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THE INFLUENCE OF WATER QUALITY PARAMETERS ON FISH SPECIES ABUNDANCE AND DISTRIBUTION NEAR SHORELINE OF LAKE VICTORIA

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ABSTRACT: *This study explores water quality parameters and their effect on fish abundance and diversity in Lake Victoria. Fish are considered as water quality indicators, especially due to their sensitivity to pollution. The municipal and industrial discharges is visible through the channels draining into the lake, which potentially increases pollution levels. This is a real threat to aquatic life and the health of humans who consume fishery resources of the lake. Three sites were selected (site1, site2 and site 3) where water and fish were sampled weekly for a month. The results of water quality showed temperature range of 26.4^{0} C- 28.8^{0} C; pH 9.34-7.23; turbidity 10.6NTU- 5.3NTU; E.C 134.17µs/cm- 216µs/cm and D.O 6.1mg/l-6.9mg/l. All the physiochemical parameters of water were within the standard levels suitable for freshwater fish survival and growth. However, there were mean differences in water quality among the sites. For example, site 1 which was located direct to Nakivubo channel had turbidity and D.O levels of 10.6NTU and 6.4mg/l, respectively compared to site 2 and 3 which had turbidity less than 10NTU. Nile tilapia was the most abundant fish species in all the sites, followed by juvenile Nile perch while haplochromine was only caught in site 3 far away from the sewage discharge point. In addition, the numbers of tilapia decreased with turbidity indicating their habitat preference while Nile perch showed a uniform distribution across the sites. In conclusion, different water quality parameters potentially influenced fish distribution and abundance, but future comprehensive study could yield more reliable results. Therefore, there should be monitoring of water quality for better management of fishery resources of Lake Victoria.*

KEYWORDS: Water Quality Parameters, Fish Species, Lake Victoria, Pollution, Aquatic

INTRODUCTION

Lake Victoria is one of the largest fresh water bodies in the world. It is shared by three countries; Uganda, Kenya and Tanzania. Its rivers and streams stretch to as far as Burundi and Rwanda. The importance of Lake Victoria is clearly shown by the fact that over thirty million people living in the catchment depend on its waters. (United Nations environment program, UNEP, 2006). It was observed that the rivers and streams feeding the lake and the near shore areas were polluted by raw and partially treated waste, urban run-off and unsanitary conditions of the shoreline settlement. Therefore, instead of the Lake being a source of food, water, employment, transport, hydroelectric power, and recreation, is now used as dumping ground for various types of wastes (Chege, 1995; Matagi, 2002; MWLE, 2006). According to

Kyomuhendo (2002), the once clear, life-filled Lake Victoria is now murky and smelly. The ecological health of Lake Victoria has been affected as a result of rapid increasing human population and intensive activities, clearance of natural vegetation along the shores. (Kyomuhendo, 2002; Larsson, 2002) and dumping of untreated effluent by several industries (Matagi, 2002). Lake pollution has led to deterioration of water quality, as manifested by algal blooms and periodic massive fish kills caused by oxygen depletion (Ochumba, 1988). The lake and its ecosystem show evidence of dramatic changes, with infestation by water hyacinth being one of the major concerns in recent years. The pollution of the lake has been manifested through alteration of physical and chemicals variables beyond safe levels, impacting on biodiversity, especially that of fishes. There are physicochemical parameters such temperature and oxygen that may have significant impact on the growth, survival and distribution of fish. Due to their sensitivity to pollution, fish are considered as water quality indicators (Mora et al., 2003, 2008. This also involves risk of extinction, contamination or migration, being as result of changes in physical and chemical parameter of water. Thus, estimating the number of fish in a given area defines the water quality of the area in question. For prioritizing conservation, identifying trends, impact and risk of extinction, species diversity estimation happens to be useful (Mora et. al, 2008). Monitoring of aquatic pollution is important for knowing the relationship between fisheries and the general ecosystem health of a lake. Although few researches on the relationships between water quality and biodiversity have been carried out, this paper will aim at assessing fish distribution in the shoreline in relation to water quality, with the abundance and species diversity being an indicator of pollution.

