

Physico-chemical studies of Akor River and distribution of prawn, *Macrobrachium Vollehovenii* and *Macrobrachium fellicinum*

*¹ Ukagwu JI, ² Deekae SN, ³ Ohaturuonye Sampson O

¹ Agricultural Science department Alvan Ikoku Federal College of Education Owerri, Nigeria

² Department of Fisheries and Aquatic Environment, Rivers state University of Science and Technology, Port Harcourt, Nigeria

³ Department of fisheries and Aquaculture Technology, Imo state Polytechnic Umuagwo, Nigeria

Abstract

The Physico-chemical factors of Akor River, has been analyzed to understand its relationship with the distribution of the palaemonids *Macrobrachium vollenhovenii* and *Macrobrachium fellicinum* in the water body. Water samples were collected fortnightly from all the three stations between 8.30 and 11.30hr on sampling days and the physical and chemical parameters were determined with standard equipment. Although some of the ranges showed significant differences ($p < 0.05$), they all fell within the normal range for freshwater prawn fish production. water temperature was between (24.75 to 29.0°C), water depth (2.31 to 5.7m), pH (6.28 to 7.65), dissolved oxygen (5.10 to 7.21mg/l), conductivity (33.53 to 69.05 μ s/cm, total alkalinity (22.25 to 43.42mg/l), nitrate-nitrogen (0.32-1.12mg/l), phosphate-phosphorus (0.05 to 1.16mg/l), total dissolved solids (9.70 to 33.33mg/l) and hardness (18.35 to 35.85mg/l). Analysis of variance was used to test the inter-station variables for water parameters while Spearman correlation coefficient was used to evaluate the relationship between the water quality and prawn abundance which revealed that some parameters positively and negatively correlated with prawn abundance ($\alpha = 0.05$). The study reveals that the water quality parameters fall within the normal range which provided favourable condition for the growth and survival of prawns. In view of its economic value, commercial cultivation of *Macrobrachium vollenhovenii* and *Macrobrachium fellicinum* can be implemented in the Ikwano regions of Akor River and recommend that fish farmers and culturists should take advantage of the aquatic environment.

Keywords: physico-chemical parameters, *macrobrachium vollenhovenii*, *macrobrachium fellicinum*, abundance, akor river

Introduction

The freshwater prawn belonging to genus *Macrobrachium* of the crustacean sub family *Palaemonidae* include more than 60% of the prawn species. They are highly esteemed as nutritive proteinaceous food, bearing a varying market price for larger forms from 60-120g and have average adult weight of 50g and a total length of 200mm. They are extensively distributed in freshwater and estuaries of the world (Kutty *et al.*, 2000) [24].

Macrobrachium vollenhovenii is the largest of the local palaemonid prawns. With a maximum size at 182mm (Holthius, 1980) [19], this species is in the same size class as *M. americanum*, *M. carcinus* and *M. malcolmsonii*. It is a hardy prawn in many ways. It thrives in murky waters (white water rivers in the Nigerian context), and will survive in waters with dissolved oxygen as low as 1 ppm. Ville (1971) [46] and Marioghae (1982) [27] reported the capture of this species from waters with natural salinities at 27 ppt and 19 ppt respectively. Mwangi (1984) [29] proved experimentally that the species can easily tolerate salinities ranging from freshwater to 22 ppt. *macrobrachium fellicinum* occurs along with *M. vollenhovenii* in non-tidal freshwater zones of White water Rivers. Oxygen and pH tolerance will therefore be probably as for *M. vollenhovenii*. However, maximum adult size (120mm), Powell (1982) [36].

