

**THE EFFECT OF HOOK SIZE ON THE CATCH RATE AND SIZE
OF THE NILE PERCH *Lates niloticus* (LINNE) FISHERY
IN THE NAPOLEON GULF, LAKE VICTORIA,
UGANDA.**

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Declaration:

I, Bassa Samuel, declare that this dissertation is my original work and has not been submitted for a degree in any other university.

Signature.......... Date.....24.11.2011.....



APPROVAL

We certify that this dissertation satisfies the partial fulfillment of the requirements for the award of the degree of Master of Science (Environmental Science) of the Islamic University in Uganda.

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Dedication:

I dedicate this work to my mother Namukose Mirabu.

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List of Abbreviations and Acronyms

CPUE	Catch per Unit of Effort
LVFO	Lake Victoria Fisheries Organization
EDF	European Development Fund
SOPs	Standard Operating Procedures
FISAT	Fish stock assessment Tool
LVFRP	Lake Victoria Fisheries Research project

Abstract

This study was undertaken in Napoleon gulf, Lake Victoria Uganda from July – December 2009. It was conducted in four landing sites; Bukaya (0.41103N, 33.19133E), Bugungu (0.40216N, 33.2028E), Busana (0.39062N, 33.25228E) and Kikondo (0.3995N, 33.21848E) all from Buikwe district (Formerly part of Mukono district). The main aim was to determine the effect of both hook size and bait type on the catch rate (mean weight) and size composition of Nile perch (*Lates niloticus*) (LINNE) fishery in the Napoleon Gulf, Lake Victoria.. The main hook sizes investigated during the experiment were 7, 8, 9, 10, 11 and 12 that were dominantly used in harvesting Nile perch in Napoleon Gulf, Lake Victoria. In this study length, weight and bait type data were collected on site from each boat at that particular fishing spot; since most fishermen in the Napoleon Gulf could sell their fish immediately the catch is caught there and then. The results indicated a total of 873 Nile perch fish samples collected during the study. Statistical tests, descriptive statistics, regression and correlation were all carried out using the Statistical Package for the Social Sciences (SPSS) in addition to Microsoft excel. The bait types in the Gulf ranged from 5-10 cm Total length (TL) haplochromine, 24.5-27 cm TL *Mormyrus kannume* and 9-24 cm TL *Clarias* species. The bait types had a significant effect on the catch rate and also on the size composition the fish harvested measured as Total length (ANCOVA $F=8.231$; $P<0.05$) despite the fact that bait type had no influence on mean weight of fish captured (ANCOVA $F=2.898$; $P>0.05$). Hook sizes used by the fishers had a significant effect on the both the size (TL) composition (ANCOVA $F=3.847$; $P<0.05$) and the mean weight (ANCOVA $F=4.599$; $P<0.005$) of the Nile perch captured. Investigations indicated hook sizes seven (7) and eight (8) were the ones that harvested the Nile perch above the slot size of 50 cm total length. In general hook sizes indicated to be the main drive in the harvesting of the Nile perch though bait type also contributed toward that. Generally there is need for management to put a law in place on the minimum hook size to be used on the harvesting of the Nile perch and also monitored by the Fisheries Management as a regulatory measure. In addition to that aquaculture should be encouraged to farm the fish for bait at a higher scale in the region in order to avoid depleting the wild stocks already in danger of extinction. Through this kind of venture, both biodiversity conservation and environmental sustainability will be observed in the Lake Victoria basin.

CHAPTER ONE

INTRODUCTION

1.0 Background of the study.

Lake Victoria is the largest freshwater system in the tropics with minimum depth of 40 meters and maximum depth of 80 meters. The lake is located at the latitudes ranging from 0° 20' N to 3 ° 0', S and longitudes of 31° -34°, 53' E with an altitude of 1136 m. The whole lake has total surface area of 68,680 km² and maximum length is 400 km and minimum 320 km. It has water retention time of 140 years and catchment area of 193,000 km², which extends into Rwanda and Burundi (Okaranon, *et al.* 1999, Ntiba, *et al.* 2001 and Balirwa, 2007). Lake Victoria fisheries have experienced recognizable changes over the last seventy years or so. It is certain that in the early years of the Lake Victoria, adequate fisheries catches were obtained with little effort, from inshore areas alone, and with simple fishing gears and the fishing intensity was almost negligible (Kudhongania and Cordone, 1974 (a)&(b), Okaranon, *et al.* 1999).

Nile perch was introduced in Lake Victoria between 1950s and early 1960s from Lake Albert and Lake Turkana for purpose of converting the less valuable haplochromine cichlids into high quality table fish (Okaranon, *et.al* 1999, Mhitu and Chande, 2004, Taabu, *et al.* 2008(b)). Major changes in the species composition occurred in early 1980's following these introductions which led to an explosive population increase in the Nile

perch (*Lates niloticus*) and *Caridina nilotica*, a small benthic shrimp. The population of Nile tilapia and indigenous small pelagic cyprinid *Rastrineobola argentea* expanded substantially at about the same time. The present fishery is made up of mainly three commercial fish species, Nile perch, Nile tilapia and *Rastrineobola argentea*. Nile perch dominates the fishery followed by *Rastrineobola argentea* and Nile tilapia (Ligtvoet *et al.* 1995). The Lake Victoria basin currently supports 40 million people and 10% of this population depend on the lake especially fish either directly or indirectly. The gross economic product is in the order of US\$4-6 billion annually (Kamanyi *et al.* 2006(a)&(b), Balirwa 2007, Muyodi *et al.* 2010, Report on Uganda Fisheries Frame survey 2008. One of the challenges facing the lake that threaten those who depend on it for their livelihood yet the fishing effort has been increasing rapidly due to increasing population and unemployment; is the fish stock decline due to capture of immature fish and use of destructive fishing gears and methods that have correspondingly occurred. Generally failure to regulate fishing gears and method has been a major cause of collapse of fisheries in several water bodies in Uganda (Ogutu-Ohwayo, *et al.* 2002).

In Lake Victoria, longline was highly developed in 1980's after the introduction of the fishing companies along the region. The hooks are baited with natural baits like small live fish, slices of meat, earthworms and insects (Ibale, 1998). This gear mainly targets Nile perch (*L*) despite the fact that other species are got as bi-catch. The fish harvested is always good for industrial process compared to that from gillnet gear. And due to that fishers have tremendously intensified in the longline practice on Lake Victoria hence

hitting hard the Nile perch, which has a high demand by the investors in Uganda. Currently a total of 2,783,428 hooks on the lake, 39% of longline hooks in use are very small (hooks size >10), which target Nile perch (Muhoozi, 2008) and yet they are on the increase. Hence effect of hook size and bait used of the fishery of Nile perch was investigated in this study.

1.1 Problem Statement

Nile perch contributes significantly to the Ugandan economy. However, recent studies in Lake Victoria indicate that its relative abundance is declining whereas fishing effort targeting the species is increasing. Nile perch biomass dropped from 542.736 tonnes (36.8%) of the total biomass to 369,498 (14.2%) between August 2006 and February 2008 for the whole Lake Victoria region (Taabu *et al.* 2008(a) & (b)). The proliferating longline fishery is likely to be one of the factors impacting on the Nile perch stocks. Currently fisherfolk are using various sizes of hooks hence harvesting the Nile perch indiscriminately right from the juvenile fish to the mature ones leading to loss of biodiversity. At the same time no law has been put in place on the suitable hook size for harvesting the Nile perch apart from the gill net fishery. In this perspective scientific information was required on the hook fishery of the Nile perch in order to guide the fisheries managers. Therefore, this experimental survey of effect of hook fishery on the catch rates and size of Nile perch in Napoleon gulf, was geared to provide the scientific information and a fisheries management guide.

1.2. The General Objective

Determine the effect of fishing gear type on the catch rate and size of Nile perch (*Lates niloticus*) (LINNE) fishery in the Napoleon gulf, Lake Victoria.

1.2.1. Specific objectives

- i) Determine the effect of bait type on the catch rate and size composition of Nile perch in selected hook sizes.
- ii) Determine the effect of hook size on the catch rate and size composition of Nile perch

1.3. Hypotheses.

- 1. There is no effect of selected hook sizes 7, 8, 9, 10, 11 and 12 on the catch rate and size of Nile perch on the in Napoleon gulf, Lake Victoria Uganda.
- 2. There is no effect by type of bait type on the catch rate and size composition of Nile perch.

1.4. Significance of the study

One of the major fishing methods used in the Nile perch fishery is use of longline hooks. This method is increasingly becoming popular in the Uganda waters of Lake Victoria.

Results from the frame survey of longline hooks on Lake Victoria show an increase between the year 2000 (254,453) and 2008 (2,783,428) in Uganda waters (Tumwebaze, 2005, LVFO, 2008). It has not been possible to determine the most suitable size of hooks to be used in the Lake Victoria Nile perch fishery. As a result fishery management adopted a precautionary approach and recommended the use of sizes 7 and 8 up to 9 in the lake (Kamanyi, 2005, LVFO, 2008). And on top of that there is no law in place on the minimum hook gear size for harvesting Nile perch in Uganda. There was need to determine the most suitable size of hooks to be used in Lake Victoria waters basing on scientific experiments.

Therefore this study basically looked at the effect of hook size plus bait type on the catch rate, size composition of Nile perch (*L*) in order to provide scientific information for use in regulation of the longline fishery.

