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CHEMICAL CONSTITUENTS OF FRESHWATER PRAWN HABITAT IN THE NIGER DELTA, NIGERIA

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ABSTRACT

Electrical conductivity, pH, dissolved oxygen, calcium, phosphate, nitrate and salinity were studied at Ovia River for a period of two years. Water samples were taken at monthly intervals from four stations along the stretch of the River. The ranges of the chemical characteristics throughout the study period are as follows: pH (5.22-7.40); electrical conductivity (26.50-92.83 µScm-1); dissolved oxygen (3.63-7.99 mg/l); calcium (1.13-6.26 mg/l); phosphate (0.00-0.47 mg/l); nitrate (0.01-1.52 mg/l); salinity (0.01-0.08 ‰). Electrical conductivity, calcium, phosphate and salinity showed significant difference ($P<0.05$) between the station in the first year (2005). In the second year (2006), pH, dissolved oxygen and calcium was significantly different ($P<0.05$) between the stations. Seasonal variation showed significant difference ($P<0.05$) in the pH, electrical conductivity, calcium and salinity in 2005 while electrical conductivity, phosphate, nitrate and salinity All the parameters studied were within the Federal Environmental Protection Agency standard for water bodies.

KEYWORDS: Chemical Constituents of Freshwater Prawn Habitat

INTRODUCTION

Freshwater prawns of the genus *Macrobrachium* are distributed throughout the tropical and subtropical countries of the world (Bello-Olusoji*et al.*, 2006). They are found in most inland freshwater areas including lakes, rivers, irrigation ditches and ponds, as well as in estuarine areas (New, 2002; Davassi, 2011). Most species require brackish water in the initial stages of their life-cycle and therefore, they are found in water that is directly or indirectly connected with the sea (New, 2003), although some species such as *M.nipponense* (Kutty, 2005) and *M. australiense* (Cook *et al.*, 2002) complete their life cycle in freshwater.

In Nigeria, Marioghae (1990) reported that *M. vollenhovenii* lives and breeds successfully in totally freshwater bodies such as Lokoja (River Niger) and Asejire (Upper Osun). There are about 200 species of freshwater prawns identified (Jayachandran, 2001). All of which live in freshwater, at least, for part of their life (Davassi, 2011). *Macrobrachium* species occur throughout the West African region (Etim and Sankare, 1998; Jimoh, 2005). However, of about 200 species that make up the genus, 4 species have been reported in Nigeria (Bello-Olusoji*et al.*, 2004). These are *M. vollenhovenii*, (African River prawn) (Herklots, 1887), *M. macrobrachion* (brackish river prawn) (Herklots, 1851), *M. felicinum* (Niger River prawn) (Holthuis, 1949) and *M. dux*. These prawns have an extensive distribution across the southern region of Nigeria (Akintola and Bakare, 2011). However, of these four only the first two are commercially important (Marioghae, 1990). They are the two largest species of the genus *Macrobrachium* in Nigerian waters. They are found in the freshwaters as well as the brackish waters and are universally accepted as food organisms and support a substantial number of local fisheries. Marioghae (1982) reported that they accounted for up to 66% of the prawn landings from the Lagos lagoon. Twenty-six species of the genus *Macrobrachium* widely distributed throughout the Indo-pacific are

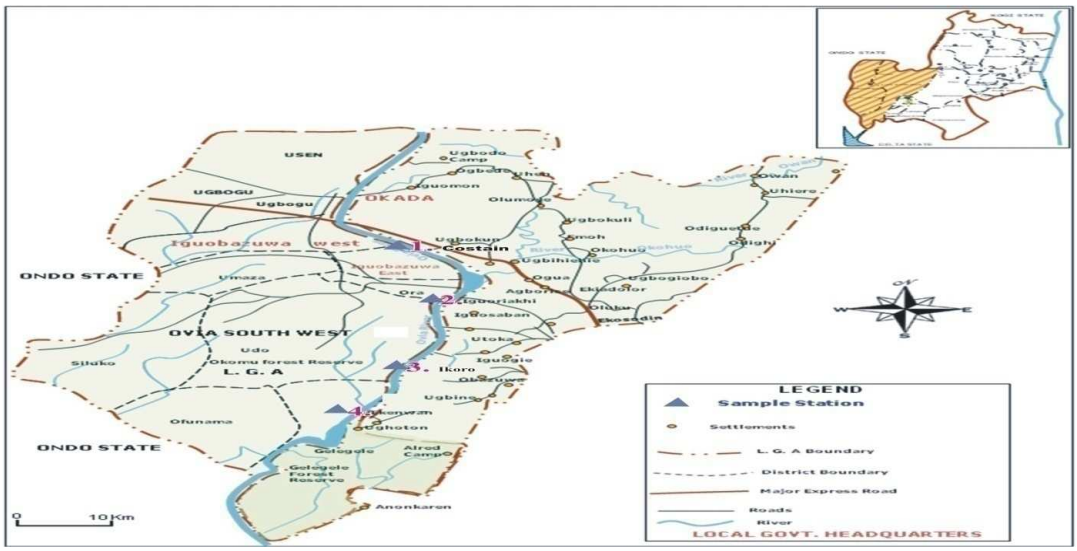
used in aquaculture (Powell, 1982). *Macrobrachium*species are reported to be of potential importance in aquaculture (Evers, 1979). These animals have numerous fascinating characteristics and play an important role in aquatic ecosystems as part of the food chain and as recyclers of organic material. For the development, exploitation and management of prawn fisheries, data on their ecology and biology is necessary. The lack of such basic scientific data is a common feature in the Nigerian fishery (Awachie, 1981; Edokpayi*et al.*, 2000).