MATERIALS AND METHODS

Study Area

Lake Victoria is the world's second largest fresh water lake in surface area. It boarded by Tanzania, Kenya and Uganda, and although not riparian, Burundi and Rwanda also lie. It stretches 412km from north to south between a latitude 0 to 30^{o} north and 3 to 12^{o} south and 350kn from west to east between longitudes 31 to 37^{o} and 34 to 53^{o} east. It is situated at an altitude of 1134 meters above sea level and has a volume of 2760 m^3 and an average maximum depth of 80m.

The study was carried out Ggaba, located on the northern shores of bordered by the Murchison by in the east and south, in Makindye Division of Kampala City, Uganda. Its relief consists of undulating terrain both hills and valleys. The lands from hill-top to valleys are used for human settlements, yet the valleys are wetlands. Ggaba is a landing site for fishing boats, and a wastewater discharge point for Nakivubo water treatment plant, Ggaba being just adjacent to the Lake with high levels of activity, it is anticipated that a big portion of surface runoffs find their ways into the lake without any form of treatment. It has been observed that the shore lake water always changes to brownish color when it rains (Bongomin, 2011). Runoffs originating from far inland sources also converge close to this area, but because they pass through swamps(a treatment facility), their pollutant concentrations are considered to be lower than that of the landing site, where no solution exist to control such pollutant flows, thus the choice to carry out the study at the site (ibidi). Furthermore, the site is a market place with bare soil surfaces, and high volume of solid waste are always dumped directly into the lake.

Study Design

The researcher shall use positivistic approach, longitudinal, experimental and correlational research designs. Positivistic research approach is a scientific research and is usually deductive i.e. it tests a theory through observed data. It seeks to explain relationships between variables, uses quantitative data

And employs controls to ensure that non research variables don't unduly influence research findings.

Longitudinal research design; this is carried out where the researcher wants to study the phenomena at more than one point in time in order to answer the research question. Since the research will be carried out at more than one point in time and data collected in a period of two month at different phases, this research design will be suitable.

Experimental research design; These represent a scientific approach in which a selected sample is subjected to a particular condition (stimulus) and then changes that result from this condition are recorded and reported. These changes may be compared with a control group not subjected to the condition or stimulus or with the state of the same group before the stimulus condition was applied.

Field experimental approach shall be conducted to establish cause and effect relationships using the same natural environment in which the dependent variable normally functions but manipulating the independent variable. In this case, water quality parameters and fish abundance and distribution shall be our variables.

Sampling Techniques

Purposive Sampling (Judgment Sampling)

In this sampling technique elements in the sample are selected from the population because they conform to certain characteristics that the investigator or the researcher is interested in. In other words, the researcher deliberately picks elements of the population that are responsible or relevant to the purpose of the investigation. Since the purpose of the research is establish the relation between physiochemical water parameters and fish abundance and distribution, only those sites with certain characteristics like water quality deterioration and proximity to the shore line (within 100m from the shoreline) will be sampled.

Water Sampling and Data Analysis

A pilot study was done in February and three sites were selected according to the researcher's interest, employing the use of purposive sampling method. The number of sites was determined by the number of point pollution sources. Water sampling was carried out from May –June. At the first phase, measurements were done within a 300-meter sampling-stretch from the shoreline into the middle of the lake and with a distance of about 1km between sites, the sites' coordinates were recorded using a GPS and demarcated with 3litre jerry cans. Sampling was done three times at intervals of one week and collection of samples and fishing was done between 8:00 - 11:00 in the morning. Physicochemical parameters including water surface temperature (To), was directly measured from the site using a mercury bulb thermometer, while pH and electrical conductivity (EC) were measured using the meter Teledo pH-meter &

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EC/TDS meter from the IURI chemistry laboratory as well as the total dissolved oxygen (DO) and turbidity. Turbidity was evaluated using an EC meter. The content of dissolved oxygen (DO) for each site was assessed with the aid of the DO Meter (YSI55). The analysis of variance (ANOVA) was run to compare the variations in physicochemical parameters between sites. The mean and standard deviations were performed to determine the mean S.D and significant differences among the physicochemical parameters using SPSS Software version 21. All the parameters were compared with water quality standards (Boyd and Tucker, 1998; Ali *et al.*, 2000) in relation to their suitability to sustain aquatic species in the selected sites.

