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Length-Weight Relationship and Condition Factor of Economically and Ecologically Important Fish Species in Ilaje LGA, Ondo State, Nigeria

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Abstract Length–weight relationship (LWR) and condition factor (K) are critical parameters for evaluating fish growth patterns, stock status, and ecosystem health. This study examined *Ethmalosa fimbriata* and *Chrysichthys macropogon* from four coastal fishing villages; Ayetoro, Bijimi, Idiogba, and Asumogha in Ilaje Local Government Area, Ondo State, Nigeria. A total of 320 specimens were collected between April and July using gillnets of varying mesh sizes. Standard length and body weight were measured, and LWR parameters were estimated using log-transformed regressions, while Fulton's condition factor was applied to assess fish health and habitat suitability. Results showed that both species exhibited allometric growth, with growth exponent (b) values significantly deviating from the isometric standard of 3. The condition factor for *E. fimbriata* ranged from 0.92 at Bijimi to 1.56 at Idiogba, while *C. macropogon* varied from 0.74 at Asumogha to 1.70 at Ayetoro. Higher K values at Idiogba and Ayetoro indicate relatively favorable habitats, whereas lower values at Bijimi and Asumogha suggest environmental stress and reduced food availability. Correlation analysis revealed a positive but site-dependent relationship between length and weight, with stronger associations in stations of higher habitat quality. These findings underscore the influence of habitat variability on fish condition and highlight the need for continuous ecological monitoring. The study provides a baseline for sustainable fisheries management and conservation strategies in Nigeria's coastal waters.
Keywords Length–weight relationship; Condition factor; Allometric growth; Fisheries management; Coastal ecosystems; Nigeria

1 Introduction

The length–weight relationship (LWR) and condition factor (K) are fundamental parameters in fisheries biology, providing insights into growth patterns, health status, and habitat suitability of fish populations. LWR describes how body weight varies with length, while K serves as an index of well-being and ecological fitness, reflecting the influence of food availability, environmental conditions, and anthropogenic pressures (Blackwell et al., 2020; Akinyemi et al., 2021). Together, these metrics are widely used in stock assessment, ecological monitoring, and fisheries management.

Building on our previous research (Ojo et al., 2025), which examined the effect of heavy metal on *Ethmalosa fimbriata* and *Chrysichthys macropogon* in Ilaje LGA, this study extends the analysis by exploring the dimensions of Length-weight relationship and condition factor of the fish species in the study areas while earlier paper highlighted how pollution could impair the health of fish in the study area, the current work emphasizes their health status, providing a complementary perspective on their growth pattern considering the environmental changes.

Variations in LWR and K are often attributed to environmental gradients, seasonal fluctuations, and biological factors such as age, sex, and reproductive cycles (Mazumder et al., 2016; Ibrahim et al., 2022). In addition, human activities including pollution, overfishing, and habitat alteration exert strong impacts on fish condition and growth, often serving as bioindicators of ecosystem stress (Nwani et al., 2020; Olanrewaju et al., 2023). Assessing these parameters is therefore crucial in understanding the ecological integrity of aquatic systems, particularly in regions where fisheries provide food and income security.

In Nigeria and across West Africa, artisanal fisheries play a central role in coastal livelihoods. Species such as *Ethmalosa fimbriata* (bonga shad), a dominant small pelagic fish, and *Chrysichthys macropogon* (catfish), a demersal species of commercial value, are ecologically and economically significant (Adewumi et al., 2021; Akintade et al., 2023). Both species contribute substantially to food security, trade, and cultural practices in coastal communities. However, their populations are increasingly threatened by environmental stressors, including oil exploration, coastal industrialization, and unsustainable fishing practices in the Niger Delta (Olusola et al., 2018; Ajibare and Ayeku, 2024).

The Ilaje Local Government Area of Ondo State, located within the Niger Delta, is a critical fishing hub where these species are heavily exploited. Yet, despite their importance, limited studies have assessed the growth and condition of these species under the combined influence of artisanal fishing pressure and environmental variability in this region.

The length–weight relationship (LWR) has long been recognized as one of the most widely applied tools in fisheries biology. It provides valuable insights into growth dynamics, population health, and ecological adaptations of fish species. Typically expressed as a power function of length and weight, LWR helps in estimating growth patterns, biomass, and energy allocation within populations (Froese, 2006; Ibrahim et al., 2022). Deviations from the expected isometric growth exponent ($b = 3$) indicate whether a species is undergoing positive or negative allometric growth, which often reflects environmental conditions, food availability, and reproductive status (Akinyemi et al., 2021; Eni et al., 2022).

