Assessing the Length-Weight Relationship of Sarotherodongalilaeus in Bontanga Reservoir of Ghana

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***Abstract*- Length – This study assess the length-weight relationships and the condition factor of *Sarotherodongalilaeus* in Bontanga reservoir in Ghana. The study was conducted between November 2016 to March 2017. Using W = aL^{b}, the length-weight relationships of the species were calculated. Condition factors of the species were obtained using the formula: W*100/L^{3}. A total of 300 *S. galilaeus* were measured with total length size range of 7.0 cm to 17.4cm and weight ranging from 7.4g to 92g.The slope b of the length-weight relationships of *S. galilaeus* were within the acceptable range of 2.5 to 3.5 with a b value of 3.028 and can be used to approximate the weight for the species in the reservoir. The monthly condition factor for this study ranges between 4.12-4.89 showed that *S. Galilaeus* was in a good state of wellbeing.The average temperature was 27.33^{o}C, DO 6.34mg/l, turbidity was 45.88NTU, transparency 76.88cm, Conductivity was 71.49µs/cm and pH 7.2 showed the reservoir was slightly alkaline. The observed physico-chemical parameters were all within optimal range for fish growth.**

***Keywords*- Fishery, Length-weight relationship, ofsarotherodo Ngalilaeus, physiochemical parameters, Bontanga reservoir - Ghana.**

I. INTRODUCTION

Among the freshwater cichlids of commercial importance which are mostly exploited as food fish, tilapias are the most common which include the members of the genera *Oreochromis,Sarotherodon and Tilapia*(Blay, 2009).They are an important source of food for people and also very common in the country.And they constitute the most important tilapia species in Ghana(Blay, 2009).*Sarotherodongalilaeus*is a tilapia species of the cichlid familyand found to strive in wide range of water bodies in the tropics including fresh and brackish waters at a depth of about 5m (Bailey, 1994). It strives between the temperatures 22^{o}C–28^{o}C(Bagenal, 1967). They are often associated with beds of submerged vegetation in lakes and feed on organic debris. They are bi-parental mouth brooders and occasionally form school or territories (Bailey, 1994).

Members of the family Cichlidae, display an interesting reproductive behaviour of high degree parental care. In tilapias, two main behavioural types are recognized: protecting of the eggs and larvae in nests, and brooding of the eggs and larvae in the mouth. The former is practiced by fish of the Genus *Tilapia* in which both parents guard the eggs and larvae, and the latter by *Sarotherodon*and *Oreochromis* species. In *Oreochromis niloticus*, the female is responsible for brooding but in *Sarotherodongalilaeus*, both parents share the fertilized eggs between them for brooding(Popma and Lovshin, 1995).

Reproductive individuals of *S. galilaeus* are greyish dorsally, silvery ventrally and the margins of caudal and dorsal fins have pink colour. Males are known to grow larger than females (Holden and Reed., 1972) with a maximum length, 41cm (Bagenal, 1967).*S. galilaeus*can grow to a maximum total length of 39.5cm (FishBase, 2010)

S. galilaeus like any other fish is a source of high quality protein. They also contain vitamins such as A, D, E and K in their oils which are used to control several sicknesses in the health sector. They supply the body with a range of inorganic minerals such as phosphorus, fluorine, potassium, iron, zinc, copper, magnesium (Adeniyi *et al*., 2010) as well as unique fat which is composed of omega-3 polyunsaturated fatty acid (Fasakin, 2006).

Length- weight relationship gives information on the condition and growth patterns of the fish(Begenal and Tesch, 1978).Length-weight relationship is an important factor in the biological study of fish and their stock assessment. It is important in estimating the number of fish landed and comparing the population in time and space (Beverton and Holt, 1957).

Condition factor gives information on the general well-being and condition of the fish related to its environment. This factor is a measure of various ecological and biological factors such as degree of fitness, gonad development and the suitability of the environment with regard to the feeding condition (Mac Gregoer, 1959). When condition factor value is higher it means that the fish has attained a better condition. The condition factor of fish can be affected by a number of factors such as stress, sex, season, availability of feeds, and other water quality parameters (Khallaf*et al*., 2003) and therefore optimum levels of physico-chemical factors is required for the growth and reproduction of *S. galilaeus.*

Research Problem Statement

Food fish currently represents a major source of animal protein, contributing to about 69 percent of the total animal protein supply for the country, Ghana. This makes Ghanaone of the highest consumers of fish in Africa (FAO, 2016). From this same report it was stated that Ghana consumes about 1 million metric tons of fish annually but currently is able to produce about400,000 metric tons. This means there is a deficit of about 600, 000 metric tons of production needed. And the consumption is also expected to increase with the increasing population in the country. There is thereforethe need for the wide gap between consumption and production to be bridged.

In Ghana, the major fish source is from the marine sector but reports have shown that the catch per annum are declining with the global climatic change, overfishing and pollution that occur along the sea. Even though the aquaculture sector is making a lot of efforts to supplement the catch from the marine sector, our reservoirs have a full potential of also helping bridge the gap.Quacoopome*et al*(2008) reported that given requisite information and adequate management, reservoirs in Ghana have the potential to complement fisheries in larger inland water bodies such as the VoltaLake, thus, increasing the production of fish in the inland sector.This will go a long way to increasethe availability of fish.The creation of the Bontangareservoir even though purposely for irrigation however has developed great potentials for fisheries.Kwarfo*et al.,*(2008) reported of identifying 26 fish species belonging to 19 genera in 11families from commercial fishing signifying the high species richness of the reservoir and an indication for high fish production with appropriate management efforts. It was reported that the estimated potential fish yield per year for the Bontanga Reservoir was 67 tons (Quacoopome*et al*, 2008).

This study seeks to generate information and undertanding on the state of *S. Galilaeus* in the reservoir and assist in the development, management and sustainable use of the fisheries of the reservoirs to enhance the socio-economic status of their respective riparian communities.Fish as a renewable natural resource have a limit as to its ability to reproduce and replace them.Increasing human populations has increase fishing pressure. The pressure does not allow the fishes to grow intosubstantial sizes. And the use of illegal fishing methods and gears to harvest both juveniles and spawning adults has led to rapid decline in catch per unit effort in our water bodies. Ofori- Danso*et al.,* (2012) reported that there is a decline in Ghana inland fishery resources and there is a need for maximum management measures to be in place for sustainable exploitation and use of the resource. This study will also provide information for effective management and conservation of fisheries resource especially *S. galilaeus*in the Bontanga reservoir which requires considerable knowledge regarding length-weight relationships and condition factor.The growth rate and maximum obtainable size of tilapias are seriously affected by the physical and biological composition of the environment (Olurin and Aderibigbe, 2006).And hence there is the need to know the condition of the water body and its influence on the condition of the fish. Thus this study seeks to provide information on the state of *S.galilaeus* in the reservoir and the current state of their environment. The condition factor of fish is a useful factor in monitoring the state, feeding intensity and growth rate of fish which is strongly affected by the physical and chemical conditions of their environment. It is also an important tool to assess the status of the aquatic ecosystem in which the fish live (Bolger and Connolly, 1989). The Main Objective of this study is therefore To estimate growth pattern and condition factor of *Sarotherodongalilaeus* in Bontangareservoir to provide information for management. The Specific Objectives are to determind the; the weight andlength (total and standard) of *S.galilaeus;* changes in physico-chemical parameters, and condition of *S. galilaeus.*

