COMPARATIVE STUDIES OF LENGTH-WEIGHT RELATIONSHIP AND CONDITION FACTOR OF CICHLIDAE SPECIES (*Oreochromis nilotucus* (*Linneus, 1758*) AND *Sarotherodon melanotheron* (*Ruppell, 1852*) OF GUBI RESERVOIR, BAUCHI STATE, NIGERIA

*[1]Alkasim, Adurrashid, [2]Modu A. Bukar and [3]Aliyu M. Dauda

[1]Jigawa State Secondary School Education Board, Dutse, Nigeria
[2]Department of Fisheries Technology, Yobe State State College of Agriculture, Science and Technology, Gujba, Yobe State, Nigeria.
[3]Department of Fisheries and Aquaculture, Faculty of Agriculture, Abubakar Tafawa Balewa University, Bauchi

*Corresponding authors' email: rshid446@gmail.com   Phone: +2348063692565

ABSTRACT

Cichilidae species are the major components that take large shares of fish biodiversity land waters in Nigeria particularly Gubi Dam and consider as the economic specie. The research carried out for eighteen months July 2023 to December 2024 and objective of the research was to assess the length-weight relationship and condition factor of Cichlidae: *Oreochromis niloticus* and *Sarotherodon melanotheron.* 360 fish sampled were assessed, 180 each specie and 90 each males and female compared. The result of fish length-weight relationship subjected to ($W = {}_aL^b$) results recorded "b" value for males *Oreochromis niloticus* 2.1306 and 0.6211 male *Sarotherodon melanotheron;* 1.7497 female *Oreochromis niloticus,* 01.1396 female *Sarotherodon melanotheron;* combined sexes 1.6831 *Oreochromis niloticus,* 0.8189 *Sarotherodon melanotheron.* The results indicated negative allometric growth pattern. Linear regression analysis at ($P>0.05$) with no significant difference for males *Oreochromis niloticus* 0.8248, *Sarotherodon melanotheron* 0.3821; females 0.7783 *Oreochromis niloticus*, 0.5916 *Sarotherodon melanotheron*; combined sexes 0.6936 *Oreochromis niloticus*, 0.8561 *Sarotherodon melanotheron.* Monthly mean condition factor subjected to ($K = W \times 100/ L^3$) males *Oreochromis niloticus* ranged 0.026 to 0.098, *Sarotherodon melanotheron* 0.022 to 0.087; Female *Oreochromis niloticus* 0.034 to 0.11, *Sarotherodon melanotheron* 0.012 to 0.215; combined sexes *Oreochromis niloticus* 0.046 to 0.087, *Sarotherodon melanotheron* 0.023 to 0.240. The mean condition factors of two species were less than 1, indicating poor condition. The study will serves as reference for future research works.

Keywords: Comparative, Allometric, Isometric, Relationship, Morphometric

INTRODUCTION

Cichilidae species are the major components that take large shares of fish biodiversity in inland waters of tropical Africa particularly Nigeria water bodies (FAO, 1995) with emphasis Gubi reservoir Bauchi state, Nigeria where thousands of households including fishers and farmers utilize as their primary sources of livelihood. Leveque (1997) documented that about 870 cichlid species belonging to 143 genera in African continent. The study of length-weight relationship and condition factor of this family of Cichlidae particularly *Oreochromis niloticus, Serathoredon melanotheron* provides true information on the environmental well being from the data generated from fish sampled. The study of length-weight relationships and condition factor of fish are important in fisheries biology and fisheries management strategies helps in the estimation of the average weight of fish of a given length by establishing a mathematical relation between the two (Beyer, 1987). Like any other morphometric characters, the Length-weight relationship can be used as a character for the differentiation of taxonomic units and relationship between various changes such as growth (Thomas *et al.,* 2003). Pauly (2009) explained the length-weight relationships predicts weight from length measurements for yield assessment. Fish can attain either isometric growth, allometric growth (negative or positive allometric growth). Isometric growth is when fish grow proportionally in all dimensions (length and weight increase at the same rate) this indicated there is no change in body shape. Negative allometric growth implies the fish becomes slenderer as it increases in weight while positive allometric growth implies the fish becomes relatively stouter or deeper-bodied as it increases in length (Reed, *et al.,* 1967) stated that when the exponent (b) value is less than 3, the fish has a negative allometric growth but when it is greater than 3, it has a positive allometric growth and when it is equal to 3, the fish has isometric growth. The length-weight relationship can also be used in setting yield equations for estimating the number of fish landed and comparing the population in space and time (Beverton and Holt, 1957). Furthermore, the empirical relationship between the length and weight of the fish provide knowledge about the natural history of fish, thereby making effective management and easier. Unavailability of research information of length-weight relationship and condition factor of chilidae family in Gubi Dam that drawn the attention of the with emphasis on *Oreochromis niloticus, Serathoredon melanotheron* with aim to provide the information for basic knowledge for future research and ecosystem management

