LENGTH-WEIGHT RELATIONSHIP AND CONDITION FACTOR OF FISH SPECIES OF OGUTA LAKE, IMO STATE, NIGERIA

[1]AGORUA, U. N., [2]F. D. SIKOKI, [2]I. F. VINCENT-AKPU
[*1]Department of Fisheries and Marine Technology, Imo State Polytechnic, Umuagwo,
[2]Department of Animal and Environmental Biology, University of Port Harcourt, Port Harcourt; E-mail:
[*]**Corresponding author:** agoruauchenna@yahoo.com

ABSTRACT
Length-weight relationship and condition factor of Oguta Lake, Imo State, Nigeria was studied for 18 months (May 2016- October 2017) with 48 species sampled. The length-weight relationship (LWR) was calculated with the formulaW=aL^b and the condition factor using Fulton Condition Factor (K) formula. The length-weight relationship shows that 'b' (growth exponent) ranged between 0.2875 and 5.1319 with Arnoldichthys spilopterus having the lowest value whereas the highest value was recorded for Petrocephalus bane bane. Most of the species exhibiteda negative allometric growth pattern. Citharinus citharus citharus, Gymnarchus niloticus, Heterotis niloticus, Labeo senegalensis, Parachelon grandisquamis, Schilbe mystus, and Petrocephalus bane bane exhibited positive allometric growth pattern while Alestes dentex and Synodontis courteti exhibited isometry growth pattern. The mean values of the condition factor (K) ranged 0.14±0.02-7.07±4.90 with the lowest mean value recorded for Polypterus senegalus senegalus and the highest recorded for Tetraodon lineatus. Thelowest condition factor 0.19 was recorded for Gymnarchus niloticus. This shows that most of the species are not in a good state which may be caused by inadequate feeding, environmental or physiological condition. Therefore, this calls for enforcement of regulations, adequate fishery management, and close monitoring of length-weight relationship and condition factor of the species for effective stock management of the lake

Keywords*:* Well-being, aquatic, management, environmental, factors.

INTRODUCTION
Fishes, especially those of tropical and sub-tropical aquatic systems show growth fluctuation due to numerous factors such as changes in environmental condition, food composition, competition within the food chain, physical and chemical properties of the aquatic ecosystem (Adedeji and Araoye, 2005; Abowei and Davies, 2009). Fish experience growth in length as well as in bulk (King, 1996). According to Bake and Sadiku (2004), growth is the change in absolute weight (energy content) or length of fish over time, whereas Adedeji and Araoye (2005) summarized growth as a function of fish size. The study of growth patterns in fish has been based mainly on the length-weight relationship or relationship between sizes of scales or other calcified tissues and body length because of their importance in age and growth analysis (Adeyemi *et al*., 2009).

Abowei and Hart (2009) reported that the length-weight relationship of fish also known as growth index is a vital management tool used in estimating the average weight at a specified length. Olurin and Aderibigbe (2006) stated that the Length-weight relationship provides information on the condition and growth patterns of fish. It is generally used in fisheries biology for several purposes such as estimating the mean weight of fish based on identified length (Araoye, 2004; Da Costa and Araojo, 2003; Akintola *et al*., 2010). Omoniyi *et al*., (2010) stated that fish growth can be evaluated from morphometric parameters relative to total length and length-weight relationship is used in morphometric inter-specific and intra-specific population comparisons to assess the index of the well-being of the fish populace. Fishes exhibit isometric growth when length increases in equal proportions with bodyweight for constant specific gravity. The regression coefficient for Isometric growth is 3 and values greater or lesser than '3' indicate allometric growth (Olurin and Aderibigbe, 2006).

Nwadiaro *et al.* (1985) studied the biometric characteristics, length/weight relationships, and condition factors in *Chrysichthys filamentosus* (Pisces: Bagridae) from Oguta Lake and reported that the weight varied directly as the total length of the fish to the exponent 2.88 and this show allometric growth. They reported that the sparse macrobenthic fauna of the Lake and the food resources for the species probably is responsible for the “thinness” of *Chrysichthys filamentosus* in Oguta.

Bolarinwa and Popoola (2013) from their study on the length-weight relationship of some economic fishes of Ibeshe waterside, Lagos Lagoon reported that the values of "b" show that most of the fish collected from the Ibeshe waterside exhibited negative allometric growth pattern apart from *Pomadasy jubelini*. Studies by Obasohan *et al*.,(2012) in Ibiekuma stream, Edo State, revealed that all the fish exhibited negative allometric growth pattern with regression exponent b values less than 3, while the correlation coefficient (r) obtained which ranged from 0.850 – 0.963 revealed a high degree of positive correlation.

The Condition factor compares the well-being of a fish and is based on the hypothesis that heavier fish of a given length are in better condition

(Bagenal and Tesch, 1978). Condition factors decrease with an increase in length (Bakare, 1970; Fagade, 1979) and also influence the reproductive cycle in fish (Welcome, 1979).

The condition factor (k) of some Economic Fishes of Ibeshe Waterside, Lagos Lagoon was reported of ranging from 0.56 in *Sphraenapis catorium* to 1.62 in *Pomadasy jubelini* and these condition factor values fall outside the range recommended as suitable for matured freshwater species in the tropics (Bolarinwa and Popoola,2013). Obasohan *et al*., (2012) from their study, reported that the condition factor of *Papyrocranus afer* and *Parachanna obscura* were less than 1 and this implied that these fishes were not in a good physiological state of well-being in the stream but the values of *M.electricus*, *Tilapia mariae*, and *O.niloticus* were greater than 1 which shows that they were in good physiological condition.