Studies on the biology and ecology of this species have been reported in some water bodies in Nigeria. For example, Anetekhai (1986) in Asejire Lake (Oyo State); Marioghae (1982), Marioghae and Ayinla (1995) in Lagos Lagoon; Abohweyere, (2008) in Lekki and Lagos Lagoon system and Nwosu (2000) in the Cross River estuary. Others include Bello-Olusoji (2004), Mwangi (1984) and Udo and Ekpe (1991). There is no reported study on the ecology of freshwater prawns especially of *Macrobrachium vollenhove*nii from Ovia River in Edo State. This is so despite the apparent contributions of this prawn to the catches of local fisherfolks. This study was therefore initiated to obtain relevant ecological information on this species in Ovia River to assist in proper sustainable management of this aquatic resource especially given the increased interest in its commercial exploitation for export trade.

MATERIALS AND METHOD

The study area is a stretch of the Ovia River. Four sampling locations were chosen along the Ovia River (Figure 1) which include Costain, Iguoriakhi ,Ikoro and Ekenwan. The River is located within the tropical climate with proportionate dry and wet (rainy) seasons. The vegetation of the area is mainly evergreen forest, which makes it suitable for farming. The occupations of the people are mainly farming, trading, fishing along the river creeks. Water samples were collected monthly for 24 months (January-December, 2006).

Collection of the water and the analysis of the Chemical parametersin each of the four stations were determined by standard methods (APHA, 1998; ASTM, 1986).The data obtained in this study was analyzedusing statistical package for social sciences (SPSS) version 16.0 for windows involving descriptive statistics, graphical presentations, correlation analysis, parametric One Way Analysis of Variance (ANOVA) and Duncan Multiple Range Test at 5% level of probability.



Source: Edo State Ministry of Land and Survey, 2010

Figure 1: Map of Edo State Showing the Location of Study Stations

RESULTS

The summary of water parameters are showed in Tables 1a, 1b, 2a and 2b while the monthly variation are illustrated in Figures 1-7. Hydrogen ion values in 2005 were between 5.22 (April) and 7.42 (July) and ranged from 6.10 (April) to 7.40(October) in 2006. pH deceased greatly at the end of the dry season for both years but increased greatly at the beginning of the rainy season in 2005 and August in 2006. Significant difference ($P<0.05$) was observed between monthly pH values obtained for the two years. pH values between stations varied from 6.38 (station 4) in 2005 to 6.81 (station 3) in 2006 but were stable across stations within years. However, there was significant difference ($P<0.05$) between pH values between the stations in 2006. The dry season had lowest meanpH of 6.37±0.69in 2005 and highest of 6.71±0.37in 2006. Significant difference ($P<0.05$) of pH values was observed between seasons in 2006.

Electrical conductivity values in 2005 ranged between 26.50 $\mu S/cm^{-1}$ (April) and 79.75 $\mu S/cm^{-1}$ (June) and ranged from 27.42 $\mu S/cm^{-1}$(February) to 92.83 $\mu S/cm^{-1}$(August) in 2006.Conductivity values increased greatly at the beginning of the rainy season for both years. However, values were low during the dry season for both years. The mean conductivity values of the stations varied from 36.36$\mu S/cm^{-1}$(station 4) in 2005 to 73.47$\mu S/cm^{-1}$ (station 1) in 2006.The dry season had lowest mean conductivity values of 39.33±18.38 $\mu S/cm^{-1}$ in 2005 while wet season had highest mean conductivity values of 82.21±17.70$\mu S/cm^{-1}$in 2006. Statistical analysis showed significant difference ($P<0.05$) for electrical conductivity values between months, stations and seasons for the two years.

