Species composition, yield and Predator/Prey relationship of Lake Liambezi

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DECLARATION

I hereby declare that this work is the product of my own research efforts, undertaken under the supervision of Dr. C. Hay and Mr. E. Simasiku and has not presented elsewhere for the award of the degree. All the sources have been duly and appropriately acknowledged.

Candidate Signature: ……………………………………………… Date: ………………………..

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CERTIFICATION

This is to certify that this report has been examined and approved for the award of the degree of Bachelor of Science in Fisheries and Aquatic Science of the University of Namibia.

External Examiner……………………………………………………………………..

Internal Examiner………………………………………………………………………

Head of Department……………………………………………………………………

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Many special thanks are due to my mother, sisters, brother, cousin and friends for their encouragement, support, sacrifice and advice ever. I give my humble thanks to God for the rich blessings given to me in His loveliness.

DEDICATION

I dedicated this work to my late beloved grandmothers (Maruakaani Krete Kapuire and Justine Hambira), father and cousin (John Vevangua Kapuire), father (John Mbazuvara), my uncle (Joshua Wapeuaune Hambira), and to my aunt and mother (Johanna Mekupi Kandjoze).

Abstract

The purpose of this study was to document the transformation in species composition brought about by the drying of the lake since 1985. The annual yield harvested by the local fishermen and the effect of fishing activities by the fishermen on the predator-prey relationship of Lake Liambezi were also noted. The field surveys took place once every season in collaboration with the MFMR surveys, over a 12 month period. 1195 fish were sampled from the lake. Total of 955 fish were caught with the monofilament gill nets, while 240 fish were caught with the multifilament gill nets. Eight fish families were recorded. Thirty five fish species were identified from Lake Liambezi experimental gear catches (Peel, 2011) (Appendix 1). The Cichlidae family was represented by most species (ten), with the Cyprinidae in second place with seven species and Mormyridae in third place with four species. Oreochromis andersonii, Serranochromis macrocephalus and Oreochromis macrochir accounted for 64.9%, 21.3% and 6.3%, of all catches according to the index of relative importance, respectively. Seven species (Barbus barnardi, Barbus bifrenatus, Barbus paludinosus, Barbus unitaeniatus, Ctenopoma multispine, Labeo cylindricus, Labeo Lunatus, Marcusenius altisambesi, Micralestes acutidens, Pollimyrus castelnaui, Tilapia ruweti, Pseudocrenilabrus philander and Rhabdalestes maunensis) were recorded from the lake after 2001 but were not recorded before 1986, while 4 species (Hydrocynus vittatus, Serranochromis robustus, Serranochromis longimanus and Sargochromis giardi) that were recorded from the lake prior to its drying up were not recorded during this study. Species richness was high in the experimental gear (29 species) than in the gill net catches (14 species). Multifilament gill nets had higher species richness (14 species) than the monofilament gill nets (13 species). The variety and relative abundance of species are high for the fishery independent data (experimental gears), comparing to fishery dependent data

(fishermen gill nets). Species diversity and richness results on fishermen gill nets show that fishermen are fishing selectively and not across the entire range of fish. The annual yield (2 581.8 tons) has doubled compared to previous values (600 to 800 tons) recorded before the dry period by Van der Waal (1990). Monofilament gill nets had relatively higher catch rates than multifilament.

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CHAPTER ONE

INTRODUCTION AND LITERATURE REVIEW

1.1 Introduction

The Caprivi Region is a narrow piece of land extending for about 450 kilometers from west to east and for about 40 kilometers to 100 kilometers from north to south, in the far north-eastern part of Namibia. The region borders with Botswana in the south (Kwando/Linyanti and Chobe Rivers), Angola and Zambia (Zambezi River) in the north and north-east, and Zimbabwe in the east (Barnard, 1998).

All the above stated River Systems support a lake known as Liambezi, found (17°59'S and 24°15'E) in the eastern parts of the Caprivi. The lake is one of the few natural lakes found within the borders of Namibia. About 5% of the lake volume is shared with Botswana. Lake Liambezi is not a permanent lake and goes through wet and dry periods. Recent research activities were carried out on the Lake from 2001 after first receiving water.