Growth of prawns depends on the ability to moult and the quality of the available food and water (Hartnoll, 1982; Kriengkrai, 2006) [23]. The occurrence, survival/ mortality

could be affected by environmental factors such as low temperature (Nelson *et al.*, 1977; Sarver *et al.*, 1982; Chappie and Burton, 1997; Zimmermann, 1998; New and Valenti, 2000; Kriengkrai, 2006 ; Prasad and Kanaujia, 2006) [23, 24, 37], low pH (Strauss *et al.*, 1991; Castro *et al.*, 2004; Kriengkrai, 2006 ; Prasad and Kanaujia, 2006) [23, 37] and low dissolved oxygen (Rogers and Fast, 1988; New and Valenti, 2000; Burton *et al.*, 2005; Kriengkrai, 2006) [23, 32]. The objective of the present study is to find out the reasons for the occurrence of *Macrobrachium vollenhovenii* and *Macrobrachium fellicinum* in akor River Ibere on the basis of physico-chemical parameters.

Materials and Methods

Study Area

Ibere is in Ikwano Local government area between latitudes 05.34829°N and Longitude 007°34468' E with elevation of 77m (Ukagwu, 2015) [45]. The Ibere region which is located in the northern part of Ikwano LGA. Three fixed stations were sampled from October 2012 to September 2014 in Akor river in Ibere. The river derived its source from the Ozuitem hills known as "Mgbele Akor" and empties itself at the Qua Iboe river in Akwa Ibom state.

Collection of prawn

The area density method was employed for the population studies. For the purpose of sampling, Akor River was delineated into three sections designed as station A, B and C.

the sampling programme spanned for twenty-four months (October 2012 to Sept 2014) with the assistance of the artisanal fishers at the three different sampling points with the use of basket traps made of bamboo and has cone shape as described by Solarin *et al.*, (2003) [41]. Sampling was conducted fortnightly between 7.30hrs and 12.30hrs and on sampling days. The prawns collected at each station were sorted into male and female). The sexes of the shrimps were determined based on morphological characteristics as stated by New and Singholka (1982) [30] and Sagua (1980) [40]. Male shrimps possess appendix masculina on the second pleopod while females have none. Females were broader than the males.

Physico-chemical parameters of the river water

Three plastic bottles measuring one thousand millilitres each were used to collect water samples. The bottles were immersed to about 6cm below the water surface and filled to capacity. They were then brought out of the water and properly closed they were then brought out of the water and properly closed. Each bottle was flushed severally and confirmed that no air bubble existed. They were then transported to the laboratory for further analysis. Water samples were collected monthly and the following parameters were examined and determined: Water temperature (°C), P^H,

Total hardness (mg/l), dissolved oxygen (mg/l), conductivity (µScm⁻¹), total dissolved solids, nitrate-nitrogen, phosphate-phosphorus. For the water analysis APHA (2005) Standards were followed as suggested by Onuoha (2009).

Statistical analysis

To establish the relationship between water parameters and prawn abundance, the spearman correlation coefficient (Bhujel, 2008) [10]. To evaluate the statistical significance of the water parameters, one-way Analysis of Variance (ANOVA) (Kothari, 1990) [22] was applied. The data were analyzed at 5% significance level.

Results and Discussion

Physico-chemical characteristics

From Fig 1, the surface water temperature for the river during the study period was within the range 24.75±0.67 °C -29.1 ± 0.62°C. The highest temperature of 29.1°C was recorded in February 2013 at station A while the least was 24.75 recorded at the same station A in August 2013. This result corroborate with the study carried out by Udoh (2010) [44], on Imo river and the Qua Iboe estuary both in the Niger delta region which had a temperature range of 24.25 – 29.15°C in the Qua Iboe estuary and 25.7-29.2°C in the Imo river estuary.

