Length-weight relationship and condition factor of *Sphyraena afra* from the coastal waters of Lagos State

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Abstract. The length-weight relationship and condition factor of *Sphyraena afra* from the Lagos coast (LC) and the Lagos lagoon complex (LLC) in the coastal waters of Lagos State were studied for a period of two years. Parameters a and b of the length-weight relationship were estimated using the equation $W = a \times TL^b$, while the condition factor was calculated with the equation $K = 100 \times BW \times TL^{-3}$. The relationships of fish condition factor and body length, sex, and seasons in Lagos coastal waters were determined. The species exhibited negative allometric growth (b < 3, P < 0.05) for males, females, and combined sexes with the length exponent (b) ranging from 2.72 to 2.85. Correlation coefficient r ranged from 0.89 to 0.98. The allometric growth values obtained in LC and LLC from the length-weight relationship indicated that the fish species exhibited increases in length rather than in weight. The overall mean condition factors (K) for *S. afra* from the LC and the LLC were 0.97 ± 0.11 and 1.17 ± 0.12, respectively. The mean condition factors of females were higher than those for males at most of the sampling stations, and *S. afra* was observed to be in better condition during the dry season.

Keywords: *Sphyraena afra*, condition factor, length-weight relationship, correlation coefficient

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Introduction

Barracudas are commercial species of the Sphyraenidae family that occur in tropical and subtropical oceans. The Sphyraenidae includes only one genus, *Sphyraena*, with 21 species (Nelson 2006). Four species of the genus *Sphyraena* were collected from the coastal waters of Lagos State and were identified using FAO guides as *Sphyraena afra* Peters*, Sphyraena guachancho* Cuvier*, Sphyraena barracuda* (Edwards), and *Sphyraena sphyraena* (L.) (Carpenter and De Angelis 2016). *S. afra* is the most abundant and commonly seen of these species in both estuaries and marine waters. The fish commands a high market value, is in high consumer demand, and is a candidate for marine culture. Establishing length-weight relationships (LWRs) is a basic, regular task in fisheries research. Length-weight relationships provide useful information for fishery management and for both basic and applied purposes (Pitcher and Hart 1982). The condition factor expresses the condition of a fish, such as the degree of well-being, relative robustness, and plumpness or fatness in numerical terms, and it is based on the hypothesis that heavier fish of a given length are in better condition (Bagenal and Tesch 1978). Length-weight relationships of marine fish resources in Nigeria are limited, and the LWR for *S.*
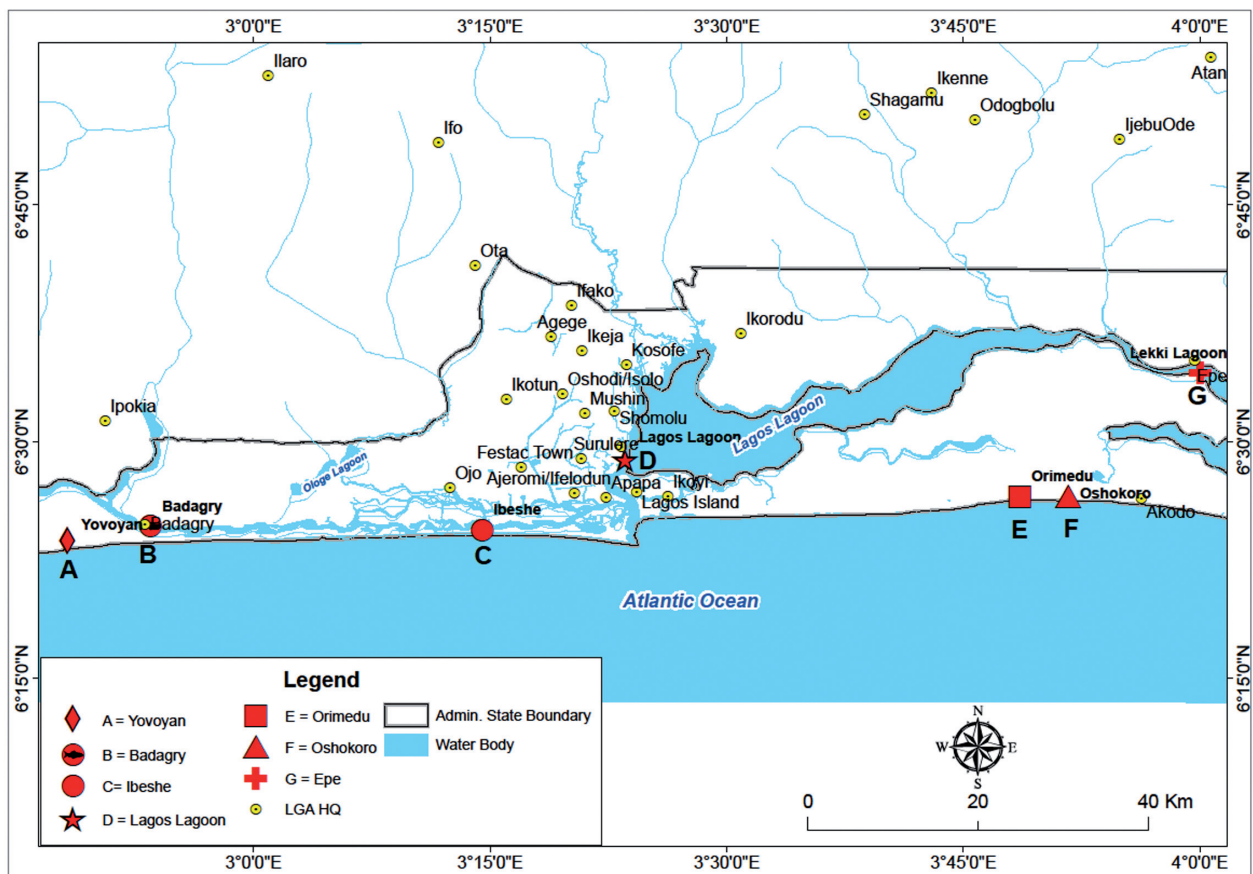
Figure 1. Map of coastal waters of Lagos State showing sampling stations.

