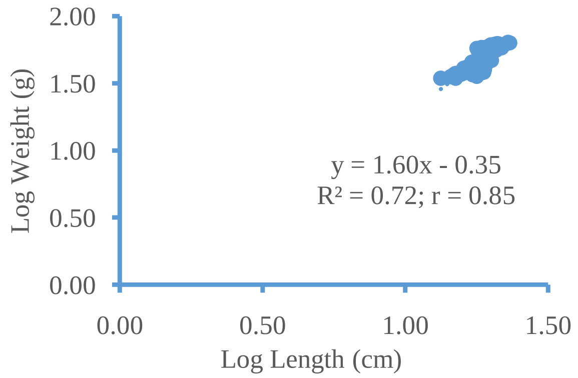

Fig. 5: Length-Weight Relationship of *Liza falcipinnis* (n=180) in Kono Landing Site

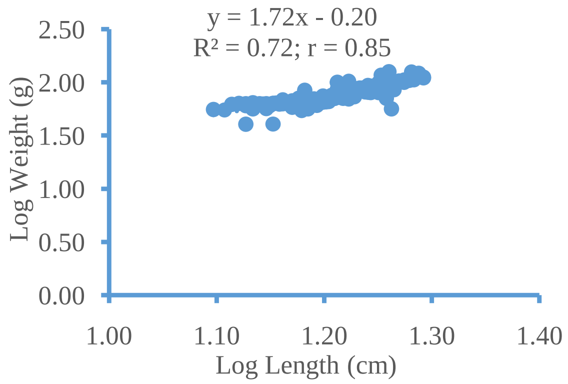

Fig. 6: Length-Weight Relationship of *Lutjanus dentatus* (n=130) in Kono Landing Site

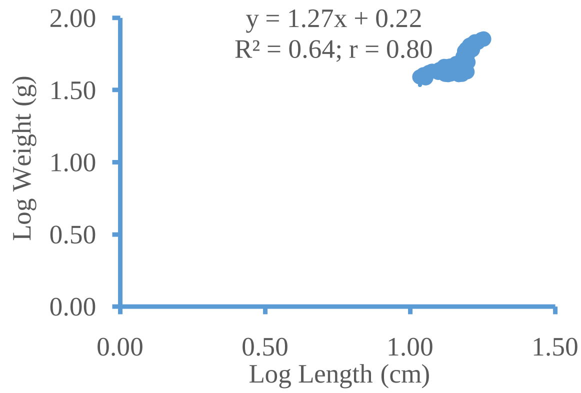

Fig. 7: Length-Weight Relationship of *Lutjanus goreensis* (n=71) in Kono Landing Site

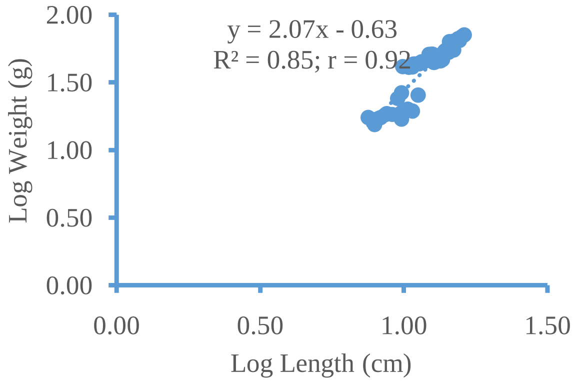

Fig. 8: Length-Weight Relationship of *Monodactylus sebae* (n=55) in Kono Landing Site

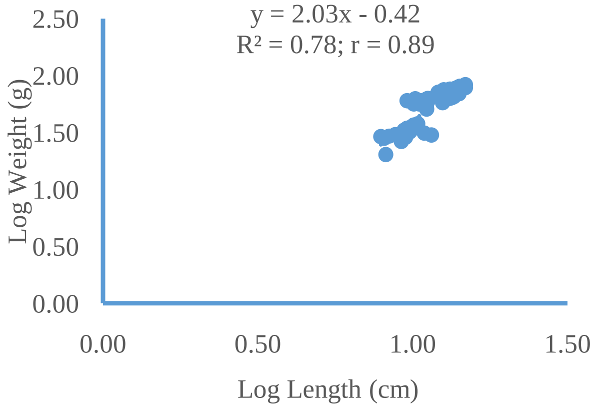

Fig. 9: Length-Weight Relationship of *Pellonula vorax* (n=75) in Kono Landing Site