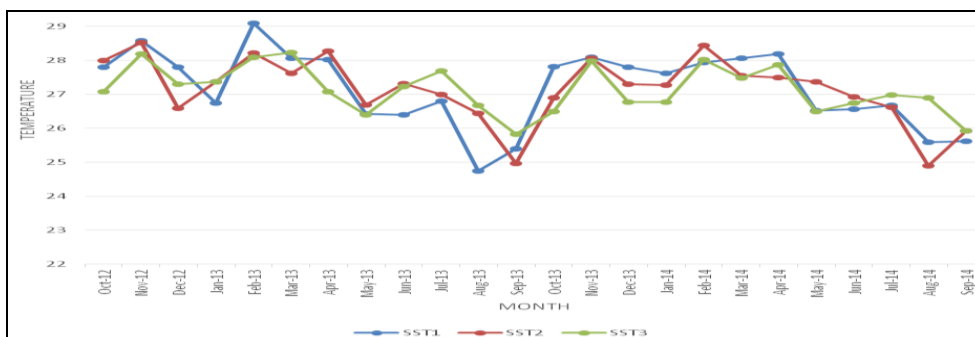


Fig 1

The water depth varied with season, being deeper in wet season and shallow in dry season. Depth values recorded within the period of study ranged from 0.04 – 5.75m which was all recorded from station C (Fig 2). The lowest depth was recorded in November 2012 at station C while the deepest was recorded in September 2014 at the same station C. Water depth is known to affect productivity of the aquatic ecosystem, shallow freshwater are said to be more productive than deeper ones (Beadle, 1981) [6]. A large seasonal variation in the level of water in the river was observed. This variation

followed rainfall pattern with the highest level of 5.75m being in September 2014, while the lowest level of 0.04m was recorded in the dry season (November 2012). This corroborates with the result of the work of Ekelemu (2006) [17] on hydrology and fish faunal communities of some freshwater bodies. Our results indicate that the catch rates were not affected by depth, whilst depth variation is an important determinant of the size composition of shrimp (Daliri *et al.*, 2013,) [14]

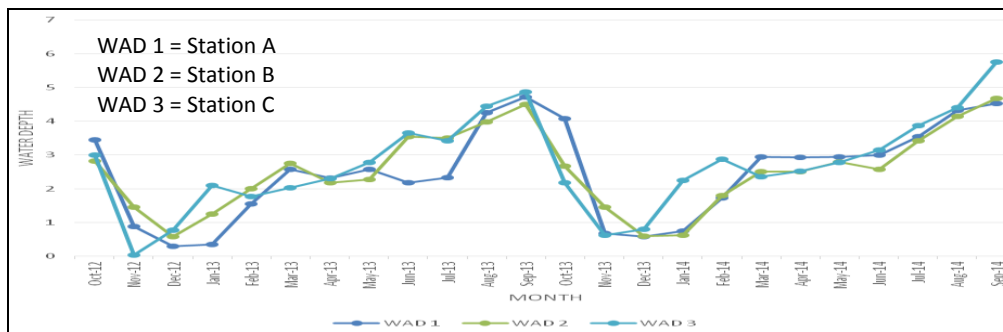


Fig 2

The pH values (Fig 3) varied between 6.20 and 7.73. The highest pH value of 7.73 was recorded in November 2012 at station A while the lowest value of 5.75 recorded in the study period was at station C in December 2012. On a station by station basis there was a slight fluctuation in pH values. The difference between the maximum and minimum pH values was 1.53 and dropped to 1.08 and 0.08 in station B and C respectively. The highest pH value recorded for the river in the course of this study was 7.73 while the mean was 7.0. These values are well within the preferred pH range of 6.5 –

9.0 for optimum prawn production. The pH correlated negatively with fish abundance which explained that any increase or decrease in the pH will negatively affect productivity in the river. ($p < 0.05$) This result corroborates the findings of Tucker and D'Abramo (2008) [48] who found problems with high pH and common in fry nursery ponds and in ponds used to grow freshwater prawns (*Macrobrachium rosenbergii*) because fertilization practices used to prepare ponds for stocking are designed to promote fast-growing phytoplankton blooms that rapidly take up carbon dioxide.