II. REVIEW OF RELEVANT LITERATURE

2.1 Biology of Cichlids

Cichlids are one of the largest families that are easily endangered among vertebrates (Reid, 1990). Cichlids display similar diversity of body shapes ranging from strongly laterally compressed species to species that are cylindrical and highly elongated (Loiselle, 1994). Generally, however, cichlids tend to be of medium size, oval in shape, generally similar to the North American sun fishes in morphology, behaviour and ecology (Helfman*et al*, 1997). Cichlids are predominantly well known for having evolved rapidly into a large number of closely related but morphologically diverse species within large lakes particularly Tanganyika, Victoria, Malawi and Edward (Snoeks, 2004). Their diversity in the African great lakes is important for the study of speciation in evolution (Kornfield and Smith, 2000).

Cichlids share a single key trait, thus the fusion of the lower pharyngeal bones into a single tooth-bearing structure. A complex set of muscles permits the upper and lower pharyngeal bones to be used as a second set of jaws for processing food, allowing a division of labour between the mandibles and the pharyngeal jaws. Cichlids are efficient and often highly specialized feeders that capture and process a very wide variety of food items. This is assumed to be one reason why they are so diverse (Loiselle, 1994).

According to Froese and Pauly, (2012)the features that distinguish them from the labroidei include; A single nostril on each side of the forehead, instead of two, no bony shelf below the orbit of the eye, division of the lateral line organ into two sections, one on the upper half of the flank and a second along the midline of the flank from about halfway along the body to the base of the tail (except for genera *Teleogramma* and*Gobiocichla*), a distinctively shaped otolith.The small intestines instead of its right sideexit from the stomachas in other Labroidei, it is rather the left-side.

2.1.1 Distribution and Habitat of Cichlids

Cichlids are the most species-rich non-Ostariophysan family in freshwaters worldwide. They are most diverse in Africa and South America. Africa is estimated to inhabit at least 1,600 species (*Katria, Oxylapia* and *Paratilapia)*, only distantly related to those on the African mainland (Froese, 2012). Native cichlids are mostly absent in Asia, except for 9 species in Israel, Lebanon and Syria (Nelson, 2006).

Although most cichlids are found at relatively shallow depth, several exceptions do exist. These include species such as *Alticorpusmacrocleithrum* and *Pallidochromistokolosh* down to 150m 490ft. below the surface in Lake Malawi (Froese, 2006). Cichlids are less commonly found in brackish and salt water habitats, though many species tolerate brackish water for extended periods; *Cichlasomaurophthalmus*for example, is equally at home in fresh water marshes and mangroves swamps and lives and breed in salt water environment such as the mangrove belt around barrier islands (Loiselle, 1994).

One of the diverse and economically important group within the family Cichlidae are the tribe Tilapiini containing the genera*Oreochromis*, *Sarotherodon*, and *Tilapia* commonly known as tilapiini cichlids or tilapias

Several species of tilapia*, Sarotherodon* and *Oreochromis* are euryhaline and can disperse along brackish coastlines between rivers (Nelson, 2006). In Ghana, cichlids are distributed in all the surface waters (Dankwa*et al*.,1999).

2.2 Biology of Sarotherodongalilaeus.

The *Sarotherodongalilaeus* which is locally called the mango tilapia has 14-17 dorsal spines, 13 soft rays (fishbase, 2010). Head length 32.5-39 percent of standard length, depth of preorbital bone 19.5-28percent of head length; inter-orbital space 36 -44percent of head length. Body depth is about 43-56.5 of the standard length (usually over 45%). Pharyngeal teeth are numerous and very small. Length of pectoral fins 36.-50% of as standard length (Boulenger, 1907). Melanin patches are found only in random individuals and the caudal is naked except at the base. Reproductive individuals are greyish dorsally and silvery ventrally. Dorsal fin with 14-17 spines and 11 soft rays and caudal fin are with pinkish margins. Anal fins have 3 spines and 19-17 soft rays. Pectoral fins usually spread out to above the vent or spinous anal fins. Males have lengthier dorsal and anal fin rays. They are often associated with beds of inundated vegetation in lakes and feed on organic debris. They are biparental mouth brooders and occasionally form school or territories (Bailey, 1994). Reproductive individuals of *S.galilaeus* are greyish dorsally, silvery ventrally and the margins of caudal and dorsal fins have pink colour. Males are known to grow larger than females (Holden and Reed., 1972) with a maximum length, 41cm (Bagenal, 1967).

2.3 Environmental Requirements of Tilapias

Fish are totally reliant on water to feed, grow, reproduce, respire and execute all other life activities. The state, feeding intensity and growth rate of fish isintensely affected by the physical and chemical situations of their environment. Tilapias are more tolerant than most commonly farmed freshwater fish to high salinity, high water temperature, low dissolved oxygen, and high ammonia concentrations(Popma and Masser, 1999).Nutrients such as nitrates, nitrites phosphate and phosphorous in freshwater maintain a healthy plankton growth as food for aquatic vertebrates as well as keep turbidity levels at 75NTU (Popma and Masser, 1999).

2.3.1 Salinity

All tilapias are tolerant to brackish water. The *Oreochromisniloticus* (Nile tilapia) is the least saline tolerant of the commercially important species, but grows well atsalinities up to 15 ppt, and Fry numbers decline substantially at 10 ppt salinity (Popma and Masser, 1999).

2.3.2 Water Temperature

S.galilaeus survives in subtropical temperature range of 22^{o}C – 28^{o}C (Baebsch and Richel, 1991). This temperature range stimulates growth, oxygen demand, food requirement and food conversion efficiency in freshwater bodies (Aquaculture, 2003). Generally, the intolerance of tilapia to low temperatures is a serious constraint for commercial culture in temperate regions. The lower lethal temperature for most species is 10^{o}C to 11.11^{o}Cfor a few days. Tilapias generally stop feeding when water temperature falls below 17.22^{o}C (Popma and Masser, 1999).Reproduction is best at water temperatures higher than 26.67^{o}C and does not occur below 20^{o}C. In subtropical regions with a cool season, the number of fry produced will decrease when daily water temperature average is less than 23.89^{o}C (Popma and Masser, 1999).Optimal water temperature fortilapia development is about 29^{o}C to 30^{o}C.Growth at this optimal temperature is typically three times greater than at 22.22^{o}C.

