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An Assessment of the Condition of Fishes in the Amadi Creek, Rivers State, Nigeria

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Abstract

A five month study was conducted to determine the condition factor of fishes and physico-chemical parameters of the water, of Amadi Creek, aimed at identifying the wellbeing of fishes in this creek, a medium for waste disposal and other anthropogenic activities. Fishery dependent data of length and weight of sampled species, from the creek, served as inputs for determination of the Condition factor (k). Results indicated the creek fauna composed of 12 species, 10 genera and seven families of fin fishes. The families and species, and their condition factor were: Cichlidae (Sarotherodon melanotheron - 2.3; Sarotherodon galilaeus - 2.5; Hemichromis fasciatus – 1.7; Coptodon guineensis – 2.6; Coptodon zilli - 1.0); Mugilidae (Parachelon grandisquamis - 2.4, Mugil cephalus – 1.3); Clupeidae (Sardinella maderensis – 1.7); Claroteidae (Chrysichthys nigrodigitatus – 1.6); Elopidae (Elops lacerta - 0.3); Eleotridae (Eleotris senegalensis – 0.9) and Haemulidae (Pomadasys peroteti - 0.7). Some of the species seemed to be in good condition compared to results of same species obtained from another brackishwater river in the Niger Delta. There was a general reduction in k values in the month of March, fluctuation was observed in K values of S. melanotheron, Coptodon guineensis, Sarotherodon galilaeus and S. maderensis while the values obtained for P. peroteti and Elops lacerta indicated poor condition of the fishes. Estimated Physico-chemical parameters, of the creek water, using standard methods indicated: temperature range of 28.6°C (February) to 35.2°C (March). Dissolved oxygen ranged between 2.1 mg/L (May) and 9.0mg/L (April). The pH ranged from 6.6 (March) to 8.7 (April). Conductivity was: 9.2S/m (April) to 9.9S/m (March), while salinity was: 17.3psu (May) to 24.0psu (February). Most of the physico-chemical parameters were in line with the dynamic nature of brackishwater systems with the exception of high values of conductivity and very low dissolved oxygen content, both indicative of pollution.

Keywords: Amadi Creek; Condition Factor; Fish Species; Physicochemical Parameters.

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1. Introduction

Condition factor (K), is a measure of the degree of well-being or relative robustness of fishes [1,2]; and is estimated using the ratio of fish body weight to body length [3]. Also, condition factor is used in fishery science to compare growth conditions of fish, and environmental quality [4,5,6,7]; as well as being important in assessing the life cycle and proper management of fish stocks, all of which are important in preserving ecosystem balance [8]. Condition factor is strongly affected by biotic and abiotic conditions, thus it is used in assessing the status of the aquatic ecosystem of fishes [9]. Condition factor becomes an index for comparing the wellbeing of fish populations based on the hypothesis that heavier fish of same length are in better condition [10,3]. However, with every increase in length of a fish, there is a decrease in condition factor [11,12]. Also, the physico-chemical parameters or water quality of a water body can influence the size and growth of fishes, as they affect food supply, climatic indices, provision of nutrients, among others in the aquatic ecosystems [13]; and in turn adversely affect the condition of fishes, since they are totally dependent upon water for their physiological functions [14]. The Amadi creek, one of the numerous creeks that make-up the aquatic ecosystem in the Port Harcourt metropolis in Rivers State, flows through a series of inland communities, before entry into its main channel, the Bonny River, and finally into the Atlantic Ocean [15]. This creek is economically important, mainly, as a source of fish for the teeming population in Port Harcourt, as fishing is a primary economic activity in Rivers State [16,15]. Also, the creek hosts several other human and economic activities both local and international, hence, it receives an assortment of industrial and domestic wastes [17,15]. Recently, several natural water bodies were reported to contain high levels of major pollutants that cause imbalance in the natural environment, due to municipal and industrial activities around them [16]. The author [18] also reported that, there was tremendous increase in anthropogenic activities around coastal areas, which included hydrocarbon exploration activities. Summarily, anthropogenic activities can lead to the introduction of substances at dangerous levels into the creek to negatively affect the water quality and the wellbeing of the fish fauna eventually. Despite afore mentioned reality, there is no study on the condition factor of fishes in relation to the physicochemical parameters in the Amadi creek. The main objective of this study therefore, is to assess the water quality and condition factor of the fish fauna of the Amadi Creek.

