COMPARATIVE STUDY ON THE ECOLOGY OF *Oreochromis niloticus* FROM RIVIER NIGER AT CABLE POINT AND ONAH LAKE, ASABA, NIGERIA.

BY

ADAGHA, Oghenefejiro
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AN M.Sc DISSERTATION SUBMITTED TO DEPARTMENT OF FISHERIES, FACULTY OF AGRICULTURE DELTA STATE UNIVERSITY, ASABA CAMPUS.

SUPERVISOR: DR. J.K. EKELEMU

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DECLARATION

I declare that this project is an original research work carried out in the Department of Fisheries, Faculty of Agriculture, Delta State University.
Asaba Campus.

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Adagha Oghenefejiro. **Date**

CERTIFICATION

This is to certify that this project work titled "**Comparative study on ecology of *Oreochromis niloticus* from Rivier Niger at Cable Point and Onah Lake**" was researched and written by **ADAGHA, Oghenefejiro,** of the Department of Fisheries, Faculty of Agriculture, Delta State University, Abraka. It is adequate both in scope and in depth for the award of Masters of Science (M.Sc.) degree in Fisheries of the Delta State University and its hereby approved.

________________________ ______________________

Dr. Ekelemu J.K. **Date**
(Project Supervisor)

______________________ _______________________

Dr. (Mrs.) Nwabueze A.A **Date**
(Head of Department)

DEDICATION

This project work is dedicated to Almighty God for His unending love and mercy upon my life and academic pursuit.

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ABSTRACT

Comparative study on ecology of *Oreochromis niloticus* from Rivier Niger at Cable Point and Onah Lake was conducted from January to December 2015. Water and Fish samples were collected once monthly between the hours of

7:30am – 10:00am from the study locations for laboratory analysis. Water samples were collected using 250ml water sampling bottles. Fish samples were collected by artisanal fishermen using various fishing nets, traps and hooks.. Length and Weight of *O. niloticus* were taken using measuring board and a weighing balance. Food items were observed using photomicrogram. Combination of numerical and frequency of occurances method were used to determine the food and feeding habits. Water physico-chmeical parameter such as temperature and transparency were determined insitu, while other parameters were determined in the laboratory. The range of values collectec for the River and Lake are respectively, temperature 24-32^{0}C and 25-32^{0}c, transparency 5.50-55.5cm and 15.5-60.5cm, D.O 3.2-7.1mg/l and 2.0-6.6mg/l, B.O.D 1.4-3.4mg/l and 1.0-3.0mg/l, TDS 10-40mg/l and 10-36mg/l, TSS 40-80mg/l and 40-66mg/l, pH 6.53-8.70 and 6.52-7.28, conductivity 60-170 us/cm and 10-170us/cm, phosphate 0.14-6.28mg/l and 0.14-0.88mg/l, Sulphate 0.16-1.6mg/l and 0.11-1.03mg/l, Calcium 12-56mg/l and 18-44mg/l, Magnessium 32-69mg/l and 26-52mg/l, nitrate 0.04-1.0mg/l and 0.11-1.03mg/l. Result of the study show mean water parameter values to be within the limit for the culture of *O .niloticus*. The values of regression co-efficient obtained for the length-weight relationship were 14.836(River) and 14.901(Lake). The values suggest positive allometric growth pattern in the two locations. Result of the stomach content analysis revealed that *O. niloticus* are omnivores feeding majorly on detritus, anabaena and diatoms. Percentage gut composition in the study revealed:- detritus (10.92%), Anabaena (13.87%) and diatoms (18.06%) in the River and Anabaena (14.89%), diatoms (15.75%) and detritus (16.17%) in the Lake.. It is recommended that further study be carried out on the reproductive biology of *O. niloticus* in these water bodies.

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CHAPTER ONE

1.1 INTRODUCTION

Nigeria is richly blessed with a vast area of inland waters. The total surface area of water bodies in Nigeria is estimated to be about (149,919km2) and this constitutes about 15.9% of the total area of Nigeria (Ita, 1993). These include natural and man-made lakes, rivers, floodplains, ponds and streams. The species composition and diversity of aquatic organisms present in these water bodies, are influenced not only by the geographical location but also by water quality of the habitat. This can in turn be adversely affected by human activities (Oben, 2000). The general desire to conserve freshwater fisheries has led to an expansion of research into their water quality requirements, in terms of their physico-chemical parameters such as temperature, transparency, dissolved oxygen biochemical oxygen demand, P^H, conductivity, total dissolved solid total suspended solids, sulphate, nitrate, phosphate, calcium, magnesium, etc. These parameters have major influence on biochemical reactions that occur within the water. Sudden changes of these parameters are indicative of the changing conditions of the water (Hacioglu and Dulger, 2009). Fish can serve as an environmental indicator of the toxification and healthy state of water bodies (APHA, 1992)

Length-weight relationship is of great importance to fishery management and can give information on the stock composition, age at maturity, life span, mortality growth and reproduction (Fafioye and Oluajo, 2005). Length weight relationship have been used frequently to estimate weight from length because direct weight measurement can be time consuming (Sinoveic *et al.,* 2004). Length-weight relationship can be estimated to know the status of a particular fishery which could be helpful for management of that fishery (Nuri-Amin *et al.,* 2005).

The Nile tilapia (*Oreochromis niloticus)* is a relatively *Cichlid* fish, native to Africa from Egypt, South to East and Central Africa, as far West as Gambia, It is also native to Israel (Azevedo and Pelicice, 2004). *Oreochromis niloticus* is one of the most important fin fish used in aquaculture in Nigeria because of their hardness, ease of breeding, fast growth rate, ability to efficiently convert organic and domestic wastes into high quality protein and good taste (Idodo-Umeh, 2003). Studies on the food and feeding habits could provide useful information in positioning of the fishes in a food web in their environment and in formulating management strategy options in multispecies fishery (Joseph and Djama, 1994)

1.2 Justification

Much emphasis has been placed on the culture of *Clarias gariepinus*. Its culture has depended mostly on imported commercial feeds. However, due to the increasing cost of these feed, the cost of producing the fish is becoming too high and unaffordable to farmers. As a result of this, there is need to shift to the culture of other fish species such as *Oreochromis niloticus,* which has the potential for fast growth, feeds at lower trophic level and therefore cheap to culture. Therefore, this research on comparative study on ecology of *O. niloticus* seeks to provide a baseline information for the successful culture and management of *O.niloticus*.

1.3 Objectives

This study will determine and compare :-

i. Some physico-chemical parameters of River Niger at Cable Point and Onah Lake.

ii. The length-weight relationship of *Oreochromis niloticus* from River Niger at Cable Point and Onah *Lake*.

iii. The food and feeding habit of *Oreochromis niloticus* from the identification and analysis of the stomach content composition in River Niger at Cable Point and Onah Lake.

CHAPTER TWO

LITERATURE REVIEW

2.0 Physico-Chemical Characteristics of Water

The quality of an aquatic ecosystem is dependent on the physico-chemical qualities of the water and the biological diversity of the system Irfanullah, (2006).

2.1 Water Temperature (^{0}C)

Water temperature is one of the most important physical characteristics of the ecosystem. It affects a number of water quality parameters that are of concern for domestic, environmental, industrial and agricultural applications (Parashor *et al*, 2007).The chemical and biological reaction rates of water increase with increase in water temperature (Parashor *et al.*, 2007); UNEP, (2006). Water temperature plays an important role in governing the growth of organisms Pandey *et al.*, (2012). Temperatures in tropics vary between 21ºC and 32ºC (Idowu *et al*, 2012; Ayoade *et al*, 2006, Kamran *et al.*, 2013). In the tropics, fish grows best at temperature of between 25ºC - 32ºC (Sikoki and Veen, 2004). The growth, feeding, reproduction and migratory behaviour of aquatic organisms including fish and shrimps is greatly influenced by the temperature of water (Suski *et al.*, 2006, Fey, 2006, Crillet and Quetin, (2006). Temperature also affects chemical reactions and reaction rates within the water, thereby influencing its suitability for irrigation (Metacalf and Eddy, 2003)

2.2 Water Transparency (cm)

Light penetration varying from 30cm to above 60cm was acknowledged to be favourable for fish production (Ali *et al.,* 2000). Colour from textile, dyeing and foam from pulp and paper mill wastes are not just aesthetically objectionable, they also limit light penetration and can reduce dissolved oxygen level. Both upset the natural ecological balance in water (Henry and Heinke, 2005). Water turbidity of 30cm is ideal for fish production (Oso and Fagbuaro, 2008). A higher transparency could be due to reduction in allochthonous substances that find their ways into the reservoir (Ikomi *et al.,* 2003; and Ibrahim *et al*., 2009). Turbidity can affect fishes in three main ways: it may afford greater protection for juvenile fish from predators, it is generally associated with areas where there is an abundance of food and it may provide an orientation mechanism for migration to and from the river Blaber, (2000),

2.3 Dissolved Oxygen (mg/l)

Dissolved oxygen is one of the most important parameters of water; its correlation with water body gives direct and indirect information on the status of the water e.g. bacterial activities, photosynthesis, availability of nutrients, stratification etc Premlata and Vika, (2009). The concentration of dissolved oxygen is not a major limiting factor for Nile Tilapia as they can tolerate levels as low as 3 – 4 mg/l Boyd, (2004). Lewis, (2000) opined that oxygen conservation is an important management principle for tropical lakes. Any observed depression in dissolved oxygen could be due to chemical and biological oxidation process as in the water.

Oxygen distribution also strongly affects the solubility of inorganic nutrients. Since it helps to change the redox potential of the medium, it can determine whether the environment is aerobic or anaerobic Abowei, (2010). In rivers and streams, turbulence ensures that oxygen is uniformly distributed across the water and in very shallow streams the water may be super saturated Abowei, (2010). Dissolved oxygen is one of the most important factors for aquatic life and most species become distressed when dissolved oxygen level drop from 4–2 mg/l Francis-Floyd, (2003). The low levels of dissolved oxygen concentration in freshwater aquatic systems are an indication of the physical and biological processes in water body Jena *et al*., (2013). Dissolved oxygen is supposed to be an indicator of destruction of organic matter and self-purification capacity of waste water body. The standard for maintaining the aquatic flora and fauna is around 5 mg/l. Values below this, lead to decreasing levels of aquatic life Akan *et al*, (2008). Dissolved oxygen is an important environmental parameter that decides ecological health of a stream and protects aquatic life Chang, (2002).

2.4 Biological Oxygen Demand (mg/l)

The biological oxygen demand of water is the amount of dissolved oxygen taken up by bacteria in degrading oxidizable matter in the sample, measured after 5 days. Incubation in the dark at 20ºC. The biological oxygen demand is simply the amount by which the dissolved oxygen level drops during the incubation period and also gives a direct measure of primary productivity (EPA, 2001). Samples with high values have direct health implications (EPA, 2001), but it is an important indicator of overall water quality. Biological oxygen demand is the amount of oxygen utilized by micro organisms in stabilizing organic matter. Accoeding to (WHO, (2002) and EPA, (2001), the stipulated guidelines are 5 and ≤ 5 respectively. Biological oxygen demand is a widely used parameter to measure water quality and also in the design of effluent treatment plants (Metacalf and Eddy, 2003). Biological oxygen demand increases due to biodegradation of organic materials which depletes oxygen in a water body (Joshi *et al.,* 2009).

2.5 Conductivity (µS/cm)

Conductivity is a measure of the ability of water to conduct electrical current. The conductivity of water is dependent on its ionic/concentration and temperature. Navneet-kumar (2010) reported that conductivity of water is affected by the presence of inorganic dissolved solids such as Nitrate, Phosphate and primarily by geology of the area through which the water flows. Electrical conductivity is a measure of the ions present in water and therefore a surrogate for total dissolved solids (Metacalf and Eddy, 2004). Conductivity provides good indication of the changes in water composition particularly its mineral concentration (Ezekiel *et al,* 2011). It is an expression of its ability to conduct electric current. It is also the best indicator of water pollution as conductivity is the indirect measure of total dissolved solids or nutrients (Pandey *et al.,* 2012). Electrical conductivity is dependent on the nature of substances dissolved, not necessarily their amount (Akin-Oriola, 2003; Chindah and Braide, 2004).

2.6 Hydrogen Ion Concentration (pH)

pH is a measure of whether the water bodies are acidic or alkaline. pH is known to influence the physiological functions of fish and other aquatic lives. In upper Ishasha River, pH was among the most important factors predicting benthic macro invertebrate assemblages (Kasangaki *et al.*, 2008). The pH of water is important because many biological activities can occur only within a narrow range (Tassaduqe *et al*., 2003). Thus, pH range for diverse fish production is between 6.5 – 9 (Ali *et al.,* 2000). Any variation beyond acceptable rate range could be fatal to many aquatic organisms (FurhamIqbal *et al.,* 2004). The pH of an aquatic ecosystem is important because it is closely linked to biological productivity. Although the tolerance of individual species varies, pH values between 6.5 and 8.5 usually indicate good water quality and this range is typical of most major drainage, basins of the world (UNEP, 2006). Abowei, (2010) reported that pH values higher than 7 but lower than 8.5 is ideal for biological productivity, while pH lower than 4 is detrimental to aquatic life. Alkaline water promotes high primary productivity (Kumar and Prabhahar, 2012). Rivers flowing through forest have been reported to contain humic acid, which is the result of the decomposition and oxidation of organic matter in them. These have low pH (Abowei and George, 2009). The pH range suitable for the existence of most biological life is quite narrow and critical and is typically 6 – 9 (Metacalf and Eddy, 2003). According to Shaikh and Yergi, (2003) pH is considered to be the most important factor particularly in the case of the green algae.

2.7 Total Dissolved Solids (mg/l)

Total dissolved solids indicates the total amount of inorganic chemicals in solution FurhanIqbal *et al.,* (2004). A maximum value of 400 mg/l of total dissolved solids is permissible for diverse fish production (Ali *et al.,* 2000). In natural water, dissolved solids are composed mainly of solutes like carbonates, chlorides, iron, manganese sodium, calcium etc (Esmaeli, 2005). There is a relationship between conductivity and total dissolved solids in water. As more dissolved solids are added water's conductivity increases Abowei *et al*., (2010). Variation of dissolved solid in water could affect the relative quantities of the various components. Untreated storm water runo-ff from urban areas can contain levels of some parameters (e.g. total dissolved solids) that exceed those found in untreated waste water (Walsh *et al.,* 2002). The many chemical compounds dissolved in water may be of natural or industrial origin and may be beneficial or harmful depending on their composition and concentrations (Henry and Heinke, 2005). Excess amount of total dissolved solids principally have organoleptic balance and cause suffocation to aquatic fauna (Pandey *et al.,* 2012).

2.8 Total Suspended Solids (mg/l)

The greater the amount of suspended solids in water, the murkier it appears and the higher the measured turbidity UNEP, (2006). Suspended solids and turbidity affect the penetration of light in water FurhanIqbal *et al.,* (2004). The material from the water body that cannot pass through the 45µm filter is assumed to be suspended solids. Total suspended solids and total dissolved solids are affected by the pH. With change in pH, some solutes dissolved in water get precipitated (Ugwu and Wakama, 2012).

2.9 Phosphate Phosphorus ($PO_4^{=}$) mg/l

Phosphate values in surface waters are generally observed to be low (Nwankwo *et al*, 2010). Phosphate ions are not desirable in surface water, because they are the most important growth limiting factor in eutrophication and result in a variety of adverse ecological effects (Fatoki *et al.*, 2001). A number of authors have reported that inorganic fertilizers are washed into standing water bodies from the farms that surround them (Batzler 2002; Dublin-Green *et al.,* 2003). Studies on plant nutrient requirements by Ayoade (2000) on phosphate phosphorus (PO_4), shows that it play a crucial role in regulating the productivity of algae. Phosphorus gets into the water through various sources including leached or weathered soils from igneous rocks and domestic sewage containing human excrement. Other sources are phosphates from detergents in industrial effluents and run offs from fertilized farmlands. Phosphorus is very important for plant growth including algal growth in water (Abowei *et al*, 2010). Phosphates are absorbed by aquatic plants and algae and constitute an integral part of their body component. The total concentration of phosphorus in uncontaminated waters is reported to be about 0.01mg/l (Abowei, 2010).

2.10 Nitrate (NO_3) (mg/l)

Nitrate (NO_3) is the major form of nitrogen found in natural waters. Other forms of nitrogen present in natural waters include molecular nitrogen (N_2) in solution, ammonia as NH_3, ammonium and ammonia hydroxides (NH_4 and NH_4OH) and nitrites NO_2 (Davis *et al*, 2008). Nitrates and phosphates are good indicators of eutrophication. Phosphorus along with nitrogen causes explosive growth of algal species (Pandey *et al.,* 2012). High nitrites concentrations in lake is related to oxidation of ammonia, agricultural run-offs, decomposition of organic matter (Ufodike *et al.*, 2001). High levels of nitrates showed the effect of high anthropogenic activities and agricultural run-offs (Kannel *et al.,* 2007). The indiscriminate disposal of human and animal waste that contributes to nitrate pollution is one of the greatest challenges of urbanization in developing nations (Jaji *et al.*, 2007).

2.11 Magnesium (Mg^{2+})

Ekelemu and Zelibe (2006) studied some aspects of hydrolology of Onah lake and reported that the magnessium ion concentration range between 3.40-3.89mg/l. Ibrahim *et al.* (2009) worked on Kontagora reservoir and reported that the dry season magnesium mean was higher than the rainy season. This could be as a result of low water level and the concentration of ions, and the lower rainy season values could be due to dillusion.

2.12 Calcium (mg/l)

High carbonates cause calcium and magnesium ions to form insoluble minerals leaving sodium as the dominant ion in solution (Bauder *et al.,* 2004). Calcium is an essential and important nutrient for aquatic organisms being a cell wall constituent and regulatory factor for physiological function. It is commonly found in all water bodies (Ansar and Prakash, 2000). Hulyah and Kaliwal (2011) opined that calcium content of pond water ranged from 32.05 to 58.11 mg/l. High concentration of calcium helps reduce salt loss through the gill of fish in fresh water ecosystem (Wurts and Messer, 2004).

2.13 Sulphate (mg/l)

Moshood (2008) observed that sulphate concentration was the lowest (9±0.2 mg/l) at the beginning of the study in station 1, at Ogun reservoir and gradually increased until a maximum concentration of (16±0,45mg/l) was obtained at station 3, sulphate was signifying higher in the wet season. Mohammed and Sehu (2012) on the effect of Physico-chemical factors on seasonal dynamics in Nguru Lake, Northeastern Nigeria reported Sulphate range from 1.0mg/l – 10.1mg/l with a mean value of 6.6mg/l

2.2 Length Weight Relationship

The length-weight relationship is an important factor in the biological study of fishes and their stock assessment (Haimovici and Velasco, 2000). It is also used to determine possible differences between separate unit stocks of the same species (King 2007). Length weight relationships are important in Fisheries Science, notable to raise length –frequency samples to total catch or to estimate biomass from under water length observations. It is also important in parameter Zinc yield equeation and in estimating the weight of a fish of a given length and also in studies of gonad development, rate of feeding, metamorphoses, maturity and conditions (Thomas *et al*, 2003). Length weight-relationship of fishes can be used as an estimation of the accuracy weight of the fish of a given length group by establishing a mathematical relationship between the two. The mathematical relationship ($w=aL^b$) between length and weight of fishes is a practical index used for understanding their growth pattern. Size is generally more biological relevant than age, mainly because several ecological and physiological factors are more size dependent than age dependent. Length-Weight relationship can also be used in fisheries science to estimate the weight of individual fish from its length, to compared life history and morphology of population belonging to different region, to study ontogenic allometric changes (Hossain, 2010).

