

ASPECTS OF POPULATION STRUCTURE OF *Pseudotolithus typus*, *Lutjanus goreensis* AND *Sphyraena afra* FROM LAGOS COASTAL WATERS, LAGOS STATE, NIGERIA

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ABSTRACT

Information on the population structure of *Pseudotolithus typus*, *Lutjanus goreensis* and *Sphyraena afra* in Lagos State, Nigeria is scanty. The present study investigates their size distributions in terms of lengths and weights, asymptotic length (L_{∞}), length at first maturity (L_m), maximum length at capture (L_{max}), length at maximum yield (L_{opt}), ratios of L_{max}/L_{∞} and L_{opt}/L_{∞} . A total of 222 *P. typus*, 182 *L. goreensis*, and 93 *S. afra* were collected from the trawlers landing sites at Kirikiri Lighter Terminal II from April to September 2019. The mean total length for *P. typus*, *L. goreensis*, and *S. afra* was 37.54 ± 14.65 cm, 36.03 ± 7.64 cm, and 68.71 ± 17.39 cm while body weights (g) were 821.63 ± 60.68 , 838.24 ± 68.56 , and 1675.60 ± 1470.90 . The estimate from POPDYN spreadsheet showed that *P. typus*, *L. goreensis*, and *S. afra* had an L_{∞} of 102.8cm, 61.6cm, and 163.3cm respectively. The slope (b) values for *S. afra*, *P. typus*, and *L. goreensis* were 2.709, 2.560, and 2.507 respectively denoting a negative allometry growth pattern. *P. typus* and *L. goreensis* had K values of 1.55 ± 0.56 and 1.79 ± 0.84 respectively, *S. afra* had 0.52 ± 0.06 . In conclusion, the results indicated that all the fish becomes vulnerable to capture before spawning, a feature of growth overfishing. Hence, fishers should embrace gear selectivity to conserve these fishes.

Keywords: Distribution, Coastal fishes, Length, Weight, POPDYN spreadsheet

INTRODUCTION

The population structure of fish depicted in length-frequency distribution provides useful information that aids fisheries management. This structure is crucial to understanding growth, reproduction, and recruitment with changes in size as an early indicator of disturbance in fish (Johnson and Tamatamah, 2013). The analysis of population structure provides essential insights into the natural fluctuations of fishery resources as well as the relative abundance of the various stocks. Its comprehension also allows for a discussion of the factors that influence the behaviour of fishers and their selection of target species (Mesquita *et al.*, 2019).

The fisheries of *Lutjanus goreensis*, *Sphyraena afra*, and *Pseudotolithus typus* are of great importance especially to the rich and middle-class people within coastal cities in Lagos, both economical and nutrition-wise. However, different factors such as poor fisheries data collection, limited resources, and paucity of information on population parameters and biology of commercially important fish species within Lagos coastal water had crippled management intervention geared towards sustainable fisheries in the area. Fish stocks have declined globally at an alarming rate in many marine coastal systems because of human activities, thus an urgent call for management actions (Pauly and Zeller, 2016).

Sequel to the above background, the

present study aimed to determine the length-weight relationship and some population structure of three fish species (*Pseudotolithus typus*, *Lutjanus goreensis*, and *Sphyraena afra*) collected from the Kirikiri Lighter Terminal II landing site, in Lagos, Nigeria, in a bid to examine their exploitation status.

MATERIALS AND METHODS

Study Area

The study was carried out in Lagos Coastal water of Lagos, Nigeria. The catches from Lekki and Badagry marine waters were focused on for this study (Figure 1). The fishing ground of Lagos is located within latitude $6^{\circ} 24' 54''$ - $6^{\circ} 25' 30''$ N and on longitude $3^{\circ} 23' 06''$ - $3^{\circ} 23' 06''$ E bounded in the North by Five Cowries Creek and the Atlantic Ocean in the South. It is bordered in the West by the Benin Republic and Lekki in the East, (Ediang and Ediang, 2013). Before the promulgation of the 1971 Sea Fisheries Regulations, this area supported almost all the industrial fishing activities in Nigeria in the 1960s, which led to the collapse of the fishery.

