

Condition factor and length weight relationship of bycatch of artisanal fisheries in Qua Iboe River estuary landed at Ibeno, Niger Delta, Nigeria

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ABSTRACT

Artisanal fishers' landings of trawled bycatch were sampled for six calendar months from Qua Iboe River estuary, Ibeno, Niger Delta in Nigeria to determine condition factor (K) and length weight relationship (LWR). Specimens were washed, sorted and identified. Results revealed that species composition was made up of 14 families, 19 genera and 22 species. Majority of the species encountered had high body condition factor (13 species; 59.09%) while the rest (9 species; 40.91%) had low condition factor. The species of fish with highest K-value were *C. lippie* and *L. laevigatus* with 3.59 whereas *T. lepturus* was the species with the least value (0.92). The exponents, b values of some of the fish were less than 3, indicating negative allometric growth pattern while others were greater than 3, which indicated positive allometric growth pattern. The correlation coefficients (r) whose values ranged from 0.10 to 0.97 in all the fish species showed a high degree of positive correlation ($P < 0.05$) between their TL and TW. For the sustainable management of these species within offshore waters and in order to achieve maximum sustainable yield, recommendations have been suggested. This study updated more information to the existing data.

KEYWORDS: Well-being, length weight relationship, bycatch, Qua Iboe River estuary, offshore waters, fisheries

INTRODUCTION

In tropical and subtropical waters, the growth fluctuation is more frequent in fishes due to variation in seasons, multiple spawning and food composition (Das *et al.*, 1997). Length-weight relationship (LWR) of fish is an important fishery resource management tool for both applied and basic uses and also for comparing life history and morphological aspects of populations inhabiting different regions (Goncalves *et al.*, 1997), estimating the average weight at a given length group (Beyer, 1987) and assessing the relative well-being of a fish population (Bolger and

Connolly, 1989). The study of LWR in fish helps to determine the mathematical correlation between two variables and calculate the variation from the expected weight for length of the individual fish (Le Crens, 1951; Wotton, 1996). They are also useful in fishery management (Pitcher and Hart, 1982) to estimate weight from length observations, calculate production and biomass of a fish population and/or provide information on stocks or fish conditions at the corporal level (Hossain *et al.*, 2006).

Furthermore, LWR helps to evaluate the condition, reproduction, life cycle and general health of the fish species (Pauly, 1993). The relationship studies give important information in fishery assessment for predicting weight from length required yield assessment and monitoring sustainable yield (Garcia *et al.*, 1998). LWR is thus, an important tool in fisheries, biology, physiology, ecology, assessment (Oscor *et al.*, 2005).

The condition factor is used to compare the condition, fatness or well-being of the fish and is based on the hypothesis that heavier fish of a given length is in a better condition (Bagenal and Tesch, 1978). Condition factor will help determine present and future population success by its influence on growth, reproduction and survival (Hossain *et al.*, 2006). It has been used as an index of growth and feeding intensity (Fagade, 1979). It has been found to decrease with increase in length (Fagade, 1979; Bakare, 1970) and influences the reproductive cycle in fish (Welcomme, 1979). The relationship between length and weight can be used to assess the well-being of individual and to determine possible differences between separate unit stocks of the same species (King, 2007).

Artisanal fisheries is a small scale fisheries whose gear is generally simple and hand operated (hooks, gillnets, traps and baskets), its craft is simple and traditional (planks, dug-out wooden boats) and catches are very important (in local, national and sometimes international trades). FAO, (1975) described artisanal fisheries as being labour intensive and conducted by artisanal craftsmen whose level of income, mechanical sophistication, quantity of production, fishing range, political influence, market outlets, employment and social mobility and

financial dependence keep them subservient to the economic decision and operation constraints placed upon them by those who buy their products. At present, the in/offshore sector constitutes a highly productive and intensively exploited zone of Nigeria's continental shelf. This intended effort can lead to resource depletion and collapse of the fisheries, if adequate management measures are not taken on time to control the rate of exploitation and protect immature fish. Hence, the Federal Government took the following management measures: limit to the size of the vessels, establishing minimum cod-end mesh size (stretched) of not less than 70 mm for fish trawlers and 44 mm for shrimpers, licensing of fishing vessels to fly the nation's flag before it is allowed to fish in the territorial waters and areas subjected to fishing restrictions, prohibitions, among others as management policies (FAO, 2007).