2.3 Food and feeding Habits

The study of the food and feeding habits of fresh water fish species is a subject of continuous research because it constitutes the basics of the development of a successful fisheries management programme on fish culture (Oransaye and Nakpodia, 2005) Nwafile and Lamai (2003) reported that Nile tilapia, *Oreochromis niloticus* is usually found in environments like benthopelagie, potamodromous, freshwater, brackish with depth of five (5) metres, and they feed mainly on phytoplankton and benthic algae. Food habit of fish could be related to its structural morphology, the way it captures food and how it digests it. Studies on fish structural adaptations could provide useful information on their food habits and management in ponds (Ipinjolu *et al,* 2004, and Malami *et al,* 2004). Understanding the stomach contents of fish is useful in guiding towards formulation of artificial diets in fish culture (Fagade, 1978). Studies of food and feeding habits of fish ascertain dietary requirements in their natural habitat, the relationship between the fish and the abiotic environment and to establish tropic inter – relationship (Ugwumba, 1998). Fish exploit food substances in an aquatic ecosystem according to the adaptations possessed (mouth, gill rakers dentition and gut system) which are related to feeding. Accoroding to Miller and Harley, (1996), food habit of fish could be related to its structural morphology, the way it captures food and how it digests its.

CHAPTER THREE

MATERIALS AND METHODS

3.1 Description of study area

River Niger at Cable Point is located in Oshimili South Local Government Area of Delta State. It lies on latitude 6º 4´ N and 6º N of the Equator and between longitude 5º 59´E and 6º 18´E of the Greenwich Meridian (Ministry of Land and Survey, 2003). Human activities such as washing, bathing, dredging and fishing are intense in River Niger at cable point.

Onah Lake is located in Oshimili North Local Government Area of Delta State. Onah Lake lies on Latitude 6º43´E and longitude 6º 11´W. It is a tropical freshwater lake, West of the River Niger, having its source from a spring called Utho. Onah Lake has a length of 2,250 kilometers, the least width of 75.20m in the dry season and maximum width of 471.75m at the peak of rainy season. Its total surface area was estimated as 516,197.2m^2 or 0.516km^2 (Ekelemu and Zelibe, 2006).

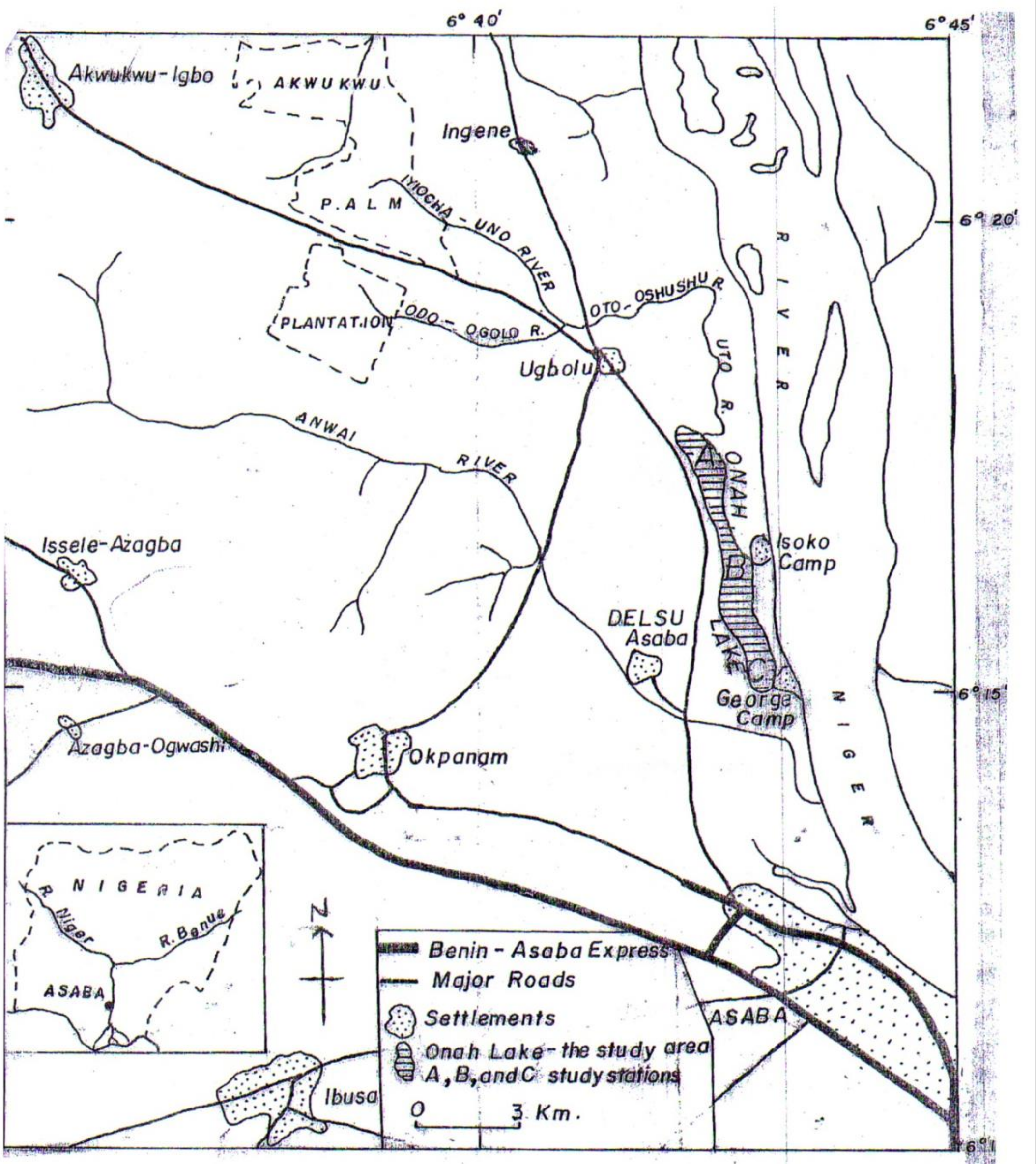


Fig. 3.1: Map of Asaba showing the study area Onah lake and River Niger

Source: Ministry of Land and Survey, (2003)

3.2 Sampling

Water samples and fish samples were collected from River Niger at Cable point and Onah Lake at Mile 5 once monthly from January to December 2015, between 7:30am-10:30am for laboratory analysis

3.2.1 Sub surface Water Temperature ºC

Surface water temperature was measured using a circular four (4) litres plastic bowl of diameter twenty centimeters (20cm) to get water out of the river and lake from the side of the boat. A rope was tied to the bowl and lowered in the water for two (2) to three (3) minutes to enable the bowl attain the same temperature as the water body. The bowl and its contents was then lifted out of the water and the temperature of the water read off using a 76mm immersion Gallen Kamp Graffin mercury in glass thermometer graduated from 0 – 110ºC at 0.1ºC intervals.

3.2.2 Transparency

The transparency of the water was determined –insitu- with the aid of a secchi disc of diameter 20cm, attached to a 1m long pole graduated in 1.0cm interval. The secchi disc was lowered into the water from the side of the boat and the depth at which the disc disappeared was recorded from the calibrated pole attached to the disc. The disc was lowered further and raised again. The point at which the disc reappeared was recorded. The mean of the two readings gave the transparency of the water.

3.2.3 Dissolved Oxygen (D.O) mg/l

250ml of water sample was fixed with 1ml of concentrated tetraoxosulphate (iv) acid (H_2SO_4) in the field. The sample was later transported to the research laboratory, Delta State University, Asaba Campus. 100ml of the water sample was measured into a conical flask. 1ml of $MnSO_4$ and 1ml of KI (Potassium iodide) was added respectively. The content was thoroughly shaken by inverting the flask. A brown precipitate was observed, 2ml of concentrated H_2SO_4 was then added to dissolve the precipitate. The content was finally titrated against 0.025N sodium trioxosulphate with the addition of few drops of starch indicator. At the end point, the initial dark blue-black colour changes to colourless. The dissolved oxygen was calculated using the formula:

Dissolved oxygen as Mg/l = (ml x N) of $Na_2S_2O_3$

$$\text{Dissolve oxygen as Mg/l} = \frac{(\text{ml} \times \text{N}) \text{ of } Na_2S_2O_3 \times 8 \times 1000}{V}$$

Where:

V = Volume of the sample bottle

N = Volume of $MnSO_4$ and K_I added (2ml)

3.2.4 Biochemical Oxygen Demand (BOD)

A dark brown narrow mouthed glass-stopper bottle of 250ml capacity was used to collect surface water in each location. The bottled waters were filled to the brim in water and covered under water to prevent atmosphere oxygen from entering. The bottles were kept inside a black polyethene bags to prevent sunlight from entering the bottles so that photosynthesis would not take place thereby preventing the liberation of oxygen to the bottled water. The bottled water sample was kept in the incubator for 5 days. At the end of the 5^{th} day, the oxygen level in the water was determined with Winkler's method expressed in Mg/L. The BOD was calculated by subtracting the first sample DO i.e.

BOD = Y – X

Y = DO of the first sample

X = DO of incubated sample

3.2.5 pH (Hydrogen ion concentration)

The pH was determined using an electronic pH meter. The pH meter was standardized with buffer solution. Buffer solution was prepared by dissolving one (1) tablet into 100ml of distilled water and after which it was used to standardized the pH meter to pH 7.00. 100ml each of the water samples were measured into a beaker. The pH was determined by immersing the electrode inside the water samples and the meter read off.

3.2.6 Total Dissolved Solid (TDS)

A beaker was washed and rinsed with distilled water, oven dried, put in a dessicator to cool and then weighed (w_1). 100ml of water samples each were filtered through a Whatman filter paper No. 41in the beaker. The samples were evaporated in the oven at 105ºC. The beakers were transferred to the dessicator to cool and then re-weighed, until a constant weight was obtained (W_2).

Weight of the dried sample = $(W_1 – W_2)$g. The TDS was calculated using the standard gravimetric method (APHA, 1992)

$$\frac{(W_1 - W_2) \times 100}{\text{Volume of Sample}}$$

W_1 = Weight of beaker + residue

W_2 = Weight of beaker

3.2.7 Total suspended solid (TSS)

This was done like total dissolved solids except that water used was not filtered.

3.2.8 Conductivity (us/cm)

The conductivity of the water was determined by using DIST DOS – 307 electronic conductivity meter. The electrode was allowed to stay in the surface water for 1 minute to stabilize before reading the value which was expressed in micro-siemens (us/cm) (Hana, 1992)

3.2.9 Calcium (Ca^{2+})

Calcium ion was determined using EDTA. Three (3.0ml) of 0.02m hydrochloric acid was added to 50ml of water samples in a conical flask to neutralize the alkalinity. This was boiled to expel carbon (iv) oxide (CO_2). On cooling to room temperature, 2.0ml of 1.0m sodium hydroxide (NaOH) solution was added, followed by 4 to 6 drops of calon indicator (Eriohrome blue-black solution) and titrated against standardized 0.02m EDTA (ethylene diaminetetracetate) solution with constant stirring until the colour changed to orchid purple. 1ml of EDTA solution = 0.40mg of calcium, (APHA, 1992).

3.2.10 Magnesium (mg^2+) ions

Magnesium ion was determined by determining the combined concentrations of magnesium and calcium and then subtracting the concentration of calcium in the water samples. In determining the concentration of Mg + Ca, 10ml of water samples were pipetted into a conical flask and diluted to 25ml with distilled water. The following were added to the content of the conical flask 25ml of concentrated Ammonia solution, 5g each of hydroxylammonnium chloride and potassium cyanide then 3 drops of Eriochrome black solution and titrated with 0.1m EDTA until the colour of the mixture turns skyblue from purple, (AHHA, 1992).

Mg = B – A

Where:

B = Concentration of Mg + Ca

A = Concentration of calcium

3.2.11 Sulphate ($SO_4^=$)

Sulphate in water sample was determined by spectronic 21D. Fifty (50ml) of water sample in a conical flask, 0.5g of barium chloride ($Bacl_2$) and 2.5ml of conditioning reagent were added and thoroughly shaken for solids to dissolve. The solution was allowed to stay for 30 minutes. A blank was prepared by adding 0.5g of barium chloride to 50ml of distilled water. The blank was allowed to stay for 30 minutes. Then 5ml of the blank solution was poured into cuvette (photo test tube) of the spectronic 21D regulated to zero and the absorbance was read at 420nm wave length.

The water samples were treated in the same way and the absorbance of the sulphate was read and multiplied by multiplying factor (13,54) calculated from the plot of sulphate against the calibration curve of the standards, (AHHA, 1992).

3.2.12 Phosphate ($PO_4^{=}$)

It was measured by adding 1ml sulphuric acid (11N) into 50ml of water sample in a conical flask, 0.4g of Ammonium sulphate was added and boil on a pre-heated hot plate for 30 – 40 minutes or until the final volume was reduced to 10ml. It was cool and diluted to 30ml, while its P^H was adjusted to 7.00 using (1N) NaOH. The mixture was then filtered and diluted to 50ml. Eight (8ml) of combine reagent was added (same thing to the standards, blank and samples) and left to stand for 10 -30 minutes Spectrophotometer set at 650nm was used to take the readings, (APHA, 1992)

3.2.13 Nitrate (NO_3^-)

Ten (10ml) of water sample was poured into 25ml pyrex flask and kept in oven at the temperature of 105ºC until the solution evaporated to dryness. The flask was removed from the oven and allowed to cool. 1ml of phenoldisulphomie acid was added, followed by addition of 10ml of distilled water. The solution was stirred thoroughly with a clean glass rod to ensure complete dissolution of all solids. 6ml of ammonia solution was added and properly stirred. The solution was then made up to 25ml with distilled water and left for 60 minutes for full colour development. A blank was prepared with distilled water in the same manner. 5ml of the blank was poured into a cuvette and calibrated to zero in spectronic 21D at absorbance of 410nm wave length. The water sample absorbance was then read and multiplied by a multiplying factor calculated from absorbance curve, (APHA, 1992).

3.2.14 Air temperature, rainfall and relative humidity

These data were collected from Federal Ministry of Aviation, Okpanam Road, Asaba.

3.3.1 Fish sampling

Fishermen were engaged for each water body and the fishing gears used were gill nets, cast nets, longlines and hooks. Specimens of *Oreochromis niloticus* caught during sampling were taken to the laboratory for analysis.

3.3.2 Identification of fish species

Identification of fish species was done using the identification key by Idodo – Umeh (2003).

3.3.3 Morphometric measurement

Total length (TL) and Standard Length (SL) were measured to the nearest 0.1cm using a graduated measuring board. Total weight of fish were measured to the nearest 0.1g using an electronic weighing balance.

3.3.4 Food and feeding habits

The fish were dissected, guts removed, cut open and stomach contents (all food items in the stomach) of the dissected fish were studied following the method of Hyslop, (1980). Each stomach content was emptied into a petri dish and dispersed with small amount of distilled water and were examined using a photomicrograph. The relative importance of different food items found in the stomach content were determined using numerical and frequency of occurrence method

Numerical method: The stomach contents were sorted into different food categories and each food items found were expressed as percentage of the total food items for each fish, (Ikusemiku and Wabarnise, 1981).

It is expressed as:

Percentage number of food items =

$$\frac{\text{Total number of a particular food item}}{\text{Total number of food items}} \times 100$$

Frequency of occurrence of food items

The number of stomach samples containing one or more of a given food item was expressed as a percentage of all non-empty stomach examined. The proportion of the population that feeds on a particular food, item was estimated and the frequency of occurrence calculated. This is usually expressed as:

Percentage occurrence of food items =

$$\frac{\text{Total number of stomach with a particular food item}}{\text{Total number of stomach with food}} \times 100$$

3.4 Length weight relationship

Length weight relationship of *Oreochromis niloticus* was calculated using Least squares regression analysis. The LWR was determined from the formular, (Hossain, 2010).

$W = aL^b$

Where W = Total body weight of the fish

L = Standard length of fish (Cm)

b = Growth exponent or regression coefficient

3.5 Data Analysis

Water quality parameters were evaluated using independent sample T-test, SPSS (2011).The data generated from the stomach content analysis was analysed by converting into percentage compositions. In addition, least square regression analysis was used to establish length-weight relationship.