Abowei and Davies (2009) observed no temporal variation in the condition of the fish throughout the year with condition index value ranging from 0.83-1.00 and condition factor value of 0.92.

STUDY AREA

Description of Study Area

Oguta Lake a freshwater body is located in Oguta Local Government Area, Imo State, Nigeria with Latitudes 5^0 41^1 and $5^0 44^1$ North and Longitudes 6^0 50^1 and 6^0 45^1 East. It is linear in shape and has closeness to RiversNjaba, Awbana, and Orashi, while Utu River (a seasonal river) flows in during the wet season.

According to Ogidi and Nwadiaro (1988), it is a small and shallow aquatic body having a flooding season maximum surface area of 2.48km^2 and a maximum depth of 9.30m. The Lake is of huge worth to the people of Oguta Local Government because it is the largest natural Lake in South-eastern Nigeria as well as the source of revenue, transportation, tourism, and catch fish for their protein from the lake.

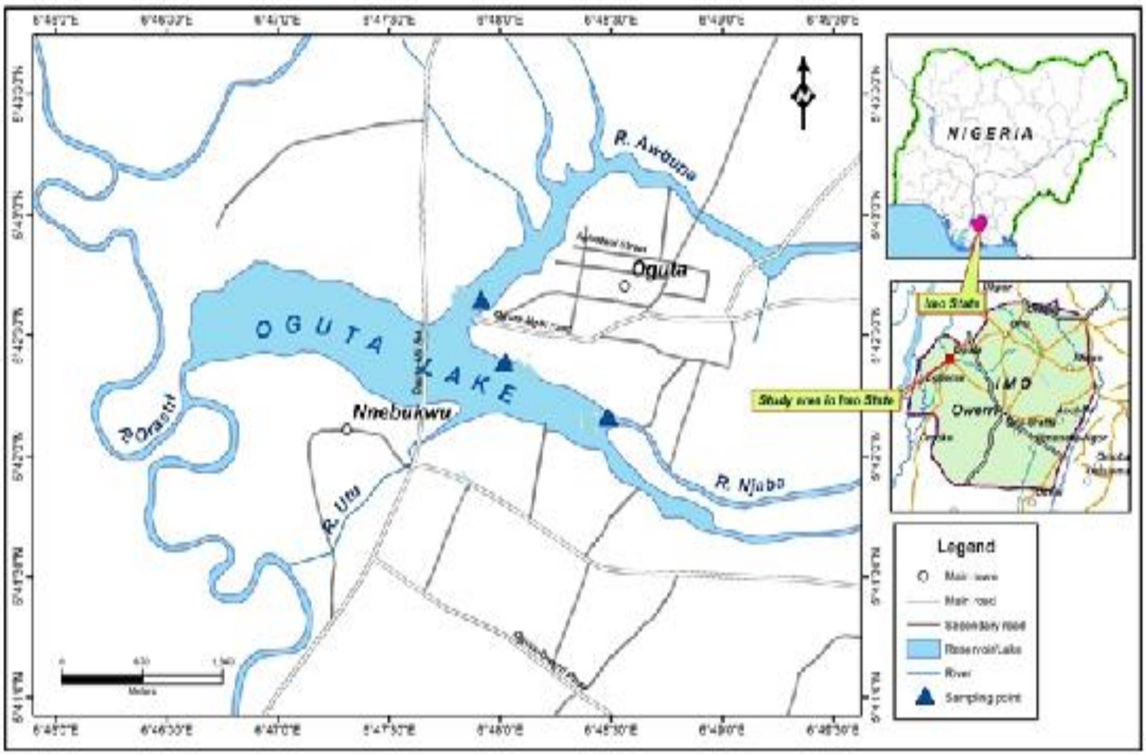

Figure 1Map of Oguta Lake showing the sampling points
Source: Ministry of Lands and Survey, Imo State.

Field Procedures and Data Acquisition of Fish Stock of Oguta Lake

Sampling and Identification of Fish Samples:

The study was done for 18 months (May 2016-October, 2017). The fishing was done with the assistance of some artisanal fishers every month and fish species caught identified with the aid of keys and description as established by Reed *et al*. (1967), Anthony (1982), Idodo-Umeh (2003), Sikoki, and Francis (2007) and Babatunde and Aminu (2013).

Length and Weight Measurements

The length of the fish species was determined using a measuring board to the nearest 0.1cm, while fish weight was determined with Kerro Electronic scale (KLS10001) to the nearest 0.1g.

Fish Sample Preservation

Preservation was done with a plastic bucket with a tightly fitted cover containing 10% formalin which was taken to the Laboratory for further identification and preservation.

Computational Analysis

The length-weight relationship was determined using:

$W=aL^b$

Where,

W=Weight (g)

L= Total Length (cm)

a= constant

b= Growth Exponent

Condition Factor

The condition factor was calculated using Fulton Condition Factor (K) formula indicated below.

$$K=\frac{W}{L^3}\times\frac{100}{1}$$

Where,

W= Weight of the fish

L= Length of the fish (Fulton, 1904).

