THE EFFECT OF PHYSICO CHEMICAL PARAMETERS OF RIVER ILAGIL, NGURORE, ADAMAWA STATE ON Clarias *gariepinus*

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BEING A THESIS SUBMITTED TO THE DEPARTMENT OF BIOLOGICAL SCIENCES, FEDERAL UNIVERSITY OF TECHNOLOGY, YOLA IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF M.TECH DEGREE IN AQUACULTURE AND FISHERIES MANAGEMENT.

SUPERVISOR

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MAY, 2011

DECLARATION

I declare that this research was carried out in its original form by KEFAS, Mathias of the Department of Biological Sciences, Federal University of Technology, Yola, Adamawa State.

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Sign Date

APPROVAL PAGE

This thesis entitled POLLUTION STATUS AND IT'S EFFECTS ON C*larias gariepinus* IN RIVER ILAGIL, NGURORE, YOLA SOUTH L.G.A, ADAMAWA STATE. By KEFAS MATHIAS meets the regulation governing the award of degree in (Masters) in aquaculture and fisheries management of the Federal University of Technology, Yola and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

This piece of work is dedicated to Mr. & Mrs. Iliya S. Kwaji and in memory of my late parents Mr. Kefas Mgadazu and Mrs. Keziya Kefas.

ACKNOWLEDGMENT

I want to thank Almighty God for sparing my life and giving me the ability to accomplish this research.

My sincere gratitude goes to my supervisor, Dr. K.A. Abubakar who despite his numerous commitments patiently instructed and guided me through his scholarly advice and criticisms through out this research work. His expertise in the field encouraged me to pursue this work with much interest, confidence and vigour.

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ABSTRACT

A six months pollution study and its effects on *Clarias garipinus* as an index of pollution status of effluents from the main market, cattle market and refuse dumping grounds along river Ilagil in Ngurore was carried out fortnightly from May to October, 2009. Water samples were collected from three (3) sites (inlet, centre and confluence) of the river for laboratory analysis, some parameters were measured insitu. Physico-chemical parameters range for the period of study were temperature (25.10±0.36 to 28.67± 0.583^{0}C), Transparency (8.00 ± 0.10 to 12.40 ± 0.44cm), Hydrogen ion concentration (pH) (5.40±0.52 to 7.50± 0.46), Free carbondioxide (2.60 ± 0.46 to 4.17 ± 0.76mg/l), Total alkalinity (26.70 ± 0.30 to 63.87 ± 4.50mg/l), Conductivity (1.34 ± 0.00 to 4.02 ± 0.61 μs/cm),Dissolved oxygen (7.33 ± 0.35 to 17.07 ± 3.85mg/l). Total ammonia (0.124 ± 0.016 to 0.165 ± 0.051mg/l), Total nitrogen (0.255 ±

0.010 to 0.349 ± 0.037mg/l), and Total phosphorus (0.021 ± 0.001 to 0.046 ± 0.007mg/l). There were various levels of correlation of these parameters between sites. There was no significant difference in variability in both sites and within months ($P>0.05$) of all physico-chemical parameters. Physico-chemical parameters were almost within tolerable values for supporting aquatic life. One hundred and forty six (146) fish (95 male and 51 females) were sampled using various mesh sizes of gill nets (''2'' ''2.5''). Routine laboratory analysis were conducted to determine conditions of the species in growth. The "b" values of males (1.220), female (0.507) and both sexes (combined) (0.250) exhibited allometric growth. There was significant correlation ($P<0.05$) between length and weight of both sexes. The monthly mean range condition factor (male) values (1.04 ± 0.062 to 1.44 ± 0.191) and (Females) values (1.09 ± 0.011 to 1.50 ± 0.053) and both sexes (combined) values (1.07 ± 0.102 to 1.35 ± 0.034) indicated that the fish were in stable condition throughout the period of research, while the fecundity values range (790.90 ± 871.73 to 1258.80 ± 527.05) observed was generally low. Drastic fall in the values of fecundity and condition factor of the species was noticed in the month of July, which coincided with low values of dissolved oxygen, and higher temperature and ammonia. Results obtained showed that the parameters studied were within recommended ranges, suggesting tolerable level of pollution in the river.

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CHAPTER ONE

INTRODUCTION

1.7 BACKGROUND OF THE STUDY

Water pollution is the contamination of water by foreign matter such as microorganisms, chemicals, industrial or other waste or sewage, such matter deteriorates the quality of the water and renders it unfit for its intended uses (Sogbesan, 1998). Water pollution comes from different sources and can affect different things. The effects of water pollution are not only devastating to people, but they can kill animals, fish and birds. Furthermore, the effects of water pollution pose a serious threat to society today and in the future (Grossman, 2001). Pollutants are substances released into the environment in sufficient concentrations to produce a measurable effect on the soil, plants, animals, human or materials. Some of these substances are not readily broken down to harmless substances and accumulate within organisms and are transferred from one organism to the other. The pollutants vary from oil, petrochemicals, pesticides, sewages, industrial pollutants, solid waste etc (Onuoha and Deekae, 2005). Water quality is usually assessed with a view to providing data for domestic water supply, controlling pollution, developing fishery resources; controlling vectors of water borne diseases, as well as planning water resources management (Haruna, 2003).

1.8 STATEMENT OF THE PROBLEM

Human destructive influence on the aquatic environment is in the form of sub-lethal to lethal pollution, which results in chronic stress conditions that have negative effects on aquatic life (Mason, 1991). The main source of freshwater pollution can be attributed to discharge of untreated waste, dumping of industrial effluent, and run-off from agricultural fields (Heath, 1991). Water pollution is a major problem in the global context. It has been suggested that it is the leading world wide cause of diseases and deaths and that it accounts for the deaths of more than 14,000 people daily world wide (West and Larry, 2006). In order to combat water pollution, we must understand the problems and become part of the solution.

1.9 JUSTIFICATION OF THE STUDY

The pollution of rivers and streams with chemical contaminants has become one of the most critical environmental problems of the century. Chemical pollutants entering rivers and streams can be classified according to the nature of its sources: point pollutants involve those pollutants sources from which distinct chemicals can be identified, such as factories, or outfall pipes. Non-point pollution involves pollutants from sources that cannot be precisely identified, such as run off from agricultural or mining operations or sewage from septic tanks or sewage drain fields (Sogbesan, 1998).

In Ngurore, the location of cattle market, main market and refuse dumping ground are not far away from river. As a result of human activities within these areas, wastes are generated and discharged directly into the river, which pollute the water body to such as extent that it becomes deleterious to aquatic fauna, for example fish. There is no documented information on the pollution status of the area.

This work is intended to provide data or baseline information data on the pollution status, and to assess its effects on both *Clarias gariepinus* and water quality of the water body, which will help in planning water resources management in Ngurore.

1.10 RESEARCH QUESTIONS

i. Is there any effect of water pollution on physico-chemical parameters of water?

ii. Is there any effect of water pollution on condition factor of *Clarias gariepinus*?

iii. Is there any effect of water pollution on length-weight relationship of *Clarias gariepinus*?

iv. Is there any effect of water pollution on the fecundity of *Clarias gariepinus*?

1.11 OBJECTIVES

GENERAL OBJECTIVES

This research aims at determining the effects of pollutants on river Ilagil.

SPECIFIC OBJECTIVES

The specific objectives of the work are as follows:

i. To determine the effect of water pollution on physico-chemical parameters of water.

ii. To determine the effect of water pollution on condition factor of *Clarias gariepinus*.

iii. To determine the effect of water pollution on length-weight relationship of *Clarias gariepinus*.

iv. To determine the relationship between water pollution and fecundity of *Clarias gariepinus*.

1.12 NULL HYPOTHESIS

The following shall be tested at 95% level of confidence (P=0.05).

i. There is no significant effect of water pollution on physico-chemical parameters of water?

ii. There is no significant effect of water pollution on condition factor of *Clarias gariepinus*?

iii. There is no significant effect of water pollution on length-weigh relationship of *Clarias gariepinus*?

iv. There is no significant relationship between water pollution on the fecundity of *Clarias gariepinus.*

CHAPTER TWO

LITERATURE REVIEW

2.5 WATER POLLUTION

Water pollution occurs when a body of water is adversely affected due to addition of large amount of materials to the water. When it is unfit for its intended use, water is considered polluted (Poppe et al., 1997). The increasing urbanization and industrialization of the country's coastal cities have gradually led to negative and conflicting uses of coastal amenities. Human development pressures point to adverse consequences for water quality and general environmental degradation which in the Lagos Lagoon have manifested in declining fisheries, visible aesthetic nuisance, and loss of the recreational amenity (Ajao *et al*., 1996).

Hydrobiology is necessary in order to understand the level of pollution in the environment, to understand eutrophication "growth of water bodies, and to understand the variety of organism and substances a bounding in aquatic systems that are directly or indirectly useful to human (Haruna, 2003). The volume of water discharged is a critical factor in shallow waters and in areas of relatively low physical energy (Adeniyi, 1980). In a review of heavy metals in the Africa aquatic environment (Biney et al., 1994). Studies on the occurrence and distribution of contaminants were observed to be concentrated in urban and industrial areas. Water pollution is a major problem in the global context. It has been suggested that it is the leading world cause of diseases and death (Daniel, 2006). West and Larry (2006) pointed out that the acute problems of water pollution in developing countries; industrialized countries continue to struggle with pollution problem as well. Burande, (2007) pointed out that oil and antifreeze makes the water have a fowl odour and have a sticky film on the surface of water that kills animals. If contaminated water enters the ground there may be serious effects. People may become very sick and there is a probability of developing liver or kidney problems and cancers or other illnesses.

Robert and Allen, (2001) suggested that fertilizers containing nutrients-nitrates and phosphorus which are found in storm water run off from agriculture, as well as commercial and residential use. According to Burande, (2007) pesticides are poisonous to all sorts of life. Rain and irrigation water drains off cultivated land that has been fertilized and treated with pesticides, the excess nitrogen and poisons are mixed with it into the water supply. These pesticides are toxic and pollute the water in a different mode. Aquatic plants growth causes deoxygenation of water and annihilates flora and fauna in streams, lake and river. Pollution is also caused when silt and other suspended solids, such as soil, wash off, plowed fields, construction and logging sites, urban areas and eroded river banks when it rains. Under natural conditions, lakes, rivers and other water bodies undergo eutrophication, an aging process that slowly fills in the water body with sediment and organic matter. When these sediments enter various bodies of water, fish respiration becomes impaired, plant productivity and water depth becomes reduced and aquatic organism and their environments becomes suffocated, (Brassard, 1996). Coliform bacteria are commonly used bacteria indicator of water pollution, although not an actual cause of disease. Other micro-organisms some times found in surface water have caused human health problems (Thomas, 2000).

The effects of acid rain are most clearly seen in lakes, streams, rivers oceans and other bodies of water. Acid rain directly falls on water, but it can flow into rivers after it falls on land. Lakes and streams become acidic when the water and the land round it cannot neutralize the acid rain. Animals that live in the water environment are hurt and possibly killed. Some fish can tolerate a certain amount of acid before dying (Grossman, 2001). Alabaster (1986) pointed out that total dissolved solid act directly on fish in water and could cause stunted growth or even death as well as reduced resistance to diseases.

Temperature affects all kinds of physical, chemical and biological processes. Water bodies undergo seasonal and daily changes in temperature. Temperature is usually the easiest field parameter to measure but will not indicate much about the health of an aquatic system without knowing anything about the other parameters (ACTFR, 2002). As the temperature of water body increases, the rate of chemical reactions increases, the evaporation and volatilization of chemical substances increases, but conversely the solubility of gases such as oxygen decrease. In warmer waters the respiration rate of aquatic organisms increases, as does the decomposition of organic matter, both of which consume oxygen (ACTFR, 2002).

Oxygen concentration in water is able to indicate immediately the apparent health of the water body (ACTFR, 2002). Most aquatic organisms acquire oxygen directly from the water rather than breathing air at the surface and additional oxygen is crucial to various reactions such as respiration (ACTFR. 2002). Most aquatic plants and animals including fish can grow and do well when dissolved oxygen is high, but a drop below 3mg/l causes death in many species (Bramley and Roth 2002).

Effler et al. (1990) suggested that nitrogen is the limiting nutrient of algal growth, comprising one to ten percent of dry mass of algae. The process of nitrification is important because it consumes oxygen and can cause substantial oxygen depletion in aquatic system. Excess of nitrogen can cause hypoxia (low levels of dissolved oxygen) and can become toxic to warm-blood animals at higher concentrations (10mg/l) and under certain conditions. Sources of nitrogen include waste water treatment plants, run off from fertilized areas, run off from animal storage areas and industrial discharges that contain corrosion inhibitors (USPEA, 1991).

Phosphorus is limiting in supply in most tropical water bodies, even a modest increases can under the right conditions, set off a whole chain of undesirable events in reservoir including acceleration of plants growth, algal blooms, low dissolved oxygen and the death of certain fish, invertebrates and other aquatic animals (Margaleff, 1996, Chapman, 1997). Source of phosphorus includes soil and rocks, waste water treatment plants, run-off from fertilized crop land etc (USPEA, 1991). Umar et al. (1996) reported that the values for Nitrate-Nitrogen and phosphate-phosphorus obtained from Nasco discharge were 27mg/L 34mg/L respectively.

Carbondioxide, unlike oxygen participates in interconnected ionic equilibria when it dissolves in water, with most of the gas becoming "bound" in ionic form as bicarbonate and carbonate ions. Free CO_2 refers to concentration of CO_2 plus carbonic acids but the latter comprises a very small proportion of the two. Water with very high free CO_2 content, which frequently occurs in fish farms with a ground water supply, has been reported to cause problems of kidney stone formation in culture salmonid fishes (Stirling, 1985).

Ammonia is an important nutrient of phytoplankton; it is also the major end-product of protein catabolism excreted by aquatic animals (Stirling, 1985). Ammonia is the nitrogen form that is most readily used by aquatic plants (ACTFR, 2002). Total ammonia in water consists of unionized (NH_3) and ionized form (NH_4+). Unionized ammonia can be toxic to fish and other animals and is therefore of considerable aquacultural significance, (Stirling, 1985).

Alkalinity is the combined concentrations of anions of weak acids, principally bicarbonate and carbonates in natural fresh waters. It is a measure of the buffering capacity of the waters i.e its ability to withstand pH changes (Stirling, 1985). Without this acid-neutralizing capacity, any acids added to a lake would cause an immediate change of PH. Measuring alkalinity is important in determining a water body ability to neutralize acid pollution from rainfall or waste water. Alkalinity is influenced by rocks, salty industrial waste water discharges etc (USEPA, 1991). An average fresh water alkalinity value is 150mg/l and observed ranges are between 5-250mg/l (Mays, 1996).

Conductivity is a measure of the ability of water to conduct electrical current, where conductance increases with increasing total salt concentration. It is measured in micro siemens per centimeter (μs/cm) and is affected by the electrical change of the dissolved solids, usually salts, within water (ACTFR, 2002). Most freshwater systems have conductivity values between 10 and 1000(μs/cm), which can equate to approximately 5 to 700mg TDS/L (ACTFR, 2002). Freshwater fish generally thrive over a wide range of electrical conductivity. The desirable range is 100-2,000 (μs/cm). High conductivity is an indication of the presence of large amounts of dissolved salts which may be detrimental to fish (Stone & Thomfielde, 2006).

The hydrogen ion concentration (pH) of water is a measure of hydrogen ions that causes acidity and alkalinity on a scale of 0-14 with 7 being the neutral state. Very low and high pH levels may reduce reproduction in fish associated with death (Stone & Thomforde, 2006). Transparency using secchi disc is a measure of turbidity of the water body and is an indication of availability of light in the water column to support photosynthesis by photoplankton. Turbidity is a measure of water clarity; the more the material suspended in the water the less light can pass through the water column (Abubakar, 2006). Suspended materials include soil particles, algae, plankton, microbes and other substances. Higher turbidity increase in water temperature because suspended particles absorbs more heat. This in turn reduces the concentrations of dissolved oxygen (DO) because warm water holds less DO than cold water (Abubakar, 2006). The common indicators for assessing water quality in limnogigal studies are temperature, transparency, dissolved oxygen, free carbondioxide, alkalinity, total phosphorus, total nitrogen, total ammonia, % unionized ammonia, pH and conductivity among others (Abubakar, 2006).

2.2 CONDITION FACTOR

According to Olurin and Aderibigbe, (2006) a well fed fish will have higher condition factor than poorly fed one. In addition to that they also stated that condition factor will always vary with strain of a fish species as well as with diet and feeding level. Condition factor studies take into consideration the health, and general well being of a fish as related to its environment; hence it represents how fairly deep bodies or robust fishes are (Olurin & Aderibigbe, 2006). Abubakar (2006) pointed out that condition factor gives a picture of general well being of the fish.

2.3 LENGTH-WEIGHT RELATIONSHIP

Elewa and Authman, (1991) reported that comparing the weight of the different length of both sexes of the species generally shows how heavier or more robust one sex is than the other. The higher weight at some length intervals of some fishes could be attributed to factors like low nitrogenous load and favourable content of dissolved oxygen i.e. clear water free from pollution. Olurin & Aderibigbe, (2006) pointed out that length-weight relationship gives information on the condition and growth pattern of fish. Fish are said to exhibit isometric growth when length increases in equal proportion with weight under constant specific gravity. The regression coefficient for isometric growth is '3' and values greater or less than "3" indicate allometric growth (Olurin & Aderibigbe, 2006).