1.5. Scope of the study.

The study explored the relationships between Nile perch catch rate and size of selected sizes of hooks using the main bait types in the Lake Victoria fishery (haplochromine, *Mormyrus kannume* and *Clarias*). The study was conducted for a period of five months in Napoleon Gulf, Lake Victoria Uganda.

CHAPTER TWO

LITERATURE REVIEW

2.0. The Nile perch

Nile perch (*Lates niloticus*) also referred to as Victoria perch belongs to the family Centropomidae. Locally it is known as Sangara (Tanzania), Chengu (Tanzania), Mbuta (Kenya), and Mputa (Uganda) among the East African community and the Congo region. It is wide spread throughout the Ethiopian region, occurring in all the major river basins including the Nile, Chad, Senegal, Volta and Zaire. It is present in the brackish waters of Lake Mariout, near Alexandria. It occurs in Lakes Albert and Turkana. Currently it grows to a maximum length of up to 190 cm total length. Earlier studies recorded a maximum of 251 cm TL with a growth factor K of 0.19. (Witte and van Densen, 1995). In Lake Victoria, Nile perch has been caught from shallow inshore areas up to depths of 60 m. The larger individuals prefer depth ranges of 10-14 meters. (Witte and van Densen, 1995). It is a predator and a long term growing species.

Nile perch was introduced in Lake Victoria in the 1950s to convert the less valuable haplochromine cichlids into high quality table fish. At the earlier period of the Nile perch introduction the species grew very fast and its population abundance increased very fast in the Lake Victoria waters. But its population explosion culminated a population decrease of other fish species including the 200 species of haplochromines and most of the non-

cichlid fishes in offshore waters decreased (Ogutu-Ohwayo, 1984, Mhitu and Chande, 2004, Pringle, 2005 and Tumwebaze, 2005). It was further expected that this introduction would extend the traditional, predominately inshore fishery to open waters, and that since *L.niloticus* existed with *Sarotherodon* and other species in lakes Turkana and Albert it would have no harmful effects to similar species in Lake Victoria (Ogutu-Ohwayo, 1984). In the East African region, Nile perch has created remarkable economic benefits, which include expansion of the artisanal fishing industry, availability of Nile perch to consumers in the region and the development of multi – million dollar export industry for chilled and frozen fillets. In 1994, the revenue from fish landings in Uganda was \$ 77.13 million, \$ 80 million in Kenya in 1998 and in the same period it reached as much as \$200 million in Tanzania (Bwathondi, *et al.* 2001, Cowx, *et al.* 2003). However, Nile perch has been the most dominant species in the fishery in the previous years but due to increased exploitation and ecosystem changes has led to its decline.

In Lake Victoria and other African lakes such as L.Malawi and L.Tanganyika, mechanized bottom trawling has altered the composition of small cichlid communities by selectively depleting the larger species (Ogutu-Ohwayo, *et al.* 1998).Trawl survey information by Lake Victoria Fisheries project under Fisheries Resource Research Institute from 1997 to 2000 indicate that catches in 4-20 m deep 60% by number were immature hence less than 50 cm TL (Okaranon, *et al.* 1999,Okaranon 2003) and yet these areas are highly exploited by fishers. The annual yield for the Ugandan portion of Lake Victoria was estimated at 107,000 t of which about 72,000 t was Nile perch estimated in

the period of 1997-2000. Regional trawl surveys indicated that the standing stock lake-wide decreased from 694,000t to 628,000 t from 1999 to 2000 while in Ugandan waters only indicated a decrease from 307,000 to 266,000 t. (Balirwa, 2007, Ogutu-Ohwayo *et al.* 2002). The hydro-acoustic results indicate that the stock of Nile perch at lake wide survey of Lake Victoria has continued decreasing and of recent was 313,789 t in 2007 compared to 721,763 t, 2001 survey (Acoustic report March, 2007, Acoustic report August 2007). Due to intensive pressure on the Nile perch the recommendation of the allowable slot size is 50-85 cm TL for whole fish at the factory gate was established. But as of now the factories are still operating under capacity due to over exploitation. The total mortality rate (Z) has been changing overtime from 0.72 year^{-1} to 2.2 year^{-1} and yet using length-converted catch curve analysis in FISAT, with the length frequency distribution with constant class size (1 cm) from the three gears employed i.e. beach seine, gillnet and Hook and line in the fishery as input data, L_{∞} was 221, K also was 0.18 with exploitation rate of 0.86 (Mugisha and Ddumba, 2006, Muhoozi, 2002 and Taabu, 2004). While looking at the length – weight relationship of Nile perch from the trawl survey data indicated the values of parameters “a” and “b” (0.0177 and 2.9082 respectively) obtained from the direct fit and log transformed models (Taabu, 2004).

2.1. The role of the Nile perch in the Uganda’s Economy.

In 2005, Uganda Fish exports earned 255 billion Uganda shillings and more than 30 million people live in the Victoria basin and 10% of them depend on the lake by catching

the fish or engaging in the fishery related activities (Kamanyi, *et al.* 2006(a)&(b)). Fish processing plants in Uganda (about 17) process Nile perch for export under strict quality control that meets the quality requirements (Kamanyi, *et al.* 2006(a)&(b)). The fish stocks of Lake Victoria are exploited using gill nets, small dagaa seines, hooks, beach seines, cast nets, traps each targeting particular fish species or a variety of species. This kind of multi-gear fishery is creating a high impact on the fish species in the lake.

The results from the previous trawl surveys carried out by implementation of the fisheries project a decline of the fishery attributed to high fishing pressure and use of illegal gears such as under size gillnets and hooks, beach seines and others. Hence there is a need to determine the catch rates of Nile perch using experimental longline hooks in Napoleon Gulf in selected sites.

2.2. Spatial distribution and exploitation of Nile perch.

Lates niloticus has a lake-wide distribution. In 1988, in the Ugandan area, specimens of a wide range of size classes were found even in swamps, when water reached a high level after heavy rainfall (Ligtvoet, *et al.* 1995). *Lates* is a bottom dwelling species, but recent observations in Mwanza area indicate that in deeper waters (20-40m) it also stays and forages pelagically in layers 10-20 m below the surface. This phenomenon is probably related to the fact that *Lates* has a relatively high demand for oxygen (Ligtvoet, *et al.*

1995). In such circumstances it indicates that Nile perch distributes itself both above and below thermocline.

Nile perch, the dominant fish species in the fishery of Lake Victoria, has shown signs of decline. Changes in the efficiency of fishing gears, motorisation of canoes and increase in total fishing effort to maintain production and extension of fishing grounds (Bwathondi *et al.* 2001) are some of the factors that have led to the decline. The gillnets target Nile perch, and Nile tilapia; the small dagaa seines target dagaa and haplochromines; the long lines target Nile perch; the traps and cast nets target Tilapiines mainly inshore. Beach seines are illegal but target Nile perch and Nile tilapia. Hooks are operated by passively set long-lines or trolling (towing the longline) or by angling (hand and line) (Kudhongania and Cordone, 1974(a, b), Standard operating procedures (SOPs) Hook fishery 2005, (Kamanyi, *et al.* 2006(a) & (b)).

This longline hook fishery has intensified in the Lake Victoria region compared to other type of gears, which requires investigations.

2.3. Longline Hook fishery

The Longline hook fishery gradually developed in 1980s mainly for exploitation of predatory fishes like Nile perch (*L.*), besides other species. It is widely used on all major water bodies (Ibale, 1998). Longlines catch *Lates niloticus* over a wide length range, from 20 up to almost 150 cm TL, with the peak at 50-55. The landed catch per canoe varies

widely due to the presence of one or two large individuals in the catch, which greatly increases the catch weight. The landed catch per canoe used to vary from zero up to 180 kg, with an average of about 80 kg (Ligtvoet, *et al.* 1995). Currently the catch per boat per fishing day for longline hook fishery ranges between 45.08 to 15.6 kg (Kamanyi, *et al.* 2006(a, b)) which indicates a big decline in the fishery. Despite that, fish caught by longline is got fresh and industries like it most, this has caused the hook and line fishery expand on both off and in shore areas of Lake Victoria.

Lake Victoria is surrounded by 11 districts with 17 fishing industries around the lake region. Today all these industries are operating at under capacity due to the decline in the catches in Lake Victoria region. The estimated total fish landed in the Uganda part of Lake Victoria indicate a decline of Nile perch from 8031 tonnes to 6569 tonnes in the period of 2006 to 2008 (LVFO 2008). The fishing effort has been increasing over time and this is being released in the increase in the longline hook fisher gear from 254,453 hooks in 2000 to 2,783,428 in 2008. It is also indicated that 39% of longline hooks in use are very small (hook size >10), which target small size Nile perch (Report on Uganda Fisheries Frame survey, 2000, Regional Status report, 2006, Muhoozi, 2008). The effect of expanding longline hooks fishery and gear selectivity needed to be evaluated and regulated in accordance to best size that should be utilized.