The Lagos coast is a small coastal shelf with a total area of 41,000 km² that stretches between 14,816 km and 27,780 km (Adebisi, 2012). This shelf is mostly soft and muddy (Tobor, 1991). Furthermore, the majority of demersal fish populations off the Lagos coast are concentrated in a region of roughly 1,800 km² between the high-water mark on the shore and the lower limit of the thermocline (Sentongo *et al.*, 1986).

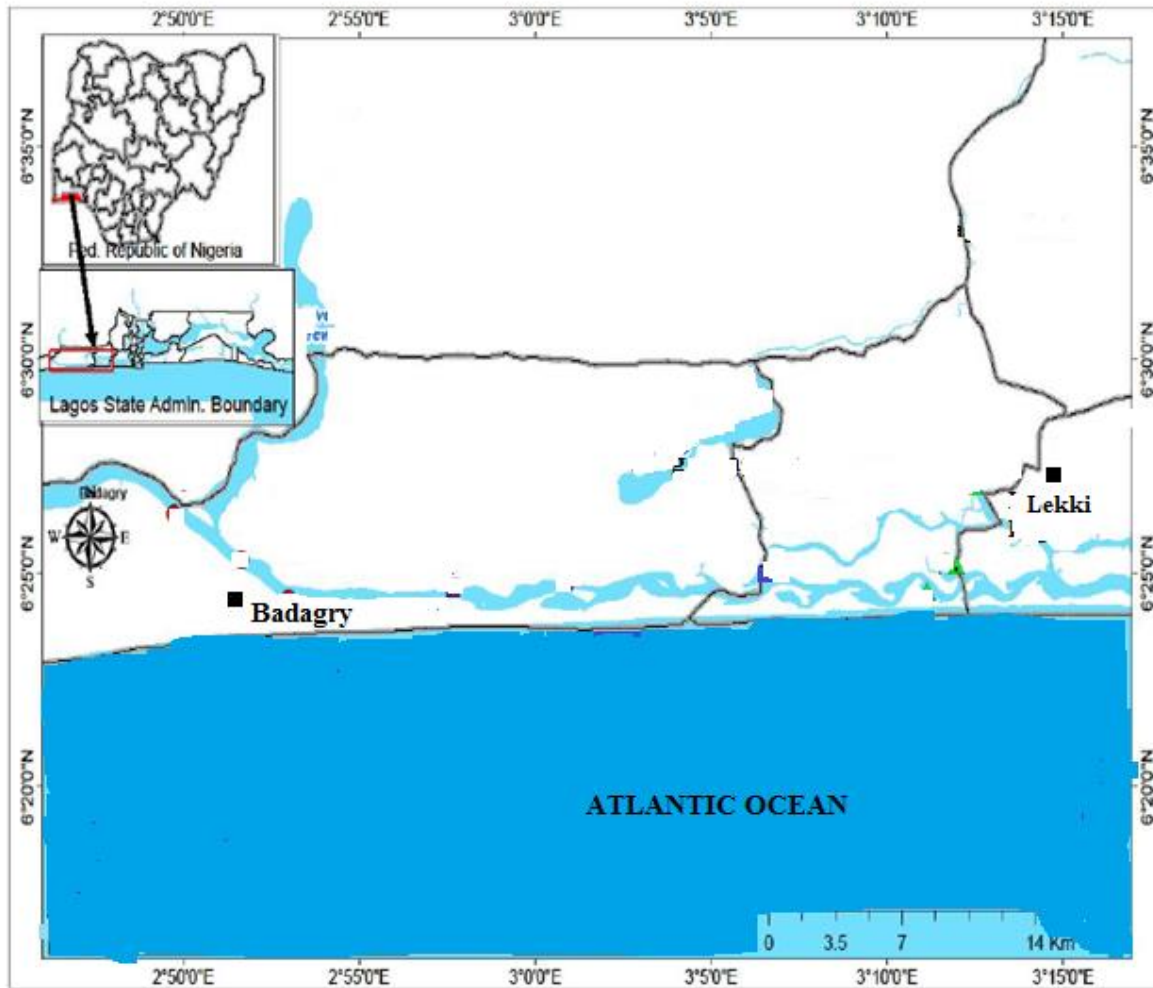


Figure 1: Location of study areas within Lagos coastal waters.