RESULTS

The mean values of the condition factor (K) ranged 0.14±0.02-7.07±4.90 with the lowest mean value recorded for *Polypterus senegalus senegalus* and the highest recorded for *Tetraodon lineatus*. The lowest condition factor ranged 0.19-0.21 which was recorded for *Gymnarchus niloticus* and the highest 2.08-6.40 recorded for *Ctenopoma nebulosum*.

Out of the 48 species sampled, 33 species were analysed for Length Weight Relationship and it was observed that 'b' ranged between 0.2875 and 5.1319. The lowest value was recorded for *Arnoldichthys spilopterus*, whereas the highest value for *Petrocephalus bane bane*. It was also observed that 2 species (*Alestes dentex* and *Synodontis courteti*) showed isometry growth, 7 species showed positive allometry growth and 24 species showed negative allometry growth.

DISCUSSION

Most of the species exhibited negative allometric growth patterns and this is in agreement with Adaka *et al*. (2015) who reported a similar result of most of the species studied in Oramiri-Ukwa River exhibiting negative allometric growth pattern.*Hemichromis bimaculatus* and *Coptodon zilli* showed negative allometric 'b' (growth exponent) values, this contradicts Atama *et al*. (2013) who reported positive allometry growth for *Hemichromis bimaculatus* and *Coptodon zilli*.

Hemichromis fasciatus and *Oreochromis niloticus* which also exhibited negative allometric growth pattern, agreed with Atama*et al.* (2013), who also reported negative allometric growth for *Hemichromis fasciatus* and *Oreochromis niloticus* on their studies on weight-length relationship and condition factor of six cichlids (Cichlidae: perciformis) species of Anambra River. The result is also similar to Gesto*et al*. (2017) who reported negative allometric growth pattern for *Oreochromis niloticus* and this is similar to Omatsuli *et al* (2017) and Omotaya *et al.* (2018) results, who reported allometric growth pattern for *Oreochromis niloticus* and *Tilapia zilli* but contradicts Ude *et al*. (2011) who reported isometric growth pattern for *Oreochromis niloticus* and *Hemichromis fasciatus*. The difference in the result could be attributed to age, sex, sampling methods, and difference in the environmental condition which may affect the length-weight relationship and conditions of fish (Ama- Abasi, 2007; Adeyemi *et al.*, 2009).

Schilbe mystus exhibited a positive allometric growth pattern and this contradicts Ude *et al.* (2011) who reported an isometric growth pattern. *Citharinus citharus citharus*has the condition factor (K) value range of 0.92-5.60 and a mean value of 1.93±0.11 and 1.10-3.99 for *Heterotis niloticus* with a mean value of 2.77±0.86. This report agreed with Ekelemu and Samuel (2006) who stated that the condition factor for *Heterotis niloticus* and *Citharinus citharus citharus* were 1.57 and 2.40 from their studies on growth patterns and condition factors of four dominant fish species in Lake Ona, Southern Nigeria.

Hemichromis fasciatus has a condition factor range of 1.40-5.47 with a mean value of 2.69±0.32, *Sarotherodon galilaeus galilaeus* ranged between 1.50-4.66 (2.42±0.18 as the mean value), *Oreochromis niloticus* was between 1.73-3.83 with a mean of 2.23±0.13, *Hemichromis ansorgii* was 0.60-3.70 (2.28±0.16 as the mean), *Coptodon zilli and Pelmatolapia mariae* ranged between 0.85-2.29 (1.76±0.05) and 2.00-2.52(2.26±0.26) respectively. This shows that Cichlidae family is in good environmental condition and this agrees with Ujjania *et al*. (2012), who stated that fish with condition factor value greater or equal to one indicates good feeding level and proper environmental condition. The value for *Oreochromis niloticus* also agreed with Getso *et al* (2017), who reported the condition factor 1.809 for *Oreochromis niloticus* from Kogi Mada sampling site *and 0.516 for Clarias gariepinus* from Marmara site. It is also in agreement with Obasohan *et al*., (2012) who reported that the values of *Tilapia mariae* and *Oreochromis niloticus* from Ibiekuma Stream, Ekpoma, Edo State were greater than one. From the result, *Chrysichythys auratus* had a condition factor mean value of 1.81±0.08 and this contradicts Adaka *et al*., (2015) who reported a value less than 1 for *Chrysichythys auratus*.

Malapterurus electricus has a condition factor value range of 1.32-3.30 and mean value of 2.15±0.43, and this is in agreement with Obasohan *et al.* (2012) who reported that the value of

Malapterurus electricus was from IbiekumaStream, Ekpoma, Edo State was greater than one and Imefon (2012), reported the mean condition factor (K) value of 3.61 for *Malapterurus electricus* from his study in Iba-Oku Stream.

Polypterus seneglus senegalus has the lowest condition factor value range of 0.119-0.149 with a mean value of 0.134. This shows that *Polyterus senegalus senegalus* may not be feeding well or is facing an adverse environmental condition.

CONCLUSION

Most of the species exhibited negative allometric growth pattern (that is the fish grows faster in length than in weight) few species exhibited positive allometric growth pattern (grows faster in weight than in length) and two species exhibiting isometric growth pattern this shows that the fishes are not in a good state. This may be caused by inadequate feeding, environmental or physiological conditions. Therefore, this calls for enforcement of regulations and adequate fishery management to secure the ecosystem and close monitoring of length-weight relationship and condition factor of the species for effective stock management in the fishery sector.