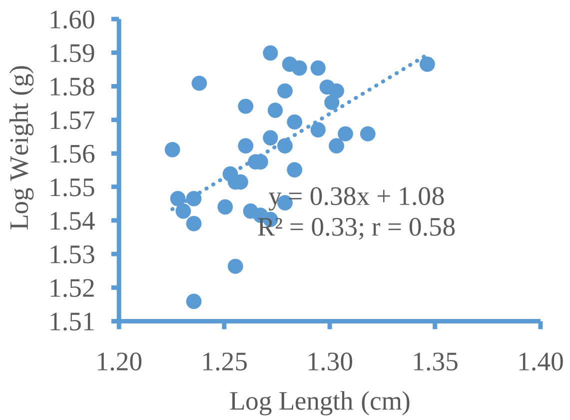

Fig. 10: Length-Weight Relationship of *Polydactylus quadrifilis* (n=40) in Kono Landing Site

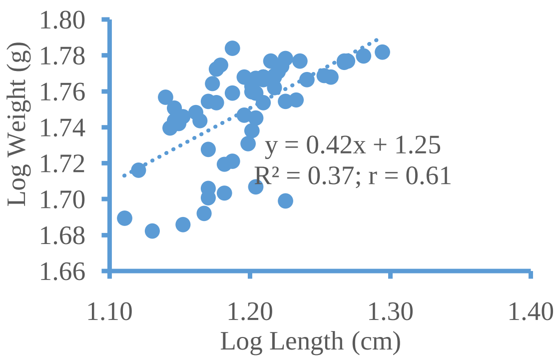

Fig. 11: Length-Weight Relationship of *Pomadasys Jubelini* (n=61) landed in Kono

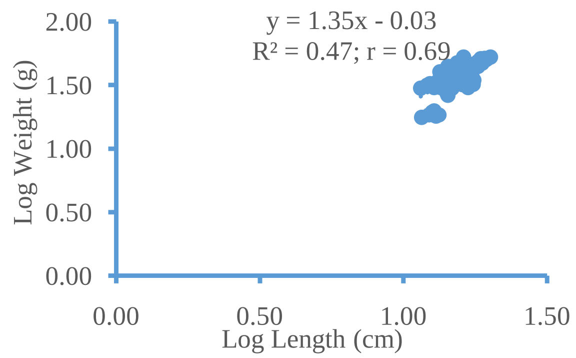

Fig. 12: Length-Weight Relationship of *Pseudotolithus elongatus* (n=126) in Kono Landing Site

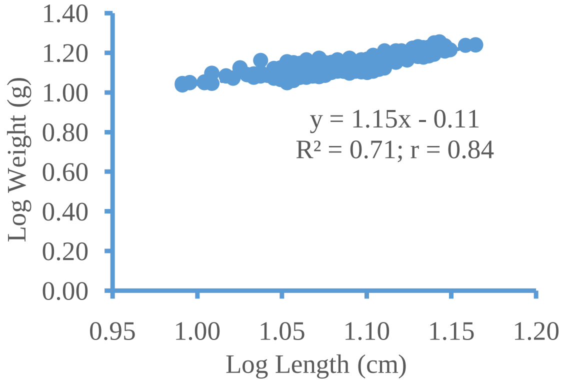

Fig. 13: Length-Weight Relationship of *Sardinella maderensis* (n=152) in Kono Landing Site

Table 2: Length-Weight Relationship and condition factor of fish species in Opuoko