Lake Liambezi supports a diverse number of fish species. Sustainable management practice is required, to protect important species (most valuable) such as *Oreochromis*, *Serranochromis* and *Clarias* species, to mention a few. Lakes that undergo dry periods due to poor flooding seasons may experience changes in species diversity and composition. A comparison of the different species that were found within the Lake before 1985-86(Van de Waal, 1990) and the types of species that are currently found within the lake is vital for the well-being of the lake community. Fishermen in most multi-species fisheries practice what is known as “fishing down the food web" phenomena in which large or most valuable fish species are over-exploitated by fishing and consequently replaced in catches by smaller sized species from lower trophic levels (Welcomme, 2001).

The lake serves as a valuable protein source and economic booster for the poor local people of the region and beyond its borders. Tweddle 2009 stated that the lake was once a critically important source of fish for subsistence fishery in the 1970s and early 1980s. Turpie and Egoh (2002) findings showed that for any individual inland fisherman, five people are assumed to be working in support functions such as transport, processing and maintenance of mokoro. Fishing in the lake is dominated by open access, is semi commercialized, small-scale, labour intensive, and is practiced by fishermen for own consumption and/or commercial purposes. The stage of the lake can be classified as artisanal to semi commercial. Commercialization of the fishery at the lake maybe classified as being on the increase. Contrast to the subsistence fisheries, a number of fully commercial operations have developed at Lake Liambezi (Heider, 2012). A fisherman at Lusu village concluded that there is a high demand for fish in the international market and requested for permission to enter these markets, as he/she referred to the Zambian high demand for fish by these markets as a case study to proof a point. With the current increase in the fishermen population (especially foreigners), the assumption is that it will become more commercialized in the near future, a concern for the sustainability of the fishery. Passive gears (gill nets) are the most common type of gear used on the lake. Fishermen prefer specific species (as supported by the definition for artisanal fisheries), and so spatial and temporal changes in species composition occur. There is a belief that the predator-prey relationship is affected by the selectivity of the fishermen, and so the biological interaction within the lake may change over time. Changes experienced in biotic interactions such as predation can influence the growth and biography of a species (Jackson et al., 1961).

Determining the stages of the fisheries is important, as it will assist with the implementation and enforcement of legislation. The project is in support of the government Article 95 and Rio convention on biological diversity. Rio Convention on Biological Diversity states that: “Many indigenous and local communities with traditional lifestyles have a close and traditional dependence on biological resources and need to share equitably in the benefits arising from biodiversity” (Namibia Brief, 1998). Article 95 of the constitution of the Republic of Namibia states that: “The state shall actively promote and maintain the welfare of the people by adopting, inter alia policies aimed at the maintenance of ecosystems, essential ecological processes and biological diversity of Namibia and utilisation of living natural resources on a sustainable basis for the benefit of all Namibians, both present and future”. It is vital to be aware of both the state of management and the stage of exploitation of Lake Liambezi fishery, as the amount of current values yielded by fisheries would be underestimates or overestimates if the current levels of harvesting were sustainable. Overexploitation may result from much less control experienced in access to fishery (such as the large number of outsiders), even where there is literally good control over the use of fishery resources (Turpie and Egoh, 2002).

Predation is one of the major determinants of community structure in lakes, fish in particular having an evidently strong effect upon numbers of their prey (Dobson and Frid, 1998).

1.1.1 Background

A large lake was observed in the same geographical location as the Liambezi by an explorer known as C. Selous during the 1870. A swamp was observed in the same vicinity around 1916 to 1933 (Hocutt and Johnson, 1993).According to literature produced by Hocutt and Johnson (1993), flooding was recorded during the late 1940s, 1950s and in mid-1960s, and so Purvis (2002) reported that the lake filled up in the period between 1946/47 to 1980.

Yields from the lake were recorded by previous research (e.g. Van der Waal, 1990) and is showing that it has increased overtime. Demand for fish in Caprivi has increased, but the important fish species have never changed (Heider, 2012).

1.1.2 Problem statement

Utilization of Lake Liambezi intensified during the last 12 months and it is important to study the impact this may have on the yield, fish species composition and their predator-prey relationships.

1.1.3 Significance of the Study

The study will contribute towards the sustainable management of the fishery on Lake Liambezi.

1.1.4 Objective

a) Compare fishery dependent catches with fishery independent catches in the lake and so indicate whether the fishermen are fishing selectively or across the entire range of the fish resource.

b) Describe the species composition and the predator-prey relationship of Lake Liambezi.