Fish Sampling

Fish sampling was carried out in three pre-selected sites between 9 – 11am. At each site, 2x4-inch nets were laid and removed after a 2hrs sampling period, during this period; fishing was performed in collaboration with the fisher men. Along the lake, fishing was done within 300-meter sampling-stretch from the shore line preferably from the point at which water samples were collected. In a 2hrs sampling, the fish captured by the fisher men was identified by species and counted which was later released back into the lake. Identification was done with the help of the fisher. The length and width of fish were also measured using a 30cm-meter ruler and recorded as well. All the information recorded.

Data Analysis

The fishing sites and locations were recorded with a GPS and mapped with the aid if Arc-Map-GIS 10.1 software. The descriptive statistics (mean, standard deviation, maximum and minimum values) of temperature, pH, turbidity, electro conductivity and dissolved oxygen were tabulated. The data presentation and analysis were done using Microsoft excel 2010 and SPSS 21.0 statistical packages.

RESULTS

Although no significant variation in pH was recorded among the three sites, site 1 recorded the highest pH value and site 3, the lowest value. There was a positive correlation between pH and fish abundance and diversity. Tilapia was found to be the most abundant fish species in all the sites. High numbers of tilapia were recorded at high pH level (9.3) and a low number was recorded at low pH (7.2). The numbers of Nile perch were relatively low in all sites compared to tilapia. The same number of juvenile Nile perch was recorded in all the sites despite the variation in pH. No haplochromine was caught at high pH while a higher number of the same species was recorded at low pH.

Table 1: Water Quality for pH

	Min	Max	Mean	SD	SE
Site 1	8.83	9.71	9.34	0.46	0.26
Site 2	7.4	9.3	8.03	1.1	0.63
Site 3	7	7.5	7.23	0.25	0.14

Temperature

As shown in the table below, temperature was found relatively consistent in all the sites. However, the highest value recorded for temperature was 28.8°C while the lowest was 26.2°C. Among the three species of fish encountered in the three sites, tilapia was the most dominant species despite the higher temperature in site 1, while the rare species was haplochromine. A higher number of the later species was only caught at low temperature in site 3 while none was found in site with either relatively high or highest temperature. The number of juvenile Nile perch followed the one of tilapia and it was uniformly distributed across the sites.

Table 2: Water Quality for Temperature (oC)

	Min	Max	Mean	SD	SE
Site 1	28.6	28.9	28.8	0.17	0.1
Site 2	26.7	27.2	27	0.25	0.14
Site 3	26	26.4	26.2	0.2	0.11

E.C

The highest electro conductivity value was recorded in site 1(216µs/cm) located around the discharge point of Nakivubo channel. Site 2 recorded the lowest E.C value (134.17µs/cm) following the one of site 3(140µs/cm). Regarding the catch rates, the results showed higher catch for tilapia in all the sites than other species. However, an equal distribution of juvenile Nile perch was recorded across the sites but still tilapia remained the most abundant species. In site 3 with relatively higher value of E.C, a higher number of haplochromines was recorded while none showed up in the sites with the lowest and highest E.C values.

Table 3: Parameter E.C

	Min	Max	Mean	SD	SE
Site 1	167	303	216	75.54	43.61
Site 2	118.3	143.9	134.17	13.86	8
Site 3	136.7	144.7	140	4.2	2.42

Turbidity

Turbidity being one of the parameters that was tested, the variations among sites were as following; the lake water was most turbid in site 1 (10.6 NTU), in site 2 turbidity was relatively lower (9.37 NTU) and the lowest turbidity (5.3 NTU) was recorded in site 3. Tilapia dominated the catches in all the three sampling sites, followed by juvenile Nile perch. Site 1 recorded highest number of tilapias, followed by site 2 and then site 3. There was an equal distribution of juvenile Nile perch in all the sites. Only site 3 recorded haplochromine. Mkumbo, et al, 1999; noted that the number of haplochromines in the lake was considerably low.