CHAPTER FOUR

RESULTS

4.1 Results of the mean physico-chemical water parameters for the two study locations at River Niger at Cable Point and Onah Lake are presented in Figure .2-.14 and Table 4.1 and 4.2,

4.1.1 Mean Monthly Weather Report

The monthly air temperature value fluctuated only narrowly during the period of study. It ranges from 30.4ºc to 35.7ºc with a peak in February 2015, while the lowest was in August. The rainfall decline from October, there was no rainfall in the months of December and January. The lowest rainfall was recorded in April (0.4mm) while the highest was in September (250.6mm). The relative humidity followed rainfall pattern as it gradually increased during the rainy season. The peak 84.8% occurred in August while the least 38.8% occurred in January, 2015 (Fig 2)

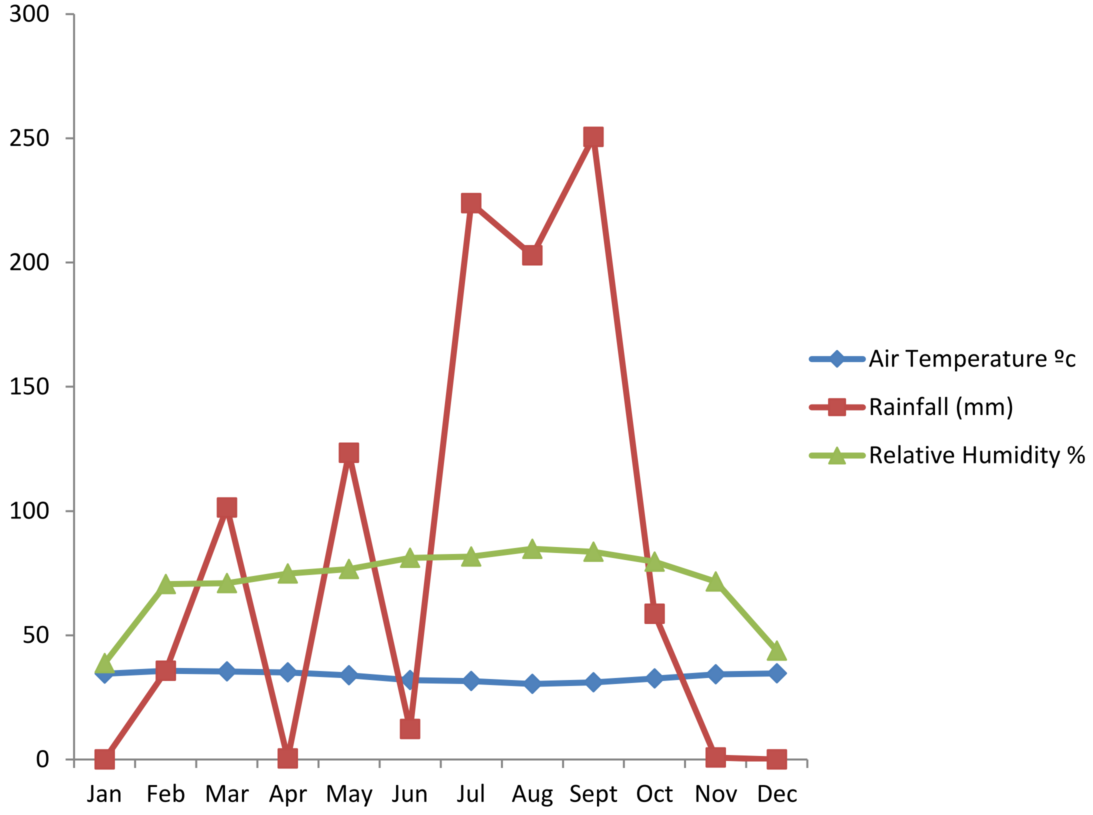


Fig. 2 Graph showing mean air temperature, rainfall and relative humidity

(Jan 2015-Dec 2015)

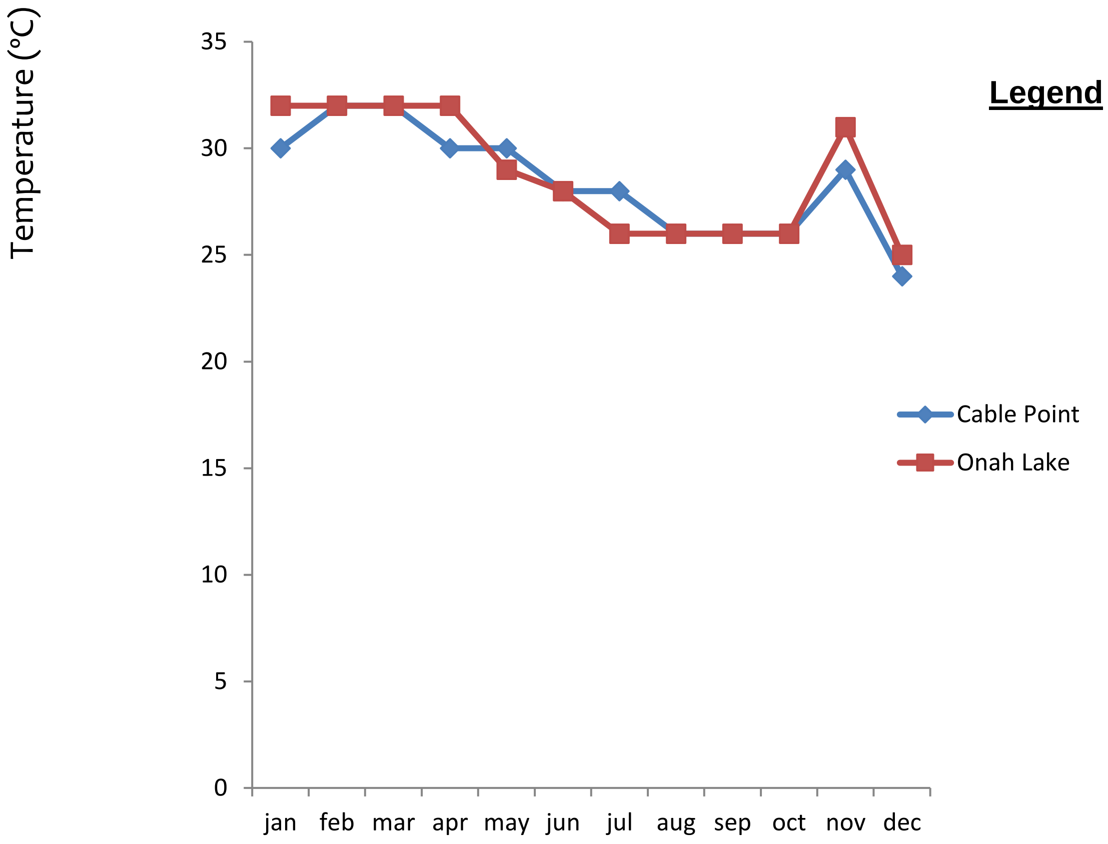
4.1.2 Sub-surface Water temperature (ºC) in the study locations

The temperature ranges were 24 - 32ºC for River Niger at Cable Point and 25-32ºC for Onah Lake. Presented in Figure 3 are the monthly variations for temperature. The lowest value of 24^0C was recorded in December in River Niger at Cable Point while the highest values of 32ºC were recorded in February and March in River Niger at Cable Point and 32**ºC** in January, February, March and April in Onah Lake.

The mean seasonal variations in temperature are shown in Table 2. In River Niger at Cable Point asand Onah Lake, higher mean values were obtained during the dry season compared to rainy season.

The values obtained were respectively 29.50ºC and 30.67ºC in the dry season and 27.33ºC and 26.83ºC in the rainy season.

Presented in Table 1 are the mean values and statistical levels of significance of temperature between the locations. River Niger at Cable Point accounted for the lowest mean values of 28.42ºC while Onah Lake accounted for the highest mean value of 28.75ºC. There was no significant difference ($p>0.05$) between the locations



Months (Jan – Dec., 2015)

Fig 3: Monthly variations in Temperature (^{0}C) in the study locations

Table 1 MEAN SPATIAL VALUES AND STATISTICAL LEVELS OF SIGNIFICANCE OF PHYSICO-CHEMICAL WATER PARAMETERS FOR RIVER NIGER AT CABLE POINT AND ONAH LAKE

LOCATIONS	**River Niger**				**Onah Lake**				P
PARAMETER	**Min.**	**Max.**	**Mean**	**S.E**	**Min.**	**Max.**	**Mean**	**S.E**	
Water Temperature (^{0}C)	24	32	28.42	0.73	25	32	28.75	.84	Not Significant
Transparency (cm)	5.55	55.5	30.00	4.39	15.5	60.5	34.33	4.25	Not Significant
Dissolved Oxygen (mg/l)	3.2	7.1	5.16	0.37	2.0	6.6	4.67	0.40	Not Significant
Biological Oxygen Demand ((mg/l)	1.4	3.4	2.56	0.18	1.0	3.0	2.04	0.18	Not Significant
Total Dissolved Solids (mg/l)	10	40	22.92	2.17	10	36	21.67	1.55	Not Significant
Total Suspended Solids (mg/l)	40	80	59.17	3.63	40	64	54.33	1.92	Not Significant
pH	6.53	8.70	7.32	0.19	6.52	8.28	7.13	0.19	Not Significant
Conductivity (us/cm)	60	170	114.17	11.38	10	170	74.17	12.09	Significant
Phosphate (mg/l)	0.14	6.28	1.39	0.49	0.14	0.88	0.47	0.07	Not Significant
Sulphate (mg/l)	0.16	1.68	0.81	0.17	0.11	1.03	0.46	0.11	Not Significant
Calcium (mg/l)	12	56	30.42	3.71	18	44	30.67	4.12	Not Significant
Magnessium (mg/l)	32	69	42.83	3.92	26	52	37.26	2.76	Not Significant
Nitrate (mg/l)	0.04	1.0	0.43	0.09	0.11	1.03	0.57	0.09	Not Significant

TABLE 2: MEAN VARIATIONS IN DRY AND RAINY SEASON OF PHYSCIO-CHEMICAL WATER PARAMETERS IN RIVER NIGER AT CABLE POINT AND ONAH LAKE

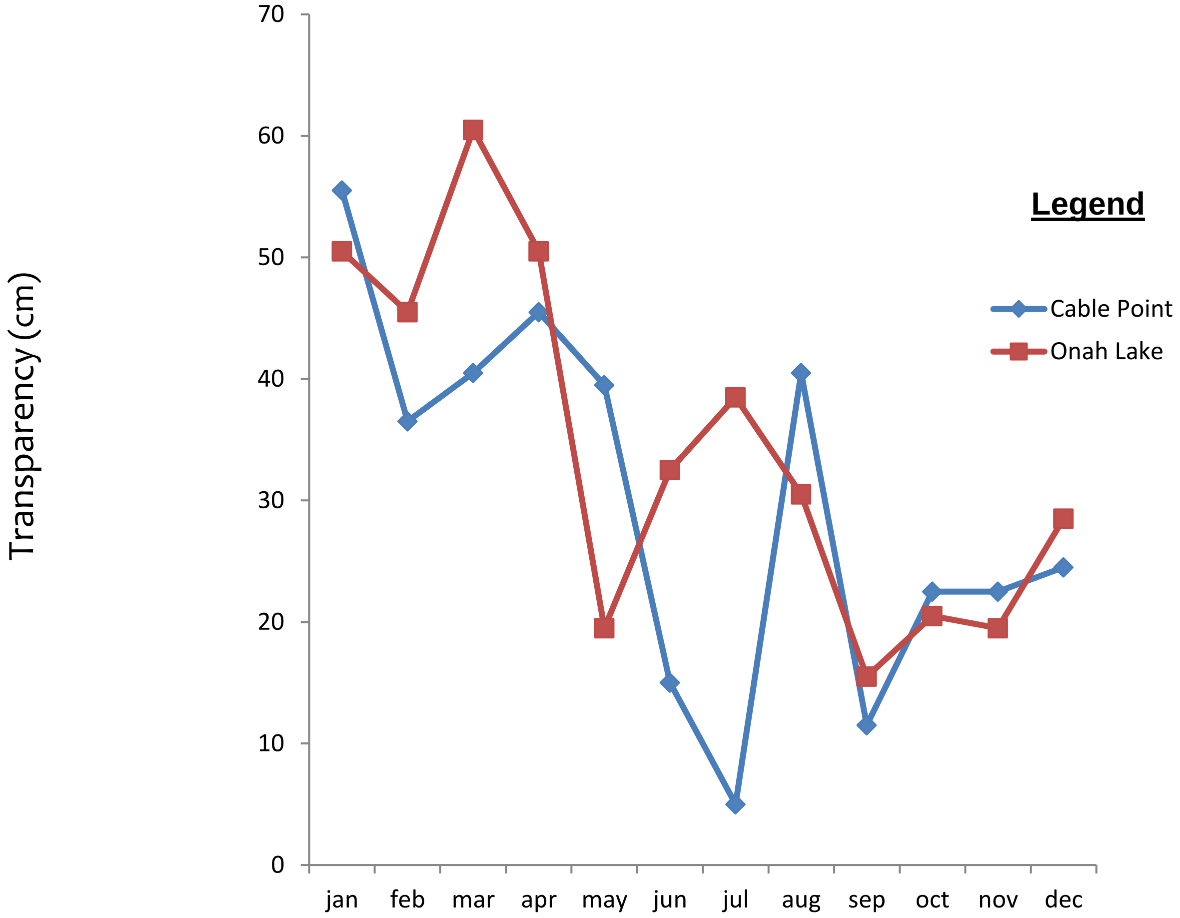
LOCATION	River Niger		Onah Lake	
PARAMETER	**Dry Season**	**Rainy Season**	**Dry Season**	**Rainy Season**
Water Temperature (^0C)	29.50	27.33	30.67	26.83
Transparency (cm)	37.50	22.50	42.50	26.17
Dissolved Oxygen (mg/l)	4.43	5.88	3.73	5.60
Biological Oxygen Demand ((mg/l)	2.22	2.88	1.63	2.45
Total Dissolved Solids (mg/l)	23.33	22.50	19.17	24.17
Total Suspended Solids (mg/l)	50.83	67.50	50.83	57.83
pH	7.33	7.31	7.14	7.13
Conductivity (us/cm)	113.33	115.00	65.00	83.33
Phosphate (mg/l)	0.66	2..16	0.28	0.66
Sulphate (mg/l)	0.55	1.07	0.35	0.57
Calcium (mg/l)	30.33	30.50	38.17	23.17
Magnessium (mg/l)	43.50	42.17	38.68	35.83
Nitrate (mg/l)	0.24	0.63	0.33	0.81

4.1.3 Transparency (cm) in the study locations

Transparency values ranges were 5.5–50.5cm for River Niger at Cable Point and 15.50 – 60.50cm for Onah lake Presented in Figure 4 is the monthly variations for transparency between the locations. The lowest value of 5.5cm was recorded in June in River Niger at Cable Point while the highest values of 60.5cm was recorded in March in Onah Lake.

The mean seasonal variations in transparency are shown in Table 2. In River Niger at Cable Point and Onah Lake, higher mean values were obtained during the dry season compared to rainy season. The values obtained were respectively 37.50cm and 42.50cm in the dry season and 22.50cm and 26.17cm in the rainy season.

Presented in Table 1 are the mean values and statistical levels of significance of transparency between the locations. River Niger at Cable Point accounted for the lowest mean values of 30.00cm while Onah Lake accounted for the highest mean value of 34.33cm. There was no significant difference ($p>0.05$) between the locations



Months (Jan – Dec., 2015)

Fig 4: Monthly variations in Transparency (Cm) in the study locations

4.1.4 Dissolved Oxygen (mg/l) in the study locations

Dissolved oxygen values ranges were 3.2 – 7.1 mg/l for River Niger at Cable Point and 2.0 – 6.6 mg/l for Onah lake. Presented in Figure 5 is the monthly variations for for D.O between the locations. The lowest value of 2.0mg/l was recorded in November in Onah Lake while the highest value of 7.1mg/l was recorded in September in River Niger at Cable Point.

The mean seasonal variations in D.O are shown in Table 2. In River Niger at Cable Point and Onah Lake, higher mean values were obtained during the rainy season compared to dry season. The values obtained were respectively 5.88mg/l and 5.60mg/l in the rainy season and 4.43mg/l and 3.73mg//l in the dry season Presented in Table 1 are the mean values and statistical levels of significance of D.O between the locations. Onah Lake accounted for the lowest mean values of 4.67mg/l while River Niger at Cable Point accounted for the highest mean value of 5.16mg/. There was no significant difference (p>0.05) between the locations

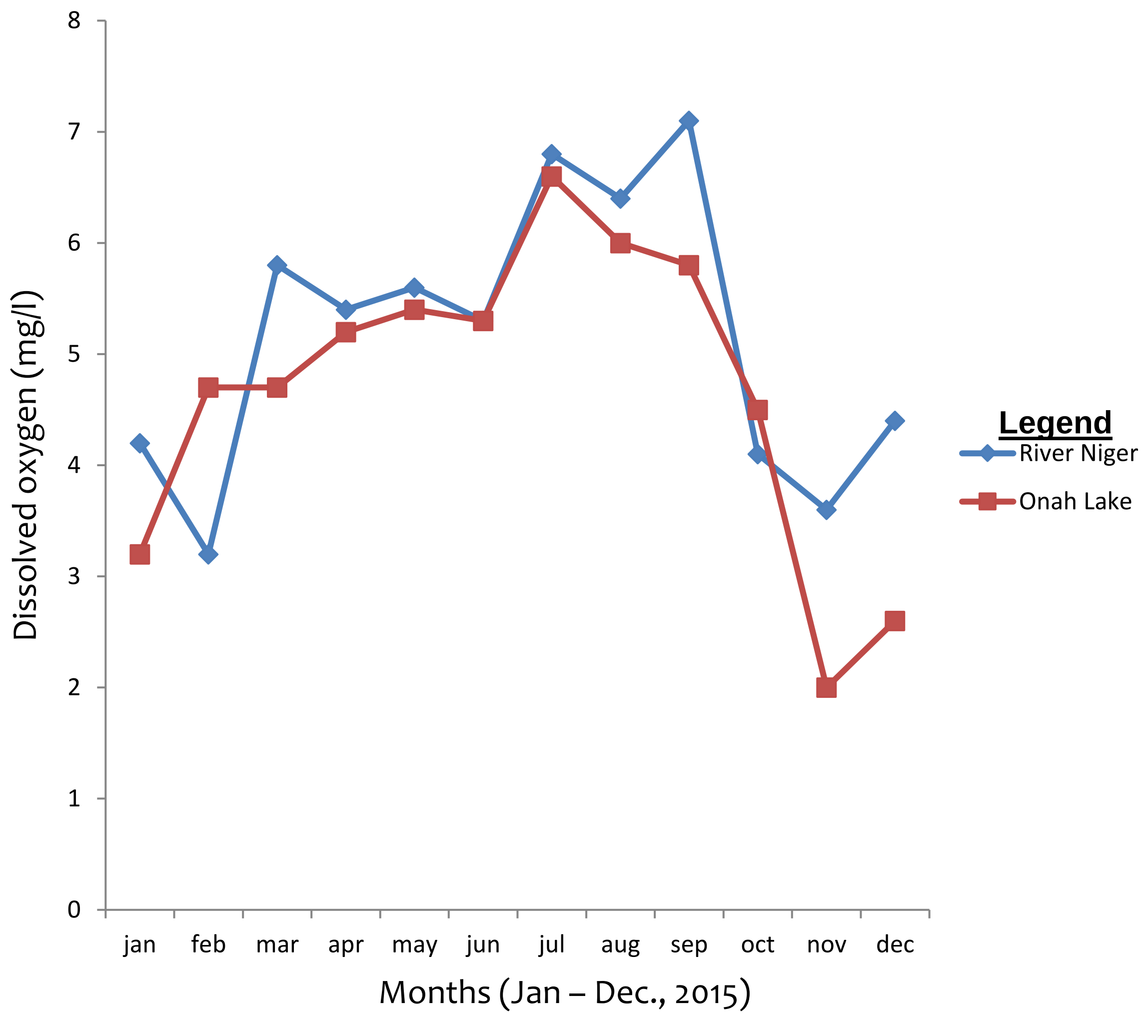


Fig 5: Monthly variations in Dissolved Oxygen (mg/l**) in the study locations**

4.1.5 Biological Oxygen Demand (mg/l) in the study locations

The biological oxygen demand values ranges were 1.4 – 3.4 mg/l for River Niger at Cable Point and 1.0 – 3.0 mg/l for Onah Lake. Presented in Figure 6 is the monthly variations for BOD between the locations. The lowest value of 1.0mg/l was recorded in December in Onah Lake while the highest value of 3.4mg/l was recorded in September in River Niger at Cable Point.

The mean seasonal variations in BOD are shown in Table 2. In River Niger at Cable Point and Onah Lake, higher mean values were obtained during the rainy season compared to dry season. The values obtained were respectively 2.88mg/l and 2.45mg/l in the rainy season and 2.22mg/l and 2.0mg//l in the dry season.

