ORIGINAL ARTICLE

LENGTH-WEIGHT RELATION AND CONDITION FACTOR OF *Mugil bananensis* (PELLEGRIN, 1927) FROM SALOUM ESTUARY, SENEGAL

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ABSTRACT

Background: In the present study, length-frequency distribution, length-weight relationship (LWR) and Condition (K) factor were determined of *Mugil bananensis*. **Objective:** The objective of this study was to provide baseline data on length-weight relationship and condition factor for *M. bananensis* from Saloum Estuary. **Methods:** Specimens used for this study were caught during experimental fishing carried out quarterly from September 2014 to June 2016 in Saloum Estuary, Senegal. The weight and length of individuals were measured using an electronic scale and an ichthyometer respectively. **Results:** The total length obtained ranged from 12.1 to 29.5 cm with a mean of 22.4±2.02 cm. The length-frequency distribution was unimodal with a size mode equal to 21 cm. The allometric coefficient (b=2.878) was significantly ($p < 0.05$) different from 3, indicating negative allometric growth for *M. bananensis*. The condition factor (K) was higher than one (>1), which showed that this species was in good conditions in Saloum Estuary's waters. Seasonal changes in the condition factor (K) slightly decreased from the hot season (1.15±0.73) to the cold season (1.03±0.378). **Conclusion:** The findings of this study are significant and can serve as vital input parameters for future evaluations and fisheries management strategies concerning *M. bananensis* in the Saloum Estuary.

Keywords: *Condition factors, length-frequency distribution, length-weight relationship, Mugil bananensis, Saloum Estuary, Senegal*.

1. INTRODUCTION

Fish belonging to the Mugilidae family are widely distributed and abundant in estuaries across tropical, subtropical, and temperate regions, making them a significant commercial resource [1, 2]. Previous studies have noted the presence of Mugilidae in West African estuaries and lagoons [3, 4]. Mugil and Liza genera are the only genera found in West Africa in brackish water [5], with the individuals moving in tight flocks indicating a separation by sex and age group. In Senegal, Mugilidae is among the most abundant taxa in estuaries [6]. The Saloum Estuary, in particular, has seven species of mullet, with *M. bananensis* being the most important in terms of landing [7]. The Senegal Sea Fisheries General Results Report of 2022 reveals that this species accounts for 9.71% of fish landings in the Sine-Saloum region. *M. bananensis* holds significant socio-economic importance in the Saloum Estuary and is intensively fished. It is among the various fish species found in the Sine Saloum and Casamance estuaries, providing a substantial supply of fresh or whole dried fish in local markets. Its economic, social, nutritional, and environmental significance has prompted special attention to be paid to M. bananensis in Senegal, particularly in the Saloum Estuary. As such, this study aims to investigate the parameters of the length-frequency distribution, the length-weight relationship, and the condition factor of *M. bananensis* in the Saloum Estuary.

2. MATERIALS AND METHODS

2.1. Study area

This study was carried out in the Saloum Estuary. The Saloum Estuary is located 100 km south of Dakar and north of the Gambia and Casamance river estuaries between 13.6° and 14.2° North and 15.8° and 16.8° West (Figure 1). The Saloum Estuary belonged to the category of reverse estuaries [8, 9]. This Estuary no longer received an influx of fresh water. It was characterized by a predominance of seawater due to the low slope, a positive upstream-downstream salinity gradient and significant losses by evaporation [10]. The Saloum Estuary presented a hyper-hyaline situation upstream with extreme salinity values that reached (sometimes exceed) four times those of the sea [11].