2. Materials and Methods

2.1. Study Area

This study was carried out in the Amadi creek (Figure 1), in Port Harcourt Metropolis, Nigeria. The Creek flows through several communities in the Port Harcourt Local Govt. Area, from Nkpogu to Abuloma communities, into the Bonny River, and eventually into the Atlantic Ocean. It lies between latitude $4^{o}46'00"$ N and longitude $7^{o}03'00"$ E [16]. The creek is one of the tributaries of the upper Bonny Estuary, and is brackish and tidal in nature with fresh water intrusion from the surrounding inland waters; so its water is more fresh during the rainy season [19,17]. The three other creeks to which the Amadi Creek is closely linked to in the Niger Delta Basin are: Okpoka Creek, Aboturu Creek and Diobu Creek. There are two distinct seasons: wet and dry seasons, while a brief dry and cold spell, the harmattan, is associated with the dry season. The Amadi creek is sparsely forested on one side of its channel by mangrove trees, and inhabited on the other side [15].The sparse

vegetation consists of a few red and white mangroves (*Rhizophora mangle* and *Avicennia africana*, respectively) with more of Nypa palm (*Nypa fruticans*) dominating most borders of the creek [20]. The main channel of the creek is deep due to dredging activities along the creek, with exposed sandy river bottom and chikoko mud intertidal banks [15].

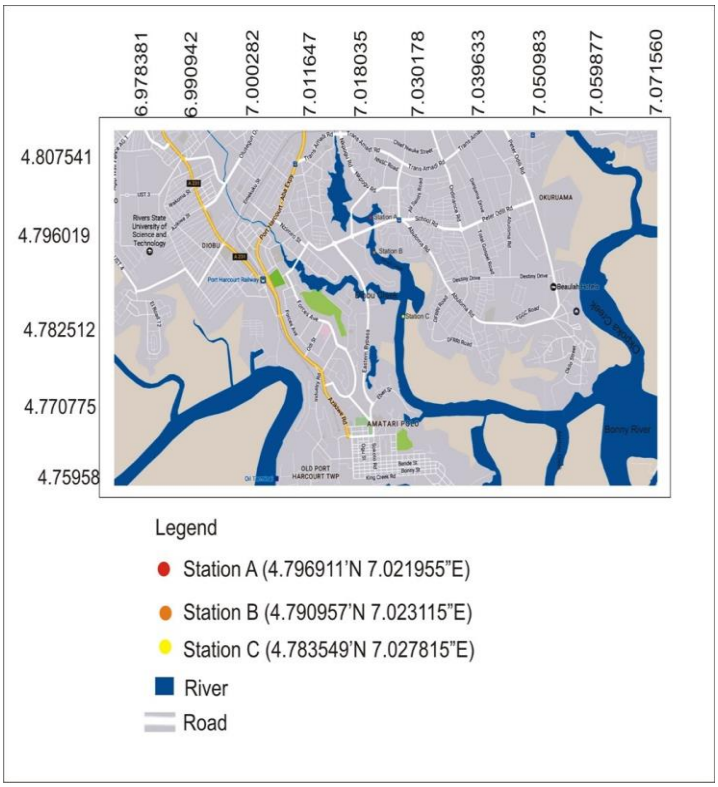

Figure 1: Map showing the Amadi Creek, Port Harcourt, Rivers State. (Source and date: Google maps; 2018.)

2.2. Fish and Water Sample Collection from Amadi Creek

The study was done for five months, January to May, 2018 within three sampling points spaced 2km kilometers apart around Amadi-Ama, Nkpogu and Julius Berger Jetty (Marine base) axis of the Amadi Creek. Sampling was done once in January but twice for the rest four months. Fish samples were randomly collected from local fishers from the three sampling points for analysis, as they landed their catch. Afterwards, fish specimens were preserved in receptacles and transported to the laboratory for biometric analysis. Also, measurements of water physico-chemical parameters from the same three sampling points were done.

2.3. Fish Identification, Length and Weight Measurements

The fishes were identified and measurements recorded. The scientific names and occurrence of each identified species were confirmed using the standard keys of [21], Nigeria Freshwater Fishes [22], Taxonomies, Ecological Notes, Diet and Utilization [23], An Atlas of fin fishes in the Andoni River in Niger Delta [24], Album of Marine and Brackish Fishes of the Niger delta Area [25], and FishBase [26]. The length measurement of fish samples were taken to the nearest centimeter (cm), and weight measurements to the nearest gram (g).