Presented in Table 1 are the mean values and statistical levels of significance of BOD between the locations. Onah Lake accounted for the lowest mean values of 2.04 mg/l while River Niger at Cable Point accounted for the highest mean value of 2.55mg/. There was no significant difference ($p>0.05$) between the locations

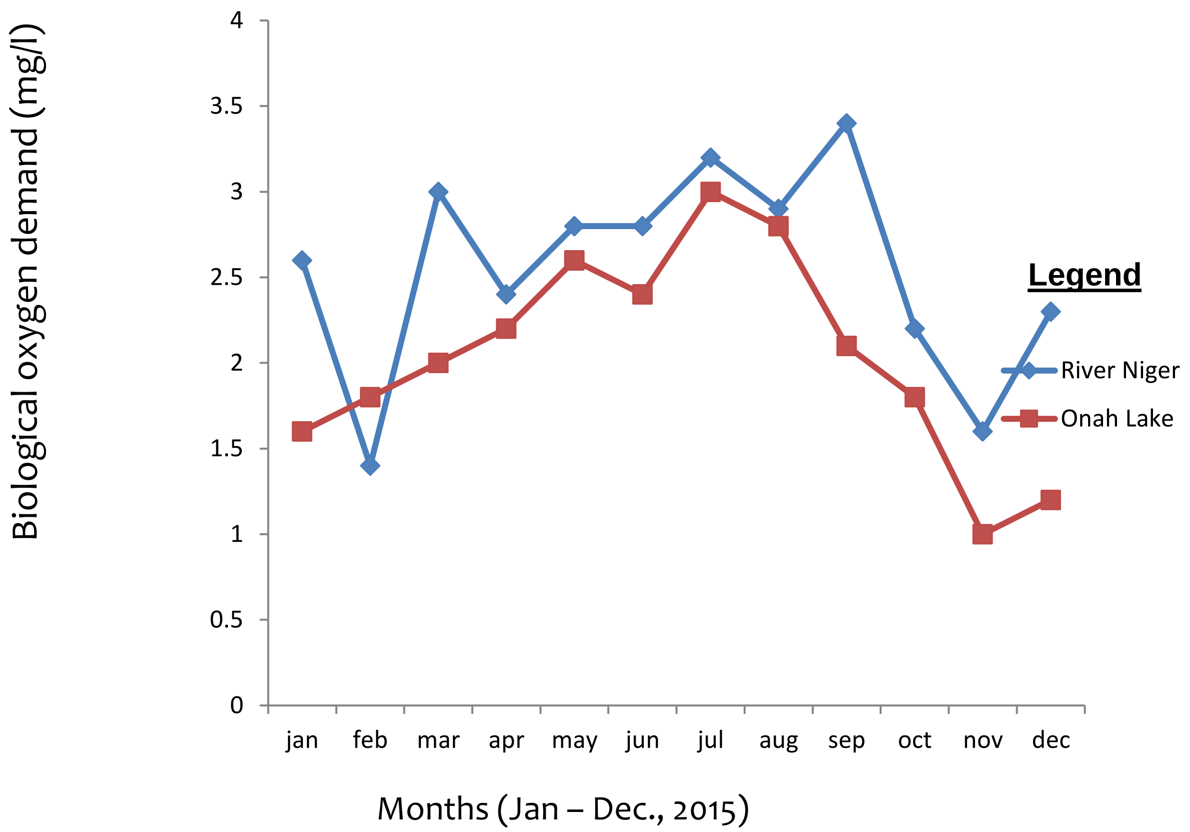


Fig 6: Monthly variations Biological Oxygen Demand (mg/l) in the study locations

4.1.6 Hydrogen Ion Concentration (P^H) in the study locations

The P^H values ranges were 6.53-8.70 for River Niger at cable point and 6.52-8.28 for Onah Lake. Presented in Figure 7 is the monthly variations for P^H between the locations. The lowest value of 6.52 was recorded in February in Onah Lake while the highest value of 8.70 was recorded in April in River Niger at Cable Point.

The mean seasonal variations in P^H are shown in Table 2. In River Niger at Cable Point and Onah Lake, higher mean values were obtained during the dry season compared to rainy season. The values obtained were respectively 7.33 and 7.14 in the dry season and 7.31 and 7.13 in the rainy season.

Presented in Table 1 are the mean values and statistical levels of significance of P^H between the locations. Onah Lake accounted for the lowest mean values of 7.13 while River Niger at Cable Point accounted for the highest mean value of 7.32. There was no significant difference ($p>0.05$) between the locations

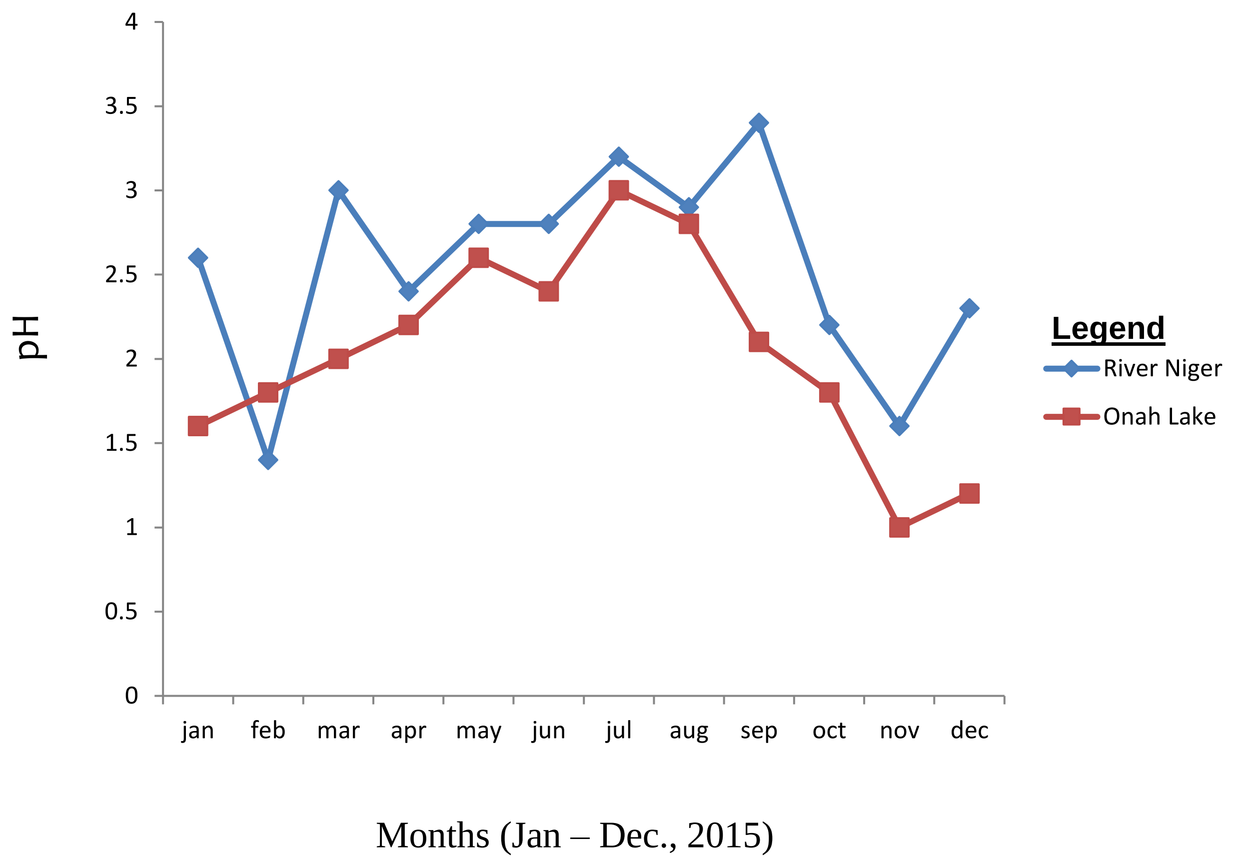


Fig 7: Monthly variations in pH in the study locations

4.1.7 Total Dissolved Solids (mg/l) in the study locations

Total dissolved solids values ranges were 10-40mg/l for River Niger at Cable Point and 10-30mg/l for Onah Lake. Presented in Figure 8 is the monthly variations for TDS between the locations. The lowest value of 10mg/l was recorded in December in River Niger at Cable Point and 10mg/l in the month of April in Onah lake. The highest value of 40mg/l was recorded in February in River Niger at Cable Point.

The mean seasonal variations in TDS are shown in Table 2. In River Niger at Cable Point, higher mean value was obtained during the dry season 23.33mg/l compared to rainy season 22.50mg/l. While in Onah Lake higher mean value was obtained during the rainy season 24.17mg/l compared to dry season 19.17mg/l

Presented in Table 1 are the mean values and statistical levels of significance of TDS between the locations. Onah Lake accounted for the lowest mean values of 21.67mg/l while River Niger at Cable Point accounted for the highest mean value of 22.92mg/. There was no significant difference ($p>0.05$) between the locations

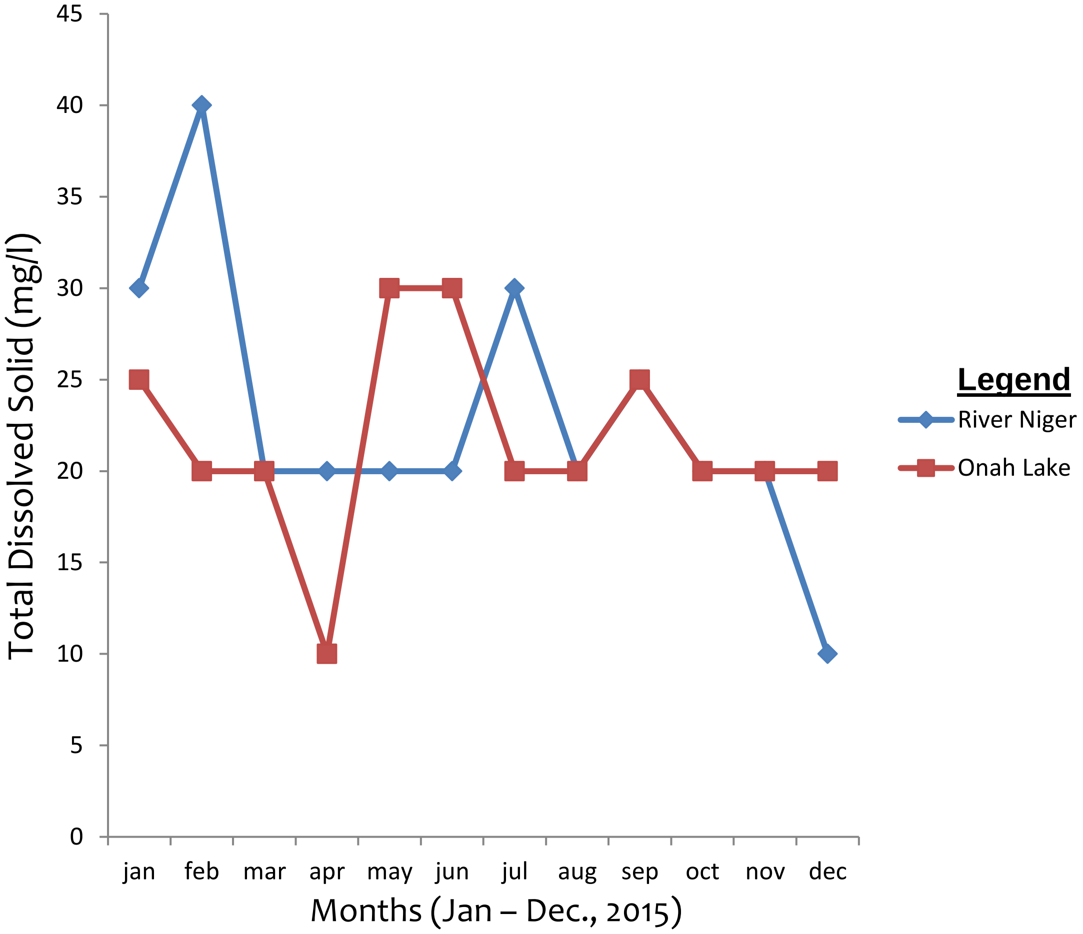


Fig 8: Monthly variations in total dissolved solid (mg/l) in the study locations

4.1.8 Total Suspended Solids (mg/l) in the study locations

Total suspended solid values ranges were 40-80mg/l for River Niger at cable points and 40-64mg/l for Onah Lake. Presented in Figure 9 is the monthly variations for TSS between the locations. The lowest value of 40mg/l were recorded in March and December in River Niger at Cable Point and 40mg/l in the month of December in Onah lake. The highest value of 80mg/l were recorded in June and July in River Niger at Cable Point.

The mean seasonal variations in TSS are shown in Table 2. In River Niger at Cable Point and Onah Lake, higher mean values were obtained during the rainy season compared to dry season. The values obtained were respectively 67.50mg/l and 57.83mg/l in the rainy season and 50.83mg/l and 50.83mg//l in the dry season.

Presented in Table 1 are the mean values and statistical levels of significance of TSS

between the locations. Onah Lake accounted for the lowest mean values of 54.33mg/l while River Niger at Cable Point accounted for the highest mean value of 59.17mg/. There was no significant difference ($p>0.05$) between the locations

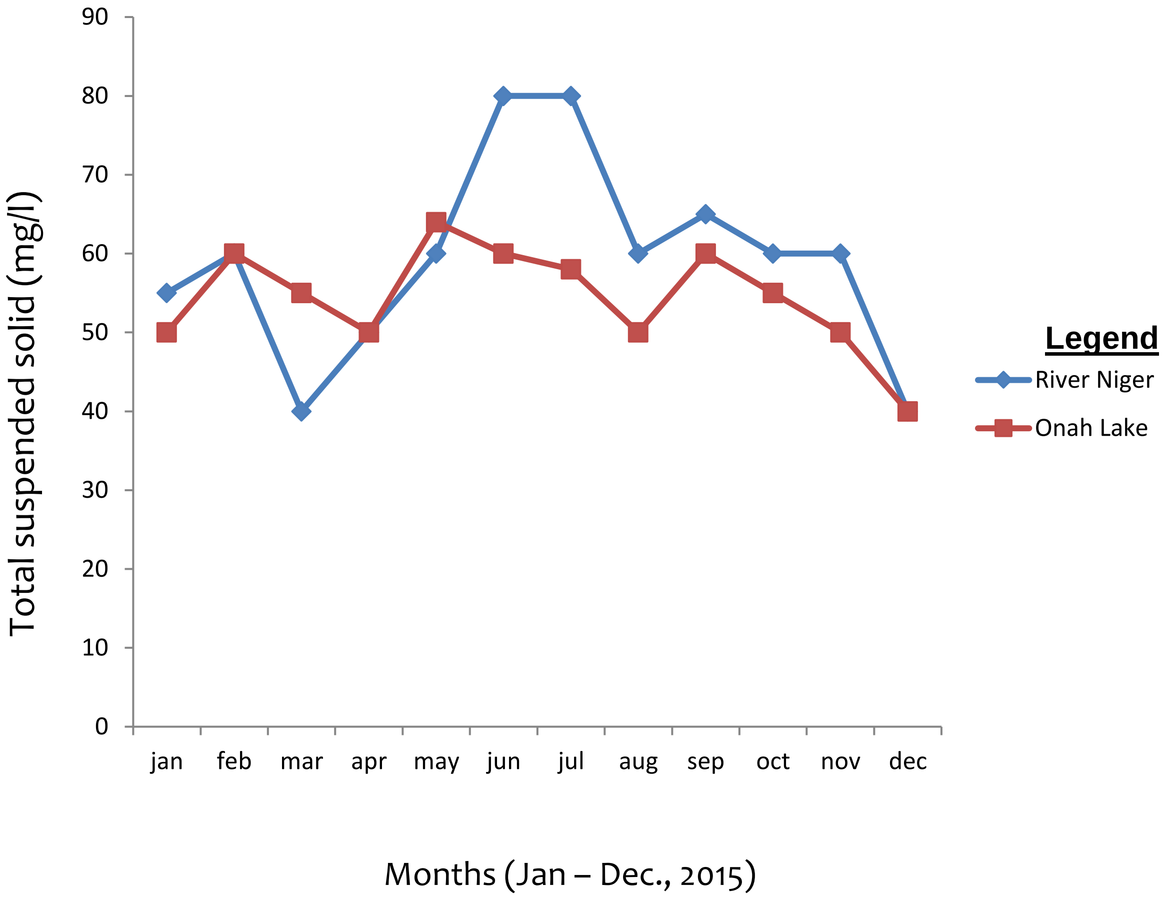


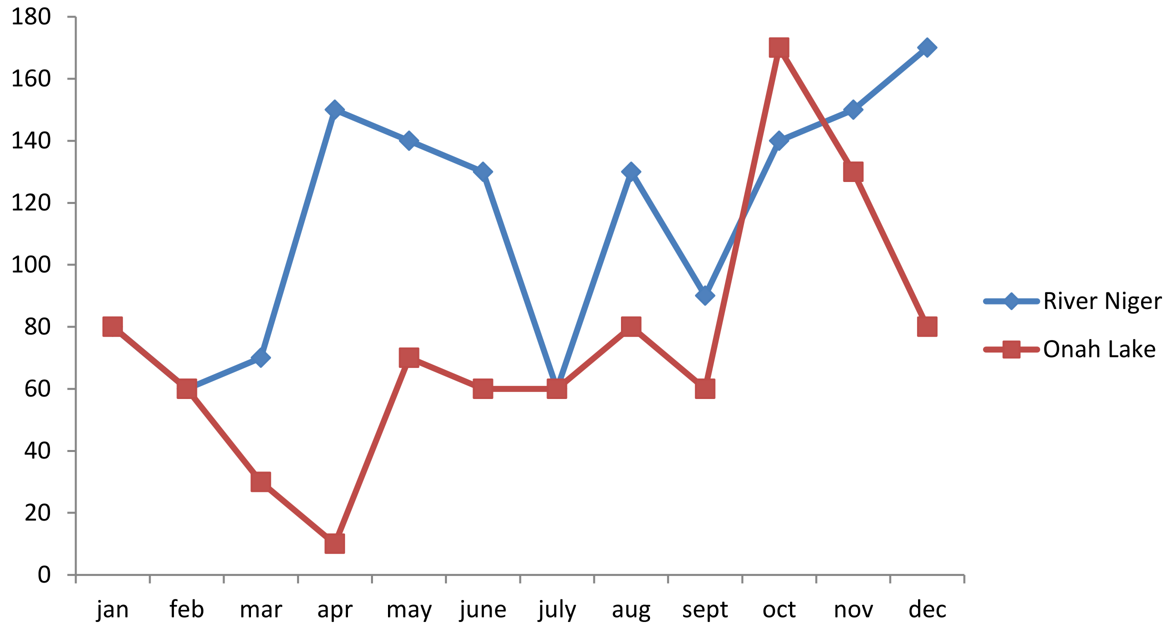
Fig 9: Monthly variations in total suspended solid (mg/l) in the study locations

4.1.9 Conductivity (us/cm) in the study locations

The conductivity values ranges were 60-170us/cm for River Niger at Cable Point and 10-170us/cm for Onah Lake. Presented in Figure 10 is the monthly variations for Conductivity between the locations. The lowest value of 10us/cm was recorded in April in Onah Lake while the highest value of 170us/cm was recorded in December in River Niger at Cable Point and 170us/cm. was recorded in October in Onah Lake..