1.1.5 Research Questions

a) Is the yield from the lake done in a sustainable manner?

b) What are the fish species compositions of the lake?

c) What are the fishermen preferences, in terms of species found at the lake?

d) How does fishing affect predator-prey populations, and vice-versa?

e) How was the lake transformed by the dry period, between 1985-86 and 2001 (species composition)?

1.1.6 Research Hypothesis

a) **H0**:

- ❖ There is no difference in species diversity between the fishery dependent catches and the fishery independent catches from Lake Liambezi.
- ❖ There is no difference in catch rates between monofilament and multifilament gill nets.

- ❖ There is no difference in species diversity between monofilament and multifilament

b) **H1**:

- ❖ There is a difference in species diversity between the fishery dependent catches and the fishery independent catches from Lake Liambezi.
- ❖ There is a difference in catch rates between monofilament and multifilament.
- ❖ There is a difference in species diversity between monofilament and multifilament.

1.1.7 Limitation for Data Collection

Yield data are considered to be secondary as they are collected from fishermen in the absent of their actual nets. Sitengu (2004) stated that fishermen are more conscious and cannot talk openly about the exact length and mesh size of their nets, and any other fishing gear that may be in their possession such as dragnets, as they are prohibited by law.

According to Sinchembe (2004), freshwater systems in the Caprivi are quite extensive and therefore difficult to study using a short-term study or project. Given the qualitative nature and gear selective biases of fish collecting methods, conclusion involving species composition, yield and predator-prey relationship cannot be given in a single year study (Hocutt and Johnson, 1993).

1.2 Literature Review

1.2.1 Species Composition and Yield

The Caprivi wetlands have the highest overall species richness of the Namibian wetland systems, and Curtis, Roberts, Griffin, Bethune, Hay and Kolberg (1998) reported that 82 fish species occur in the Namibian part of this water system.

Van der Waal's (1990) studies once estimated that the Caprivi Region produced 1,500metric tons of fish per year, with Lake Liambezi contributing over one half of that before it dried in 1985-86**.** Van der Waal's (1985) study also showed that of the species that were known from the lake, 27 were captured by the given gill net fishery; concluding that fisherman selectivity may have an effect on species composition, predator-prey relationship (Biotic interaction) and the yield from the lake. Turpie and Egoh(2002) observed that the catches were composed of a variety of species, and found that *Oreochromis*, *Clarias* and *Serranochromis* species were dominating by weight. Interestingly, Barnard (1998) found that all previous studies in fishery depicted a decline in yield, as fishing methods are becoming more advance i.e. traditional baskets to gillnet. According to Pauly (2005), a decline in catch per unit effort, a decline in trophic structure (predator-prey relationship) and a decline in biomass (yield) of a fishery are indicating characters of overfishing. Taylor (2001) believed that increased human population, fishing gear improvements, and invasion by neighboring fishers (e.g. Zambian, Congolese and others in the case of Lake Liambezi) are some of the reasons for an increased pressure on the fish resource in recent days.

1.2.2 Predator-Prey Relationship

Juanes et al., (2002) found that the predator-prey relationship can be divided into two categories, namely functional response and numerical response. A functional response was further divided into type I (density-independent predation), type II (negative density-dependent predation) and type III by Holling in 1965.The type I response occurs when the number of prey eaten stays constant; type II response is represented by a decrease in prey consumed with increasing prey density and according to Eby et al., 1995, the type III response is depicted by a situation with high predation rates at low prey fish densities. Holling (1965) concluded that several factors can lead to a type III functional response, and named a few such as introduced predator preying on an unaware prey, prey refuge and the presence of alternative prey. Hassell (1978) found that most vertebrates have a type II or III functional response and Juan*e et al.*, (2002), further concluded that piscivorous fish have a type II response.

CHAPTER TWO

MATERIALS AND METHODS

2. Methodology

2.1 Study Area: Lake Liambezi

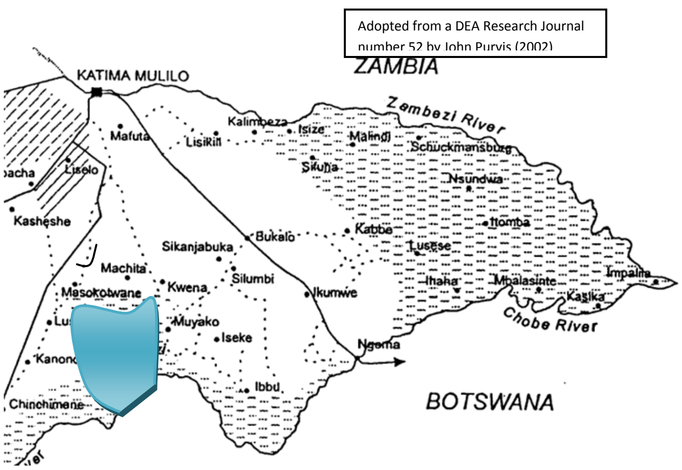


Figure 1: Map of the study area, showing Lake Liambezi surface area (highlighted in blue) and its bordering settlements (Lusu, Masokotwane, Muyako, etc). More specifically, the project was based at Muyako.