2.3.3 Dissolved Oxygen Concentration

Tilapia survive routine dawn dissolved oxygen (DO) concentrations of less than 0.3 mg/L, considerably below the tolerance limits for most other cultured fish (Popma and Masser, 1999). In research studies, Nile tilapia grew better when aerators were used to prevent morning DO concentrations from falling below 0.7 to 0.8 mg/L (compared with unaerated control ponds).Growth was not further improved if additional aeration kept DO concentrations above 2.0 to 2.5mg/L. Although tilapia can survive acutelow DO concentrations for several hours, tilapia ponds should be managed to maintain DO concentrations above 1 mg/L. Metabolism, growth and possibly, disease resistance are depressed when DO falls below this level for prolonged periods. The minimum DO requirements of tilapia species is 5mg/L and if the concentration of DO decreases, respiration and feeding activities also decrease (Mallya, 2007).

2.3.4 pH

In general, tilapia can survive in pHranging from 5 to 10 but do best in apH range of 6 to 9. *S.galilaeus* in fresh and brackish water requires pH of 6.5- 9.0(Stone and Thomforde, 2005). Therefore, total alkalinity in freshwater streams ideally should be maintained at 20- 30mg/l to provide a buffering capacity to keep pH at 6.5- 9.0

2.3.5 Conductivity

Freshwater streams ideally should have conductivity between 30-500 μS/cm to maintain osmotic balance in fishes (Stone and Thomforde, 2005).

2.4 Length- Weight Relationship

Length weight relationships are important in fish biology and can be used to provide information on stock condition (Begenal and Tesch, 1978). It is also an important tool to evaluate the status of the aquatic ecosystem in which the fish live (Bolger and Connolly, 1989).Beverton and Holt, (1957) also reported that length weight relationships are also used in assessing the well-being of the fish population and it is important in estimating the number of fish landed and comparing the population in time and space.

Pauly, (1993) reported that length weight relationships are important in the calculation of the average weight at certain length class and the conversion of an equation of growth in length into an equation of growth in weight. Length weight relationships may vary geographically (Sparre*et al* 1989) and may change seasonally. And it is always practical to make use of values obtained locally (Jones, 1976). Also, fishes are said to exhibit isometric growth when length increases in equal proportions with the body weight. The regression co-efficient of isometric growth is 3. Values greater or less than 3 indicate allometric growth (increase in length is not proportional to the body weight). In a study of the length -weight relationship and condition factor of *O. niloticus,T.zillii, S.galilaeus and H. fasciatus*by Alhassan*et al.*(2015) showed that the length weight relationship for *O. niloticus*and *H. fasciatus*in the Golinga reservoir were described by the relation $W= 0.035L^{3.073}$, $r = 0.889$ and $W = 0.129L^{2.554}$, $r = 0.938$ respectively which shows that *O. Niloticus* population in the Golinga reservoir were growing isometrically(b =3.07) and that of *H. fasciatus*were growing allometrically (b = 2.554). And also the length weight of *S. galilaeus* and *T. zillii* in the Golinga reservoir were shown by the relation $W =0.061L^{2.9085}$, $r = 0.9753$ and $W = 0.0808L^{2.7534}$, $r = 0.9595$ respectively showed that the population of *T.zillii and S. Galilaeus* were both growing allometrically with b values of 2.753 and 2.909 respectively.

2.5 Condition Factor

The study of condition factor, a standard practice in fisheries ecology and it's based on the analysis of length weight data and assumes that, heavier fish of a given length are in better condition(Begenal and Tesch, 1978; Bolger and Connolly, 1989). Condition factor is recommended to measure the deviation of an individual fish from the baseline weight for length in the respective sample and to investigate changes in the stock over time. The condition factor of fish is a useful factor in monitoring the state, feeding intensity and growth rate of fish which is strongly affected by the physical and chemical conditions of their environment. It is also an important tool to assess the status of the aquatic ecosystem in which the fish live (Bolger and Connolly, 1989). According to Anene, (2005), the condition factor of a fish is influenced by both biotic and environmental conditions and this can be used as an index to assess the status of the aquatic ecosystem in which the fish live. The condition factor of fish hasbeen reported to be influenced by other factors such as stages of gonadal development (Hoda, 1987).

III. METHODS AND RESULTS

3.1 Study Area

This study was conducted in Bontanga community reservoir in Kumbungu district of Northern region in Ghana. It lies between latitude 9º 30'' 9º 35''N and longitude 1º 20'' 1°04''W.

The Bontanga reservoir was formed by construction of a dam across the Bontanga River, a tributary of the White Volta. The constructional works of the reservoir commenced in 1981 and the reservoir was commissioned in 1986 (Quacoopome*et al.,* 2008). The reservoir was primarily constructed to support irrigation agriculture, watering of livestock and to serve as domestic water source to surrounding communities. The expanse of water created by the reservoir has also provided fisheries resource that provides livelihood opportunities to fishers in the riparian communities and migrant fishers from southern Ghana.

It has a surface area of 770 ha. It has a maximum depth of 9m and maximum storage capacity of 25million m^3 (Kwarfo*et al.,* 2008). The vegetation is a Guinea savannah zone mainly of grassland with few economic trees such as Shea and Neem.

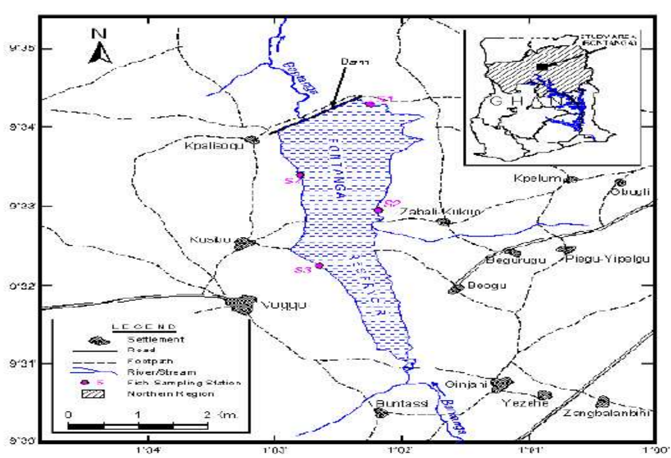

Figure 1: Map of Bontanga, in Northern Ghana (culled from Kwarfo*et al.,* 2008)

3.2. Data Collection

Data was collected for a period of five months from November to March.Fish samples (Plate 1)were collected using fisheries dependent data that is; from the fishermen's catches. Samples were collected from commercial gillnet and cast net catches of mesh sizes 1.7/8 and 1cmEach fish was measured for standard length (SL), in cm, total length (TL) in cm and weight (W) to 0.1g accuracy using a measuring board and electronic balance respectively. Monthly length -weight relationship was computed from the length weight measurement of fish samples(Plate 2)respectively.

Plate 1: *Sarotherodongalilaeus* from Bontanga reservoir

a) b)

Plate 2: Measurement of **(a)the length of the fish, and (b)the weight of the fish** *S. galilaeus* in Bontanga reservoir, Northern Ghana

3.3Measurement of Physico-Chemical Parameters

Physicochemical parameters such as, temperature, conductivity, oxygen, pH, turbidity, transparency and salinity readings were taken using multi-purpose probe and secchi disc (for transparency). Readings were taken every month for a period of five months from November 2016 to March 2017. Five different coordinates were chosen at each sampling site using GPS. Two replicate samples were taken at each of the coordinated points.