2.4. Source of bait used in the Hook fishery of Nile perch.

On Lake Victoria, the bait used in the hook fishery consists mainly of haplochromine, *Clarias carsonii*, *Clarias gariepinus*, *Bagrus*, *Protopterus*. Though one of the challenges by the fishers is the scarcity of bait during dry season (Tumwebaze, 2005). Studies conducted indicate average cost of baits per species ranges, *C. carsoni* of 14.2 cm TL at 98 Uganda Shillings (Ug.Shs.) and *Synodontis sp* of 13 cm FL at 70 Ug. Shs and haplochromine species ranges between from 5 – 13 cm and the price varies with the quantity collected by the fisher (Kamanyi, *et.al* 2006(a)&(b)). Currently due to the increase in the hook fishery the price of *Clarias* bait has increased to 300 Ug. Shs per fingerling, mainly from farmers. The Haplochromine are collected from the wild using small mesh gill nets, which are illegal and destructive to other fish species. *Clarias* bait is mainly obtained from fish farmers and to a limited extent from wetlands in the wild. There has been a concern regarding the collection of bait from the wild because most of these are collected from refugia of endangered species, which poses a threat to the already endangered species biodiversity of fish species in the lake (Kamanyi, 2005). But due to intensive fishing using the longline and hooks the wild stock is increasingly being fished for bait. Currently in the Napoleon Gulf some fishermen have resorted to use *Mormyrus kannume* in addition to other types of bait; especially those using bigger hooks like hook size 7 and above.

CHAPTER THREE

MATERIALS AND METHODS

3.0. Study Area

The study was carried out on Lake Victoria, Uganda in Napoleon gulf (Figure 1). The Napoleon gulf has a shoreline typical of Lake Victoria, indented with shallow bays at the lake margin. It is 1.5 km wide and its depth ranges between 1.5 and 19 m i.e. from the shoreline to deeper areas. It has too large permanent streams namely Bugungu and Budumbuli and some other small ones (Akumu, 1999). Most of the gulf shoreline is covered by vossia species and water hyacinth. Some shoreline areas are covered with *Cyperus papyrus* and *Phragmites*. The gulf is also surrounded with landing sites both in Buikwe district (formerly Mukono district) and Jinja district. Some parts of the gulf like the areas near Nasu point are a bit rocky. The study was carried out in this gulf basically due to accessibility and also the unique features explained above which also occurred in various areas of Lake Victoria. Sampling was carried out in landing sites which basically carryout Nile perch Hookfishery around Napoleon Gulf and these are Bugungu, Bukaya, Busana and Kikondo landing sites (Figure 3.1)

3.1. Experimental design.

Before data collection was done a visibility study was undertaken in the four landing sites i.e. Bukaya (0.41103N, 33.19133E), Bugungu (0.40216N, 33.2028E), Busana (0.39062N, 33.25228E) and Kikondo (0.3995N, 33.21848E) that were sampled. During that time

consultations with the beach management chairmen were done and we realised that the hook and line fishing boats on each landing sites were as follows: - Bukaya 25, Bugungu 1, Kikondo 1 and Busana had 12. The interaction with these chairmen of these landing sites it was realised that most of the hook and line fishers in the Napoleon Gulf sell their fish in the waters before landing; so a new method of data collection from then had to be designed instead of waiting catches at the landing site. In this case I had to put fuel in the out boat engine operated by the deckhand and we could stay in Napoleon Gulf waters with the fishermen while fishing so that every fish caught by the hook could be weighed, total length taken and hook size and locality where the fisher comes from recorded at that material time before could be sold to the business men. The sampling basically targeted fishers dealing in Nile perch with hook size of 7, 8, 9, 10, 11 and 12. Using this kind of method the element of mixed catch was avoided in this experiment. The experiment was carried for 6 days per month for a period of 5 months in Napoleon gulf. Data collection was done during morning hours from 8:00 a.m to noon.

3.2. Type of bait used by the fishers in Napoleon gulf.

During the experiment all the fishers dealing with Nile perch fishery in Napoleon Gulf were using live bait. The fishers encountered, each one had individual type of bait though with various hook sizes. In most cases each boat could have four hooks with two fisher men one piloting it using oars; while the other had to make sure that the hooks are safe during the movement while hunting for fish from one place to another (towing) in the

gulf. In this case a fisher per boat could use haplochromine or *Clarias* or *Mormyrus kannume* bait only. In this case individual fish was weighed and also total length taken in accordance to the hook size and also the type of bait was recorded. The live bait was placed on the hook passing through the flesh of the back between the dorsal fin and the backbone, once hooked (Figure 3.2 and 3.3); the bait could swim about on the hook for some hours in order to attract the Nile perch. The target Nile perch hook fishers by bait type were from sizes 7, 8, 9, 10, 11 and 12 during the investigation of this study.

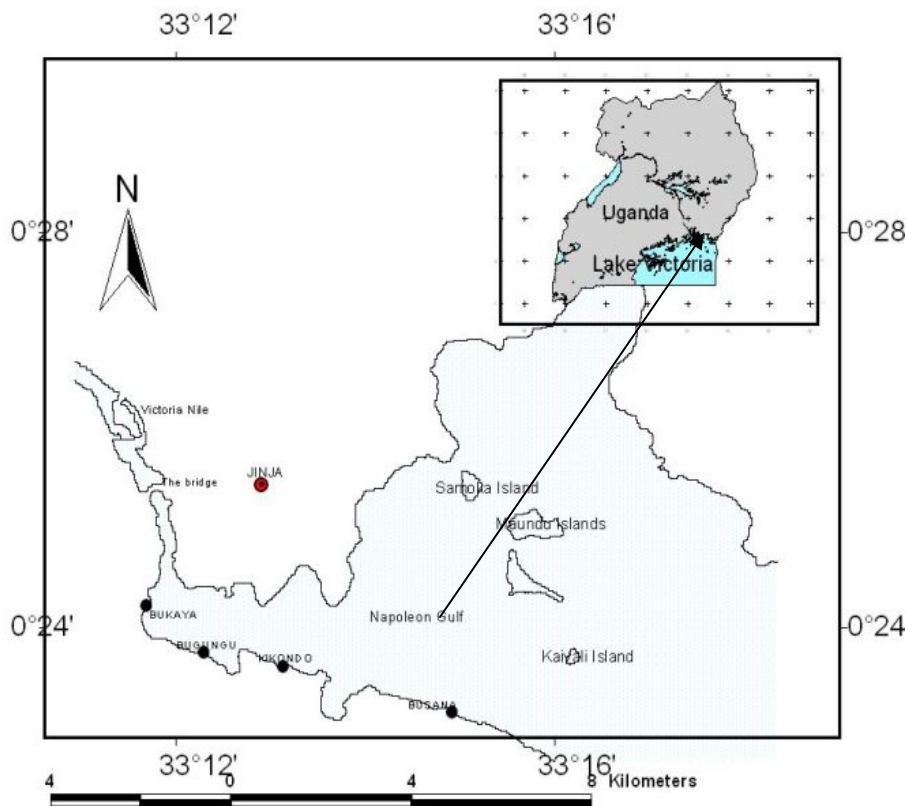


Figure 3.1: The map showing the Longline experimental stations where sampling was carried out. Above the black rectangular box indicates the sites on the map of Uganda.



Figure 3.2: Showing the Nile perch harvested from Lake Victoria, Uganda

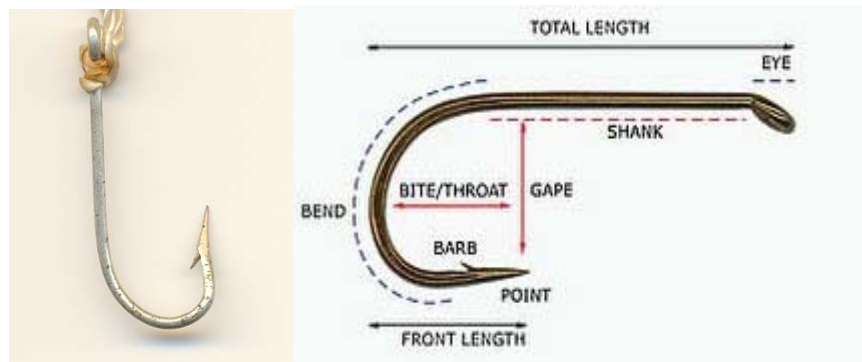


Figure 3.3: The Iron hook used on Long-line hooks set for Nile perch.

3.3. Catch rates of Nile perch by Hook sizes.

Catch rate is defined as the total catches of the specific fish species in terms of weight in a specified area of the water body. This can be in kilogram per square kilometre, per day or kilogram per the fishing gear used. The mean and percentage contribution by weight either per haul or per gear is calculated including standard deviation of the mean (SOPs-Trawl 2005). Alternatively we can determine catch rates in terms of catch per unit of

effort CPUE. The CPUE for example, the numbers caught per trawl hour, is a quantity which can be assumed proportional to the number of fish in the sea (Sparre and Venema 1998). In commercial catches of longline/hook fishery, total catch per boat by weight and number of the fish species caught the two parameters determined (Standard operating procedures (SOPs) Hook fishery (2005).

During this experiment the catch rates of Nile perch by hook sizes were investigated by weighing individual weight in grams per hook size caught. The mean weight per hook size was determined in order to get the catch per unit of effort of Nile perch (mean weight (g)/hook size). The overall average per individual hook size was determined in order to come up with the catch per unit of effort (CPUE) of Nile perch in the Napoleon gulf.

3.4. Size composition of Nile perch by Hook sizes.

Size composition of Nile perch was determined by measuring Total length of fish caught in centimetres from each hook sizes with its standard error $\pm$. Size composition of the Nile perch was categorised in accordance to gear size of the hooks right from size 7, 8, 9, 10, 11 and 12.