Lake Liambezi (17°59'S/24°15'E), is shared between Namibia (about 95%) and Botswana (about 5%). It lies between Lusu and Muyako villages, south of Masokotowani, stretching southward and ends a few kilometers inside the Botswana border (figure 1).The water level in the Zambezi River determines the flow of water in the Chobe; when the level of water is high, the direction of water flow in the Chobe is in a southeasterly direction into the lake, but changes direction with a drop in the water level of the Zambezi River. The lake is supported with water flowing in from the Zambezi River, through the Bukalo channel, during period of flooding. Water also percolates through the Linyati swamp into the Lake. The lake has a minimum shallow depth of about 1mm and a maximum depth of about 6 meters, and can cover an area of 10,000 hectares (open water area), when filled to its maximum capacity (Turpie and Egoh, 2002). Direct rainfall and rainfall run-off is also considered as a source of water. Major floods were recorded in 2000, 2003 and 2009 (Heider, 2012).

2.2 Study Design and Sampling

2.2.1 Species Composition

The lake was firstly separated into three different zones; zone A, zone B and zone C.

- Zone A is characterized by backwater and is very shallow, with more reefs than all the other zones; the entry point of the Bukalo channel into the lake. At maximum capacity this zone is probably no more that 0.5m deep.
- Zone B is the mid-point of the Lake; deeper than Zone A and locate almost in the mid-point of the lake. This zone is characterised by growing reeds when full (<3m deep).
- Zone C is located upstream, closer to the Chobe river in-flow, and is considered as the deepest of the three zones (3-6m deep).

Passive gear, monofilaments (3.0 inch to 5.0 inch) and multifilaments (3.0 inch to 5.0 inch) were set in the evening (around 17hrs) using a boat, and collected the next morning (around 06hrs). This was repeated in each zone for 3 consecutive days. The nets (100 meters each) were set in the middle of the water body tighten to reeds or marginal vegetation of the lake on one side, and covered an area of 1 kilometer in length. Fish caught were removed from the nets and placed in plastic bags onboard the boat. The entire catch was brought to the camping site to be sorted manually into the different species.

A weighing scale was used to determine measurements of the total body mass (to the nearest g), for each individual fish. A measuring board was used to determine the measurement of the total length (nearest mm) for each individual fish. Standard length (nearest mm) was measured for each cichlids individual fish. Sex of each fish and its maturity level were determined. Experimental gear data obtain from 1975/76 (Van der Waal, 1980), 2001 (Hay et al, 2002), 2005(Hay et al, 2006), 2007 (Hay et al, 2008) and 2010/2011 (Peel, 2012), were used to compare various species composition data, from the lake.

Figure 2: Measurement of total and standard length of a juvenile *Oreochromis macrochir*

2.2.2 Yield

Shamauka was the preferred landing site, as it was considered to be the most active and a good representation of yield from the other landing sites on the lake. Catches were weighed (in weighing container) using a weighing scale and were recorded twice (2 days) per week. These were secondary data, since they are collected from fishermen. Yield samplings were done from June 2011 to October 2012.

The market price of 11 158 dried fish was averaged to produce the average market price of dried fish per kg (N$39.47) .The above stated data was collected by NNF in conjunction with the MFMR from Ngweze market in Katima Mulilo, as from 6 January 2011 to the 13 January 2012; therefore include all variations in seasonal prices of fish sold at this market.

Estimated gross income of the lake fishery was obtained by multiplying the weight of all fish caught from the lake with the given price's to obtain the estimated gross income of the lake fishery.

Figure 3: Fish caught from the lake are being processed at Shamauka landing site, Muyako.

2.2.3 Predator-prey relationship

Different trophic level species were identified from catches from the Lake. The fish species were divided into different trophic levels according to Hay (1996).