3.4 Measurement of Biological Data

- Total Length: This was measured using a meter board with length of individual fish taken from the snout to the tip of the caudal fin.
- Standard Length: This was measured from the snout to the base of the caudal fin.
- Weight: This was measured using an electronic balance.

3.5 Data Analysis

Data were computed using Microsoft Excel 2010.The L-W relationship was analysed by using the equation $W= aL^b$ (Pauly, 1983).

Where by W= weight of fish in gram

L= Length of fish in cm

a = describe the rate of change of weight with length (intercept)

b = weight at unit length

The values of the exponent bprovide biological information on kind/pattern of growth of fish. The growth is isometric if b=3 and the growth is allometric if $b\neq3$(negative allometric if $b<3$ and positive allometric if $b>3$).In order to check if the value of b was significantly different from 3, the Student's t-test was conducted as expressed by the

equation according to Sokal andRohlf (1987)ts=(b-3)/SE, where tsis the t-test value, bthe slope and S.E the standard error of the slope b.

The test statistics (ts) value was compared with critical values from the T-Table. All the statistical analyses were considered at significance level of 5% ($p<0.05$).

Condition factor (K) of the experimental fish was estimated from the relationship:

$K= 100W/L^3$

K= (Fulton's index)

Where K = condition factor

W = weight of fish (g)

L = Length of fish (cm)

4.1 Length Weight Relationship

Table 1 below shows the mean monthly Length,Weight and condition factor measured from November 2016 - March 2017.

Table 1: Mean monthly standard length, total length and condition factor of *S. galilaeus* collected from November 2016 - March 2017.

MONTH	MEAN SL(cm)	MEAN TL(cm)	MEAN W(g)	C.F (k)
November	7.813 ± 0.95	10.378 ± 1.15	21.845 ± 7.01	4.58
	6.0 - 11.5	8.1 - 14.8	13.2 - 55.4	
December	9.535 ± 1.35	12.513 ± 1.68	42.382 ±12.27	4.89
	7.0 - 12.0	9.4 - 15.5	16.4 - 81	
January	8.963 ± 1.35	11.828 ± 1.78	34.128 ± 15.8	4.74
	6.2 - 13.4	8.4 - 17.4	11.7 - 92.6	
February	7.942 ± 1.48	10.463 ± 1.86	24.135 ± 13.25	4.82
	6 - 11.8	7.4 - 15.1	7.6 - 65.2	
March	8.14 ± 1.54	10.818 ± 1.95	27.103 ± 15.20	5.03
	5.2 - 12.1	7.0 - 16.0	7.4 - 82.5	

The highest Total Length was 17.4cm recorded in January 2017. And the lowest value for total length was recorded in March 2017 as 7.0cm..

Highest standard length of fish was recorded in January 2017 as 13.4cm and the lowest value recorded in March as 5.2cm. The highest mean total length of fish was recorded in December 2016 as 12.513cm with the minimum recorded in November 2016 as 10.378cm.The highest weight was 92.6g recorded in January 2017 and the lowest weight was recorded in March as 7.4g. The highest average weight was recorded in December 2016 as 42.382g and the lowest mean weight was recorded as 21.8 in November 2016.

The figure 2 below shows the length-weight relationship of *S. galilaeus* from Bontanga reservoir.

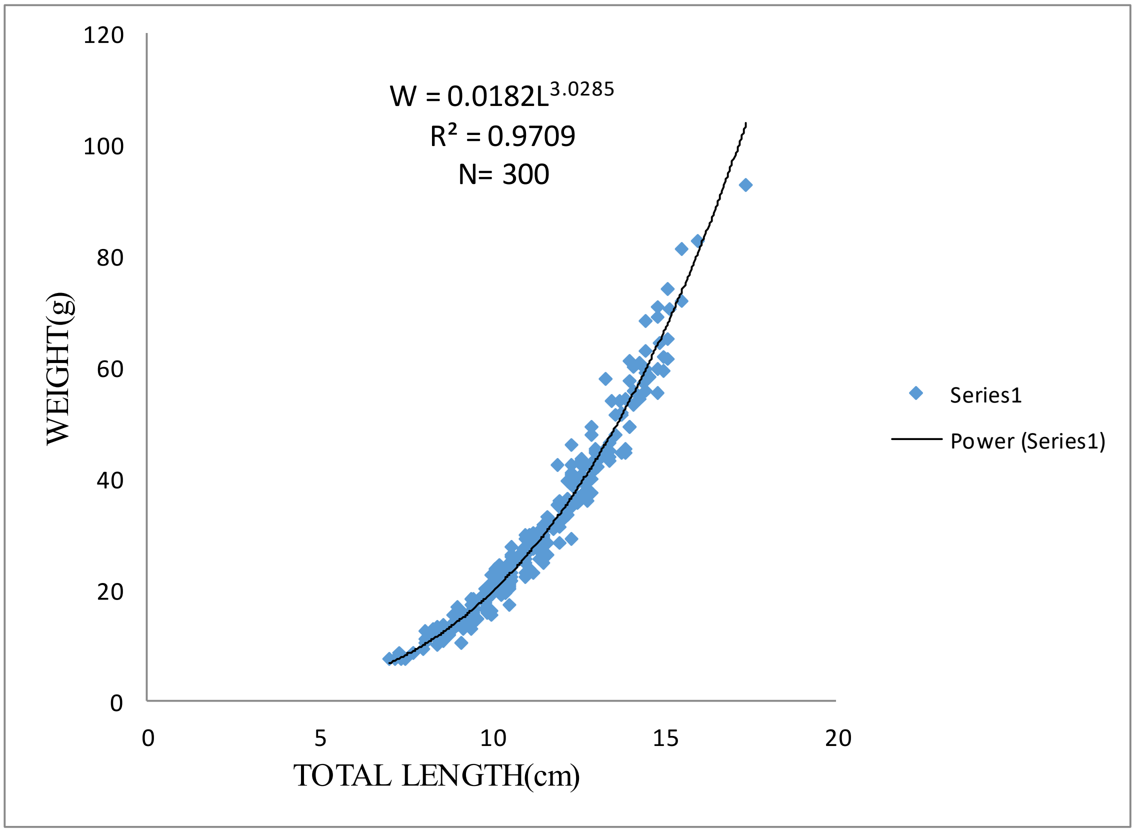

Figure 2: Length –weight relationship of *S. galilaeus* from November 2016 – March 2017 in Bontanga reservoir.