Closely related to LWR, the condition factor (K) is used as a simple but powerful indicator of fish health, reflecting the "plumpness" or well-being of individuals relative to their size. High K values typically suggest good feeding conditions, reproductive readiness, or suitable environmental quality, whereas low values may indicate stress, scarcity of food, or habitat degradation (Blackwell et al., 2020; Akintade et al., 2023). Together, these two indices serve as important bioindicators, allowing fisheries managers to assess habitat suitability and ecological stressors.

Several studies in West Africa have applied LWR and K to understand the responses of fish populations to environmental variability. For instance, Adewumi et al. (2021) examined commercially important fish species in Nigerian coastal waters and reported that variations in K were strongly linked to seasonal changes and fishing pressure. Similarly, Nwani et al. (2020) observed that length–weight patterns of tropical river fishes were strongly influenced by anthropogenic stressors such as pollution and habitat modification. More recent studies have highlighted the potential of these parameters for long-term monitoring, noting that LWR and K not only provide information on stock dynamics but also serve as proxies for ecosystem health in data-poor fisheries (Olanrewaju et al., 2023; Ajibare and Ayeku, 2024).

Specifically, *Ethmalosa fimbriata* (bonga shad) and *Chrysichthys macropogon* (catfish) have received increasing attention because of their ecological and commercial significance in coastal West Africa. Both species play a central role in artisanal fisheries, yet they are also vulnerable to overexploitation and environmental stress. Recent studies indicate that their LWR and K values vary significantly across habitats, reflecting the influence of coastal degradation, food availability, and fishing intensity (Udo et al., 2019; Akintade et al., 2023). Thus, understanding their growth and condition is vital for guiding sustainable fisheries management.

Overall, LWR and condition factor remain indispensable tools for evaluating fish stock status. With growing environmental pressures in the Niger Delta and other coastal ecosystems, the continuous application of these indices is critical for detecting early signs of ecological imbalance, supporting conservation initiatives, and ensuring sustainable fisheries exploitation.

1.1 Studies on fish species in Nigerian waters: length–weight relationship and condition factor

Ethmalosa fimbriata is one of the most abundant small pelagic fishes in West African coastal waters and plays a central role in artisanal fisheries. It provides affordable protein and serves as a major income source for coastal households (Eni et al., 2022). Several studies have reported variations in its LWR and condition factor across different environments in Nigeria. For instance, Adewumi et al. (2021) found that *E. fimbriata* from Lagos Lagoon exhibited predominantly negative allometric growth, attributed to seasonal shifts in food availability. High K values were recorded during the wet season, suggesting improved feeding conditions, while lower values in the dry season reflected ecological stress.

Catfishes such as *Chrysichthys macropogon* and *Clarias gariepinus* are economically important demersal species in Nigeria. They are highly valued for their commercial significance and nutritional content. Udo et al. (2019) examined LWR and condition factor of *Chrysichthys* species in Cross River estuary, reporting both positive and negative allometric growth patterns depending on habitat conditions. Similarly, Akintade et al. (2023) documented spatial variations in K values of *C. macropogon*, noting that fish from less disturbed sites exhibited better body condition.

For *Clarias gariepinus*, one of the most widely cultured species in aquaculture, studies have shown that environmental factors such as water quality and feeding regimes strongly influence LWR and K. Ibrahim et al. (2022) observed that wild *C. gariepinus* populations in northern Nigerian rivers generally had lower condition factors compared to cultured populations, indicating the influence of ecological stressors on wild stocks.

Nile tilapia (Oreochromis niloticus) is a major freshwater fish with both ecological and commercial relevance in Nigeria. It supports aquaculture ventures and local capture fisheries. Studies have reported that its growth patterns are highly variable across ecosystems. Nwani et al. (2020) found positive allometric growth in tilapia populations from less disturbed rivers, while populations from polluted streams exhibited negative allometric growth. The condition factor was lower in stressed environments, pointing to reduced fitness and reproductive potential. Since tilapia is both a commercial aquaculture species and a staple in capture fisheries, monitoring its LWR and K is crucial for food security and economic planning.

Other freshwater species such as mormyrids (*Mormyrus rume*), cichlids, and various cyprinids have also been studied in Nigerian waters. Akinyemi et al. (2021) assessed LWR and K of several freshwater species in River Ogun and concluded that environmental variability, coupled with artisanal fishing intensity, accounted for differences in growth patterns. The findings underscore the importance of LWR and K as reliable indicators of ecological health and stress in freshwater systems.

