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A Preliminary Study of Growth Pattern, Condition Factor and Population Structure of Sicklefin Mullet, *Liza falcipinnis* (Valenciennes, 1836) in the New Calabar River, Nigeria

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Abstract: A study on growth pattern, condition factor and stock characteristics of the Sicklefin Mullet *Liza falcipinnis* Valenciennes, 1836 from the New Calabar River, Nigeria was undertaken from January to December 2017. The length of *L. falcipinnis* ranged from 9.1 to 37.1 cm while weight was between 13 to 370 g. The result of length weight relationship revealed negative allometric growth pattern with the b value of 2.38 and condition factor (k) of 0.88. The asymptotic length (L∞), growth coefficient (K) and index of growth performance (φ – phi prime) were estimated at 33.1 cm, 0.18 per year and 2.295 per year respectively. The total, natural and fishing mortality rates recorded in the study were 1.17 per year, 0.56 per year and 0.61 per year respectively while the exploitation ratio (E) value was 0.52. The Logistic regression of the probability of capture routine gave an estimate of L_C 50% at 13.8 cm. The exploitation rate which maximises yield per recruit produced values of Emax was 0.88, which indicated that the species was overfished. All these results reveal the need to regulate fishing activities in the New Calabar River for sustainable exploitation of the studied fish species.

Key words: Size, growth, mortality, exploitation, *Liza falcipinnis. New Calabar River.*

Büyüme Modeli Bir Ön Çalışma, Durum Faktörü ve Yeni Kalaba River, Nijerya'da Sicklefin Kefali, *Liza falcipinnis* (Valenciennes, 1836) Nüfus Yapısı

Özet: Nijerya'daki New Calabar Nehri'nden Sicklefin Mullet *Liza falcipinnis* Valenciennes 1836 nın büyüme modeli, durum faktörü ve stok özellikleri üzerine bir araştırma Ocak-Aralık 2017 arasında yapıldı. *L. falcipinnis*'in uzunluğu 9.1 ila 37.1 cm arasında değişirken ağırlık 13 ila 370 g olarak değişmektedir. Uzunluk ağırlık ilişkisinin sonucu negatif allometrik büyüme paternini değeri b=2.38 ve koşul faktörü (k)= 0.88 ile ortaya çıkarılmıştır. Asimptotik uzunluk (L∞), büyüme katsayısı (K) ve büyüme performans endeksi (φ - phi prime) sırasıyla 33.1 cm, yılda 0.18 ve yıllık 2.295 olarak hesaplandı. Araştırmada kaydedilen toplam doğal ve balıkçılık ölüm oranları sırasıyla yıllık 1.17, yıllık 0.56 ve yıllık 0.61 iken, kullanma oranı (E) değeri 0.52 olmuştur. Yakalama rutini olasılığının lojistik regresyonu 13,8 cm'de % 50 LC tahmini yapmıştır. İstihdam başına üretilen Emax değerlerini maksimuma çıkaran sömürü oranı 0,88 olup bu türlerin aşırı avlandığını göstermiştir. Tüm bu sonuçlar, çalışılan balık türlerinin sürdürülebilir kullanımı için New Calabar Nehri'ndeki balıkçılık faaliyetlerinin düzenlenmesi gerektiğini ortaya koymaktadır.

Anahtar kelimeler: Elektronik, yazarlar için talimatlar, makale şablonu.

1. Introduction

Mugilidae is represented in Nigerian freshwater by genus consisting of three species namely *Mugil cephalus*, *Liza falcipinnis* and *Mugil hyselopterus* [1]. *Liza falcipinnis* is the most widely spread species of mullets [2]. The species has the distinctive features like dark spot at the base of pectoral fin, silvery in colour with darker back and thin upper lip [1]. The biology and ecology of this species have been studied extensive [3-8].

Between 2010 and 2015, the production of mullets in Nigerian water bodies have been oscillating between 10,000 and 11,000 metric tonnes per annum. In 2012, 2013, 2014 and 2015 respectively the figures were 11,324, 10,821, 10,923 and 11,962 metric tonnes [9]. Based on these figures the stock has reached the peak. In order to reduce total catch to biologically and economically sustainable level, there is a need to assess mullets stock in Nigerian water bodies.