Table 2: Monthly length weight relationship from Bontanga reservoir, Northern Ghana

Month	$W= aL^b$	A	B	R^2
November	$0.0616L^{2.4975}$	0.0616	2.4975	0.9125
December	$0.0255L^{2.9147}$	0.0255	2.9147	0.9652
January	$0.0214L^{2.9578}$	0.0214	2.9578	0.9725
February	$0.0182L^{3.0209}$	0.0182	3.0209	0.9801
March	$0.0156L^{3.091}$	0.0156	3.091	0.9736

The highest b-value (regression co-efficient) was recorded in March 2017 and the lowest recorded in November 2016.

4.2 Condition Factor.

The monthly condition factor of *S. galilaeus*is shown in Fig. 3 below.

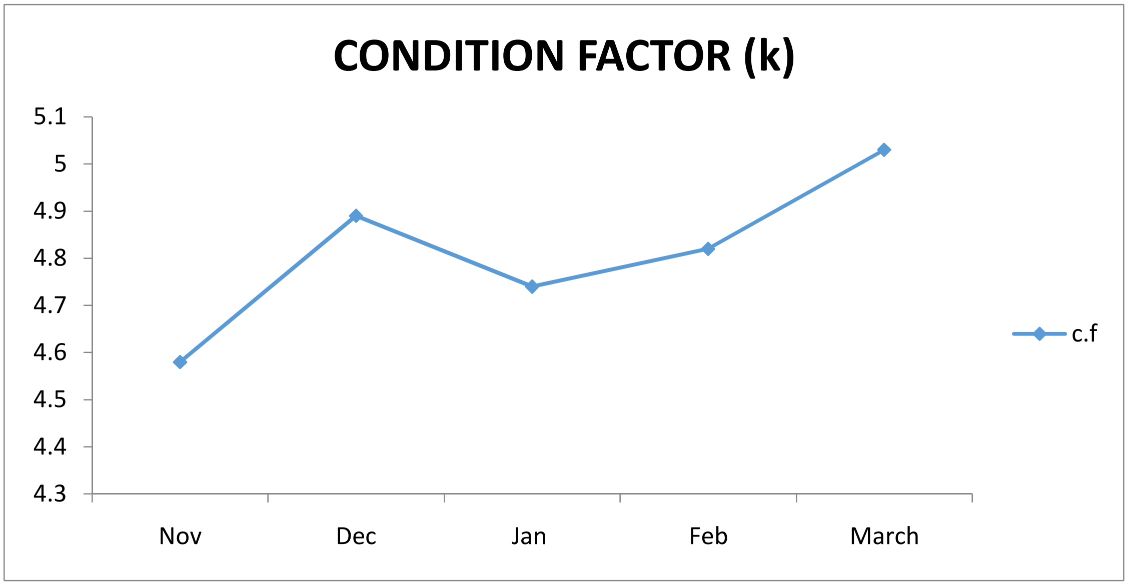

Figure 3: Monthly condition factor of *S. galilaeus* collected in Bontanga reservoir from November 2016 - March 2017.

From the graph the average condition factor from November 2016 to March 2017 was 4.812. With the highest recorded in March 2017 and lowest in November.

4.3. Physico- Chemical Parameters

4.3.1 Temperature

The average recorded for the period of the study was 27.33ºc. The highest was recorded as 30.18ºc in March and the lowest was recorded 24.28ºc in January as shown in Fig. 4 below.

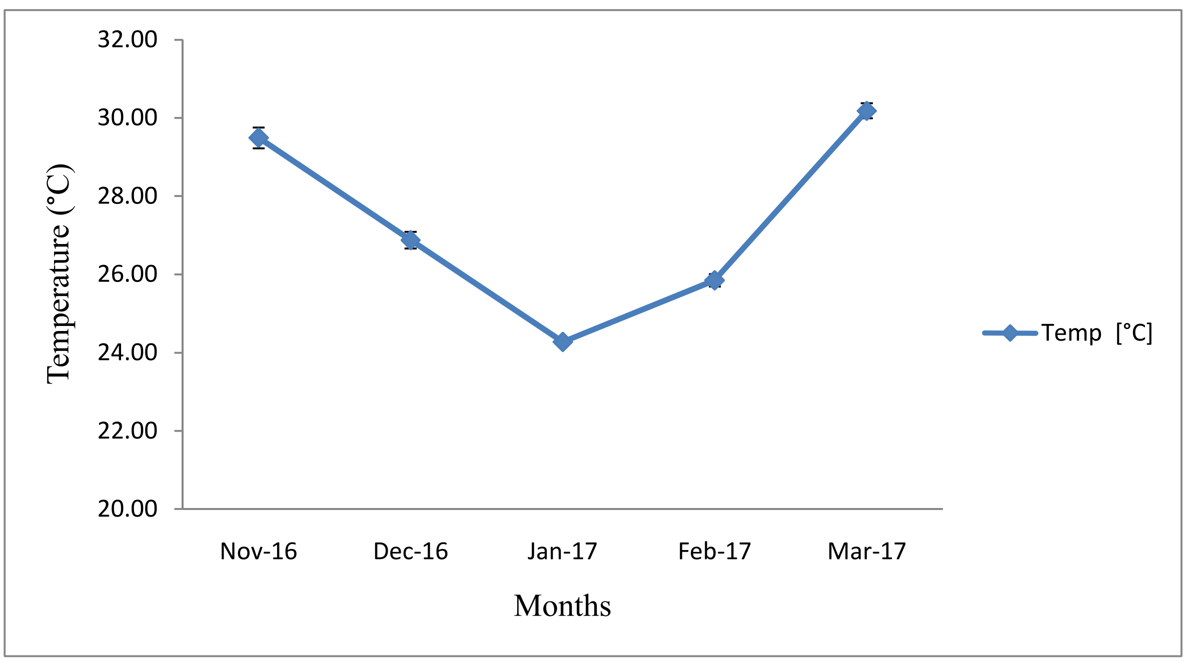

Figure 4: Monthly mean temperature recorded for Bontanga reservoir from November 16 – March 2017