2.4. Physico-chemical Parameters of Water of the Amadi Creek (Water Quality) Determination

The water quality of the Amadi Creek was determined by taking weekly measurements to assess its Physico-chemical parameters, which were;

Temperature - this was measured in-situ with a mercury-in-glass thermometer on the field. The thermometer was immersed deep into the water, 1 metre away from the shoreline, for two minutes to ensure stability before the temperature was taken. The pH (Hydrogen ion concentration) of the creek water was measured with a pH meter (WTW pH 330), and recorded immediately, while the Dissolved Oxygen was measured with Milwaukee DO meter (MW 600). For conductivity and salinity measurements**,** hand held Digital Meter, Gon Do Multi-meter (TS-406) was used.

2.5. Determination of Condition Factor of Fish Species from the Amadi Creek

Condition factor of sampled fish species from the Amadi Creek were estimated using formula:

$K=(W/L^3)*100$ [27];

where K= Condition Factor; W= Wet weight of fish in grams (g) and L= Total length of fish in centimeters (cm); while the 100 is to bring the answer to unity [28].

2.6. Data analysis

Statistical Package for Social Scientists (SPSS), Version 16.0 was used for calculation.

3. Results

3.1. Species Composition and Condition Factor of Amadi Creek Ichthyofauna

Table 1: Checklist and Composition of Fin Fish species of the Amadi Creek, Port Harcourt, Rivers State (Jan – May, 2018)

S/N	Species	Families	Total No. Caught
1	*Sarotherodon melanotheron*	Cichlidae	10,979
2	*Sarotherodon galilaeus*	″	1,209
3	*Coptodon guineensis*	″	7,097
4	*Coptodon zilli*	″	2
5	*Hemichromis fasciatus*	″	30
6	*Mugil cephalus*	Mugilidae	132
7	*Parachelon grandisquamis*	″	25
8	*Sardinella maderensis*	Clupeidae	30
9	*Chrysichthys nigrodigitatus*	Claroteidae	25
10	*Elops lacerta*	Elopidae	2
11	*Eleotris senegalensis*	Eleotridae	1
12	*Pomadasys peroteti*	Haemulidae	2
Total	12	7	19,534

The fish fauna of the Amadi Creek as identified from artisanal landed catches (Table 1), is composed of 12 species, 10 genera and seven families of fin fishes. The identified species were: *Sarotherodon melanotheron, Sarotherodon galilaeus, Coptodon guineensis, Sarotherodon galilaeus, Mugil cephalus, Sardinella maderensis, Hemichromis fasciatus, Parachelon grandisquamis, Chrysichthys nigrodigitatus, Pomadasys peroteti, Elops lacerta,* and *Eleotris senegalensis.*

Table 2: Monthly Mean Condition Factor of fin fish species of the Amadi Creek, Port Harcourt, Rivers State (Feb – May, 2018).

Fish species	February	March	April	May	Mean
Sarotherodon melanotheron	2.6	1.5	2.1	2.3	2.3
Sarotherodon galilaeus	3.3	2.5	2.6	2.3	2.5
Coptodon guineensis	3.5	2.3	2.0	2.7	2.6
Coptodon zilli	1.1	0.8	_	_	1.0
Chrysichthys nigrodigitatus	1.4	_	1.5	_	1.6
Elops lacerta	0.3	_	_	_	0.3
Eleotris senegalensis	0.9	_	_	_	0.9
Hemichromis fasciatus	_	_	_	1.7	1.7
Mugil cephalus	1.1	1.3	1.6	1.4	1.3
Parachelon grandisquamis	2.4	_	_	_	2.4
Pomadasys peroteti	0.7	_	_	_	0.7
Sardinella maderensis	_	2.1	1.6	1.3	1.7

3.2. Condition Factor (K) of Fish Species from the Amadi Creek

Condition factor was estimated during the five months of study as available data allowed for only four species namely *Sarotherodon melanotheron, Coptodon guineensis, Sarotherodon galilaeus and Mugil cephalus* indicating these species were always available. There was a general reduction in the K values in the month of March and a general rise in subsequent months with the exception of *S. maderensis* for which its highest k value was in March and reduced thereafter. Fluctuation was observed in K values of *S. melanotheron, Coptodon guineensis, Sarotherodon galilaeus* and *S. maderensis* while the values obtained for *P. peroteti and Elops lacerta* were low (Table 2). Monthly variation in the condition factor of *Mugil cephalus, Chrysichthys nigrodigitatus* and *Coptodon zilli* could be regarded as negligible. Condition factor was not estimated in some months for *H. fasciatus, P. grandisquamis, C. nigrodigitatus, C. zilli, P. peroteti, E. lacerta,* and *E. senegalensis,* for not being found in sampled population.