2.4 FECUNDITY

According to Khanna and Singh, (2003) fecundity is the number of eggs that are likely to be laid by fish during the spawning season. James and Ronald, (1988) suggested that the frequency of spawning is dependent on temperature and therefore on latitude and altitude. Khanna and Singh, (2003) reported that a correct knowledge of fecundity of species helps in fishery management. James and Brutun (1992) stated that an increasing environmental harshness leads to early sexual maturity at a smaller size, extended spawning season, increase fecundity and high mortality. Lagler et al, (1977) reported that an increase in fecundity of an individual within the population represent an adaptive response of the population to environmental changes where an increase in fecundity ensures the preservation of the species, its relative both in space and in time, in the event of fairly wide fluctuations the environmental conditions.

CHAPTER THREE

MATERIALS AND METHODS

3.1 STUDY AREA

River Ilagil is located in Ngurore, Yola South Local Government Area of Adamawa State within the north-eastern region of Nigeria. Yola south local government is located at latitude 9^{o}14′N and longitude 12^{o}18′E and area covers about 1,213km and it situated in the Sudan savannah vegetation zone of the country. The Local Government is bordered by Fufore in the East, Mayo-belwa in the west, Demsa in the west-north, while Yola-North and Girei in the North. The sampling sites are close to the inlet siteI cattle market, centre siteII main market, confluence siteIII refuse dumping grounds (fig.1) (ADSMLS, 2005). Herd of cattle, flock of small ruminants visit the sites for water. The vegetation type is best referred to as combrectaceous woodland savanna. It is made up of grasses, aquatic weeds in the river and land weeds interspaced by shrubs and woody plants (Adebayo, 2004).

In Ngurore, the location of cattle market, main market and refuse dumping ground are not far away from river. As a result of human activities within these areas, wastes are generated and discharged directly into the river, which pollute the water body to such as extent that it becomes deleterious to aquatic fauna, for example fish.

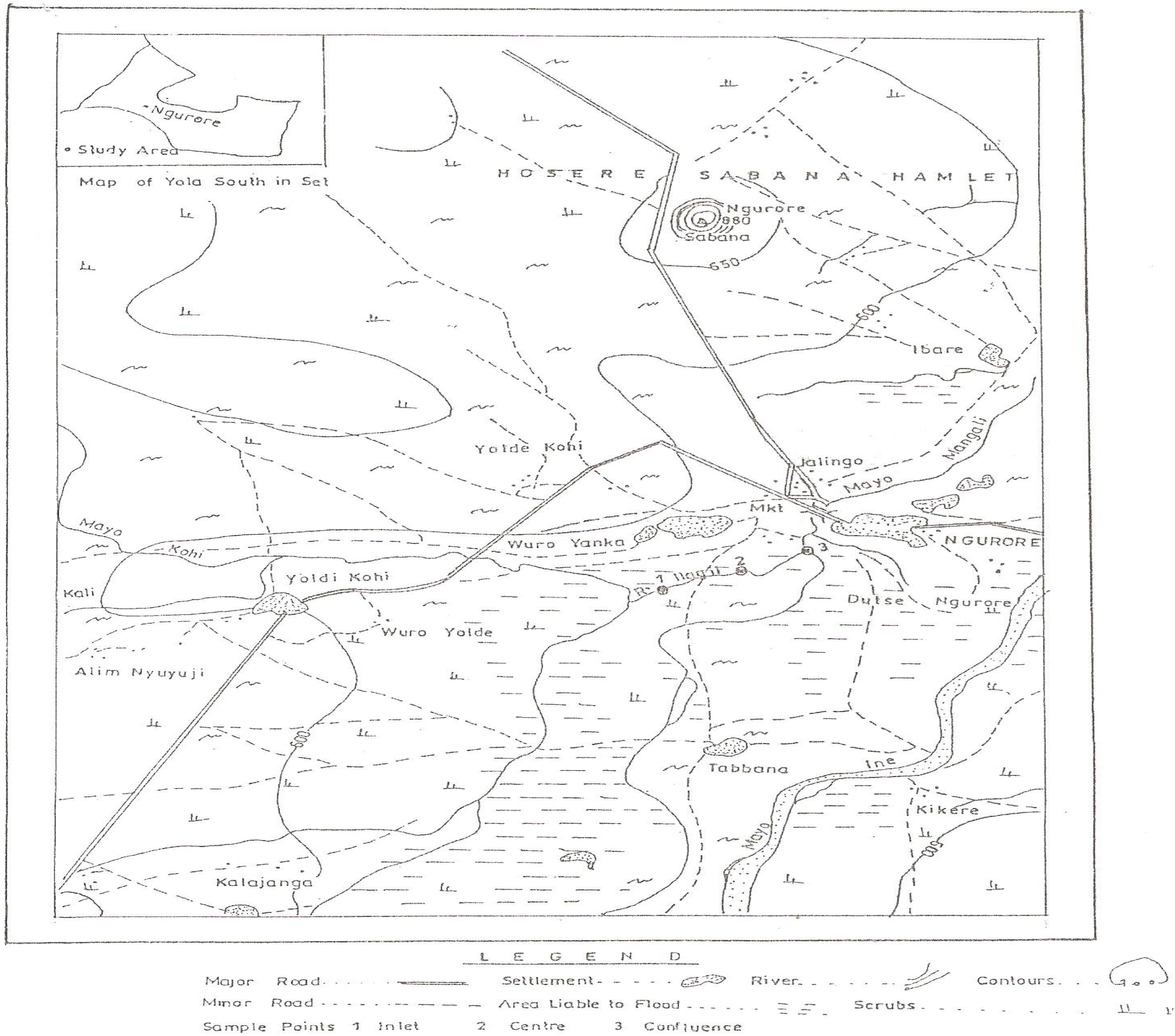

Fig. 1 Map of River Ilagil, Ngurore Showing Sample Sites and Map of Yola-South L.G.A (In Set)

ADSMLS, 2005.

3.2 DESCRIPTION OF FISH SPECIES

Clarias gariepinus belong to the order siluriformes (Haruna, 2003) and family clariidae (Swift, 1993). Although more than 10 species of this genus have been identified in Africa, a recent systematic revision based on morphological, anatomical and biological studies carried out by Teugels, (1984) recognized 32 valid species.

DeGraaf and Janseen, (1996) described the catfish as displaying an eel shape, having an elongated cylindrical body width both fins containing only soft fins rays. The outer pectoral fin is in the form of spine and the pelvic fin normally has six rays. The head is flattened and highly ossified. The skin generally has dark pigment on the dorsal flanks and grayish olive on the belly, on exposure to light, the colour generally becomes lighter. They have four pairs of unbranched barbees Two plates are present on the jaw as well as on the vormer. The male has a distinct sexual papilla located behind the anus which is absent in female (plate 1).

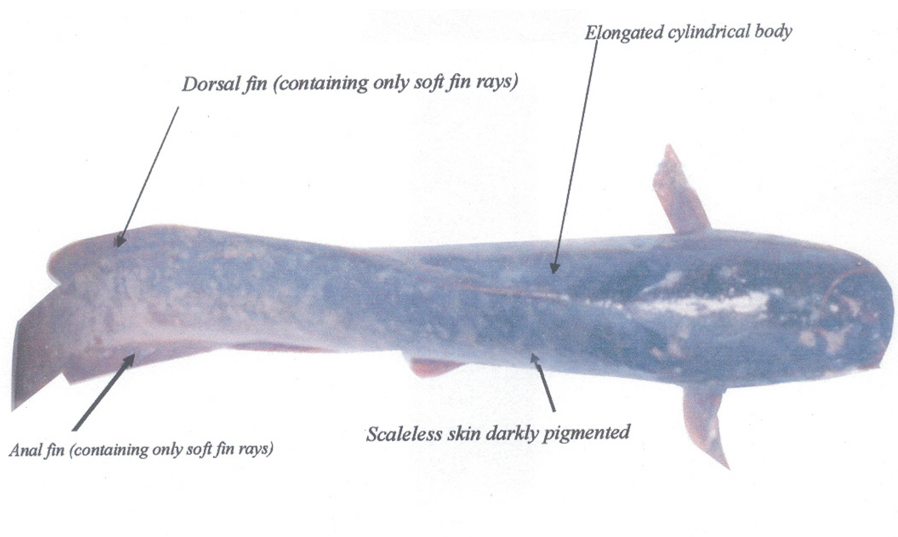

Plate 1: showing *Clarias gariepinus*

3.3 SAMPLE COLLECTION AND PRESERVATION

The sample bottles used to collect and store the water samples were thoroughly cleaned by soaking first (after washing with detergent and rinsing) with 1:3 nitric acids for 2 days followed by a thorough wash with deionised distilled water. They were further soaked for at least 48 hours with deionised distilled water acidified with nitric acid to pH<1. This cleaning process removes trace metals and other pollutants from the bottle wall (Struempler, 1973) and thus prevents or minimizes contamination of the collected samples by the container. The bottles were used directly for sampling.

Sample of water and fish were taken fortnight over a period of six (6) months (i.e from May to October, 2009) from 6 am local time. Water samples for physico-chemical analysis were collected from three (3) sites (i.e at the inlet centre and confluence) below the water surface. Water samples were taken in triplicates at each sampling sites using sample bottles. The bottles were rinsed with the water before being filled with the samples. Sample bottle of 100Ml was dipped below the water surface. The bottle was filled to the brim and covered immediately to avoid air bubbles inside. Water sample were preserved using chemical reagents before being transported to the laboratory for processing .Water samples were collected in labeled and fixed sampling bottles. It usually takes about 40minutes to transport the water samples from the field to the laboratory. Physico chemical parameters were analysed as below.

3.4 DETERMINATION OF TEMPERATURE

Temperature reading were taken directly at the sample site (insitu) mercury bulb thermometer (glaswekwer Tein model) was used. The bulb was placed in water and allowed for about two minutes period. This was to achieve equilibration, and readings were taken. The bulb was dipped in triplicates at each site to deep of 5cm.

3.5 DETERMINATION OF TRANSPARENCY

Transparency was measured as described by Stirling, (1985) using secchi disc depth. The disc was lowered until it disappears from view and the depth recorded. The disc was then raised until is just appears and the depth recorded. The secchi disc visibility was estimated by taking the average of the two readings i.e. $(L_1 + L_2)/2$. The readings were taken while viewing the disc directly from above and backing the sun. The measurements were taken around 12:00 hours for excellent results.

3.6 DETERMINATION OF DISSOLVED OXYGEN

Dissolved oxygen was determined as described by Saxena, (1990). In the field glass stoppered of 100ml volume was filled with sample avoiding any bubbling. Air was not trapped in the bottle after the stopper is placed. The bottle was opened and 1ml of each manganous sulphate and alkaline reagents (potassium iodide plus potassium hydroxide) using separate pipettes was poured in it. A precipitate appears. The stopper was placed and the bottle was shaken thoroughly. 2ml of H_2SO_4 (reagent) was added and shaken thoroughly to dissolve precipitate. 50ml of content was transferred gently (avoiding bubbling) in a conical flask. Four (4) drops of starch indicator was added. Tritration was done against sodium thiosulphate solution and the end point was noted when initial blue colour turn to colourless.

Calculation:

50ml of contents was used for titration

$$DO\ (mg/l) = \frac{V_1 \times N \times 8 \times 1000}{V_4 \frac{(V_2 - V_3)}{V_2}}$$

Where,

DO = dissolved oxygen

V_1 = volume of titrant (ml)

N = normality of titrant (0.025)

V_2 = volume of sampling bottle after placing the stopper (ml)

V_3 = volume of $MnSO_4$ + (KI + KOH) added (ml)

V_4 = volume of the contents used for titration (50ml).

To obtain the value of DO in m/l divide the DO in mg/l by 1.43.

3.7 DETERMINATION OF FREE CARBONDIOXIDE

Free carbondioxide was determined as described by Saxena, (1990). 50ml of water sample was put into a flask and 3 drops of pHenolpthalin indicator (reagent) was added. If the colour turns pink free CO_2 was absent in the sample. If the sample remained colourless, it was titrated against sodium hydroxide solution (reagent) until pink colour appeared (end points).

Calculation

$$\text{Free } Co_2 \text{ (mg/l or PPM)} = \frac{Vt \times 100}{Vs}$$

Where

V_T = volume of titrant (ml)

Vs = volume of sample (ml)

3.8 DETERMINATION OF HYDROGEN ION (pH)

The (pH) of the water body was determined at the sites using a pH meter (model: Hanna instruments model No H18915ATC). The electrode of the meter was standardized using buffer solution, which have the same temperature as the water. After calibrating the electrode in the buffer solutions, it was washed in distilled water before placing deep into water sample for about 2 minutes for equilibration. The electrode was always standardized with a buffer solution before measurement was taken (Abubakar 2006).

3.9 DETERMINATION OF TOTAL PHOSPHORUS

Total phosphorus was determined as described by AOAC, (1990). 5ml of the sample was measured into a test tube. 1ml ammonium molybdate solution was added and allowed to stand for 20 seconds. 1ml of hydroquinone solution, that flask was rotated to mix and 1 ml of Na_2SO_3 was added. 2ml distilled H_20 was added. The test tube was stopped by thumb and was shaken to mix thoroughly. The mixture was allowed to stand for 30 minutes and then measured with spectrophotometer set at 650nm, along side blank. A calibration curve was prepared using standard phosphorus concentration.

3.10 DETERMINATION OF TOTAL AMMONIA

Total ammonia was determined according to Philips, (1985). Samples collected were immediately filtered through pre-rinsed Whatman GF/C filter paper. The phenol-hypochloride method was adopted for fresh water samples. 1.0ml of phenol-nitropruside reagent was added to 25ml of sample. It was mixed and 1.5ml of alkaline hypochloride reagent was added. The flask was covered and the mixture was left to stand in the dark for 1 hour at room temperature. The absorbance of standards of Ammonia stock was serially diluted with the same procedure used for sample and reagent and calibration curve was prepared using standard ammonia concentration.

3.11 DETERMINATIONS OF TOTAL ALKALINITY

Total alkalinity was determined as described by Stirling (1985). 50ml of the water sample was measured and transferred into conical flask, 3 drops of methyl orange indicator was added. The sample was titrated with standard 0.0/m H_2S0_4 from a 10ml burette with continuous shaking until the colour changes from blue to pale pink. The total alkalinity was calculated from the equation;

$$\text{Alkalinity in mg/l} = \frac{n \times V_2 \times 1000}{V_1}$$

Where

n = normality of standard H_2So_4

V_1 = volume of the sample

V_2 = volume of acid used.

3.12 DETERMINATION OF CONDUCTIVITY

Electrolyte conductivity of the water body was determined at the site using conductivity metre (model: PHYTE 65667.00). The unit of measurement was expressed in $\mu s / cm$ which is the SI units. All measurements were made at temperature other than 25^{o}C. The observed conductivity was corrected by multiplying by a factor given in a standard table of conversion.

$$\text{Conductivity (K)} = C \times \frac{1}{R}$$

Where

C = cell constant

R = resistance.

3.13 DETERMINATION OF NITROGEN

Nitrogen was evaluated as described by Philips, (1985). Sample of water collected was immediately filtered through pre-rinsed What-man GF/C filter paper. 25ml of sample was measured in a 150ml conical flask and 1ml concentration H_2So_4 and a dozen anti-bumping granules were added. The sample procedure was carried out on standard and distilled water as blank.

The sample was boiled on a hot plate until the white fumes of sulphur-trioxide appeared, then the flask was removed from the hot plate, 1g of potassium persulphate was added to the flask. The mixture was strongly heated at fuming temperature for exactly 10 minutes. Sufficient time was allowed for cooling and 15ml distilled water was added and transferred to a 50ml volumetric flask. The mixture was gently heated to dissolve the digest in the water. The conical flask was rinsed 3 times with fresh distilled water to ensure that the sample is completely transferred. 1 drop of methyl red solution and 10M sodium hydroxide will be added until the solution turned clear. The solution was back titrated by adding 4M H_2SO_4 drop by drop until the solution turned red. The sample was made up to 50 ml with distilled water. 1.0ml of phenol-nitropruside and 1.5ml of alkaline hypochloride was added to the sample and blank. Samples were allowed to stand for 24 hours before the absorbance of standard and samples was taken against a reagent blank at 635nm. A calibration curve will be prepared using standard nitrogen concentration.

3.14 FISH SAMPLING

Fish were sampled using gill nets of two mesh sizes (i.e 2", 2.5"), which was set in the morning hours from 5.30am and was retrieved 9am. Fish were selected from the catch and transported to the laboratory for measurements.

Laboratory measurement was done as described by Olatunde, (1983). Total length was measured from the tip most part of the mouth to the tip of the caudal fin. Standard length was measured from tip most part of the mouth to the tip of hypural bone using ruler. Fresh weight of the fish was measured using an electronic balance, after removing water and substances on the fish using filter paper. The total length and standard length was measured in centimeters, while weight of fish was measured in grammes.

Laboratory measurements were used to determine the length-weight relationship and condition factor of fish.

3.15 LENGTH-WEIGHT RELATIONSHIP

The length-weight relationship was determined using the conventional formula described by Lecren (1951).

$W = aL^b$

The equation and data was transformed to logarithm before the determination was made. The equation was therefore transformed into:

$\log W = \log a + b \log L$

Where

W= Weight of fish in grammes

L = Standard length of fish in cm

a = a constant

b = an exponent

3.16 CONDITION FACTOR

The condition factor "K" was determined for individual fish using the conventional formula described by Worthington and Richard (1931).

The ratio of the length to the weight of the fish was determined as:

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

Where K = condition factor

W = weight in grammes

L = standard length in cm

3.17 FECUNDITY

According to Khanna and Singh (2003) fecundity can be determined using Gravimetric method. Matured Ovaries were carefully removed (after making an incision from the vent to the lower jaw to expose the visceral organs of the fish) and preserved in 10% formalin in a Petri dish for 30 minutes. The weight of ovaries was determined and 3 samples of 100mg each was taken at random from anterior, middle and posterior parts. The number of eggs in each sample was counted under a binocular microscope.