The monthly mean Dissolved oxygen values in 2005 were between 4.08 mg/l (October) and 7.99mg/l (June) and ranged from 3.63 mg/l (July) to 7.72mg/l (September) in 2006.Dissolved oxygen values dropped greatly in the months of the rainy season for both years and was significant($P<0.05$) for the two years which was greater in 2006. The mean dissolved oxygen values of stations ranged from 5.00 mg/l (Station 4) in 2006 to 6.64 mg/l (Station 2) in 2005. No significant difference ($P>0.05$) was observed between stations in 2005, although significant difference ($P<0.05$) was observed between stations in 2006(Tables 1a and 1b). The dissolved oxygen values of seasons ranged from 5.31±1.83 mg/l wet season in 2006 to 6.35±1.86mg/l dry season in 2005, no significant difference ($P>0.05$) was observed between seasons for both years.

Calcium values in 2005 were between 2.15mg/l (April) and 6.26mg/l (July) and ranged from 1.13mg/l (June) to 2.86mg/l (October) in 2006. Monthly Calcium values fluctuations was greater between May and October in 2005 than in 2006 and varied significantly ($P<0.05$) for both years. The mean calcium values of stations ranged from1.64mg/l (Station 3) in 2006 to 4.85mg/l (Station 1) in 2005. Calcium values of seasons ranged from 1.94±1.13mg/l (wet season) in 2006 to 4.50±2.23mg/l (wet season) in 2005. Calcium values varied significantly ($P<0.05$) between stations and seasons in 2005 but no significant difference ($P>0.05$) was observed between stations and between seasons in 2006.

Phosphatevalues in 2005 were between 0.00mg/l (April) and 0.47mg/l (October) and ranged from 0.00mg/l (December) to 0.27mg/l (September) in 2006. Monthly phosphate values fluctuated greatly between the end of the rainy season and early dry season for both years but was greater in 2006, however significant difference ($P<0.05$) was observed in 2006. The mean phosphate values of stations ranged from 0.00 mg/l (Station 4) in 2005 to 0.05 mg/l (Station 1 and 2) in 2006.Phosphate values of seasons ranged from 0.01±0.02 mg/l (wet and dry season) in 2005to 0.06±0.09 mg/l (wet season) in 2005. There was significant difference ($P<0.05$) of phosphate values between stations in 2005 and between seasons in 2006.

Nitrates values in 2005 were between 0.01mg/l (August) and 0.17 mg/l (November) and ranged from 0.08 mg/l (February) to 1.52 mg/l (November) in 2006. Nitrate values fluctuated greater in months between September and December in 2006. Although, significant difference ($P<0.05$) between nitrate values was obtained for the two years. The mean nitrate values ranged from 0.04 mg/l (Station 4) in 2005 to 0.48 mg/l (Station 1) in 2006. No significant difference ($P>0.05$) of nitrate values was recorded between stations for the two years. Nitrate values of seasons ranged from 0.05±0.07 mg/l (wet seasons) in 2005to 0.57±0.60 mg/l (wet season) in 2006. Significant difference ($P<0.05$) was observed in nitrate values between seasons in 2006.

Salinity values in 2005 were between $0.01^{o}/_{oo}$ (April) and $0.44^{o}/_{oo}$(June) and ranged from $0.01^{o}/_{oo}$ (March) to $0.08^{o}/_{oo}$ (June) in 2006 and showed significant difference ($P<0.05$) between monthly values obtained for the two years. The mean salinity values between stations ranged from $0.02\ ^{o}/_{oo}$(Station 3 and 4) in 2005 to $0.05\ ^{o}/_{oo}$(Station 1) in 2006. Salinity values showed significant difference ($P<0.05$) in 2005 but not in 2006. Salinity values of seasons ranged from 0.02±0.01 $^{o}/_{oo}$(dry seasons) for both years to 0.06±0.02$^{o}/_{oo}$(wet season) in 2006. Significant difference ($P<0.05$) was observed in salinity values between seasonsfor both years.