The mean seasonal variations in conductivity are shown in Table 2. In River Niger at Cable Point and Onah Lake, higher mean values were obtained during the rainy season compared to dry season. The values obtained were respectively 115.0us/cm and 83.33us/cm in the rainy season and 113.33us/cm and 65.0us/cm in the dry season.

Presented in Table 1 are the mean values and statistical levels of significance of conductivity between the locations. Onah Lake accounted for the lowest mean values of 74.17us/cm while River Niger at Cable Point accounted for the highest mean value of 114.17us/cm there was sisgnificant difference ($p>0.05$) between the locations



Months (Jan – Dec., 2015)

Fig 10: Monthly variation of conductivity (μs/cm) in the locations

4.1.10 Calcium (mg/l) in the study locations

The calcium values ranges were 12-56mg/l for River Niger at Cable Point and 18-44mg/l for Onah Lake. Presented in Figure 11 is the monthly variations for calcium between the locations. The lowest value of 12.00mg/l was recorded in June in River Niger at Cable Point while the highest value of 56mg/l was also recorded in December in River Niger at Cable Point.

The mean seasonal variations in calcium are shown in Table 2. In River Niger at Cable Point, higher mean value was obtained during the rainy season 30.50mg/l compared to dry season 30.33mg/l. While in Onah Lake higher mean value was obtained during the dry season 38.17mg/l compared to rainy season 23.17mg/l

Presented in Table 1 are the mean values and statistical levels of significance of calcium between the locations. River Niger at Cable Point accounted for the lowest mean values of 30.42mg/l while Onah Lake accounted for the highest mean value of 30.67mg/. There was no significant difference ($p>0.05$) between the locations

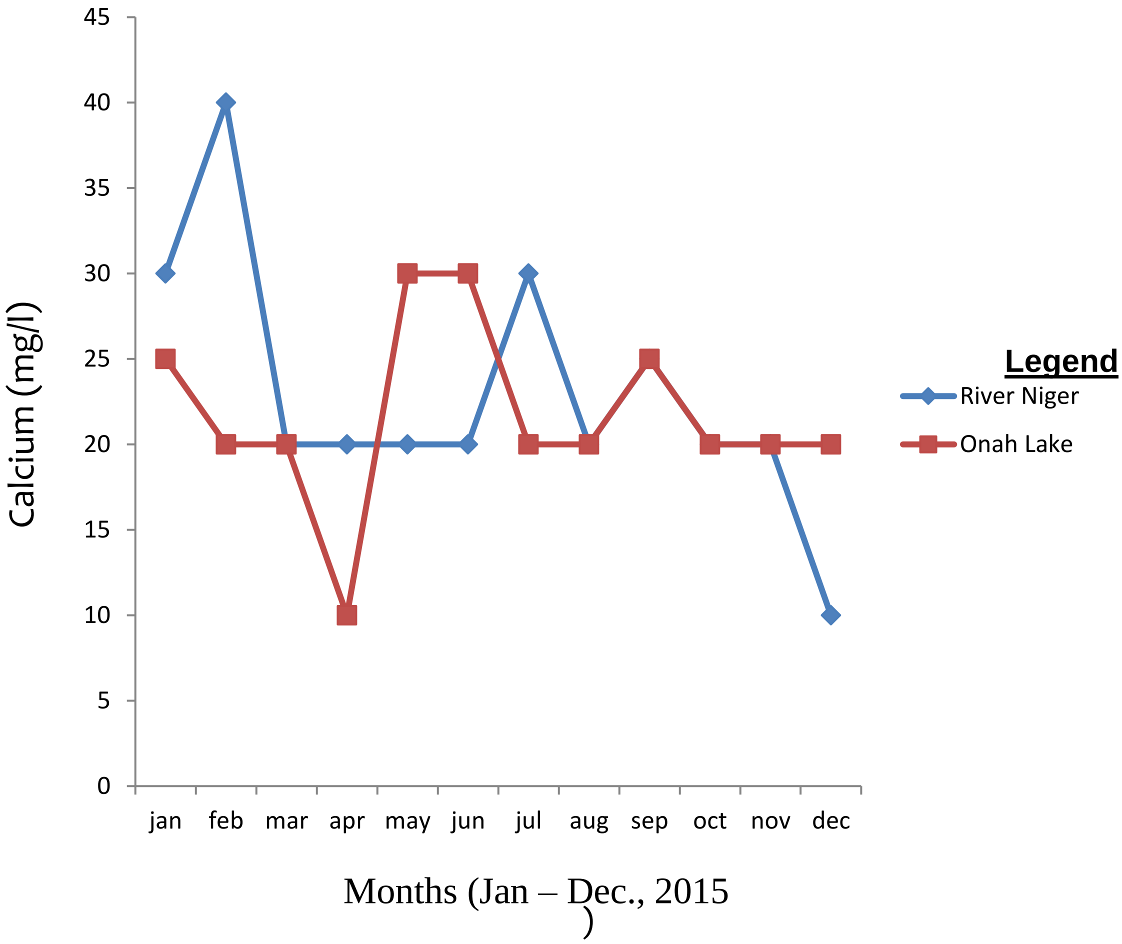


Fig 11: Monthly **variation of calcium (mg/l) in the study locations**

4.1.11 Magnesium (mg/l) in the study locations

The magnesium values ranges were 32-69mg/l for River Niger at Cable Point and 26-52mg/l for Onah Lake. Presented in Figure 12 is the monthly variations for magnesium between the locations. The lowest value of 26mg/l was recorded in April in Onah Lake while the highest value of 69mg/l was recorded in December in River Niger at Cable Point.

The mean seasonal variations in magnessium are shown in Table 2. In River Niger at Cable Point and Onah Lake, higher mean values were obtained during the dry season compared to rainy season. The values obtained were respectively 43.50mg/l and 38.68mg/l in the dry season and 42.17mg/l and 35.83mg//l in the rainy season.

Presented in Table 1 are the mean values and statistical levels of significance of magnesium between the locations. Onah Lake accounted for the lowest mean values of 37.26mg/l while River Niger at Cable Point accounted for the highest mean value of 42.83mg/l. There was no significant difference ($p>0.05$) between the locations

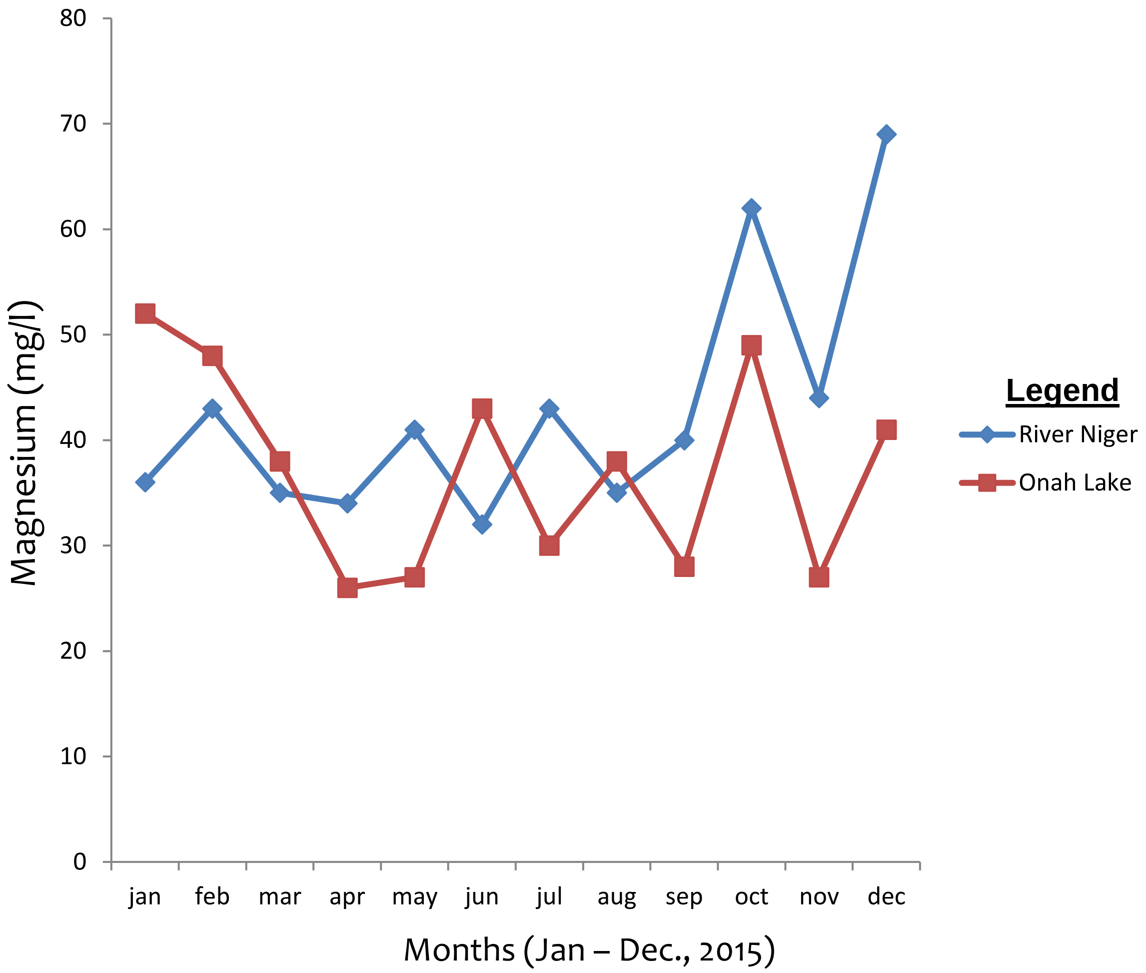


Fig 12: Monthly variations of magnesium (mg/l) in the study locations

4.1.12 Phosphate (mg/l) in the study locations

The phosphate values ranges were 0.14-6.28mg/l for River Niger at Cable Point and 0.14-0.88mg/l for Onah Lake. Presented in Figure 13 is the monthly variations for phosphate between the locations. The lowest value of 0.14mg/l was recorded in April in River Niger at Cable Point and 0.14mg/l in March in Onah Lake. The highest value of 6.28mg/l was recorded in June in River Niger at Cable Point.

The mean seasonal variations in phosphate are shown in Table 2. In River Niger at Cable Point and Onah Lake, higher mean values were obtained during the rainy season compared to dry season. The values obtained were respectively 2.16mg/l and 0.66mg/l in the rainy season and 0.66mg/l and 0.28mg// in the dry season.l

Presented in Table 1 are the mean values and statistical levels of significance of phosphate between the locations. Onah Lake accounted for the lowest mean values of 0.47mg/l while River Niger at Cable Point accounted for the highest mean value of 1.39mg/. There was no significant difference ($p>0.05$) between the locations

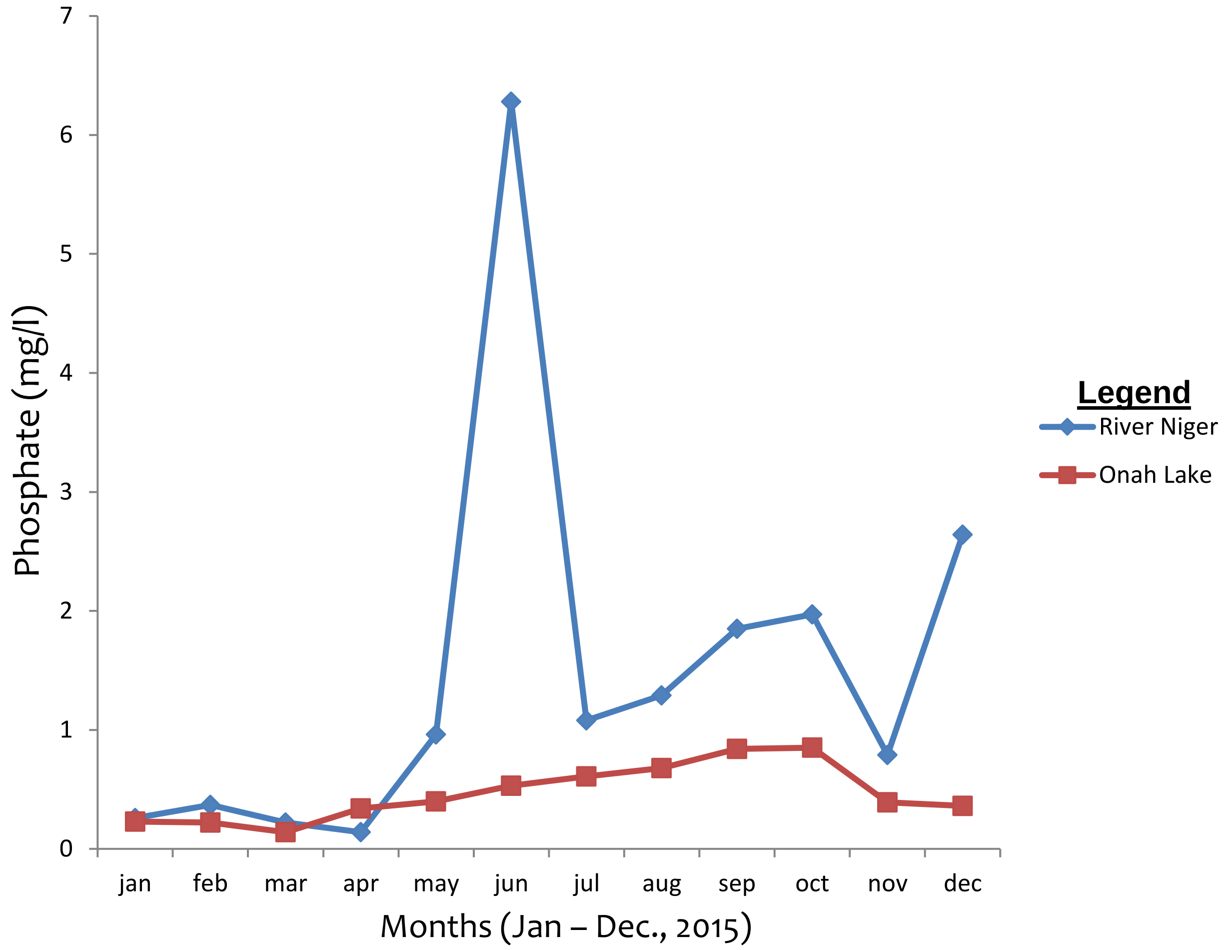


Fig 13: Monthly variations of phosphates (mg/l) in the study locations

4.1.13 Sulphate (mg/l) in the study locations

The sulphate values ranges were 0.16-1.65mg/l for River Niger at Cable Point and 0.11-1.15mg/l for Onah Lake. Presented in Figure 14 is the monthly variations for sulphate between the locations. The lowest value of 0.11mg/l was recorded in January in Onah Lake while the highest value of 1.65mg/l was recorded in September in River Niger at Cable Point.

The mean seasonal variations in sulphate are shown in Table 2. In River Niger at Cable Point and Onah Lake, higher mean values were obtained during the rainy season compared to dry season. The values obtained were respectively 1.07mg/l and 0.57mg/l in the rainy season and 0.55mg/l and 0.35mg//l in the dry season.

Presented in Table 1 are the mean values and statistical levels of significance of sulphate between the locations. Onah Lake accounted for the lowest mean values of 0.46mg/l while River Niger at Cable Point accounted for the highest mean value of 0.81mg/. There was no significant difference ($p>0.05$) between the locations

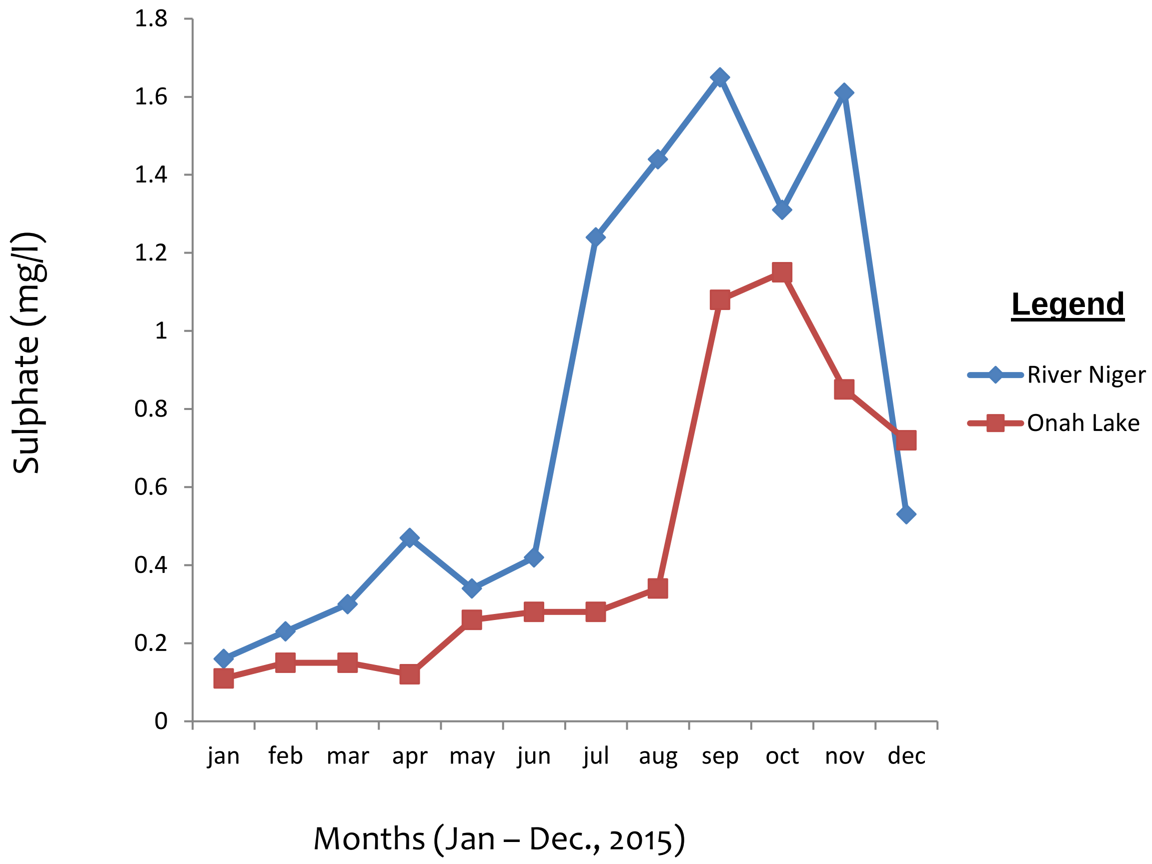


Fig 14: Monthly variations of sulphate (mg/l) in the study locations

4.1.14 Nitrate (mg/l) the study locations

The nitrate values ranges were 0.04-1.0mg/l for River Niger at Cable Point and 0.11-1.03mg/l for Onah Lake. Presented in Figure 15 is the monthly variations for nitrate between the locations. The lowest value of 0.04mg/l was recorded in November in River Niger at Cable Point while the highest value of 1.03mg/l was recorded in September in Onah Lake.