Stock assessment is the basis for understanding changing fishery patterns and issues such as habitat destruction, predation and optimal harvesting rates. It forms the basis for calculations leading to knowledge of the growth, mortality, recruitment and other fundamental parameters of their populations. In spite of its

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economic importance and rate of exploitation, there has been no attempt to study the stock characteristics of the *Liza falcipinnis* in Nigerian water bodies, Nigeria.

This information is needful for sustainable management of *Liza falcipinnis* in the river, where it is caught in large numbers with unregulated fishing gears and methods. It against this background the present work set out to determine growth, mortality, yield per recruit mortality coefficient, exploitation rate and ratio, recruitment pattern virtual population for better management of this important fish species.

2. Materials and Methods

The New Calabar River, Nigeria is a partially mixed estuary system that lies between latitude 4º25′N and longitude 7º16′E (Figure 1). It runs through the most densely populated areas in the hinterland and empties into the Atlantic Ocean at the southern tip of Bonny in the south.

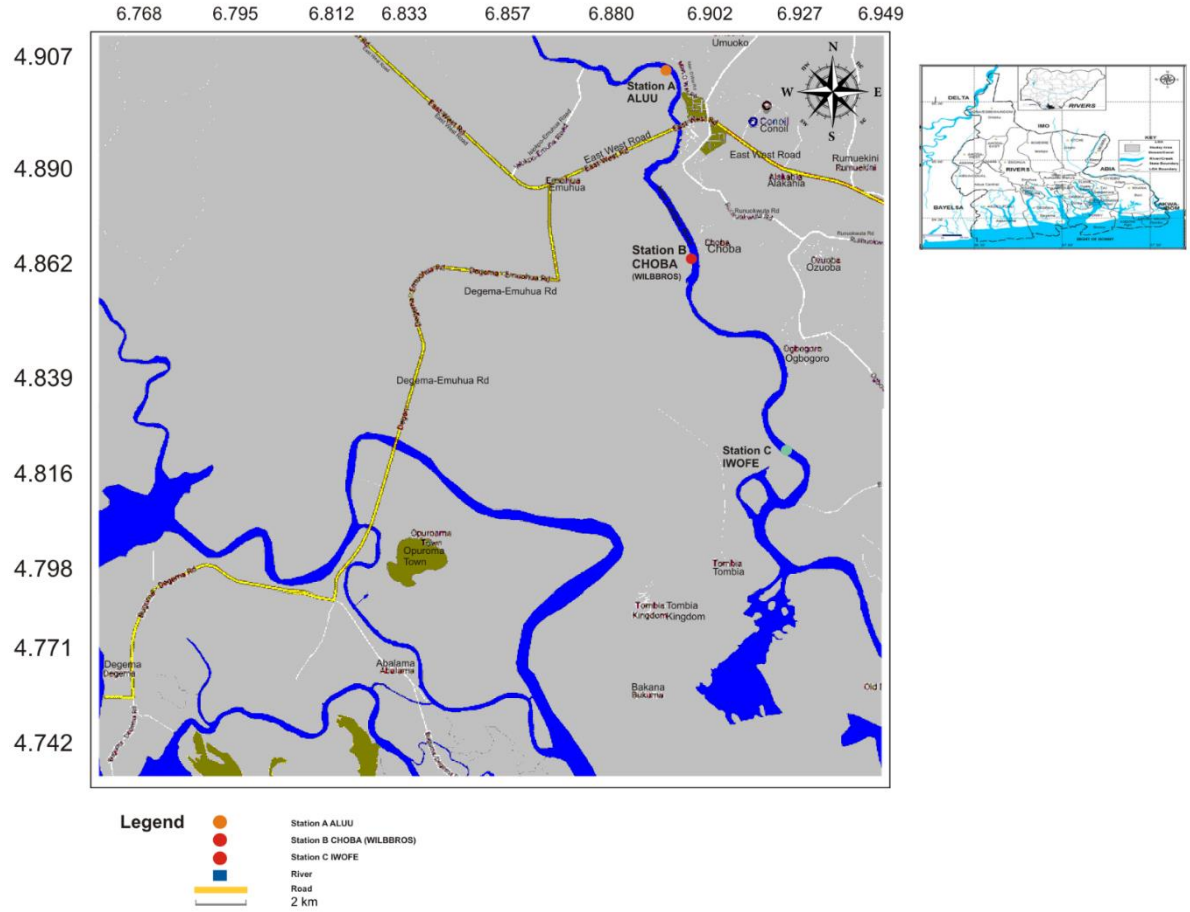

Figure 1. Map of Nigeria showing the location of sampling area

Fish specimens were sampled on a monthly basis during January 2009 to May 2010 from three major landing sites of the river (Aluu, Iwofe and Choba). Fish specimens were sampled from the catches of the local fishermen which were harvested using different types of fishing gears: seine net (80 m long with 25 and 45 mm mesh sizes), fixed gill nets (50 to 80 m long with 12.5 to 45 mm mesh sizes), cast nets (4 to 9 m diameter with 6.35 and 15 mm mesh sizes). The specimens collected were identified using the keys and works of [1]. The total length and weight of *Liza falcipinnis* specimens were measured in the laboratory using a measuring board and an electronic balance to the nearest 0.1 cm and 0.01 g respectively. The length-frequency data were pooled monthly from different sampling sites and subsequently grouped with one cm class intervals for analysis. The length-frequency distribution for *L. falcipinnis* was constructed using 1 cm intervals of total length. The length-weight relationships were estimated using the formula $W = aL^b$, where, W is the total weight in g, L is the total length in