3.3. Water Physico-Chemical Parameters of Amadi Creek

The Physico-chemical parameters were observed as shown in Figure 2 and Tables 3 and 4. Temperature range was 28.6°C (February) to 35.2°C (March) with a mean of 31.5±0.1°C. The highest temperature was recorded in February in the dry season, while the lowest (28.6°C) was in March, a time of interface of dry season with early

rains. Dissolved oxygen ranged between 2.1 mg/L (May) and 9.0mg/L (April) with a mean of 3.98±0.26mg/L. The pH ranged from 6.6 (March) to 8.7 (April) and mean, was 7.1±0.1. Conductivity was: 9.2S/m (April) to 9.9S/m (March) with mean of 9.6±0.1mS**,** while salinity was: 17.3psu (May) to 24.0psu (February) and a mean of 21.7± 0.4psu. There was hardly fluctuation in conductivity, and a little in pH and salinity; however, salinity reduced with the on-set of rains while Dissolved Oxygen increased and also fluctuated with the rains.

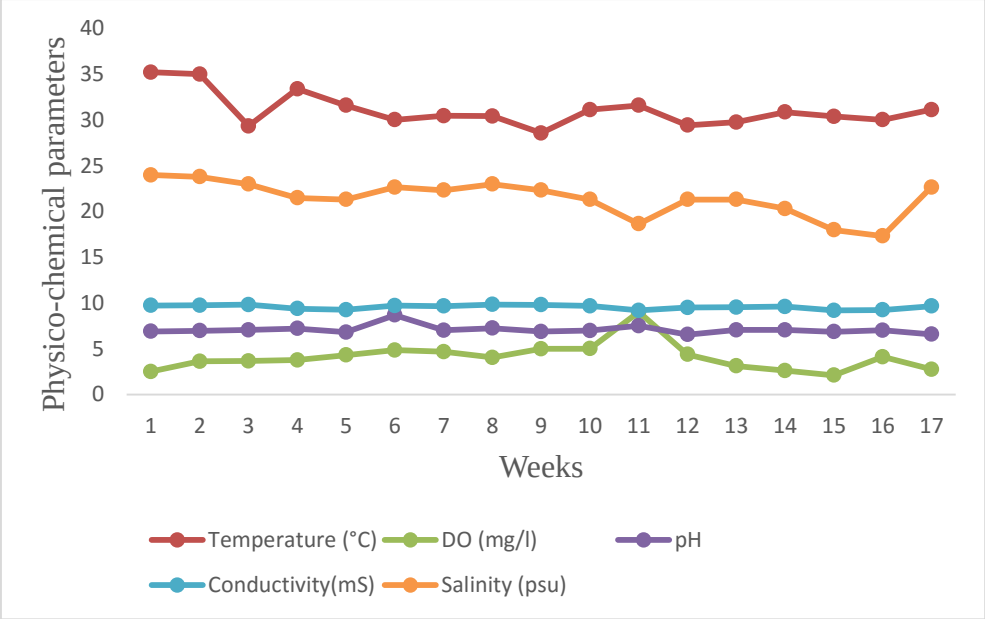

Figure 2: Monthly Physico-chemical parameters Water of the Amadi Creek (Jan-May, 2018)

Table 3: Monthly mean and range of Physico-chemical Parameters of Water of the Amadi Creek (Jan-May, 2018)

	February	March	April	May
Temperature **(°C)**	32.4(29.4 - 35.0)	30(28.6-30.5)	30.5(29.4 - 31.6)	30.61(30 - 31.1)
pH	7.0(6.8 - 7.2)	7.5(6.9-8.7)	7.0(6.6 -7.5)	6.9(6.6 - 7.1)
DO (mg/L)	3.9(3.6 - 4.3)	4.7(4.1-5.0)	5.4(3.1- 9.0)	2.9(2.1- 4.1)
Conductivity (S/m)	9.6(.3 - 9.8)	9.8(9.7-9.9)	9.5(9.2 - 9.7)	9.4(9.2 - 9.7)
Salinity (psu)	22.4(21.3 - 24.0)	22.6(22.3 - 2 3.0)	20.7(18.7 - 21.3)	19.6(17.3 - 22.7)