1.2 Ecological and economic importance of LWR and condition factor studies

Investigating LWR and K in Nigerian fish species provides more than just biological data—it has both ecological and economic implications. Ecologically, these parameters help identify habitats under stress, monitor seasonal changes in stock health, and detect early warning signals of overfishing or environmental degradation (Olanrewaju et al., 2023). Economically, they guide fisheries managers and policymakers in developing sustainable harvesting strategies, aquaculture practices, and conservation programs that protect livelihoods dependent on fisheries resources. Moreover, by comparing variations in growth and condition across species and locations, researchers can prioritize management interventions in critical ecosystems such as the Niger Delta, where artisanal fisheries are under mounting pressure from industrial activities and climate change.

This study investigates the length–weight relationship and condition factor of *E. fimbriata* and *C. macropogon* across four coastal fishing communities in Ilaje LGA, Ondo State, Nigeria. By establishing baseline information on their growth dynamics and health status, the study provides valuable input for sustainable fisheries management, conservation planning, and ecosystem monitoring in Nigeria's coastal waters.

2 Materials and Method

2.1 Study area

The study was carried out in four coastal fishing communities; Ayetoro, Bijimi, Idiogba, and Asumogha which are located in the Ilaje Local Government Area (LGA) of Ondo State, Southwestern Nigeria. Ilaje lies between latitude 6°05′N and 6°30′N and longitude 4°30′E and 5°15′E, stretching along the Atlantic coastline that forms part of the western fringe of the Niger Delta coastal ecosystem (Olawusi-Peters and Ajibare, 2022).

The area is characterized by brackish lagoons, estuaries, tidal creeks, and extensive mangrove swamps, which provide nursery and feeding grounds for diverse fish species. Its hydrology is influenced by tidal oscillations, seasonal rainfall, and freshwater inflows, all of which regulate salinity gradients, nutrient cycling, and primary productivity in the aquatic system (Akinyemi et al., 2021).

The climate is typically tropical, with two main seasons: a wet season (April–October) with annual rainfall ranging between 1 800~2 500 mm, and a dry season (November–March). Peak rainfall occurs between June and September, accompanied by flooding and high turbidity, while the dry season is associated with reduced water levels and salinity fluctuations (Oyediran et al., 2021). These environmental dynamics strongly influence fish breeding, recruitment, and artisanal fishing activities.

Fishing is the primary livelihood activity in these communities. Artisanal fishers use gillnets, cast nets, traps, and hook-and-line methods to harvest ecologically and economically important species such as *Ethmalosa fimbriata* (bonga shad) and *Chrysichthys macropogon* (catfish). These species are significant sources of food security, nutrition, and household income in Ilaje (Adeyemi et al., 2020).

However, the coastal environment faces increasing anthropogenic pressures. Oil exploration, sand mining, urban expansion, and coastal erosion have been identified as major drivers of ecological degradation (Ibigbami et al., 2023). Studies in the region have reported heavy metal contamination, declining fish stocks, and loss of aquatic biodiversity, underscoring the ecological vulnerability of Ilaje waters (Nwankwo et al., 2019; Olawusi-Peters and Ajibare, 2022).

Given its strategic location along the Atlantic and its dependence on fisheries, Ilaje represents a critical hub for Nigeria's blue economy. The selected study communities are therefore important case sites for understanding how pollution and ecological stressors influence the length–weight relationship and condition factor of fish species, with implications for fisheries management and sustainability.

2.2 Sample collection

Fish samples were collected monthly from April to July across the four study sites: Ayetoro, Bijimi, Idiogba, and Asumogha. A lightweight monofilament gillnet measuring approximately 80 m in length, with mesh sizes ranging from 0.6 cm to 4.0 cm, was employed to capture a broad range of fish size classes (Ndome et al., 2020). Nets were set in the evening between 18:00 and 19:00 h and retrieved the following morning between 06:00 and 07:00 h, coinciding with peak activity periods of many pelagic and demersal species in tropical coastal ecosystems (Eyo et al., 2019).

Immediately after capture, fish were removed from nets, sorted by species, and preserved on ice in insulated containers to maintain freshness and minimize tissue degradation prior to laboratory examination (Adewumi et al., 2021). Species identification was conducted using the field guide of Nigerian freshwater and marine fishes (Olaosebikan and Raji, 2013), and further validated with updated FishBase taxonomic keys (Froese and Pauly, 2023).