Many investigations had been carried out about LWR of fish and condition factor in Nigerian waters (Fagade, 1979; Lebo *et al.*, 2010; Kumolu-Johnson and Ndimele, 2010; Omogoriola *et al.*, 2011; Oribahbor *et al.*, 2011; Olopade and Tarawallie, 2014; Oscar and Emeka, 2016; Dienye and Olopade, 2018; Famoofo and Abdul, 2018) and in Akwa Ibom State (King, 1996; Brownson, 2015; Ekpo and Effanga, 2018). There is scanty information on the condition factor and length weight relationship of the different fish species occurring as bycatch fisheries landed at Ibeno Beach (Brownson, 2015) (one of the most important coastal estuaries in Akwa Ibom State). So, the present investigation is an attempt to update documentation on the LWR and condition factor on the multispecies bycatch which will definitely help the fisheries researchers, planning and policy makers for the sustainability and management of the species in the offshore waters.

Procurement of fish samples, preservation, identification and measurement

Monthly fish samples were procured from coastal trawled fishery by artisanal fishers through their representatives i.e. the fish mammals. Samples were collected once a month for 6 calendar months from March – August 2015. The specimens were transported in plastic buckets to the Fisheries Laboratory, Department of Fisheries and Aquatic Environmental Management, University of Uyo, Uyo. The procured fish samples were first sorted out into different groups, rinsed and preserved in 10% formaldehyde solution and labeled accordingly. All preserved samples were removed from the formaldehyde solution and thoroughly washed with clean water to reduce the effect of the chemical. They were placed slanting with the mouth facing downward to enable the draining of the remaining fluid to ensure that the weights of the specimens were not influenced. Identification of the fish samples to the species level was aided by the use of keys such as FAO (1981, 1990) and Edwards *et al.*, (2001). Each specimen was measured to the nearest 0.1 cm total length using a 1-50 cm wooden measuring board as the distance from the tip of the snout to the end of the caudal fin and weighed to the nearest 0.1 g total weight on a top loading Sartorius ‘PT’ 600 balance.

Statistical analysis

SPSS (version 19) package was used to determine the means, range, one-way ANOVA and Duncan Multiple Range Tests. Microsoft Excel 2010 was used for graphical illustrations of all parameters.

Length Weight Relationship (LWR)

This is a mathematical transformation used to determine how weight is related to length of

a particular fish. It also helps in prediction of potential yield and determination of size at captured for obtaining optimum yield (Lawson, 2010). The relationship between the length and weight of the fish were established using the parabolic equation according to Froese, (2006):

$$W = aL^b \text{ -----(1)}$$

Where:

W = Weight of fish (g); L= Length of fish (cm); a = Constant and, b = an exponential expressing the relationship between length and weight.

This relationship when converted into the logarithmic form gives a straight line relationship graphically thus:

$$\text{Log } w = \text{Log } a + b \text{ Log } L \text{ ----- (2)}$$

Where:

a = constant and b = slope of the line

Condition Factor

Condition factor (K) indicating the well-being of fish was calculated using the formula below:

$$K = \frac{100W}{L^3} \text{ -----(3)}$$

Where:

K = Condition factor; W = Weight (g); and L = Total length (cm)

The condition factor of a fish is regarded as the fitness or relative well-being of the fish and it indicates the general metabolism of the fish (Sambilay, 1990). Condition factor depends on how well a fish feeds and generally, it is believed that small-sized individuals feed more than the larger ones. Therefore, fishes with condition factor values greater than one (≥ 1) were considered as high while those < 1 were considered low.