Table 4: Range and Mean Physico-chemical Parameters of Water of the Amadi Creek (Jan-May, 2018)

Parameters	Range	Mean
Temperature (°C)	28.6-35.2	31.5±0.1
Dissolved oxygen (mg/L)	2.1-9.0	4.0±0.3
pH	6.6-8.7	7.1±0.1
Conductivity (S/m)	9.2-9.9	9.6±0.1
Salinity (psu)	17.3-24.0	21.7± 0.4

4. Discussion

4.1. Condition Factor of Fish Species from the Amadi Creek

No information or study on the fin fish condition has been recorded in the Amadi Creek. However, several studies on fish condition have been reported in other water bodies. The author of [29], reported condition factor of 0.64-3.00 for *Sarotherodon melanotheron* in the Andoni River. While the author of [30], reported a monthly condition factor ranging from 0.8 – 0.95, with a mean condition factor of 0.947 for *Sardinella maderensis* in the Nkoro River. However, the Condition factor (K) of fish species in this creek are likely to be different from similar fish species in other water bodies, even in close proximity. It was stated that, condition factor 'K' provides information of the state of well-being of individual species in their habitat [31,32,33,34,35,36], and is also important in understanding the proper management of fish species [8]. Also, the variation in fish condition could be said to be influenced by many biotic and abiotic factors in their local environments [9]. The author [37] reported that, the numerical magnitude of fish condition factor can be affected by such factors as; sex, maturity stage, time of year, and stomach content of the fishes. Thus, difference in condition factor of different fish populations, of same species is indicative of several factors including, food supply, timing and duration of breeding, among others [10]. The Amadi Creek, has been known to receive domestic and industrial waste discharge, and impacted upon by several human activities that continually affect its natural state [17,15], thus the condition of fishes in this creek are likely to be different from those in other water bodies. However, in this study, several fish species (*Sarotherodon melanotheron, Coptodon guineensis, Sarotherodon galilaeus, Hemichromis fasciatus, Mugil cephalus, Parachelon grandisquamis, Sardinella maderensis* and *Chrysichthys nigrodigitatus*) were observed to be in good condition compared to results obtained for same species from brackish water rivers in the Niger Delta while the k values for *P. peroteti* and *E. lacerta* indicated poor conditions as their K values were lower than reported elsewhere. The author [29], attributed relatively low condition of *Sarotherodon melanotheron* in Andoni river to crude oil related activities that were going on in the river system. This may also have been responsible for the reported poor condition factor for *E. lacerta* and *P. peroteti*. The high values of K for some species meant the species were in good condition, and an indication that the species were doing well in the habitat and have fat deposits due to their feeding activity [33,34,31,35,36]. However, the authors [38,36] reported that, low K values can be synonymous with more developed gonad stages that might mean resource transfer to the gonads during the reproductive period. For the species in Amadi Creek therefore, abiotic properties of the environment and other factors may have negatively affected the fish species with low k. According to the author [39], fish condition reflects the variation in food reserves, and reproductive

changes in fish such as, the time and duration of gonad maturation, among others.