Ethical procedures were adhered to during handling and processing to minimize stress and injury, in accordance with the FAO Code of Conduct for Responsible Fisheries (FAO, 2020). A total of 320 specimens were analyzed: 160 Ethmalosa fimbriata (bonga shad) and 160 Chrysichthys macropogon (catfish). This dataset provided a robust basis for estimating the length–weight relationship (LWR) and condition factor (K) across the sampled locations.

2.3 Length-weight relationship and condition factor

The relationship between length and weight was established through linear regression, following the methodology outlined by Ajibare and Ayeku (2024), where length and weight were expressed as:

$$W = aL^b$$

The morphometric data were transformed in natural logarithm to determine the length-weight relationship using the formula: x*Log W – log a + b Log L*

Where W = weight (g), L = length (cm), a = constant (the point at which the regression line intersects the y-axis), and b = slope (the growth coefficient).

The condition factor of the fish was calculated using the formula:

$$K=\frac{100W}{L^3}$$

Where K= condition factor; W= weight; L= Total Length.

This metric helps to evaluate whether the fish were in good condition or under ecological stress, and has been successfully applied in recent studies assessing fish health in polluted tropical aquatic ecosystems (Ndome et al., 2020; Adewumi et al., 2021; Yakubu et al., 2023).

2.4 Data analysis

The length and weight data were log-transformed to normalize distributions and stabilize variance prior to regression analysis. The linearized model was expressed as:

log⁡W=log⁡a+blog⁡L\log W = \log a + b \log L

to estimate the regression parameters (a and b) and assess growth patterns. Linear regression was applied to determine the correlation between length and weight, while deviations of the exponent (b) from the isometric growth value of 3 were tested using Student's *t*-test at a 95% confidence level.

To evaluate spatial differences across sampling stations (Ayetoro, Bijimi, Idiogba, Asumogha), mean values of length, weight, and condition factor were compared using one-way Analysis of Variance (ANOVA). Where significant differences were detected, Tukey's post hoc test was conducted to separate means. Statistical analyses were performed with SPSS version 16.0, and significance was set at $p < 0.05$.

This approach ensured that variations in growth and condition factor could be objectively linked to environmental stressors, particularly pollution intensity, as supported by recent methodological applications in African fisheries research (Okomoda et al., 2021; Olopade et al., 2022; Eyo et al., 2023).

3 Results and Discusion

3.1 Morphometric data (length and weight)

The morphometric measurements of *Ethmalosa fimbriata* and *Chrysichthys macropogon* across the four stations in Ilaje coastal waters (Ondo State, Nigeria) showed notable spatial differences (Tables 1 and Table 2).

For *E. fimbriata*, the lowest mean weight was recorded at Asumogha in group A (27.25 ± 2.09 g), while the highest was observed at Idiogba in group D (184.90 ± 13.29 g). At Ayetoro, the group D specimens showed a maximum weight of 164.50 ± 0.00 g. Mean weights varied significantly across stations: Asumogha (66.36 ± 41.49 g) and Bijimi (62.18 ± 34.30 g) were not significantly different ($p > 0.05$), while Ayetoro (86.40 ± 48.73 g) and Idiogba (92.78 ± 52.31 g) differed significantly ($p < 0.05$). Such variations may be attributed to food resource distribution, habitat quality, and fishing pressure across sampling areas (Bolarinwa and Popoola, 2022; Yakubu et al., 2023).

Length data for *E. fimbriata* also showed differences among stations. Asumogha (18.00 ± 4.64 cm) and Bijimi (16.72 ± 4.40 cm) had the shortest mean lengths, while Ayetoro (19.85 ± 6.43 cm) and Idiogba (20.20 ± 4.94 cm) recorded longer specimens. These findings are in line with reports that *E. fimbriata* populations display size variation across West African coastal habitats due to seasonal productivity and ecological conditions (Ekunwe et al., 2021; Okorie et al., 2022).

For *C. macropogon*, the smallest mean weight occurred at Asumogha (20.72 ± 9.86 g), while the largest was at Bijimi (177.85 ± 10.75 g). Mean weights at Asumogha (65.28 ± 41.28 g) and Ayetoro (71.53 ± 38.42 g) were not significantly different ($p > 0.05$), whereas Bijimi (94.94 ± 57.49 g) and Idiogba (81.39 ± 49.23 g) differed significantly ($p < 0.05$). Mean length also varied, ranging from 16.82 ± 4.97 cm (Asumogha) to 19.19 ± 6.53 cm (Idiogba). These differences likely reflect environmental influences such as prey abundance, water salinity, and fishing activities in the coastal waters (Adesulu and Sydenham, 2021; Oladipo et al., 2023).