Condition factor is a measure of how the mass of fish is distributed per unit volume of the fish when environmental conditions are poor. Low K values are recorded also spawning pressures could be marked by low K values in female. Condition factor is more accurate and representative index in growth and physiological fitness in fish (Haruna, 2003). According to Olurin and Aderibigbe (2006) pointed out that fish that well fed with good feed will grow and developed higher total length compared with poorly fed (Kefas, 2016). Kefas, 2016, Kefas and Abubakar (2010) and Abubkar (2006) pointed out that change in condition factor of fish species can be attributed to changes in physical and chemical condition of the habitat which can affect the physiology.

MATERIALS AND METHODS
Details of the Study area
Gubi Dam (fig. 1) is a zoned earth fill with clay core dam located at Firo Village, Ganjuwa Local Government Area of Bauchi State, Nigeria about 8km off Maiduguri Road constructed in 1979 by Bauchi state government to impound water from the upstream side of River Gubi during the rainy season primarily with an attempt to improve food security through irrigation and fishing. The Dam has a total surface area of 6.860km with its spill way at the eastern end of the Dam. The dam lies on longitude 10°25′N to 10⁰26′N and latitude 9⁰51′E to 9⁰52′E and rainfall is the main source of water. The rainfall ranges from 970mm to 1400mm with peak occurring in July, to September. The dam also receives its water from Tatimari, River Ran, River Tagwaye, Kwarin Dinya, Rafin Makaranta, Larkarina, RuduYausa, Kumi, Ba'ila, and Kwarin Kira tributaries (Ataguba, *et al.,* 2014). The variation in the water levels in the reservoir depends on the seasonal rainfall, temperature and daily public uses especially irrigation (Aliyu, *et al.,* 2025).
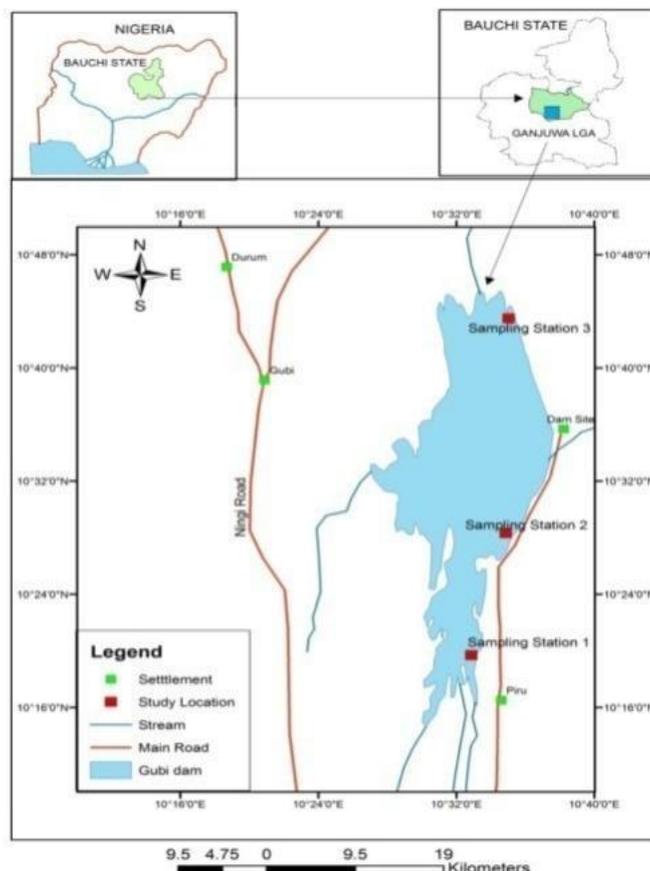

Figure 1: Map of Gubi Dam showing sampling stations
(Source: GIS Laboratory Department of Geography, MAUTECH, Yola 2019)

Sampling stations
Three sampling stations for the study of fish length-weight relationship and condition factor of *Oreochromis niloticus, Serathoredon melanotheron* of Gubi reservoir where identified based on fishing activities. Station A popularly called Kwatam Kifi, station B at Kwata Yashi and station C spill way.