2.3 Research Materials

a) Gill nets (Multifilament's and Monofilaments from 3.0 inch to 5.0 inch)

b) A boat

c) Weighing scale

d) Weighing container

e) A Guide book in fish identification by Skelton

f) Measuring board

g) Dissecting Kit

h) Plastic bags

2.4 Data collection

2.4.1 Biological Data

Data on species composition were collected in collaboration with the Ministry of Fisheries and Marine Resources, during selected monthly surveys on Lake Liambezi. The surveys were carried out seasonally; in February, April, June-July and in September. Gill nets, similar to those used by the fishermen were used. Data on yield were collected from the Shamauka landing site (actual catches from the fishery) at the lake, twice per week.

2.4.2 Species Diversity

Species diversity is defined as both the variety and the relative abundance of species (Hay *et al.* 2002). To calculate the relative importance and diversity of the different species, an index of relative importance (IRI) was used, as well as a measure of the number species weighted by their relative abundance, expressed as the Shannon diversity index (H`). The Shannon index of diversity (H`) is a measure of the number of species weighted by the relative abundances (Begon *et al*., 1990). A high Shannon index of diversity indicates high species diversity (Hay *et al.* 2002). Index of relative importance (IRI) showed the most important species in terms of weight, number and the frequency of occurrence in the catches from the lake. This index is a measure of relative abundance or commonness of the different species in the catch.

2.4.3 Catch per unit effort

Catch per unit of effort was used as a rough indicator of the relative abundance of fish in the sampled data (Hay *et al*. 2002). For a standard series of gill nets in this study, catch per unit effort (CPUE) was defined as the relative number or weight of fish caught in 12 hours of fishing for each 100 meter gill net.

Outcome on catch per unit will be presented in number and weight of fish.

2.5 Data Analysis

- PASGEAR computer software was used to determine species composition and the Catch per unit effort. This package helps with the entering, storage and analysis of large amounts of experimental data (Hay *et al*., 2002).

- PASGEAR is a customized data software intended for experimental fishery data. It contains predefined extraction, condensing and calculation programmes to assist with data examination and analysis from fisheries survey (Hay *et al.*, 2002).

- 2011 version of PASGEAR was used for this study.

- Microsoft EXCEL was used in studying the relation between predator and prey and in determining the Yield from the lake.

CHAPTER THREE

RESULTS

3.1 Species Composition

Table 3.1: **Species composition from Lake Liambezi, for two distinct period (1975/6 and after 2011). The species highlights in red indicated species that were only recorded from the lake system after 2001, while species highlighted in red indicate species that were not recorded from the lake system after 2001 but were recorded before 1985/6, while species highlighted in blue indicate species that were not recorded from the lake system after 2001 but were recorded before 1985/6. Species are grouped according to their families.**

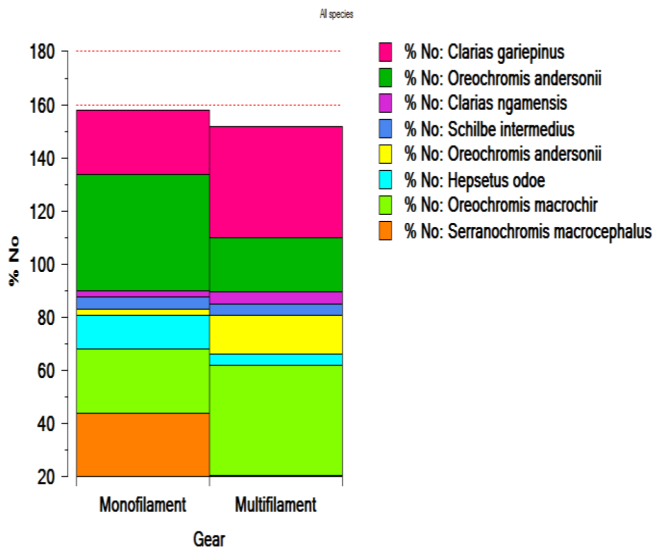
Species recorded before 1985/6	Species recorded after 2001
Characidae	
Brycinus lateralis	**Anabantidae**
Hydrocynus vittatus	
Cichlidae	*Ctenopoma multispine*
Oreochromis andersonii	**Characidae**
Oreochromis macrochir	*Brycinus lateralis*
Tilapia rendalli	*Micralestes acutidens*
Tilapia sparrmanii	*Rhabdalestes maunensis*
Sargochromis carlottae	**Cichlidae**
Sargochromis codringtonii	*Oreochromis andersonii*