Collection of fish samples and measurement

Fish samples consisting of 222 *Pseudotolithus typus*, 182 *Lutjanus goreensis*, and 93 *Sphyrna afra* were collected fortnightly from the trawlers landing sites at Kirikiri Lighter Terminal II from April to September 2019. Using the taxonomic key described by Allen (1985), the fish species were identified.

The total lengths (distance from the tip of the anterior or part of the mouth to the caudal fin) were measured with meter-rule to the nearest 0.1cm while the corresponding weight of each fish was measured using a Camry Model top-loading analogue scale to the nearest 50g.

Population structure

Population was determined using POPDYN spreadsheet (Froese and Binohlan,2000). The estimated population structure using POPDYN spreadsheet included asymptotic length (L_{∞}), length at first maturity (L_m), maximum length at capture (L_{max}), Length at maximum yield (L_{opt}), ratios of L_{max}/L_{∞} and L_{opt}/L_{∞} .

Length- weight relationship

The relationship between the length (L) and weight (W) of fish was expressed by the equation given by Ricker, (1973):

$$W = aL^b$$

The relationship ($W = aL^b$) when converted into the logarithmic form gives a straight line relationship graphically and thus, transformed into:

$$\text{Log } W = \text{Log } a + b \text{ Log } L$$

Where, W = Weight of fish in (g), L = Total length (TL) of fish in (cm), a = Constant (intercept) i.e. a coefficient associated to body form, and b = slope (an exponential expressing relationship between length-weight). The constant value –a and also the slope-b were obtained using the regression equation. For every species, the data collected were validated by the analysis of the graph equivalent to length-weight relationships (Ecoutin and Albaret, 2003). Also, values of r^2 were determined to ascertain the relationship between the variables.

Condition factor

Fulton’s condition factor (K) to determine fish wellbeing (Ricker, 1975) of the three fish species was calculated using the following equation:

$K = 100 W/L^3$. Where, K = Condition factor, W = Weight of fish (g), L = Length of fish (cm)

DATA ANALYSIS

Data were computed and analyzed by using IBM SPSS statistics version 20. To verify if the calculated b was significantly different from 3, the Students t-test was used; this is expressed by the equation according to Sokal and Rohlf (1987), $t_s = (b-3)/SE$ where t_s is the t-test value, SE the standard error of the slope b. The type of growth was determined using the t_s value: If $t_s > 1.96$ this implies that $b \neq 3$ so an allometric growth (negative allometric if $b < 3$ and positive allometric if $b > 3$) and if $t_s < 1.96$ the implication is $b = 3$ and therefore an isometric growth.

RESULTS

Size distribution

The summary of the total length and body weight of the fish species (*Pseudotolithus typus*, *Lutjanus goreensis*, and *Sphyaena afra*) is presented in Table 1. The total length for *P. typus*, *L. goreensis* and *S. afra* ranged from 20-100cm (mean = 37.54 ± 14.65), 14.6-59.4 cm (mean = 36.03 ± 7.64) and 34 - 160 cm (mean = 68.71 ± 17.39) respectively. However, the corresponding range of their body weight were 100-5500g (mean = 821.63 ± 60.68 , *P. typus*), 100-6000g (mean = 838.24 ± 68.56 , *L. goreensis*) and 200-14000g (mean = 1675.60 ± 1470.9 , *S. afra*).

Table 1: Summary of Total Length and Body Weight of *Pseudotolithus typus*, *Lutjanus goreensis*, and *Sphyaena afra* from Lagos Coastal Waters

Parameter	<i>P. typus</i>				<i>L. goreensis</i>				<i>S. afra</i>			
	Min.	Max.	Mean	SD	Min	Max	Mean	SD	Min.	Max	Mean	SD
TL	20	100	37.54	14.65	14.6	59.4	36.03	7.64	34	160	68.71	17.39
BW	100	5500	821.63	60.68	100	6000	838.24	68.56	200	14000	1675.60	1470.9

TL = Total Length (cm), BW=Body Weight (g), Min= Minimum, Max= Maximum, SD=Standard Deviation

Length–frequency and body weight-frequency distributions

The length-frequency distribution of *Pseudotolithus typus*, *Lutjanus goreensis*, and *Sphyaena afra* were shown in figures 2-4 respectively. The modal total length of *P. typus* was

20-29cm (82, 27 %) while the least frequent length range was 90-99(1, 0.3 %) and 100 (1, 0.3 %). The least length frequency for *L. goreensis* was 10-19cm (3, 1.65 %) while the modal length range was 30-39(102, 56.04 %). On the other hand, the most frequent total length for *S. afra* was 60-69(40, 43 %).