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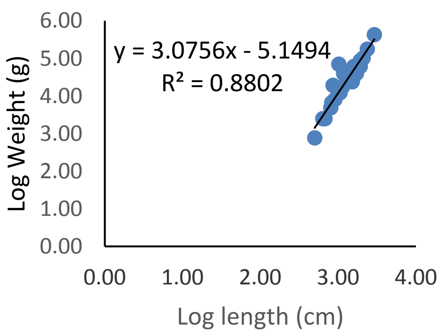
Table 1: The Condition factor and growth pattern of selected species

Fish Species	**K**		**a**	**B**	**R²**	**Growth pattern**
	Mean±SE	Range				
Alestes dentex	0.75±0.03	0.55 - 1.53	-5.1494	3.0756	0.8802	Isometry
Alestopetersius symkalai	5.56±2.22	0.46 - 38.40	1.5759	0.3219	0.2526	Negative allometry
Arius gigas	0.85±0.16	0.69 - 1.01				
Arnoldichthys spilopterus	2.46±0.71	1.05 - 3.20	0.4695	0.2875	0.0173	Negative allometry
Bagrus bajad	0.68±0.04	0.64 - 0.71				
Bathygobius soporator	0.96±0.05	0.85 - 1.10	-2.6459	2.1375	0.8753	Negative allometry
Chrysichthys auratus	1.81±0.08	0.74 - 5.21	-0.4494	1.4964	0.4758	Negative allometry
Citharinus citharus citharus	1.93±0.11	0.92 - 5.60	-5.2159	3.3713	0.895	Positive allometry
Clarias anguillaris	1.69±0.08	1.61 - 1.76				
Coptodon zilli	1.76±0.05	0.85 - 2.29	-3.3604	2.7205	0.8998	Negative allometry
Ctenopoma nebulosum	4.24±2.16	2.08 - 6.40				

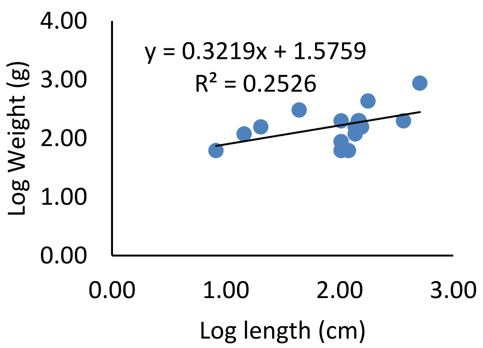
Distichodus rostratus	1.67±0.15	0.99 - 2.88	-3.7255	2.8382	0.9461	Negative allometry
Hemichromis bimaculatus	5.97±1.82	1.88 - 20.41	-1.661	2.2225	0.3276	Negative allometry
Hemichromis fasciatus	2.69±0.32	1.40 - 5.27	-2.2364	2.4798	0.8744	Negative allometry
Heterotis niloticus	2.77±0.86	1.10 - 3.99	-11.13	5.0278	0.9824	Positive allometry
Hydrocynus forskali	0.85±0.03	0.73 - 0.94	-2.5565	2.1932	0.6286	Negative allometry
Hyperopisus bebe	0.79±0.07	0.58 - 1.34	-4.3658	2.7972	0.9283	Negative allometry
Ichthyborus monody	0.44±0.05	0.39 - 0.49				
Labeo coubie	1.28±0.00	1.28 - 1.28				
Labeo senegalensis	1.65±0.34	1.02 - 3.92	-6.7759	3.8406	0.9536	Positive allometry
Lates niloticus	1.32±0.11	1.21 - 1.42				
Parachelon grandisquamis	2.32±0.40	0.95 - 13.58	-4.7003	3.227	0.6059	Positive allometry
Malapterurus electricus	2.15±0.43	1.32 - 3.30	-0.3805	1.6582	0.703	Negative allometry
Mormyrops anguilloides	0.91±0.09	0.66 - 1.08	-2.7486	2.2048	0.9258	Negative allometry
Mormyrus rume rume	0.82±0.00	0.82 - 0.82				
Oreochromis niloticus	2.23±0.12	1.73 - 3.83	-2.4917	2.5444	0.9587	Negative allometry
Papyrocranus afer	1.02±0.43	0.43 - 7.40	-0.8791	1.766	0.5653	Negative allometry
Parachanna africana	1.48±0.23	0.50 - 4.95	-0.9208	1.8804	0.5727	Negative allometry
Parailia pellucida	1.87±0.17	1.33 - 2.31	-2.7166	2.3789	0.9977	Negative allometry
Pelmatolapia mariae	2.26±0.26	2.00 - 2.52				
Petrocephalus ansorgii	1.13±0.00	1.13 - 1.13				
Petrocephalus bane bane	1.37±0.07	1.19 - 1.49	-8.9033	5.1319	0.3333	Positive allometry
Petrocephalus bovei bovei	1.16±0.03	0.95 - 1.30	-2.7892	2.2217	0.8578	Negative allometry
Petrocephalus soudanensis	1.19±0.03	1.14 - 1.25	-3.497	2.5554	0.7575	Negative allometry
Phago loricatus	0.47±0.00	0.47 - 0.47				
Polypterus senegalus senegalus	0.14±0.02	0.12 - 0.15				
Sarotherodon galilaeus galilaeus	2.42±0.18	1.50 - 4.66	-0.9366	2.1216	0.6191	Negative allometry
Schilbe mystus	1.93±0.83	0.74 - 9.37	-7.2594	4.0985	0.7026	Positive allometry
Synodontis courteti	1.24±0.03	1.13 - 1.39	-4.6714	3.0967	0.9975	Isometry
Synodontis membranacea	1.68±0.52	0.67 - 15.63	-2.2295	2.278	0.6214	Negative allometry
Synodontis resupinata	1.01±0.31	0.70 - 1.32				
Synodontis schall	1.29±0.11	0.35 - 1.94	-3.306	2.6464	0.517	Negative allometry
Synodontis violacea	1.39±0.12	1.00 - 2.79	-3.3087	2.6719	0.8834	Negative allometry
Tetraodon lineatus	7.07±4.90	1.72 - 36.44	0.5463	1.5436	0.8203	Negative allometry
Thysochromis ansorgii	2.28±0.16	0.60 - 3.70	-2.9286	2.5916	0.6856	Negative allometry
Trachinotus teraia	1.34±0.00	1.34 - 1.34				
Xenomysytus nigri	1.04±0.00	1.04 - 1.04				