The mean seasonal variations in nitrate are shown in Table 2. In River Niger at Cable Point and Onah Lake, higher mean values were obtained during the rainy season compared to dry season. The values obtained were respectively 0.63mg/l and 0.81mg/l in the rainy season and 0.24mg/l and 0.33mg//l in the dry season.

Presented in Table 1 are the mean values and statistical levels of significance of nitrate between the locations. River Niger at Cable Point accounted for the lowest mean values of 0.43mg/l while Onah Lake accounted for the highest mean value of 0.57mg/. There was no significant difference ($p>0.05$) between the locations

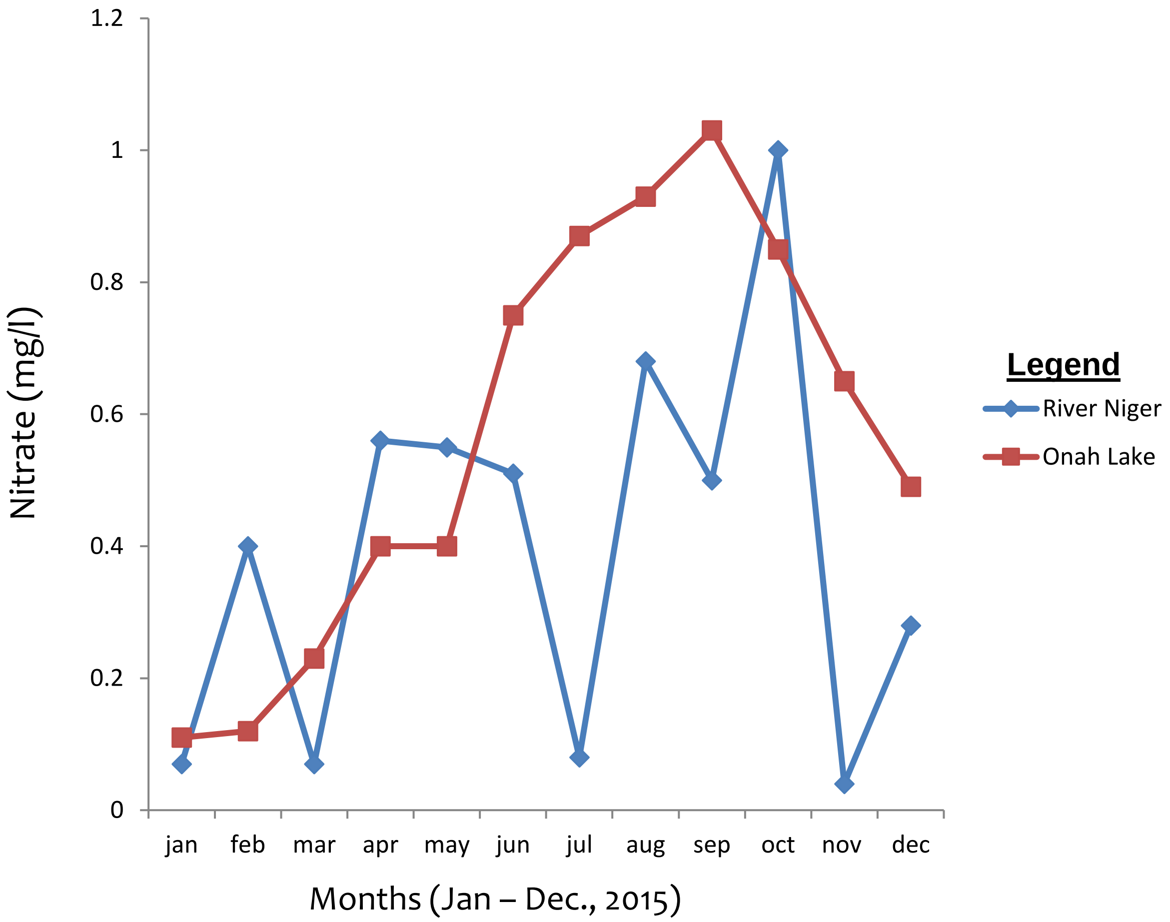
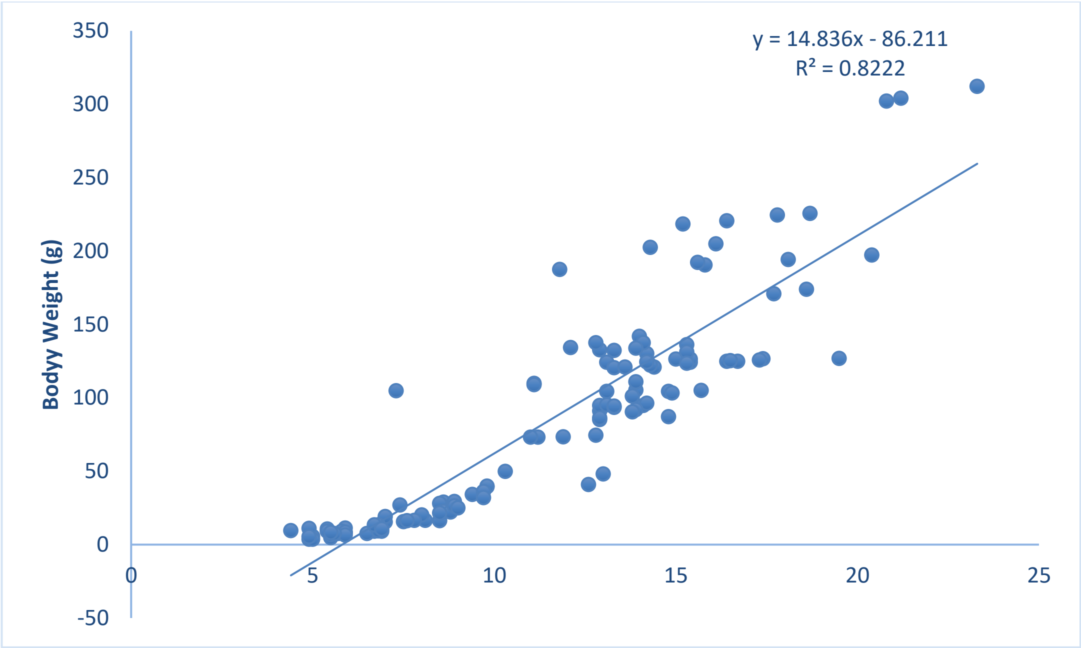


Fig 15: Monthly variations of nitrate (mg/l) in the study locations

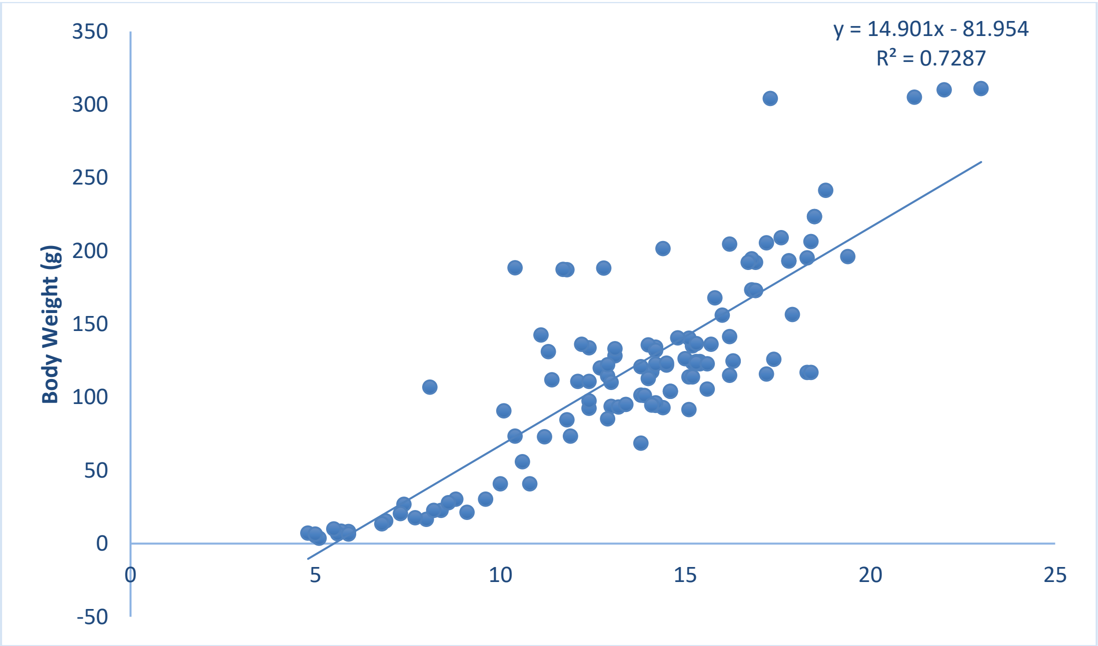
4.2 Length-Weight Relationship

The result for length weight relationship showed that the “b” values of *Orechromis niloticus* 14.830 (river) and 14.901 (lake) respectively. The length-weight relationship and logistic length-weight relationship of *Orechromis niloticus* in River Niger at Cable point and Onah Lake are shown in Figure 16 and 17. The relationship between sl and bw were lineer and significant ($p<0.001$). the “b” values of 14.830 (river) and 14.901 (lake) are more than “3” and it indicate positive allometric growth pattern of *Oreochromis niloticus* in the two study locations.



Standard Length (cm)

Fig. 16: Standard length and body weight relationships of *Oreochromis niloticus* in River Niger at cable point



Standard Length (cm)

Fig. 17: Standard length and body weight relationships of *Oreochromis niloticus* in Onah Lake

4.3 Food and feeding habits of *Oreochromis niloticus*

A total of 240 samples of *Oreochromis niloticus* were assessed from River Niger at Cable Pooint and Onah Lake.Thirty-six (36),15% had empty stomachs and two hundred and four (204), 85% contained food items such as Anabaena, Tetrahymena, Oligochaete, Lingulodinium, Fragillaria, Diatoms (Navicula and Stephenopyxis), polygonium, alaxandrium, oikopleura, detritus and coscinodiscus.

4.3.1 Seasonal variations in the Diet of *Oreochromis niloticus* in River Niger at cable point and Onah Lake.

Seasonal composition of food organisms in River Niger at cable point and Onah Lake during dry and rainy season are shown in Table.3. During the dry season Diatoms, (Navicula and Stephenopyxis) accounted for (20.13%), Anabaena (17.45%), Detritus (12.08%), Tetrahymena (10.07%), Lingulodinium, Fragillaria and Alaxandrium accounted for (7.38%) respectively, oligochaete and polygonuim accounted for (6.71%) respectively, while Oikopleura (4.70%) accounted for the lowest food item observed.

During the rainy season, Diatom (Navicula and stephenopyxis) accounted for (14.60%), polygonium (13.48%), Tetrahymena and Alaxandrium (11.24%) respectively, fragillaria and Detritus (8.99%) respectively, Anabaena (7.89%), Oligochaete (6.74%) and Oikopleura (5.62%).

In Onah Lake during the dry season detritus accounted for (17.42%), Anabaena and Diatoms (Navicula and stephenopyxis) (16.77%), Tetrahymena (11.61%), fragillaria(6.45%) polygonium and coscinodiscus (5.81%) respectively, Oligochaete and lingulodinium (5.16%) respectively and Oikopleura (3.87%)

During the rainy season Diatom (Navicula and stephenopyxis) and detritus accounted for (13.75%), Anabaena (11.25%), Tetrahymena (10.00%), Lingulodinium, Fragillaria and Coscinodiscus(8.75%) respectively, Alaxandrium and Polygonium (7.5%) respectively, Oligochaete and Oikopleura (5.0%) respectively.

Table 3: Frequency and Percentage(%) occurrence of organisms in the stomach of *Oreochromis niloticus* in dry and rainy season for River Niger at cable point and Onah Lake

	River Niger at cable point						**Onah Lake**					
	Dry Season			**Rainy Season**			**Dry Season**			**Rainy Season**		
	Freq occ.	% occ.		Freq occ.	% occ.		Freq occ.	% occ.		Freq occ.	% occ.	
Anabaena	26	17.45		7	7.87		26	16.77		9	11.25	
Tetrahymena	15	10.07		10	11.24		18	11.61		8	10.0	
Oligochaete	10	6.71		6	6.74		8	5.16		4	5.0	
Lingulodinium	11	7.38		10	11.24		8	5.16		7	8.75	
Fragillaria	11	7.38		8	8.99		10	6.45		7	8.75	
Navicula }	17	11.41	} 20.13	9	10.11	} 14.60	16	10.32	} 16.77	5	6.25	} 13.75
Stephenopyxis }	13	8.72		4	4.49		10	6.45		6	7.5	
Alaxandruim	11	7.38		10	11.24		8	5.16		6	7.5	
Oikopleura	7	4.70		5	5.62		6	3.87		4	5.0	
Detritus	18	12.08		8	8.99		27	17.42		11	13.75	
Polygonuim	10	6.71		12	13.48		9	5.81		6	7.5	
Coscinodiscus							9	5.81		7	8.75	
							155	**100%**		**80**	**100%**	

4.3.2 Feeding Regime in River Niger at cable point and Onah Lake

Presented in Figure 18 and 19 is the pyramid showing percentage composition of food organisms in the stomach of *Oreochromis niloticus*in River Niger at cable point Diatoms (Navicula and Stephenopyxis) accounted for the highest (18.06%) while Oikopleura accounted for the lowest (5.04%)

In Onah Lake Detritus accounted for the highest (16.17%), while Oikopleura accounted for the lowest (4.26%).

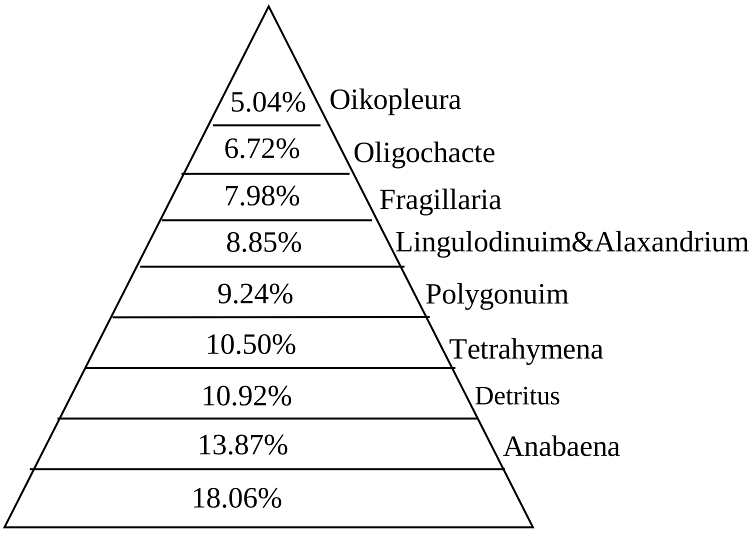


Fig 18: Pyramid showing percentage composition of food organisms in the stomach of *O.niloticus* in River Niger at Cable Point

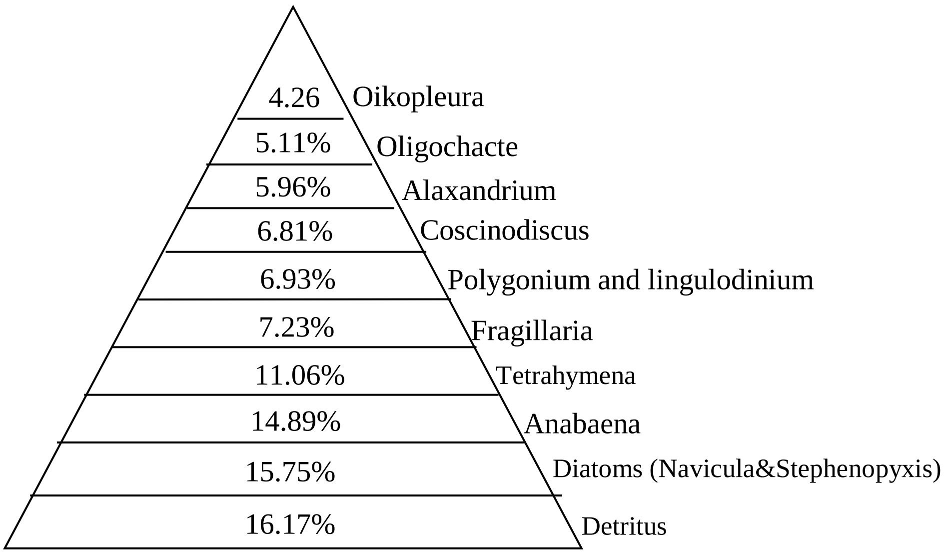


Fig 19: Pyramid showing percentage composition of food organisms in the stomach of *O.niloticus* in Onah Lake

CHAPTER FIVE

DISCUSSION

The sub surface water temperature reading in River Niger at Cable point and Onah Lake during the study period ranged from 24-32°C for the River and 25-32°C for the Lake. The River water temperature ranges in this study disgrees with Ewebiyi *et al*, (2015) that recorded the range of 21.8- 28.9°C within Kaduna metropolis. The Lake water temperature recorded in this study is supported by the work of Ayoade *et al, (2006*) who reported a similar range of 24-31.5 °C in Asejire Lake. Temperature ranges in this study is also supported by the study of Ekeh and Sikoki, (2003) who Stated that tropical fishes are known to grow best in water temperature of between 22-32 °C. The spatial variation of water temperature indicates that the highest mean values was obtained in Onah Lake 28.75°C compared to River Niger at Cable point 28.42 °C. There was a slight variation in water temperature between the locations during the study period.

The seasonal variation of water temperature in River Niger at Cable Point and Onah Lake result showed that water temperature were higher during the dry season in the two locations 29.50°C (River) and 30.67°C (Lake) compared to rainy season 26.83°C (Lake) and 27.33°C (River). The seasonal variation result in River Niger at Cable Point buttressed with the findings of a research by Usoro *et al*, (2013) in Iko River who reported higher mean water temperature values during the dry season 24.5°C as compared to rainy season 24.08°C . However, the seasonal variation result in Onah Lake disagrees with the findings of Eyo *et al*, (2008) who reported higher mean water temperature values during the rainy season 28.46°C compared to dry season 26.97°C in a Tropical Rainforest Lake. The low water temperature value observed during the rainy season in River Niger at Cable Point and Onah Lake could be traced to the cooling effects of the rain and high relative humidity which could reduce evaporation of water. The water Transparency in River Niger at Cable point and Onah Lake during the study period ranged from 5.5 - 55.50cm for the River and 15.5 - 60.50cm for the Lake. The river transparency range in this study disagrees with the findings by Akaahan *et al*, (2015) who reported transparency ranges of 3.00 - 258..00cm in River Benue. However, the Lake water transparency ranges are supported by the findings of David *et al*, (2008) who reported water transparency ranges of 1.25 - 69.30cm in two lakes in Adamawa State. Light penetration varying from 30 - 60cm was acknowledge to be favorable for fish production (Ali, 2000). The spatial variation of transparency showed that the highest mean value was obtained in Onah Lake (34.33cm) while the lowest was obtained in River Niger at Cable point (30.00cm) during the study period. The low mean value obtained in River Niger at Cable point could be attributed to the waste discharge into the river and the continuous dredging activities which made the water turbid.