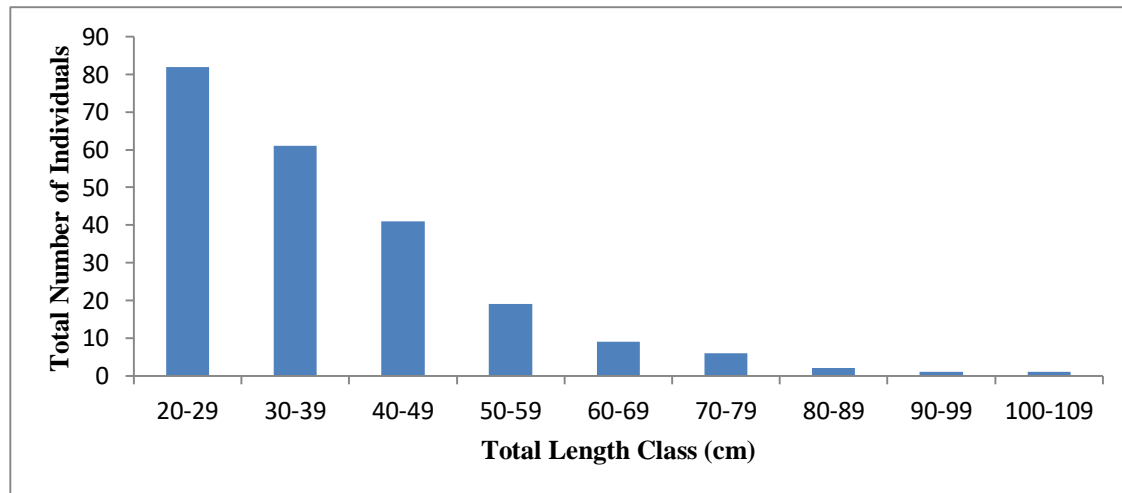


Figure 2: The total number of *Pseudotolithus typus* samples according to length classes (n=222)

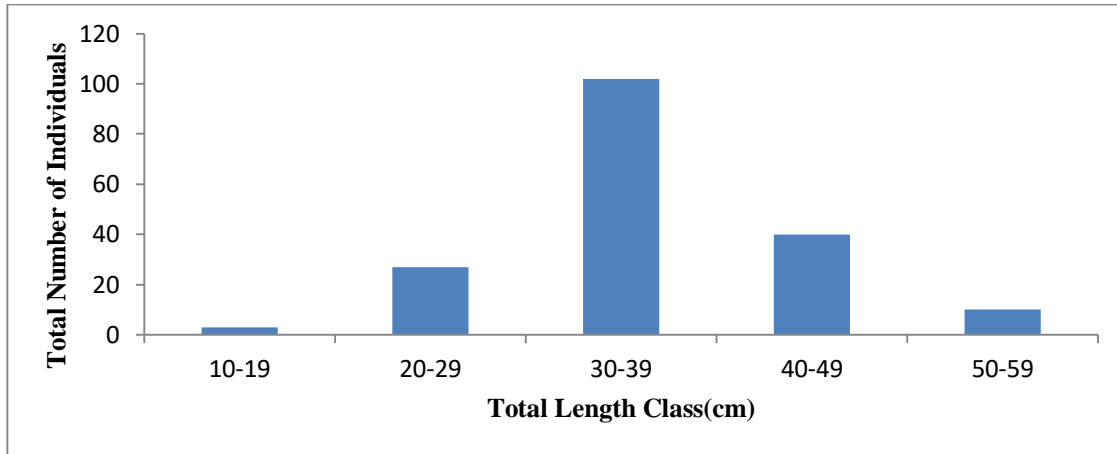


Figure 3: The total number of *Lutjanus goreensis* samples according to length classes (n=182)