Species	a	b	K ± S.D	R^2	Growth Pattern
Caranx hippos	-0.346	1.557	$1.38^e \pm 0.29$	0.803	Negative Allometry
Chrysichthys nigrodigitatus	-1.780	2.803	$0.88^i \pm 0.13$	0.840	Negative Allometry
Ethmalosa fimbriata	-1.646	2.686	$0.90^h \pm 0.24$	0.627	Negative Allometry
Gerres nigri	+0.410	0.724	$1.14^f \pm 0.30$	0.773	Negative Allometry
Liza falcipinnis	-1.030	1.821	$2.02^a \pm 2.17$	0.614	Negative Allometry
Lutjanus dentatus	-0.250	1.778	$1.85^b \pm 0.32$	0.861	Negative Allometry
Lutjanus goreensis	+0.143	1.321	$1.49^c \pm 0.31$	0.344	Negative Allometry
Polydactylus quadrifilis	+0.924	0.507	$0.58^k \pm 0.07$	0.334	Negative Allometry
Pomadasys jubelini	+1.306	0.369	$1.43^d \pm 0.36$	0.292	Negative Allometry
Pseudotolithus elongatus	+0.058	1.286	$1.11^g \pm 0.28$	0.478	Negative Allometry
Sardinella maderensis	-0.023	1.073	$0.78^j \pm 0.15$	0.720	Negative Allometry

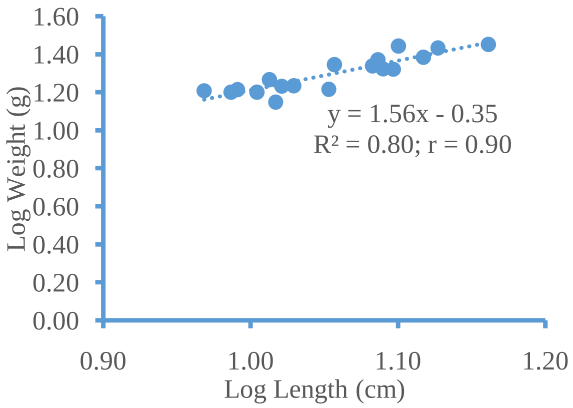

Fig. 14: Length-Weight Relationship of *Caranx hippos* (n=18) in Opuoko Landing Site

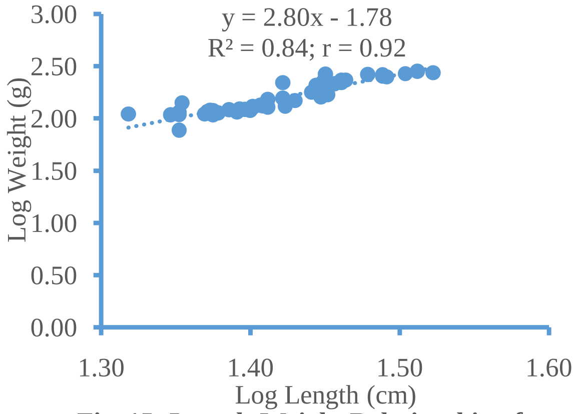

Fig. 15: Length-Weight Relationship of *Chrysichthys nigrodigitatus* (n=45) in Opuoko Landing Site

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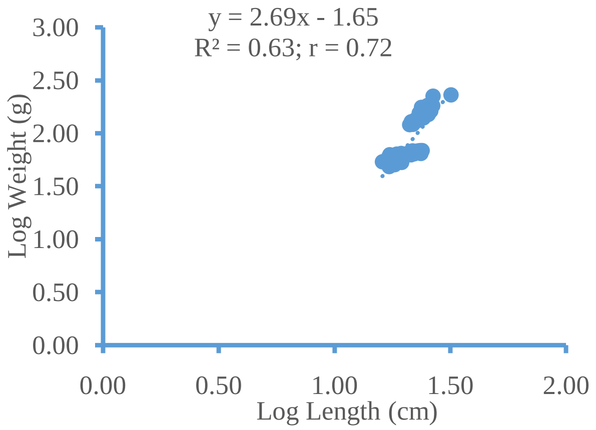

Fig. 16: Length-Weight Relationship of *Ethmalosa fimbriata* (n=65) in Opuoko Landing Site