Fecundity was then determined as;

$$F = \frac{S \times OW}{100}$$

Where

F = fecundity

S = Average number of eggs from 3 samples of 100mg each

OW = Total weight of ovary.

3.18 DATA ANALYSIS

All data were subjected to one-way analysis of variance (Anova), correlation matrix, descriptive statistics, regression analysis, graph (bar-chart), means and standard deviations were calculated following established statistical procedures (graph pad distant window, 2003 and Excel window, 2003).

CHAPTER FOUR

4.1 RESULTS

The lowest mean water temperature value of 24.8^{o}C was recorded at the centre in the month of August. While the highest value of 29.0^{o}C at the inlet, centre and confluence in the months of May and October respectively (Fig. II).The lowest temperature value recorded at the centre in the month of August might be due to wet season weather condition.

The monthly mean variations of water temperature ranged from 25.10^{o}C in the month of August to 28.67^{o}C in the month of May and October respectively. The monthly prediction of temperature is inlet = 5.219+0.9536x (centre)-- 0.14724 x (confluence). There was a sly correlation between temperature and sampling sites ($r = 0.9262$). There was no significant difference in variability in both sites and within months ($P > 0.05$). The strongest correlation value ($r=0.9660$) was observed between the centre and inlet during the period of the study (Table 1). The strongest correlation value observed between centre and inlet might be due to inflow of water and suspended materials.

The lowest mean water transparency value of 7.2cm was recorded at the inlet in the month of June. The highest value of 12.7cm at the confluence in the month of October (fig. III). The lowest mean transparency value recorded as the inlet might be due to their accumulation of suspended particles associated with the site. The monthly mean variations of transparency range from 8.00cm to 12.40cm in the month of October. The monthly prediction for transparency is inlet=0.6004+0.7511 x (centre) + 0.2528 x (confluence). There was a sly correlation between transparency and sampling sites. (r=0.8443). There was no significant differences in variability in both sites and within months ($P > 0.05$). The strongest correlation ($r = 0.9013$) was recorded between the centre and inlet during the period of the research (Table 2). The strongest correlation of transparency observed between a centre and inlet of the river may be due to suspended materials and turbulence created by inflow of water from the inlet.

The lowest mean water pH value of 4.8 was recorded at the inlet and confluence in the months of May and June respectively. While the highest value of 8.0 at the centre in the month of October (Fig. iv). The monthly mean variations of water pH ranged from 5.40 in the month of May to 7.50 in the months of August, September and October respectively. The lowest monthly mean pH value of 5.40 might be attributed to the influx of rain water into the river. The monthly prediction for pH is inlet= 0.1611+1.606 x (centre) - - 0.7042 x (confluence). There was a sly correlation between pH and sampling sites (r = 0.5200). There was no significant differences in variability in both sites and within months (P >0.05). The strongest correlation value (r = 0.8221) was recorded between centre and confluence and confidence and centre respectively (Table 3).

TABLE 1: CORRELATION MATRIX FOR TEMPERATURE

	B CENTRE	C CONFLUENCE	A:(Y) INLET
B CENTRE	1.0000	0.9378	0.9660
C CONFLUENCE	0.9378	1.0000	0.8892

Table 2: CORRELATION MATRIX FOR TRANSPARENCY

	B CENTRE	C CONFLUENCE	A:(Y) INLET
B CENTRE	1.0000	0.7729	0.9013
C CONFLUENCE	0.7729	1.0000	0.7881

Table 3: CORRELATION MATRIX FOR WATER (pH)

	B CENTRE	C CONFLUENCE	A:(Y) INLET
B CENTRE	1.0000	0.8221	0.7575
C CONFLUENCE	0.8221	1.0000	0.3601

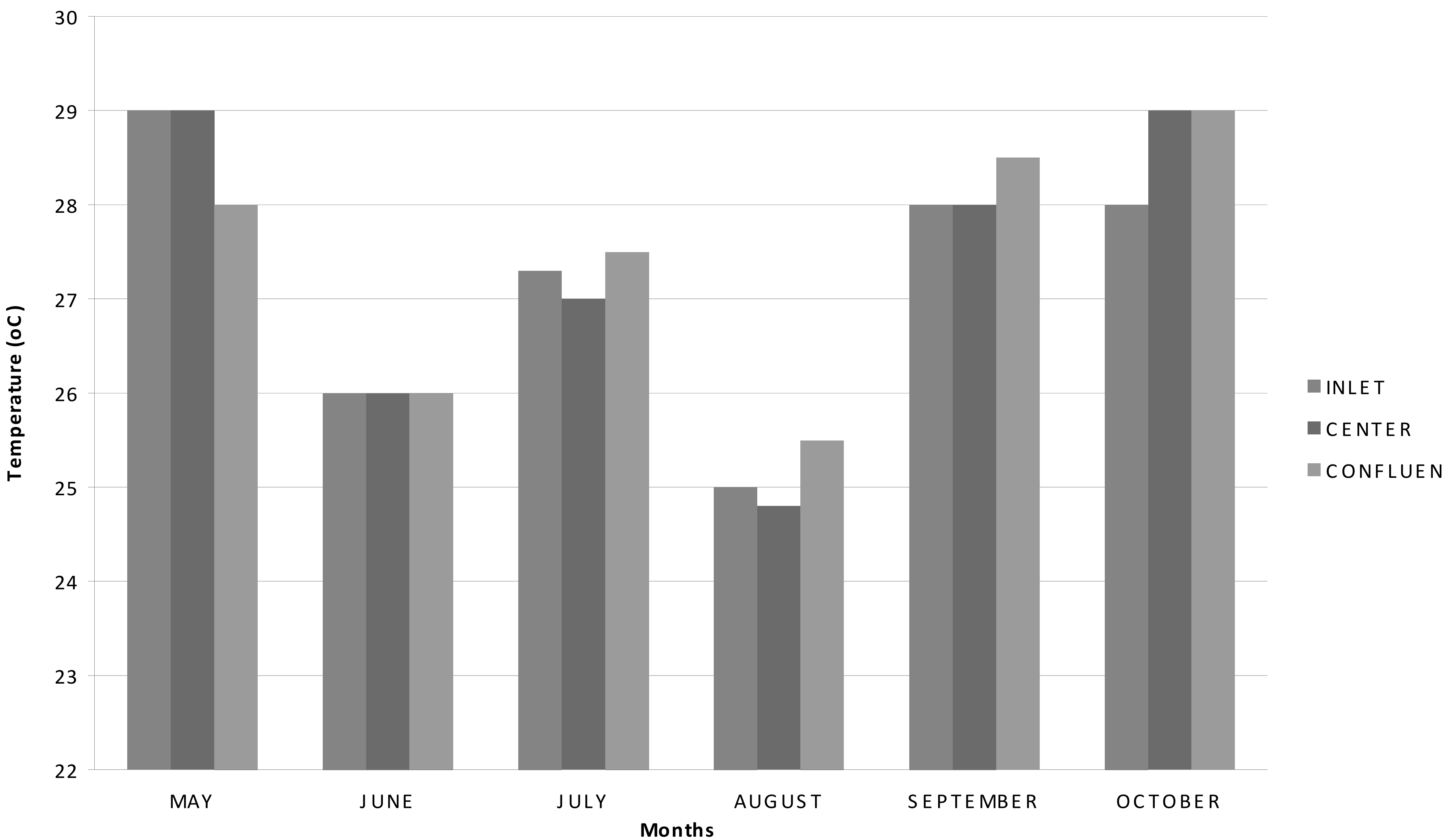

Figure II Monthly Variation of Temperature (oC) in river Ilagil, Ngurore, Yola-South.

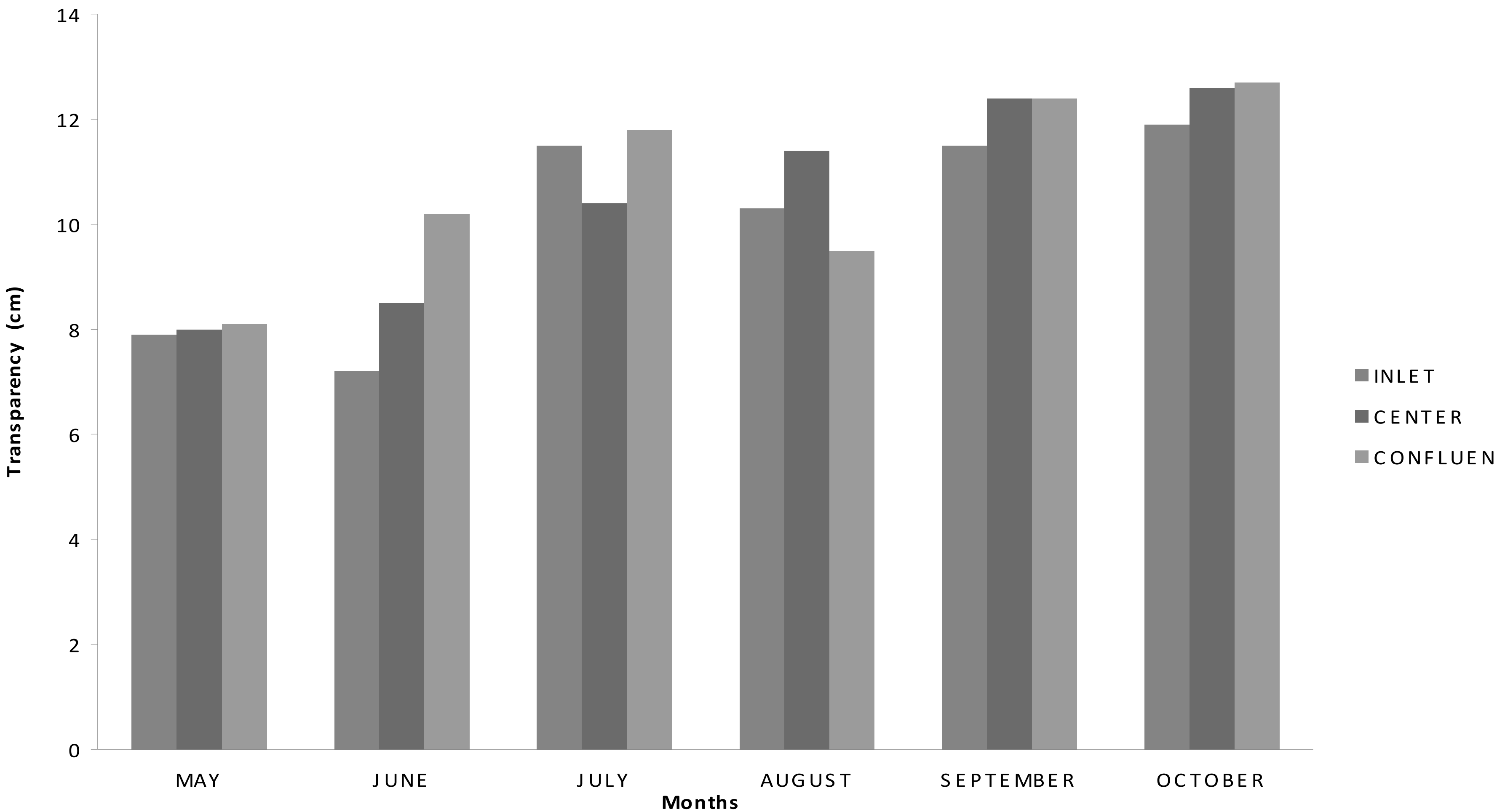

Figure III Monthly Variation of Transparency (cm) in river Ilagil, Ngurore, Yola-South.

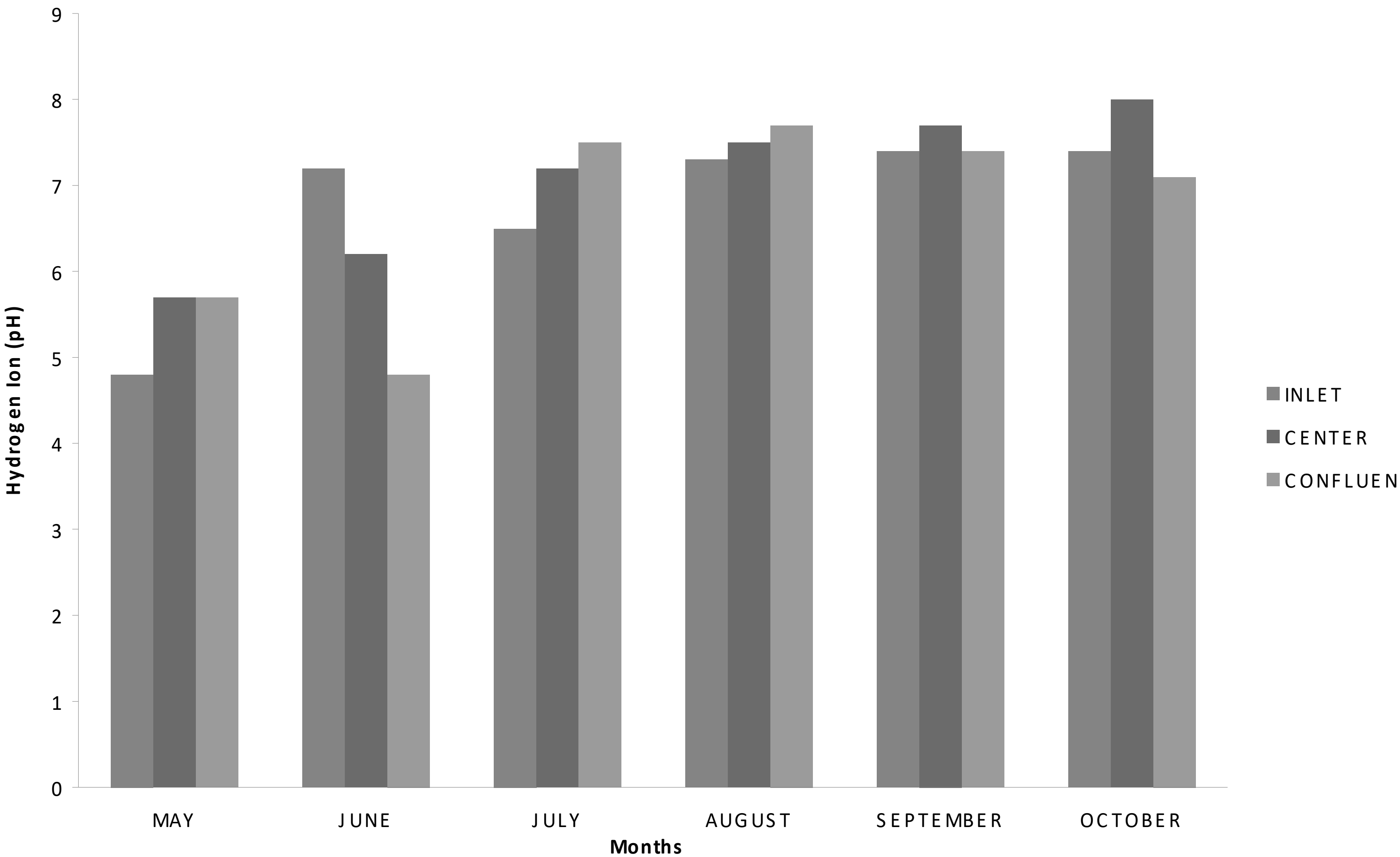

Figure IV. Monthly Variation of Hydrogen Ion (pH) in river Ilagil, Ngurore, Yola-South.

Free carbondioxide (CO_2) recorded the lowest mean value of 2.0mg/l at the confluence in the months of July and October respectively and the highest value of 5.0mg/l at the inlet and centre (Fig. V). The monthly mean variations of free CO_2 ranged from 2.60mg/l in the month of August to 4.17 mg/l in the month of June. The lowest value of free carbondioxide observed in the month of august may be attributed to the utilization of free carbondioxide by phytoplankton for primary productivity. The monthly prediction for free CO_2 is inlet = 0.9833 + 0.3927 x (centre) +0.4249 x (confluence). There was a sly correlation between free carbondioxide and sampling sites ($r = 0.2916$). There was no significant difference in variability in both sites and within months ($P > 0.05$). The strongest correlation value ($r = 0.3974$) was recorded between centre and inlet (Table 4).

Total alkalinity recorded the lowest mean value of 26.4mg/l at the centre in the month of September and highest value of 62.4mg/l at the centre in the month of May (Fig. vi). The highest value recorded as the centre may be due to the leaching effect of bicarbonate from the soils as rain water runs off. The monthly mean variations total alkalinity ranged from 26.70mg/l in the month of September to 63.87mg/l in the month of May. The monthly prediction for total alkalinity is inlet = 9.920 + 0.6638 x centre + 0.1136 (confluence). There was sly correlation between total alkalinity and sampling sites (r = 0.9455). There was no significant differences in variability in both sites and within months (P >0.05). The strongest correlation value (r = 0.9649) was recorded between centre and inlet (Table 5).

Conductivity of the water body recorded its lowest mean value of 1.34 μs/cm at inlet, centre and confluence in the month of October and a high value of 4.68 μs/cm at inlet in the month of May (Fig.vii). The highest conductivity mean value recorded at the inlet in May might be attributed to high concentration of suspended matter associated with flow of water through site. The monthly mean variations of water conductivity ranged from 1.34 μs/cm in the month of October to 4.02 μs/cm in the month of May. The monthly prediction for conductivity is inlet = -0.4607 + 1.111 x (centre) + 0.2205 x (confluence). There was sly correlation between conductivity and sampling sites. (r = 0.9815). There was no significant difference in variability in both sites and within months (P >0.05). The strongest correlation value (r = 0.9769) was recorded between confluence and inlet (Table 6).