3.5. Effect of bait on the size composition of the Nile perch

In the Napoleon Gulf, the fishers used Haplochromine, *Clarias* and *M.kannume* species as bait for harvesting Nile perch in the hook sizes of 7,8,9,10,11. Each fisher per boat was

using only one type of bait depending on the size of the hooks. Information on the type of bait in conjunction with the weight and length plus the hook sizes was collected. An average weight of each type of bait was put into consideration.

3.6. Data Analysis.

Data input was done in both SPSS and Microsoft excel. During the analysis of the Nile perch hook fishery data with a total number of 873 Nile perch fish samples collected during the survey; correlation was carried out using Pearson square at 0.01 level of significance and basically looking at the hook gear in relation to catch rate and size composition. The length weight ($W = aL^b$) data was transformed to natural logarithm for regression.

Catch rate and size composition were carried out basing on both percentage frequency and overall means per hook gear size using standard error bars on the latter. Where: $s \cdot n^{1/2} = S.E$ and $t = t_{score}$ ($p < 0.05$, two tailed tests) at $(n-1)$ df, (Muhoozi 1998 and Flower and Cohen 1990). Analysis of Covariance (ANCOVA) which is a test for differences in means was carried out on the overall data at 0.05 level of significance. These tests were on the catch rates and size composition relation to the hook size gear of 7, 8, 9, 10, 11, and 12. Analysis of covariance (ANCOVA) tests was also carried out on the effect of bait type on the hook size and thus the catch rate and size composition of the Nile perch. Statistical tests, descriptive statistics and correlation were all carried out using the SPSS

package; the same was applied for the bait types i.e. haplochromine, *Momyrus kannume* and Clarias species.

During the sampling, time factor was considered hence this work targeted fishermen who fish from 7.00 a.m to 12:00 noon. The main hook size targeted were 7, 8, 9, 10, 11 and 12 despite the fact that other hook size used by fishers like hook sizes 4, 5 and 6 which catch bigger fish which are the mothers of the next generation hence above the slot size of 80 centimetre total length and also hook sizes 13 and 14 which target more juvenile fishes. The highest number of fishers had 4 hooks used for fishing using trawling method while hunting for the Nile perch in most of the localities of the Napoleon gulf. Each fisher boat was using one type of bait and these were Clarias, Haplochromine or *Mormyrus kannume* species.

CHAPTER FOUR

RESULTS

4.0 Nile perch fish samples in Napoleon gulf

A total of 873 Nile perch fish samples were collected the mean catch rate was 895.42 g/boat with a range of 50 – 43000 grams and mean size composition of 35.02 cm/boat with a range of 17.30 - 157.30 cm total length. Correlation matrix was carried out on the Nile perch fish sample using Pearson square at 0.01 level of significant on total length in centimeters, weight in grams and the type of bait (Table 4.1). The correlation matrix of natural logarithm of total length and weight to hook size indicated the value of coefficient r of -0.730(**) and -0.727(**) hence strong correlation as shown in (Table 4.1).

Table 4.1: Showing the correlation matrix of Catch rate and Size composition of hook fishery of Nile perch in Napoleon Gulf Uganda.

		GEAR SIZE	LN_TL	LN_WT
Hook Size	Pearson Correlation	1	-.730(**)	-.727(**)
	Sig. (2-tailed)	.	.000	.000
	N	873	873	873
LN_TL	Pearson Correlation	-.730(**)	1	.977(**)
	Sig. (2-tailed)	.000	.	.000
	N	873	873	873
LN_WT	Pearson Correlation	-.727(**)	.977(**)	1
	Sig. (2-tailed)	.000	.000	.
	N	873	873	873

** Correlation is significant at the 0.01 level (2-tailed).

4.1. Length - weight relationship of the Nile perch from the hook/longline fishery.

Looking at the Length – weight parameters “a” and “b” in the length- weight relationship, $W = aL^b$, were estimated using data from the hook/longline fishery. A log transformed model using a spread sheet produced a linear equation for easy estimation of length-weight parameters. The values of parameters “a” and “b” were 0.0058 and 3.2005 respectively (with R^2 0.9532) were obtained (Figure 4.1).

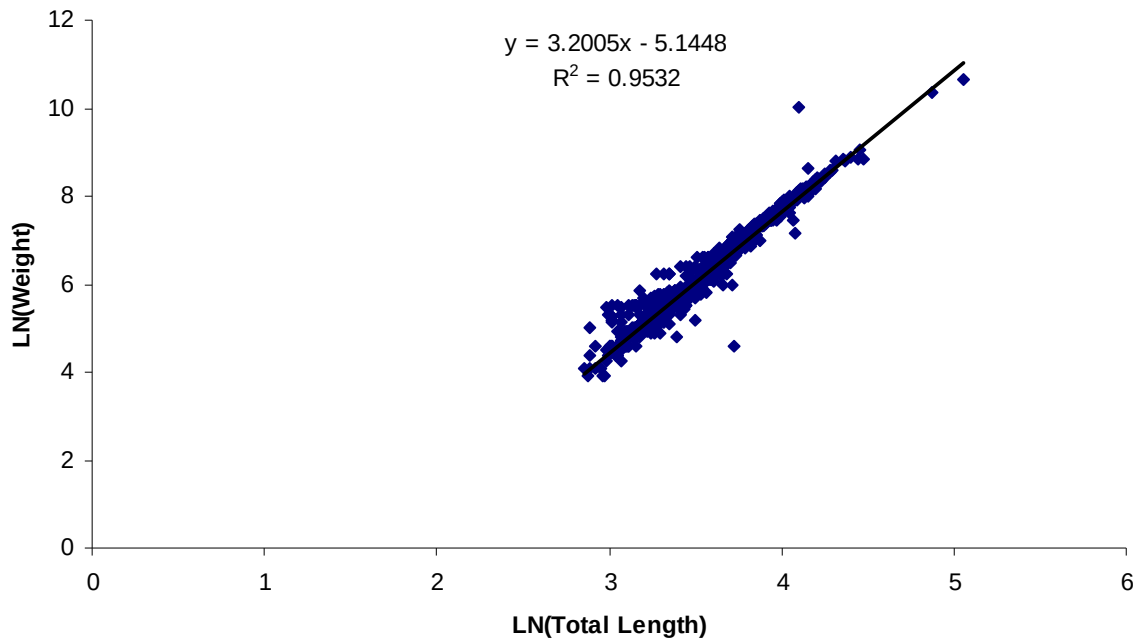


Figure 4.1: Length –weight relationship of hook fishery in Nile perch sampled from Napoleon Gulf Lake Victoria Uganda using regression.

4.2. Size Composition of Nile perch by Hooks sizes

Size composition of Nile perch and catch rates by hook sizes were carried out by percentage frequency (Figures 4.2 and 4.3) graphical representation indicated that the trend of harvesting more mature Nile perch fish samples were decreasing from hook size 7 up to hook size 12. The Lake Victoria Fisheries Organisation came up with the recommendation of the minimum slot sizes for the Nile perch as 50 to 85 cm TL which is required for harvesting in the lake region (Muhoozi and Kamanyi, 2004, Njiru *et al.* 2009). Basing on that recommendation the middle arrow in these graphs is the 50 cm Total length slot size which is equivalent of 2.5 kg weight as seen in Figures 4.2 and 4.3 respectively.

4.3. Bait types used in hook fishery in Napoleon Gulf, Uganda

In the hook fishery survey bait types were investigated in Napoleon Gulf mainly those used to harvest Nile perch: the haplochromine bait had a range of 5-10 cm total length, *Clarias* bait was from 9-14 cm and *Mormyrus kannume* bait was ranging from 24.5-27 cm total length respectively. From the total number of bait type per hook size collected during the experiment, percentage frequency was done and the results indicated that hook size 7 was dominantly using *Mormyrus kannume* with 92.9% while hook size 12 was using more of the haplochromine with 99.5% compared to other hook sizes that varied accordingly (Table 4.2).