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Table 4: Parameter Turbidity

	Min	Max	Mean	SD	SE
Site 1	9.1	12.4	10.6	1.67	0.96
Site 2	5.3	14.1	9.37	4.44	2.56
Site 3	4.9	5.6	5.3	0.36	0.21

Dissolved oxygen showed no significant differences among the sites. D.O values were highest in site 2 and lowest in site 3, respectively 6.9mg/l and 6.1 mg/l while D.O value in site 1 was 6.45 mg/l. Three fish species were recorded, with a majority of tilapia appearing in all the sites. The two other species were Nile perch and haplochromine cichlids. A rare occurrence of haplochromine was observed thus caught only in site 3. Juvenile Nile perch catch was relatively low but uniform in all the sites.

Table 5: Parameter D.O

Location	Min	Max	Mean	SD	SE
site 1	6.3	6.6	6.45	0.21	0.15
site 2	6.5	7.4	6.9	0.46	0.26
site3	5.9	6.4	6.1	0.26	0.15

Site 1 was directly a long discharging point of Nakivubo channel discharge point. Nakivubo channel traverses a highly polluted Kampala slum, markets, industrial areas and wetland. The discharge point is only 2km from the raw water of the lake. Although the wetland before the lake tries to bring down the pollution degree, pretreatment before discharge might be of huge importance (Kayima et al, 2010). The water sample was picked at a distance of 300m from the discharge point. A dark or dark green color was observed in the area giving water in this site the highest turbidity. Furthermore, the shoreline near the channel was covered by aquatic plants. Tilapia and Nile perch were the fish species recorded in this site. The length of 22.13±4.22cm and width of 8.06±0.11cm were recorded for mature tilapia. Only one juvenile Nile perch was recorded in this site with a length and width of 11 cm and 3.2 cm, respectively.

Table 6: Tilapia (Site 1)

Site 1	Min	Max	Mean ± SD
Length	19.4	27.0	22.13± 4.22
Width	8.0	8.2	8.06± 0.11
Number	1.0	6.0	2.67± 2.89

The sampling site 2 was located at about 1.5 km from Ggaba landing site and 1 km from the municipal sewage discharge point of Nakivubo channel. The water in this area was relatively turbid. Two species of fish composed of tilapia and Nile perch; were caught in this site. Tilapia being the most abundant species in this area, the mature tilapia measured 19.1±0.76cm of length and a width of 7.5±0.5 cm. the length of a juvenile tilapia in this site was 8.45±2.19 cm

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and the width, 3.3±0.71 cm. although not involved in the analysis, a juvenile Nile perch was caught in the site (length 14cm and width 4cm)

Table 7: Tilapia – Oreochromis (Site 2)

Site 2		Min	Max	Mean ± SD
	Mature	18.6	20.0	19.13± 0.76
Length	Juvenile	6.9	10.0	8.45± 2.19
	Mature	7.0	8.0	7.5± 0.5
Width	Juvenile	2.8	3.8	3.3± 0.71
	Mature	1.0	4.0	2± 1.73
Number	Juvenile	1.0	1.0	1±0

About 500m along the shore line from Ggaba landing site, was the third sampling site. In this site water was much clearer than the water in the two previous sites. A mature tilapia caught in this site measured 19.47±4.94cm of length and 7.1±1.85cm of width. A juvenile Nile perch was also recorded in the site (length15.2cm and width 6.9cm). Fish caught in this site presented a specific characteristic, especially tilapia looked cleaner with a brighter skin than the tilapia caught in other sites.

Table 8: Tilapia (Site 3)

Site 3	Min	Max	Mean± SD
Length	15.5	25	19.47± 4.94
Width	5,3	9	7.1± 1.85
Number	1	3	2±1

In addition, haplochromines were also recorded in site 3. This fish species was only caught in site 3 with relatively clean water compared to other sites (5.3NTU). Mature haplochromine had a length of 10.4±2.97cm and a width of 3.7±1.7cm.