cm and 'a' and 'b' are the constants. The condition factor was calculated for the species under study using the following equation: $K= (W/L^3) x100$ [10]. Growth parameters such as L∞ and K were calculated according to [11, 12]. The overall growth performance index (Phi prime) for the fish were calculated empirically [13] using the formula, Phi prime = log10 K + 2 log10 L∞, where, K is expressed on annual basis and L∞ in cm. Length at first capture (Lc_{50}) was estimated by plotting cumulative percentages of length against length classes. Critical length at capture was estimated as the ratio of length at first capture to asymptotic length (L∞)

The total mortality rate (Z), natural mortality rate (M), fishing mortality rate (F) and rate of exploitation (E) were estimated by [14-15] at the mean habitat temperature which was 27.8 °C. One year recruitment pattern was obtained by projecting the length frequency data backward on to the time axis as described in the FiSAT routine. Relative yield per recruit (Y'/R) and relative biomass per recruit (B'/R) were derived from [16]. The data were analysed using FiSAT II (FAO-ICLARM Stock Assessment Tools) as explained in details [17].

3. Results

Length weight relationship and condition factor

The total length ranged from 9.1 to 37.1 cm, with a mean of 20.96±0.41 and weight ranged between 13 – 370 g with a mean value of 97.39±5.86. The length weight relationship results revealed exponent (b) value of 2.38 and highly correlation coefficient (r) value of 0.88. The condition (K) of *L. falcipinnis* ranged between 0.44 and 1.73 with a mean value of 0.88±0.02 (Table 1).

Table 1. Length weight and condition factor *L. falcipinnis*

Species	TL (cm)		TW(g)		a	b	r^2	K	
	Mean±SE	Range	Mean±SE	Range				Range	Mean±SE
L. falcipinnis	20.96±0.41	9.1 - 37.1	97.39±5.86	13 – 370	-4.07	2.38	0.88	0.44 - 1.73	0.88±0.02