RESULTS

Species composition of the trawled by-catch at Ibeno was made up of 14 families, 19 genera and 22 species.

Condition factor (K)

Majority of the species encountered had high body condition (13 species; 59.09%) while the rest (9 species; 40.91%) had low condition factor values as shown in Fig. 2. The thirteen fish species namely; *Eucinomastomus melanopterus* (1.01), *Hemicaranx bicolor* (1.01), *Melanopterus drepane* (1.06), *Chaetodipterus lippie* (3.59), *Lagocephalus laevigatus* (3.59), *Lutjanus fulgens* (1.34), *Epinephelus goreensis* (1.21), *Decapterus rhonchus* (1.53), *Drepane africana* (1.58), *Pseudopenaeus prayensis*

(1.58), *Cynoglossus senegalensis* (1.88), *Illisha africana* (3.58) and *Sardinella aurita* (1.26) had high body condition values while low condition values were recorded in nine species such as *Ethmalosa fimbriata* (0.99), *Trichiurus lepturus* (0.54), *Pseudotolithus elongatus* (0.98), *P. senegalensis* (0.95), *Lutjanus endecacanthus* (0.91), *Selene dorsalis* (0.60), *Epinephelus aeneus* (0.90), *Chrysichthys nigrodigitatus* (0.87) and *Tetraodon fahaka* (0.88). The fish species with highest K-value were *C. lippie* and *L. laevigatus* with 3.59 whereas *T. lepturus* was the species with the least value (0.54).