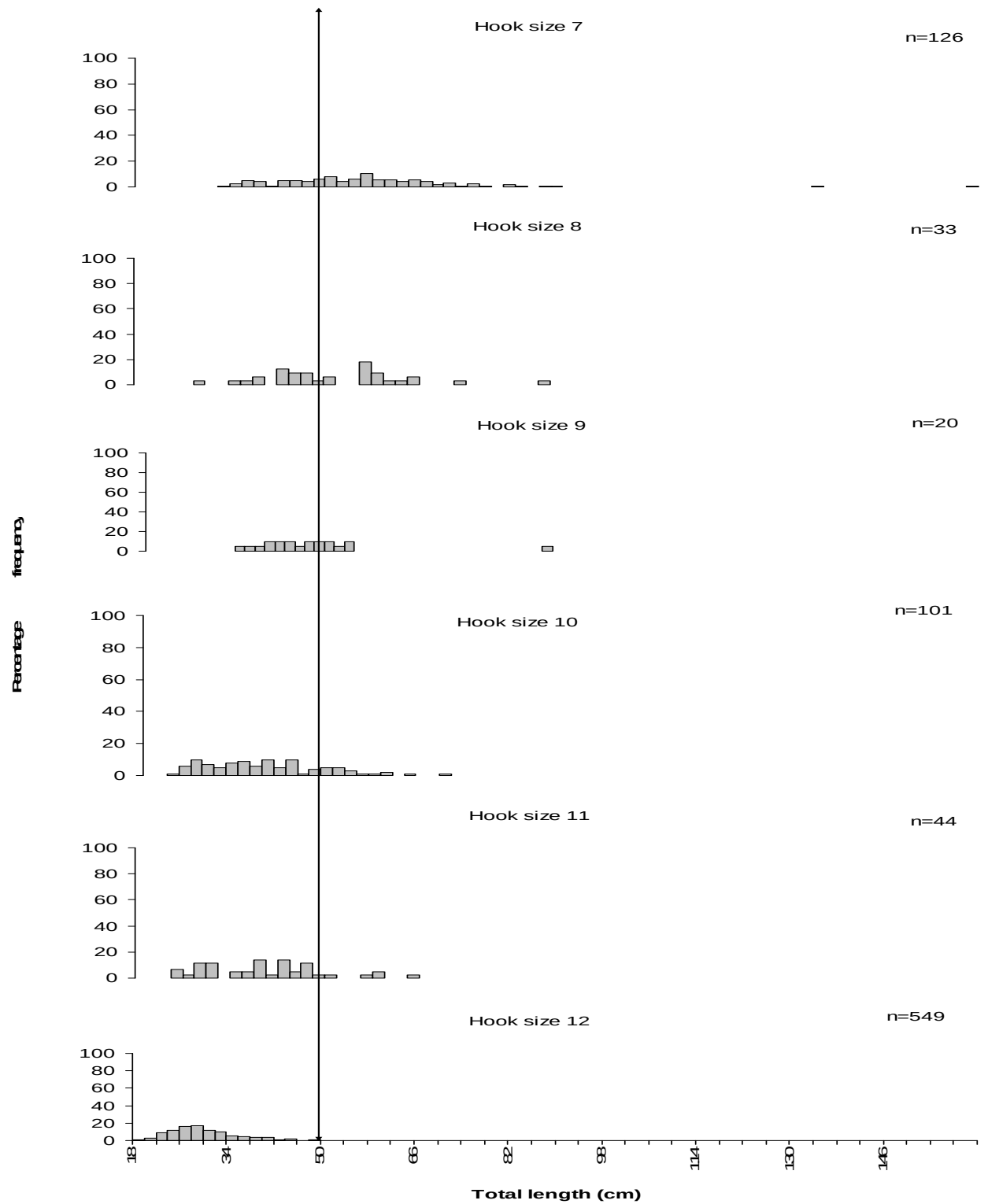


Figure 4.2: Size composition of Nile perch of hook fishery in Napoleon Gulf, Uganda

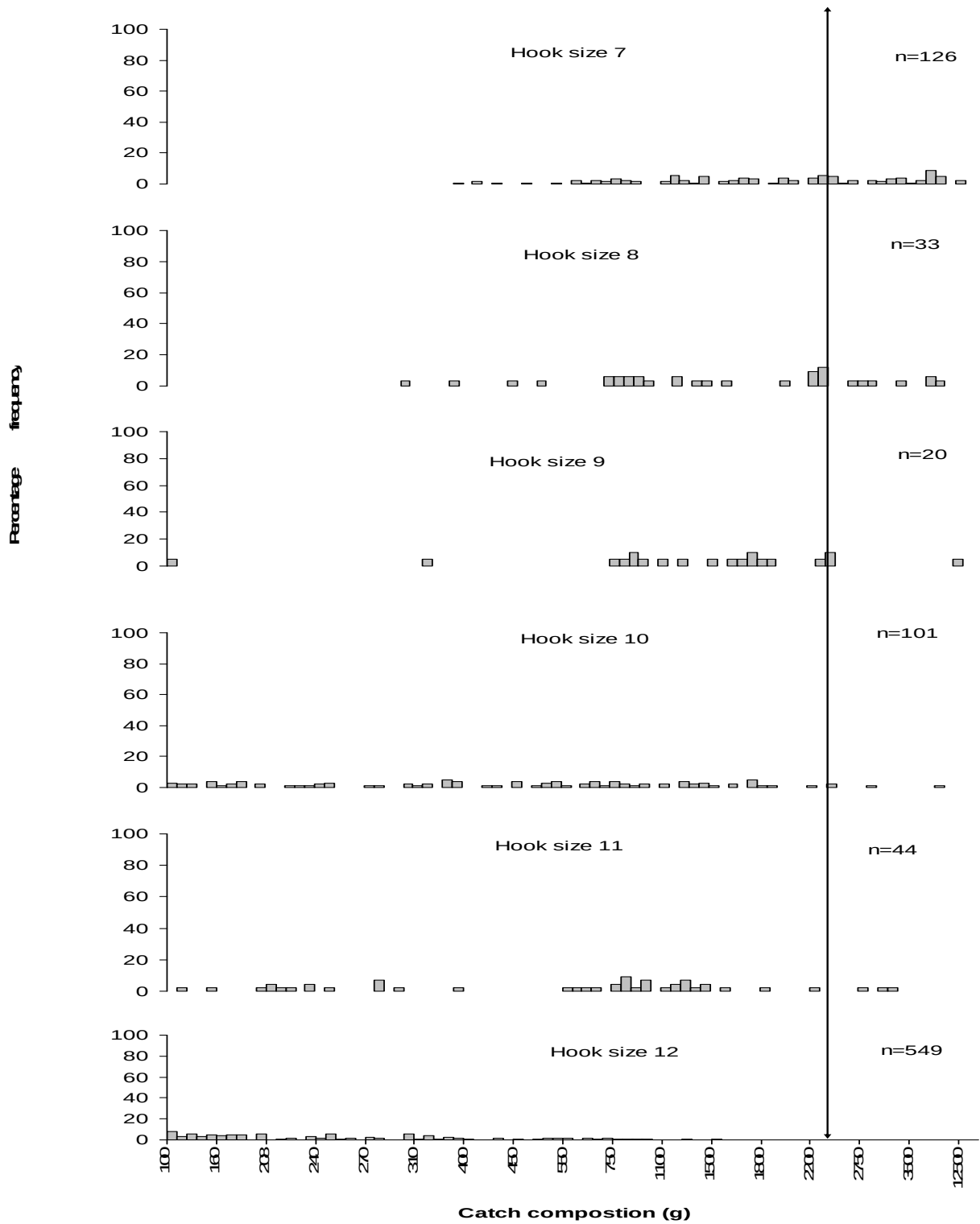


Figure 4.3: Catch rates of Nile perch of hook fishery in Napoleon Gulf, Uganda

Table 4.2: Showing the three dominant types of bait used in catching Nile perch in Napoleon gulf Lake Victoria Uganda.

Hook size	7	8	9	10	11	12
<i>Clarias</i> bait	2.4%	3.0%	10.0%	12.9%	6.8%	0.2%
Haplochromine bait	4.8%	9.1%	35.0%	81.2%	90.9%	99.5%
<i>Mormyrus kannume</i> bait	92.9%	87.9%	55.0%	5.9%	2.3%	0.4%

4.4. Size composition by bait type.

During the investigation of the bait type haplochromine bait was more used in hook sizes 10, 11 and 12 as shown in (Figure 4.4) while *Mormyrus kannume* bait was mainly used by hook sizes 7, 8 and 11 (Figure 4.5) and *Clarias* bait was highly used by fishers using hook size 10 in the Napoleon Gulf (Figure 4.6).

Analysis of covariance (ANCOVA) test for differences in means was carried out on the bait type used for harvesting Nile perch in Napoleon gulf Lake Victoria indicated a significant difference of ($F=8.231$; $P<0.05$) (Appendix 2). The same test was carried on the hook size and the bait type and a significant difference of ($F=368.257$; $P<0.05$) (Appendix 3) was observed. The ANCOVA test that was carried on the natural logarithm of weight of the Nile perch with bait type, indicated no significant difference of ($F=2.898$; $P>0.05$) (Appendix 4). ANCOVA test on all the baits at individual basis i.e.

haplochromine, *Clarias* and *M.kannume* on the hook sizes, could not yield any results as indicated in (Appendix 5, 6, 7) respectively.