4.3.2 Dissolved Oxygen

Fig 5 below shows the monthly DO of Bontanga reservoir

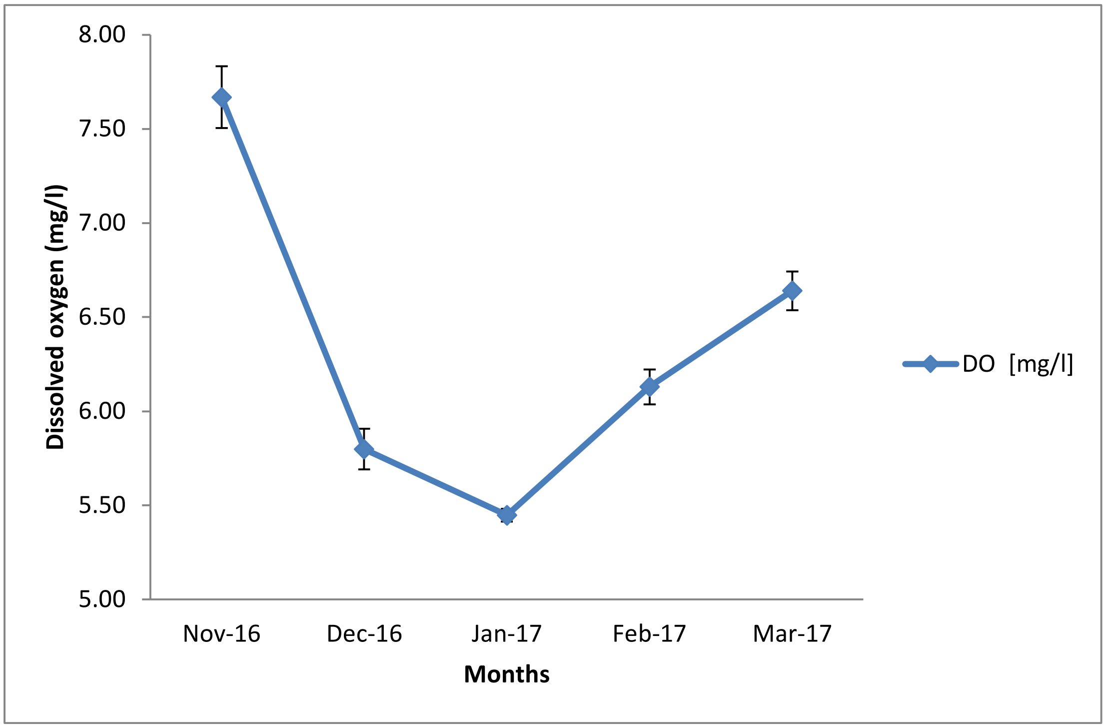

Figure 5: Mean monthly DO of Bontanga reservoir recorded from November 2016- March 2017.

The average was 6.34mg/l with the highest recorded as 7.67 mg/l in November and the lowest recorded as 5.45 mg/l in January.

4.3.3 pH

Fig. 6 below shows the monthly pH from Bontanga reservoir

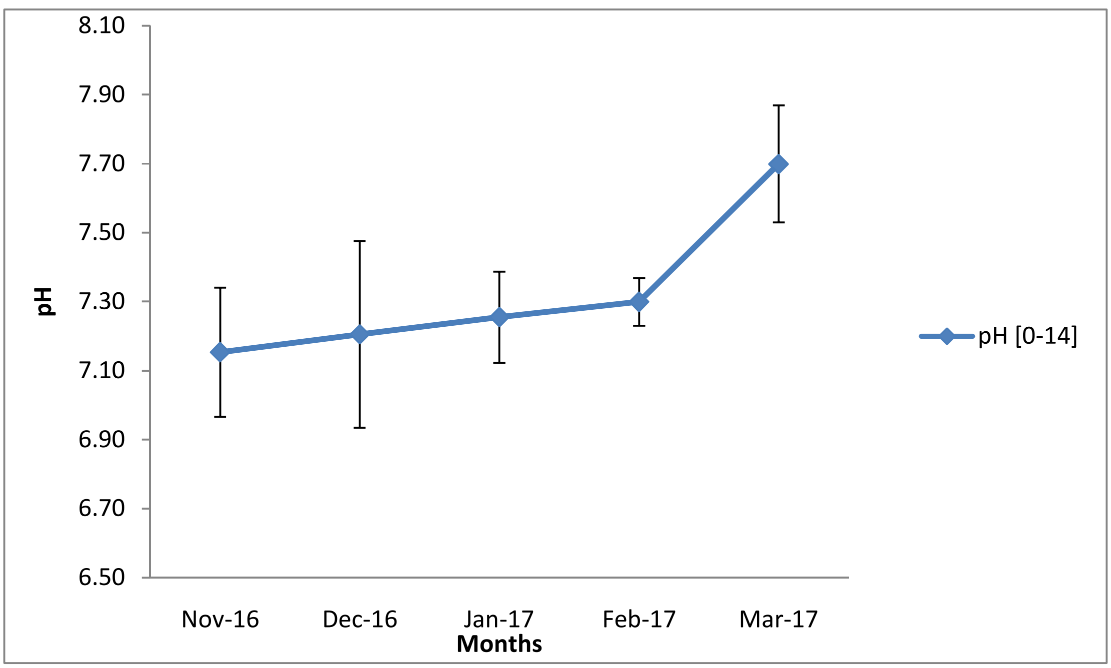

Figure 6: mean monthly pH of Bontanga reservoir recorded from November 2016 – March 2017

The average recorded for the period of the study was 7.32 with the highest 7.70 recorded in March and the lowest recorded as 7.15 in November.

4.3.4 Turbidity

The Fig.7 below shows the monthly turbidity from Bontanga reservoir.

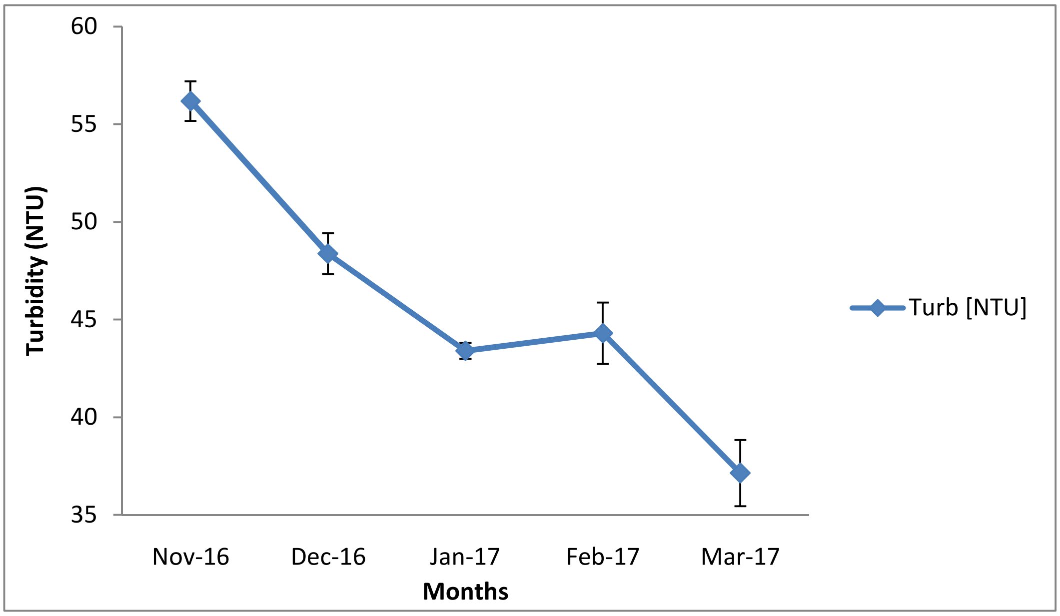

Figure 7: Mean monthly turbidity recorded for BontangaNovember from 2016- March 2017.

The average recorded during the period of study was 45.88NTU with the highest recorded as 56.18 in November and the lowest recorded in March as 37.14NTU.

4.3.5 Transparency

The Fig. 8 below shows the monthly transparency from Bontanga reservoir.