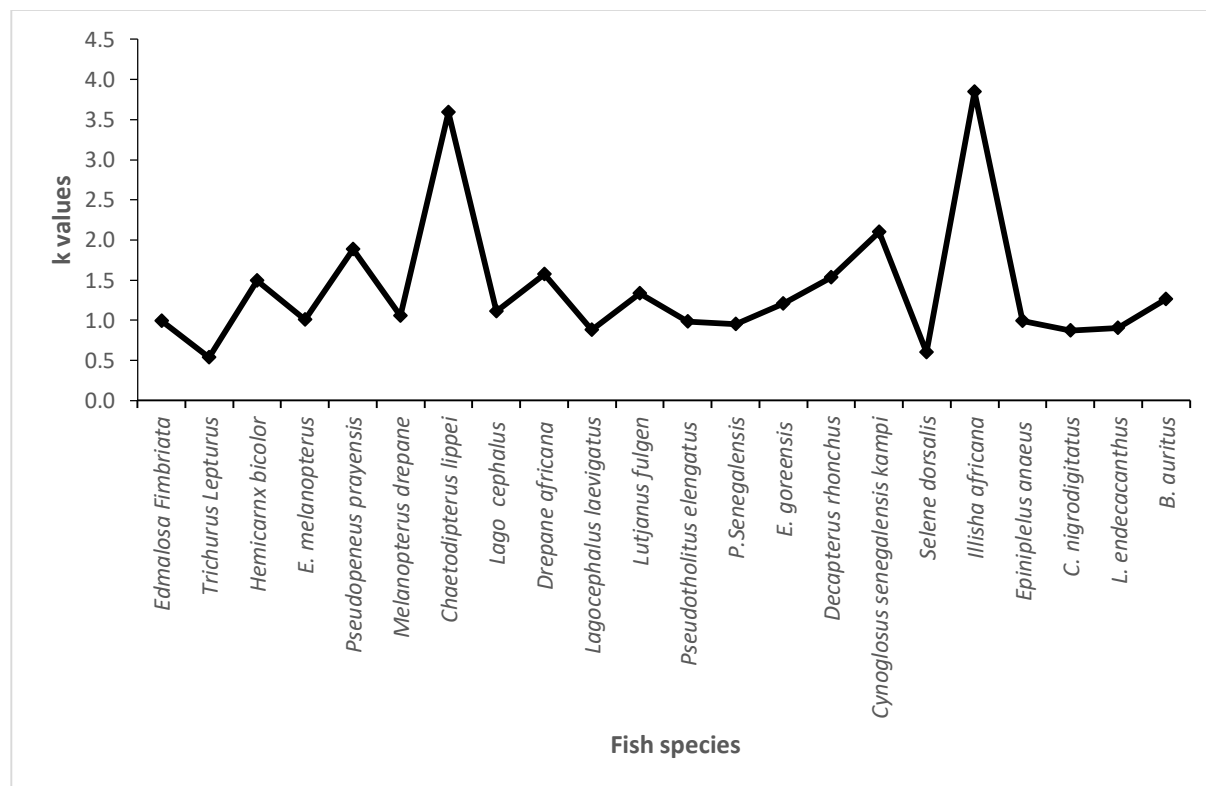


Fig. 2. Mean condition factor values for the trash fish species landed in Ibeno beach, Nigeria

Length-Weight Relationship (LWR)

T. lepturus had the highest values with TL range of 50.0 – 58.0 cm and TW range of 55.6 – 122.6 g, *L. laevigatus* was next with 15.0 – 35.0 cm while TW ranged from 58.2 – 162.0 g (Table 1). However, the least was *C.*

nigrodigitatus with TL of 7.0 – 10.5 cm and a corresponding TW of 11.3 – 12.0 g.

The 95 % confidence interval values of the regression coefficients (a and b) and the correlation coefficient (r) were also presented in Table 1. The intercept, a values of the

fishes were (2.11) *D. africana*, (3.83) *H. bicolor*, (1.12) *C. lippie*, (0.50) *C. nigrodigitatus*, (0.29) *L. laevigatus*, (2.19) *M. drepane*, (2.15) *C. senegalensis*, (0.20) *S. dorsalis*, (2.42) *E. fimbriata*, (0.92) *T. lepturus*, (2.19) *E. melanopterus*, (1.63) *P.*

elongatus, (2.39) *P. senegalensis*, (0.44) *E. goreensis*, (4.79) *D. rhonchus*, (0.61) *P. prayensis*, (0.21) *I. africana*, (1.95) *E. aeneus*, (0.24) *L. endecacanthus*, (2.36) *S. aurita*, (1.23) *T. fahaka* and (2.15) *L. fulgens*.

Table 1: Total length and total weight ranges and length-weight relationship parameters of trash fish landed at Ibeno, Nigeria

Fish Species	N	TL, cm ranges		TW, g ranges		a	b	r	R ²
		Min	Max	Min	Max				
<i>Ethmalosa fimbriata</i>	15	13.0	17.2	7.2	34.4	2.42	1.29	0.86	0.72
<i>Trichiurus lepturus</i>	18	50.0	58.0	55.6	122.6	0.92	0.34	0.93	0.87
<i>Eucinomastomus malanopterus</i>	36	10.5	17.6	22.8	49.5	2.19	0.27	0.73	0.55
<i>Hemicaranx bicolor</i>	7	13.5	16.1	30.2	71.6	3.83	2.81	0.97	0.94
<i>Melanopterus drepane</i>	10	12.0	17.0	25.0	55.3	2.19	1.06	0.84	0.71
<i>Chaetodipterus lippie</i>	4	8.0	17.2	34.4	56.8	1.12	0.43	0.80	0.66
<i>Lagocephelus laevigatus</i>	6	15.0	55.0	58.2	162.0	0.29	1.24	0.37	0.14
<i>Pseudotolithus elongatus</i>	34	12.5	16.6	18.3	40.2	1.63	0.41	0.54	0.35
<i>P. senegalensis</i>	78	8.5	17.2	7.2	36.5	2.39	1.34	0.90	0.83
<i>Epinephelus goreensis</i>	110	15.0	16.4	28.0	38.0	0.44	1.58	0.82	0.67
<i>Decapterus rhonchus</i>	38	14.0	15.5	24.0	25.3	4.79	3.96	0.58	0.47
<i>Drepane africana</i>	10	12.0	17.0	25.0	56.3	2.11	3.34	0.56	0.58
<i>Pseudopenaeus prayensis</i>	73	14.0	18.0	120.0	210.0	0.61	0.88	0.10	0.01
<i>Selene dorsalis</i>	20	12.2	18.1	18.2	32.5	0.20	1.55	0.13	0.79
<i>Cynoglossus senegalensis</i>	67	15.0	23.2	30.0	40.0	2.15	0.86	0.59	0.36
<i>Epinephelus aeneus</i>	40	14.3	15.7	26.2	21.3	1.95	0.34	0.93	0.91
<i>Illisha africana</i>	65	12.0	18.0	91.5	293.5	0.21	1.63	0.80	0.02
<i>Chrysichthys nigrodigitatus</i>	7	7.0	10.5	11.3	12.0	0.50	0.87	0.40	0.12
<i>Lutjanus endecacanthus</i>	35	12.0	18.1	24.9	75.0	0.24	1.20	0.14	0.02
<i>Lutjanus fulgens</i>	4	12.0	18.1	34.4	56.8	2.15	0.90	0.63	0.39
<i>Sardinella aurita</i>	39	16.0	17.0	34.8	38.9	2.36	1.20	0.72	0.92
<i>Tetraodon fahaka</i>	7	26.0	28.0	15.6	361.1	1.23	0.27	0.76	0.32