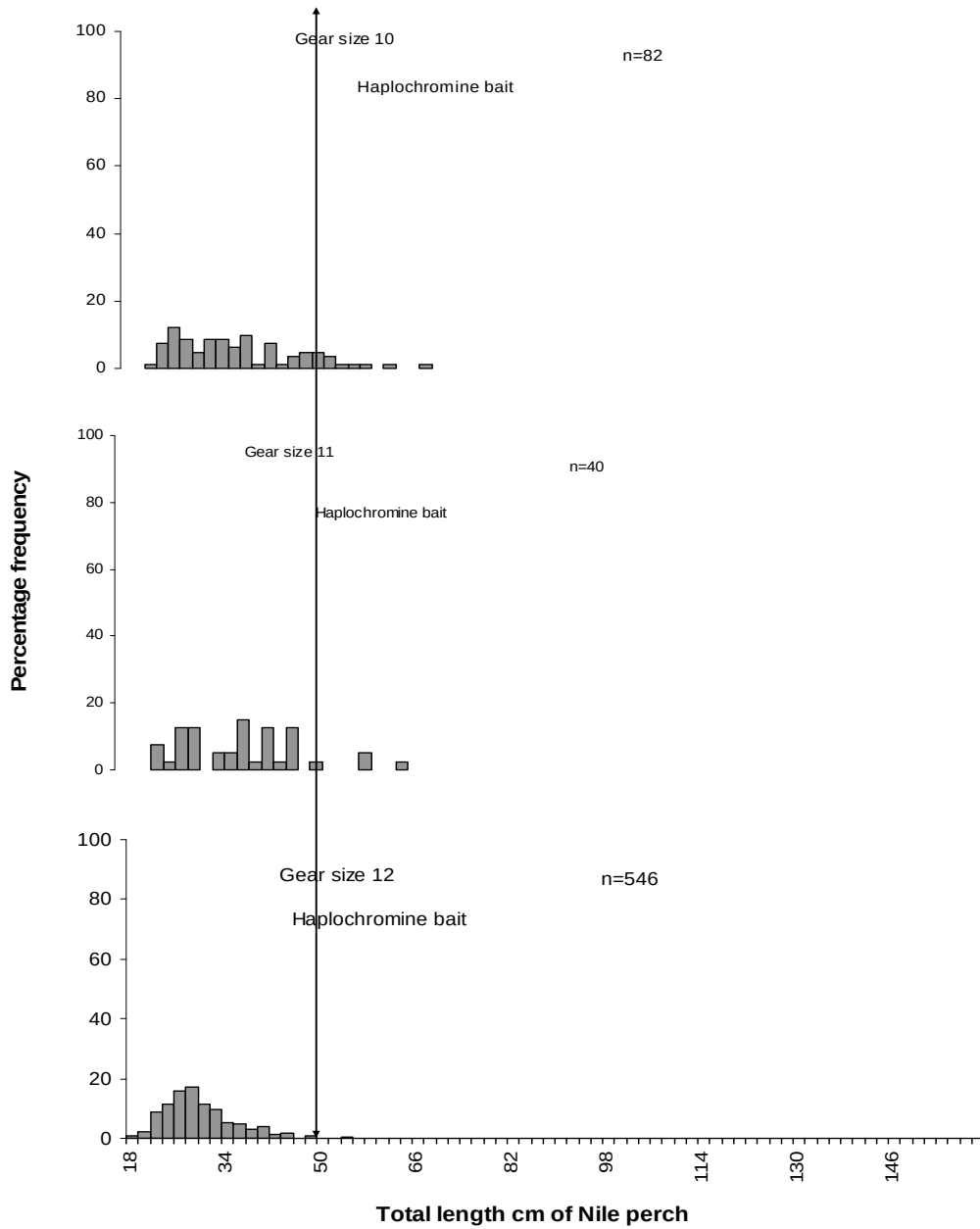


Figure 4.4: Showing the size composition of Nile perch by bait type of haplochromine and gear type.

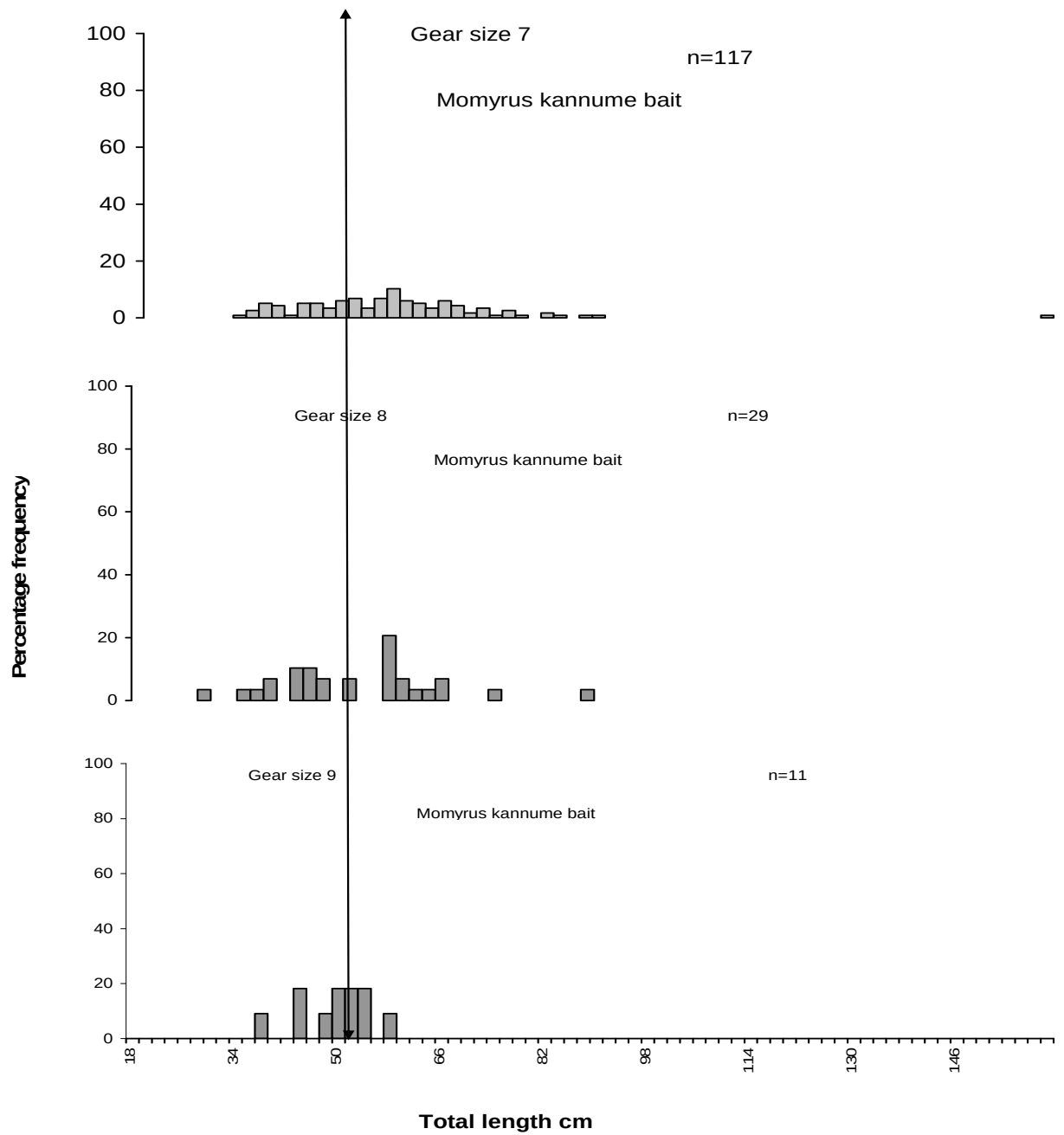


Figure 4.5: Showing the size composition of Nile perch by bait type of *Mormyrus kannume* and gear type

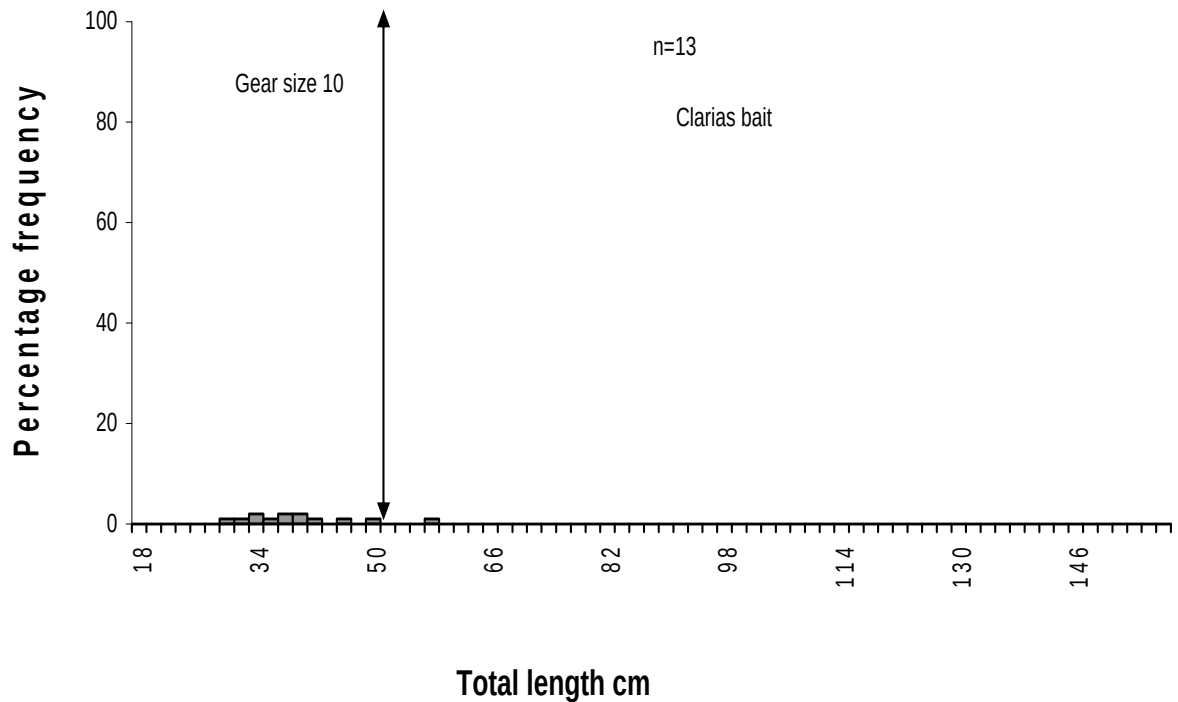


Figure 4.6: Showing the size composition of Nile perch by *Clarias* bait type.