Table 9: Haplochromine (Site 3)

Site 3	Min	Max	Mean ± SD
Length	8.3	12.5	10.4±2.97
Width	2.8	4.6	3.7± 1.27
Number	1	5	3±2.83

DISCUSSION

Lake Water Quality Parameters at Different Sites

Of all the three sites selected, the temperature ranged between 26.2°C and 28.8°C, which was still within the favorable range for aquatic life (Chapman et al, 1992). Lawal et al. 2014 recorded temperature of 25.80°C in the month of June which is a period characterized by rainfall, the same period when this study was carried out. Alabaster et al (1982), added that the normal range of temperature in the tropics to which fish is adapted is between 8^{o}C and 30^{o}C. However no significant fluctuations were observed between sites, temperatures fitted within the limit's standards (Colman *et al*., 1992; Boyd, 1998). Furthermore, tropical regions are characterized by high temperatures with relatively little variations (Lowe-McConnell, 1987).

Dissolved oxygen is among the critical parameters indicating water quality. D.O was highest in site 2 followed by site 1 and then site 3. Although no significant variation was reported among sites, D.O was above 5mg/l in all the sites. The values recorded for D.O were still within the permissible range for aquatic survival, given than D.O value below 5mg/l impairs the growth and reproduction of fish, furthermore making them more susceptible to disease and becomes deleterious below 2mg/l. (Mulongaibalu et al, 2014, Jose et al 1980 Boyd et al, 1981). Furthermore, water receives DO through air or from plant byproduct. This happens when oxygen diffuse across the water's surface from the atmosphere or generated as a waste product of photosynthesis from phytoplankton, algae. (Fondriest, 2019) this explains well the availability of DO in the shoreline as well as the presence of phytoplankton in site (Fondriest, 2019).

Conductivity was recorded highest in site 3 above 200µ/cm. The site stretches at about 300m from the shoreline, location at 2km from the discharge point of Nakivubo channel. The result of the previous research indicated deterioration in water quality reporting heavy contamination in the Inner Murchison bay especially at the discharge point where the mean electrical conductivity was 250 µs/cm. (Frederick J et al, 2005). In other word, we recorded a slightly lower E.C than the previous research. The EC values indicate possibly higher chemical concentrations at the shoreline, which are often influenced by land runoff than the open waters. However, Lake Victoria falls in category I defined by TALLING as lakes with conductivity less than 600, including most African lakes (Talling, 1996). There was insignificant variation in mean of in E.C between site 2 and site 3. The EC values may be attributed to seasonal influence specifically rain fall. Higher E.C was recorded during rainy season when rivers would be flowing most strongly and carrying dissolved ions into the lake (Balirwa *et al*., 2004).

The highest turbidity in site 1 might be attributed to pollution with sewage from Nakivubo channel. This site was mostly covered by phytoplankton probably due to high levels of nutrients and materials that may favor its growth, introduced into the lake by partially or untreated wastewater. Increased phytoplankton and stirring of water by wind leading to suspension of bottom silt, may result into high levels of turbidity (MA Kishe, 2004). Turbidity might also be attributed to an increase in human population (Bootsma and Hecky 1993) in the catchment area with subsequent increase in anthropogenic input of materials to the lake. However, the impacts of population in the catchment area of this study may be less significant given that the samplings sites, were not directly located in areas with dense population. (500m away from Ggaba market).

pH

Both natural and man-made factors can affect water pH. Natural factors are due to interactions with the surrounding environment, such as rocks; while pH can also vary with precipitation (acid rain), waste water or mining discharges (Fondriest, accessed 2019). Although precipitation can be one of the causes for fluctuation we recorded in pH because the study was carried out in rainy season, high pH in site 1 can be attributed to sewage discharge from