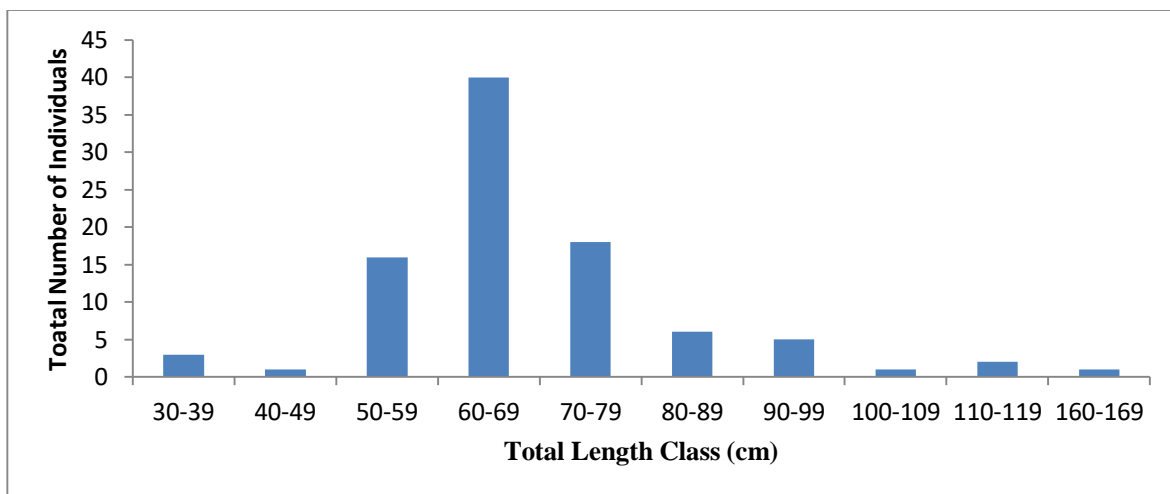


Figure 4: The total number of *Sphyraena afra* samples according to length classes (n=93)

The corresponding bodyweight frequency distribution of *P. typus*, *L. goreensis*, and *S. afra* was in figures 5-7 respectively. The most frequent bodyweight range for *P. typus* was 100-1000g (182, 82.4%), followed by bodyweight range of 1001-1900 (22, 9.9%) while the least frequent range was 3701-4600(1, 0.45%) as indicated in figure 5. The

least frequent bodyweight for *L. goreensis* was 5350-6000g (1, 0.55%) while the most frequent bodyweight was 100-720(97, 53.30%) as shown in figure 6. On the other hand, the most and least frequent bodyweight class respectively for *S. afra* was 200-2000(78, 83.9%) and 12200-14000(1, 1.08%).

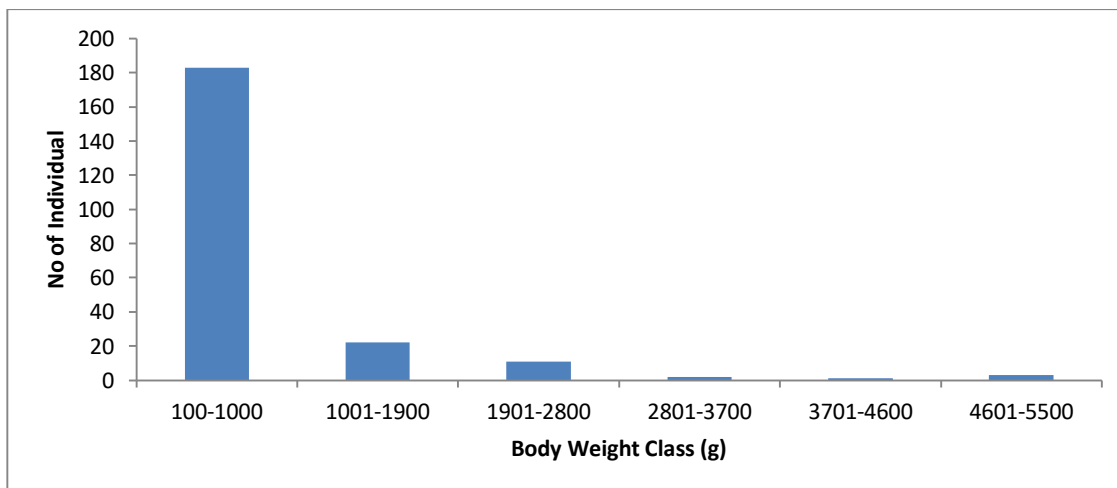


Figure 5: Body weight frequency distribution for *P. typus* (n=222)