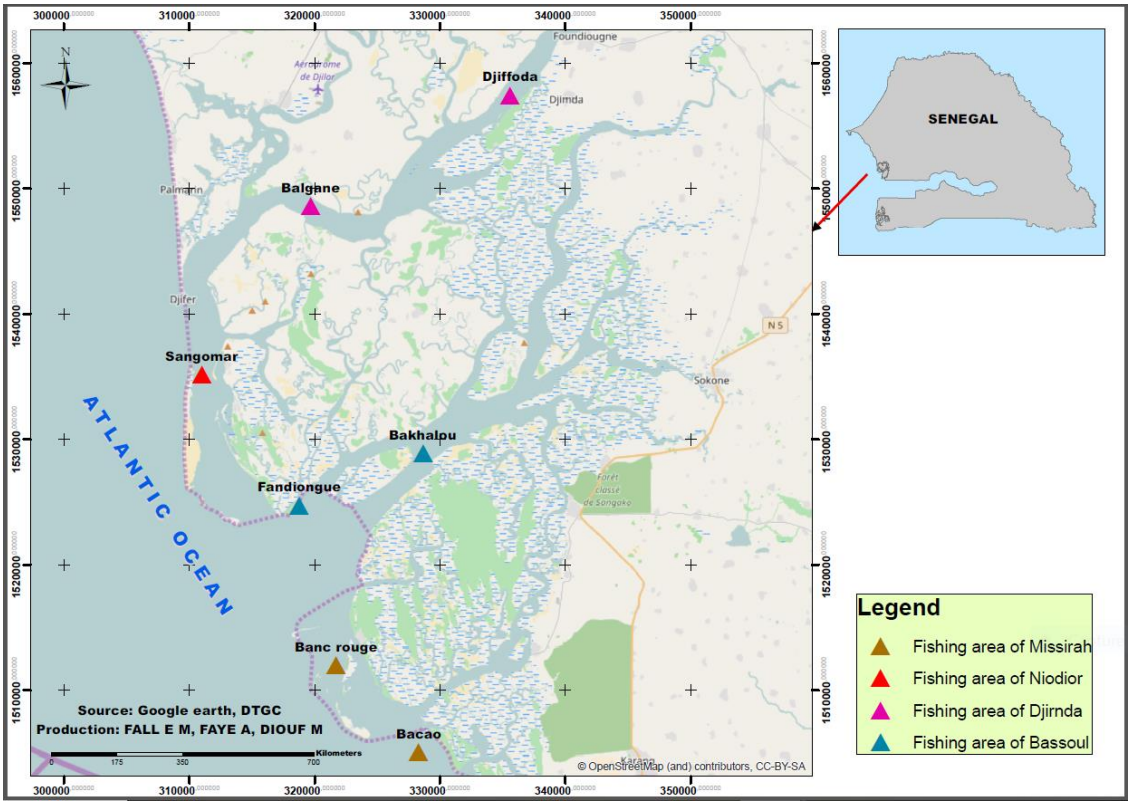

Figure 1: The figure showed the sampling stations.

2.2. Sampling protocol

The individuals of *M. bananensis* used for this study were caught during experimental fishing carried out quarterly from September 2014 to June 2016. The purpose of this experimental fishing was to study the selectivity of the gillnets used to catch *Ethmalosa fimbriata*. The fishery was carried out with a gillnet consisting of an arrangement of six layers of polyamide monofilament with a length of 160 m, each having successive meshes of 28; 30; 32; 36 and 40 mm side meshes.
After each tow, total length (L) in centimeters and weight (W) in grams of individuals of each species were recorded. The total length of the fish was measured with an ichthyometer, while the weight was weighed with an electronic balance with the accuracy of 0.01 g.

2.3. Length-frequency distribution

The total length measurements performed on specimens allowed to plot the length-frequency distribution of *M. bananensis.* The various measured lengths were grouped into 1 cm class intervals. The following formula was used to calculate the size frequencies:

$$Fi = Ni \times \mathrm{N} \times 100 \qquad \textbf{(1)}$$

Where Fi = Frequency, Ni = Number of specimens for a given Length, N = Total number of specimens.