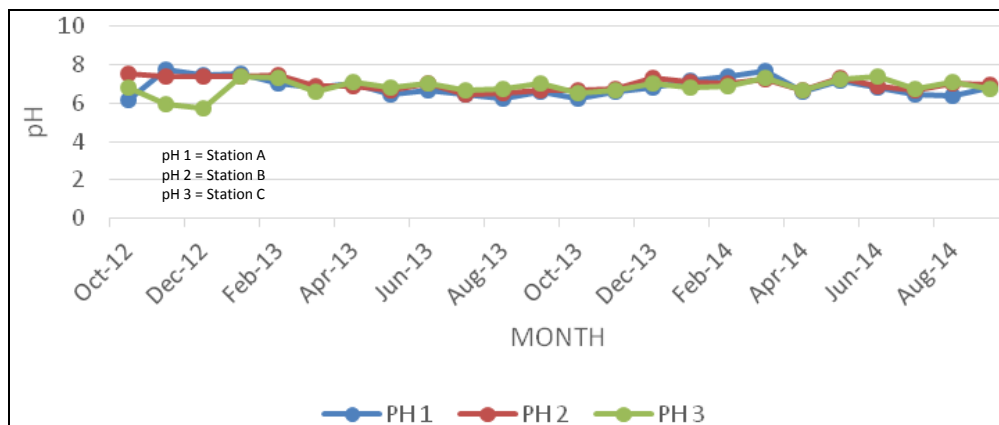


Fig 3

There was wide fluctuation in the concentration of dissolved oxygen value recorded in the different stations (fig 4). The highest concentration of dissolved oxygen value of 7.2mg/l was observed in August 2014 at station A while the least

value of 5.10mg/l was recorded in April 2014 at station C. Station C had the widest range of dissolved oxygen concentration values with a range of 5.1 – 7.20mg/l, station B had the narrowest range of 5.05 – 7.18mg/l.

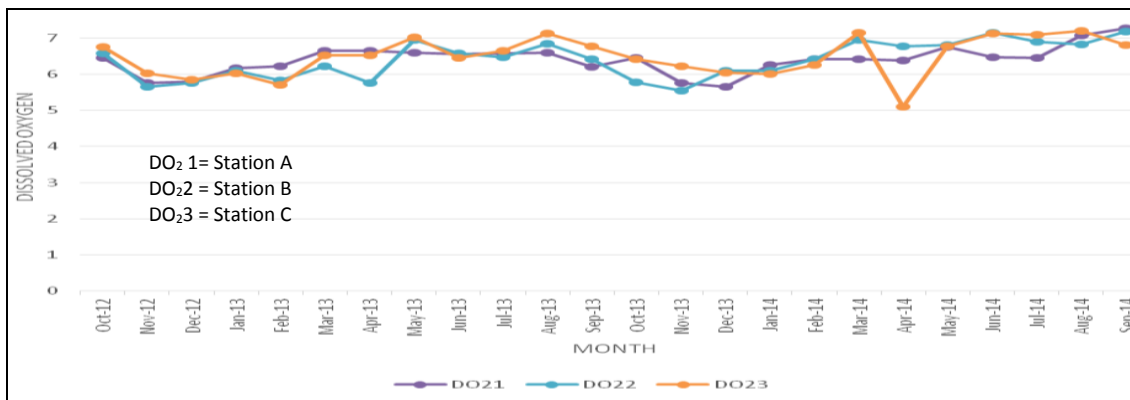


Fig 4

The concentrations quoted in this study shows that the river contains normal concentrations of dissolved oxygen. The overall mean of 6.3mg/l – 6.78mg/l is well above the 4 ppm at which prawns start to get stressed (Avault, 1987) [4], although slightly above the 6-8 ppm New (1990) claims as being the usual target concentration in *M. rosenbergii* culture. There was wide level of fluctuation in the conductivity values for each station (Fig 5). Conductivity range for the river was 22.43 – 69.05µSm⁻¹. The highest value of 69.05 µSm⁻¹ was recorded at station B in October 2012 while the least value of 22.43 µSm⁻¹ was observed at station A in september 2013

(Fig 5). Station A which recorded the the least conductivity value of 22.43 µSm⁻¹ exhibited the narrowest range 22.43 – 66.88 µSm⁻¹. In the same vein, station B had the widest range of 24.2 – 69.05 µSm⁻¹. Dry season conductivity values were generally higher than those of the wet season. Akor River Ibe having conductivity values of less than 100 µSm⁻¹ is described as a freshwater body. This follows from (Egborge, 1994) [16] who classified waters with conductivity values below 100 µSm⁻¹ as fresh, those above 1000 µSm⁻¹ as marine or salt while those in between are brackish.