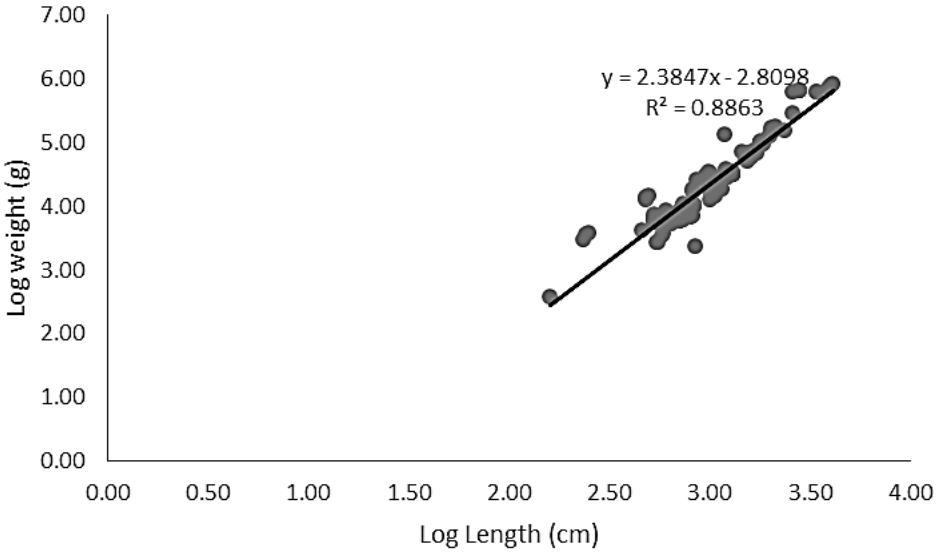

Figure 2. Length weight relationship of *L. falcipinnis* from the New Calabar River

Growth Parameters

The growth curve generated by ELEFAN I for L. falcipinnis is shown in Figure 3. The asymptotic length (L∞), growth coefficient (K) and index of growth performance (φ – phi prime) were estimated at 33.1 cm, 0.18 per year and 2.295 respectively (Table 2).

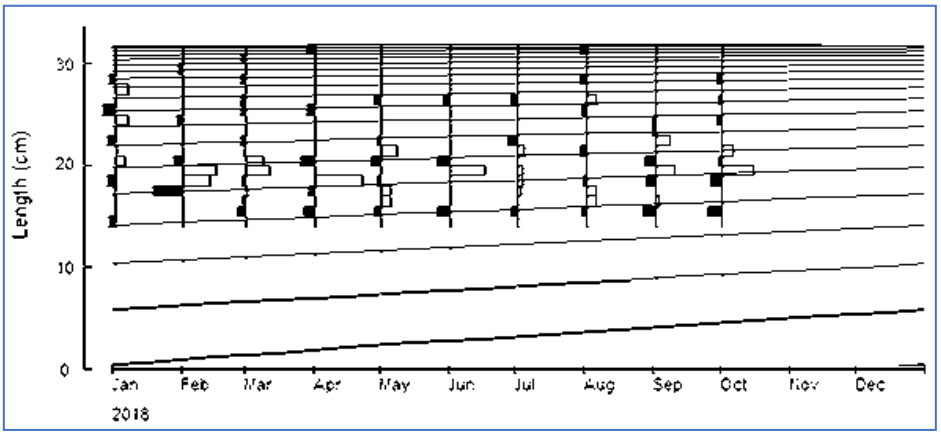

Figure 3. ELEFAN I growth curve of *L. falcipinnis* from the New Calabar River

Table 2. Population dynamics of *L. falcipinnis* from the New Calabar River

Parameters	***L. falcipinnis***
L∝	33.1 cm
Growth co-efficient – K	0.18
Φ	2.295 per year
Z	1.17 per year
M	0.56 per year
F	0.61 per year
E	0.52

Mortality and exploitation

The total mortality (Z) of *Liza falcipinnis* estimated by the length converted catch curve was 1.17 per year while the natural mortality as per Pauly's empirical formula keeping the habitat temperature as 27.8°C was found to be 0.56 per year and the estimated fishing mortality (Z-M=F) was 0.61 per year (Table 2). The exploitation ratio E was found to be 0.52 (Figure 4).