DISCUSSIONS

The pH range of 5.20-7.44 in the Ovia River system indicated that this water is slightly acidic. Homogeneity in pH values was observed in the river. A similar trend had been reported by Omoigberale (2005) from River Osse. There was no distinct variation between stations and seasons in the values obtained. However, pH values were relatively lower in the dry season than in the rainy season in 2005. This contradicts the trends in many African rivers in which pH values are lower in the wet season but rises during the dry season months (Egborge, 1971; Adebisi, 1981 and Omoigberale, 2005). pH values were relatively lower in the dry season than in the rainy season months. The acidic nature of African rivers might be due to the nature of the materials flowing into the river especially in the wet months (Holden and Green, 1960; Egborge, 1971 and Adebisi, 1981). The pH of waters usually determines the nature of carbon dioxide in water; free carbon dioxide is known to be present at lower pH ranges of 4.8 -5.5, the carbonate and bicarbonate dominate at higher pH (Onwudinjo 1990). Bello-Olusoji (2007) recorded pH values of 6.9 and 7.1 for *Caridina africana* and *M. vollenhovenii* respectively in their natural habitats. Arrignon *et al.*,(1994) reported that the pH of 9.0 is lethal for post -larvae and gave desirable pH for shrimps as between 7.5-8.8. Jose (1980) stated that *M. rosenbergii* preferred a pH range between 4.0 to pH 8.5.

Conductivity is primarily determined in water by the presence and levels of concentration of sodium and magnesium ions and to some extent calcium ions. Their ions help buffer the effect of bicarbonate and carbonate ions, thus maintaining the pH (Raymont, 1983). The high values recorded during the rainy season could be related to the influx of minerals from land runoff. This finding is in accord with many results such as Oguzie (1996) who reported higher conductivity values in Ikpoba River and Idodo-Umeh (2002) from selected water bodies in Olomoro in the rainy season months. This phenomenon has generally been explained by the fact that there is a higher ionic content during the rainy season due to rain run-off. The observed conductivity of the water studied was low at all stations thus classifying the area of study as freshwater. According to Egborge (1994a) waters with conductivity values below 1000 µS/cm are classified fresh and those above 40,000µS/cm are marine and those in between are brackish.

The dissolved oxygen concentration of the river showed that it was a well aerated system. Dissolved oxygen mean values obtained during the study ranged between 3.63-8.01 mg/l. This showed that there was fluctuation in DO during the study period. However the drop in monthly mean DO during rainy season suggest that that the river may have been

polluted with untreated sewage, petrochemical materials, detergent and industrial effluents (Ezekiel *et al*., 2011).Jose (1980) have recommended oxygen concentration of 5.8mg/l for freshwater prawn (*Macrobrachium*species). The lower dissolved oxygen values during the wet season could be attributed to flood and municipal drains depositing wastes (organic, inorganic and debris) into the River leading to degradation. Egborge, (1994) reported that degradation results in oxygen depletion. This observation disagrees with the results of other studies where higher dissolved oxygen values were observed during the rainy season (Kumar, 1992, Fufeyin, 1994; Ogbeibu and Victor, 1995). Higher dissolved oxygen values during the dry season at for both years may be attributed to increase in primary production by phytoplankton (Adebisi, 1981), macrophytes (Welcomme, 1975) and reduction in suspended organic matter and debris (King and Nkata 1991; Kumar 1992; Ogbeibu and Victor, 1995). However, the observed mean DO concentration for both seasons falls within the DO concentration required for the normal growth which is between 5 and 7mg/l.

Mean calcium values ranged from 1.30-6.50mg/l which is close to the range of calcium values (1.10 – 9.62mg/l at River Osse reported by Omoigberale (2005). In comparison with other Nigerian water bodies these values are low. Holden and Green (1960) recorded 10.0 – 42.0mg/l for River Sokoto; Egborge (1972) reported 5.93-11.03mg/l for River Osun. The mean value of calcium in African rivers is 12.50mg/l. One major source of calcium in freshwater is the bedrock and weathering of calcium bearing rocks (Waite, 1984). Higher calcium values were observed during the rainy season than during the dry season months probably due to erosion of clay soil from land and the banks of the river. Influx of terrestrial materials loaded with calcium and carried to the water body by rain water run-off could also be a contributing factor. The suitable values recommended for freshwater prawns are 0.01-18.6mg/l (New, 2002).

The mean phosphate values ranged from 0.00-0.47mg/l in the river water. This range is within the recommended range for the culture of freshwater prawns (New, 2002). Higher values were recorded during the rainy months of September and October in all the 4 stations. This could be a result of surface water run-off carrying allochthonous materials into the water bodies.