Length-weight relationship graph

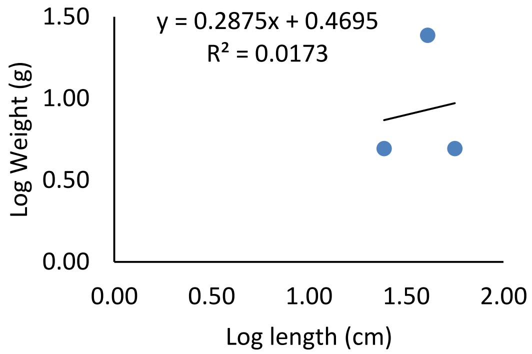
Alestes dentex



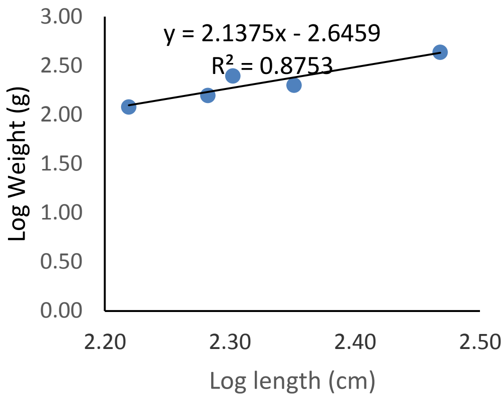
Alestopetersius symkalai



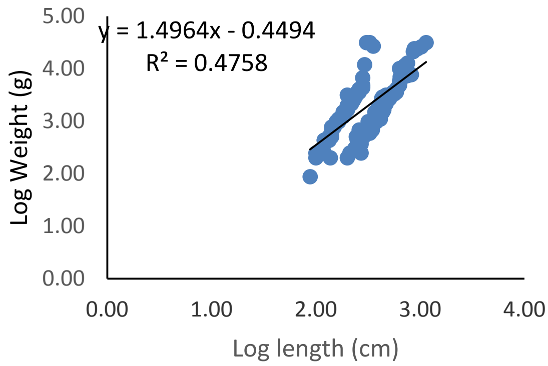
Arnoldichthys spilopterus



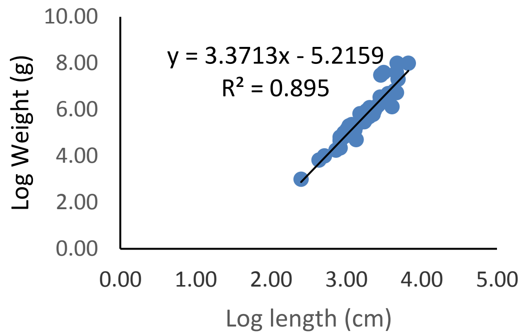
Bathygobius soporator



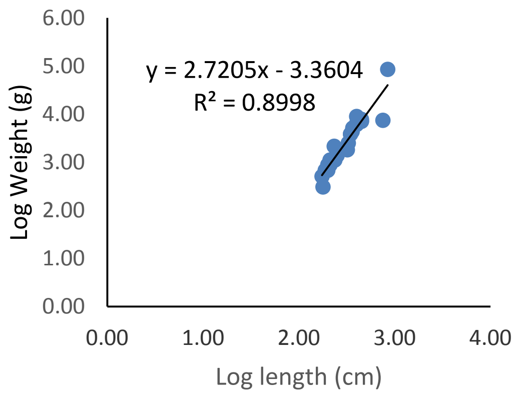
Chrysichthys auratus



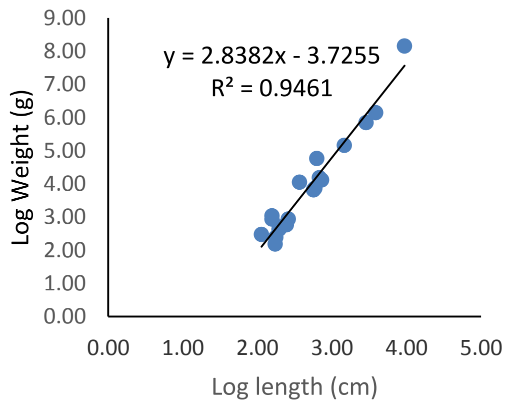
Citharinus citharus citharus



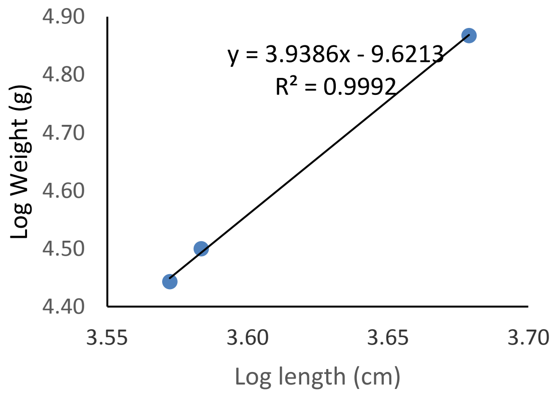
Coptodon zilli



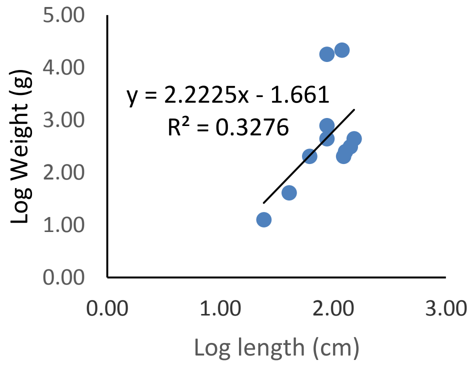
