Length-Weight Relationship and Condition Factor of Fish Species Caught by Cast Net in New Calabar River, Nigeria

Henry Eyina Dienye[1*] and Olaniyi Alaba Olopade[1]

[1]*Department of Fisheries, Faculty of Agriculture, University of Port Harcourt, Choba, P.M.B.5323, Nigeria.*

Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

Original Research Article

ABSTRACT

The length -weight relationship and condition factor (K) of fish species caught by cast net were studied from three stations in the New Calabar River, Rivers State, Nigeria. A total of 1541 specimens of 26 fish species and representing 11 families were randomly collected using cast net with mesh sizes of 1.5 and 2.5 cm. Sample sizes of the different fish species examined in this study ranged from 8.79±0.25 cm (*Caranx hippos specie*) to 31.48±4.93 cm (*Sphyraena barracuda specie*) in total length and 15.45±0.40 g (*Elops lacerta*) to 156.00±39.30 g (*Pelmatolapia mariae*) in weight. The entire length-weight data in all the three stations were pooled together and the calculated correlation coefficient showed a high positive correlation (1.00) between length and weight of all the fish species except in *Caranx hippos* (0.18) with low positive correlation. The b value obtained ranged from 2.13 for *Ethmalosa fimbriata* with negative allomerty to 3.53 for *Pelmatolapia mariae* with positive allometry. By negative allometry (b < 3), the fish is said to be lighter for its length as it grows and (b>3), the fish gains weight as it grows. The mean condition factor ranged from 0.36 ± 0.03 recorded for *Sphyraena barracuda* to 2.20 ± 0.02 for *Coptodon guineensis* and *Coptodon zillii*. Apart from *Sphyraena barracuda* general wellbeing of all the fish

Corresponding author: Email: henry.dienye@uniport.edu.ng;

species were found to be good, as indicated by the values of condition factor, which were nearer to or greater than 1. The results of the present study will provide an effective tool for further studies of population dynamics and stock assessment studies in the study area.

1. INTRODUCTION

All fishing gears are species and size selective particulary in multispecies fisheries. The area of operation of a gear, the inconstant behavior of the fish relative to the gear, and size of the fish determine the part of a stock that can be caught by a gear [1]. A generally important technical measure for fishing gears is the size selectivity which is defined as the probability of fish being retained in a fishing gear as a function of the length of the fish [2]. In fisheries management, it is often desired that commercial fishing gear be highly selective for larger fish to minimize impact of fishing on the fish population and maximized yield [3,4].

Cast net is a falling gear, conical in shape with lead sunken or weights attracted at regular intervals on the lead rope forming the circumference of the cone. The cheapness and transportability make cast nets one of the most common gears in inland water fisheries [5]. This type of fishing gear is usually used in shallow waters and cast from the shore or from a boat to catch fish by falling and closing in on them. Cast nets are selective for lower size ranges, and larger, faster-moving fish can escape the falling net but may become entangled in the process [6].

Knowing selectivity of the gear is very important since it affect population parameters such as length-weight relationship, gender ratio, estimate of population size through marking trails and growth and death ratios [7]. These relationships provide additional information about condition of fish in its habitat and also are vital in the biology of fisheries, assessing the fish's average weight in a given length using mathematical equations [8]. The parameters like general well-being of any fish species either in its natural habitat or cultivable environment, comparison of growth pattern, onset of maturity spawning, fecundity etc., can be assessed with the help of length-weight relation and condition factor [9]. Condition factor is important in understanding the life cycle of fish species and it contributes to adequate management of these species, hence, maintaining the equilibrium in the ecosystem [10]. The study was designed to provide basic scientific information on the length-weight relationship of some fish species in the New Calabar River, Niger Delta Nigeria.

2. MATERIALS AND METHODS

2.1 The Study Area

The study area is the section of the New Calabar River as shown in Fig. 1. The New Calabar River lies between longitude 006º53 53086'E and latitude 04º53' 19.020'N in Choba, Rivers State, Nigeria. The entire river course is situated between longitude 7º60'E and latitude 5º45'N in the coastal area of the Niger Delta and empties into the Atlantic Ocean.

Three sampling stations (S1 – Aluu, S2 – Choba, and S3 – Iwofe) were established along the main course, which depict a section of the River. The three stations were established based on fishing communities and for easy accessibility of the different sections of the River. Fish species were collected monthly for 4 consecutive months (March to August, 2017) from the three sampling stations with the assistance of local artisanal fishers using different cast nets (1.5 and 2.5cm mesh sizes).