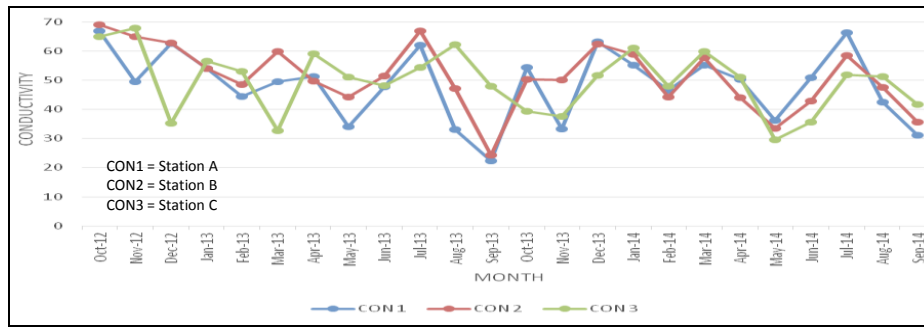


Fig 5

It was observed that conductivity did not significantly correlate with dissolved oxygen, total alkalinity and salinity at station B ($p > 0.05$) signifying that any increase in conductivity value will affect the dissolved oxygen content of the river which corroborates with the report of Boyd and Litchktoppler (1979).

Total alkalinity had a range from 22.55 to 45.4mg/l. The minimum value of 22.5mg/l was observed at station A in July 2013 (Fig 6). The highest value of 45.4mg/l was observed at same station in March 2014. The range of total alkalinity

recorded in the study is within the range of total alkalinity values (20.0 – 150.0mg/l) needed for fish production.(Boyd, 2000) [8] The minimum value recorded was in the wet season while the maximum value recorded was in the dry season. The high value in the dry season could be attributed to evaporation and concentration of the bases in water. Furthermore, waters with total alkalinities of 20-150 mg/l are said to contain suitable quantities of carbon (iv) oxide that permit plankton growth for fish production.(Ukagwu, 2015) [45]

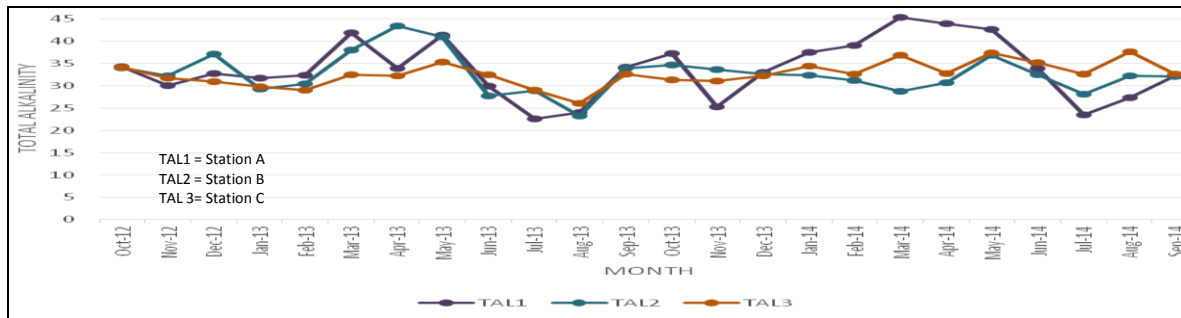


Fig 6

The range of nitrate concentration in the river was 0.07-0.79 mg/l. (Fig 7) These values were recorded in January 2013 and June 2013 and both values were reported at station A. Comparing the stations, station A had the widest range of nitrate concentration (0.07 -0.79 mg/l), while the lowest range of 0.2 – 0.58mg/l) was at station C. The wet season nitrate values were generally higher than those of the dry season.

The values of nitrate are within the recommended range for optimum shrimp growth (New and Singholka, 1982) [30]. These reports from the study showed that nitrate concentrations are higher in the wet season. This also agrees with the observations of Ekelemu (2006) [17] for a freshwater body in the Niger Delta, which indicated that nitrate concentrations were more in the wet season than dry season.