TABLE 4: CORRELATION MATRIX FOR FREE Co2

	B CENTRE	C CONFLUENCE	A:(Y) INLET
B CENTRE	1.0000	-0.2960	0.3974
C CONFLUENCE	-0.2960	1.0000	0.1835

TABLE 5: CORRELATION MATRIX FOR CONDUCTIVITY

	B CENTRE	C CONFLUENCE	A:(Y) INLET
B CENTRE	1.0000	0.9764	0.9939
C CONFLUENCE	0.9764	1.0000	0.9769

TABLE 6: CORRELATION MATRIX FOR TOTAL ALKALINITY

	B CENTRE	C CONFLUENCE	A:(Y) INLET
B CENTRE	1.0000	0.9519	0.9649
C CONFLUENCE	0.9519	1.0000	0.9300

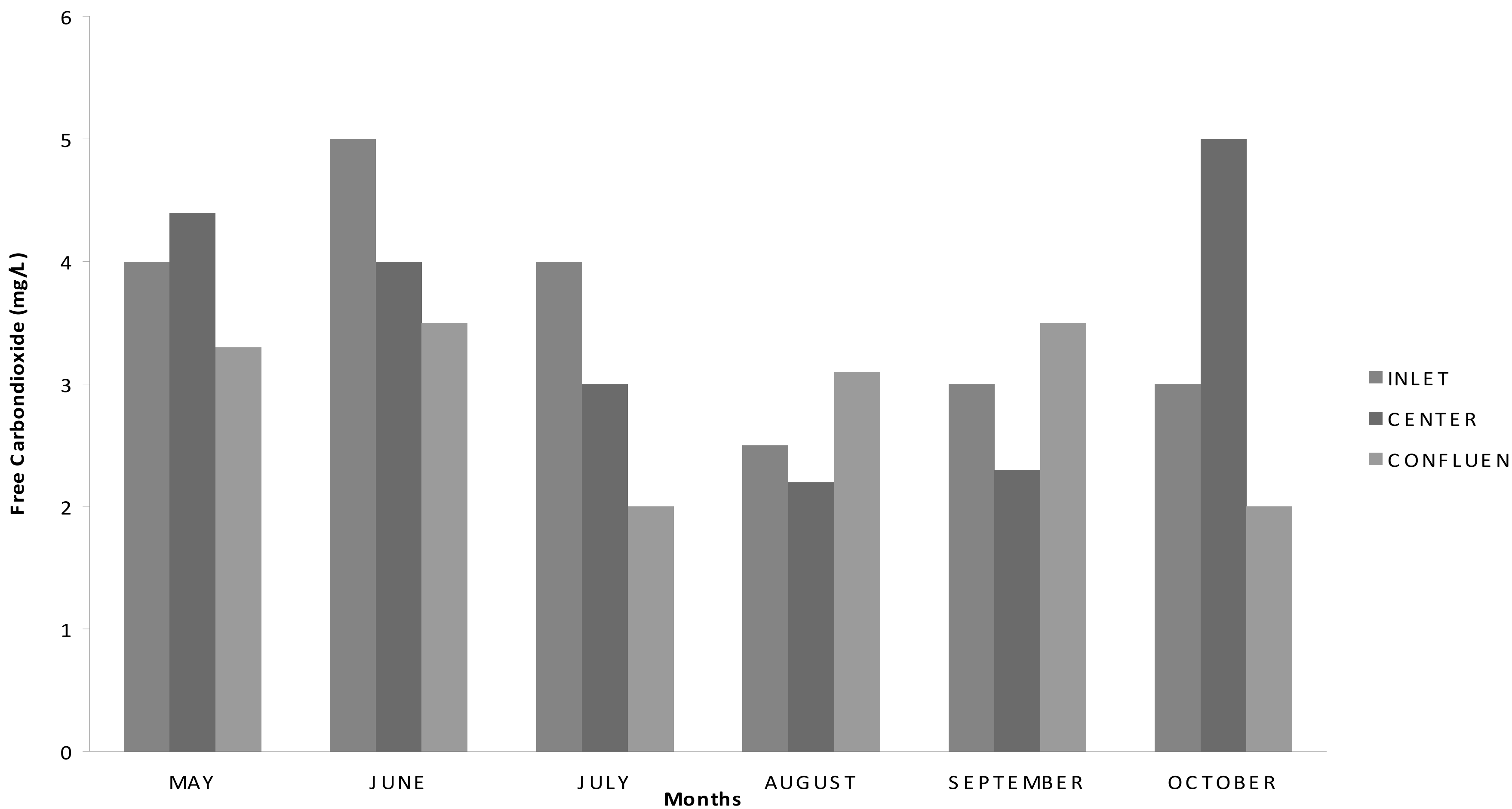

Figure V. Montly Variation of Free carbondioxide (mg/L) in river Ilagil, Ngurore, Yola-South.

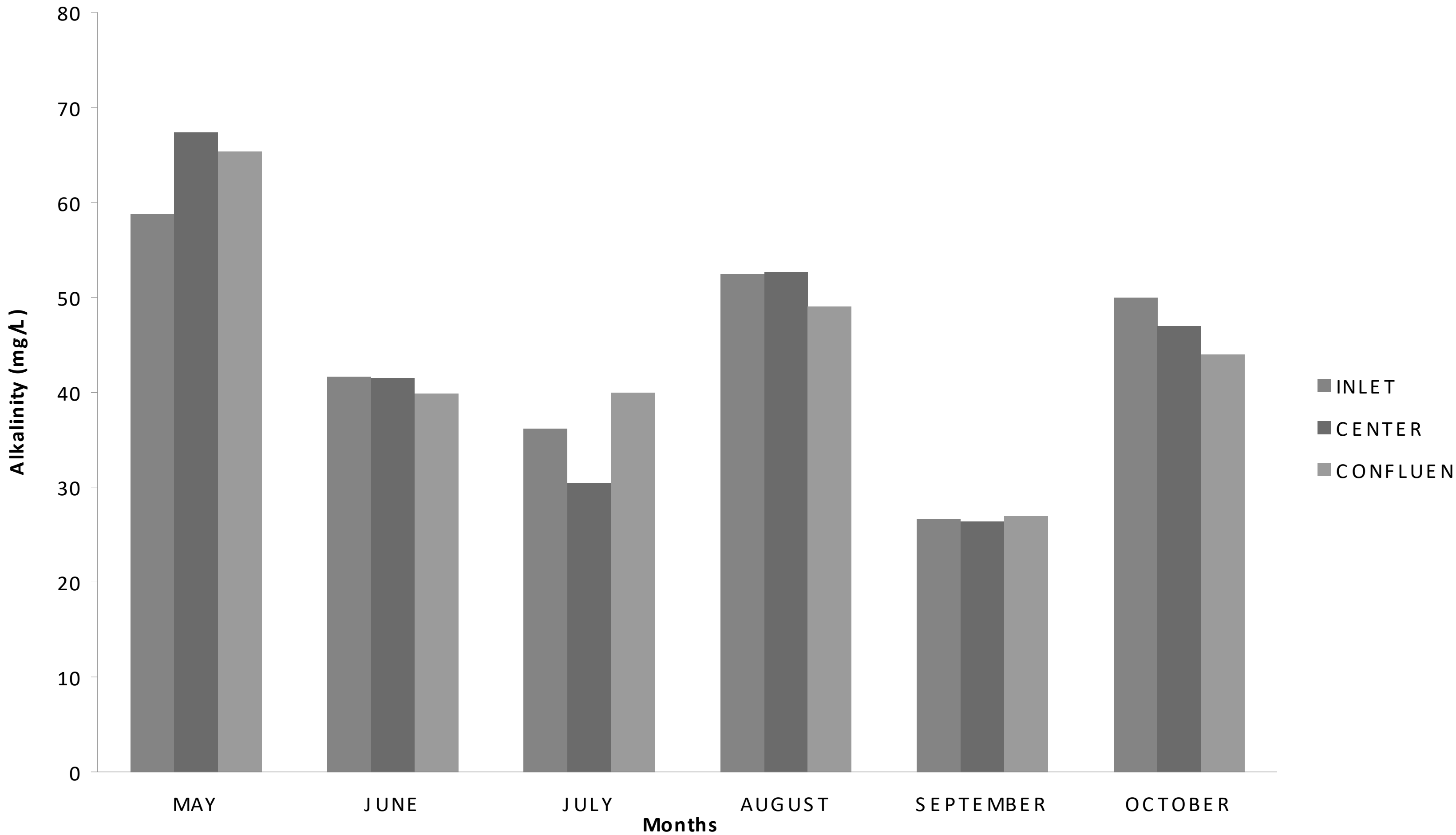

Figure VI. Monthly Variation of Total Alkalinity (mg/L) in river Ilagil, Ngurore, Yola-South.

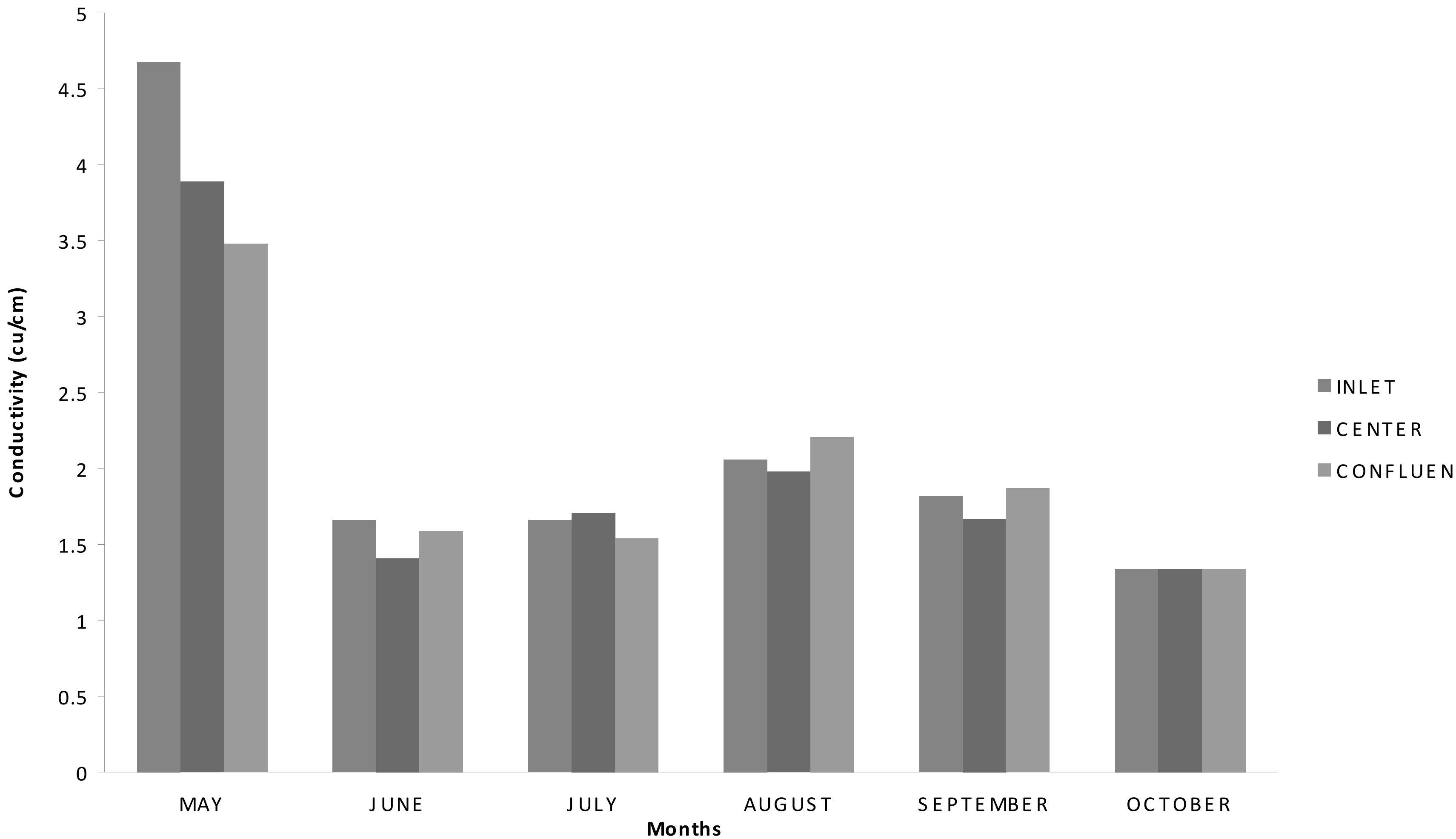

Figure VII. Monthly Variation of Conductivity (us/cm) in river Ilagil, Ngurore, Yola-South.

The lowest mean dissolved oxygen (DO) value of 6.9mg/l at centre in the month of June. The highest value of 20.5mg/l at confluence in the month of October (Fig VIII). The highest main value of DO recorded at the confluence might be due to prevailing cool wind action during wet season. The monthly mean variations of DO ranged from 7.33mg/l in the month of July to 17.07mg/l in the month of October. The monthly prediction for Do is inlet = 3.994 - - 0.3145 x (centre) + 0.8722 x (confluence). There was sly correlation between DO and sampling sites. (r = 0.8617). There was no significant difference in variability in both sites and within months (P >0.05). The strongest correlation (r = 0.9813) was recorded between centre and inlet (Table 7). The strongest correlation observed between centre and inlet might be due to decomposition of organic matter.

The lowest mean total ammonia value of 0.106mg/l at confluence in the month of June. The highest value of 0.232mg/l at centre in the month of October Fig (IX). The monthly mean variations of total ammonia ranged from 0.124mg/l in the month of June to 0.165mg/l in the month of October. The monthly prediction for total ammonia is inlet = 0.1303 + 0.1263 x (centre) - - 0.127 x (confluence). The correlation of total ammonia of the month with the different sites is low (r = 0.3607). There was no significant difference in variability in both sites and within months (P >0.05). The highest correlation value (r = 0.7472) was recorded between centre and inlet (Table 8).

The lowest mean total nitrogen value of 0.241mg/l at confluence in the month of July. The highest value of 0.411mg/l at centre in the month of June (Fig X). The lowest new value of total nitrogen recorded at the confluence could be as a result of high concentration of Do observed during the period of the study. The monthly mean variations of total nitrogen ranged from 0.255mg/l in the months of July to 0.349mg/l in the month of May. The monthly prediction for total nitrogen is inlet = 0.1411 + 0.4109 x (centre) + 0.05787 x (confluence). There was sly correlation between total nitrogen and sampling sites. (r=0.6530). There was no significant different in variability in both sites and within months (P >0.05). The strongest correlation value of (r = 0.8885) was observed between the centre and inlet (Table 9).

TABLE 7: CORRELATION MATRIX FOR DISSOLVED OXYGEN

	B CENTRE	C CONFLUENCE	A:(Y) INLET
B CENTRE	1.0000	0.9185	0.8699
C CONFLUENCE	0.9185	1.0000	0.9813

TABLE 8: CORRELATION MATRIX FOR TOTAL AMMONIA

	B CENTRE	C CONFLUENCE	A:(Y) INLET
B CENTRE	1.0000	-0.1570	0.7472
C CONFLUENCE	-0.1570	1.0000	-0.4079

TABLE 9: CORRELATION MATRIX FOR TOTAL NITROGEN

	B CENTRE	C CONFLUENCE	A:(Y) INLET
B CENTRE	1.0000	0.3584	0.8885
C CONFLUENCE	0.3584	1.0000	0.4027

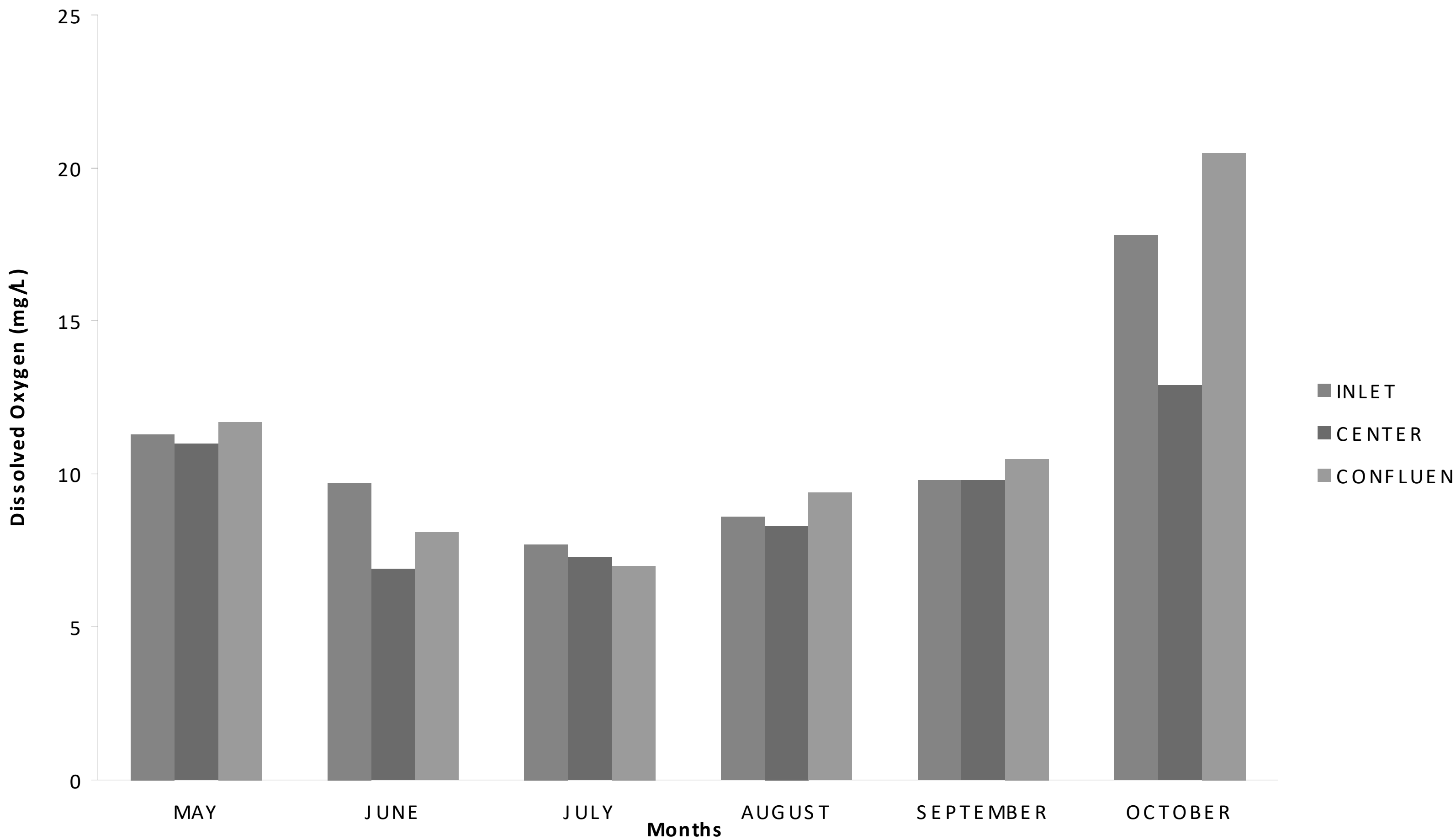

Figure VIII. Monthly variation of Dissolved Oxygen (mg/L) in river Ilagil, Ngurore, Yola-South.