2.2 Fish Sampling

The fish were sampled on a monthly basis between the months of March to August 2017, from all the three stations with the assistance of local artisanal fishermen using cast nets of varying mesh sizes *(1.5 cm and 2.5 cm).*The specimens were immediately preserved in iced packed cooler and transferred to the Fisheries Laboratory, Faculty of Agriculture, University of Port Harcourt, Choba where it was preserved in formalin in the laboratory, and immediately after, appropriate labelling and identification was made with the aid of relevant texts, [11] and Fish base [12]. Catch composition of cast nets were recorded by physical examination of the total catch, the Total Length (TL) and Standard Length (SL) were measured in centimeter (cm) using a measuring of 30 cm ruler and the Body Weights (BW) were measured in grams (g). With electronic sensitive scale model AJ5303 (capacity 6000 g; readability 0.2 g).The Total Length (TL) of each fish was taken from the tip of the snout (mouth closed) to the extended tip of the caudal fin using a meter rule.
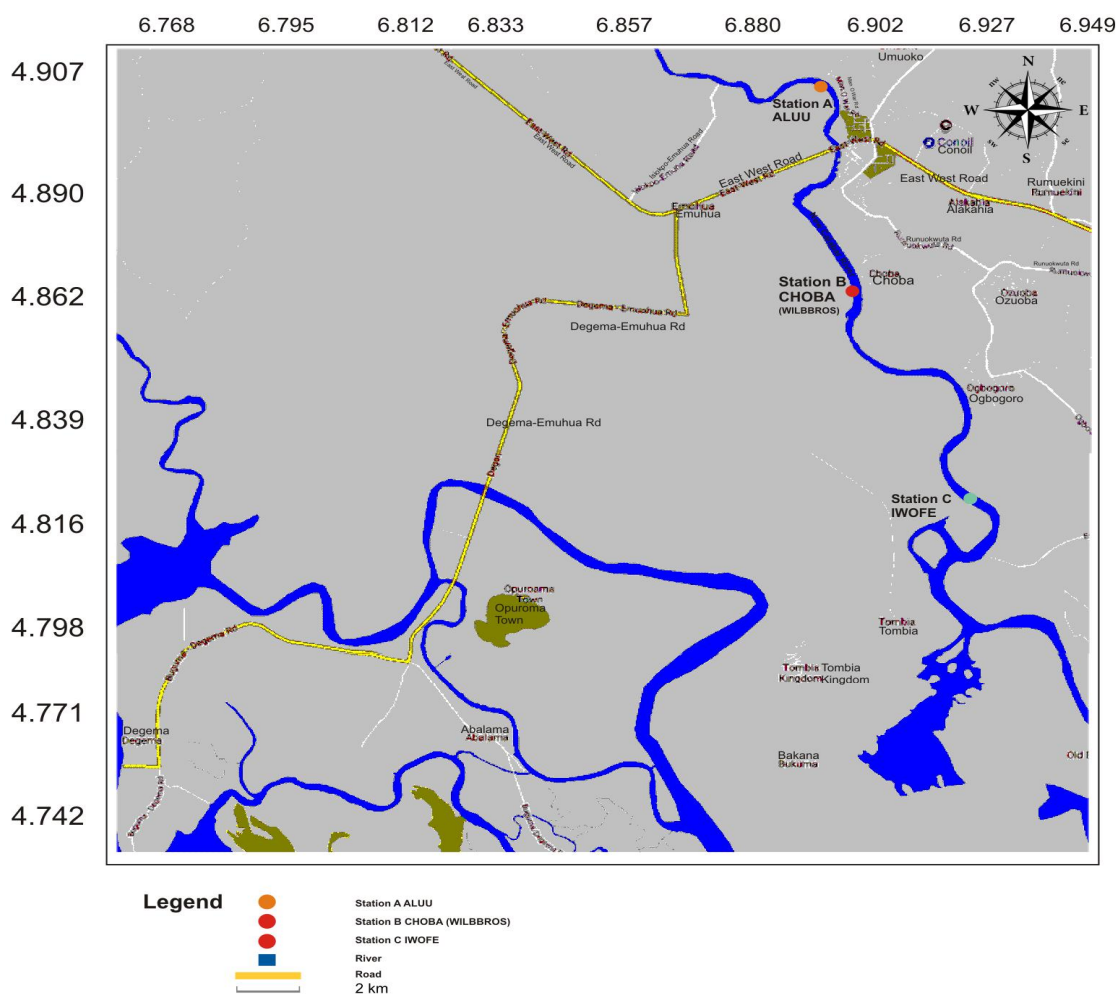
Fig. 1. Map showing the sampling stations

The length–weight relationship is expressed by the equation $W = aLb$, where W = body weight (g), and L = total length (cm), [13]. Parameters a and b were estimated by the logarithmic expression: log W = log a + b log L [12].

The condition factor which shows the degree of wellbeing of the fish in their habitat was determined by using the equation, K = 100W/ Lb [14]. Where by K = condition factor W = the weight of the fish in gram (g) L = the total length of the fish in centimeters (cm) b = the value obtained from the length-weight equation.

Statistical evaluations of Length-weight analysis and the variations observed in the different species, the scatter diagram was also plotted for

the species using FiSAT II (FAO-ICLARM Stock Assessment Tools by Gayanilo et al. [15].

3. RESULTS

A total of 1541 specimens of 26 fish species, representing 11 families were examined but only 18 species were analysed for length-weight relationship in this study. *Coptodon guineensis* recorded the highest number of individual (287), followed by *Coptodon zillii* (286) while *Liza grandisquamis* recorded the lowest number of individuals (2). Sample sizes of the species examined in this study ranged from 8.79±0.25 (*Caranx hippos*) to 31.48±4.93 cm (*Sphyraena barracuda*) in total length and 15.45±0.40 (*Elops lacerta*) to 156.00± 39.30 g (*Pelmatolapia mariae*) in weight (Table 1).
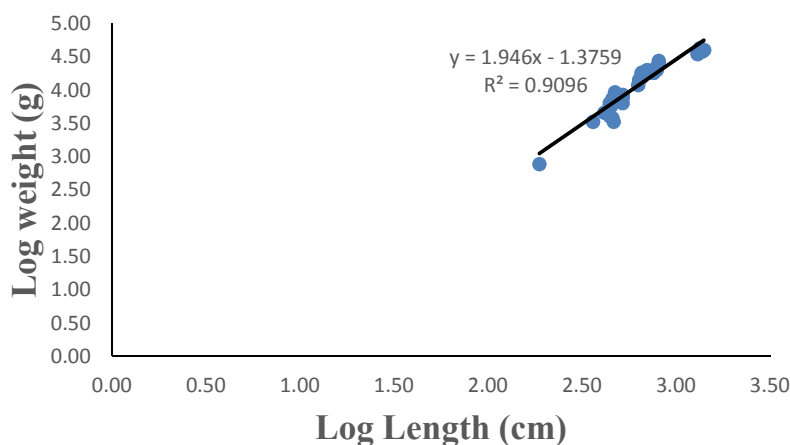
Table 1. Sizes range of fish species caught with cast net