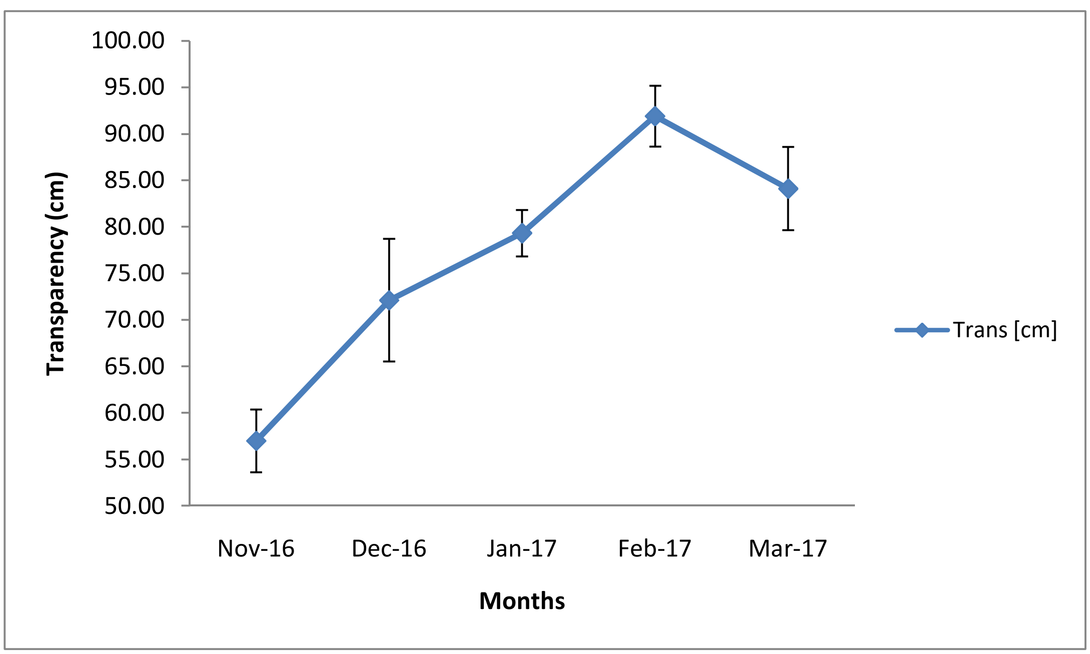

Figure 8: Mean monthly transparency recorded from November 2016 – march 2017

The average recorded during the period of study was 76.88 with the highest recorded as 84.10cm in March and the lowest recorded as 57.0cm in November.

4.3.6 Conductivity

The Fig 9 below shows monthly conductivity from Bontanga reservoir.

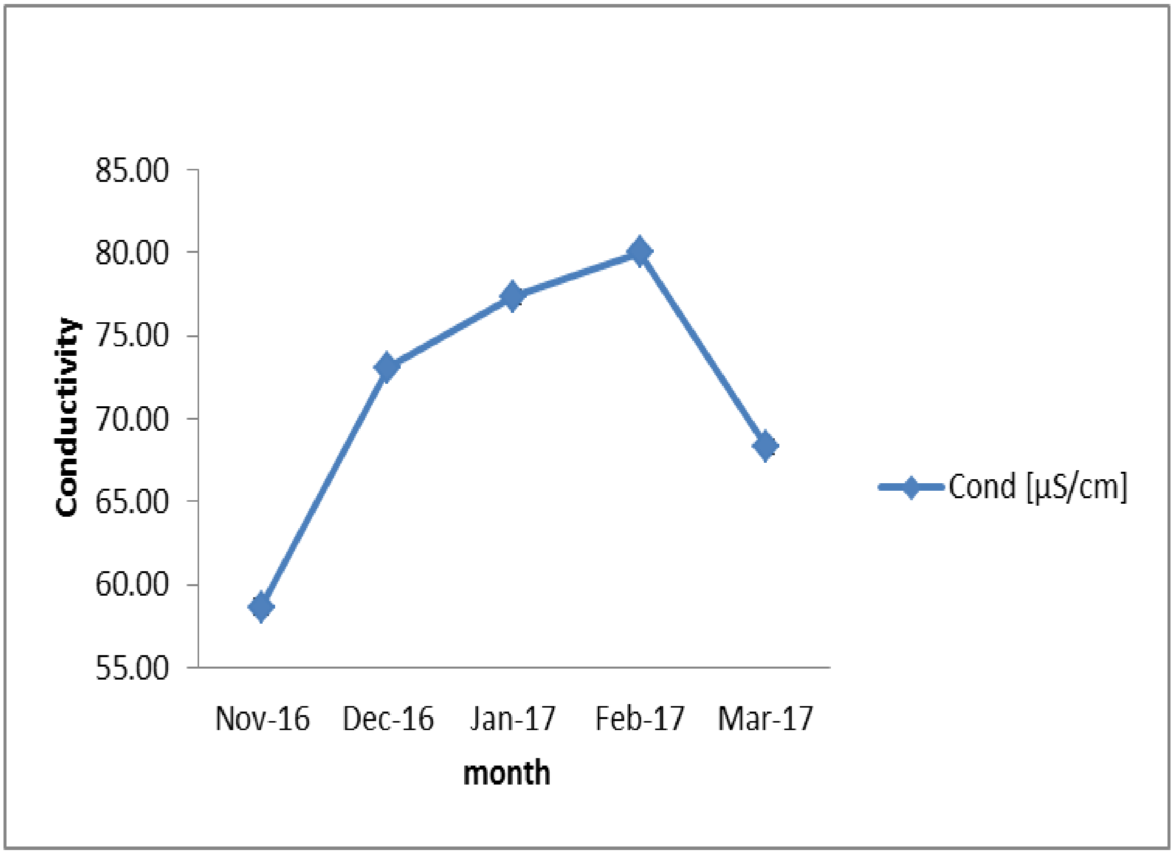

Figure 9: Mean monthly conductivity recorded for bontanga reservoir from November 2016 – March 2017

The average recorded was 71.49µS/cm. the highest was recorded in February as 80.00µS/cm and the lowest was recorded in November as 58.68µS/cm.

V. DISCUSSION

5.1 Length Weight Relationship

For an ideal fish that shows isometric growth, the regression co-efficient (b) is 3.0 and populations in which the co-efficient (b) differs significantly from 3.0 (less than or greater than) exhibit allometric growths (Beverton and Holt, 1966). The regression coefficient (b) for this study was 3.02846 at a confidence interval of 2.968648 - 3.088279 with Standard error 0.03039 of b at 5% Confidence limit. This showed that *S. galilaeus* was growing isometrically. Gayanilo and Pauly, (1997) suggested that 'b' values ranges from 2.5 to 3.5 which support the results of this study.