Sargochromis giardi	*Oreochromis macrochir*
Serranochromis angusticeps	*Serranochromis macrocephalus*
Serranochromis longimanus	*Tilapia rendalli*
Serranochromis macrocephalus	*Tilapia ruweti*
Serranochromis robustus	*Tilapia sparrmanii*
Serranochromis thumbergi	*Pharyngochromis acuticeps*
Pharyngochromis acuticeps	*Sargochromis carlottae*
Clariidae	*Sargochromis codringtonii*
Clariasgariepinus	*Serranochromis angusticeps*
Clariasngamensis	*Pseudocrenilabrus philander*
Cyprinidae	**Clariidae**
Barbuspoechii	*Clarias gariepinus*
Barbusradiates	*Clarias ngamensis*
Hepsetidae	**Cyprinidae**
Hepsetus Odoe	*Barbus barnardi*
Mochokidae	*Barbus bifrenatus*
Synodontis macrostigma	*Barbus paludinosus*
Synodontis nigromaculatus	*Barbus poechii*
Synodontis sp.	*Barbus radiates*
Synodontis woosnami	*Barbus unitaeniatus*
Mormyridae	*Labeo cylindricus*
Marcusenius macrolepidotus	*Labeo Lunatus*
Mormyrus lacerda	**Hepsetidae**

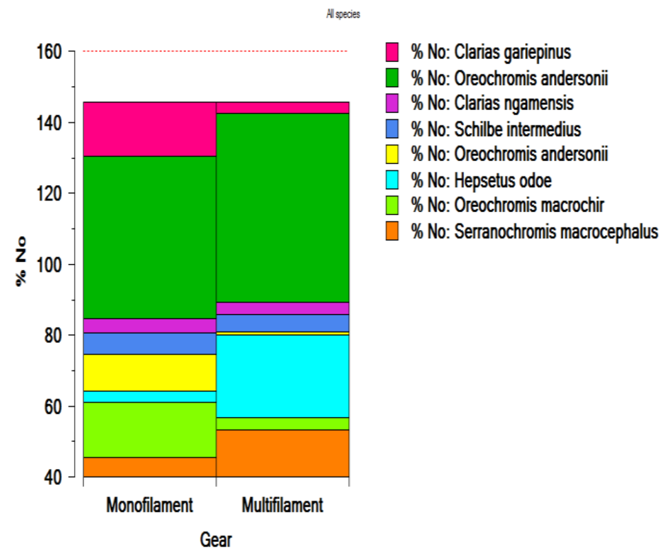
Petrocephalus catostoma **Schilbeidae** *Schilbe intermedius*	*Hepsetus Odoe* **Mochokidae** *Synodontis nigromaculatus* *Synodontis sp.* **Mormyridae** *Marcusenius altisambesi* *Marcusenius macrolepidotus* *Mormyrus lacerda* *Petrocephalus catostoma* *Pollimyrus castelnaui* **Schilbeidae** *Schilbe intermedius*

Four species, namely, *Hydrocynus vittatus*, *Serranochromis robustus*, *Serranochromis longimanus* and *Sargochromis giardi* were not recorded from the lake system in 2011 but were recorded by Van der Waal in 1975/6, while *Barbus barnardi*, *Barbus bifrenatus*, *Barbus paludinosus*, *Barbus unitaeniatus*, *Ctenopoma multispine*, *Labeo cylindricus*, *Labeo Lunatus*, *Marcusenius altisambesi*, *Micralestes acutidens*, *Pollimyrus castelnaui*, *Tilapia ruweti*, *Pseudocrenilabrus philander* and *Rhabdalestes maunensis* were not recorded by Van der Waal in 1975/6 season but were recorded by Peel (2012) (**Table 3.1**)