Species	N	Total length (Cm) Mean±SE	Range (Cm)	Total weight (g) Mean±SE	Range (g)
CICHLIDAE					
Coptodon guineensis	287	16.35±0.25	8.7 - 33.7	121.80±6.73	13 – 697
Coptodon zillii	286	15.69±0.23	9.3 - 30.1	101.96±5.88	16 – 645
Coptodon dageti	47	16.16±0.52	9.5 - 26.3	96.15±9.04	20 – 311
Sarotherodon galilaeus	53	13.56±0.54	7.8 - 22.8	59.96±6.81	12 – 259
Sarotherodon melanotheron	66	16.19±0.38	8.3 - 23.5	86.06±5.29	15 – 213
Pelmatolapia mariae	6	18.25±1.67	13.2 - 22	156.00±39.30	41 – 242
Pelvicachromis taeniatus	6	15.07±0.36	14.1 - 16.5	57.33±3.23	49 – 70
Chromidotilapia guntheri	4	14.25±0.39	13.2 - 15	55.75±2.78	48 – 61
Hemichromis fasciatus	4	14.33±0.45	13 - 14.9	57.25±3.57	47 – 63
MUGILIDAE					
Liza falcipinnis	157	20.96±0.41	9.1 - 37.1	97.39±5.86	13 – 370
Liza grandisquamis	2	9.80±0.70	9.1 - 10.5	13.50±1.50	12 – 15
Mugil cephalus	24	19.27±0.68	14.7 - 27.1	73.88±7.78	39 – 185
CLUPEIDAE					
Ethmalosa fimbriata	17	15.76±0.26	13.6 - 17.3	57.06±2.02	39 – 69
Sardinella maderensis	31	11.04±0.23	9.2 - 13.5	30.26±1.99	12 – 49
ALESTIDAE					
Brycinus macrolepidotus	37	15.23±0.67	9.6 - 22.5	51.78±4.65	16 – 94
Brycinus nurse	18	17.04±0.49	12.9 - 23.3	65.57±3.18	34 – 103
CLAROTEIDAE					
Chrysicthys aluuensis	12	13.45±1.47	9.9 - 22.4	39.50±4.32	27 – 69
Chrysicthys nigrodigitatus	10	15.11±1.62	9.8 - 22.3	50.90±16.84	16 – 195
LUTJANIDAE					
Lutjanus agennes	21	16.36±0.56	11.7 - 20.8	65.14±5.41	25 – 123
Lutjanus dentatus	32	16.24±0.42	12.8 - 20.6	64.09±4.25	32 – 120
CARANGIDAE					
Caranx hippos	18	8.79±0.25	7.3 - 10.5	25.72±1.04	19 – 33
Trachinotus teraia	10	10.83±0.92	7.5 - 14.1	27.10±2.27	19 – 38
ELOPIDEA					
Elops lacerta	74	12.76±0.30	7.6 - 15.7	15.45±0.40	9 – 22
HAEMULIDAE					
Pomadasys jubelini	24	10.89±0.30	8.8 - 14.3	21.78±2.43	11 – 69
MONODACTYLIDAE					
Monodactylus sebae	22	9.63±0.16	8.8 - 10.7	31.09±1.52	23 – 45
SPHYRAENIDAE					
Sphyraena barracuda	6	31.48±4.93	19.3 - 45	155.83±52.01	30 – 278

Table 2. Pooled growth pattern and conditional factor

Species	Condition factor (K) Mean±SE	Range	a	b	r²	Growth pattern
Brycinus macrolepidotus	1.44±0.05	0.83±1.94	-2.12	2.21	0.95	Negative allometry
Coptodon dageti	2.12±0.09	1.08±4.55	-2.43	2.47	0.83	Negative allometry
Coptodon guineensis	2.20±0.02	0.20±4.61	-3.42	2.85	0.95	Negative allometry
Coptodon zilli	2.20±0.02	1.48±4.79	-3.71	2.96	0.97	Negative allometry
Ethmalosa fimbriata	1.46±0.03	1.29±1.62	-1.83	2.13	0.90	Negative allometry
Hemichromis fasciatus	1.95±0.07	1.84±2.14	-4.79	3.36	0.95	Positive allometry
Liza falcipinnis	0.98±0.03	0.44±2.70	-2.81	2.38	0.89	Negative allometry

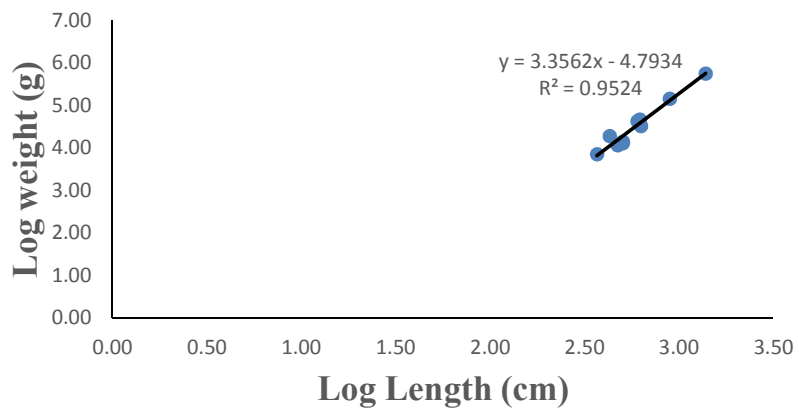| Species	Condition factor (K)		a	b	r^2	Growth pattern
	Mean±SE	Range				
Lutjanus agennes	1.46±0.06	1.03±1.91	-2.36	2.32	0.84	Negative allometry
Lutjanus dentatus	1.47±0.05	1.03±2.22	-3.00	2.55	0.90	Negative allometry
Monodactylus sebae	3.43±0.04	2.94±3.83	-4.20	3.36	0.93	Positive allometry
Mugil cephalus	1.01±0.05	0.75±1.95	-2.34	2.22	0.81	Negative allometry
Pelmatolapia mariae	2.17±0.14	1.63±2.51	-5.33	3.53	0.98	Positive allometry
Pelvicachromis taeniatus	1.67±0.03	1.56±1.78	-2.08	2.26	0.96	Negative allometry
Pomadasys jubelini	1.66±0.13	1.21±4.26	-3.80	2.86	0.86	Negative allometry
Sardinella maderensis	2.16±0.05	1.54±2.59	-4.52	3.28	0.88	Positive allometry
Sarotherodon galilaeus	2.06±0.07	1.05±4.64	-3.07	2.68	0.94	Negative allometry
Sarotherodon melanotheron	1.92±0.06	1.34±5.42	-2.87	2.60	0.93	Negative allometry
Sphyraena barracuda	0.41±0.03	0.31±0.55	-4.37	2.66	0.98	Negative allometry