4.8. The mean total length of Nile perch species per hook sizes.

The mean total length of Nile perch per hook sizes was done in order to come up with an overall size composition of the hook fishery in the Napoleon Gulf as indicated in (Figure 4.7). Graphical representation indicated hook sizes 7 and 8 harvested fish above 50 cm total length which is the required slot size according to the fisheries management (Muhoozi and Kamanyi 2004) and hook sizes 8, 9, 10, 11 and 12 the sizes were below the required harvestable levels as per the Lake Victoria Fisheries Organisation regulations.

ANCOVA test indicated that size composition was significantly different among hook sizes used ($F=3.847$; $P<0.05$) as indicated in (Appendix 6).

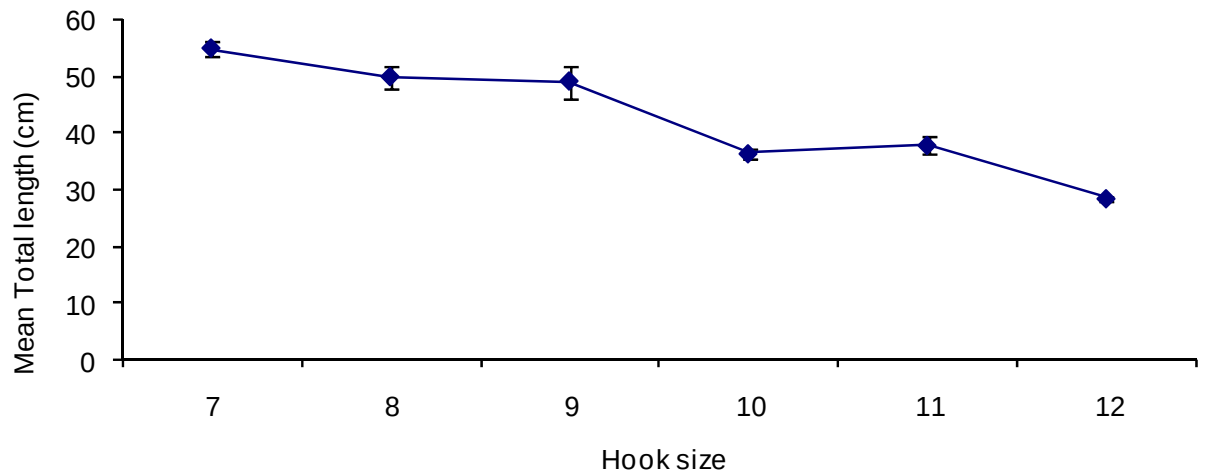


Figure 4.7: Showing Mean Total length of Nile perch among different hook sizes.

4.9. The mean weight of Nile perch species per hook sizes.

The mean weight of Nile perch by hook sizes were investigated that it was only hook size 7 that could harvest Nile perch and was compliant to the slot size i.e. fish above 2.5 kilogram that in the same length of 50 cm total length (Figure 4.8). ANCOVA test for differences in means was carried out on the natural logarithm of weight of all the Nile perch sampled to hook sizes used in Napoleon gulf Lake Victoria indicated a significant difference of ($F=4.599$; $P<0.05$) (Appendix 7).

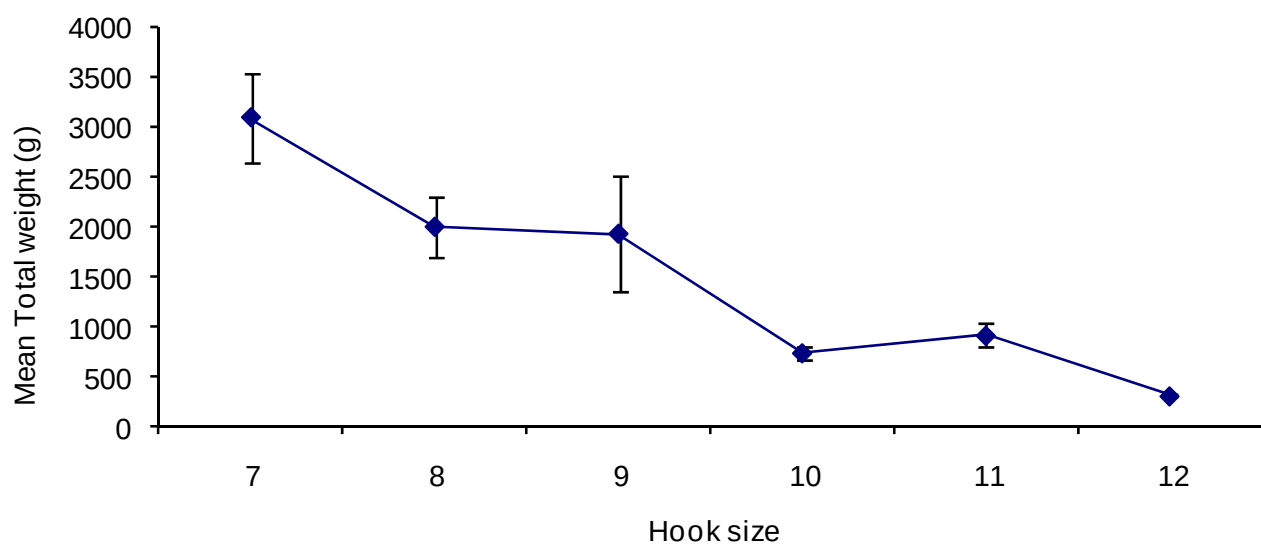


Figure 4.8: Showing Mean total weight of Nile perch among different hook sizes.

CHAPTER FIVE

DISCUSSION, CONCLUSION AND RECCOMENDATIONS.

5.0. Discussion

The decline of species diversity in Lake Victoria is usually associated with the increased predation of Nile perch, overfishing and environmental change, but the impact of baited hook fishery had been so far been completely overlooked (Mkumbo and Mlaponi, 2007). As gillnet yields of Nile perch stagnated in the middle of the 1990's, the hook and line fishery intensified in Lake Victoria. During the same period the increased use of endemic fish species as bait had gone largely unnoticed (Mkumbo and Mlaponi, 2007). In addition to the bait, even the hook gear size in conjunction to the Nile perch fishery has been neglected. The increased demand of Nile perch has led to an increase of hook gear fishery from (254,453) in the year 2000 to (2,783,428) in 2008 in the Ugandan waters (Tumwebaze 2005, LVFO 2008). And with the whole Lake Victoria basin the long line fishery increased from 3,500,000 in 2000 (98.5% in long lines) to over 11,000,000 in 2008 (99.4%in long lines) (Chitamwebwa, *et al.* 2009). This is and indication that fishers of hook fishery are operating unchecked by the fisheries management.

The bait type used in the fishing of Nile perch in Napoleon Gulf were the Clarias, haplochromine and *Mormyrus kannume* species despite the fact the Mkumbo and Mlaponi (2007) identified Clarias, haplochromines, *Rastrineobola argentea*, Synodontis, Mormyrus and Labeo as the types of bait used in the Tanzanian waters. The surveys done

in the gulf indicated that *Mormyrus kannume* was highly used by the hook sizes like the 7 and 8 at 92.9% and 87.9% respectively compared to other gear sizes (Table 4.2 and Figure 4.5) this is most likely that because of this bait; these hook sizes were harvesting large fish in terms of total length compared to others despite the fact size 7 harvested more than the later. The haplochromine bait was most used by hook sizes 12, 11, 10 and 9 compared the other gears like 8 and 7 the same to Clarias bait mostly by hook size 10 (Figures 4.4 and 4.6). These five hook sizes harvested juvenile fish which was below the 50 cm total length and this was in correlation to the size of bait used. (ANCOVA) test for differences in means carried out on the bait type used for harvesting Nile perch of (F=8.231; P<0.05) and on the hook size and the bait type with (F=368.257; P<0.05) indicated that bait type plays a big role both the size of the Nile perch harvested and also the hook sizes used during the fishing. Though the weight of Nile perch did not create an impact on the bait type used as realised in the ANCOVA test (F=2.898; P>0.05). This is and indication that fishers who use *Mormyrus kannume* whose length is higher than the haplochromine bait always harvest higher catches in terms of weight and length and most of it is above the 50 cm total length slot size.

Fishing down and fishing hard has been realised as a potent ecological force in the Lake Victoria and other water bodies like Lake Nabugabo. The Nile perch which contributes multi-million dollar fishing industry is being threatened by over exploitation (Paterson and Chapman, 2009). This is seen by the increased fishing effort on the Lake Victoria waters in especially the hook and line fishery also the decline in the fish stock levels of

Nile perch from hydroacoustic surveys conducted by LVFRP as 1.13 million to 0.55 million as per the IFMP (Taabu *et al.* 2008(a)&(b)). Our information indicated that size composition plays a big role in the harvesting of Nile perch per hook sizes ($F=3.847$ $P<0.05$) and the same applied to the catch composition ($F=4.599$ $P<0.05$). Chitamwebwa, *et al.* 2009 indicated that hook sizes 9-4 would be suitable for the fish harvest of the Nile perch. Basing on the our information we realised a difference in the fish harvest in that even size 9 could harvest juvenile fishes of the Nile perch that could also affect the fish species diversity in the lake ecosystem. This could indicate that the Nile perch stocks could be declining in the case that hook sizes that were expected to be harvesting mature species have now also turned to be on fishing young ones. Through this we realised that most of the mature Nile perch that are required in accordance to the slot size were harvested by fishers who were using hook sizes 7 and 8, despite the fact our study mainly looked at hooks from the above mentioned to hook size 12.