Fish sampling, collection and identification
Fish sampled were collected from the fishermen for the period of eighteen months July 2023 April 2024 the samples were carefully sorted, arranged into groups of species and sexes for determination of length and weight. The identification was achieved with aid of "Field guide to Nigeria freshwater fisheries, Olaosebikan and Raji (2013), based on physical features such as color pattern, sports and body marks, shapes, scale, fins with help of fishermen. The pictures were snapped for reference and preparation of check list of the study area to provide information for future researchers and reference.

Data analysis
Determination of Length-weight relationship and condition factors

The measurement of total length and weight carried out with aid of weighing valance TH-500 in ways recommended by Kefas (2016) Length-weight relationship was observed with aids of constructed measuring board and 1m measurement rule.

The results of weight-length relationship were calculated using conventional formula Lecren (1951).

$W = {_a}L^b$

W = weight of the fish, L = standard length of fish, a = constant, b = exponent

Condition factor determined by the use of conventional formula recommended by Worthington and Richard (1931).

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

Where K = condition factor, W = weight in grams, L = standard length

The species of *Oreochromis niloticus, sarotherodon melanotheron* were selected for the study of weight-length

relationship and condition factor. The sampled were collected from the fishermen. The total length (L) was measured to the nearest of 0.1cm from the tip of the snout to the extended tip of the caudal fin with the aid of constructed measuring board and 1m measuring rule in ways recommended by (Kefas, 2016 and Binta, 2025). Likewise, the Body weight of each individual fish were observed with aid of portable Electronic/Battery sensitive weighing scale/balance TH-500 in ways recommended by (Kefas, 2016; Getso, 2017; Indrayani *et al.,* 2023 and Binta, 2025).

Length-weight relationship (LWR) was calculated and growth pattern of each fish species was determined based on LWR regression analysis using the formula recommended by (Le Cren, 1951; Kefas and Abubakar 2010; Kefas 2016; Nazeef 2019; and Binta 2025). The formula was derived as follows:

$W = {}_aL^b$

Where: W is the weight of the fish in gram (g), L is the total length of the fish in centimeter (cm) "a" is the constant and "b" is the exponent of the relationship (regression coefficient). Length-Weight Relationship result of each fish species were displayed in the tables and plotted graph. "b" value represents fish growth. If "b" equal to 3 (b=3) the growth is isometric and if the result is b is >3 positive allometric and if b is < 3 negative allometric (Ricker & Carter, 1958). However, the parameters (a) and (b) are functional relationship between length and weight (Sparre and Venema 1992).

The condition factor of each fish species were determined with conventional formula or equation adopted and recommended by (Worthington and Richard 1931 and Ja'afaru and Tashara 2009) also used by (Kefas 2016; Kefas and Abubakar 2016; Nazeef, 2019 and Binta 2025). The formula derived below:

RESULTS AND DISCUSSION

Length–Weight Relationship and Condition Factor of *Oreochromis niloticus* and *Sarotherodon melamotheron* of Gubi Reservoirs

Comparatively the result of weight length relationship of *Oreochromis niloticus* and *Sarotherodon melanotheron* of Gubi Reservoir during this research documented that b value for male *Oreochromis niloticus* were 2.1306 and 0.6211 male *Sarotherodon melanotheron*, 1.7497 female *Oreochromis niloticus* and 01.1396 *Sarotherodon melanotheron* and 1.6831combined *Oreochromis niloticus,* 0.8189 for *Sarotherodon melanotheron.*

The linear regression analysis revealed 0.8248 for male *Oreochromis niloticus* and 0.3821 male *Sarotherodon melanotheron*, 0.7783 female *Oreochromis niloticus* also 0.5916 female *Sarotherodon melanotheron* and 0.6936 combined sexes *Oreochromis niloticus* likewise 0.8561 *Sarotherodon melanotheron* combined sexes with no significant correlation coefficient at (P>0.05).