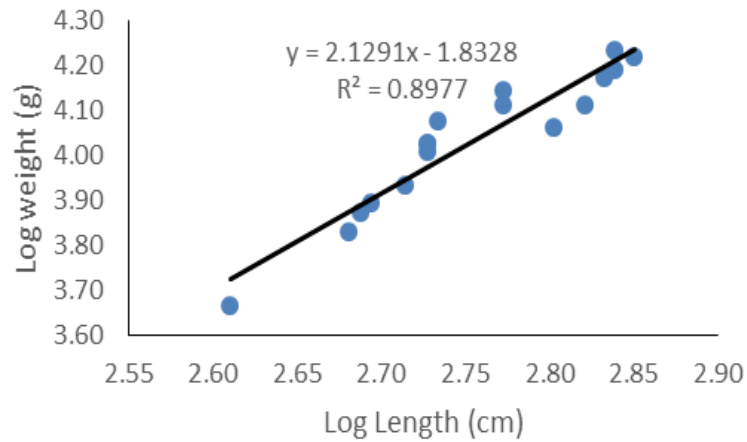**Brycinus macrolepidotus**
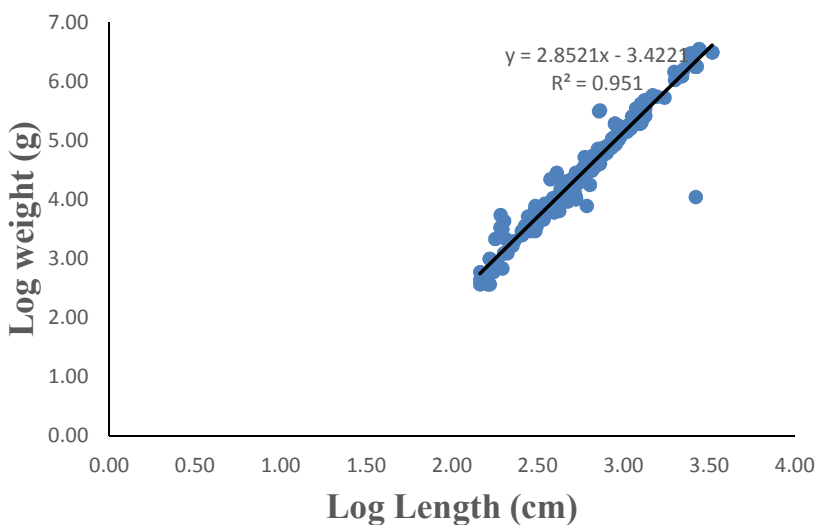
Coptodon dageti
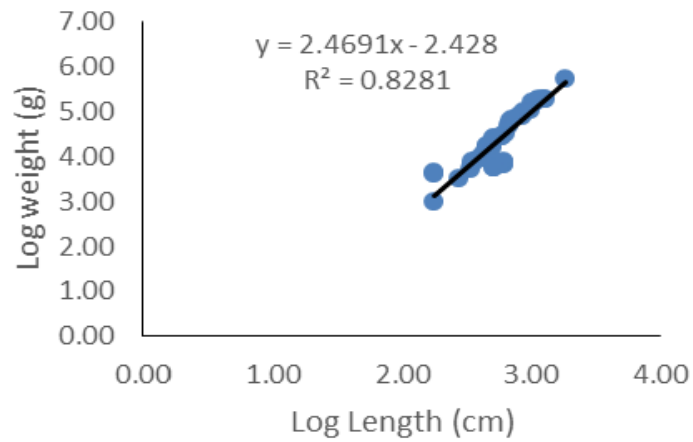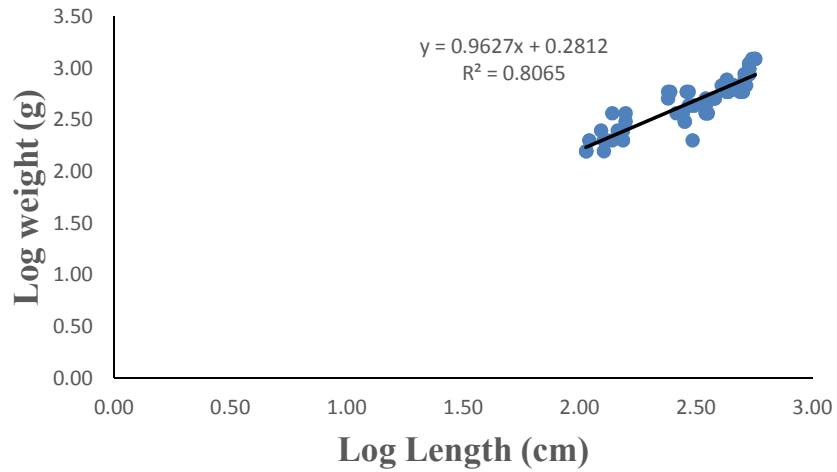
$y = 2.4691x - 2.428$
$R^2 = 0.8281$