Distichodus rostratus



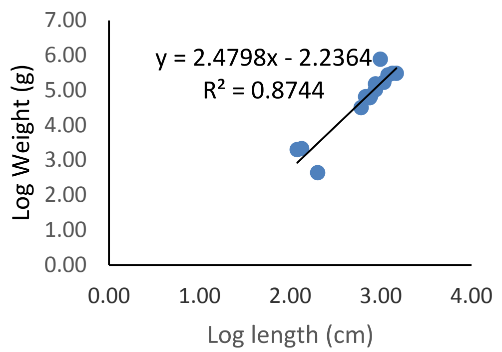
Gymnarchus niloticus



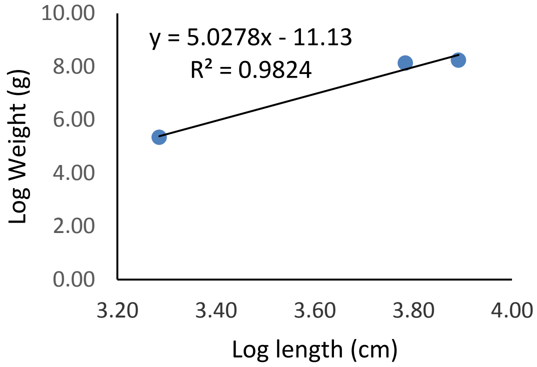
Hemichromis bimaculatus



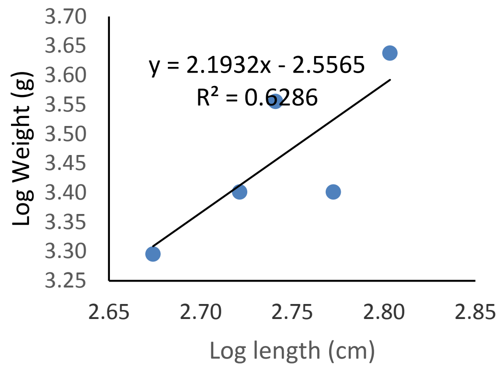
Hemichromis fasciatus



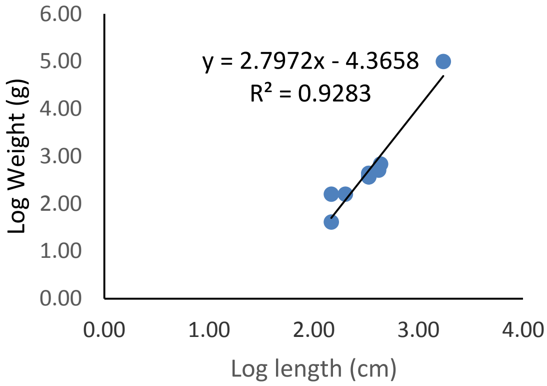
Heterotis niloticus



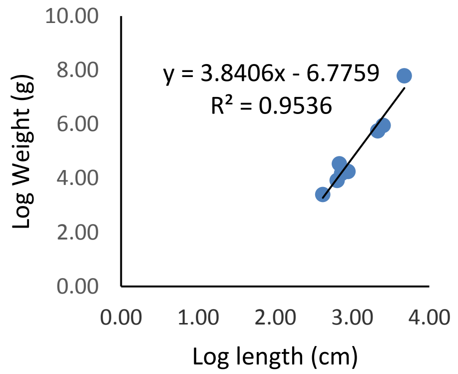
Hydrocynus forskali



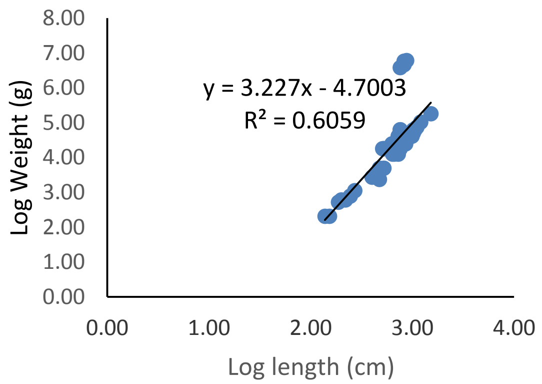
Hyperopisus bebe



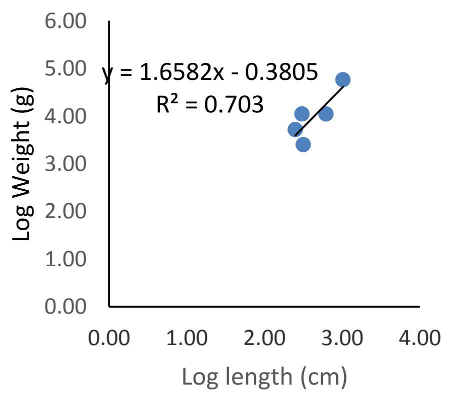
Labeo senegalensis



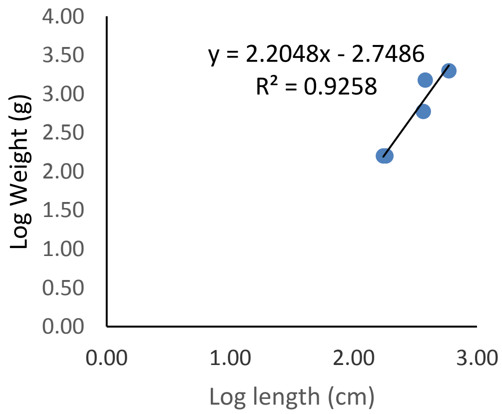