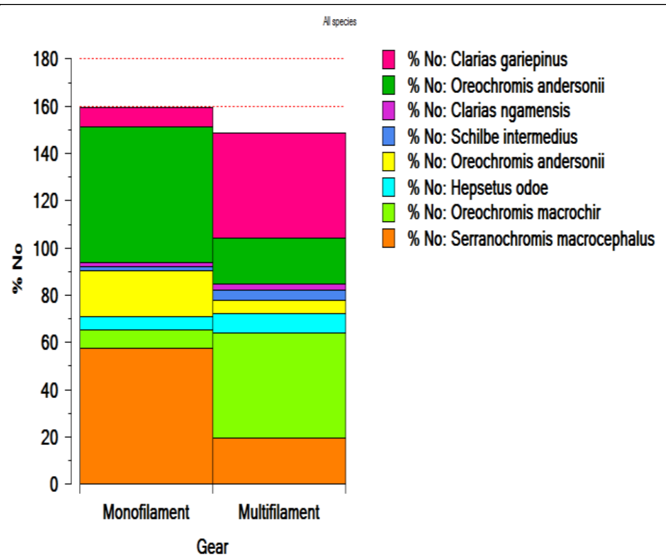
Species composition continues….



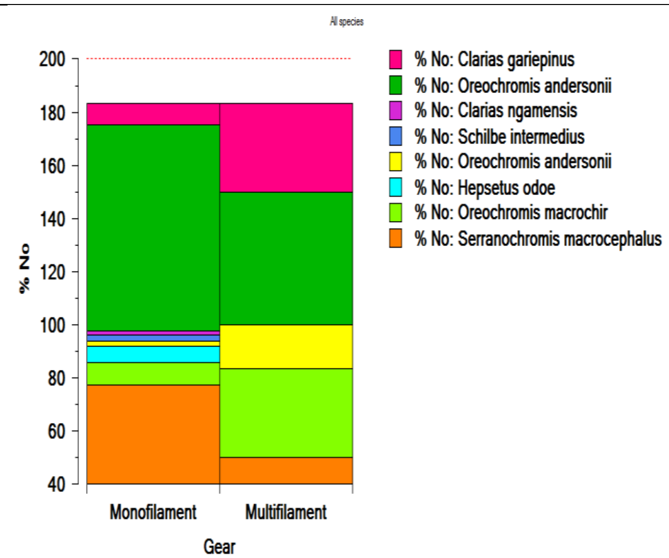
a) 3.0 to 5.0 inch



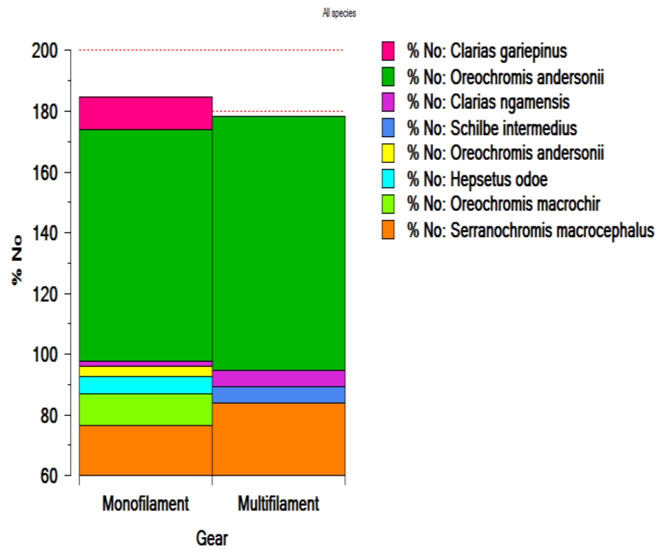
b) 3.0 inch



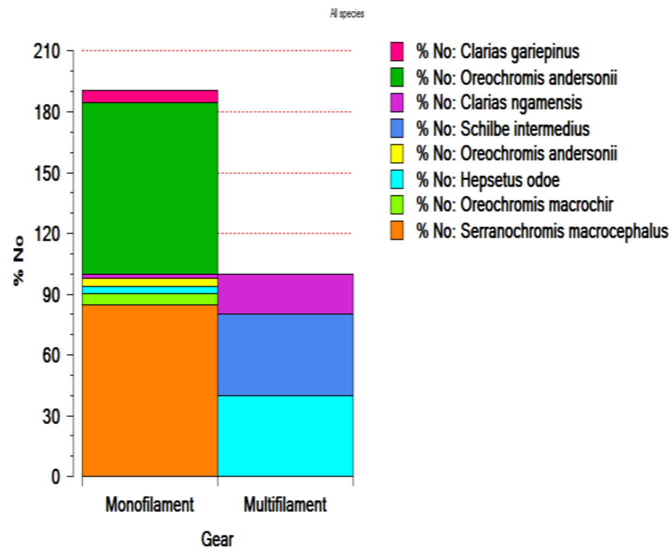
c) 3.5 inch



d) 4.0 inch



e) 4.5 inch



f) 5.0 inch

Figure 4: **Comparisons in species composition between the important (based on IRI) species caught by fishermen gill nets, in their respective mesh size; a) 3.0 to 5.0 inch, b) 3.0 inch, c) 3.5 inch, d) 4.0 inch, e) 4.5 inch and f) 5.0 inch**

The species caught during the surveys were ranked based on the index of relative importance. Experimental gears produced by Peel (2012) are adopted by this study and used in determining species composition from the lake.