Coptodon guineensis

$y = 0.9627x + 0.2812$
$R^2 = 0.8065$

Coptodon zilli

$y = 3.3562x - 4.7934$
$R^2 = 0.9524$

Ethmalosa fimbriata

$$y = 2.1291x - 1.8328$$
$$R^2 = 0.8977$$

Hemischromis fasciatus

$$y = 0.7756x + 0.3846$$
$$R^2 = 1$$

Liza falcipinnis

$$y = 2.5491x - 2.9951$$
$$R^2 = 0.903$$

Lutjanus agennes

7

y = 2.3237x - 2.3628
R² = 0.8434

Lutjanus dentatus

y = 2.2243x - 2.3406
R² = 0.8143

Monodactylus sebae

y = 3.3588x - 4.1954
R² = 0.9347

Mugil cephalus

$$y = 2.2583x - 2.0812$$
$$R^2 = 0.9583$$

Pelmatolapia mariae

$$y = 3.5291x - 5.326$$
$$R^2 = 0.9765$$

Pelvicachromis taeniatus

$$y = 1.6791x - 1.0826$$
$$R^2 = 0.7986$$
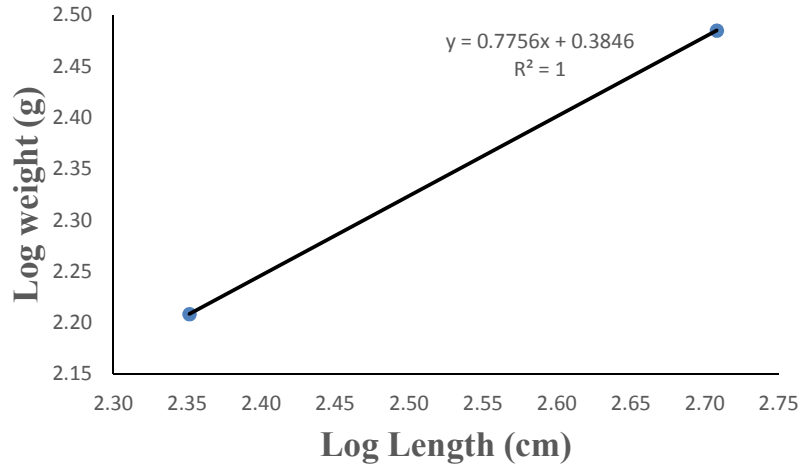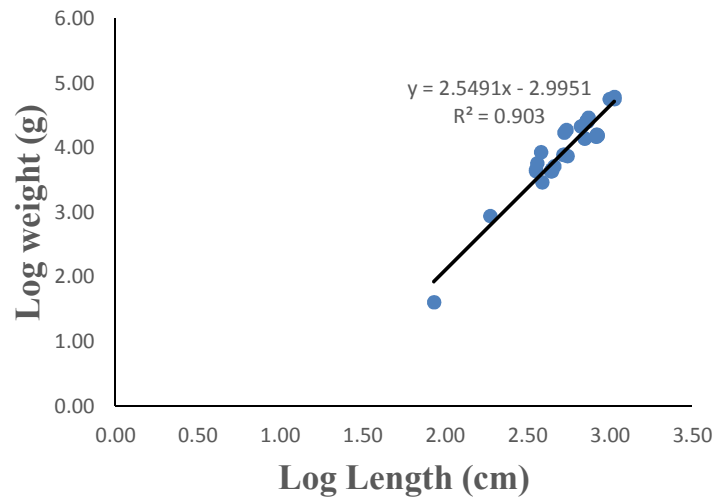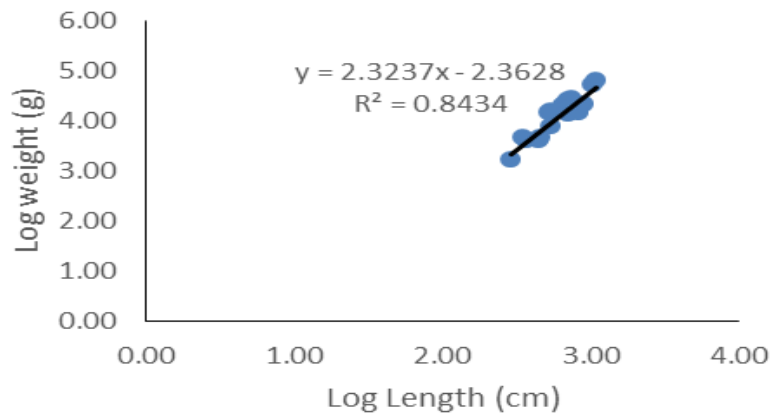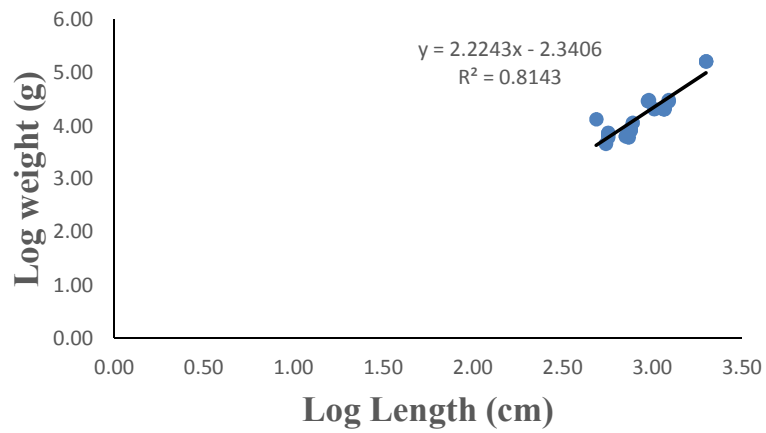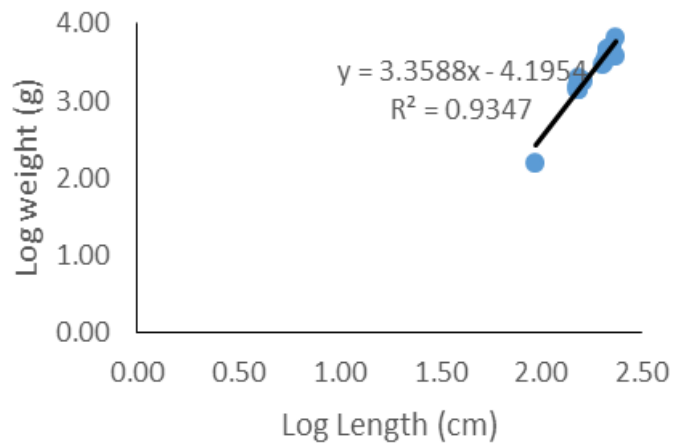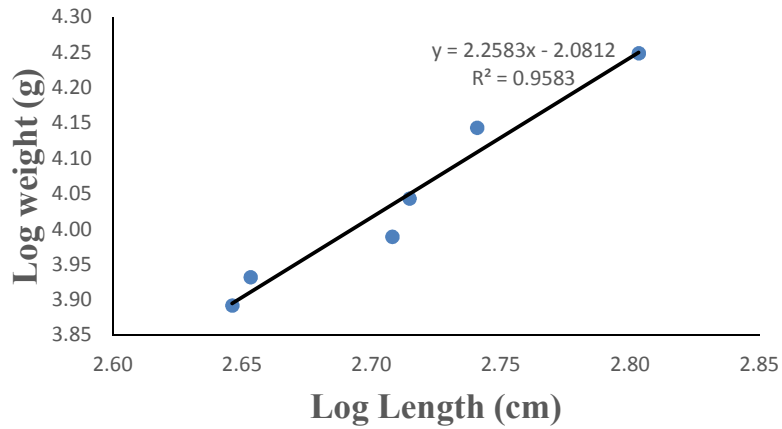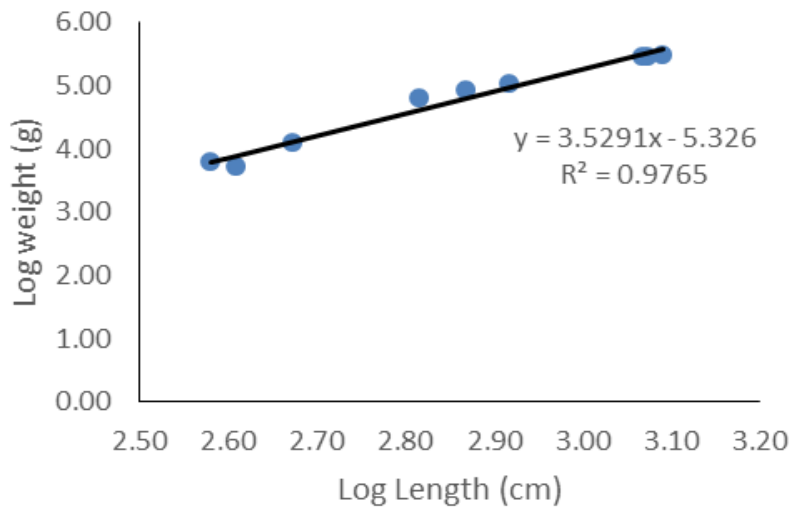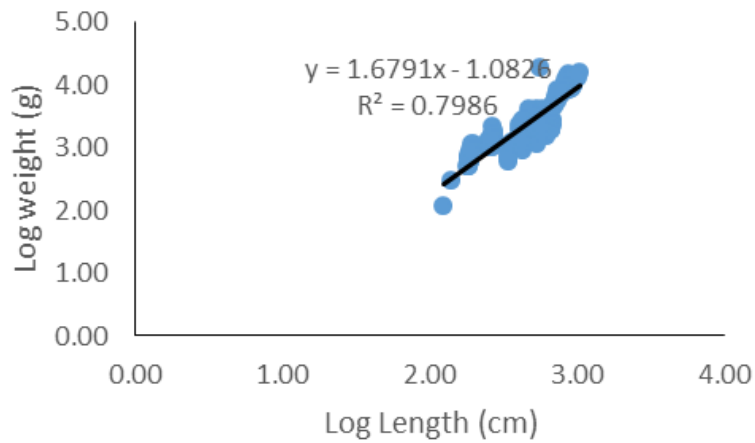
Pomadasys jubelini
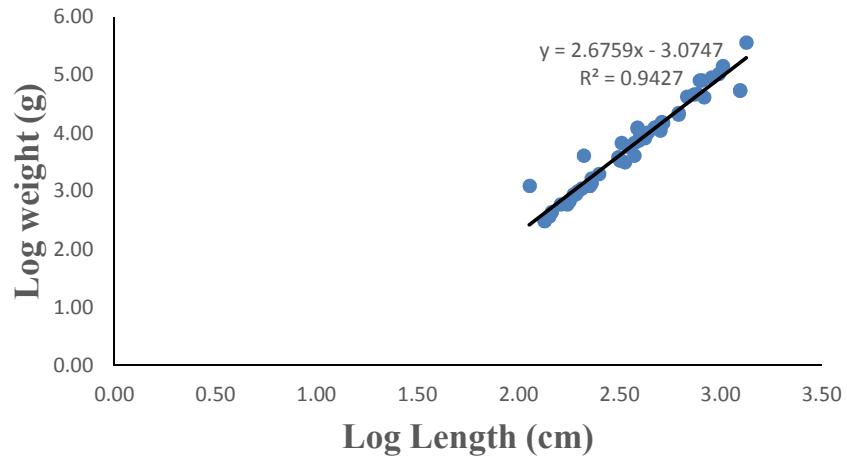
Sardinella maderensis
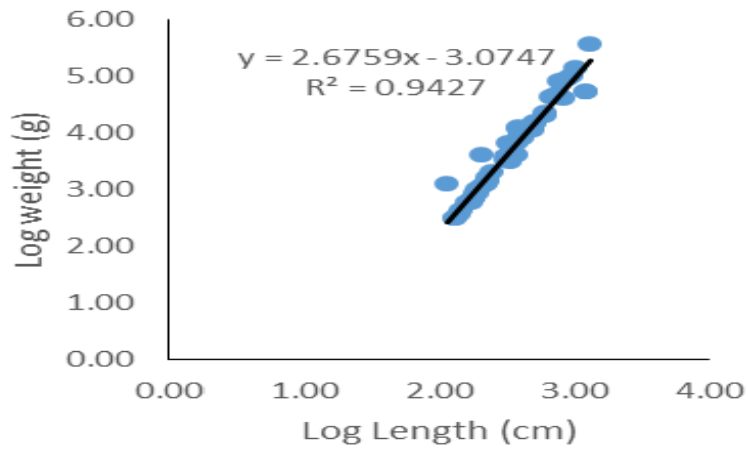
Sarotherodon galilaeus