The seasonal variation result showed that highest transparency values of 37.50cm in the River and 42.5 cm in the Lake were obtained during the dry season compared to rainy season means of 22.50cm in the River and 26.17cm in the lake. The low mean values recorded in the two location during the rainy season could be attributed to the fact that during rainy season there is usually increase run-off from the surrounding catchment area bringing in allochthonous materials. The seasonal variation result in River Niger at

Cable point disagrees with the finding of Enej*i et al*, (2012) who reported higher transparency during the rainy season 5.10± 0.05cm compared to dry season 4.5 ± 0.72cm in River Benue. Seasonal variation result in Onah Lake disagrees with the findings of a research by Usman *et al*, (2013) in Lake Alau where higher transparency values were reported during the rainy season 79.70cm compared to dry season 72.25cm.The comparison of variation in water transparency showed that fluctuations during the season and locations were not significantly different (P>0.05).

The Dissolved oxygen (D.O) concentration in River Niger at Cable point and Onah Lake during the study period ranged from 3.2 - 7.1mg/l for the River and 2.0 - 6.6mg/l for the Lake. The river D.O ranges in this study disagreed with the findings of a study within Kaduna Metropolis by Ewebiyi *et al*, (2015) were D.O ranges of 5.5 - 1685mg/l were reported. The range of D.O observed in this study were within the range 4.08-8.98 mg/l reported by Idowu *et a*l, (2012) in a Tropical Reservoir.. The result of the spatial changes of D.O in River Niger at Cable point and Onah Lake during the study period indicated that the highest mean value of 5.16mg/l was obtained in River Niger at Cable point compared to Onah Lake 4.67mg/l. The highest value recorded in River Niger at Cable Point could be attributed to wind effect which created turbulence and strong current which increased oxygen solubility.

The seasonal variation result showed that the highest D.O mean values of 5.6mg/l in the Lake and 5.88mg/l in the River were obtained during the rainy season in the two locations compared to dry season 3.73mg/l in the Lake and 4.43mg/l in the River. The

River seasonal variation results is supported by the findings of Eneji *et al*, (2012) with D.O value of 4.91± 0.06mg/l for rainy season and 1.93± for dry season in River Benue. The lake seasonal variation results is supported by the findings of Atobatele *et al*, (2008) that recorded higher D.O mean value during the rainy season 7.40±0.24 mg/l compared to dry season 6.95±0.35 mg/l in Abia Reservoir.

The biological Oxygen demand (B.O.D) concentration in River Niger at Cable point and Onah lake during the study period ranged from 1.4 - 3.4 mg/l for the River and 1.0 - 3.0 mg/l for the Lake. The River B.O.D ranges in this study disagrees with the findings of Ewebiyi *et al*, (2015) who reported B.O.D values that ranged from 0.6 - 10.1mg/l within Kaduna Metropolis. On the other hand the lake B.O.D ranges in this study is supported by the findings of Usman *et al*, (2013) who reported B.O.D values of 0.55 - 2.79 mg/l in Lake Alau. The result of the spatial changes of B.O.D in River Niger at Cable point and Onah Lake during the study period showed that the highest mean value of 2.25mg/l was obtained in River Niger at Cable point compared to Onah Lake 2.04 mg/l.

The seasonal variation results showed that the highest mean values of 2.45mg/l in the Lake and 2.88mg/l in the River were obtained during the rainy season compared to dry season 1.65mg/l in the lake and 2.22mg/l in the River. The River seasonal variation result is supported by Eneji *et al*, (2012) in River Benue who reported higher mean B.O.D values of 11.3± 0.83mg/l during the rainy season compared to dry season mean of 6.18 ± 0.47mg/l. On the other hand the lake seasonal variation result disagrees with the findings of Usman *et al,* (2013) in Lake Alau who reported higher BOD values during the dry season 0.66-2.79mg/l compared to rainy season 0.55-0-64mg/l

The phosphate phosphorus concentration in River Niger at Cable point and Onah Lake during the study period ranged from 0.14 - 6.28 mg/l in the River and 0.14 - 0.88 mg/in the Lake. The River phosphate ranges in this study disagrees with the findings of Eneji *et al,* (2012) who reported phosphate range of 1.20 - 19.0 mg/l in River Benue. However, the lake Phosphate ranges in this study is supported by Usman *et al,* (2013) who reported a similar range of 0.04 - 0.46 mg/l in Lake Alau. .Phosphate values in surface water are generally observed to be low Nwankwo *et al,* (2010). The spatial variation of Phosphate indicates that the highest mean value of phosphate was obtained in River Niger at Cable Point (1.39mg/l) compared to Onah Lake (0.47mg/l). The highest mean value obtained in River Niger at Cable Point maybe attributed to phosphate run-off from waste water discharged directly into the river. The highest value of 6.28mg/l recorded in June in River Niger at cable point maybe due to maximum anthropogenic activities in that month.

The seasonal variation result of phosphate showed that the highest mean values were obtained during the rainy season 0.66mg/l in the lake and 2.16mg/l in the River compared to dry season 0.26mg/l in the lake and 0.64mg/l in the River. This could be attributed to the fact that farmers use inorganic fertilizers to fertilize their farms and some of these fertilizers are leached into the waters whenever there is heavy down pour. The River phosphate seasonal variation result disagrees with Akaahan *et al,* (2015) in

River Benue who reported higher phosphate mean value of 2.61±0.31mg/l during the dry season compared to rainy season (2.26±0.90mg/l). The lake seasonal variation result also disagrees with Usman *et al,* (2013) who reported higher phosphate ranged during the dry season 0.12-0.46mg/l compared to rainy season 0.04-0.14mg/l.

The nitrate concentration in River Niger at cable point and Onah Lake during the study period ranged from 004 – 1.0mg/l in the River and 0.11 - 1.03mg/l in thelake. The River nitrate ranges in this study disagrees with the findings by Usoro *et al*, (2013) who reported nitrate that ranged from 1.66 – 278mg/l in Iko River, The lake nitrate ranges in this study is supported with the findings of Eyo *et al*, {2008) who reported nitrate that ranged from 0.04 – 0.83mg/l in a Tropical Rainforest lake. The spatial variation of nitrate indicates that the highest mean value of nitrate was obtained in Onah lake (0.57mg/l) compared to River Niger at cable point (0..43). This is supported by Ufodike et al, (2011) who stated that high nitrate concentration in lake is related to oxidation of ammonia agricultural rum-offs and decomposition of organic matter.

The result of the seasonal variation of nitrate showed that the highest mean values of nitrate were obtained during the rainy season 0.63mg/l in the River and 0.81mgl in the lake. The highest values obtained in the two locations during the rainy season could be attributed to surface water run-off carrying allochthonous materials to the waters. The River seasonal variation result disagrees with the findings by Usoro *et al*, (2013) in Iko River who reported higher mean value of nitrate 2.5mg/l during the dry season compared to rainy season 1.91mg/l. However the lake seasonal variation result is supported by the findings of Eyo *et al*, (2008) in a Tropical Rainforest lake that reported higher mean nitrate value during the rainy season 0.74mg/l compared to dry season 0.09mg/l..

The calcium concentration in rive Niger at Cable Point and Onah lake during the study period ranged from 12 – 56mg/l in the River and 18- 44mg/l in the lake. The River calcium ranged in this study disagrees with the findings by Usoro *et al,* (2013) in Iko River who reported calcium that ranged from 10.99 – 17.74mgl. On the other hand the lake calcium ranges in this study disagrees with the findings of Usman *et al,* (2013) in lake Alau who reported calcium that ranged from 0.21 – 3.55mgl. The spatial variation of calcium indicated that the highest mean value of calcium was obtained in Onah lake (30.67mg/l) compared to River Niger at Cable Point (30.42mg/l).

The seasonal variation result showed that calcium did not follow a seasonal trend as the highest mean value of calcium was obtained during the rainy season in River Niger at cable point (30.50mg/l) compared to dry season (30.33mg/l). This could be attributed to surface water run-off carrying allochthonous materials to the River. The result disagrees with the findings of Usoro *et al,* (2012) in Iko River who reported higher mean value of calcium during the dry season 15.21mgl compared to rainy season 13.97mg/l. However, in Onah lake highest mean value of calcium was obtained during the dry season (38.17mg/l) compared to rainy season (23.17mgl).This could be attributed to reduction in water volume resulting from evaporation of water during the dry season leading to high concentration of calcium in the lake. This result disagrees with the findings of Eyo *et al,* (2008. in a Natural Tropical Rainforest lake who reported higher mean value of calcium during the rainy season 5.68mg/l compared to dry season 3.86mg/l.

The magnesium content in River Niger at Cable Point and Onah lake during the study period ranged from 32 – 69mg/l in the River and 26 – 52mg/l in the lake. The River magnesium ranges in this study disagrees with the findings by Usoro *et al*, (2013.) in Iko River who reported magnesium values that ranged from 553.1 – 981.4mg/l. However the lake magnesium ranges in this study disagrees with the findings of Usman *et al,* (2013) in lake Alau that reported magnesium values that ranged from 0..12 – 3.62mg/l. The spatial variation of magnesium indicates that the highest mean value of magnesium was obtained in River Niger at Cable Point (42.83mg/l) compared to Onah lake (37.26mg/l).

The seasonal variation result showed that higher mean value of magnesium were obtained in the two locations during the dry season 38.68mg/l in the lake and 43.50mg/l in the River compared to rainy season 35.83mg/l in the lake and 42.17mg/l in the River, This could be attributed to reduction in water volume resulting from evaporation of water in the dry season leading to high concentration of magnesium ions. The river seasonal variation result in this study is supported with the findings of Usoro *et al*, (2013) in Iko River who reported higher mean value during the dry season 885.5mg/l compared to rainy season 212.7mg/l. On the other hand the lake seasonal variation result is supported with the findings of Usman *et al*, (2013) in Lake Alau who reported higher magnesium values during the dry season 0.12 – 0..46mg/l compared to rainy season 0.04-0..69mgl.

The sulphate concentration in River Niger at Cable Point and Onah lake during the study period ranged from 0.16 – 1.65mg/l in the River and 0.11 – 1.03mg/l in the Lake. The River sulphate ranges in this study disagrees with the findings by Akaahan *et al*, (2015) who reported sulphate that ranged from 0.80 – 90.00mg/l in River Benue. However the lake sulphate ranges in this study disagrees with Moshood, (2008) in Ogun Reservoir who reported sulphate that ranged from 9-12.8mg/l. The spatial variation of sulphate showed that the highest mean value of sulphate was obtained in River Niger at Cable Point (0.81mg/l) compared to Onah Lake (0.43mg/l). The highest mean value of sulphate in River Niger at Cable point could be attributed to the input of anthropogenic waste from the surrounding that are discharged into the River Niger at Cable Point.

The seasonal variation result of sulphate showed that the highest mean values of sulphate were obtained during the rainy season 0.57mg/l in the lake and 1.07mg/l in the River compared to dry season 0.35mg/l in the lake and 0.55mg/l in the River. The River sulphate seasonal variation result disagrees with Usoro *et al*,(2013) In Iko River who reported higher mean value of sulphate during the dry season 225.9mg/l compared to rainy season 184.3mg/l. However the lake seasonal variation result is supported by Moshood,(2008) in Ogun Reservoir who reported higher sulphate mean during the rainy season 11.5mg/l compared to dry season 10.42mg/l.

The total dissolved solids in River Niger at cable point and Onah Lake during the study period ranged from 10 - 40mg/l in the River and 10 - 36mg/l in the lake. The result of this study is supported with the result of a study by Ewebiyi *et al*, (2015) within Kaduna metropolis who reported TDS that range from 9-40mg/l. However the result disagrees with the result of Eneji *et al*, (2012) in River Benue who reported TDS values that ranged from 17.1 – 70mg/l.. The spatial variation in TDS values in River Niger at Cable Point and Onah Lake indicates that the highest mean value of 22.92mg/l was obtained in River Niger at Cable Point compared to Onah Lake 21.67mg/l. The highest value recorded in River Niger at Cable Point could be attributed to the waste from the surroundings that are discharged directly into the River.

The result of the seasonal variation showed that River Niger at Cable Point and Onah Lake did not follow a seasonal trend. The highest mean value of 23.33mg/l was obtained in River Niger at Cable Point during the dry season compared to rainy season 22.50mg/l. The result of this study is supported by Eneji *et al,* (2012) who reported higher mean value of TDS during the dry season 424±1.4mg/l compared rainy season 360±2.0mg/l in River Benue. However, in Onah lake the highest mean TDS value was obtained during the rainy season 24.17mg/l compared to dry season 19.17mg/l. The lake result in this study is supported by Akaahan *et al,* (2015) in River Benue who reported higher TDS mean value during the rainy season 69.78mg/l compare to dry season 69.77mg/l.

The total suspended solids values in River Niger at Cable Point and Onah Lake during the study period ranged from 40 – 80mg/l in the River and 40-64mg/l in the Lake, Akaahan *et al*, (2015) reported TSS values in River Benue that ranged from 5.00 - 410.00mg/l which the findings of this study disagrees with. The spatial variation in TSS indicates that the highest mean value of 59.17mg/l was obtained in River Niger at Cable Point compared to Onah Lake 54.33mg/l.

The seasonal variation results showed that the highest TSS mean values of 57.83mg/l in the lake and 67.50mg/l in the River were obtained during the rainy season compared to dry season 50.83mg/l in the River and Lake respectively. The result of this study is supported by the findings of Eneji *et al*, (2012) in River Benue who reported higher mean TSS value during the rainy season 113±1.3mg/l compared to dry season 98.1±7.5mg/l. The highest TSS values obtained in the two locations during the rainy season could be attributed to high load of allochthonous materials brought to the water by run-off of rain water.

The conductivity readings in River Niger at Cable Point and Onah Lake during the study period ranged from 60 – 170us/cm in the River and 10 – 170us/cm in the lake. The River conductivity ranges in this study disagrees with the findings of a study by Ewebiyi *et al*, (2015) within Kaduna metropolis who reported conductivity values that ranged from 130.00 – 580.0us/cm . However the lake conductivity ranges in this study disagrees with the findings of Eyo *et al*, (2008) in Natural Tropical Rainforest lake that reported conductivity values that ranged from 0.10 – 19.83us/cm. The spatial variation in conductivity indicates that the highest mean value of conductivity was obtained in River Niger at Cable Point 114.17us/cm compared to Onah Lake 74.17us/cm. The highest mean value obtained in River Niger at Cable Point maybe due to the types of human activities in the river

The seasonal variation result showed that the highest mean conductivity values of 83.33us/cm in the lake and 115.00us/cm in the River were obtained during the rainy season in the two locations compared to dry season 65.00us/cm in the lake and 113.33us/cm in the River. The result is evident of the fact that during the rainy season there is increase in precipitation and hence increased run-off accounting for higher conductivity. The River seasonal variation result disagrees with the findings by Eneji *et al*, (2012) in River Benue who reported conductivity value of 85.2±2.7us/cm during the dry season compared to rainy season 58.2±1.3us/cm. However the lake seasonal variation result also disagrees with the findings of a study by Usman *et al*, (2013) in Lake Alau, North East, Nigeria who reported higher conductivity values 102.08 – 172.02us/cm during the dry season compared to rainy season 79.31 – 95.98us/cm.

The P^H values in River Niger at Cable Point and Onah lake during the study period ranged from 6.53 – 8.70 in the River and 6.52 -8.28 in the lake. The variation of P^H in the river in this study is supported by Abowei, (2010) who reported P^H that ranged from 6.8 – 8.5 in Nkoro River. However the lake P^H range in this study disagrees with Idowu *et al*, (2012) who reported P^H that ranged from 5.63 – 9.82 in a Tropical Reservoir. The spatial variation of P^H indicates that the highest mean value of P^H was obtained in River Niger At Cable Point 7.32 compared to Onah Lake 7.14.

The seasonal variation results showed that highest mean P^H values of 7.14 in the lake and 7.33 in the River were obtained during the dry season compared to rainy season 7.13 in the lake and 7.31 in the River. The River seasonal variation result disagrees with

Akaahan *et al*, (2015) who reported higher P^H mean 7.51±0.97 during the dry season compared to rainy season 6.35±0.41 in River Benue. However the lake seasonal variation result also disagrees with Atobatele *et al*, (2008) in Aiba Reservoir who reported higher P^H value of 8.32+0.12 during the rainy season compared to dry season 7.44+0.19.

Oreochromis niloticus in River Niger at cable point and Onah Lake in this study showed positive allometric growth pattern. The regression co-efficient values for standard length and body weight were 14.836 (river) and 14.901 (lake). Several authors have reported isometric and allometric growth pattern of *O.niloticus* from the different water bodies. The positive allometric growth observed in this study is supported by Abowei *et al*, (2009) in Nkoro River who reported a positive alloometric growth pattern with “b” value higher than 3. However the result is in disagreement with Musa *et al*, (2016) in Shirmu Lake Hungu who reported negative allometric growth of *O. niloticus with* “b” value less than 3.

The stomach content analysis results revealed that *O. niloticus* is an omnivore as the fish fed on anabaena, tetrahymena, Oligochaete, Lingulodium, Oikopleura, Fragillaria, diatoms (Navicula and Stephenopyxis), polygonnim, Alaxandrium, Detritus and Coscinodiscus. This is supported by the works of Ali *et al*, (2015) in lake Alau, and Agbabiaka, (2012) in River Otamiri. *O. niloticus* are generally omnivorous feeding on zooplankton and phytoplankton of which diatoms was the major dietary component Flipos *et al*, (2013). The types of food items found in the stomach of *O. niloticus* collected from River Niger at Cable point and Onah Lake were quite similar with the findings of Oso *et al*, (2006)

In addition to phytoplankton, detritus and polygonium were also considerably important in the diet of *O. niloticus*. Several authors have reported similar interpretations about the importance of detritus and diatoms in different parts of Africa (Shipton *et al.,* 2008, Oso *et al l*, 2006, Kamil *et al.,* 2010, Flipos*et et al,* 2013).

In this study, the proportion of diatoms were higher during the rainy season and dry season in River Niger at Cable Point while in Onah Lake the proportion of detritus was higher during the dry season and diatoms and detritus dominated the rainy season. More food organisms were found in Onah Lake compared to River Niger at Cable Point.

The composition differences and relative contribution of food items may partly be due to differences in macro habitat occupied by the fish. During rainy season fish moves to shallow parts of the River and Lake for reproduction and stay for longer period of time by feeding on detritus and diatoms, polygonium and other organisms. In addition during the rainy season,, due to high rainfall and run-off from the catchment area, fluctuations in water level and increasing turbidity in River and lake are usually experienced.. This decreases the penetration of light in the River and Lake and thereby affecting the growth and abundance of phytoplankton in the water.