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Nakivubo channel. The wastewater discharged is partially treated by NWSC and then discharge in the wetland at 2km from the lake. The channel does not only carry treated water but also runoff from different parts of the city without any treatment; introducing high level of chemicals into the lake. Wetland encroachment and destruction might be one of the reasons why this water reaches the lake without being properly purified. Waste water can as well alter the pH of any wetland and thus making their way into the nearest water body. Minerals that exist in the soil surrounding the wetlands, such as salt, can as well affect the pH of wetlands. (Papagiorgio, 2017). Most wetland near the lake are either destroyed or degraded that they cannot play their role effectively.

pH affects the ability of fish and other aquatic organisms to regulate basic life-sustaining processes. When Ph exceeds levels that organism can tolerate, it may result in numerous negative effects on fish by reducing growth rate and even causing mortality (Robertson, 2004). No precise value has been determined beyond or below which an aquatic organism can be harmed. However, permissible ranges are given for some organisms (Alabaster and Lloyd 1980). We recorded pH values >7. The highest pH was recorded in site 1, followed by site 2 and then site 3, but still fell within the acceptable range 6.5 to 9.0 for aquatic life, particularly fish. (Ellis 1937, McKee and Wolf 1963). However, pH depends on several factors, including prior pH acclimatization, water temperature, dissolved oxygen concentration, and the concentrations and ratios of various cations and anions (McKee and Wolf 1963). Moshood k. Mustapha et al., 2018 recorded death at pH low that 4 and morphological and behavioral changes in Nile tilapia such as coloration and slimy mucous secretion on the body, peeling and erosion of the skin, bleeding of the dorsal fins as well as impairment in feeding. While Alabaster and Lloyd (1980), identified pH range for fish between 5-9, Wood and McDonaild, (1982) observed no significant effects on fish between pH 4-9 depending on the species, life.

Salinity and conductivity show a measure of what is dissolved in water. High levels of conductivity indicate high levels of dissolved chemicals in water (Fondriest staff, 2010). Changes in conductivity may show disturbance which decreases the health of the water body. Human activities as well tend to increase the amount of dissolved solid in water which may result into elevated valued of EC.(EPA,2017). However, the E.C in all the sites were still within the favorable ranges for aquatic life, if sewage is still released untreated or partially treated, and wetland around the lake destroyed; the water may become unfavorable for aquatic organisms. Channels and most streams range between 50 to 1500 µS/cm. Freshwater streams ideally should have a conductivity between 150 to 500 µS/cm to support diverse aquatic life. (Sharon, 1997).

Impacts of Physio-Chemical Parameters on Tilapia, Haplochromine and Nile perch

The most abundant fish species caught was Nile tilapia. They belong to the class of cichlids and live in lakes, inland and coastal rivers of middle and near east Africa, however it can also adapt to brackish or salt water. Tilapia was caught in high numbers in the shoreline compared to other fish species, this basically shows their habitat to be in shallow waters. Members of this species dwell at the surface or in depth of 6 to 20m and prefer the temperature between 16-29^{o}C. Furthermore, an adult tilapia measures between 20 and 60cm but can reached maturity at 7cm.This correlates with the results of our research where the mean temperature ranged between 26.2 and 28.8^{o}C favoring the tilapia population, and lengths for tilapia were both beyond and below 7cm meaning juvenile and mature tilapia were caught. They prefer muddy or sandy area where they find shelter from their predators. Since they live in shoreline, they basically feed on phytoplankton and invertebrate (Billo, 2018). Their presence in shoreline can also be attributed to predation; Tilapia feeds on eggs and juvenile of other species found in the shoreline. Turbidity is also critical for tilapia. Their color varies from dark olive to silver-grey depending on their age and environment. In other words, breeding male tilapia tends to become dark while the environment they live in, may also affect their color (NSW, 2019). The tilapia caught in site 1 with the highest turbidity was dark whereas the ones caught in site 3, had brighter or cleaner color, this shows that the water in site 1 near Nakivubo channel had higher turbidity than water in other sites. The number of tilapias decreased with low turbidity indicating its habitat preference as mentioned above. No significant fluctuation in pH was observed across the site the sites. The pH varied from neutral to slightly alkaline, not having significant impacts on tilapia. Vanesa, et al, 2016 concluded that the suitable pH range for Nile tilapia can be set at 5.5-9.0, implying that the pH of water recorded during this research is still in the permissible ranges for tilapia however if pollution continues, water will tend to be more alkaline. Saad, et all, 2009 concluded pH of 7-8 to be the suitable range for survival and growth of tilapia.