2.4. Length-weight relationship (LWR)

Knowledge of this relationship had applications in fisheries biology and fish stock assessment [12, 13]. In fishery assessment, important information was obtained from the length-weight relationship of fish species [14, 15]. Indeed, fish weight from length, ontogenetic allometric changes and condition index was determined from the length-weight relationship [16]. Estimates of the length-weight relationship were relevant for stock management and assessment [15].
The relationship between total length (L) and total weight (W) for almost all fish species was expressed by the following equation [17]:

$$\mathrm{W} = \mathrm{a} \times \mathrm{L}^{\mathrm{b}} \qquad \textbf{(2)}$$

Where:
W = Weight (g) of fish in grams,
L = Total length of fish in centimeters,
a = Exponent describing the rate of change of weight with length,
b = The slope of the regression line (also referred to as the allometric coefficient).

The constants **a** and **b** were derived through the least squares linear regression method using logarithmically transformed length and weight values. [18]:

$$\log\mathrm{W} = \log(\mathrm{a}) + \mathrm{b} \times \log(\mathrm{L}) \qquad \textbf{(3)}$$

The 95% confidence limits for b (CL 95%) were computed using the equation [19]:

$$CL = b \pm (1.96 \times SE) \quad \textbf{(4)}$$

Where SE = the standard error of b. In order to check if the value of b was significantly different from 3, the Student's t-test was conducted as expressed by the following equation according to Sokal and Rohlf (1987) [20]:

$$ts = \frac{(b-3)}{SE} \quad \textbf{(5)}$$

Where:

ts = The t-test value,
b = The slope,
SE = The standard error of the slope
b. Growth is isometric (**I**) if b equal or very close to 3 and allometric if b significantly different from 3; negative allometric (**A**$^-$) if b 3 and positive allometric (A^+) if b > 3 [21, 22].

2.4. condition factor (K)

The condition factor has usually been represented by the letter K when the fish was measured and weighed in the metric system. The K value was calculated from the weight (g) and length (cm), and could be used to estimate changes in nutritional condition. The formula most often used is:

$$K = \frac{W}{L^3} \times 100 \quad \textbf{(6)}$$

Where:

K= condition factor,
W= Weight of fish (g),
L= total length of fish (cm).

2.4. Statistics

Statistical processing and graphics were performed with Microsoft Office Excel 2010, and R software. The Student's t-test was used to verify the significance of the results at α = 0.05 significance level.

3. RESULTS

3.1. Length frequency distribution

A total of 213 specimens were used for this study. The total length of *M. bananensis* ranged from 12.1 to 29.5 cm with a mean of 22.4±2.02 cm. The length-frequency distribution showed unimodal distribution. The modal size was 21 cm as shown in figure 2. Analysis of the length-frequency distribution indicated the presence of three groups of *M. bananensis* individuals in Saloum Estuary. The first group included individuals of size between 12.1 and 19 cm. The second group was made up of individuals ranging in size from 20 to 24 cm, while the size of individuals in the third group varied between 25 and 29 cm. However, the second group accounted for the majority of the captures.

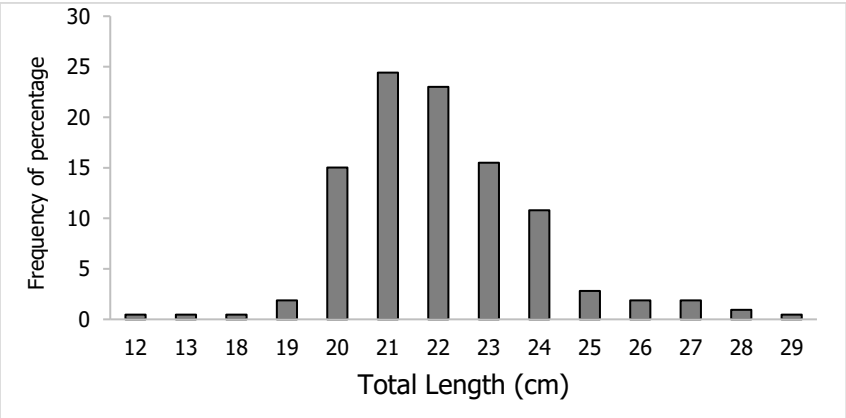

Figure 2: The figure showed the length-frequency distribution of *M. bananensis.*

3.2. Length-weight relationship

Length-weight relationship parameters a and b, 95% confidence interval for b, correlation determination r^2, with a number of specimens, min-max length, min-max weight and growth type were given in Table 1 and Figure 3. The length-weight relationship of *M. bananensis* was found highly correlated and the coefficient of determination being r^2= 0.925. The b coefficient was significant (Student t–test: p<0.05) less than 3 for *M. bananensis*, meaning that growth was negatively allometric.