Parachelon grandisquamis



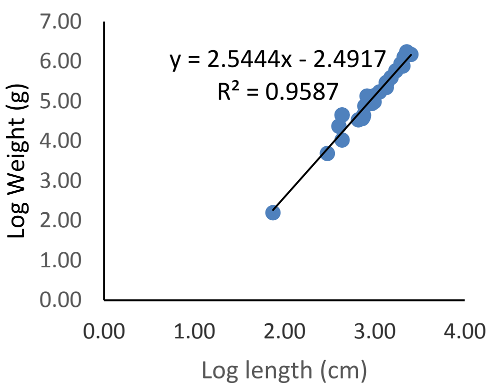
Malapterurus electricus



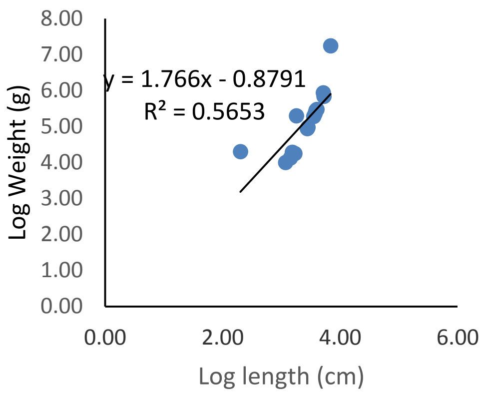
Mormyrops anguilloides



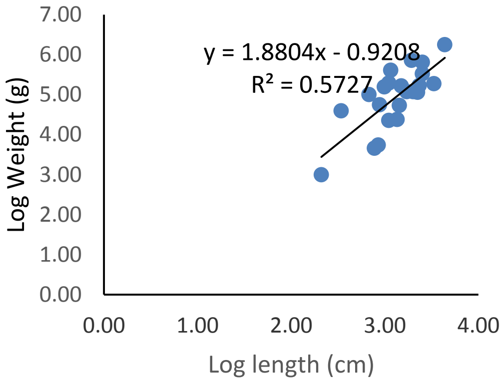
Oreochromis niloticus



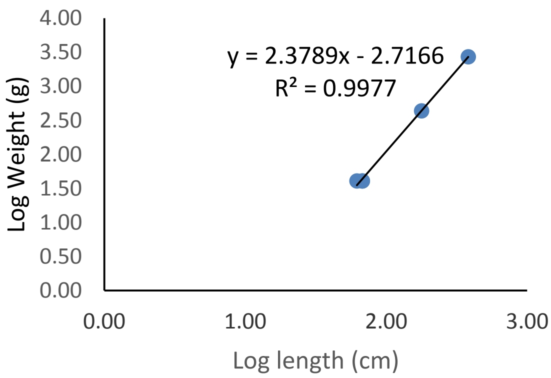
Papyrocranus afer



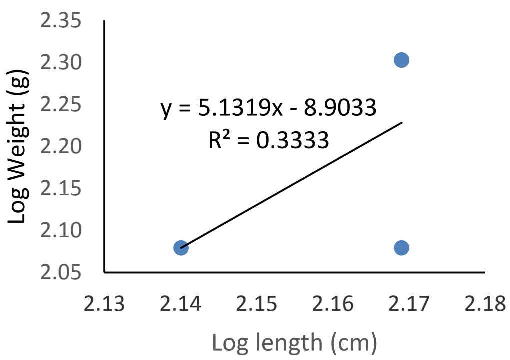
Parachanna africana



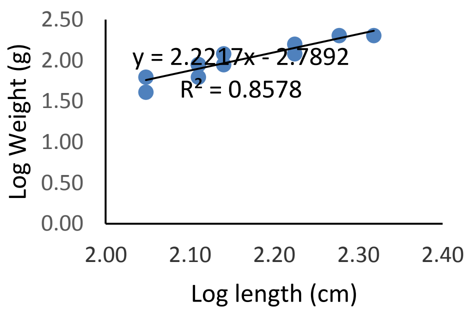
Parailia pellucida



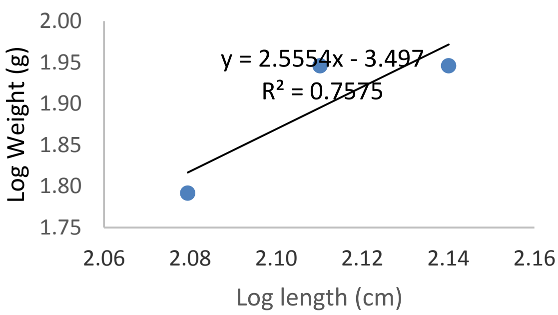
Petrocephalus bane bane