The corresponding exponent, b values were presented in Table 1. Thus, the b-values ranged from 0.27 in *E. melanopterus* and *L. laevigatus* and 3.96 in *D. rhonchus*. The exponents of some of the fish were less than 3, indicating negative allometric growth pattern while others (*D. rhonchus* and *D. africana*) were greater than 3, which indicated positive allometric growth pattern.

The correlation coefficients (r) whose values ranged from 0.10 to 0.97 (Table 1) showed that not all species had high degrees of positive correlation ($P < 0.05$) between their TL and TW. A greater number (17) of the species (*E. malanopterus*, *M. drepane*, *C. lippie*, *L. laevigatus*, *P. elongatus*, *E. goreensis*, *D. rhonchus*, *D. africana*, *P. prayensis*, *S. dorsalis*, *C. senegalensis*, *I. africana*, *C. nigrodigitatus*, *L.*

endecacanthus, *L. fulgens*, *S. aurita* and *T. fahaka*) had correlation coefficient (r) for their length-weight relationship to be low which indicated increase in length with no increase in weight. However, the remaining 5 species (*E. fimbriata*, *T. lepturus*, *H. bicolor*, *P. senegalensis* and *E. aeneus*) revealed high correlation coefficient (r) for the length-weight relationship of the fishes indicating that an increase in length corresponded with an increase in weight.

DISCUSSION

The length-weight parameters of same species may be different in the population because of factors such as feeding, reproduction activities, fishing, etc., which can be frequently used in the analysis of ontogenic changes. Wild variability in parameter estimates for a single species occur when comparing length weight relationships found in literatures (Frota *et al.*, 2004). This has been attributed to the fact that the LWR is affected by many factors related to population variability and to sampling and estimation methods. Sampling-related factors include sample size, length distribution in the sample and type of length measure, while nutritional conditions account for intrinsic biological variability (Ricker, 1975). Furthermore, LWRs allow life history and morphological comparisons between different fish species or between fish populations from different habitats and/or regions.

The correlation coefficients, r ranged from 0.10 in *Pseudopenaeus prayensis* to 0.97 in *Hemicaranx bicolor*, indicating that a combination of negative and positive allometry growth patterns obtained among the bycatches landed in Ibeno Beach. *P. senegalensis* had a , b and r values of 2.39, 1.34 and 0.90 while those of *P. elongatus* were 1.63, 0.41 and 0.54 respectively. In

agreement with this finding are Olopade and Tarawallie (2014); Famoofo and Abdul (2018) who showed that *P. senegalensis* showed a positive allometry growth pattern in the coastal water in Sierra Leone. *E. aeneus* had a high correlation coefficient of 0.97 in the study. Furthermore, Olopade and Tarawallie (2014) opined that the combined LWR for both sexes of *P. senegalensis* showed their b and r values to be -2.57 , 3.35 and 0.899 respectively. However, this is not in agreement with Oribahbor *et al.*, (2011) in which this species was reported to have very low r (0.22). The disparity may be due to variability in population, estimation and sampling duration and methods. Taiwo and Olopade (2017) reported that significant ($P < 0.01$) relationship exists between weight and length of by-catch species from industrial shrimp trawl fishery in Nigerian coastal waters.