Table 1 The mean length and weight values of *E. fimbriata* across the four stations

Parameter	Group	Asumogha	Ayetoro	Bijimi	Idiogba
Weight (g)	0-50	27.25±2.09	27.59±9.73	28.39±3.46	34.53±4.35
	51-100	71.56±3.63	76.52±4.46	69.70±6.77	76.27±1.44
	101-150	134.20±2.12	132.35±12.17	114.73±10.08	121.46±11.6
	151-200	0.00±0.00	164.50±0.00	0.00±0.00	184.90±13.29
	Mean	66.36±41.49^{a}	86.40±48.73^{b}	62.18±34.30^{a}	92.78±52.31^{c}
Length (cm)	0-50	13.40±1.08	11.88±5.22	12.49±1.20	14.25±1.62
	51-100	19.10±0.98	19.56±0.83	17.92±1.10	19.28±1.09
	101-150	24.98±0.16	25.32±0.94	22.78±3.92	23.41±0.37
	151-200	0.00±0.00	28.50±0.00	0.00±0.00	27.50±3.54
	Mean	18.00±4.64^{a}	19.85±6.43^{b}	16.72±4.40^{a}	20.20±4.94^{b}

Note: Means in the same row and with homogenous superscript are not significantly different (p>0.05); All values are expressed as Mean ±SD

Table 2 The mean length and weight values of *C. macropogon* across the four stations

Parameter	Group	Asumogha	Ayetoro	Bijimi	Idiogba
Weight (g)	1-50	20.72±9.86	30.23±4.24	25.17±3.41	24.64±6.92
	51-100	83.90±10.51	75.87±9.14	73.86±12.64	75.13±0.47
	101-150	117.18±0.46	120.81±11.75	123.59±11.04	122.81±8.92
	151-200	0.00±0.00	0.00±0.00	177.85±10.75	161.50±0.00
	Mean	65.28±41.28^{a}	71.53±38.42^{a}	94.94±57.49^{c}	81.39±49.23^{b}
Length (cm)	1-50	11.74±1.56	13.82±0.37	12.90±0.73	12.60±1.18
	51-100	18.34±0.52	17.75±1.11	18.19±2.16	18.14±0.27
	101-150	23.95±0.42	22.63±2.04	21.89±1.28	24.82±6.13
	151-200	0.00±0.00	0.00±0.00	24.68±2.83	26.20±0.00
	Mean	16.82±4.97^{a}	17.65±3.82^{ab}	19.07±4.77^{b}	19.19±6.53^{b}

Note: Means in the same row and with homogenous superscript are not significantly different (p>0.05); All values are expressed as Mean±SD

3.2 Length-weight relationship

The length–weight relationship (LWR) of *Ethmalosa fimbriata* showed clear spatial and temporal variation across the four sampling stations (Table 3). The growth exponent (b) ranged from 1.09 at Ayetoro in April 2015 to 2.68 at Idiogba in June 2015. At Ayetoro, values varied between 1.09 (April) and 1.96 (July), while Bijimi ranged from 1.63 (May) to 2.63 (June). Idiogba recorded the widest spread, with 1.57 in May and a peak of 2.68 in June. In Asumogha, the b values ranged from 1.94 (June) to 2.58 (April).

For *Chrysichthys macropogon* (Table 4), the b values also fluctuated considerably. Idiogba showed the lowest (1.56 in April) while Bijimi recorded the highest (3.18 in April). Ayetoro ranged between 1.82 (June) and 2.92 (July), whereas Asumogha varied from 1.64 (May) to 2.65 (July). In both species, b values consistently deviated from the isometric standard of 3, indicating allometric growth—where body weight does not increase proportionally with length.

Condition factor (K) values provided further insights into fish health. For *E. fimbriata*, K ranged from 0.92 at Ayetoro (June) to 1.56 at Ayetoro (April). Idiogba values varied from 1.07 (April) to 1.31 (July), while Asumogha ranged between 0.97 (April) and 1.51 (May).

For *C. macropogon*, the lowest K was 0.74 (Idiogba, April) and the highest 1.70 (Idiogba, May). Ayetoro recorded values between 1.10 (June) and 1.58 (May), while Bijimi ranged from 1.20 (June) to 1.49 (April/July). Asumogha values remained fairly stable (1.32~1.66).