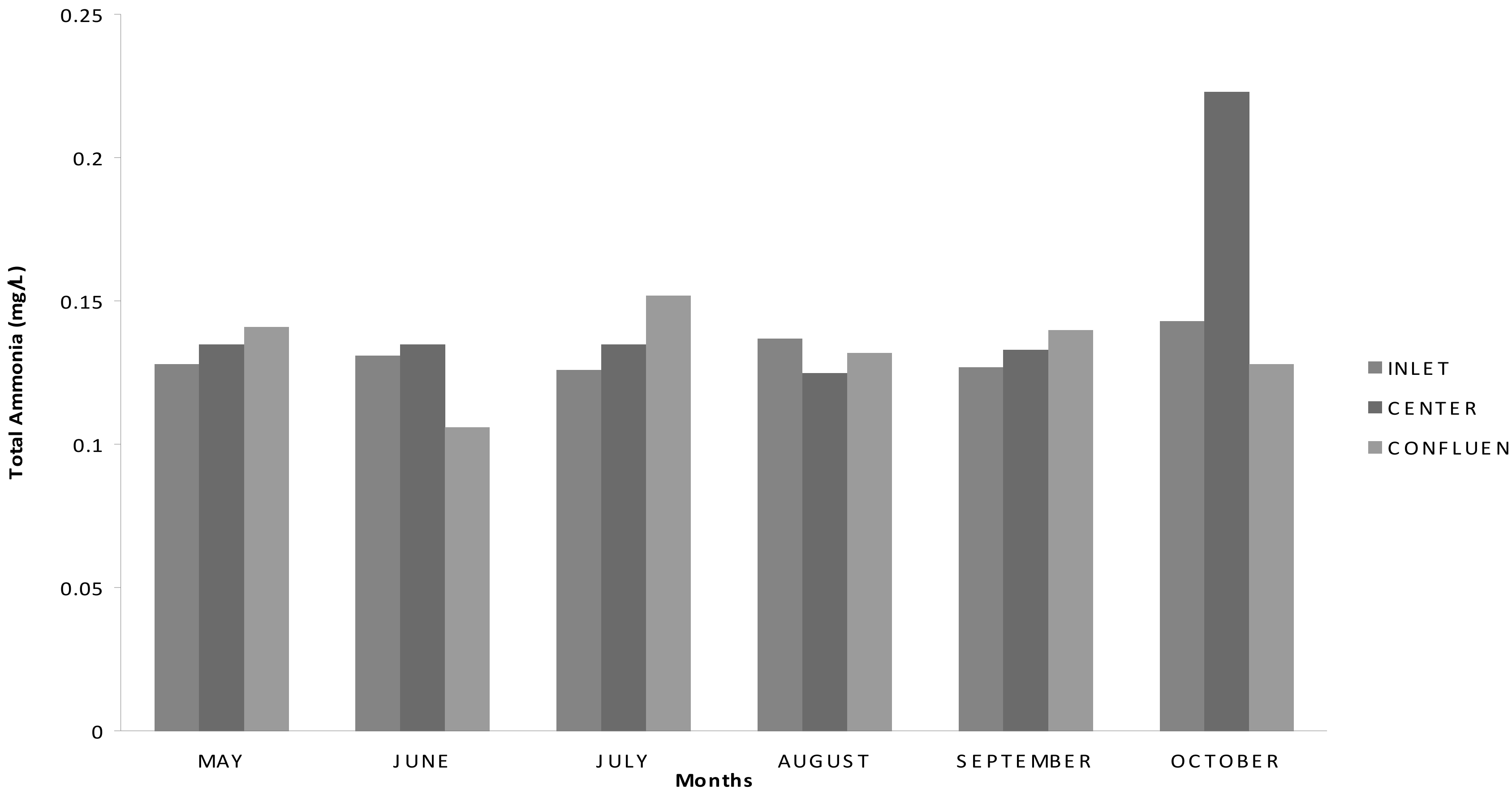

Figure IX. Monthly variation of Total Ammonia (mg/L) in river Ilagil, Ngurore, Yola-South.

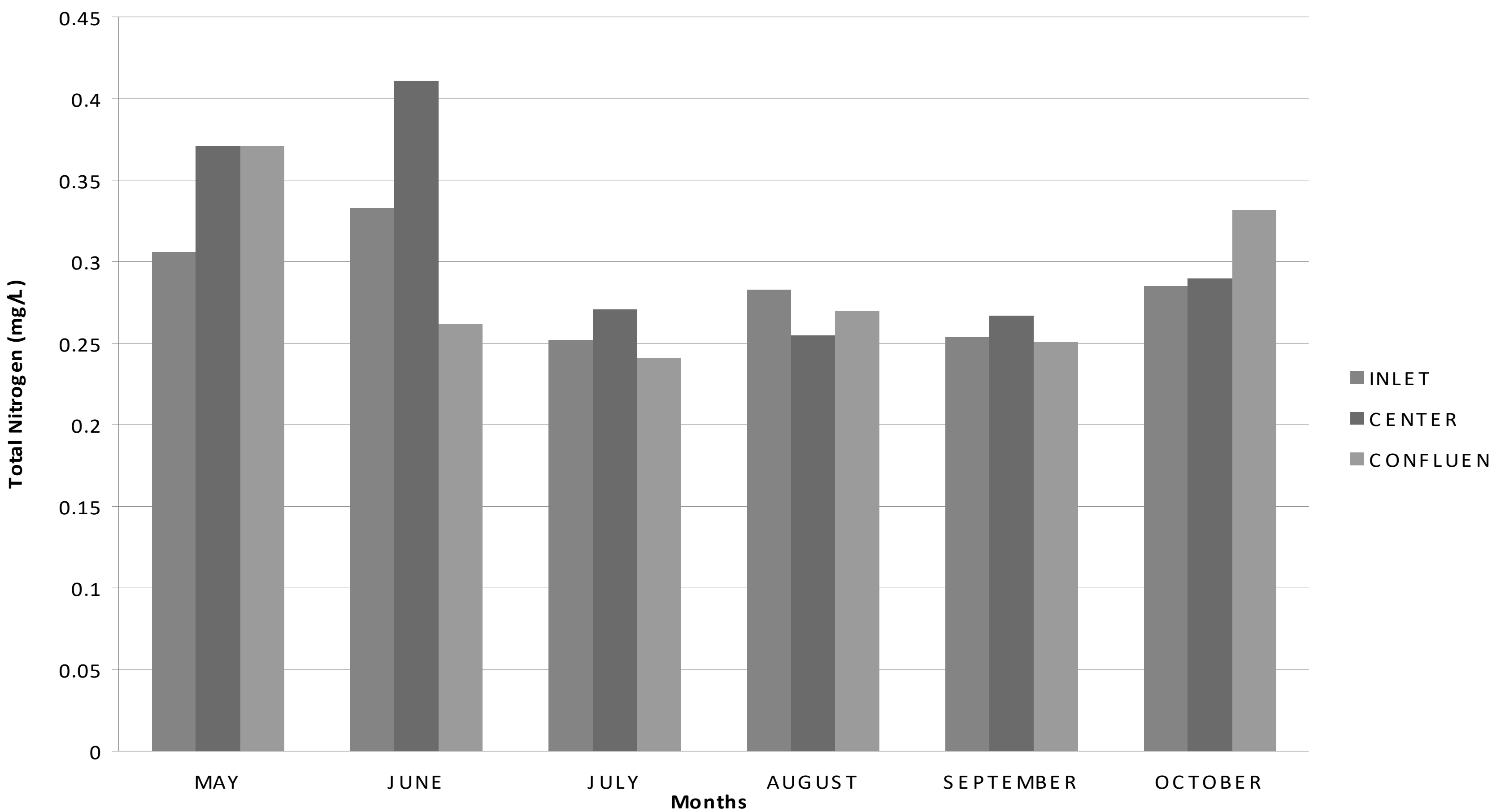

Figure XI. Monthly Variation of Total phosphorus (mg/L) in river Ilagil, Ngurore, Yola-South.

The lowest mean total phosphorus value of 0.018mg/l at inlet in the month of May. The highest value of 0.054mg/l at confluence in the month of August (Fig. XI). The monthly mean variations of total phosphorus ranged from 0.021mg/l in the month of October to 0.046mg/l in the month of august. The monthly prediction for total phosphorus is inlet = 0.01082 + 0.8420 x (centre) - - 0.1748 x (confluence). There was sly correlation between total phosphorus and sampling sites. (r = 0.3989). There was no significant difference in variability in both sites and within months (P > 0.05). The strongest correlation value (r = 0.8672) was recorded between the centre and confluence and confluence and centre respectively (Table 10). The strongest correlation observed at the centre and confluence respectively, might be due to water flow and sedimentation of organic waste associated with the site.

TABLE 10: CORRELATION MATRIX FOR TOTAL PHOSPHORUS

	B CENTRE	C CONFLUENCE	A:(Y) INLET
B CENTRE	1.0000	0.8672	0.4669
C CONFLUENCE	0.8672	1.0000	0.3599

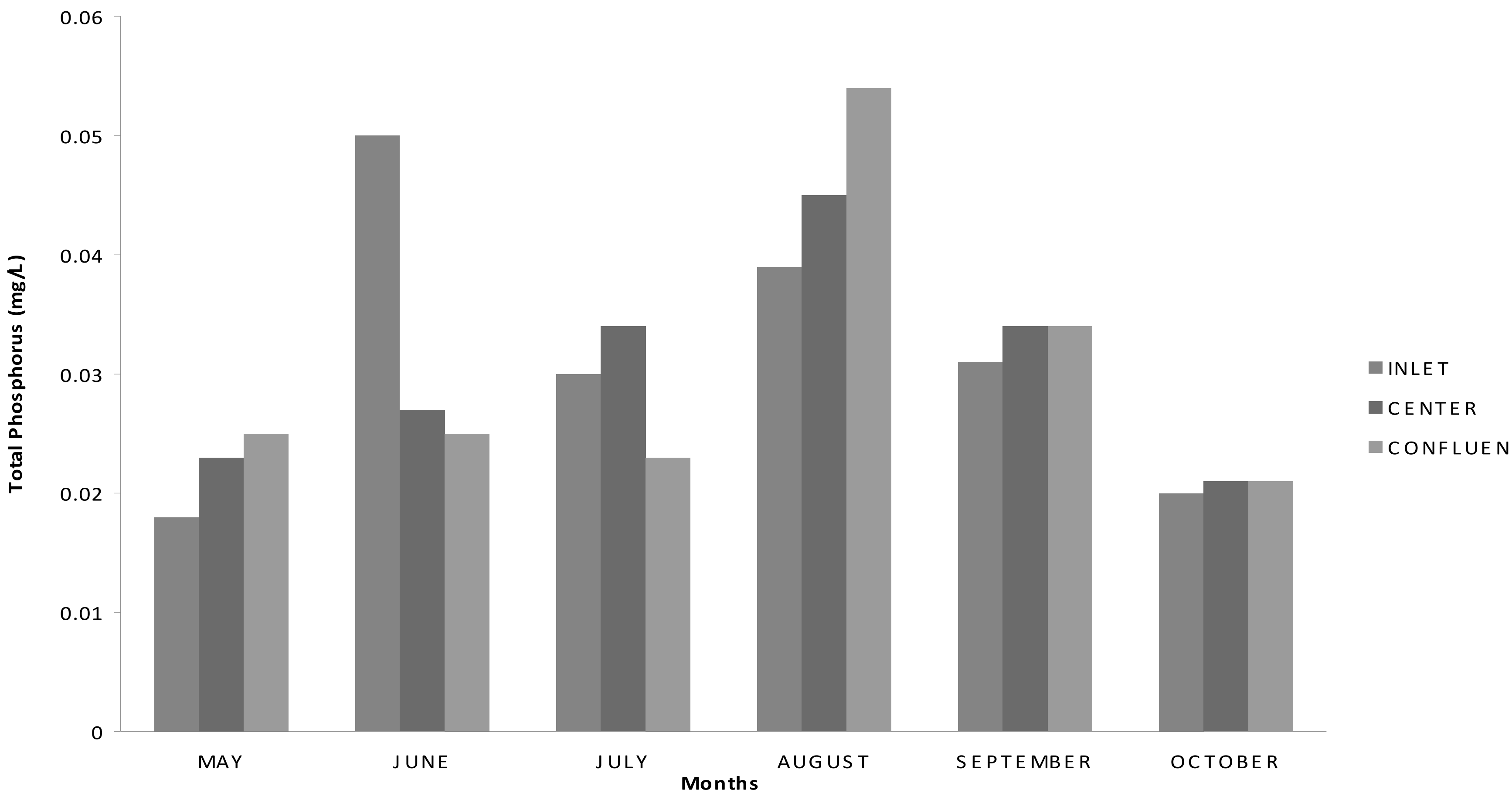

Figure X. Monthly Variation of Total phosphorus (mg/L) in river Ilagil, Ngurore, Yola-South.

4.2 CONDITION OF FISH

The result of length-weight regression analysis of *Clarias gariepinus* is shown in Table (II). The 'b' values for males (1.220), females (0.507) and combined (0.2502), all show allometric growth. The length-weight relationship of males (Figure XII), females (figure XIII) and combined (figure XIV) showed linear relationship with significant correlation coefficient of 0.069, 0.840 and 0.3944 in males, females and combined respectively ($P > 0.05$) between length and weight.

The monthly mean condition factor values of male *Clarias griepinus* (figure XV) (Appendix II) ranged from 1.04 in July to 1.44 in September, while that of female ranged from 1.09 in July to 1.50 in May. The combined condition factor for both sexes ranged from 1.07 in July to 1.35 in September. There was no significant difference ($P>0.05$) in variability within months. (Appendix III) (Fig XVI) shows the monthly mean fecundity ranged from 790.90 in the month of July to 1258.80 in the month of May. The lowest mean fecundity recorded in July might be due to poor environmental condition. There was no significant difference ($P>0.05$) in variability within months.