Table 1: Length-Weight Regression Analysis of *Oreochromis niloticus* of Gubi Reservoir July 2023 – December 2024

Sex	No of Fish Examined	Log a	b	Coefficient of Correlation (r)
Male	54	2.1999	2.1306	0.8248
Female	36	1.7584	1.7497	0.7783
Combined	90	1.6712	1.6831	0.6936

Table 2: Length-Weight Regression Analysis of *Sarotherodon melanotheron* of Gubi Reservoir July 2023 – December 2024

Sex	No of Fish Examined	Log a	b	Coefficient of Correlation (r)
Male	54	0.4080	0.6211	0.0656
Female	36	1.0266	1.1396	0.8177
Combined	90	0.6548	0.8189	0.1561

The lowest monthly mean condition factor of male *Oreochromis niloticus* rages from 0.026 September to 0.098 in May while for male *Sarotherodon melanotheron* ranges from 0.022 September to 0.087 September. Female *Oreochromis niloticus* ranges from 0.034 observed in June to 0.119 November, for *Sarotherodon melanotheron* from 0.012 November to 0.215 July. Finally, combined sexes of *Oreochromis niloticus* from 0.046 to June to 0.087 in August likewise, combined sexes of *Sarotherodon melanotheron* were 0.023 June to 0.240 in May (figure).

Table 3: Monthly Mean Condition Factor of male *O. niloticus* and *S. melanotheron*

Month	Mean Length	Mean Weight	Mean Condition Factor	
			O. n	*S. m*
July 2023	18 – 11	3.3 - 0.9	0.067	0.067
August 2023	15.6 – 11	2.2 -1.00	0.063	0.062
September 2023	23 – 11	17.2 1.6	0.067	0.022
October 2023	14.5 - 10.6	2.4 - 0.9	0.067	0.052
November 2023	17 - 6.5	2.9 - 0.2	0.059	0.072
December 2023	22 – 11	3.00 - 0.8	0.097	0.077
January 2024	10 - 6.5	1 - 0.2	0.059	0.087
February 2024	13.5 - 7.8	1.7 - 0.3	0.059	0.058
March 2024	15.5 - 8.00	2.5 - 0.4	0.059	0.061
April 2024	13.6 - 9.4	1.4 - 0.5	0.056	0.059
May 2024	21 - 5.5	1.9 - 0.4	0.098	0.068
June 2024	16 – 13	2.5 - 1.4	0.06	0.063

Month				
July 2024	26 -7.00	2 - 0.2	0.063	0.058
August 2024	14-Dec	1.9 – 1	0.025	0.086
September 2024	16 - 7.00	0.5 - 0.3	0.026	0.087
October 2024	15 - 6.5	2.7 - 0.2	0.053	0.08
November 2024	16 – 10	3.2 - 0.7	0.057	0.075
December 2024	19 - 8.00	2.8 - 0.3	0.069	0.06

Table 4: Monthly Mean Condition Factor of female *O. niloticus* and *S. melanotheron*

Month	Mean Length	Mean Weight	Mean Condition Factor	
			O. n	*S. m*
July 2023	22 - 9.00	4.7 - 0.4	0.054	0.054
August 2023	13.7 -12.9	1.6 - 1.3	0.068	0.074
September 2023	12..3 – 10	0.9 - 0.8	0.072	0.08
October 2023	26.9 -16.9	4.00 - 2.4	0.08	0.049
November 2023	8 - 6.7	0.4 - 0.3	0.065	0.132
December 2023	26 - 13.5	3.3 - 1.4	0.063	0.018
January 2024	17 – 9	2.7 - 0.5	0.034	0.054
February 2024	16 - 15.5	2.5 - 2.00	0.06	0.061
March 2024	22 – 10	2.7 - 0.9	0.065	0.09
April 2024	17-Oct	3.1 - 0.6	0.063	0.06
May 2024	16 - 7.00	2.6 - 0.2	0.065	0.063
June 2024	12 - 7.3	1.3 - 0.3	0.054	0.077
July 2024	17 - 5.7	3.2 - 0.2	0.081	0.215
August 2024	8.2 - 7.2	2.2 - 0.2	0.054	0.053
September 2024	33 – 31	4.9 - 4.8	0.06	0.016
October 2024	28 - 7.00	3.2 - 0.3	0.053	0.014
November 2024	36 – 12	5.9 - 1.6	0.119	0.012
December 2024	30 – 14	4.1 - 2.4	0.055	0.087