Haplochromine was only caught in site 3, where the mean turbidity was 5.3±03 NTU. In other words, water in this site was clearer compared to site 1 and 2, 10.6 and 9.37 NTU respectively. Clear water favors different feeding techniques and year-round spawning for haplochromine as well as mate choice. This explains that a recovery of haplochromine and an increase of species hybrids and diversity after decline in number of Nile perch (Witte, et al, 2012). Its presence in only one site may also be attribute to the introduction of Nile perch predators in the lake driving an estimated of about 200 species into extinction. Haplochromine constitutes now only 1% of the fish biomass in Lake Victoria. However, pollution from industries and population centers around the lake causing eutrophication which results into oxygen depletion and as well as reduced water clarity/high turbidity; makes it hard for haplochromine to identify their mates (SFFB, accessed 2019). Previous experiment showed that females base their mate choice on male color (Seehausen et al. 1997, 1999; Seehausen and Van Alphen 1999).as well as territory quality is critical in mate choice(Peter D, et al, 2008). Thus site 1 and more site 2, were not favorable for haplochromine survival due to high turbidity. The DO value was still in the permissible range for all fish including haplochromine in all the site, so probably turbidity justifies its absence in site 1 and site 2.

Nile perch inhabit fresh waters. They prefer warm, tropical waters where they grow to large sizes and occur in high densities. Adult Nile perch are found in all habitats in lakes and rivers as long as there is sufficient oxygen but they are not found rocky areas, swamps, and the pelagic zone. Small juveniles inhabit shallow near-shore environments (Luna, 2002; Queensland Government, 2002). This research carried out in the shoreline, recorded juvenile Nile perch in all the site. D.O was in within the acceptable range for aquatic animals including Nile perch. Nagelkerke, 2015 recorded highest number of Nile perch in the shallow part of the Mwanza Gulf and during the wet seasons. In contract we recorded low number of juvenile Nile perch during the same season. However, Nile perch are also found in deep waters of Lake Victoria where shrimps are high in density, they tend to escape low oxygen levels during rainy season by migrating to the inshore (Goudswaard, et al, 2011).

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CONCLUSIONS

The research was conducted in Ggaba, Lake Victoria. Sampling stations were identified within the lake shoreline where water was sampled and fish were caught to analyze the suitability of water for fish ecology. From the overall result of this study, we can conclude that water quality was still within the permissible ranges to support aquatic life. The temperature was still favorable and within the range of tropical lakes, electro conductivity fell in the range of African lakes as well as in the range favorable for fish. Turbidity recorded even in the highly polluted site, did not exceed the ranges however it was almost at the extreme limit, pH was still favorable for aquatic life according to the standards and D.O was >5mg/l meaning it was sufficient for fish respiration.

Temperature and E.C did not directly affect fish, rather they affected other parameters such as D.O and indicated the levels of pollution, respectively. Turbidity showed impact on specific fish species such as haplochromine and tilapia. Haplochromine's distribution did not occur in sites with more turbid water. Tilapia showed resistance even to condition considered harsh such as high turbidity. This was due to their habitat tolerance range and foraging, they lived in muddy and areas with high amount of phytoplankton. Juvenile Nile perch was favored by the D.O recorded in all the sites, reason being habitat for juvenile in the shoreline was attributed to adaptation before they migrated in deep waters and low level of D.O in deep waters during rainy season.

We can conclude that the water quality in each site affected the fish distribution and diversity. Fish were distributed in the sites according to their habitat preferences based on the quality of water. However, in all the sites, the water quality is still acceptable to support aquatic life, especially fish; increasing pollution levels may lead to unfavorable habitat for fish. This can easily be seen around the discharge point of Nakivubo channel, where no fish was caught. The species of fish found in that site could have become tolerant to harsh conditions.

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