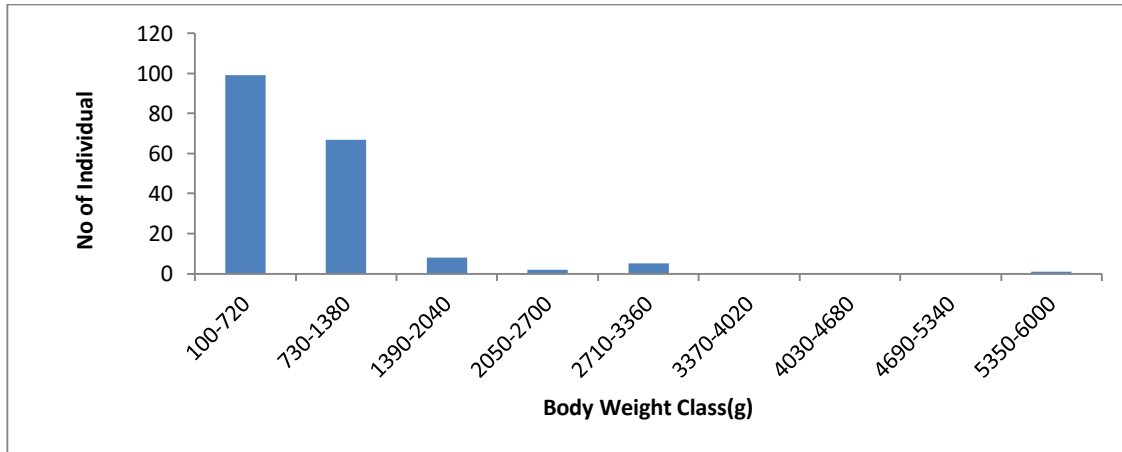


Figure 6: Body weight frequency distribution for *L. goreensis* (n=182)

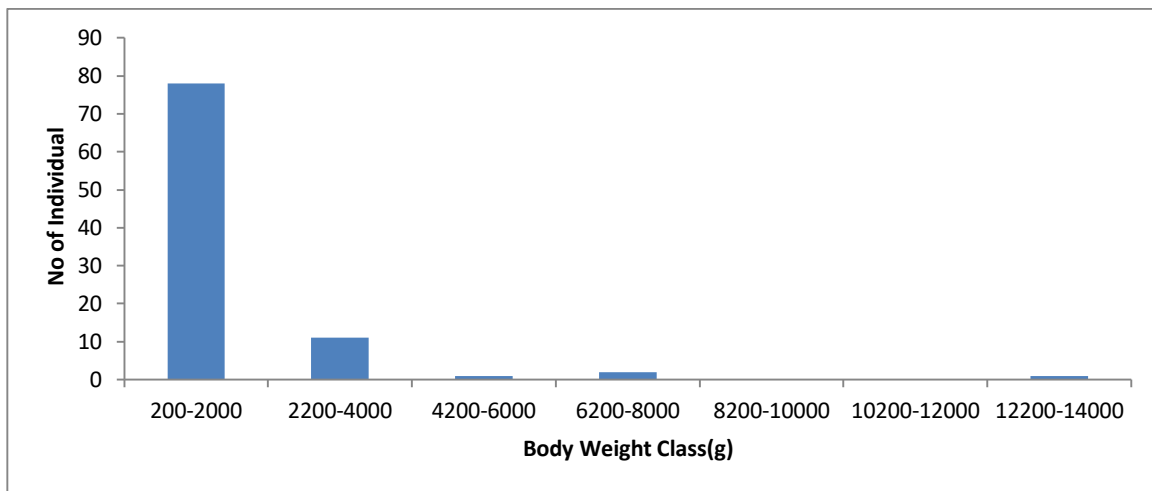


Figure 7: Body weight frequency distribution for *S. afra* (n=93)