Nitrate is the major form of nitrogen used by phytoplankton (Kutty, 1987). The range 0.00-1.52 mg/l fell within the range of values reported for other African waters. These include 0.04-1.14mg/l for Osse River (Omoigberale, 2005), 0.02mg/l-0.37mg/l for River Osun (Egborge, 1971) and 1.10-2.42mg/l at Olomoro, (Idodo-Umeh, 2002). The higher value recorded during the dry season could be presumed to be due to faster decomposition of organic matter and mineralization of mineral salts through evaporation. Similar findings have been reported by Idodo-Umeh (2002); Akpan (1995). The values recorded in this study were far below the maximum acceptable level of 45, 20, 50mg/l of FEPA (1990). The low value could be due to run-off from land with little or no amount of nitrate in it indicating little or no application of fertilizers by the local farmers.The low pH values observed in this study might also be responsible for the inhibition of the oxidation of ammonium to nitrate.Nitrate is required for algal growth so low level will affect algae production. The low nitrate level in this river is an indication of a low level of organic pollution in the river. Moreover, nitrates have been positively associated with production of invertebrates in any water body. Increase in nitrogen has been shown to accelerate the rate of decomposition of detritus and increases the protein content of leaves through colonization of microorganisms.

The salinity values of $0.00^{o}/_{oo}$-$0.44^{o}/_{oo}$ showed that the water is completely a fresh water habitat. This agrees with the report of Egborge, (1994b) that waters with salinity below $1^{o}/_{oo}$are fresh and waters with salinity higher than $1^{o}/_{oo}$are brackish/marine. Seasonal variation observed in Ovia river may be attributed to the combined effect of humic acid freshwater ions input (Ogamba *et al*., 2004). This may also be attributed to drainage areas, the nature of its rocks

precipitation, human activity in the area and proximity to marine water (McNeely *et al*., 1979). Higher salinity values recorded in the dry season agrees with the results obtained from Badagry creek by Akintola *et al*., (2010) but differs from other studies reported from other water bodies in Nigeria (Onyema and Nwankwo *et al*., 2009, Nkwoji *et al*., 2010; Deekae *et al*., 2010 and Emmanuel and Onyema, 2007).

CONCLUSIONS

In conclusion, Ovia river exhibited chemical constituents of a fresh water habitat, which could be a suitable environment for reproduction of prawns and assist in proper sustainable management of this aquatic resource especially given the increased interest in its commercial exploitation for export trade All the parameters studied were within the Federal Environmental Protection Agency standard for water bodies.

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APPENDICES

Table 1a: Summary of Some Chemical Parameters of Ovia River Study Stations January 2005- December 2005 Study Period

	Station 1				Station 2				Station 3				Station 4				
	Mean	SD	Max	Min	Mean	SD	Max	Min	Mean	SD	Max	Min	Mean	SD	Max	Min	ANOVA
Ph	6.53^{a}	0.89	7.85	4.45	6.54^{a}	0.83	7.65	4.78	6.67^{a}	0.48	7.39	5.42	6.38^{a}	0.63	7.52	4.65	P>0.05
EC	66.61^{a}	21.72	96.00	31.00	57.75^{a}	22.18	89.00	27.00	40.83^{b}	18.77	87.00	23.00	36.36^{b}	18.79	76.00	14.00	P<0.05
DO	6.39^{a}	1.47	10.00	3.10	6.64^{a}	1.82	10.80	3.60	6.00^{a}	2.61	10.90	1.20	5.83^{a}	3.02	15.20	1.60	P>0.05
Ca2+	4.85^{a}	2.01	10.26	2.45	4.38^{a}	2.18	8.71	1.28	3.31^{b}	1.77	7.70	1.28	2.64^{b}	1.54	6.41	0.31	P<0.05
PO42-	0.03^{a}	0.03	0.10	0.00	0.01^{b}	0.03	0.10	0.00	0.01^{bc}	0.01	0.05	0.00	0.00^{c}	0.00	0.01	0.00	P<0.05
NO3-	0.08^{a}	0.09	0.32	0.01	0.05^{ab}	0.07	0.20	0.00	0.06^{ab}	0.07	0.21	0.00	0.04^{b}	0.04	0.12	0.00	P>0.05
Salinity	0.04^{a}	0.01	0.05	0.02	0.03^{a}	0.01	0.05	0.01	0.02^{b}	0.01	0.05	0.01	0.02^{b}	0.01	0.04	0.01	P<0.05

∗Means in the same row with the same superscript are not significantly different (P>0.05)

Table 1b: Summary of Some Chemical Parameters of Ovia River Study Stations January 2006- December 2006 Study Period