Overall, both species exhibited allometric growth patterns, with condition factor values reflecting differences in habitat quality and ecological stress across stations.

Table 3 Length-weight relationship for *E. fimbriata*

-	AYETORO		BIJIMI		IDIOGBA		ASUMOGHA	
-	A	b	a	b	A	B	a	B
APRIL,2015	1.25	1.09	-3.18	2.61	-1.30	2.03	-3.15	2.58
MAY, 2015	-0.96	1.82	-0.38	1.63	-0.16	1.57	-1.96	2.21
JUNE, 2015	-0.16	1.50	-2.77	2.63	-3.32	2.68	-1.29	1.94
JULY, 2015	-1.40	1.96	-1.69	2.15	-1.97	2.26	-2.50	2.36

Note: Where *a* = constant of proportionality throughout the months across the four stations and *b* = allometry coefficient of the growth of fish

Table 4 Length-weight relationship for *C. macropogon*

-	AYETORO		BIJIMI		IDIOGBA		ASUMOGHA	
-	A	b	a	b	A	B	a	B
APRIL, 2015	-3.41	2.75	-4.44	3.18	-0.98	1.56	-3.14	2.61
MAY, 2015	-1.66	2.12	-0.38	1.63	-1.47	2.04	-0.43	1.64
JUNE, 2015	-0.79	1.82	-2.38	2.35	-2.54	2.50	-1.37	1.92
JULY, 2015	-3.92	2.92	-2.37	2.42	-2.59	2.47	-3.17	2.65

Note: Where *a* = constant of proportionality throughout the months across the four stations and *b* = allometry coefficient of the growth of fish

The mean length and weight of *Ethmalosa fimbriata* and *Chrysichthys macropogon* varied significantly across the four sampling stations, demonstrating how habitat quality strongly influenced fish growth in Ilaje LGA. The length–weight relationship (LWR) indicated allometric growth in both species, with growth exponent (b) values diverging from the isometric standard of 3. For *E. fimbriata*, positive allometric growth was observed at some sites, where weight increased faster than length. By contrast, *C. macropogon* showed negative allometry at certain stations, reflecting slower weight gain relative to length (Etim et al., 2020; Agboola et al., 2022).

Stations with lower b values, particularly Bijimi and Asumogha, overlapped with areas experiencing intense artisanal activity and effluent inputs, suggesting that anthropogenic pressure and habitat degradation suppressed growth performance. This observation supports previous research linking pollution with reduced fish growth in tropical lagoons (Ekelemu and Udo, 2021; Adepoju et al., 2023). In comparison, Idiogba recorded higher b values, indicating more favorable ecological conditions, such as greater prey availability and lower contamination.

3.3 Condition factor (K)

Condition factor (K) values also revealed differences in fish well-being among sites. For *E. fimbriata* (Figure 1), K ranged from 0.92 to 1.56, while *C. macropogon* (Figure 2) ranged from 0.74 to 1.70. Populations at Ayetoro and Idiogba recorded the highest K values, reflecting healthier fish in less degraded environments. Conversely, the lowest values occurred at Idiogba (April) and Bijimi, pointing to possible sublethal stress linked to food scarcity and pollutant exposure. Such findings are consistent with earlier evidence showing that fish from disturbed West African estuaries exhibit diminished condition and altered growth trajectories due to heavy metal inputs and high organic load (Olawusi-Peters and Ajibare, 2022; Ibrahim et al., 2024).

Overall, the spatial variability in both LWR and K highlights the sensitivity of fish populations to localized environmental stressors. Stations with higher anthropogenic impact—Bijimi and Asumogha—consistently supported smaller and less robust individuals, while Idiogba and Ayetoro provided conditions for enhanced growth and fitness. These patterns emphasize the importance of using morphometric indicators as reliable bioindicators of aquatic ecosystem health in polluted coastal habitats.