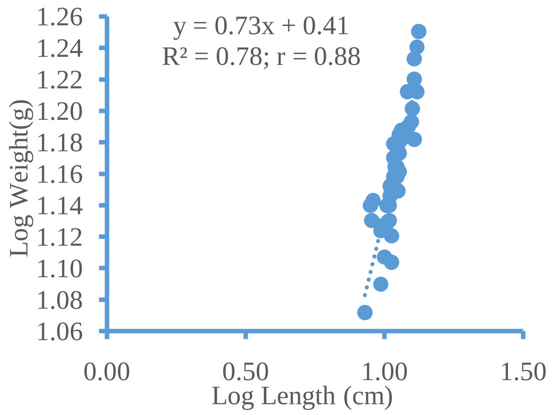

Fig. 17: Length-Weight Relationship of *Gerres nigri* (n=45) in Opuoko Landing Site

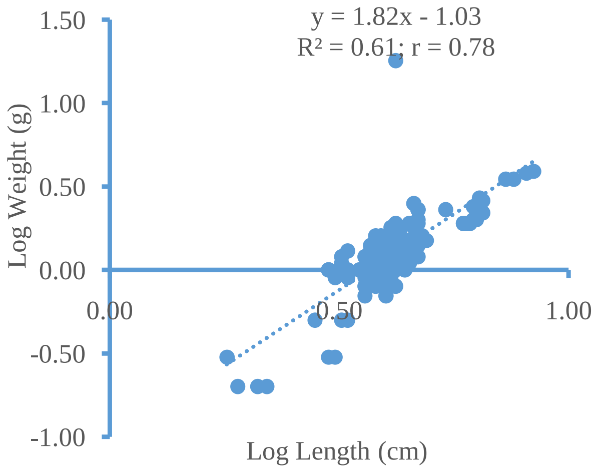

Fig. 18: Length-Weight Relationship of *Liza falcipinnis* (n=122) in Opuoko Landing Site

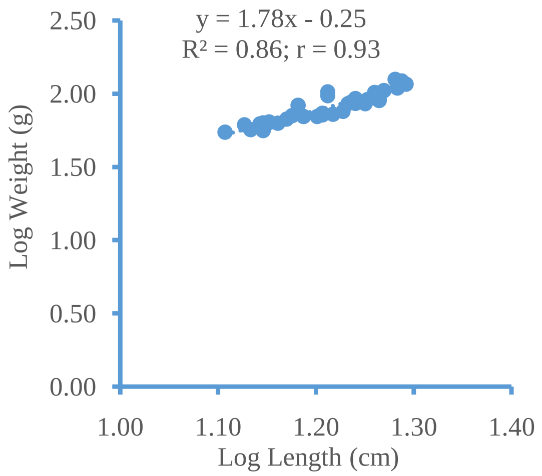

Fig. 19: Length-Weight Relationship of *Lutjanus dentatus* (n=42) in Opuoko Landing Site

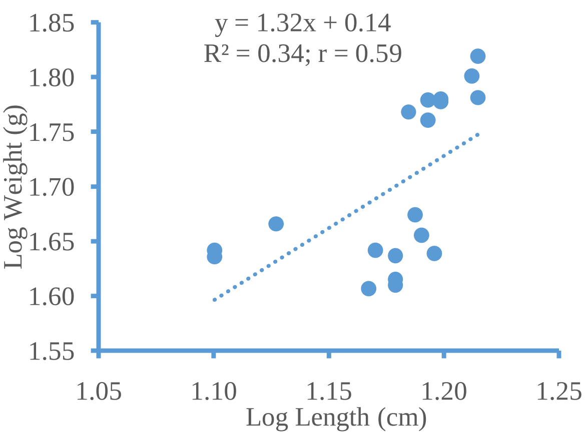

Fig. 20: Length-Weight Relationship of *Lutjanus goreensis* (n=19) in Opuoko Landing Site