TABLE 11: LENGTH-WEIGHT REGRESSION ANALYSIS OF *Clarias gariepinus*

SEX	NO OF FISH EXAMINED	loga	b	COEFFICIENT OF CORRELATION
MALE	95	0.066	0.220	0.069
FEMALE	51	0.438	0.507	0.840
COMBINED	146	0.8666	0.2502	0.3944

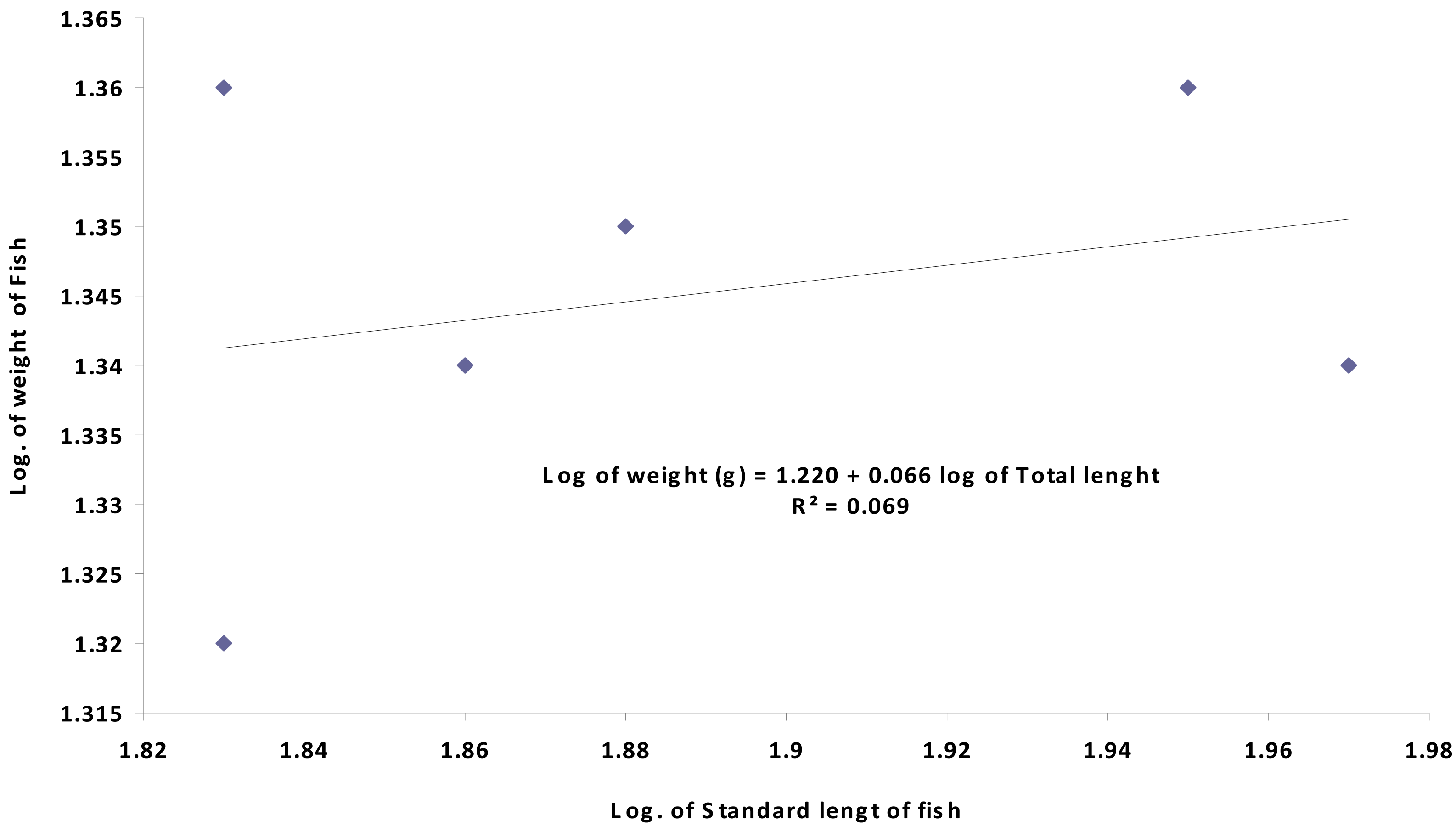

Figure XII. Length - weight relationship of Male *Clarias gariepinus* in liver Ilagi, Ngurore

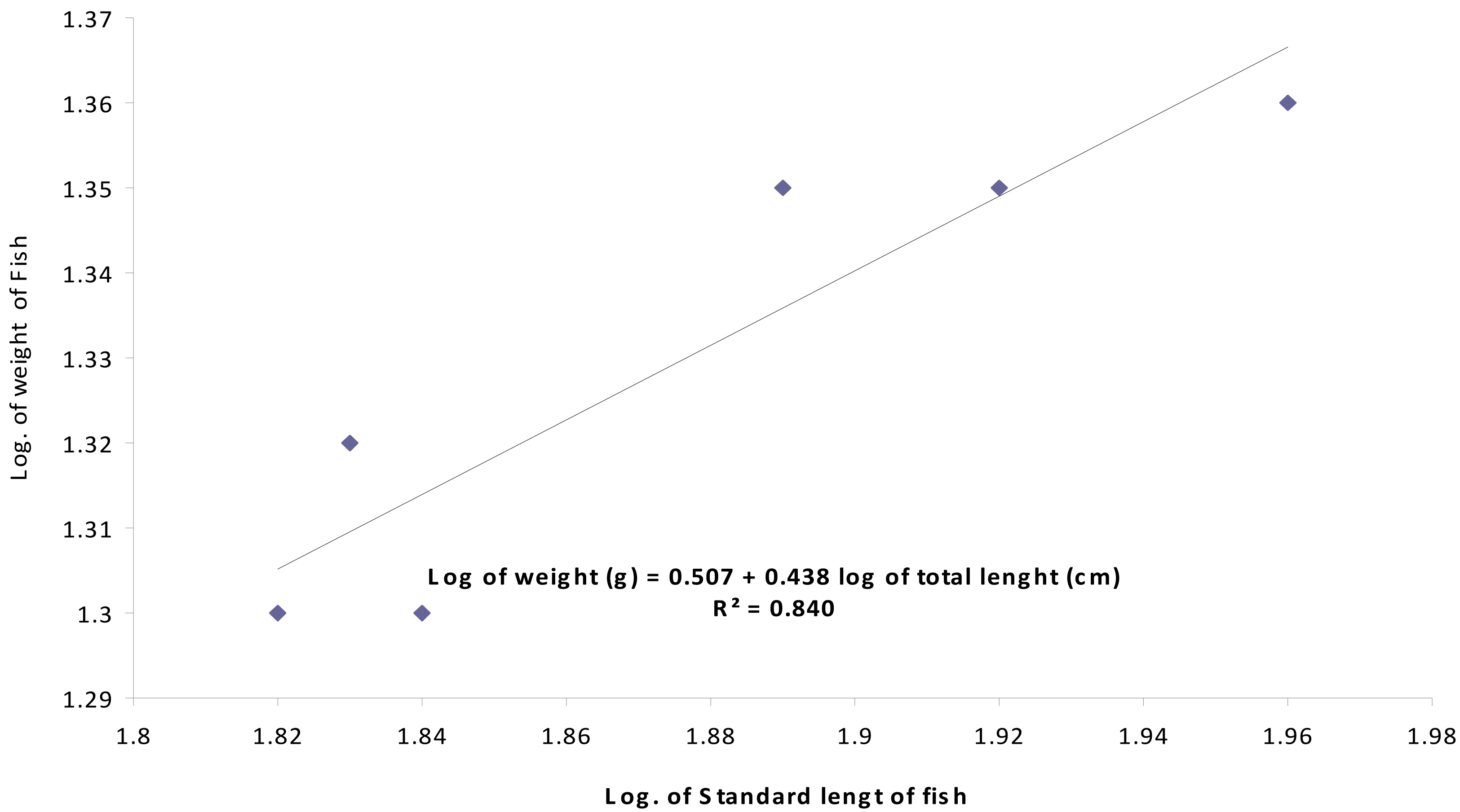

Figure XIII. Length -weight relationship of Female *Clarias gariepinus* in River Ilagi, Ngurore

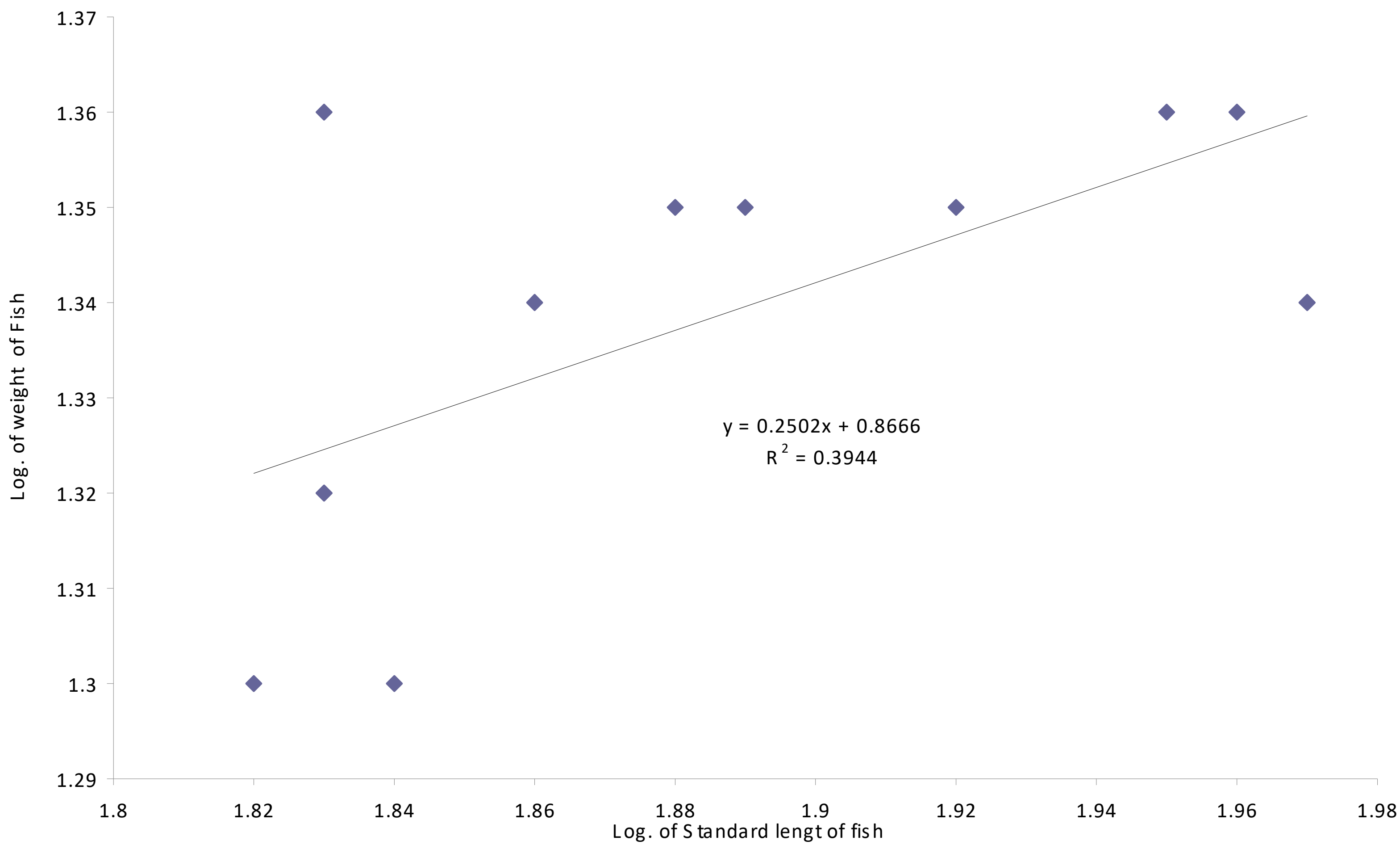

Fig. XIV Length - weight relationship of both sexes Clarias gariepinus in river ilagil, Ngurore, Yola-South

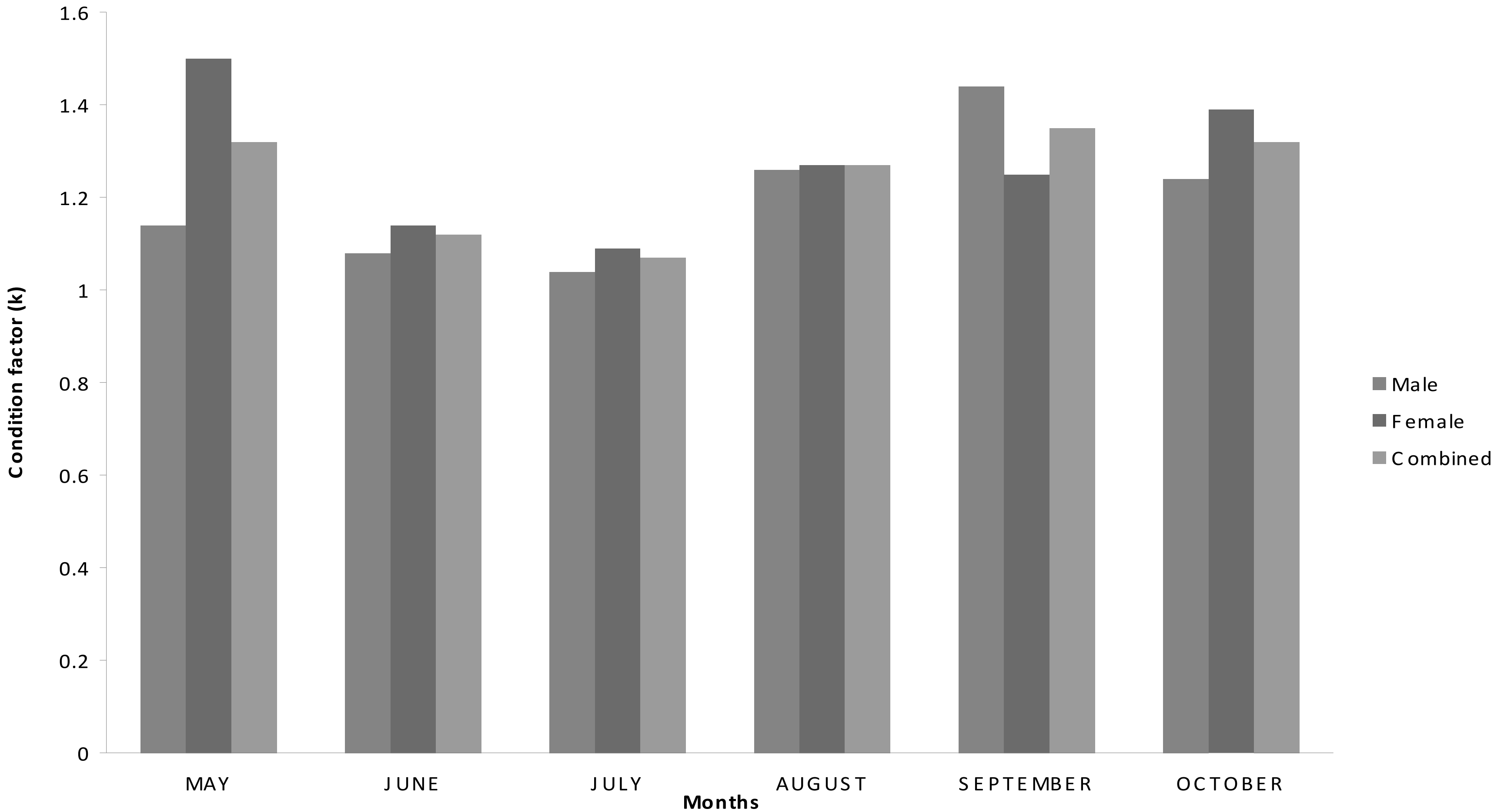

Fig XV. Monthly mean condition factor of Clarias gariepinus in river ilagil, Ngurore, Yola-South

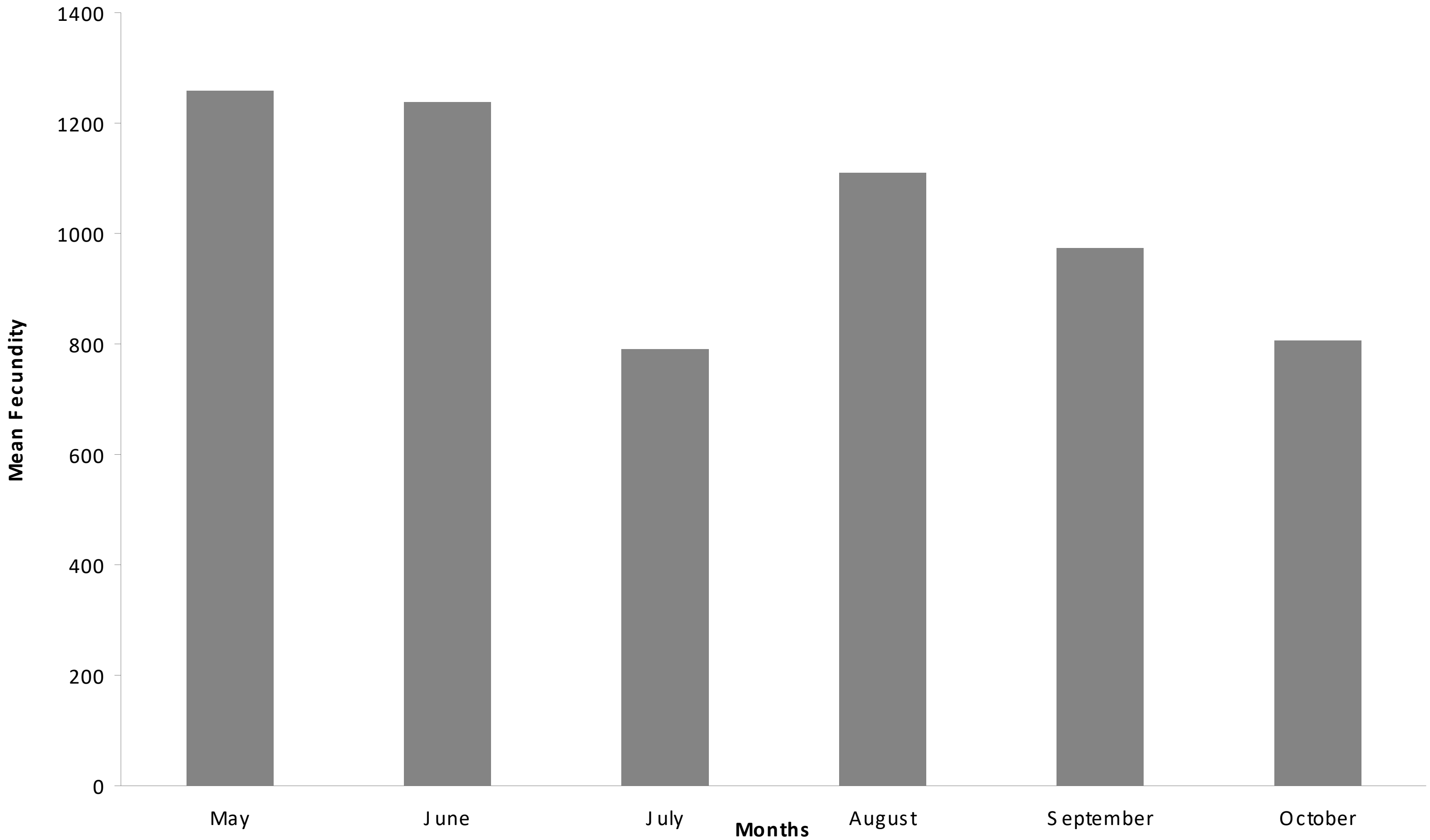

Fig. XVI. Monthly Variation of Fecundity of Clarias gariepinus in river ilagil, Ngurore, Yola-South

CHAPTER FIVE

DISCUSSION

5.1 DICUSSION

Temperature of the river fluctuated between 25.10°C and 28.67°C during the period of the research. This is within the normal range of 8-30°C which fish adopted in the tropics; which are the critical thermal, minimum and maximum respectively (Alabaster and Lloyd, 1980). The relative high temperature observed in this river could be due to the shallow nature of the river, which could be favourable to fish growth and development (Haruna, 1992). Outside the ranges mention various effects occur: Temperature affects the oxygen content of water, the rate of photosynthesis by aquatic plants, the metabolic rates of aquatic organism; and the sensitivity of organisms to toxic wastes, parasites and disease (USEPA, 1991) and Chapman (1997). The ranged of temperature observed during the period of the studies was almost in line with (27.3-29.4°C) obtained by Oladipupo and William (2003) in some selected fish ponds in Lagos state.