Table 2: Summary of Length-Weight Relationship and K Factor of the Fish Species from Lagos Coastal Waters

Species	LWR ($Y=a+bX$)	B	a	R ²	K
<i>P. typus</i>	$Y = -3.182 + 2.560x$	2.560	-3.182	0.845	1.55 ± 0.56
<i>L. goreensis</i>	$Y = -2.382 + 2.507x$	2.507	-2.382	0.850	1.79 ± 0.84
<i>S. afra</i>	$Y = -4.334 + 2.709x$	2.709	-4.334	0.960	0.52 ± 0.06

LWR = length-weight relationship, a = intercept, b = slope of graph, r² = correlation coefficient, K= Fulton's condition factor

DISCUSSION

The total length (20-100cm, mean = 37.54 ± 14.65) recorded for *Pseudotolithus typus* in this study was higher than the total length range of 14-64 cm (mean = 34.11) reported in the marine water of Liberia (Austin, 2014). Similarly, the total length range recorded for *P. typus* in this study was greater than 20-30cm reported for the same species in Cotonou marine water (Sossoukpe *et al.*, 2013). However, the range of total length of *P. typus* in this study was lower than the total length of 73.8cm reported by Sidibé (2003) in Guinea marine water. Olapade and Tarawallie (2014) also recorded a total length of 36.5 cm (24.3 to 54 cm) for *P. senegalensis* in Sierra Leone coastal water. The total length range

of *Lutjanus goreensis* (14.6-59.4 cm, mean = 36.03 ± 7.64) in this study being >35cm size-class of the fish corresponded to large-adults in *L. peru* (Reddy *et al.*, 2013). However, the mean total length of *L. goreensis* in this study was greater than 32.89 ± 6.14 cm reported by Fakoya *et al.* (2015) for the same species from Lagos coastal water. Also, the total length range of *L. goreensis* in this study was higher than 14 - 31.7 cm recorded for *L. quinquelineatus* from the Red Sea off Hurghada, Egypt (Sahar *et al.*, 2017). Sequel to size classification opined by Hammerschlag-Peyer *et al.* (2013) and Fakoya *et al.* (2015) for *L. goreensis*, it is clear that the *L. goreensis* in the present study are adults, however, the value was below the

maximum total length of 80cm reported for the species in the Gulf of Guinea (Allen, 1985). On the other hand, the mean total length for *Sphyraena afra* (68.71 ± 17.39 cm) in this study was higher than 26.4cm total length of *S. obtusata* landed by trawlers at Cochin, south-west coast of India (Najmudeen *et al.*, 2015). However, a total length of *S. afra* up to 154cm has been reported in Yovoyan, Orimedu, and Oshoroko marine water in Lagos state (Ayo-Olalusi and Ayoade, 2019). The differences in values of the past reports and the present finding for all the fish species in this study could be attributed to the type of gears used, their selectivity in the water bodies, and/or food availability for the fish species.

In this study, the corresponding bodyweight for *P. typus*, *L. goreensis* were 821.63 ± 60.68 g, 838.24 ± 68.56 g, and 1675.60 ± 1470.9 g respectively. Olapade and Tarawallie (2014) reported a lower value in bodyweight of *P. senegalensis*. In like manner, the range of bodyweight for *L. goreensis* in this study was higher than that reported in Lagos coastal water (Fakoya *et al.*, 2015). The mean total length of *Sphyraena afra* (68.71 ± 17.39 cm) in this study, on the other hand, was higher than the 26.4cm total length of *Sphyraena obtusata* landed by trawlers in Cochin, India's south-west coast (Najmudeen *et al.*, 2015).

The differences observed with values from other researchers could be affixed to several factors including the fish size, the pattern of the size distribution, period of sampling, the geographical location of fishing ground, and certain environmental factors (Amponsah *et al.*, 2016). The regression coefficient values in this study which showed a positive correlation confirmed that the length-weight relationship is a good parameter for testing population dynamics. Sinovic *et al.* (2004) had reported that direct weight measurement was time-consuming, hence regression co-efficient is essential in estimating weight from length.