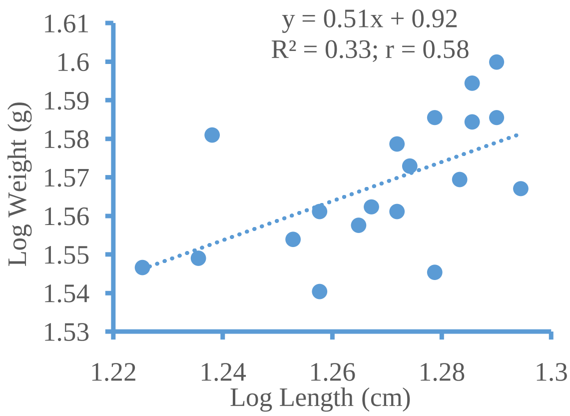

Fig. 21: Length-Weight Relationship of *Polydactylus quadrifilis* (n=19) in Opuoko Landing Site

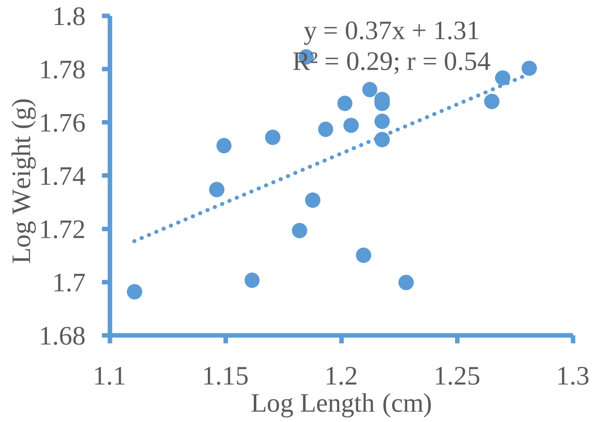

Fig. 22: Length-Weight Relationship of *Pomadsys jubelini* (n=22) in Opuoko Landing Site

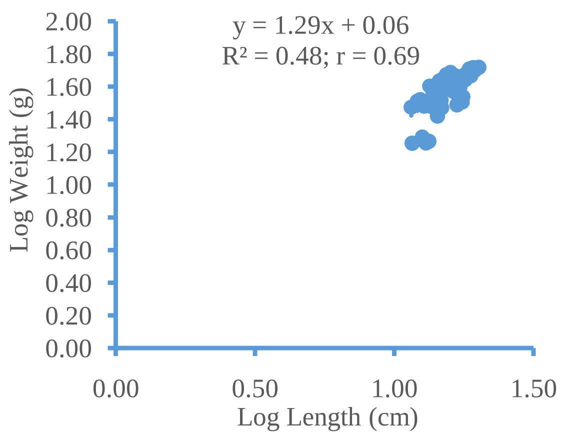

Fig. 23: Length-Weight Relationship of *Pseudotolithus elongatus* (n=96) in Opuoko Landing Site

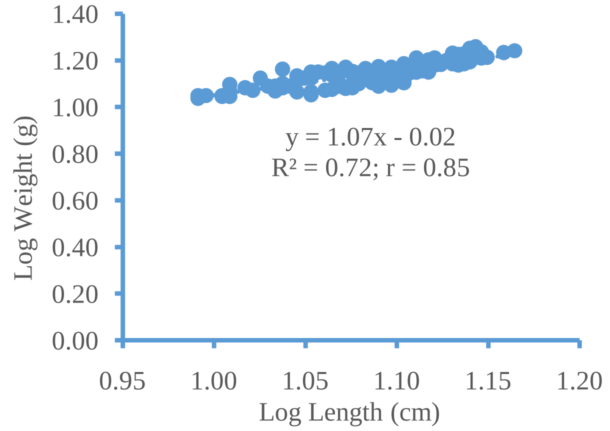

Fig. 24: Length-Weight Relationship of *Sardinella maderensis* (n=125) in Opuoko Landing Site