During dry season fish may move to pelagic region of River and Lake and feeding mainly on suspended phytoplankton and zooplankton. During this period phytoplankton production may be high due to increased light penetration into the photic zone of the River and Lake. The seasonal variation on the feeding habit of *O. niloticus* in River Niger at Cable Point and Onah Lake is due to seasonal succession of phytoplankton in the water body.

CHAPTER SIX

CONCLUSION, RECOMMENDATIONS AND CONTRIBUTION TO KNOWLEDGE

6.1 Conclusion

Based on the result of this study, it can be concluded that the physico-chemical water parameters of River Niger at Cable Point and Onah Lake are within the acceptable limit for the culture of *Oreochromis niloticus*

O. niloticus in River Niger at Cable Point and Onah Lake are omnivores feeding on: Anabaena, Tetrahymena, Oligochaete, Lingulodinium, Fragillaria, Diatoms (Navicula and Stephenopyxis) Polygonium, Alaxandrium, Oikopleura, Detritus and Coscinodiscus.

The mean exponent (b = 14.836 and 14.901) of length weight relationship in River Niger at Cable Point and Onah Lake respectively indicate positive allometric and growth pattern of *O. niloticus* in these water bodies.

6.2 Recommendation

As a follow up to the knowledge gained from this study on the ecology of *O. niloticus*, it is recommended that further study be carried out on the reproductive biology of the *O. niloticus* in these water bodies.

6.3 Contribution to knowledge

1. *O. niloticus* can survive and grow in waters with transparency and dissolved oxygen values as low as 5.5cm and 2mg/l respectively..
2. Anabaena, Detritus and Diatoms making up 46% and 43% of its diet in the River and Lake.

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APPENDIX I: Physio-Chemical Parameters

ONAH LAKE

TEMP	D. O	B.O.D	T.D.S	T.S.S	PH	COND	CA	MAG	PHOS	SUL	NIT	TRANS
JAN. 32	3.2	1.6	25	50	7.8	80	70	52	0.23	0.11	0.11	50.5
Feb. 32	4.7	1.8	20	60	6.52	60	40	48	0.22	0.15	0.12	45.5
Mar. 32	4.7	2	20	55	7.03	30	25	38.5	0.14	0.15	0.23	60.5
Apr. 32	5.2	2.2	10	50	8.25	10	35	25.6	0.34	0.12	0.4	50.5
May 29	5.4	2.6	30	64	7.21	70	25	27	0.4	0.26	0.4	19.5
June 28	5.3	2.4	30	60	6.52	60	22	43	0.53	0.28	0.75	32.5
July 26	6.6	3	20	58	6.58	60	18	30	0.61	0.28	0.87	38.5
Aug. 26	6	2.8	20	50	7.47	80	18	38	0.68	0.34	0.93	30.5
Sep. 26	5.8	2.1	25	60	8.28	60	22	28	0.87	1.08	1.03	15.5
Oct. 26	4.5	1.8	20	55	6.72	170	34	49	0.85	1.15	0.85	20.5
Nov. 31	2	1	20	50	6.68	130	34	27	0.39	0.85	0.65	19.5
Dec. 25	2.6	1.2	20	40	6.52	80	25	41	0.36	0.72	0.49	28.5

RIVER NIGER

TEMP	D. O	B.O.D	T.D.S	T.S.S	PH	COND	CA	MAG	PHOS	SUL	NIT	TRANS
JAN 30	4.2	2.6	30	55	7.71	80	28	36	0.26	0.16	0.07	55.5
Feb 32	3.2	1.4	40	60	6.53	60	24	43	0.37	0.23	0.4	36.5
Mar. 32	5.8	3	20	40	7.9	70	18	35	0.22	0.3	0.07	40.5
Apr. 30	5.4	2.4	20	50	8.7	150	20	34	0.14	0.47	0.56	45.5
May 30	5.6	2.8	20	60	8.03	140	31	41	0.96	0.34	0.55	39.5
June 28	5.3	2.8	20	80	7.11	130	12	32	6.28	0.42	0.51	15.5
July 28	6.8	3.2	30	80	7.47	60	23	43	0.58	1.24	0.08	5.5
Aug. 26	6.4	2.9	20	60	7.28	130	37	35	1.29	1.44	0.68	40.5
Sep. 26	7.1	3.4	25	65	6.94	90	30	40	1.85	1.65	0.95	11.5
Oct 26	4.1	2.2	20	60	7.05	140	50	62	1.97	1.31	1.001	22.5
Nov. 29	3.6	1.6	20	60	6.54	150	36	44	0.79	1.61	0.04	22.5
Dec. 24	4.4	2.3	10	40	6.57	170	56	69	2.04	0.53	0.28	24.5

APPENDIX II

Morphormetric Measurement

Appendix 2					ONAH LAKE	
S/N	TL	SL	BW	GW	SW	SEX
			JANUARY			
1	10.2	7.4	26.81	22.21	0.53	M
2	13.5	8.8	30.32	27.88	0.31	F
3	12.6	10	40.82	34.6	0.33	M
4	10.5	8.4	22.54	19.07	0.48	M
5	6.5	5	5.4	4.34	0.15	M
6	7.8	5.9	8.19	7.85	0.12	F
7	18.5	14.1	117.41	108.55	0.22	F
8	19.3	15.6	105.61	99.31	0.34	M
9	17.1	13.8	101.41	93.9	0.53	F
10	20.1	16.8	173.4	168.61	0.32	M
			FEB			
11	22.2	18.5	223.41	215.71	0.34	M
12	21.1	16.9	172.81	166.62	0.23	M
13	16.1	12.4	92.3	90.32	0.11	F

14	18.3	14.6	104	98.21	0.23	M
15	20.1	15.8	167.82	162.71	0.42	M
16	9.4	7.3	20.53	17.06	0.55	M
17	7.5	5.7	8.37	4.83	0.25	M
18	7	5.6	6.61	5.28	0.2	F
19	6.9	5.5	9.99	7.19	0.42	M
20	5.9	5.1	3.7	3.17	0.08	F
			MARCH			
21	22.4	17.3	304.11	284.12	0.33	F
22	20.8	16.2	114.87	107.64	0.51	F
23	15.2	10.4	188.41	172.78	0.47	F
24	16.2	11.8	187.11	178.13	0.39	M
25	15.4	11.3	131.06	124.32	0.42	F
26	18.9	14.4	201.54	195.04	0.34	M
27	14.3	10.1	90.62	82.12	0.52	F
28	16.2	12.4	133.71	129.44	0.34	F
29	12.9	8.1	106.82	99.67	0.42	F
30	20.1	15.2	123.57	115.87	0.43	F
			APRIL			
31	18.7	12.8	188.31	178.11	0.44	M

32	22.5	17.8	193.14	183.14	0.4	M
33	24.6	19.4	196.11	185.12	0.41	M
34	18.3	14.2	134.12	127.32	0.32	F
35	22.3	17.4	125.84	123.79	0.51	M
36	18.3	14.2	94.37	84.14	0.33	F
37	17.4	12.7	119.87	118.31	0.41	M
38	21.9	16.3	124.61	116.41	0.51	F
39	21.7	17.2	115.91	108.41	0.31	M
40	9.9	8	16.46	13.38	0.46	M
			MAY			
41	22.2	18.5	223.42	215.71	0.32	M
42	21.2	16.9	172.81	166.63	0.23	M
43	16.1	12.4	97.33	94.32	0.14	F
44	18.3	14.6	104	98.24	0.22	M
45	17.3	12.9	114.41	105.53	0.12	F
46	17.6	13.1	128.18	120.66	0.64	F
47	17.2	13.9	101.16	92.92	0.32	F
48	18.2	14.4	92.94	87.19	0.89	F
49	20.8	16.2	204.56	198.07	0.24	M
50	19.8	15.1	113.84	106.16	0.48	F

			JUNE			
51	21.4	16.9	192.1	182.13	0.41	M
52	14.5	15.2	135.11	128.31	0.36	F
53	19.3	14.5	121.86	120.8	0.33	M
54	21.8	17.2	205.56	199.06	0.49	M
55	17.3	13	93.64	85.13	0.23	F
56	19.5	15.1	140.38	134.99	0.51	M
57	18.1	14	135.67	131.99	0.26	F
58	19.1	14.2	122.59	114.86	0.42	F
59	18.9	14	112.84	105.66	0.46	F
60	27.3	22	310.11	290	0.55	F
			JULY			
61	21.5	16.8	194.44	188.82	0.3	M
62	18.4	14.8	140.62	132.62	0.21	M
63	18.9	14.5	123.25	116.48	0.35	M
64	20.7	16	155.94	144.92	0.43	M
65	22.4	17.6	208.89	188.45	1.14	M
66	20.5	17.9	156.43	145.41	0.53	M
67	23.4	18.8	241.43	232.93	1.13	M
68	19.6	15.7	136.13	124.66	1.12	F
69	19.1	14.2	131.9	124.21	0.42	F

70	17.1	13	110.12	98.65	0.62	F
			AUG			
71	21.2	16.3	124.82	122.78	0.4	M
72	17.2	13.1	133.11	126.31	0.32	F
73	23.5	18.3	195.1	184.11	0.51	M
74	21.4	16.7	192.13	182.13	0.4	M
75	17.6	11.7	187.3	177.1	0.41	M
76	8.8	6.9	15.45	12.37	0.45	M
77	22.8	18.3	116.92	109.42	0.32	F
78	18.5	13.8	120.85	109.32	0.42	M
79	17.3	13.2	93.37	83.14	0.31	F
80	22.6	18.4	116.97	109.59	0.41	F
			SEPT			
81	19.5	15	126.3	118.99	0.39	M
82	19.8	15.4	124.25	116.5	0.41	M
83	16.3	12.9	85.1	79.22	0.36	M
84	15.3	11.9	73.41	61.87	0.4	M
85	17.8	14.2	96.16	91.73	0.44	F
86	15.4	11.2	73.04	64.99	0.29	F
87	18.7	12.9	122.24	114.89	0.39	M

88	15.4	11.8	84.43	78.22	0.4	M
89	16.7	13.4	95.12	90.84	0.42	F
90	14.3	10.4	73.41	64.84	0.35	F
			OCT			
91	9.6	7.7	17.62	15.4	0.41	M
92	8.4	6.8	13.43	11.95	0.17	M
93	6.7	4.8	7.18	6.84	0.14	F
94	7.3	5.9	6.41	5.33	0.17	M
95	7.5	5	6.42	5.34	0.14	M
96	12.3	8.6	27.92	23.23	0.55	M
97	14.3	9.6	30.35	27.88	0.3	F
98	13.4	10.8	40.81	34.59	0.41	M
99	11.1	9.1	21.27	19	0.91	F
100	10.3	8.2	22.52	19.05	0.48	M
			NOV			
101	17.4	13.8	68.52	65.88	0.43	M
102	13.4	10.6	55.87	53.09	0.32	M
103	16.3	11.4	111.85	108.24	0.55	M
104	28.4	23	311	281.04	0.56	F
105	20.3	15.4	122.85	117.75	0.35	M

106	15.3	11.1	142.38	135.91	0.52	F
107	16.7	12.1	110.88	103.61	0.51	M
108	20.6	15.3	124.41	116.85	0.44	F
109	16.7	12.4	110.84	103.64	0.45	F
110	19.7	15.1	91.6	86.11	0.53	F
			DEC			
111	19.8	15.2	113.86	106.86	0.44	F
112	28.8	18.4	206.44	200.07	0.51	M
113	26.2	21.2	305.02	289.11	0.54	F
114	22.4	17.8	193.11	184.16	0.43	M
115	19.2	15.3	136.58	132.96	0.34	F
116	18.2	14.1	94.65	86.14	0.31	F
117	20.2	15.3	123.44	115.96	0.44	F
118	20.5	16.2	141.35	135.67	0.52	M
119	15.4	12.2	136.07	130.32	0.37	F
120	20.4	15.6	122.87	121.83	0.37	M

						RIVER NIGER
S/N	TL	SL	BW	GW	SW	SEX
1	10.4	8.5	16.2	14.89	0.33	M
2	9.9	8.1	16.47	13.38	0.56	M
3	8.6	6.7	9.07	7.15	0.12	M
4	13.4	10.3	49.81	43.59	0.52	M
5	14.5	9.8	39.37	36.91	0.46	F
6	8.7	6.8	9.18	8.91	0.22	M
7	7.9	6.5	7.6	7.56	0.31	F
8	6.8	5.4	10.51	9.26	0.22	F
9	6.7	5.5	4.71	4.15	0.12	F
10	10.2	7.4	26.91	22.23	0.44	M
			FEB			
11	8.9	7	15.46	12.86	0.46	M
12	6.9	5.5	6.6	5.27	0.19	F
13	7.1	5.7	7.6	6.56	0.14	F
14	6.8	5.4	8.98	7.98	0.4	M
15	7.6	5.9	8.06	6.15	0.09	M
16	5.5	4.4	9.51	8.62	0.19	F
17	7.6	5.8	8.36	6.62	0.24	M

18	6.8	5	5.59	4.82	0.04	M
19	5.7	4.9	3.68	3.15	0.06	F
20	9.2	7	19.16	12.37	0.81	F
			MARCH		0.12	F
21	16.4	13.1	104.42	98.33	0.12	F
22	17.6	13.1	124.18	116.66	0.64	F
23	17.1	13.9	105.15	96.93	0.53	M
24	21.3	18.6	173.9	168	0.22	F
25	16.7	12.9	90.93	87.16	0.93	M
26	8.6	6.9	9.06	7.15	0.19	M
27	7.5	5.9	11.3	9.28	0.37	M
28	8.4	6.8	13.42	11.21	0.12	M
29	7.9	5.8	8.99	7.99	0.22	M
30	5.5	5	3.69	3.16	0.07	F
			APR			
31	24.2	18.7	225.61	217.69	0.31	M
32	19.3	15.7	105	99.3	0.22	M
33	18.7	14.2	130.14	122.67	0.75	M
34	20.2	16.4	220.42	213.71	0.33	F
35	17.1	13.8	101.15	93.91	0.53	M

36	11.4	8.6	28.91	34.22	0.52	F
37	7.7	5.9	8.46	6.72	0.54	M
38	7.3	5.9	6.41	5.33	0.17	M
39	7	5.6	7.6	6.27	0.19	F
40	7.7	6.8	9.36	7.62	0.34	M
			MAY			
41	11.3	8.5	27.92	23.22	0.54	M
42	133.4	8.9	29.36	26.89	0.28	F
43	12.4	9.8	39.81	33.59	0.41	M
44	10.2	8	20.26	11.32	0.91	F
45	10.4	8-Jan	22.53	19.06	0.47	M
46	6.4	4.9	11.1	9.05	0.34	M
47	6.3	4.9	5.41	4.33	0.14	M
48	7.7	5.5	8.18	7.84	0.11	F
49	8.3	6.7	13.41	11.91	0.11	M
50	9.4	7.5	15.61	13.38	0.31	M
						F
			JUNE			M
51	22.5	18.1	194.11	184.13	0.51	M
52	17.4	13.3	132.12	125.31	0.33	F
53	21.4	16.7	124.84	122.81	0.38	M

54	18.9	14.3	202.46	1966.24	0.43	M
55	17.3	12.9	132.71	131.24	0.29	M
56	16.4	12.8	137.42	131.89	0.53	M
57	15.2	14.1	94.62	84.12	0.31	F
58	21.2	16.4	124.71	118.45	0.43	F
59	13.8	11.1	109.86	102.62	0.52	F
60	26.4	21.2	304.04	285.01	0.51	F
			JULY			
61	20.3	15.8	190.44	180.12	0.56	M
62	13.4	12.1	134.12	129.47	0.64	F
63	18.2	14.4	120.87	119.97	0.54	M
64	20.7	16.1	204.82	198.07	0.61	M
65	16.2	12.9	94.63	86.14	0.38	M
66	18.4	14	141.88	136.07	0.61	F
67	17.1	14.1	137.44	132.95	0.49	F
68	18.2	13.3	120.44	115.52	0.46	F
69	18.7	13.9	110.84	104.62	0.51	M
70	28.4	23.3	312.12	291.13	0.62	F
			AUG			
71	19.5	15	126.3	118.99	0.64	M

72	19.8	15.4	124.25	116.5	0.54	M
73	16.3	12.9	85.1	79/22	61	M
74	15.3	11.9	73.41	61.87	0.38	M
75	17.8	14.2	96.14	91.73	0.388	F
76	15.4	11.2	73.04	64.99	0.61	F
77	18.8	14.3	122.15	116.84	0.49	M
78	18.3	14.8	87.09	81.23	0.46	M
79	16.7	13.1	95.17	\90.42	0.51	F
80	19.7	15.4	126.25	119.96	0.62	M
				SEPT		
81	17.7	11.8	187.31	177.17	0.44	M
82	20.4	15.6	192.12	181.42	0.21	M
83	25.6	20.4	197.13	186.14	0.44	M
84	19.4	15.3	136.14	129.36	0.53	F
85	24.4	19.5	126.84	124.81	0.37	34
86	17.4	13.3	93.42	85.41	0.42	F
87	188.4	13.6	120.96	118.14	0.43	M
88	22.5	17.4	126.62	118.44	0.52	F
89	11.8	7.3	104.73	101.68	0.42	F
90	22.4	17.3	125.58	117.92	0.49	F

			OCT			
91	14.2	13	48.15	44.32	33	M
92	12.3	9.4	34.12	32.15	34	F
93	10.6	8.8	22.14	20.15	332	M
94	10.9	8.9	26.22	24.39	26	M
95	9.5	7.8	16.44	14.45	16	F
96	9.6	8.5	21.36	19.16	18	F
97	10.7	9	24.99	21.32	21	F
98	9.4	7.6	16.32	14.84	14	M
99	12.4	9.7	36.17	33.14	0.31	M
100	13.4	12.6	40.94	43.41	0.34	M
			NOV			
101	8.6	6.9	10.54	8.82	0.28	M
102	20.4	17.7	170.82	166.69	0.44	M
1103	19.1	15.2	218.44	212.81	0.54	M
104	18.4	14.8	104.41	98.67	0.38	M
105	17.6	13.9	91.96	88.26	0.88	F
106	18.2	14.9	103.14	95,94	0.56	F
107	17	13.8	90.38	87.27	0.54	F
108	12.5	9.7	32.01	28.42	0.33	M
109	23.3	17.8	224.51	215.78	0.42	M

110	19.7	15.3	131.16	124.68	0.65	F
			DEC			
111	16.7	13.3	94.18	90.64	0.42	F
112	17.3	12.9	86.11	80.23	0.37	M
113	18.6	14.2	124.32	116.98	0.41	M
114	25.6	20.8	302.09	286.41	0.46	F
115	20.1	15.3	123.6	117.42	0.32	F
116	18.3	13.9	133.7	128.97	0.41	M
117	16.3	12.8	74.42	62.97	0.41	M
118	20.7	16.5	125.33	117.52	0.44	M
119	15.2	11	73.11	65.89	0.31	F
120	13.7	11.1	108.96	103.64	0.41	F