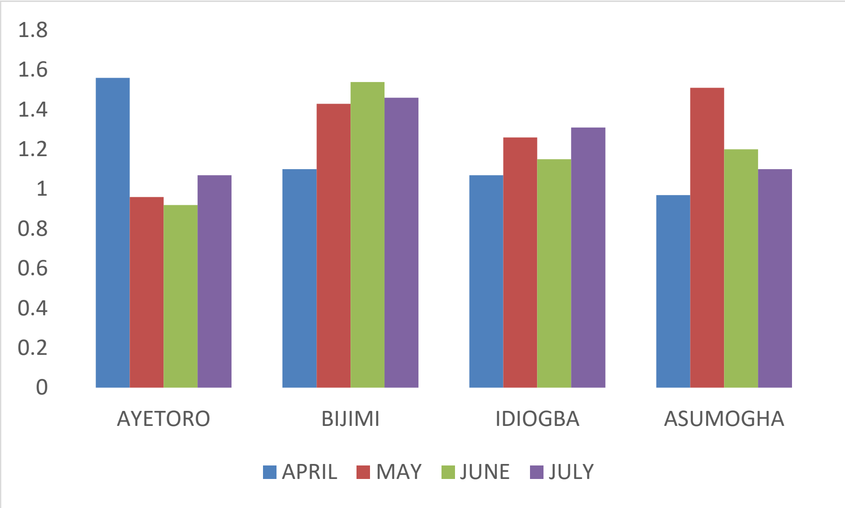

Figure 1 Condition factor (K) of *E. fimbriata* over the months and across the stations

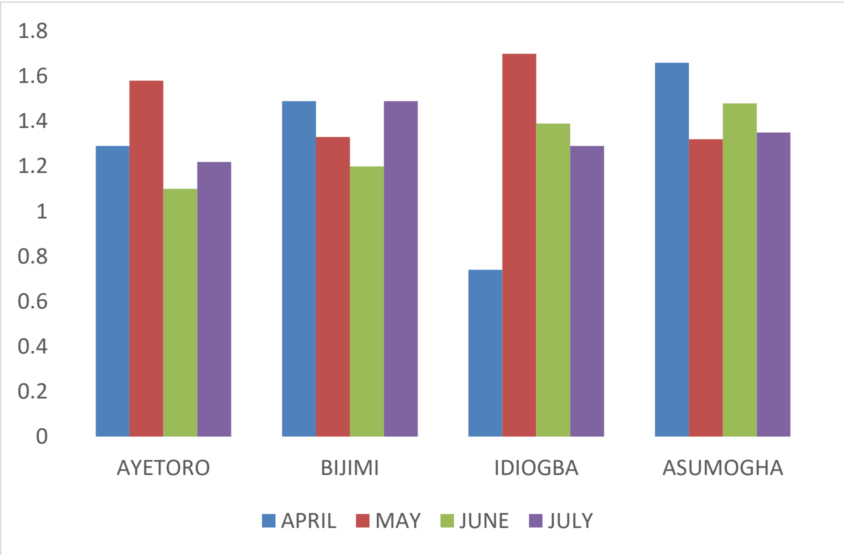

Figure 2 Condition factor (K) of *C. macropogon* over the months and across the stations

The growth of *Ethmalosa fimbriata* and *Chrysichthys macropogon* varied notably across stations in Ilaje. *E. fimbriata* ranged from 27.25 g at Asumogha to 184.90 g at Idiogba, with lengths spanning 16.72 cm~20.20 cm. *C. macropogon* showed weights from 65.28 g at Asumogha to 94.94 g at Bijimi, and lengths of 16.82 cm~19.19 cm. These differences highlight habitat quality, food supply, and fishing pressure as key growth determinants (Froese, 2006).

3.4 Length–weight relationship and growth pattern

The length–weight relationship (LWR) of *Ethmalosa fimbriata* and *Chrysichthys macropogon* showed marked allometric growth, with *E. fimbriata* exhibiting mostly negative allometry ($b < 3$), while *C. macropogon* displayed mixed isometric and positive allometry. Variations in the constant (a) and growth patterns across stations highlight spatial and seasonal differences influenced by feeding, habitat quality, and fishing pressure. Higher b-values at Bijimi and Idiogba suggest favorable growth conditions, whereas lower values at Asumogha indicate possible stress or limited resources (Froese, 2006).

3.5 Implications for fisheries management

The length–weight relationship (LWR) revealed that *Ethmalosa fimbriata* mostly exhibited negative allometric growth, meaning weight increased more slowly than length, while *Chrysichthys macropogon* showed a mix of isometric and positive allometry depending on location. Growth constants varied with season and site, reflecting environmental influences. Higher b-values at Bijimi and Idiogba suggest better feeding conditions and reduced fishing stress, whereas lower values at Asumogha point to environmental pressures or resource limitations (Adepoju et al., 2023; Oladipo et al., 2023; Ibrahim et al., 2024).