Table 5: Monthly Mean Condition Factor of combined sexes of *O. niloticus* and *S. melanotheron*

Month	Mean Length	Mean Weight	Mean Condition Factor	
			O. n	*S. m*
July 2023	17 - 9.00	2.7 - 0.8	0.056	0.058
August 2023	15.5 – 11	2.2 - 1.00	0.058	0.057
September 2023	23 – 10	17.2 - 0.8	0.066	0.129
October 2023	26.9 - 10.6	4.00 - 0.9	0.066	0.075
November 2023	17 - 6.7	2.9 - 0.2	0.073	0.059
December 2023	26 – 11	3.3 - 0.8	0.059	0.023
January 2024	17.5 - 6.5	2.7 -0.2	0.063	0.072
February 2024	16 - 8.00	2.5 - 0.3	0.062	0.069
March 2024	22 - 8.00	2.7 -0.4	0.052	0.097
April 2024	17 - 9.5	3.1 - 0.5	0.058	0.055
May 2024	21 - 5.5	2.6 - 0.2	0.058	0.024
June 2024	16 - 7.00	2.4 - 0.3	0.046	0.061
July 2024	26 - 7.00	2.5 - 0.2	0.078	0.078
August 2024	14 - 7.2	1.9 - 0.2	0.066	0.057
September 2024	33 - 7.00	4.9 - 0.3	0.067	0.068
October 2024	28 - 6.6	3.2 - 0.3	0.066	0.084
November 2024	36 – 10	5.9 - 0.7	0.087	0.078
December 2024	30 - 8.00	4.1 - 0.3	0.066	0.058

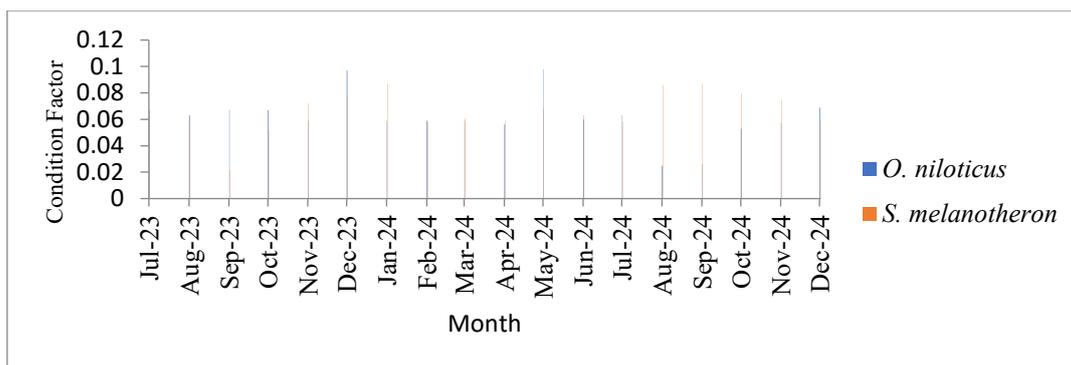*o. n = Oreochromis niloticus, s. m= Serathoredon melanotheron*

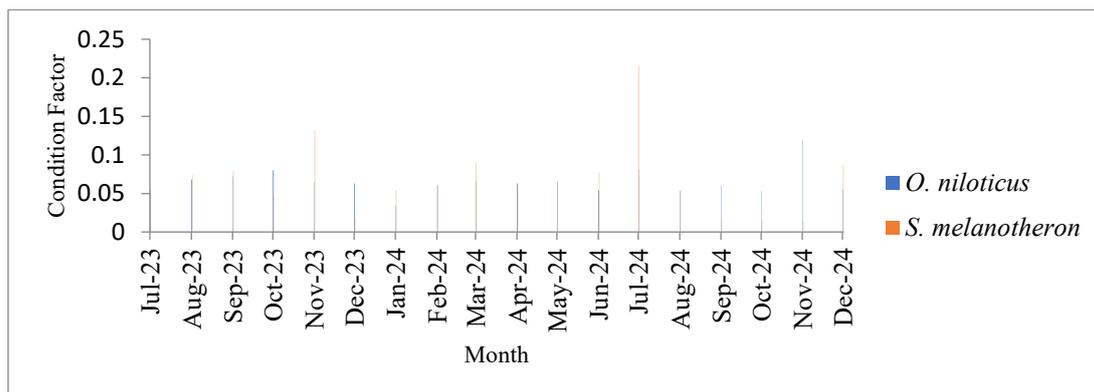Figure 2: Monthly mean Condition Factor of males