	Station 1				Station 2				Station 3				Station 4				
	Mean	SD	Max	Min	Mean	SD	Max	Min	Mean	SD	Max	Min	Mean	SD	Max	Min	ANOVA
pH	6.46^{a}	0.38	7.26	5.73	6.63^{ab}	0.34	7.48	6.08	6.81^{b}	0.75	10.62	6.23	6.76^{b}	0.48	7.88	6.07	P<0.05
EC	73.47^{a}	27.67	110.00	33.00	66.64^{ab}	27.89	97.00	27.00	56.86^{ab}	24.98	89.00	24.00	62.00^{b}	28.31	99.00	23.00	P>0.05
DO	5.56^{ab}	1.52	9.20	3.20	6.08^{b}	1.38	8.80	3.20	5.06^{a}	1.86	8.80	1.60	5.00^{a}	1.62	7.80	1.20	P<0.05
Ca2+	2.48^{a}	1.01	6.68	0.61	1.86^{b}	0.79	3.06	0.61	1.64^{b}	0.74	2.76	0.61	1.79^{b}	1.14	6.13	0.61	P<0.05
PO42-	0.05^{a}	0.08	0.30	0.00	0.05^{a}	0.08	0.29	0.00	0.04^{a}	0.07	0.25	0.00	0.04^{a}	0.09	0.32	0.00	P>0.05
NO3-	0.48^{a}	0.55	2.02	0.09	0.45^{a}	0.48	1.82	0.08	0.39^{a}	0.50	2.12	0.07	0.42^{a}	0.57	2.12	0.05	P>0.05
Salinity	0.05^{a}	0.03	0.10	0.02	0.04^{a}	0.02	0.09	0.02	0.04^{a}	0.02	0.08	0.01	0.04^{a}	0.02	0.08	0.01	P>0.05

∗Means in the same row with the same superscript are not significantly different (P>0.05)

Table 2a: Seasonal Variation of Chemical Parameters of Ovia River in 2005

Parameters	Season		
	Dry Season	Wet Season	p-value
pH	6.37±0.69^{b}	6.64±0.73^{a}	.031
EC	39.33±18.38^{b}	58.29±23.97^{a}	.000
DO	6.35±1.86^{a}	6.12±2.59^{a}	.554
Ca^{2+}	2.81±1.27^{b}	4.50±2.23^{a}	.000
PO_4^{2-}	0.01±0.02^{a}	0.01±0.02^{a}	.607
NO_3^{-}	0.08±0.07^{a}	0.05±0.07^{a}	.091
Salinity	0.02±0.01^{b}	0.03±0.01^{a}	.000

∗**Year=**2005, **Dry** = November-March, **Rainy** = April-October

∗Means in the same row with the same superscript are not significantly different (P>0.05)

Table 2b: Seasonal Variation of Chemical Parameters of Ovia River in 2006

Parameters	Season		
	Dry Season	Wet Season	p-value
pH	6.71±0.37^{a}	6.64±0.62^{a}	.465
EC	40.28±19.20^{b}	82.21±17.70^{a}	.000
DO	5.58±1.34^{a}	5.31±1.83^{a}	.334
Ca^{2+}	1.95±0.71^{a}	1.94±1.13^{a}	.944
PO_4^{2-}	0.02±0.05^{b}	0.06±0.09^{a}	.001
NO_3^{-}	0.57±0.60^{a}	0.34±0.43^{b}	.008
Salinity	0.02±0.01^{b}	0.06±0.02^{a}	.000

∗**Year=**2006, **Dry** = November-March, **Rainy** = April-October

∗Means in the same row with the same superscript are not significantly different (P>0.05)