The modal length and weight frequency distributions of *P. typus*, *L. goreensis*, and *S. afra* in this study indicated that most of the fish species were within the sub-adult group. A similar report has been revealed on *L. goreensis* from Lagos coastal water (Fakoya *et al.*, 2015).

In the field of fisheries management, the mathematical description of growth is critical since the growth parameters, such as L_{∞} obtained are a key input to various models used to assess the status of an exploited stock. The estimated L_{∞} for *P. typus* (102.8cm) and *S. afra* (163.3cm) in this study were higher than L_{∞} recorded in Liberia coastal water for *P. typus* (Austin and Amponsah, 2017) and *S. afra* from Florida coastal water (Kadison *et al.*, 2010). The disparity in results could be explained by the variety of methodologies employed to analyze growth factors, the length of the largest species, the time and period of sampling, and the length

distribution's nature. In this study, the proportion of the asymptotic length was greater than the estimated proportion for length at first capture. This implies that the fish species in Lagos coastal waters become vulnerable to capture before spawning, a feature of growth overfishing. A similar finding was reported on *Sardinella maderensis* in Liberian coastal waters (Wehye *et al.*, 2017). The ratio of L_{\max} and asymptotic length (L_{∞}) for all the fish species examined in this study indicated that most of the fish could be short-lived. According to Mathews and Samuel (1990), the maximum length (L_{\max}) of short-lived species is less than the asymptotic length (L_{∞}).

The negative growth pattern of *Pseudotolithus typus*, *Lutjanus goreensis*, and *Sphyraena afra* recorded in this study is an indication that the fish species exhibited increased length rather than weight. This implies that at a certain stage of fish growth, weight increases ceased to be directly proportional to increases in length. Similarly, Oribhabor *et al.* (2011) recorded a negative allometric growth pattern in juvenile *L. goreensis* collected from Niger Delta Mangrove Creek, while Edah (2016) reported negative allometric growth for juvenile *P. typus* from Lagos Lagoon. Negative allometry was reported for *L. malabaricus* (Raesi *et al.*, 2011), *L. guttatus* (Martinez-Andrade, 2003; Sarabia-Mendez *et al.*, 2010) and *L. fulviflamma* (Grandcourt *et al.*, 2006). Allometric growth coefficients for *P. typus*, *L. goreensis* and *S. afra* in this study fell within the expected range of $2.5 < b < 3.5$ (Froese, 2006), indicating that the cubic law could be safely applied within the indicated length. The cubic law states that if an animal is growing isometrically and doubles in length, its weight will increase with the increase in volume; that is by 8 or (2^3) times (King, 2007).

The b values recorded in *S. afra* (Ayo-Olalusi and Ayoade, 2019) and *L. goreensis* (Fakoya *et al.*, 2019) for this study are lower than that reported in the same species in coastal waters of Lagos State.

The differences in b values could have been due to the variations in environmental or ecological conditions of different habitats or to the variation in the physiology of the animals or both (Jaiswar and Kulkarni, 2002). According to Jennings and Kaiser *et al.* (2001), population b values are dependent on the physiological condition of fishes, such as the gonad development stage and food availability. In addition, Muchlisin *et al.* (2010) stated that the b value is also affected by fish behavior; for example, active swimming fish may show lower b values compared to passive swimming fish. This is most likely related to the allocation of energy for mobility and growth. This opinion was supported by Shukor *et al.* (2008) who argued that a fast-flowing stream environment could lower b value and vice versa. Ozaydin and Taskavah (2007) reported that

parameter b may vary seasonally, daily, and between habitats.

The k values of the fish species (except k for *S. afra* =0.52±0.06) indicated that the fishes are in good condition in Lagos coastal water. The k factor obtained in this study was higher than k values recorded from Egyptian Mediterranean waters (Philips, 2014). However, k values in this study were lower than those obtained in *Lutjanus russellii* harvested from Indonesia (Zainal *et al.*, 2017).

CONCLUSION

The values of length-weight relationship slope (b) for *S. afra*, *P. typus* and *L. goreensis* in this study indicated negative allometry in growth pattern. The sizes distribution of the fish species implied that they become vulnerable to capture before spawning, a feature of growth overfishing. However, fish species (except *S. afra* with k =0.52±0.06) indicated that the fishes are in good condition in Lagos coastal water.

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