IV. DISCUSSION

The Length-weight relationship (LWR) is a crucial tool for learning about the growth trends of different fish species (Ighwela *et al.*, 2011). According to Fafioye and Ayodele (2018), b-values in length-weight relationships have been used to analyse fish growth patterns, which are said to vary between stocks of the same species (Ndome *et al.*, 2012). Negative allometric growth in fish is indicated when the "b" value is less than 3. A value of more than 3 denotes a positive growth pattern (Alam *et al.*, 2014). All of the fish species in Kono and Opuoko displayed negative Allometry (b<3) in the current study. Similar research was conducted by Seiyaboh *et al.* (2016) in the Sangana River, Niger Delta, where they reported negative allometry for *Mugil cephalus*, *Caranx latus* and *Polydactylus quadrifilis*. *Chrysichthys nigrodigitatus* and *Sardinella maderensis* have both been found to have negative allometry in the Ogun coastal estuary, according to Abdul *et al.* (2016). Similar to this, *Chrysichthys nigrodigitatus* and *Schilbe mystus* in Erelu lake, Oyo state were found to have negative allometry according to Kareem *et al*. (2015). For a number of fish species in Nigeria, however, positive Allometry has been documented. In a brackish water body in Badagry, Agboola and Anetekhai (2007) reported finding positive allometry for *Mugil cephalus*, *Pellonula leonensis*, *Monodactylus sebae* and *Polydactylus quadrifilis*. Similar to this, Ude *et al.* (2011) reported positive allometry for the following species in the Ebonyi River: *Alestes imberi*, *Tilapia guineensis*, *Heterotis niloticus* and *Oreochromis niloticus*. The allometric relationship between the fish species in the two study sites suggests that the fish become thinner as their length increased (King, 1996). The age, sex, and fecundity of the fishes, the sampling methods and sampling sizes, as well as the current ecological condition in the water body at different times (Adaka*et al.,* 2015), may all be factors in the discrepancies between the exponential growth pattern (b) observed between this study and other studies that showed a contrary exponential growth pattern (b). In Kono, the coefficient of determination (r^2)

between the total length and weight of fish species ranged from 0.292 (*Pomadasys jubelini*) to 0.840 (*Chrysichthys nigrodigitatus*) and from 0.38 (*Polydactylus quadrifilis*) to 2.56 (*Ethmalosa fimbriata*) in Opuoko indicating both strong negative and strong positive relationships between the fish species in the two stations. In the current study, it was found that *Lutjanus goreensis*, *Polydactylus quadrifilis*, *Pomadasys jubelini* and *Pseudotolithus elongatus* all had negative relationships, whereas the other species had higher degrees of positive relationships. The consequence is that the rate of increase in weight is smaller than the rate of increase in length for fish with positive relationships, and vice versa for fish with negative relationship between total length and weight (Obasohan *et al.*, 2012).

The condition factor reflects the fish population's physiological state, productivity, and overall health (Richter, 2007). Any condition factor K > or equal to 1 indicates that the fishes are in good condition or have a high nutritional state, according to Bagenal and Tesch (1978). In this study, four species (*Chrysichthys nigrodigitatus*, *Ethmalosa fimbriata*, *Polydactylus quadrifilis* and *Sardinella maderensis*) had K < 1 in Opuoko, indicating poor conditions, compared to three species (*Chrysichthys nigrodigitatus*, *Ethmalosafimbriata* and *Polydactylus quadrifilis*) that had K < 1 in Kono. The condition factor value of other species at the two stations was greater than 1(K > 1) indicating that the fish were in good condition. Environmental factors in the water body may have had an impact on the physiological condition of the fish species, contributing to the bad condition factor observed in the two stations (Olanrewaju *et al.,* 2016). Compared to species in poor condition, those in good condition enjoyed better environmental conditions (Kareem *et al.*, 2015).

V. CONCLUSION

This research on the length-weight relationship (LWR) and condition factor has shed light on the health of the various fish species in the estuary of the Imo River. the fishes in Kono and Opuoko all exhibited negative allometry. Overall, four species were in poor condition. *Sardinella maderensis* in Opuoko, *Chrysichthys nigrodigitatus*, *Ethmalosa fimbriata*, and *Polydactylus quadrifilis* in Kono, and Opuoko respectively; other species in the two stations were in good condition. Therefore, to support the production of healthy fish stock and improve fisheries production in the area, it is advised for effective sustainable fish stock management and monitoring of the water quality.

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