Figure 3: Monthly mean Condition Factor of females
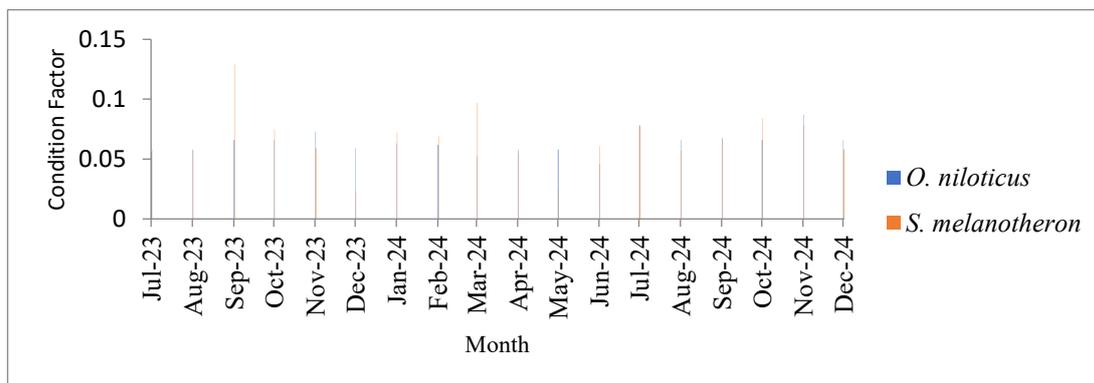

Figure 4: Monthly mean Condition Factor of Combined sexes

Discussion

The sustainability of fishery resources requires effective knowledge and management of all the processes involved in breeding. It also requires the detailed knowledge of the population parameters such as length-weight relationship. Length–weight relationship is useful for estimation of mean length-weight relationship among fish of the same specie or different within the same or different environment. (King, 2007; Beyer, 1987) also provides valuable information on the habitat and in the modeling of the ecosystem. (Kulbicki *et al.,* 2005; Pauly, 1993 and Fagbuaro, 2019). The result of length-weight regression analysis of fish sampled from Gubi Reservoir indicated that "b" value of both males, females and combined sexes of both *Oreochromis niloticus* and *Serotherodon melanotheron* exhibited negative allometric growth performance as the results was less than <3. Comparatively the length-weight relationship of *Oreochromis niloticus* the result revealed b value observed the highest value of 2.1 was observed in male *Oreochromis niloticus* higher than 1.1 the highest observed in female *Serotherodon*

melanotheron even though both results obtained from the two species indicated negative allometric performance being less than 3. The b value of 2.1 obtained from male *Oreochromis niloticus* agreed or in line with value of 2.1 obtained by Lowson *et al.,* (2013), 2.1 in male *Oreochromis niloticus* Adedoye, *et al.,* (2007) almost similar with Guisse, *et al.,* (2021), Adite, *et al.,* (2017), Indriyani, *et al.,* (2013). Also higher than 0.11 – 0.8 recorded by Getso*, et al.,* (2017) from River Wudil. Other results obtained from the two species from both male, female and combined sexes the result considered lower compared with 3.1, and 5.2 lowson, *et al.,* (2024), 3.0 recorded in Indrayani (2013) also, 3.0 and 3.1 Adite, *et al.,* (2017), 3.0 Saha, *et al.,* (2019) and 3.00 reported by Ahmad, *et al.,* (2016). Generally, negative allometric (the increase in fish length was more dominant than the increase in fish weight) also means that the increase in length is not equal in proportion to the weight under constant specific gravity and the fish will become thinner. This confirmed the fish do not grow symmetrically as reported by Tesch (1968). King (1996) also reported that fish becomes slender with the increase in