afra was not available in Fish Base (Froese and Pauly 2019). The aim of this article is to provide information on the LWRs of *S. afra* that will foster the development of successful management programs in the wild and in culture in the coastal waters of Lagos State.

Material and methods

The study area was in the coastal waters of Lagos State, and seven stations were selected; three from the Lagos lagoon complex (LLC; Lagos, Lekki, and Badagry lagoons) and four from off the Lagos coast (LC; Yovoyan, Ibeshe, Oshoroko, and Orimedu). The stations were selected to cover the west by the Republic of Benin and the south stretching for 200 km along the coast of the Atlantic Ocean. The study area was located between the longitudes of 2°45' and 3°60' and the latitudes of 6°20' and 6°34' (Fig. 1). The climate is typical of rainforest/tropical coastal waters with a prolonged wet season (April to October) and a short dry season (November to March). Monthly sampling was carried out from August 2009 to July 2011. Water temperature, dissolved oxygen, salinity, and water transparency were measured in-situ with a mercury-in-glass thermometer and validated with a Jenway DO meter, a hand refractometer (Biomarine, Aquafauna model), and a Secchi disc (Model 9071), respectively. Specimens were collected at landing sites of the seven stations from local fishermen who used combinations of fishing gears that included trawl nets, purse seines, gill nets, trammel nets, and longlines. The species were

Table 1
Results of the physicochemical parameters of the coastal waters of Lagos State

Parameters	Lagos coast		Lagos lagoon complex	
	Rainy season	Dry season	Rainy season	Dry season
Temperature (°C)	27.5 ± 0.12	30.5 ± 0.11	27.5 ± 0.20	30.7 ± 0.08
Salinity (‰)	27.1 ± 0.06	33.2 ± 0.02	1.2 ± 0.11	7.2 ± 0.03
Water transparency (m)	0.25 ± 0.02	0.51 ± 0.12	0.17 ± 0.04	0.39 ± 0.01
Dissolved oxygen (mg O_2 dm^{-3})	5.6 ± 0.08	7.5 ± 0.13	5.5 ± 0.11	7.3 ± 0.18

identified with the FAO guide. The total length (TL) and body weight (BW) of fish specimens were measured to the nearest 0.1 cm with a meter rule and to the nearest 0.01 g with a digital scale, respectively. LWRs were calculated with linear regressions of log-transformed data of the equation $BW = a \times TL^b$, where BW = weight (g), TL = total length (cm), and a is the intercept and b is the allometric coefficient (Roff 1986). Fulton's condition factor (K) to determine fish wellbeing (Ricker 1975) was calculated using the following equation: $K = 100 \times BW \times TL^{-3}$. The data collected were analyzed using descriptive statistics (means and standard deviation). All the analysis was performed using IBM SPSS 20.0 at significance levels of P = 0.05 and P < 0.001. Analysis of covariance was used to compare the length-weight relationship between the sexes, condition factors between the sexes, seasons, and length. The Chi square (X^2) test was used to determine if a population contained equal proportions of males and females. The t-test was used to determine the level of significance of the parameters in the two water bodies.

Results

The results of the physicochemical parameters are shown on Table 1. The surface water temperature mean values ranged from 27.5 ± 0.12 to 30.7±0.08°C, mean salinity values ranged from 1.2 ± 0.11 to 7.2 ± 0.03‰ in LC and 27.1 ± 0.06 to 33.2 ± 0.02 in LLC. LC had higher salinity gradients than LLC (Table 1). Water transparency ranged from 0.17

± 0.04m to 0.51 ± 0.12 m, while the dissolved oxygen mean values ranged from 5.5 ± 0.11 to 7.5 ± 0.13mg L^{-1} (Table 1).

A total of 2,354 specimens (LLC: n = 638; LC: n = 1,716) were examined. Descriptive statistics and estimated parameters of length-weight relationships for *S. afra* are shown in Table 2, while Table 3 presents the summary of the length-weight equation of *S. afra* from the coastal waters of Lagos State. The b values ranged from 2.75 to 2.85 in LLC and from 2.72 to 2.75 in LC. The coefficient of determination ranged from 0.94 to 0.95 and 0.89 to 0.93 in LLC and LC, respectively.