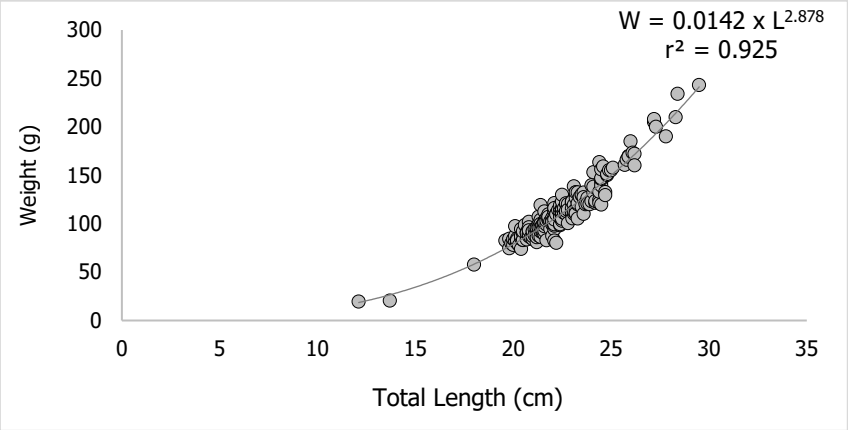

Figure 3: The figure showed the length-weight relationships for *M. bananensis.*

Table 1: The table showed the descriptive statistics and estimated parameters of the length-weight relationship for *M. bananensis* from the Saloum Estuary.

Number	Length range (cm)	Weight range (g)	Regression parameters			95% CL of b	r^2	Growth type
	Min-Max	Min-Max	a	b	SE of b			
213	12.1-29.5	19.4-243.1	0.0142	2.878	0.056	2.767-2.990	0.925	I

3.3. Condition factor

Boxplot diagrams were used to show the variation in condition factors (K) for *M. bananensis*. All seasonal K values were greater than 1 (Figure 4). The highest condition factor (K) was recorded during the hot season (1.15±0.73) while the lowest condition factor (K) was obtained in the cold season (1.03±0.378). However, the condition factor (K) was not significantly (p>0.05) different between the hot season and cold season.