Transparency of the river was lowest in May and highest in October. May is usually the beginning of raining season which sets in with corresponding high turbidity which might be attributed to increase in debris load. The secchi disc depth is inversely related to turbidity and determines the conditions of availability of light in the water column to support photosynthesis by phytoplankton, and hence production (Stirling 1985). Abubakar, (2006) also pointed out that reduced activity on the lake and complete lack of rains accounted for very high transparency. Higher turbidity increases water temperature because suspended particles absorb more heat; this in turn reduces the concentration of dissolved oxygen because it reduces the amount of light penetrating the water, which reduces photosynthesis (APHA, 1992). The highest correlation of transparency observed between the centre and inlet of the river may be due to suspended matter and turbulence created by inflow of water from the inlet. Abubakar (2006) states that turbidity is a measure of water clarity; the more suspended materials are in water the less light passes through the water column.

The monthly mean variation of the pH values ranged from 5.40 to 7.50. The recorded values fall almost within the recommended values of 6 to 9 in most tropical natural water (ACTFR, 2002). Abubakar, (2006) reported that pH is an important parameter in many ecological studies because there is a strong relationship between pH and the physiology of most aquatic organisms. USEPA, (1991) observed that extreme pH values outside the range of 6.5 to 9.0 stressed the physical system of most aquatic organisms and reduced reproduction. The mean pH correlation observed between the centre and confluence of the river might be due to high temperature recorded at both sites. Stirling (1985) pointed out that pH is depended upon temperature of water sampled. Abubakar (2006) observed that low pH allows toxic elements and compound to become mobile and available for uptake by plants and animals. The lowest monthly mean pH value of 5.40 might be attributed to the influx of rain water into the river. ACTFR (2002) suggested that high rain water inputs reduce pH to less than 6.

The monthly mean variation of free CO_2 ranged between 2.60mg/l in August and 4.17mg/l in June. The lowest value of free Co_2 observed in the month of August may be attributed to the utilization of free CO_2 by phytoplankton for primary productivity (Abubakar, 2006). Absalom et al (2002) also states that high free CO_2 in water indicated low photosynthetic activities. However, the values obtained fall within the recommended safety limit of 10mg/l as observed by Haruna (2003). Saxena (1990) observed that high alkaline (hard water) water bodies are characterized by negative value of free CO_2. Waters with high free CO_2 content may cause problem of kidney stone formation in fishes (Stirling, 1985).

The monthly mean variations of total alkalinity ranged from 26.70 to 63.87mg/l during the period of the study which is higher than 9.1 to 28.3 reported by Abubakar (2006) in lake Geriyo and less than 84-128mg/l reported by Kolo and Yisa (2002) in river Suka. The pH values of less than 7 observed in the river shows the low buffering capacity of the water body. Saxena (1990) reported that in high productive waters the total alkalinity ought to be over 100mg/l. ACTFR (2002) observed that the alkalinity buffering capacity in natural fresh water systems is due mainly to the presence of bicarbonate leached from the soils in rain water runs off. Saxena (1990) also states that increase pH values of water with high alkalinity (hard water) ranged from 8.5 upward. The highest correlation of total alkalinity was recorded between centre and inlet which might be attributed to the leaching effects of bicarbonate from the run off at both sites as results of localized stream effects which originate from ground water spring. The study also observed fluctuation in monthly mean of total alkalinity of the water as the raining season progresses. Stirling (1985) reported that the alkalinity is the measure of buffering capacity of the water i.e. its ability to with stand pH changes.

The monthly mean variation of conductivity values ranged between 1.340 μs/cm and 4.107 μs/cm which is less than 4.99- 44.19 μs/cm reported by Abubakar (2006). The low conductivity values observed may be due to the narrow fluctuation of monthly mean values of pH around the neutral point of 7 recorded in the river. Stirling (1985) states that the very acidic (pH<4.5) or alkalinity (pH>10) waters have appreciate higher conductivity values. Therefore, discharges can change the conductivity of a river because of their make-up. Discharges could raise the conductivity because of the presence of chloride, phosphorous and nitrate (USEPA, 1991).

The study observed negative relationship between conductivity and temperature values in the river which is not in lined with Abubakar, (2006) reported that higher values of conductivity when temperature values are higher. The highest conductivity mean value recorded at the inlet in May might be attributed to high concentration of suspended matter associated with flow of water through the site. According to Kolo and Yisa (2000), suspended matter influences the availability of ions in water probably through absorption and disposition effects of these ions on surface of suspended matter. These conductivity values fall below recommended 10 µs/cm to 1000 µs/cm (ACTFR, 2002).

Dissolved oxygen (DO) is a very important parameter of water quality and is an index of physical and biological processes going on in the water (Saxena, 1990). The monthly mean variation of the DO ranged from 7.33mg/l in the month of July to 17.07mg/l in October. The monthly mean value of DO observed during the period of study is almost in agreement with 12.02mg/l to 19.50mg/l as obtained by Abubakar (2006). The fluctuation of DO during the period of research might be due to decomposition of organic matter resulting in the competitive use of oxygen. Abubakar (2006) pointed out that apart from the photosynthetic activities which added to the maintenance of high oxygen levels, the cool wind action cause the water to mix thereby the phenomenon of bottom-up and top-bottom is enhance. The observed range (7.33 to 17.07mg/l) which is in line with EIFAC/T19 (1993) reported that DO value of 5mg/l as satisfactory for most species of aquatic life. Super saturated oxygen conditions are caused by algal bloom while low oxygen (anoxic) conditions reduce the number of species being formed and frequently leads to the release of undesirable odours until aerobic or oxic condition develop

(Mays, 1996). Dissolved oxygen values correlated positively with transparency values. The highest transparency was recorded in October may be due to low influx of suspended inorganic matter into the river. Ufodike and Garba, (1992) observed that decrease in water transparency reduces production of natural food in water.

The monthly mean total ammonia variations ranged from 0.124mg/l to 0.165mg/l this is higher than 0.025mg/l recommended by Alabaster and LIoyd (1982). Ammonia in water is released as an end product of decomposition of organic matter and also as excretory product of some aquatic animal (Saxena, 1990). Ammonia is an important nutrient of phytoplankton (Philips, 1985). The high total ammonia observed during the period of the study might be due to decomposition of organic materials and also the low correlation values might be due to no strong association between values of the three points. Stirling and Philips (1990) states that ammonia could originate where the farm water supply is polluted with sewage, silage or other organic rich water. Haruna, (2003) reported that high ammonia cause poor growth, increase susceptibility to disease and eventually death.

The monthly mean total nitrogen fluctuation between the ranges of 0.255mg/l in July to 0.349mg/l in May which is less than 0.44 to 1.21mg/l as reported by Abubakar (2006) in lake Geriyo. The values of total nitrogen obtained in the river were less than the limit of 10mg/l reported by Abubakar (2006). Excess nitrogen at higher concentration of 10mg/l or higher can cause low level of dissolved oxygen and become toxic to warm-blooded animals under certain conditions. The low values of total nitrogen observed in the river might be due to the high concentration of dissolved oxygen recorded during the period of research. Anonymous (1972) states that in well-oxygenated water, nutrient element form a bond with sediments that prevents their recycling. Nitrogen is an important source of nutrients for aquatic plants and animals (Philips, 1985). Haruna (2003) reported that its role in the formation of major constituents of protein. With increase in rains and hence accumulation of run off water in the river, it is also observed that there is increase in concentration of total nitrogen. The concentration of total nitrogen obtained within the tolerable limit of about or less than 1mg/l (USEPA, 1991).

Saxena, (1990) pointed out that domestic and industrial effluents and agricultural run-off are major source of nitrogen in water.

The monthly mean variation of total phosphorus ranged from 0.021mg/l to 0.046mg/l is in agreement with 0.04 to 0.05mg/l observed by Kolo and Yisa (2000) in river Suka. The highest correlation of total phosphorus was observed between centre and confluence and confluence and centre respectively might be due to water flow and sedimentation of organic waste associated with the sites. ACTFR (2002) states that artificial sources of phosphorus include fertilizers, detergent, waste water, industrial effluent and animal excreta amongst others. With increase in rains and accumulation of run-off water in river, it was observed that concentration of phosphorus increased, but the concentration of phosphorus recorded during period of the study was within safety limit of about or less than 1mg/l (USEPA, 1991).

5.2 CONDITION OF FISH

The result of length-weight regression analysis showed that the "b" values, the males, females and both sexes (combined) exhibited allometric growth. The values of "b" obtained during the period of the study shows that the increase in length is not in equal proportion with the weight under constant specific gravity. This is in consonance with the findings of other works (Abubakar, 2006) and (Haruna, 1992).

It has been observed that certain factors such as increase in weight due to intake of water or food, season of the year, and the time of the day when the fish was captured, loss of weight due to food regurgitation and spawning can among other things affects "b" values (Lagler, 1952). There was significant correlation ($P<0.05$) between length and weight exhibiting linear relationship which is similar to observation made by Abubakar (2006) and Abubakar and Ishaya (2000). Treasurer (1976) states that gill nets can select the fatter of short fish and the thinner of long fish, thereby affecting the length weight relationship.

The low alkalinity vales recorded in river might be responsible to allometric growth by the fish. Saxena (1990) reported that in high productive waters the total alkalinity ought to be over 100mg/l.

The mean condition factor values indicated that males, females and both sexes (combined) were in a stable condition throughout the period of research, slight fall was however observed in June and July during period of research. This might be due to changes in the physical and chemical condition of the habitat which can affect the fish physiologically (Abubakar, 2006). Olatunde (1983) observed that there was fall in condition factor of *Clarias gariepinus* in Zaria from October to February during the dry season.

Lagler (1952) observed that sexual differences, age, changes in the season, length and weight of fish, nutritional level of fish or stomach fullness and maturity level of the fish can influence the values of the condition factor.

In the fecundity studies, the number of eggs in mature ovaries of *Clarias gariepinus* ranged from 790.90 to 1258.80 which is almost in lined (494 to 1590) with the observation made by Abubakar (2006). Fecundity could be affected by environmental factors such as food and pollution (Abubakar, 2006). It was observed that fish specimens of the same length and weight had variable fecundities. Bagenal (1967) asserted that fish species exhibit wide fluctuations in fecundity among fish of the same species, size and age.

CHAPTER SIX

SUMMARY, CONCLUSION AND RECOMMENDATION

Pollution status and its effects on *Clarias gariepinus* in river Ilagil was investigated. Samples were carried out fortnightly for six months from May to October, 2009. Fish samplings were carried out using different mesh sizes of gill net. ("2" "2.5").

Water temperature fluctuated between 25.10^{o}C to 28.67^{o}C adequate for supporting aquatic life. Transparency was low in May and high in October. Hydrogen ion (pH) generally remained around the neutral value with slight changes not exceeding the minimum and maximum allowable threshold level for aquatic life. Free carbondioxide level ranged from 2.60 to 4.17mg/l was within the recommended safety limit of 10mg/l maximum. The relatively low total alkalinity values gave the river low ability to withstand pH changes. The low conductivity values of 1.34 to 4.02 μs/cm obtained in the river were below the recommended values of 10μs/cm to 1000 μs/cm for tropical inland water bodies. Dissolved oxygen values were low in July and high in October. The highest values of total ammonia obtained were above recommended values of 0.025mg/l. Total nitrogen concentration observed ranged from 0.255 to 0.349mg/l was within the recommended values of 10mg/l. total phosphorous fluctuation between 0.021mg/l to 0.046mg/l was within the safe limit of about or less than 1mg/l. All these physico-chemical parameters show no significant difference ($P>0.05$) in variability between sites and within months.

Length-weight regression analysis showed that the "b" values, the males, females and both sexes (combined) exhibited allometric growth. There were significant correlation ($P<0.05$) between length and weight of both sexes. The monthly mean condition factor indicated that the fish were in a stable condition throughout the period of research. Fecundity values observed were generally low. Drastic fall in the values of condition factor and fecundity were recorded in the month of July, which coincides with the low values of dissolved oxygen and a higher temperature and total ammonia.

Result of the study showed that the value of physico-chemical parameters obtained is almost within the recommended ranges. This can be maintained by ensuring proper management of the resources of the river. Standard waste management generated from the cattle market should be employed. This will reduce the danger of polluting the river in future. Study of the conditions of other fish species in the river is also recommended.

REFERENCES

Absalom, K.V.; Musa, S.O; Akpa, L.E. and A. Oyindashola (2002). Protozoa Diversity in a Productive Fish Pond of a Tropical Plateau. *Journal of Aquatic Science* 17 (12) 109-112.

Abubakar, K.A. (2006). A Study of Aspects of Productivity and Stock Status of *Oreochromis nitoticus* and *Clarias gariepinus* in Lake Geriyo, Yola Adamawa State, Nigeria. PH.D Thesis Federal University of Technology, Yola, Nigeria. 212.

Abubakar, K.A. and Ishaya, R.M. (2000). Some Biological Aspects of *Orechromis niloticus* in Lake Geriyo, Yola, Adamawa State, Nigeria. *Journal of Education and Technology* vol.1; No.1:91-95.

ACTFR. (Austria centre for tropical fresh water research) (2002). Water Quality for Sustainable Agriculture NRM Wet Tropics. *Australian Centre for Tropical Fresh Water Research*. 10-15

Adeniyi, M.T. (1980). Microbial Decomposition of faeces in the Lagos. PH.D Thesis University of Lagos. 20-25.

Adebayo, A.A (2004) Yola-South Region, A Geographical Synthesis. Paraclete Publishers, Yola-Nigeria. 22 – 25.

ADSMLS (2005) Adamawa State Ministry of Land Survey.

Ajao, E.A. Oyewo, E.O. Unyimadu, J.P. (1996). A Review of the Pollution of Coastal Water in Nigeria 15-18.

Alabaster, J.S. and R. LIoyd (1980). "Water Quality for Fresh Water Fish" FOA and Butter Worths, London 29.

Alabaster, J.S. and R. LIoyd (1982). "Water Quality Criteria for Freshwater Fish". FAO and Butterworths, London 297.

Alabaster, J.S. (1986). Testing the Toxicity of Effluents to Fish Chemical Ind. 759-764.

Anonymous (1972). Limnology of the Main stream Okanagan Lakes. Preliminary Study Data-Bulletin No.3 Study Committee, Canada-British Columbia-Okanagan Basin Agreement, Penticton, B.C. 4p.

AOAC. (1990). The Official Methods of Analysis Association of Official Analytical Chemists, 17th edition Washington DC.

APHA, (American Public Health Association) (1992). Standard Methods for the Elimination of Water and Waste Water. 18th edition. American Public Health Association, Washington, D.C.

Bagenal, T.B. (1967). A Short Review of Fish Fecundity in the Biological Basis of Fresh Water Fish Production. (Ed. Gerking, S.D) Proceeding of IBP Symposium, Oxford Blackwells, 89-111.

Biney, C; Amuzu, A.T; Calamari, P.B.O; Osibanjo, O; Radegonde, V; and Sa'ad, M.A.H. (1994). Review of Heavy Metal (ed) Calamari David and Henrier Naeve 33-60 CIFA Technical Paper No.25, Rome, FAO.

Bramley, R.G and C. Roth (2002). Land-use Effects on Water Quality in an Intensively Managed Catchments in Australia Tropics. *Marine and Fresh Water Research* **53** (5): 931-940.

Brassard, P.G. (1996). Wetlands and Water Pollutions Beston Coll. Environ. Aff. Law Rev. Vol.23, No.4, 885-919.

Burande, A. (2007). Effects of Water Pollution. A single resources 2: 17-19.

Chapman, D. (1997). Water Quality Assessment. A Guide to the use of Biota, Sediments and Water in Environ. Monitoring 2nd Ed. & En. SPON. London. 210.

Daniel, A. (2006). Investing in Tomorrow Liquid Gold. 12 -15

DeGraaf, G. and Jansseen, H. (1996). The Artificial Production and Pond Rearing of the African Catfish *C. gariepinus* in Sub-sahara, Africa. A Handbook FAO Fisheries Technical Paper No.362. FAO Rome 37.

Effler, S.W; Brooks Cui, M.T. Aller and S.M. Doerr (1990). Free Ammonia and Toxicity Criteria in a Polluted Urban Lake. *Journal of Water Pollution Control* Feb. **62**:71-779.

EIFA/T19 (1993). European Inland Fisheries Advisory Commission on Water Quality Criteria for European Fresh Fish. Report on Dissolved Oxygen and Inland Fisheries. EIFAC Technical Paper: 19:10.

Elewa, A.A. and Authman, M. (1991). Limnological Studies on bahr Shebeen Canal; El-menofia Government, Egypt. *Bullp-fae.sci. Zagazing Uni.Egypt* **13**(12): 470-480.

Grossman, S. (2001). Effects of Pollution. Water quality int. 30-33.

Haruna, A.B. (1992). Studies on Aspects of Water Quality and Biology of the Fish of Jakara Lake, M.Sc Thesis BUK 151.

Haruna, A.B. (2003). "Aquaculture in the Tropics: Theory and Practice" Al-Hassana Publisher Abuja. Kaduna, Kano Nig. 253-271.