Sarotherodon melanotheron

$$y = 2.6045x - 2.8696$$
$$R^2 = 0.9273$$
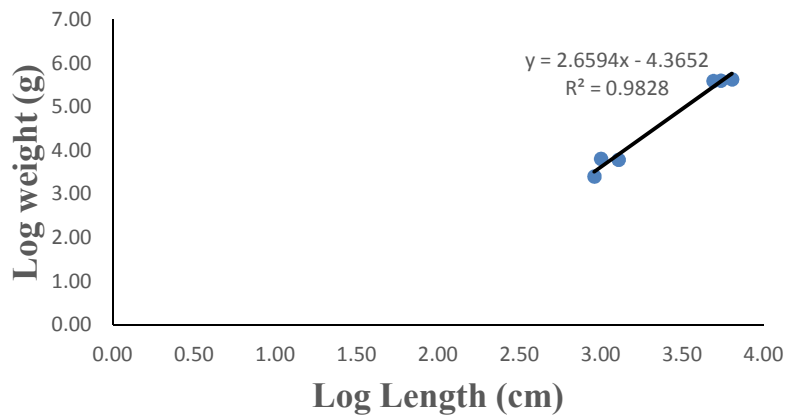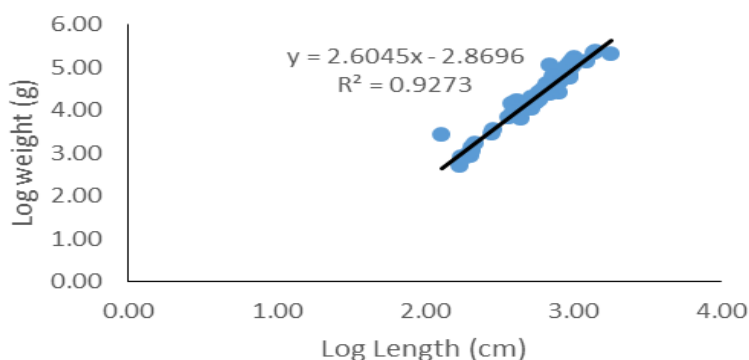
Sphyraena barracuda

Fig. 2. Length-weight of fish species from New Calabar River

The length–weight relationships of 18 fish species are shown in Table 2, which shows the values of parameter b varied between 2.13 for *Ethmalosa fimbriata* to 3.53 for *Pelmatilapia mariae*. The coefficients of determination (r^2) of the LWR regressions ranged from 0.81 for *Mugil cephalus* to 0.98 recorded for both *Sphyraena barracuda* and *Pelmatilapia mariae*. The mean condition factor ranged from 0.36 ± 0.03 recorded for *Sphyraena barracuda* to 2.20±0.02 for *Coptodon guineensis* and *Coptodon zillii.*

4. DISCUSSION

In this study most of the samples consisted mainly juvenile with the sizes of fish species ranging from 8.79±0.25 to 31.48±4.93 cm in length and 15.45±0.40 to 156.00±39.30 g in weight. This can be ascribed to selectivity of the cast nets used in the study area and anthropogenic impacts, especially the fishing pressure and habitat destruction. The second most common indicator of unsustainable fishing is the observation of a decrease of large-sized fish, or a decrease in the mean size of the fish in the catch [16].

Length–weight relationships in fishes can be affected by multiple of factors including the number and length range of the sampled specimens (often affected by the type of fishing gear used), seasonality, habitat, gonad ripeness, sex, diet, stomach fullness, and growth phase [12,17,18]; however, these factors were not considered in the present study due to the duration of the study.