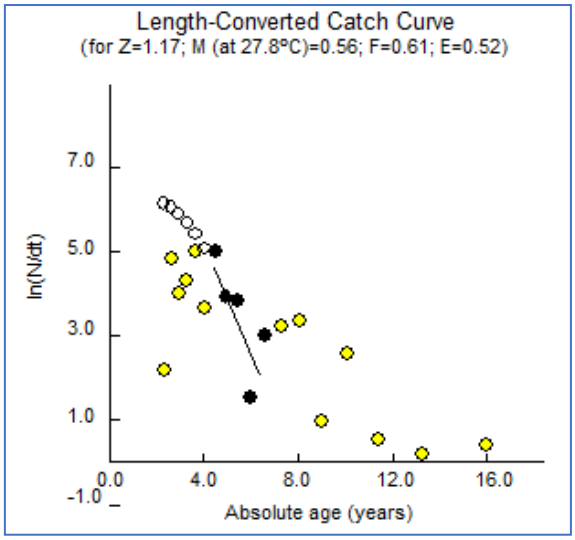

Figure 4. Length converted catch curves of *L. falcipinnis* in the New Calabar River

Recruitment strength

Figure 5 shows the recruitment pattern of *L. falcipinnis* in New Calabar River. The results revealed the bimodal recruitment pattern of *L. falcipinnis* with unequal strength pulses. The period of recruitment peak during April and July and the percentage of recruitment were 13.4% and 15.2% respectively.

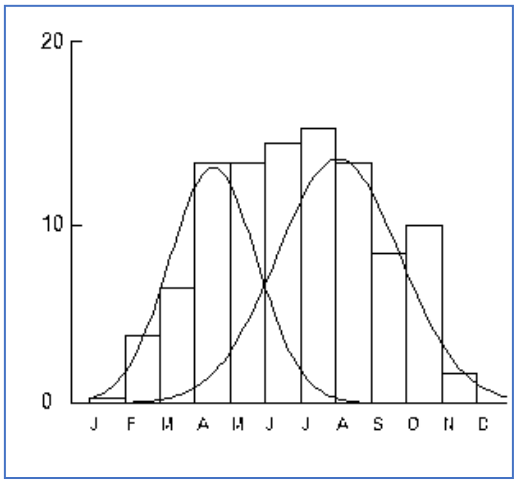

Figure 5. Recruitment patterns of the studied fish species in the New Calabar River

Probability of capture and Length at first maturity (Lc50)

The Logistic regression of the probability of capture routine gave an estimate of L50% at 13.8 cm (Figure 6). The L25% and L75% were also calculated as12.6 cm and 15.1 cm respectively. In this study, the critical length at capture (Lc50/L∞) ratio was found to be 0.42.

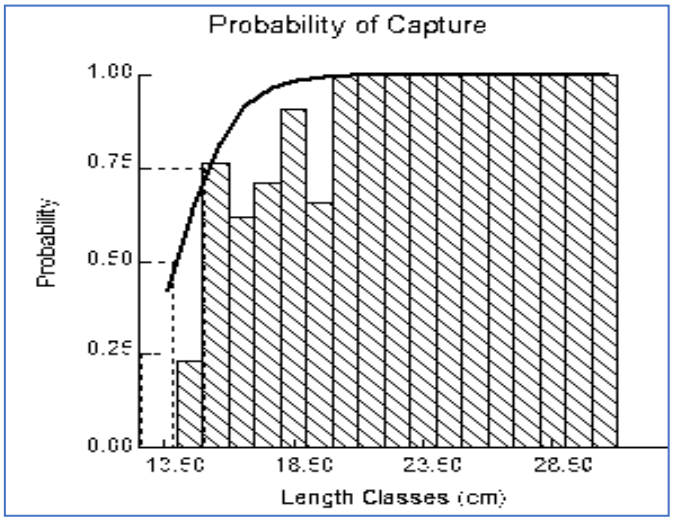

Figure 6. Length at capture (L50) of *Liza falcipinnis*

Yield-per-recruit and biomass-per-recruit

The Beverton-Holt relative yield per recruit (Y'/R) and relative biomass per recruit (B'/R) estimated using selective ogive procedure of FiSAT for the assessed fish species are given in Figure 7. The analysis indicated that the exploitation rate (E) which maximises yield per recruit produced values of Emax = 0.88, E 0.1 = 0.71 and E 0.5 = 0.36