Heath, A.G. (1991). Water Pollution and Fish PHysiology. Lewis Publishers, Boca, Ranton, Florida. USA. 5-8

James, F.M. and Ronald, J.R. (1988). Recent Advances in Aquaculture vol.2 Croom Helm Ltd. Provident House Burrell Roww, Beckenham, kent BR3 IAT Sydney-Australia.

James, N.P.E. and Brutun, M.N. (1992). Alternative Life-history Traits Associated with Reproduction in *Oreochroni*, *massambicus* (Pisces Cichlidae) in Small Water Bodies of Eastern Cape, South Africa. Env. Biol. Fish 34:379-392.

Khanna, S.S. and Singh, H.R. (2003). A Textbook of Fish Biology and Fisheries. Narendra Publishing House Delhi-India.22-25.

Kolo, R.J. and M. Yisa (2000). Preliminary Baseline assessment of the water quality of river Suka, Nigeria State *Journal of Fisheries Technology* Federal College of Fresh Water Fisheries Technology New Bussa and Alau-Nigeria Vol.2:99-106p.

Lagler, K.E. (1952). Fresh Water Fishing Biology (2^{nd} edition) IOWA W.M.C. Brown USA.

Lagler, K.F; J.E. Bardack; R.R. Miller and D.R.M. Passion (1977). Ichythylogy 2^{nd}. John Wiley and Sons New York.

Le-Cren, E.D. (1951). The Length-Weight Relationship and Seasonal Cycle in Gonad Weight and Condition in the Perch (Perca Fluviatitus) *J. Anim. Ecol*. Vol.81, No.1.

Margaleff, R. (1996). Limnology Now. A Paradigm of Planetary Problems. Elsevier, Amsterdam. 52-55.

Mason, C.F. (1991). Biology of Fresh Water Fishes. Longman Scientific and Technical, New York, USA 351pp.

Mays, S.L.W. (1996). Resources Handbook. McGraw Hill, New York, 92.

Oladipupo, A.E. and William, A.B. (2003). PHysico-Chemical Parameters and PHytoplankton Community of Some Selected Fish Ponds in Lagos, Nigeria. *Journal of Aquatic Sciences* 18(1) 53-57.

Olatunde, A.A. (1983). The Length-Weight Relationship and the Diets of *Clarias* in Zaria. *Processing of the 3rd Annual Conf. of Son, Maiduguri* 183-192.

Olurin, K.B. and Aderibigbe, O.A. (2006). Length-Weight Relationship & Condition Factor of Pond Reared Juvenile *Oreochromis niloticus*. *World Journal of zoology* 1(2):82-85. Idosi Publication.

Onuoha, G.U.C and Deekae, S.N. (2005). Effects of Oil Pollution on fish Production. *Fisheries Society of Nigeria.*2:120-125.

Philips, M.J. (1985). Analysis of Nutrients. In Stirling H.P. (ed) Chemical & Biological Methods of Water Analysis for Aquaculture. First edition Institute of Aqua. University of Stirling, Stirling Printed & made in Great Britain 110.

Poppe, Wayne, Hurt and Renee, (1997). Water Pollution, Water Quality Inst. 39-43.

Richman, M.IND. (1997). Water pollution, Waste Water vol.5, No.2, 24-29.

Robert, P. and Allne, G.B.Jr. (2001). Stromwater Effects. Handbook: A Toolbox for Watershed Managers, Scientists, and Engineer New York. CRC/Lewis Publishers.

Saxena, M.M. (1990). Environmental Analysis: Water, Soil and Air. Agro-Botanical Publisher India.32-35.

Sobgesan, A.O. (1998). Water pollution. Fresh and Green Ltd. 5-10.

Stirling, H.P (Ed) (1985). Chemical and Biological Methods of Water Analysis for Aqua. University of Stirling. Printed and made in Great Britain 119.

Stirling, H.P. and M.J. PHilips (1990). Lecture Notes on the Water Quality Management for Aquaculture and Fisheries Materials edited by BAFRU-Bangladesh Aquaculture and Fisheries, Resources Unit (Overseas Devt. Admin) Institute of Aquaculture of Aquaculture Publication Univ. of Stirling 78p.

Stone, N.M and Thomforde, H.K. (2006). Understanding your Fish Ponds. Water Cooperation Aqua/Fisheries Ext. prog. University of Akansas.

Struempler, A.W. (1973). Adsorption Characteristics of Ag. Pb, Zn and Ni on Birosilicate Glass, Polythene and Polypropylene Container Walls and Chem. 45: 225-254.

Swift, D.A. (1993). Aquaculture Training Manual 2nd edition Fishing New Book 105-114.

Teugels, G.G.C. (1984). The Nomenclature of African Catfish, *Clarias* Species used in Aquaculture. *Aquaculture* 38:373-374.

Thomas, D. Neese, S. Lindsey, T. (1996). Pollution Prevention. Water Quality International 32-36.

Thomas, R.S. (2000). Microbes and Urban Watersheds: Concentration Sources and Pathways. Reprinted in the Practice of Watershed Protection.

Tressurer, J.W. (1996). The Age, Growth and Length-Weight Relationship of Brown Trout, *Salmo trutta* (L) in the Loch of Strathbeg, Aberdeemshire. J. Fish Biology 8, 241-247.

Ufodike, E.B.C and Garba, A.J. (1992). Seasonal Variations in Limnology and Productivity of a Tropical Highland Fish Pond in Jos Plateau, Nigeria *Journal of Aquatic Sciences* 7; 29-34.

Umar, D.M., Ofokekwu, P.C., Onyeka, J.O.A. (1996). Pollution Status of Industrial Wastes and their Effects on Macro-invertebrates Distribution Along Anglo-Jos Water Channel, Jos. *Journal of Aquatic Science* 11:1-6.

USEPA, (1991). Volunteer Lake Monitoring a Methods Manual, EAPA 4404-91-002 office of Water US Environment Protection Agency Washington D.C.

West and Larry (2006). World Water Dag. "A Billion People Worldwide Lack Safe Drinking Water.6:21-25

Worthington, B.E. and Richard, C.K. (1931). Scientific Results of the Cambridge Expedition to the East African Lakes. No. 15. The Fishes of Lake Rudoff and Lake Beringo. *J. Limnsoe Zoology* 267:353-389.

APPENDIX I: PHYSICOCHEMICAL DATA

WATER TEMPERATURE (°C) TABLE

READING (°C) SITES:

Month	Inlet	Centre	Confluence	Mean	Std Deviation
May	29.0	29.0	28.0	28.667	0.577
June	26.0	26.0	26.0	26.000	0.000
July	27.3	27.0	27.0	27.267	0.252
August	25.0	24.8	25.5	25.100	0.361
September	28.0	28.0	28.5	28.167	0.289
October	28.0	29.0	29.0	28.667	0.577
Mean	27.2	27.3	27.4		

TRANSPARENCY TABLE (CM)

READING (CM) SITES:

Month	Inlet	Centre	Confluence	Mean	Std Deviation
May	7.9	8.0	8.1	8.000	0.100
June	7.2	8.5	10.2	8.633	1.504
July	11.5	10.4	11.8	11.233	0.737
August	10.3	11.4	9.5	10.400	0.954
September	11.5	12.4	12.4	12.100	0.520
October	11.9	12.6	12.7	12.400	0.436
Mean	10.1	10.6	10.8		

HYDROGEN ION (PH)

READING (PH) SITES:

Month	Inlet	Centre	Confluence	Mean	Std Deviation
May	4.8	5.7	5.7	5.4000	0.519
June	7.2	6.2	4.8	6.0667	1.2055
July	6.5	7.2	7.5	7.0667	0.5132
August	7.3	7.5	7.7	7.5000	0.200
September	7.4	7.7	7.4	7.5000	0.173
October	7.4	8.0	7.1	7.5000	0.458
Mean	6.8	7.1	6.7		

FREE CO_2 (mg/l)

READING (mg/l) SITES:

Month	Inlet	Centre	Confluence	Mean	Std Deviation
May	4.0	4.4	3.3	3.9000	0.5568
June	5.0	4.0	3.5	4.1667	0.7638
July	4.0	3.0	2.0	3.0000	1.000
August	2.5	2.2	3.1	2.6000	0.4583
September	3.0	2.3	3.5	2.9333	0.6028
October	3.0	5.0	2.0	3.333	1.5275
Mean	3.6	3.5	2.9		

TOTAL ALKALINITY TABLE (mg/l)

READING (mg/l) SITES:

Month	Inlet	Centre	Confluence	Mean	Std Deviation
May	58.8	67.4	65.4	63.867	4.500
June	41.7	41.5	39.9	41.033	0.987
July	36.2	30.5	40	35.567	4.782
August	52.5	52.7	49.1	51.433	2.023
September	26.7	26.4	27	26.700	0.300
October	50.0	47.0	44.0	47.000	3.000
Mean	44.3	44.3	44.2		

CONDUCTIVITY TABLE (μS/CM)

READING (μs/CM) SITES:

Month	Inlet	Centre	Confluence	Mean	Std Deviation
May	4.68	3.89	3.48	4.0167	0.6099
June	1.66	1.41	1.59	1.5533	0.1290
July	1.66	1.71	1.54	1.6367	0.0874
August	2.06	1.98	2.21	2.0833	0.1168
September	1.82	1.67	1.87	1.7867	0.1041
October	1.34	1.34	1.34	1.3400	0.0000
Mean	2.20	2.00	2.01		

DISSOLVED OXYGEN (DO) TABLE (mg/l)

READING (mg/l) SITES:

Month	Inlet	Centre	Confluence	Mean	Std Deviation
May	11.3	11.0	11.7	11.333	0.351
June	9.7	6.9	8.1	8.233	1.405
July	7.7	7.3	7.0	7.333	0.351
August	8.6	8.3	9.4	8.567	0.737
September	9.8	9.8	10.5	10.033	0.404
October	17.8	12.9	20.5	17.067	3.853
Mean	10.8	9.4	11.2		

TOTAL AMMONIA TABLE (mg/l)

READING (mg/l) SITES:

Month	Inlet	Centre	Confluence	Mean	Std Deviation
May	0.128	0.135	0.141	0.135	0.00651
June	0.131	0.135	0.106	0.124	0.01572
July	0.126	0.135	0.152	0.138	0.0132
August	0.137	0.125	0.132	0.131	0.00603
September	0.127	0.133	0.140	0.133	0.00651
October	1.143	0.232	0.128	0.165	0.05107
Mean	0.132	0.148	0.133		

TOTAL NITROGEN TABLE (mg/l)

READING (mg/l) SITES:

Month	Inlet	Centre	Confluence	Mean	Std Deviation
May	0.306	0.371	0.371	0.349	0.03753
June	0.333	0.411	0.262	0.335	0.0445
July	0.252	0.271	0.241	0.255	0.01021
August	0.283	0.255	0.270	0.269	0.01400
September	0.254	0.267	0.251	0.257	0.00601
October	0.285	0.290	0.332	0.302	0.00874
Mean	0.286	0.311	0.288		

TOTAL PHOSPHORUS TABLE (mg/l)

READING (mg/l) SITES:

Month	Inlet	Centre	Confluence	Mean	Std Deviation
May	0.018	0.023	0.025	0.022	0.0036
June	0.050	0.027	0.025	0.034	0.0138
July	0.030	0.034	0.023	0.029	0.005568
August	0.039	0.045	0.054	0.046	0.00755
September	0.031	0.041	0.034	0.033	0.00173
October	0.020	0.023	0.021	0.021	0.000577
Mean	0.031	0.032	0.030		

STANDARD AMMONIA TABLE FOR CALIBRATION CURVE

CONCENTRATION (mg/l)	ABSORBANCE
0.5	0.256
1.0	0.512
1.5	0.768
2.0	1.024

STANDARD NITROGEN TABLE FOR CALIBRATION CURVE

CONCENTRATION (mg/l)	ABSORBANCE
0.25	0.14
0.5	0.28
1.0	0.56
1.5	0.89

STANDARD PHOSPHORUS TABLE FOR CALIBRATION CURVE

CONCENTRATION (mg/l)	ABSORBANCE
2	0.055
4	0.133
6	0.148
8	0.214
10	0.211

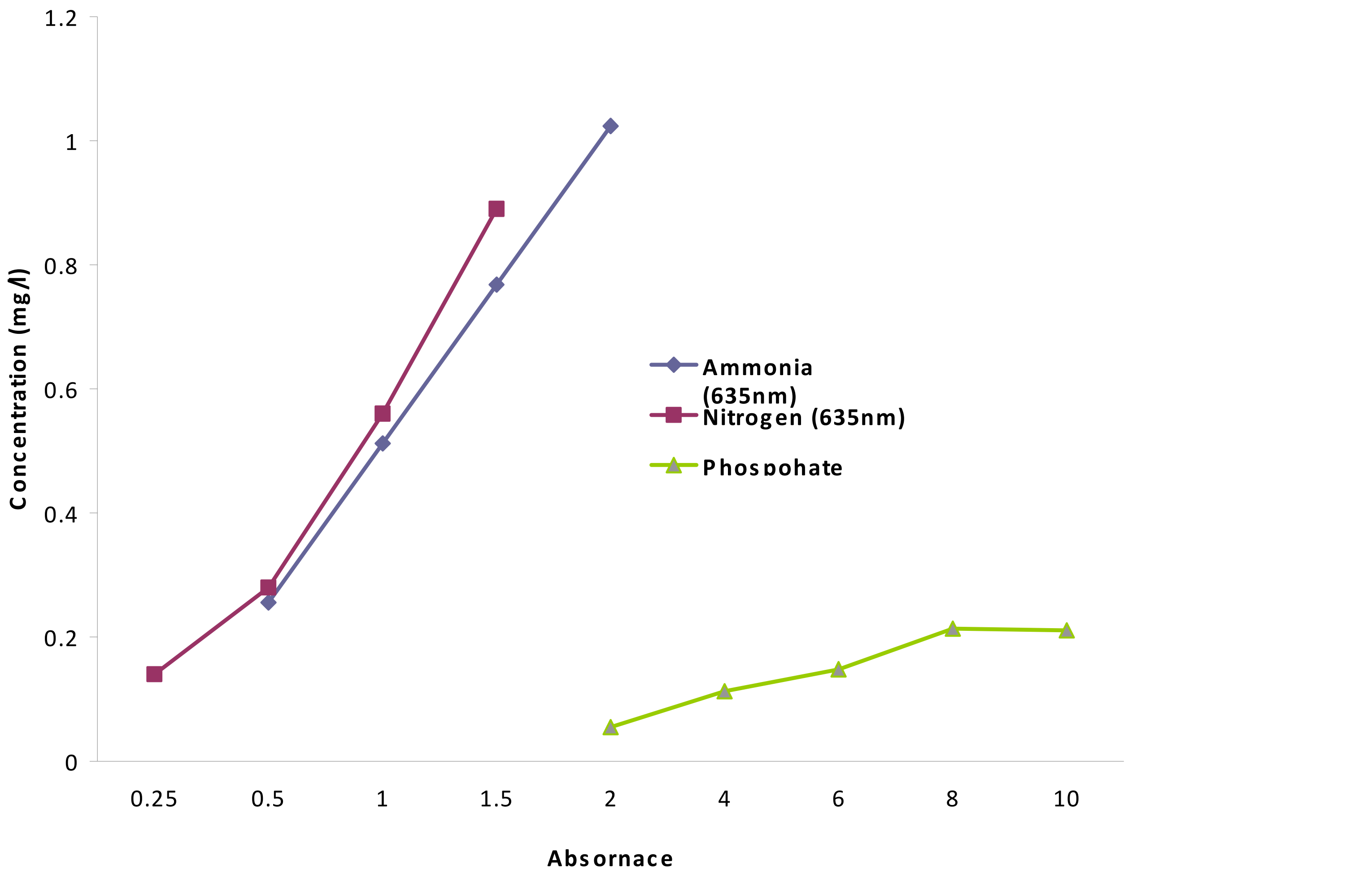

Figure 8. Absorbance curves of Ammonia, Nitrogen and Phosphate

PPENDIX II

MONTHLY MEAN CONDITION FACTOR (FEMALE)

Month	Total Examined	Condition range	Factor Mean	Std deviation
May	8	1.45-1.55	1.50	0.053
June	7	1.18-1.10	1.14	0.042
July	11	1.09-1.09	1.09	0.011
August	7	1.09-1.44	1.27	0.185
September	10	1.32-1.18	1.25	0.074
October	8	1.43-1.36	1.39	0.037

MONTHLY MEAN CONDITION FACTOR (MALE)

Month	Total Examined	Condition range	Factor Mean	Std deviation
May	11	1.25-1.03	1.14	0.114
June	17	1.07-1.09	1.08	0.0103
July	17	0.98-1.10	1.04	0.062
August	16	1.10-1.41	1.26	0.160
September	16	1.62-1.25	1.44	0.191
October	18	1.18-1.30	1.24	0.062

MONTHLY MEAN CONDITION FACTOR (COMBINED)

Month	Total Examined	Condition range	Factor Mean	Std deviation
May	19	1.35-1.29	1.32	0.031
June	24	1.13-1.10	1.12	0.111
July	28	1.04-1.10	1.07	0.102
August	23	1.10-1.43	1.27	0.185
September	26	1.47-1.22	1.35	0.034
October	26	1.31-1.33	1.32	0.092

APPENDIX III

MONTHLY MEAN FECUNDITY (FEMALE) ***Clarius garipinas***

Month	Total Examined	Condition range	Factor Mean	Std deviation
May	8	756-1756	1258.80	527.05
June	7	576-2084	1237.70	794.79
July	11	488-2142	790.90	871.73
August	7	408-1946	1110.20	810.60
September	10	462-2037	974.00	830.10
October	8	590-1376	806.00	414.26