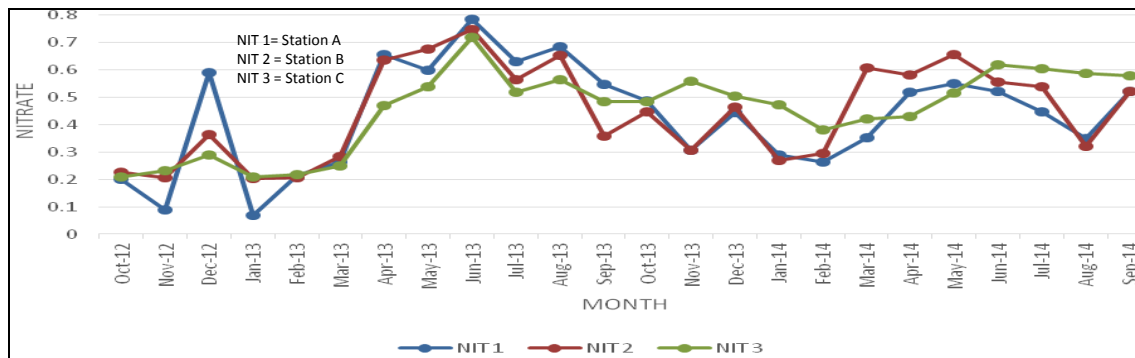


Fig 7

The phosphate concentrations recorded had a range of 0.04 - 1.12 mg/l.(Fig 8) The highest concentration of 1.12 mg/l was recorded January 2013 at station A while the least concentration of 0.04 mg/l was recorded in October 2012 at

same station A. Ukagwu (2015) [45] related the high phosphate concentrations in the dry season to high rate of decomposition of organic matter and mineralization of the mineral salts through evaporation in the dry season. The range of

phosphate-phosphorus values recorded by Ghosh (1992), Mondal (2001) [21] and Das (2002) [15] in water quality for prawns in rice fields were 0.03-0.99 mg/L, 0.27-0.98 mg/L

and 0.51-1.23 mg/L respectively which are almost similar to the values obtained in the present study.

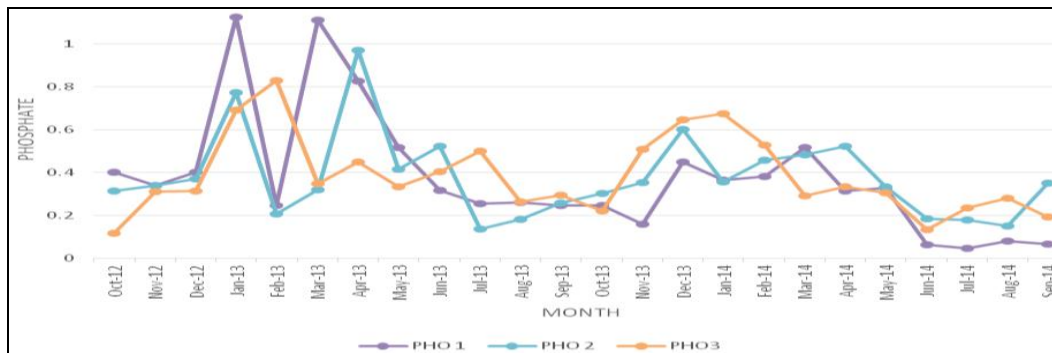


Fig 8

Total dissolved solids recorded ranges between 8.58 – 31.85 mg/l (Fig 9). The least concentration value of 8.58 mg/l was recorded in June 2014 in the wet season at station A. on the other hand; the highest concentration value of 31.85 mg/l was recorded in January 2013 during the dry season. The concentration of total dissolved solid in the river was generally higher in the dry season having a maximum mean value of 26.97 mg/l compared to that of the wet season with a maximum mean of 17.52 mg/l. The higher dry season concentration could be attributed to evaporation and

mineralization thereby concentrating the dissolved inorganic particles in the river water. This is also in agreement with the findings of Ootoba (1995) [35] and Allison (2006) [2] in the Nun River and may be attributed to evaporation effects in the dry season. The positive correlation established in this study between total dissolved solids and conductivity ($p > 0.05$) in all stations agrees with Ryder (1965) [38] who stated that total dissolved solids and conductivity are correlated that one can be used to predict the other correctly.