Several authors [19,20] opined that the value of 'b' may range between 2.5 and 4.0 for tilapia

Ambloplites rupestris specie(Rock bass) Ideally, the regression coefficient "b" of a fish should be very close to 3.0 [21]. The b values outside of this range are generally considered to be erroneous [13,8]. Le Cren [9] pointed out that the variation in 'b' value is due to environmental factors, season, food availability, sex, life stage and other physiological factors. The b value obtained in this study ranged from 2.13 to 3.53 revealed that the studied species did not followed the cube law as all the species studied had allometric growth pattern. Since the b value from the result of this study which showed negative allometry for *Ethmalosa* (2.13) which is said to be lighter for its length as it grows to 3.53 for *Pelmatolapia mariae* with positive allometry which indicates that the species gains weight as it grows.

According to several authors [9,22] the relative condition factor (Kn) is an indicator of general well-being of the fish. (Kn) greater than one (1) is indicative of the general well-being of fish, whereas its value less than one (1) indicates that fish is not in a good condition. It was noticed that fish species in Table 1 in the pooled condition factor had highest condition factor values (2.13-3.53). The result of this study is in agreement with the findings.

The present work revealed that the pooled mean condition values factor ranged from 0.41±0.03 to 4.23±0.49 with only *Sphyraena barracuda* had less than one. This implies that the fish species are in good condition. However, the variations in the condition factor (K) observed in different fish species may be attributed to different factors, such as environmental condition, food availability and the gonadal maturity, as suggested by many workers [9].

5. CONCLUSION

The study has provided baseline information to understand the length-weight relation and condition factor of different fish species caught using cast net in the New Calabar River. The study revealed that the catches are made up of relatively small sizes and allometric growth pattern in all the studied fish species which indicates that the fish species are not allowed to grow to maturity before capture (recruitment overfishing). The condition factor indicated that almost all the species were thriving very well in the river. It is hoped that the results of the present study will provide an effective tool for further studies of population dynamics and stock assessment studies.

ETHICAL APPROVAL

As per international standard or university standard written ethical approval has been collected and preserved by the author(s).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Food and Agricultural Organization (FAO). Management, co-management or no management? Major Dilemmas in Southern African Freshwater Fisheries. FAO Fisheries Technical Paper 426/1; 2003.
2. Misund OA, Kolding J, Fréon P. Fish capture devices in industrial and artisanal fisheries and their influence on management. In: Handbook of Fish Biology and Fisheries, (Eds. P. J. B. Hart and J. D. Reynolds). Blackwell Science, London. 2002;2:13-36.
3. Gulland JA. Fish stock assessment: A manual of basic methods- New York: Wiley; 1983.
4. MacLenna DN. Fishing gear selectivity. Fish Res. 1992;13:201-204.
5. Jawad LA. Fishing gear and methods of the lower Mesopotamian plain with reference to fishing management. Marina Mesoptamica. 2006;1(1):1-37.
6. Welcomme RI. Inland fisheries: Ecology and management. Fishing News Books, Blackwell Science, Oxford, U.K. 2001;358.
7. Hamley JM. Review of gillnet selectivity. Journal Fish Res. BD. Can. 1975;32:1943-1969.
8. Oscoz J, Campos F, Escala MC. Weight–length relationships of some fish species of the Iberian Peninsula. Journal of Applied Ichthyology. 2005;21:73-74.
9. Le Cren ED. The length–weight relationship and seasonal cycle in gonad weight and condition in the perch (*Perca fluviatilis*). J. Anim. Ecol. 1951;20:201–219.
10. Imam TS, Bala U, Balarabe ML, Oyeyi TI. Length-weight relationship and condition factor of four fish species from Wasai Reservoir in Kano, Nigeria. African Journal of General Agriculture. 2010;6(3):1595-6984.
11. Adesulu EA, Sydenham DHJ. The fresh water and fisheries of Nigeria. Macmillan Nigeria Publishers, Lagos. 2007;397.
12. Froese R. Cube law, condition factor and length-weight relationships: History, meta-analysis and recommendations. Appl. Ichthyol. 2006;22:241–253.
13. Ricker WE. Computation and interpretation of biological statistics of fish populations. Bulletin of the Fisheries Research Board of Canada. 1975;191:1-382.
14. Gomiero LM, Braga FMS. The condition factor of fishes from two river basins in Sao Paulo State, Southeast of Brazil. Acta Scientiarum. 2005;27:73-78.
15. Gayanilo FC, Sparre PP, Pauly D. FISAT II Users' Guide, FAO; 2005. Available:http/www.FISAT II
16. Worm B, Hilborn R, Baum JKT, Branch TA. Rebuilding global fisheries. Science. 2009;325:578–585.
17. Karachle PK, Stergiou KI. Length-length and length weight relationships of several fish species from the North Aegean Sea (Greece). J. Biol. Res. (Thessalon). 2008;10:149–157.
18. Mir JI, Gusain O, Gusain MP, Mir FA, Sarkar UK, Pandey A. Length–weight and length–length relationships of the vulnerable dark mahseer, *Puntius chelynoides* (McClelland, 1839) from Garhwal Himalaya, India. J. Appl. Ichthyol. 2013;30:225–226.
19. Hile R. Age and growth of the Cisco, *Amloplites rupestris* (Refineseque) in Nebish Lake, Wisconsin. Trans. Wis. Acad. Sci. Arts. Lett. 1936;33:189-337.
20. Martin WR. The mechanism of environmental control of body form in

fishes. Univ. Toronto. Stu. Biol. 58: Ont. Fish. Res. Lab. 1949;70:1-91.

21. Allen KR. Some observations on the biology of the trout (*Salmo truta*) in Windermere. J. Anim. Ecol. 1938;7:333-349.

22. George JP, Sharma AK, Venkatshvaran K, Sinha PSRK, Venogopal G, Birader RS. Length –weight relationship and relative condition factor in *Cirrhina mirgala* and *Labeo rohita* from a sewage-fed tank. The Annals of Zoology. 1985;23(2):79-90.