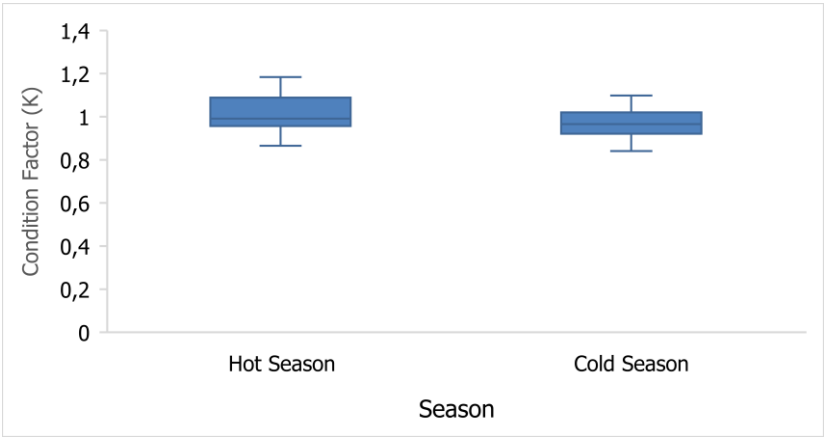

Figure 4: The figure showed the condition factor (K) of *M. bananensis.*

4. DISCUSSION

The total lengths of the examined *M. bananensis* specimens ranged from 12.1 cm to 29.5 cm. Other studies from different locations have reported significantly smaller length ranges, such as 4.4-15.5 cm from the Kakum Estuary in Ghana [23]. According to Ergüden (2021), the length of differences in values could be explained with the habitat differences, environmental factors and fishing period [24]. In addition, fish length can vary with sex, season, feeding rates, gonad development, water flow, and behavior [25]. The length-frequency distribution analysis showed the presence of three groups of *M. bananensis* individuals, with sizes ranging from 12.1 to 19 cm, 20 to 24 cm, and 25 to 29 cm, respectively. These three groups would consist of juvenile, adult and subadult individuals.

The value of *M. bananensis* allometric coefficients also suggested a negative allometric growth (b= 2.878 < 3). Previous studies [26-23] have discovered comparable findings in the Mvassa Lagoon (Republic of Congo) and Kakum Estuary (Ghana), respectively. Nevertheless, positive allometric growth of *M. bananensis* has been observed by Dankwa (2011) [27] in the Pra Estuary (Ghana), Coulibaly (2018) in the Grand Lahu Lagoon (Ivory Coast), and in the Saloum Estuary (Senegal) [28, 29]. The study of the Dankwa (2011) [27], reported LWR of *M. bananensis* from Volta Estuary (Ghana) with b value showing an isometric growth (Table 1). In the present study, the estimated b value for *M. bananensis* was found within the normal expected ranged of 2.5-3.5 [30, 31]. The observed differences in b values could be attributed to differences in geographical areas with varying environmental conditions [32-24] or habitat factors [33], including seasonal effect, degree of stomach fullness, gonad maturity, food richness [34, 35], sex, health, reproductive period, and seasonal variation [21-36].

Table 2: The table showed the parameters of a length-weight relationship for *M. bananensis* from various regions.

Country	Number	Type of Length (cm)	Parameters			Growth type	Author
			a	b	r^2		
Senegal	94	FL	-	3,097	0,949	A+	[29]
Ghana	-	SL	0.0191	3.030	0.989	I	[27]
Ghana	-	SL	0.0175	3.104	0.977	A^+	[27]
Republic of Congo	64	SL	0.042	2.688	0.988	A^-	[26]
Ghana	171	TL	0.030	2.480	0.92	A^-	[23]
Ivory Coast	179	SL	0.005	3.211	0.932	A^+	[28]
Senegal	213	TL	0.0142	2.878	0.925	A^-	Present study

M. bananensis condition factor (K) values varied slightly from the warm season to the cold season. According to King (1995) and Dasgupta (1991), several factors, such as spawning, food abundance, influenced the condition factor (K) of fish [37, 38]. One of the factors leading to the decline of the condition factor (K) of fish was reproduction [39]. This could explain the slight decrease in the condition factor of *M. bananensis*. Indeed, previous studies had shown that *M. bananensis* reproduced during the cold season [40, 41]. During this cold season, *M. bananensis* should undergo a loss of energy related to the development of sexual products and sexual maturation of the gonads; which led to a decrease in the condition factor (K). Condition factors (K) recorded in *M. bananensis* were greater than one (>1). According to Nehemiah et al., (2012) and Ouahb (2021) previously reported that a K value greater than one means a fish was in good condition [42, 43].

5. CONCLUSION

The study of length-weight relationship (LWR) and condition factor was an important tool that provided information on growth patterns of fish. The present study, which provided information on the length-weight relationship and condition factor of *M. bananansis*, was one of the few studies dealing with the biological aspects of this species in Senegal. The results obtained highlighted a unimodal length-frequency distribution. The length-frequency distribution suggested that 20-24 cm size class groups were more abundant. The result obtained in this study showed a negative allometric growth for *M. bananansis*. The results showed fluctuations in K values of *M. bananensis* during the two seasons. This seasonal variation in the condition factor could be linked to the spawning period. The findings of the present study were preliminary data for a study of the species *M. bananansis*, and they should help to develop strategies for the sustainable management of fishing for this species in Saloum Estuary.

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