Discussion

A characteristic of the length-weight relationship in fishes and invertebrates is that the value of exponent b is 3 when growth is isometric (without changing shape), while b > 3 is positive allometric growth and b < 3 is negative allometric growth. Statistical analysis of the length-weight data showed that *S. afra* males, females, and the sexes combined exhibited negative allometric growth in the coastal waters of Lagos State since the value of b (the exponential) of the regression equations representing their length-weight relationships was less than 3. The allometric growth values obtained at all the stations from the length-weight relationships indicated that the fish species exhibited increased length rather than weight. These showed that even though there were corresponding increases in weight and length,

Table 2

Descriptive statistics and estimated parameters of the length-weight relationship of *S. afra* from the coastal waters of Lagos State

Location	N	TL (cm) Min-Max	BW (g) Min-Max	Fulton condition factor Min-Max	Mean Fulton condition factor Mean ± SD	Regression parameters a	b	95% Cl of b	SE (b)	r^2
Lagos lagoon complex										
Males	296	18.9-183.3	28.5-25000	0.76-1.15	1.13 ± 0.24	0.0088	2.75	2,71-2.790	0.076	0.94
Females	342	18.0-153.2	27.6-15300	0.95-1.21	1.19 ± 0.18	0.0092	2.85	2,743-2.970	0.059	0.95
Sum	638	18.0-183.3	27.6-25000	0.76-1.21	1.17 ± 0.12	0.009	2.80	2,721-2.890	0.068	0.95
Lagos coast										
Males	820	17.6-116.9	27.2-6305	0.89-1.18	0.96 ± 0.13	0.01125	2.72	2,669-2.785	0.092	0.93
Females	896	18.4-154.4	27.3-15300	0.93-1.21	0.98 ± 0.24	0.01144	2.75	2,761-2.828	0.112	0.89
Sum	1716	17.6-154.4	27.3-15300	0.89-1.21	0.97 ± 0.11	0.01135	2.73	2,720-2.802	0.087	0.91

N – sample size, TL – total length (cm)m BW – body weight (g), a – intercept, b – slope, allometric growth coefficient, CL – confidence limit; SE (b) – standard error of slope b; r^2 – coefficient of correlation

Table 3

Summary of the length-weight equation of *S. afra* from coastal waters of Lagos State

Location	N	Equation (BW = a TL^b)	r^2
Lagos lagoon complex	638	BW = 0.0090 $TL^{2.80}$	0.91
Lagos coast	1716	BW = 0.01135 $TL^{2.73}$	0.95

N – sample size, BW – fish body weight, TL – total length, r^2 – coefficient of correlation

at certain stages of fish growth, increases in weight ceased to be directly proportional to increases in length as revealed in some fish species. The b value range determined of 2.72–2.85 for *S. afra* in this study fell within the expected range of 2.7–3.4 (Froese 2006) and that of 2.5–3.49 reported for great barracuda, *S. barracuda* (Froese and Pauly 2019). Jaiswar et al. 2004 reported a b value range of 2.72–2.73 for *Sphyraena obtusata* Cuvier in Bombay waters of the west coast of India, while a b value range of 2.84–2.89 was reported for the same species from the Jaffna Lagoon in Sri Lanka (Sivashanthini et al. 2009). Hosseini et al. (2009) also reported a b value range of 2.77–2.87 for *Sphyraena jello* Cuvier from the Persian Gulf. Some investigators reported that slight 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 (Bhattacharya and Acharya 1984, Jaiswar and Kulkarni 2002).

Variations in the coefficient of condition of fish primarily reflect the state of sexual maturity and the degree of nourishment. Wootton (1990) reported fish species with high K values are heavy for their length, while those with low K values are light for their length. The condition factor values of *S. afra* females were higher than those of males. This could have stemmed from differences in gonad development. The highest K values are attained in fish that are fully mature and have the highest reproductive potential (Agboola et al. 2008). The overall mean condition factor (K) for *S. afra* of 0.97 ± 0.12 and 1.17 ± 0.11 obtained off the LC and the LLC, respectively, indicated better condition in LC than in LLC, and these values varied slightly with the results of other studies: Kumolu-Johnson and Ndimele (2010) reported a K value of 1.92 for *S. afra* in the Ologe Lagoon, and Philips (2014) obtained a K value of 0.651 (calculated by gutted weight) for *Merluccius merluccius* (L.) from Egyptian Mediterranean waters. *S. afra* was observed to be in better condition during the dry season.

In conclusion, the LWR of *S. afra* revealed negative allometric growth in the two water bodies. The K value suggested that the condition of the coastal waters of Lagos State is favorable for the species. *S. afra* can survive off of the LC and LLC and in good condition despite the differences in the salinity gradient of the two environments. The present study provides

the first records of LWRs of this species, which will enhance its effective management and conservation. High dissolved oxygen content indicated that the coastal water of Lagos State can successfully support aquatic life including fish.

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