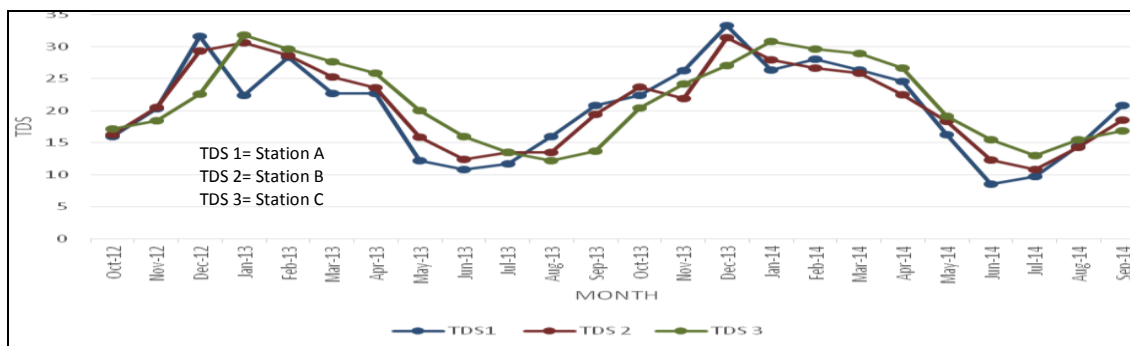


Fig 9

Water hardness recorded ranges between 18.35 – 35.85 mg/l (fig 10). The least concentration value of 18.35 mg/l was recorded in August 2014 in the wet season at station C. on the other hand, the highest concentration value of 35.85 mg/l was recorded in February 2014 during the dry season in station A. Water hardness in the river was generally higher in the dry season having a maximum mean value of 35.85 mg/l compared to that of the wet season with a maximum mean of 27.52 mg/l. The higher dry season concentration could be attributed to human activities thereby concentrating the dissolved inorganic particles in the river water which was contrary to what Alagoa and Aleleye-Wokoma (2012) recorded in the upstream of the Lower Taylor creek in Niger

Delta. This may also be as a result of the evaporation effects in the dry season. On the hand, the generally low mean concentration of water hardness in the wet season may be due to dilution from the rain and inflowing waters during the wet season. The trend of changing concentration in water hardness with season is in agreement with the findings of (Williams, 2004) who noted that acceptable range for free calcium in culture waters is 25-100mg/l. The water hardness in the sampling sites all fell within the tolerable range except for station C which was below 25mg/l in the rainy season thus could be as a result of dilution of the river by inflowing waters.