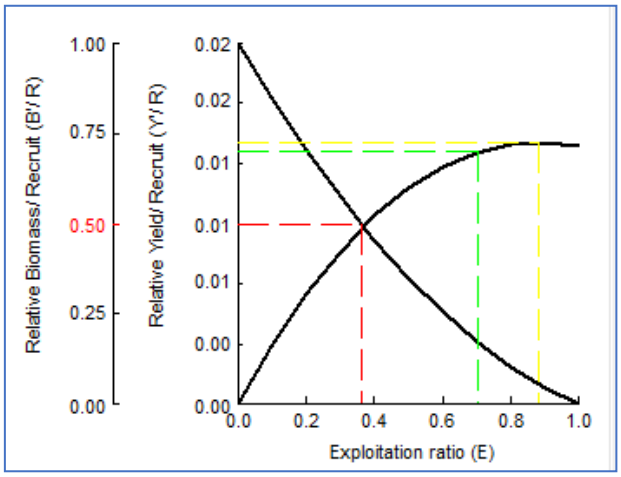

Figure 7. Yield-per-recruit and biomass-per-recruit

4. Discussion

The size of *L. falcipinnis* recorded in this study ranged from 9.1 to 37.1 cm for total length and 13 – 370 g for weight. Dankwa and Blay, [18] studies on Imo-River estuary, Qua-Iboe estuary, Cross River estuary and Bonny estuary reported between 3.4-29.7 cm (TL) for *L. falcipinnis.* Similar results were recorded [19-20]. The population of this stock is said to be dominated by the young class based on the classification proposed by [21].

The length-weight relationship revealed a highly correlation (r) and the exponent of (b) value of 2.38 indicating negative allometric growth which implies that growth in length increase faster than in weight. This result was similar to what [20] reported on *L. falcipinnis* from Badagry creek in Lagos State, Nigeria. The mean condition factor (K) in this study was estimated to be 0.88. Condition factor (K) less than 1 indicates poor wellbeing of the assessed fish species. This result was in consistency with [22] who reported almost the same value (0.82) on the same species in Qua Iboe River estuary, Nigeria.

In the present study, the bimodal recruitment pattern of *L. falcipinnis* occurred in April and July with the peak in July. The major recruitment peak is in close relation with [23] who observed that major peak in recruitment occur during wet season months (April - August) coincide with breeding period. This result was in line with [15] observed a double recruitment pulse per year for tropical fish species and for short lived species.

The $L\infty$ =33.1 cm and K = 0.18 per year observed in this study were higher than earlier for this species from and [8]. The differences between the values might be due to the fishing pressure. According to [24], the strong tendency of fish length to decrease as fishing pressure increases means that length linked changes occur in several demographic parameters. The length-based index of growth performance (φ – phi prime) was found to be2.295. This value is in agreement with [25] who reported that the ϕ' mean value for some important fishes in Africa range from 2.65 - 3.32, which they considered as low.

The total mortality (Z) recorded in this study was 1.17 per year which is slightly lower than [26] who reported total mortality of Z = 1.32 per year. The exploitation ratio E was found to be 0.52 which is almost close to 0.5 indicating that the sustainable yield of the assessed fish species is optimized at F = M [27]. The fishing mortality (0.61 per year) was also higher than natural mortality of 0.56per year. This implies that the fishing activities in the New Calabar River accounts for greater percentage of the stock's mortality. An exploitation ratio should be maintained at 0.4 level for sustainable level [28]. The result was in agreement with [29] who observed that high fishing and natural mortality are the common features of tropical fish also coincides with the present findings.

In this study, the estimated length at first capture (Lc) was estimated at 13.8 cm. The critical length at capture (Lc) was estimated as 0.42 which revealed that small sizes are vulnerable to capture. This situation is also described by [30] as growth overfishing; when fishes are caught before they can realize their full potential. The high fishing effort could lead to overfishing when the total yield decreases with increasing fishing effort [31]. Also the high fishing effort has resulted in a higher percentage of relatively young fish. In view of these results there is need to improve management of commercially important fish stocks in the New Calabar River through better monitoring and control and educating fishers about the consequence of their fishimg practices.

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