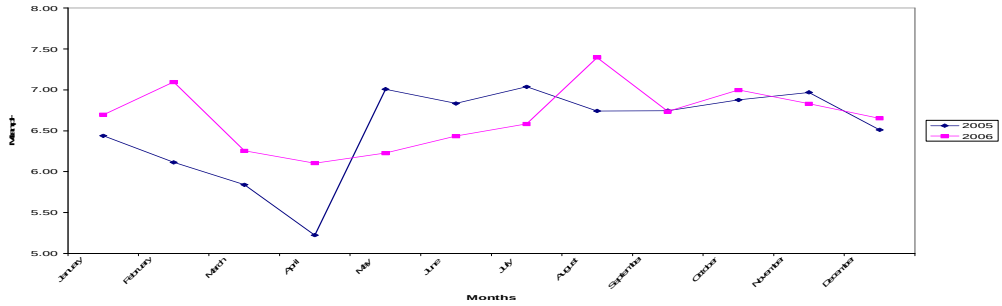

Figure 2: Monthly Variation of pH in Ovia River in 2005 and 2006

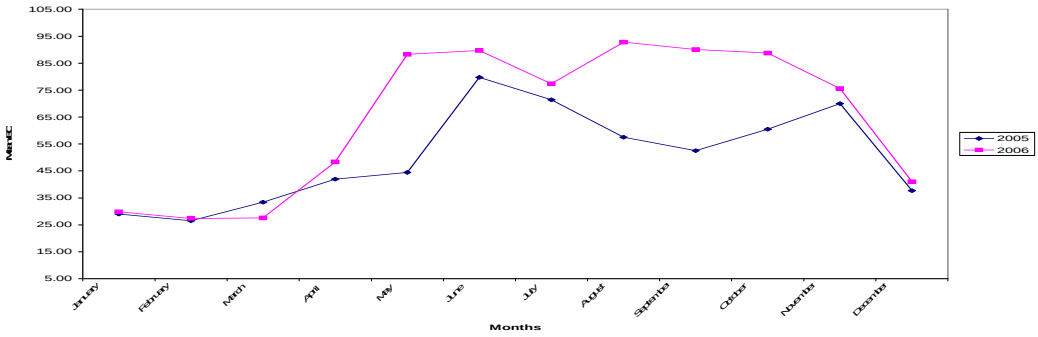

Figure 3: Monthly Variation of Electrical Conductivity in Ovia River in 2005 and 2006