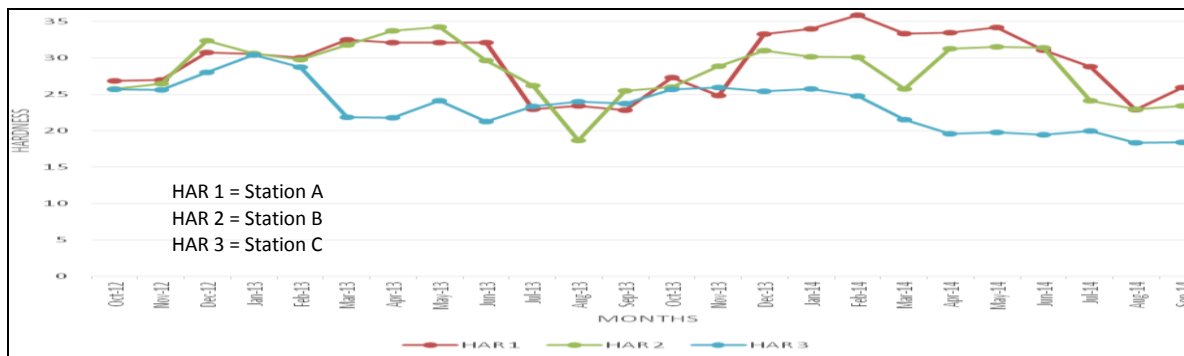


Fig 10

Effect of water quality parameters on prawn occurrence and abundance

Instantaneous fluctuations in environmental variables can result in inter-annual variability in catch per unit effort (CPUE) of prawns (Barko and Hrabik, 2004). In the tropical region, the important factors that affect distribution and abundance of shrimps are temperature, salinity, nourishment and substrate (Costa and Fransozo, 2004) [13]. The result of the correlation analysis of fish abundance with water parameters of Akor River are presented in table 1. It shows that sub surface water temperature, dissolved oxygen, nitrate and water depth have positive correlation with fish abundance ($p > 0.05$) at Station A. The other water parameters correlated negatively. This station is made up of less three canopy, it is exposed to direct sunlight and temperature is warmer, so it is a better condition for phytoplankton to thrive (Ekelemu, 2006) [17]. At station B ($r = 0.3343$), water temperature, dissolved oxygen, nitrate and water depth correlated positively while other water parameters correlated negatively. This is at the level in which any increase or decrease in the

water parameters in the river will affect the abundance of fish in the station. At station C ($r = 0.3338$), dissolved oxygen, phosphate, nitrate, water depth and hardness correlated positively ($p > 0.05$) while other parameters correlated negatively with fish abundance ($p < 0.05$). This report corroborates with the findings of (Kingdom *et al.*, 2013) [21]. The abundance of *M. fellicinum* which was positively correlated with water level and total hardness, but negatively with pH and dissolved oxygen. His model did not reveal any significant effects of temperature, rainfall, water velocity, total dissolved solids, total alkalinity, conductivity, habitat, and plankton abundance on *M. fellicinum* abundance. Although, behavioural attributes such as migrations for feeding, breeding, mortality cycles and biological factors such as predation, competition and parasitism (Mann, 1980) [26] may also affect the actual numbers of fish, Lowe - McConnell (1987) [25] reported that in rivers, abiotic factors, such as water levels and deoxygenation, may be more important than biotic factors in controlling prawn populations.

Table 1: Correlation matrix of fish abundance with water parameters

Variable	Station A		Station B		Station C	
	Coeff	t-ratio	Coeff	t-ratio	Coeff	t-ratio
Intercept	65.714	4.16	258.527	2.59	69.297	2.89
Sub-surface temperature	3.060	2.44	3.422	1.98	-2.603	-0.41
Dissolved oxygen	7.838	2.34	23.277	3.82	8.194	3.33
PH	3.002	-2.82	-7.543	-2.40	-0.867	-0.08
Total dissolved solid	0.517	-1.40	-1.153	-2.21	-0.862	-4.18
Total alkalinity	-0.121	-0.18	-1.605	-2.69	-40.411	-0.26
Conductivity	-0.128	-0.63	-0.384	-1.82	-0.416	-2.55
Phosphate	-8.784	-1.09	-12.895	-1.00	3.505	0.12
Nitrate	13.042	0.99	2.961	0.18	16.888	0.49
Water depth	6.897	1.96	3.376	3.63	0.237	0.06
Hardness	-0.533	-0.50	-0.373	-0.10	2.367	1.20
r^2	0.6816		0.7870		0.6481	
R	0.3898		0.3343		0.3338	
f-ratio	2.34		3.40		2.21	

This study on physico-chemical parameters of Akor river and occurrence of *Macrobrachium* species explains that the water quality parameters: Temperature, Dissolved oxygen, pH, Conductivity, Alkalinity, depth, Nitrate-nitrogen, phosphate-phosphorus, hardness in the three stations supported the occurrence of *macrobrachium* species in the river though there were variations in their values. The water holds good amount of oxygen which provided favourable condition for the growth and survival of prawns. These two species had a

wide scope for aquaculture. In view of its economic value, commercial cultivation of *Macrobrachium vollehovenii* and *Macrobrachium fellicinum* can be implemented in the Ikwuano regions of Akor river.

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