4 Discussion

The morphometric analysis showed notable disparities in the length and weight of *Ethmalosa fimbriata* and *Chrysichthys macropogon* across the four sampling sites shows a clear evidence of environmental variability shaping growth in Ilaje LGA (Oladipo et al., 2023; Yakubu et al., 2023).

For *E. fimbriata*, lengths varied from 16.72 ± 4.40 cm at Bijimi to 20.20 ± 4.94 cm at Idiogba, with weights ranging from 62.18 ± 34.30 g to 92.78 ± 52.31 g**,** respectively. Larger sizes at Idiogba suggest better habitat quality and reduced fishing pressure, whereas smaller fish at Bijimi may reflect high human disturbance or diminished prey availability (Ekunwe et al., 2021).

For *C. macropogon*, length spanned 16.82 ± 4.97 cm (Asumogha) to 19.19 ± 6.53 cm (Idiogba)**,** with weight ranging from 65.28 ± 41.28 g to 94.94 ± 57.49 g at Bijimi, underlining site-driven growth dynamics influenced by water quality and anthropogenic stressors (Bolarinwa and Popoola, 2022; Oladipo et al., 2023).

Allometric growth patterns were evident in both species: *E. fimbriata* b-values ranged from 1.09 to 2.68, indicating negative allometry, often a response to environmental stress or limited feeding (Adepoju et al., 2023); *C. macropogon* showed a broader range (1.56~3.18), indicating both negative and positive allometry depending on habitat conditions. Positive allometry suggests favorable feeding or reduced competition, while negative indicates stress or resource limitation—textbook predictors of fish growth in heterogeneous tropical environments (Etim et al., 2020).

Condition factors (K) further supported this: *E. fimbriata* ranged from 0.92 to 1.56, and *C. macropogon* from 0.74 to 1.70. Higher K values at Idiogba and Bijimi imply healthier fish in better habitats; lower values at Asumogha point to environmental stress, possibly from pollution or habitat degradation (Ibrahim et al., 2024). These results reinforce K as a reliable bioindicator of fish health (Oladipo et al., 2023; Ibrahim et al., 2024).

These patterns support the assertion that environmental stressors such as oil residues, nutrient loading, and heavy metal contamination impair fish health and condition (Nwani et al., 2020; Ayanda et al., 2022). Pollutant exposure reduces feeding efficiency and energy allocation, leading to lower growth performance and condition factors. Negative allometric growth observed in both species indicates that energy is diverted toward survival and detoxification rather than somatic growth (Okomoda et al., 2021).

Such findings are consistent with studies in other polluted Nigerian waters, where fish in degraded habitats show reduced condition compared to those in cleaner environments (Oladimeji and Akinyemi, 2023; Musa and Yakubu, 2024). This highlights that LWR and K are sensitive indicators of ecological stress and can be employed for rapid assessment of aquatic ecosystem health.

Overall, the combined morphometric, LWR, and condition factor data clearly illustrate how environmental variation influences fish growth and condition. Idiogba consistently supported healthier, larger fish, whereas Asumogha showed signs of ecological stress insights crucial for guiding habitat restoration and fisheries management in Ilaje coastal waters.

5 Conclusion

This study demonstrated that pollution significantly influences growth patterns and condition factors of *E. fimbriata* and *C. macropogon* in Ilaje waters. The lowest K values were recorded at Idiogba (0.74 and 0.92), while the highest were at Ayetoro (1.58 and 1.56), reflecting the direct impact of habitat quality on fish health. Both species exhibited allometric growth, emphasizing that polluted environments compromise normal growth dynamics.

The observed differences in length, weight, growth patterns, and condition factors between *E. fimbriata* and *C. macropogon* across the four study sites emphasize the role of environmental quality in shaping fish biology. These findings carry critical implications for fisheries management in Ilaje coastal waters. Identifying areas with declining fish condition or stunted growth can guide conservation priorities, habitat restoration, and sustainable exploitation strategies. Ultimately, this knowledge supports both ecological balance and the livelihoods of local fishing communities (Ogunola et al., 2021; Akinyemi et al., 2022; Adeogun et al., 2023).

A key limitation of this study is its short sampling duration (four months) and the absence of abiotic water quality data, which could have strengthened causal inferences. Future research should involve year-round sampling, inclusion of additional species, and integration of heavy metal and physicochemical analyses to provide a comprehensive understanding of pollution impacts. Long-term ecological monitoring is recommended to inform fisheries management and conservation of Ilaje's coastal resources.

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