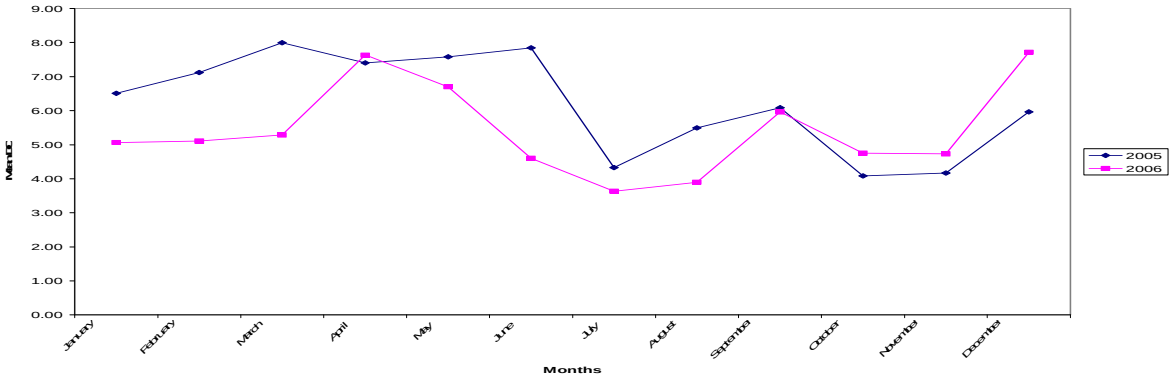

Figure 4: Monthly Variation of Dissolved Oxygen in Ovia River in 2005 and 2006

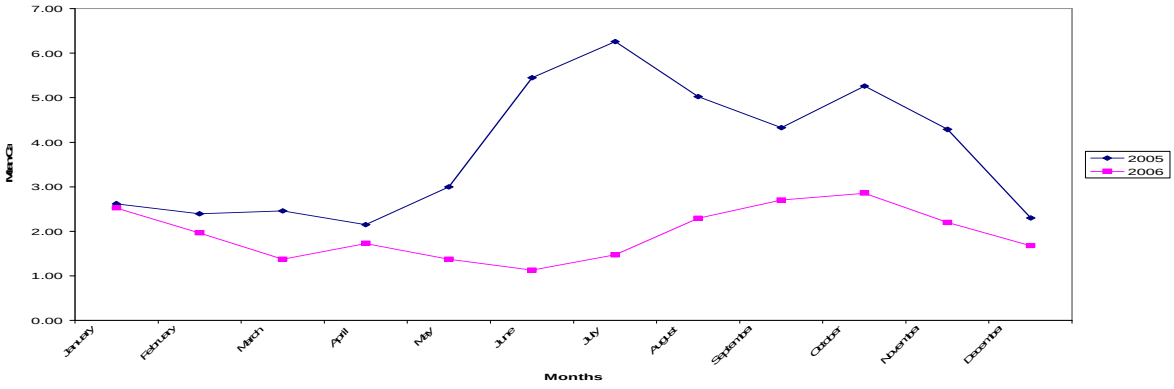

Figure 5: Monthly Variation of Calcium in Ovia River in 2005 and 2006

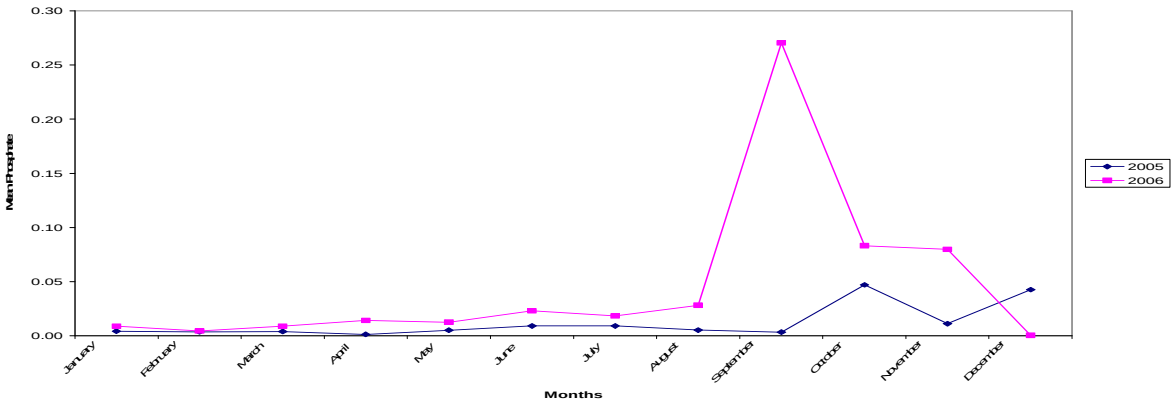

Figure 6: Monthly Variation of Phosphates in Ovia River in 2005 and 2006

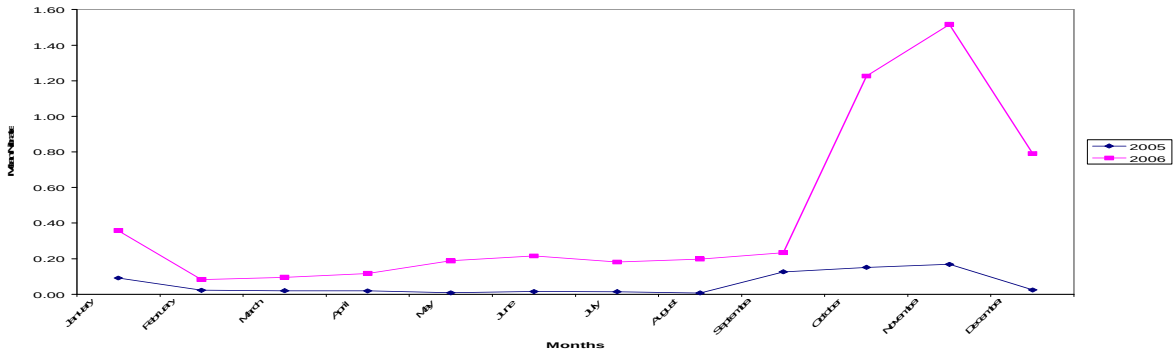

Figure 7: Monthly Variation of Nitrates in Ovia River in 2005 and 2006

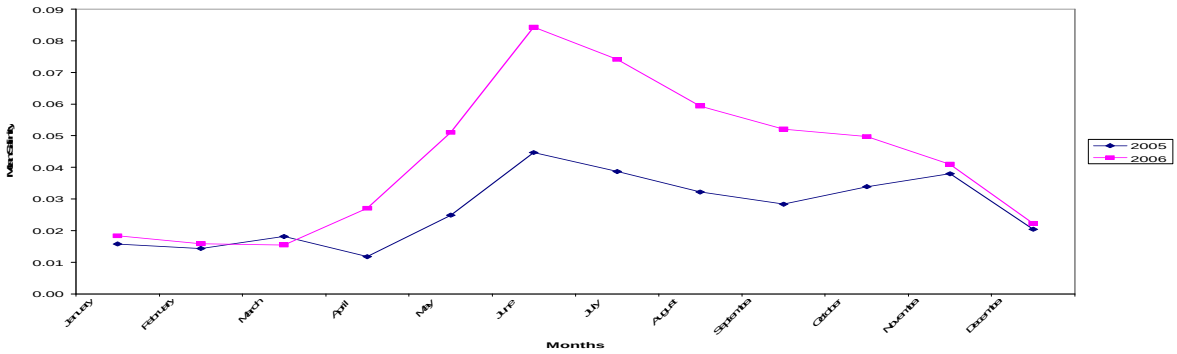

Figure 8: Monthly Variation of Salinity in Ovia River in 2005 and 2006