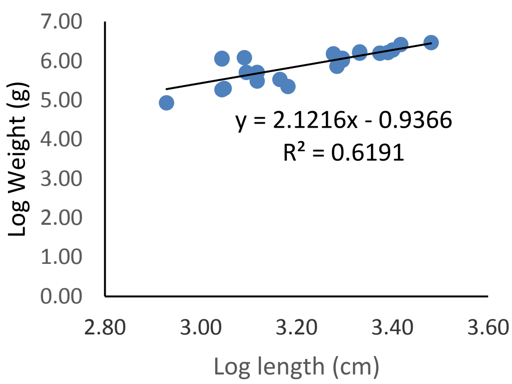
Petrocephalus bovei bovei



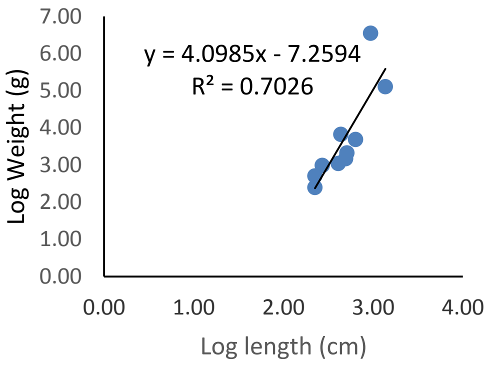
Petrocephalus soudanensis



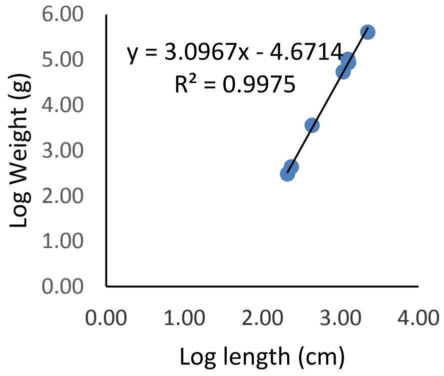
Sarotherodon galilaeus galilaeus



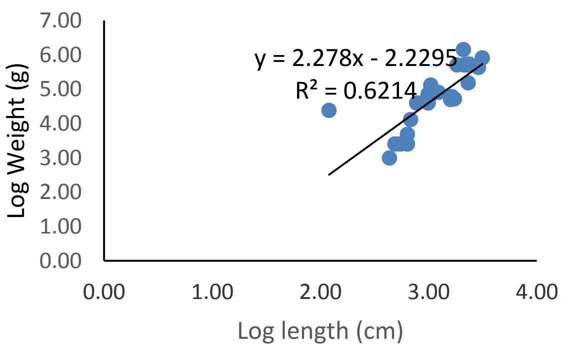
Schilbe mystus



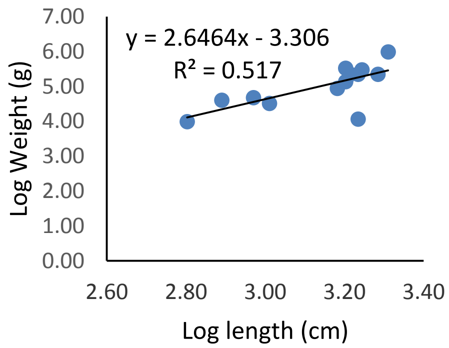
Synodontis courteti



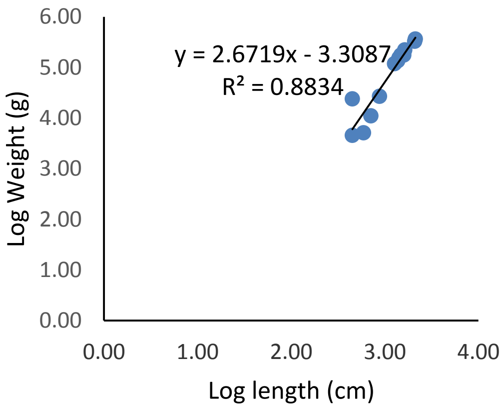
Synodontis membranacea



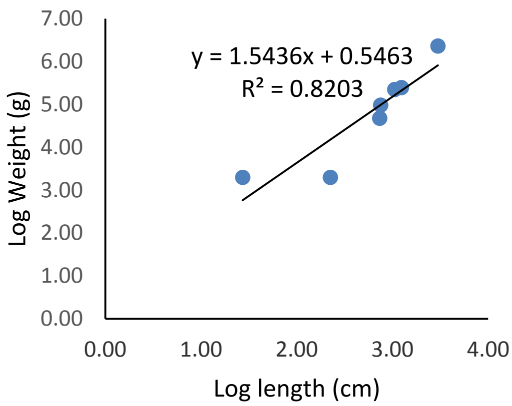
Synodontis schall



Synodontis violacea



Tetraodon lineatus



Thysochromis ansorgii