their length. The result also agree with decisions of Oso and Iwalaye (2016), Dan- Kishiya (2013), Peter and Diyaware (2014), Abubakar (2006) from some freshwater fishes of Nigeria. Moreover, positive allometric (weight gain was more dominant than the increase in fish length). Ricker and Carter (1958). Conversely, fish growth conditions will be optimal if the fish growth pattern is positive allometric. The results on length-weight relationship may be greatly influenced by both physical and biological factors. Some of these factors include the sex of the fish, age, season, habitat and geographical distribution (Olarin and Aderibigbe, 2006). Also, other factors such as increased feed intake, season of the year, general water quality such as temperature, pH, dissolve oxygen etc have been reported to have great impact on the weight of the fish. Food regurgitation and spawning also affect weight (Fagbuaro *et al.,* 2019) also environmental factors (biotic and abiotic factors) (Morato *et al.,* 2001; Anene, 2005), as well as the influence of variations in water temperature (De Giosa *et al.,* 2014; Jisr *et al.,* 2018 and Indrayani, *et al.,* 202 3). However, in general, larger fish is considered anatomically and physiologically healthier (Indrayani, *et al.,* (2023).

The length-weight regression analysis often used to determine the condition factor (Le-cren, 1951 and Kefas, 2016) also applied to determine the relationship between length and weight of sampled fish. The results confirmed the males, females and combined sexes of *Oreochromis niliticus, Sarotherodon malenotheron* of Gubi Reservoir there was no significant correlation (P>0.05) between the length and weight exhibiting linear relationship which in line Kefas (2016) and contrary with observation documented by Kefas and Abubakar, (2010) and confirmed by Kefas (2016) the result also agreed with Guisse *et al.,* (2022) revorded r value close to one show close relationship between length and weight. However, the results corresponded with findings of Adite *el, al.,* (2017) from Toho Lake, Mohmari, *et. al.,* (2022), Faizal, *etal.,*(2024). Also Idhwela, *et. al.,* (2011) also was higher than the results documented by Getso *et al.,* (2017) from River Wudil from Ruwan Yan' Akuya site, and Ruwan Jaki site. Lastly, the "b" documented by Turker *et al.,* (2019) and Yedier, *et al.,* (2020) were higher than the result of this study.

Condition factor

Condition factor (K) is described as a morphometric index which provides information on the physiological state of fish in their different habitats in relation to its welfare based on the principle that fish with better growth rate are said to be in better condition (Fagbuaro *et al.,* 2019) condition factor again expresses the degree of well-being, relative robustness, plumpness or fatness in numerical terms (Binta, 2025). In Gubi Reservoir the highest condition factor of 0.240 observed in female *Sarotherodon melanotheron* May 2024 this indicated throughout this research both the male, female and combined sexes were not in stable condition which might be due to the changes in the physical and chemical condition of the environments which usually hinder the physiological state of the fish (Kefas, 2016). However, Kefas (2016) reported low condition factor of fish from Lake Gerio Adamawa state confirmed as the result of heavy metals that were recorded above the permissible limit. (Ankita, *et al.,* 2022; and Faizal, *et al.,* 2024) reported the condition factor greater than 1 the fish said to be in good health whereas any result less than 1 the fish were not in good health condition, any condition less than 1 is a sign of poor condition, Also (Fugbuaro *et al.,* 2022) cited in (Bangal and Tesch, 1978) 2.9 – 4.8 condition factors recommended for mature fish which is closely in line with the

result documented by (Indrayani *et al.,* 2023) from Yousefa Bay.

CONCLUSION

This research carried out for eighteen months and 360 fish species samled were assessed, moreover, the results provided first hand information on length-weight relationship and condition factorof the Cichidae species; *Oreochromis niloticus* and *Serotherodon melanotheron* in Gubi Reservoir. The results of the two species showed nagetive allometric growth performance with no significant different at (P<0.05). Likewise, the condition factor indicated poor environmental condition and wellbeing of the fish. The result of this research will serves as guide for researchers and supporting data for policy implementation to ensure effective ecosystem management, fish stock availability and sustainability.

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