From the results, the b value for the month November 2016, December and January2017 were 2.4975, 2.9147 and 2.9578 respectively indicating a negative allometric growth which means that the increase in length was not proportional to the body weight. These findings were similar to the findings of Alhassan *et al* (2015), which reported *S. galilaeus* (b = 2.91) and *T. zillii* (b = 2.75) showed negative allometric growth. In agreement also with Alhassan, (2011) which reported allometric growth in *S. galilaeus* (b=2.793) in Dahwenya reservoir. Mahomoud*et al.* (2011) also reported a negative allometric growth for *S.galileaus* in Rosetta branch of Nile River, Egypt. Whereas the b value for February2017 and March 2017 were 3.091 and 3.09801 respectively indicating an isometric growth, meaning the increase in length was proportional to the weight during growth.

5.2 Condition Factor

According to Abowei (2010), condition factor greater than 2 suggests that the fish is in a very good condition. Considering the condition factor of *S. galilaeus*recorded for this study (4.53-5.03), it implies the fish is growing well even though there were monthly variations in the condition factor. The lowest condition factor recorded in November 2016 could be as a result of the physico- chemical parameters. Turbidity was highest in November which resulted in the low transparency recorded for this month. This means that light penetration was low and hence there was much of productivity in the reservoir for the fish to feed on for their wellbeing. This could also be attributed to water usage and anthropogenic activities that goes on along the reservoir. The highest condition factor recorded in March 2017 could be as a result of availability of their food resources in the reservoir. Furthermore, the observed physicochemical parameters could be providing favorable environmental conditions for the growth of the fish. However, the condition factor (K) was higher than that of (1.06- 2.02) reported by Dan-Kishiya, (2013), in an assessment of length –weight relationship and condition factor of five species from a tropical water supply reservoir in Abuja, Nigeria. The result was also similar to condition factor mean values for *O. niloticus* (K = 3.66), *S. galilaeus* (K = 4.29*), T. zillii* (K = 4.51) and *O. niloticus* (K = 3.58) recorded by Alhassan *et al*(2015) in a study of cichlids in Golinga reservoir which were higher than values reported by Imam *et al*. (2010) from reservoirs in Nigeria.

5.3 Physico-Chemical Parameters

The average temperature recorded during the period of study (27.33^{o}C) was within the acceptable range of 22^{o}c – 28^{o}c reported by (Baebsch and Richel, 1991) which is similar to Huet (1990) to be suitable for culturing *Sarotherodon*spp in a reservoir. But the result was lower than annual mean temperature of 30.3^{o}C recorded by Quacoopome*et al*.,(2008) for this same reservoir.

Dissolved oxygen is essential to all forms of aquatic life. The solubility of oxygen decreases as temperature increase. Concentrations in unpolluted waters are usually close to, but less than 10 mg/l (Chapman and Kimstach, 1996). The minimum DO requirements of tilapia species is 5 mg/L and if the concentration of DO decreases, respiration and feeding activities also decrease (Mallya, 2007) concentrations below 2 mg/l may lead to the death of most fish. The dissolved oxygen range of 5.45mg/l to 7.67mg/l recorded in the current study was within the acceptable ranges of DO less than 10 mg/l) quoted by Chapman and Kimstach, (1996) and above the minimum of 5mg/l quoted byMallya, (2007). This result was lower than that reportedby Quacoopome*et al* (2008) for dissolvedoxygen (DO) with a mean value of 15.4 mg/l.

The conductivity of most freshwater bodies ranges from 10µS/cm to 1000µS/cm (Chapman and Kimstach, 1996). The conductivity obtained in this study (58.68µs/cm -80.00 µs/cm) was within this range and hence suitable for development of fisheries resources in the reservoir. It was within the limit of 30-500µS/cm (Stone and Thomforde, 2005) suitable to maintain osmotic balance in fishes.Quacoopome*et al.,*(2008) recorded annual mean conductivity value 80.7µS/cm for Bontanga which was similar to the results of this study.

pH indicates the intensity of the acidic or basic character of a solution and is controlled by the dissolved chemical compounds and biochemical processes in the solution. The pH of freshwater bodies ranges from 6.0 to 9.0 Chapman and Kimstach, (1996) or 5.0 to 10.0 Bennett, (1970). The pH range of 7.15-7.70 obtained in this study was within these ranges. The pH recorded in this study shows that the reservoir was slightly alkaline.PH range of 5.69 and 8.67 was recorded by Quacoopome*et al* (2008) for Bontanga reservoir which depicts slight variations in the values recorded.

The average turbidity recorded within this period of study was 45.88NTU which was lower than the maximum turbidity levels of 75NTU suggested by Popma and Masser, (1999) for a healthy environment. The low turbidity also accounted for high transparency recorded (76.88) andthis indicates high light penetration and productivity of thereservoir.

VI. CONCLUSION AND RECOMMENDATION

6.1 Conclusion

The study conclude that length weight and condition factor of *S. galilaeus* in Bontanga reservoir, as well as physiochemical parameters of the reservoir showed the regression coefficient (b) for *S. galilaeus* was 3.02846 at a confidence interval of 2.968648 - 3.088279 with Standard error 0.03039 of b at 5% Confidence limit.This showed that *S. galilaeus* was growing isometrically and the fishes were in a good state of wellbeing with condition factor (4.53- 5.03). The average temperature was 27.33^{o}C, DO 6.34mg/l, turbidity was 45.88NTU, transparency 76.88cm and Conductivity was 71.49µS/cm. Indicating that all the observed physico- chemical parameters were within the optimum range required for the wellbeing and growth of *S. galilaeus.*

6.2. Recommendation

The study recommends that this study should be carried out for a period of one year in this reservoir to compare variations in the wet and dry season.The study could also be carried out for different fishing gears to compare variations in length weight in respect to the different gears. Responsible authorities (Fisheries commission and Ghana irrigation development committee) to enforce management principles in this reservoir because the gears and methods used in fishing does not allow fishes to grow to their maximum sizes.

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APPENDICES

Appendix A: Mean monthly Physico-chemical Parameters from Bontanga Reservoir from November 2016 to March 2017

Month	Nov-16	Dec-16	Jan-17	Feb-17	Mar-17	Mean
Temp [°C] SD	29.49	26.88	24.28	25.85	30.18	27.33
	±0.27	±0.21	±0.06	±0.16	±0.19	±0.18
DO [mg/l] SD	7.67	5.80	5.45	6.13	6.64	6.34
	±0.16	±0.11	±0.03	±0.09	±0.10	±0.10
pH [0-14] SD	7.15	7.21	7.26	7.30	7.70	7.32
	±0.19	±0.27	±0.13	±0.07	±0.17	±0.17
Turb[NTU] SD	56.18	48.38	43.40	44.30	37.14	45.88
	±1.01	±1.05	±0.41	±1.57	±1.69	±1.15
Trans [cm] SD	57.00	72.10	79.30	91.90	84.10	76.88
	±3.37	±6.59	±2.50	±3.28	±4.48	±4.04
Cond µ/cm SD	58.68	73.08	77.35	80.00	68.32	71.49
	±0.48	±0.28	±0.49	±0.00	±0.48	±0.34