5.1. Conclusion:

In general, the hook sizes play a big role in the harvesting of the Nile perch. In addition to that bait also contributes to the Nile perch harvest but there is still a need to explore more on this bait type in the hook fishery since various types are used in the Victoria basin. In this case the Nile perch fishery will be able controlled since is a renewable resource and in that the fishers will be able to a harvest mature fishes hence boosting the national economy of this country.

5.2. Recommendations:

Therefore to ensure that the hook and line fishery of the Nile perch is regulated in the Lake Victoria basin, we recommend the following;

- A minimum of hook sizes 7 and 8 should be used in the Lake Victoria for harvesting the Nile perch; hence hook sizes 8, 7, 6, 5 and 4 should be the only applicable in the Nile perch fishery.
- The Fisheries managers under the Ministry of Animal Resources and Fisheries should put laws in place on the recommended minimum hook sizes to harvest the Nile perch in the Ugandan waters in order to ensure sustainability of the fish diversity.
- A minimum number of hooks per boat need to put in place and ensure that it is followed by the fishers in the region and also monitored by the Fisheries Management as a regulatory measure.
- There is need to encourage fish farmers to culture more fish which can be used as bait in order not to deplete the stocks in the wild which are already in danger due to predation by the Nile perch most especially fishes like *Clarias* species and *Mormyrus kannume*.
- Haplochromine bait should be discouraged from the hook fishers since is most widely used by those with small hooks that catch immature fish below the slot size and always harvested from the wild stocks of whom some species are already in danger of extinction.

- There is also need to look at other fish species in relation to the right hook sizes that could be used for harvesting them.

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Appendix 1: Descriptive statistics of Nile perch data sampled from Napoleon gulf in Lake Victoria Uganda.

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
TL (CM)	7	126	54.9241	16.42521	1.46327	52.0281	57.8201	32.00	157.30
	8	33	49.9182	11.84387	2.06175	45.7185	54.1178	26.50	86.00
	9	20	49.1550	12.95927	2.89778	43.0899	55.2201	35.10	97.00
	10	101	36.4218	9.76446	.97160	34.4942	38.3494	21.50	67.50
	11	44	37.8727	9.74606	1.46927	34.9097	40.8358	23.50	63.30
	12	549	28.5581	6.26872	.26754	28.0326	29.0836	17.30	57.80
	Total	873	35.0220	13.59961	.46028	34.1187	35.9254	17.30	157.30
	Model	Fixed Effects		9.39685	.31804	34.3978	35.6462		
		Random Effects			8.61277	12.8822	57.1619		
WT (G)	7	126	3090.3175	4996.77495	445.14809	2209.3141	3971.3208	400.00	43000.00
	8	33	2000.9091	1694.01956	294.89095	1400.2359	2601.5823	300.00	8500.00
	9	20	1931.5000	2569.45678	574.54800	728.9572	3134.0428	100.00	12500.00
	10	101	742.5248	723.45616	71.98658	599.7054	885.3441	100.00	4500.00
	11	44	916.5000	757.20798	114.15340	686.2877	1146.7123	120.00	3250.00
	12	549	313.9199	298.23553	12.72838	288.9175	338.9222	50.00	2750.00
	Total	873	895.4215	2225.99570	75.33854	747.5555	1043.2876	50.00	43000.00
	Model	Fixed Effects		1998.83922	67.65046	762.6437	1028.1994		
		Random Effects			860.32645	-1316.1180	3106.9611		

Appendix 2: Showing the ANCOVA test between bait type and Natural logarithm of Total length (LN_TL).

Between-Subjects Factors

	Value Label	N
BAIT_1 TYPE	Haplochromis	683
2	Clarias	23
3	Mormyrus Kannume	167

Tests of Between-Subjects Effects

Dependent Variable: LN_TL

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	557.637(a)	3	185.879	341.358	.000
Intercept	2635.105	1	2635.105	4839.241	.000
BAIT_TYPE	8.964	2	4.482	8.231	.000
GEAR_SIZE	88.605	1	88.605	162.718	.000
Error	473.195	869	.545		
Total	32928.873	873			
Corrected Total	1030.832	872			

a R Squared = .541 (Adjusted R Squared = .539)

Appendix 3: Showing the ANCOVA test between bait type and Natural logarithm of weight (LN_Wt).

Between-Subjects Factors

	Value Label	N
BAIT_TYP E	Haplochromis	683
2	Clarias	23
3	Mormyrus Kannume	167

Tests of Between-Subjects Effects

Dependent Variable: LN_WT

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	91.652(a)	4	22.913	4550.872	.000
Intercept	20.001	1	20.001	3972.544	.000
LN_TL	40.048	1	40.048	7954.212	.000
BAIT_TYPE	.029	2	.015	2.898	.056
GEAR_SIZE	.052	1	.052	10.374	.001
Error	4.370	868	.005		
Total	10767.353	873			
Corrected Total	96.022	872			

a R Squared = .954 (Adjusted R Squared = .954)

Appendix 4: Showing the ANCOVA test between gear size (Hook sizes) and bait.

Between-Subjects Factors

	Value Label	N
GEAR SIZE	7	126
	8	33
	9	20
	10	101
	11	44
	12	549

Tests of Between-Subjects Effects

Dependent Variable: BAIT TYPE

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	449.366(a)	6	74.894	678.119	.000
Intercept	24.681	1	24.681	223.471	.000
GEAR_SIZE	203.359	5	40.672	368.257	.000
LN_TL	.927	1	.927	8.398	.004
Error	95.645	866	.110		
Total	2278.000	873			
Corrected Total	545.010	872			

a R Squared = .825 (Adjusted R Squared = .823)

Appendix 5: Showing the ANCOVA test between haplochromine bait and hook sizes.

Between-Subjects Factors

		Value Label	N
Hook size	1	7	6
	2	8	3
	3	9	7
	4	10	82
	5	11	40
	6	12	545

Tests of Between-Subjects Effects

Dependent Variable: Haplochromine_bait

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.000(a)	5	.000	.	.
Intercept	52.795	1	52.795	.	.
Hook Size	.000	5	.000	.	.
Error	.000	677	.000		
Total	683.000	683			
Corrected Total	.000	682			

a. R Squared = . (Adjusted R Squared = .)

Appendix 6: Showing the ANCOVA test between Clarias bait and hook sizes.

Between-Subjects Factors

		Value Label	N
Hook size	1	7	3
	2	8	1
	3	9	2
	4	10	12
	5	11	3
	6	12	1

Tests of Between-Subjects Effects

Dependent Variable: Clarias_bait

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.000(a)	5	.000	.	.
Intercept	44.308	1	44.308	.	.
Hook_Size	.000	5	.000	.	.
Error	.000	16	.000		
Total	88.000	22			
Corrected Total	.000	21			

a. R Squared = . (Adjusted R Squared = .)

Appendix 7: Showing the ANCOVA test between *M.kannume* bait and hook sizes.

Between-Subjects Factors

	Value Label	N
Hook size 1	7	115
2	8	28
3	9	11
4	10	5
5	11	1
6	12	2

Tests of Between-Subjects Effects

Dependent Variable: *M.kannume*_bait

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.000(a)	5	.000	.	.
Intercept	19.615	1	19.615	.	.
Hook_Size	.000	5	.000	.	.
Error	.000	156	.000		
Total	162.000	162			
Corrected Total	.000	161			

a. R Squared = . (Adjusted R Squared = .)

Appendix 8: Showing the ANCOVA test between gear size (Hook sizes) and Natural logarithm of Total length (LN_TL).

Between-Subjects Factors

	Value Label	N
GEAR_SIZE	1	7
	2	8
	3	9
	4	10
	5	11
	6	12
		126
		33
		20
		101
		44
		549

Tests of Between-Subjects Effects

Dependent Variable: LN_TL

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	985.227(a)	7	140.747	2669.570	.000
Intercept	68.155	1	68.155	1292.712	.000
GEAR_SIZE	1.014	5	.203	3.847	.002
BAIT_TYPE	.269	1	.269	5.103	.024
LN_WT	413.834	1	413.834	7849.265	.000
Error	45.605	865	.053		
Total	32928.873	873			
Corrected Total	1030.832	872			

a R Squared = .956 (Adjusted R Squared = .955)

Appendix 9: Showing the ANCOVA test between gear size (Hook sizes) and Natural logarithm of Total Weight (LN_Wt).

Between-Subjects Factors

	Value Label	N
GEAR SIZE	1	7
	2	8
	3	9
	4	10
	5	11
	6	12
		126
		33
		20
		101
		44
		549

Tests of Between-Subjects Effects

Dependent Variable: LN_WT

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	91.701(a)	7	13.100	2622.138	.000
Intercept	24.494	1	24.494	4902.717	.000
GEAR_SIZE	.115	5	.023	4.599	.000
LN_TL	39.215	1	39.215	7849.265	.000
BAIT_TYPE	.010	1	.010	2.014	.156
Error	4.321	865	.005		
Total	10767.353	873			
Corrected Total	96.022	872			

a R Squared = .955 (Adjusted R Squared = .955)