The exponent, b ranged from 0.27 in *Tetraodon fahaka* to 3.96 in *Decapterus rhonchus*. In confirmation to the findings of this study, Hile (1936) and Martin (1949) reported that the value of ' b ' usually ranges between 2.5 and 4.0. By negative allometry ($b < 3$), the fish is said to be lighter for its length as it grows and positive allometry ($b > 3$), the fish gains weight as it grows (Dienye and Olopade, 2018). The change of b values depends primarily on the shape and fatness of the species although other factors may be responsible for the differences in the parameters of the length weight relationship among seasons and years such as temperature, salinity, food, sex, time of year and stages of maturity (Pauly, 1984; Olopade and Tarawallie, 2014). In the present study, the length weight relationship of the fishes examined showed that the b -values fall within and without (i.e. 0.26–39.3) reported limits for the fishes elsewhere: 2.0–4.0 in Lagler *et al.*, (1977); 0.97–5.67 in Oribahbor

et al., (2011) in the brackishwater fish species in the Niger Delta mangrove creek; 2.1–2.99 in Kumolu-Johnson and Ndimele (2010) in the Ologe Lagoon in Lagos; 3.35 in Olapade and Tarawallie (2014) in the coastal water of Sierra Leone; 0.94–4.12 in Brownson (2015) in the trash fishery landed in Qua Iboe River estuary in Ibeno; 1.067 to 3.41 in Famoofo and Abdul (2018) in the Lekki Lagoon. LWR of fish species vary greatly among regions, fishes and authors (Frota *et al.*, 2004). This is because LWRs are affected by population variability factor or due to sampling and estimation methods.

The result showed that the condition factor of *P. elongatus* was 1.63 while it was 2.83 for *P. senegalensis*. Thirteen fish species recorded high body wellbeing while nine had low K. The K-values of the bycatch ranged from 0.54 in *T. lepturus* to 3.59 in *C. lippie* and *L. laevigatus*. However, Famoofo and Abdul (2018) obtained K values between 0.80 and 1.28 in the Lekki Lagoon. Olapade and Tarawallie (2014) revealed that the condition factor varied from 0.64–1.0; attributing this range to environmental conditions of the water. Condition factor of different species of sciaenid fish have been reported by Jayasankar (1990, 1994); Omogoriola *et al.*, (2011); Sharma and Ansari (2010). In similar study, Dienye and Olapade (2018) observed that apart from *Sphyraena barracuda* general wellbeing of the twenty-two fish species were found to be good, as indicated by the values of condition factor, which were nearer to or greater than 1 in the New Calabar River.

CONCLUSION

A record of the fish length and weight from different habitats for proper management decision is of outmost significance. Sustainable management of the species also requires that the environment where the fish grows be protected against human anthropogenic perturbations. Thus, the following recommended policies should be upheld according to Ajayi and Talabi (1984):

- ✓ Regulation of effort and fishing capacity: restriction on fishing gear, restriction on fishing areas/closed areas, vessel licensing, removal of subsidies, distribution of fishing effort and consultative arrangements.
- ✓ Fisheries resources monitoring: ensure that adequate data on effort and capacity used in harvesting the nation's fisheries resources are collected and collated for its sustainable management, search and rescue operations for distressed fishing vessels, sea patrol and surveillance to ensure compliance with fishing regulations and monitoring of the resource to enable it advise Government on the state of the resource.

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