4.2. Physico-Chemical Properties of Water of the Amadi Creek

The mean temperature, dissolved oxygen, pH, conductivity and salinity values in the study area ranged from 28.6-35.2°C, 2.1-9.0mg/l, 6.6-8.7, 9.20-9.9 S/m, and 17.3-24.0psu respectively. Information on the Amadi Creek is scarce, but the few available studies in this creek revealed that, all these physico-chemical parameters recorded in this study were in conformity with those reported by author [16], in the same creek, with exception of the salinity range in the present study, that was much higher. Present study was done in the late dry season when the water influx from rain and run-offs had reduced, leading to increased salinity as opposed to the wet season situation of the creek during the study of author [16]. Furthermore, contrary to this study, author [15] in the wet season, in Amadi Creek, had a temperature range of 27.2-28.7°C, pH range of 5.2-6.9, conductivity range of 7.2-9.05 S/m and salinity range of 4.1-5.95psu, which were all lower than those recorded in the present study. The higher range of physico-chemical parameters in this study can be attributed to difference in season, as supported by [40]. Although the physico-chemical parameters recorded varied within the period of study, they were still within the acceptable range for the wellbeing of living organisms in their natural aquatic system. The pH values recorded in this study were within the range of 6.5 - 8.5, known for most lakes and streams of the world [[41,42,43]]. It is also within the EU set protection limit of pH which is from 6 to 9 for fisheries and aquatic life [44]. Current temperature values were in agreement with the report of [45] and [42]. According to author [43], temperature of natural inland waters in the tropics generally vary between 25°C and 35°C.The high salinity recorded, was as a result of the influence of the dry warm season, and the gradual decrease could have been due to gradual onset of the early rainy season. This pattern of high salinity gradually decreasing with the onset of rains was similar to the works of author [47] in the New Calabar River tributary, the Omuheichem stream. The DO concentration of this creek was below World Health Organization standard [16,42,43]. Low Dissolved Oxygen can result from the various anthropogenic activities and release of organic substances whose decay require oxygen. According to author [16], allocthonous pollutants are deposited into the Amadi Creek. Anthropogenic materials have been reported to release substances that undergo decomposition in water bodies, and use up the dissolved oxygen therein [47]. The low DO could also be attributed to the high water temperatures during the dry period of the study, thereby causing reduction in DO solubility [48]. However, in the month of April, DO value was higher but at the minimum concentration of 5mg/l, required for survival of aquatic organisms [49]. Thus, while the DO of the water body was poor, and that of conductivity being too high for a brackish water system, the other parameters were for some period of study within the range suitable for fish production. The parameters on a general note, were higher than earlier results for this same creek [15].

4.3. Interesting Observations in the Physico-chemical Parameters of Water of the Amadi Creek

There were some interesting observation in the Physico-chemical properties of the creek water; for instance the Dissolved Oxygen began to increase with on-set of the rains in April but lowest value was obtained in May when more rains were supposed to be experienced. This seeming unusual decrease in Dissolved Oxygen at this time of rains may be due to pollution by anthropogenic sources in the creek, as already reported above. Again, since conductivity is an indirect measure of salinity, whereby higher salinity is associated with higher

conductivity [50]. They also reported that, when there is a sudden increase or decrease in conductivity in a water body, it is an indication of pollution in that water body. This was the case in present study, with the highest conductivity value recorded during the dry season month of March but lowest values in the raining season month of May, indicating pollution due to increased inorganic ions in the creek. They further reported that, conductivity increases with temperature. This phenomenon was also observed in present study, as the highest conductivity values in March tallied with recorded highest temperature in March, and March is part of the dry season in the Niger Delta. Acidic water produce higher conductivity and since acidic rains have been reported in the Niger Delta, the recorded lowest pH value in March, beginning of raining also seems to corroborate the observed relationship of acidic water giving rise to higher conductivity as being confirmed by this study. The fact that the observed general decrease of k values in the month of March tallied with the time temperature and conductivity values were highest; followed by more acidic condition, indicate the high probability of abiotic factors of this water body having negative impact on the wellbeing of the living aquatic resources of this creek.

5. Conclusion and Recommendation

Condition factor could not be calculated for some species in some months of the study due to their unavailability in sampled population and thus highlighting rarity of the species. Fluctuations observed in the monthly condition factor of most of the species is expected since many abiotic and biotic factors affect this index. General reduction of k values in the month of March tallied with the time temperature and conductivity values were highest; with lowest pH: indicating impact of the physico-chemical properties of the water on the living aquatic resources therein. Some of the physico-chemical parameters were within suitable ranges for survival of fish in the creek except for high conductivity, and dissolved oxygen which was lower than the acceptable range for most months of the study. Some of the fish species had high k values depicting good condition while a few others were in poor living conditions compared to results obtained from other brackish water river in the Niger Delta. It is therefore recommended that, study with longer period be conducted to establish more reports on the condition factor of the fishes, the physico-chemical properties of water of the creek, and the possible level of interaction between both. Such results will help to produce the requisite information for the appropriate management of the Amadi Creek in order to ensure sustainable fish populations and fishery. Subsequently, therefore, there will be need to develop strategies that can best regulate the anthropogenic activities that can negatively impact on the living aquatic resources through perturbations and pollutants released into this aquatic water system.

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