A total number of 1195 fish were caught in fishermen gill nets during the selected months of the surveys (**Appendix 1**). 955 (79.92%) of the total fish caught, were caught by the monofilament gill nets (**Appendix 2**), while 240 (20.08%) fish were caught by the multifilament gill nets (**Appendix 3**). A total biomass of 421.86 kg was caught using gill nets (**Appendix 1**). 80.92% of the total biomass caught was from monofilament gillnets (**Appendix 2**), while the remaining 19.06% was caught using multifilament gill nets (**Appendix 3**). Eight fish families were caught in the experimental gear (**Appendix 10**). The Cichlidae family was represented by ten species and the Cyprinidae by seven species (**Appendix 10**). The Mormyridae was represented by four species (**Appendix 10**). *Serranochromis angusticeps* was only recorded in fishermen gill net catches but absent in experimental gears catches. *Mormyrus lacerda* was only caught in multifilament fishermen gill nets and experimental gears and no fish were recorded in monofilament fishermen gill nets. Twenty nine species were commonly caught by experimental gears, while 14 species were caught by fishermen gill nets (**Appendix 10**). The Cichlidae family (93.3%) was the most important family in the fishermen gill nets catches according to Index of relative importance (IRI). *Oreochromis andersonii*, *Serranochromis macrocephalus* and *Oreochromis macrochir* accounted for 64.9%, 21.3% and 6.3%, respectively (**Appendix 10**).All the other 11 species caught by the gill net fishery were below 3% with respect to the index of relative importance. Eight of the most important species caught by the monofilament gill net according to the index of relative importance are shown in **figure 2**.

3.1.1 Fishermen monofilament gill net

Oreochromis andersonii (43.7%) was the highest recorded species with respect to biomass caught by fishermen monofilament gill nets (**figure 4a**). Second highest species caught, with respect to biomass, was *S. macrocephalus* (24.3%) and thirdly *O. macrochir* (12.9%) (**figure 4**). *Oreochromis andersonii* was the most important species in all monofilament gill net mesh size, respectively. *Synodontis nigromaculatus (0.2%)* was the lowest recorded species in monofilament catches (**Appendix 2**). Other species caught by the monofilaments were *Clarias gariepinus* (2.1%), *Clarias ngamensis* (2.5%), *Hepsetus odoe* (2.2%), *T. rendalli* (2.8%), *S. intermedius* (4.5%), *S. codringtonii* (2.1%), *M.lacerda* (1.2%), and Synodontis *spp*. (0.3%), respectively (**Appendix 2**). The species diversity measured as the Shannon diversity index (H`) was the highest in monofilament gill net catches in the 3.0 inch (1.846) (**Appendix 4**), second highest in the 3.5 inch (1.376) (**Appendix 5**), 4.0 inch (0.919) (Appendix 6) was the third highest, the four being 4.5 inch (0.891) (**Appendix 7**) and 5.0 inch (0.637) (**Appendix 8**) had the lowest diversity.

3.1.2 Fishermen multifilament gill net

Serranochromis macrocephalus (41.7%) was the highest recorded species in multifilament gill net catches. *Oreochromis andersonii* (20.4%) was the second highest caught, followed by *H. odoe* (14.6%) (**figure 4a**). *Sargochromis codringtonii*(0.2%)was the lowest recorded species in fishermen multifilament gill net catches (**Appendix 3**).Other important species caught with respect to number were *C. ngamensis* (4.6%), *O. macrochir* (4.2%), *S. intermedius* (4.2%), *C. gariepinus* (2.9%), *S. angusticeps* (1.7%), *T. rendalli* (01.3%), *Synodontis sp. (*1.3%), *T. sparrmanii* (1.3%), *M. lacerda* (0.8%), *S. nigromaculatus* (0.8%) and *S. codringtonii* (0.4%), in their descending order respectively (**Appendix 3**). The species diversity measured as the Shannon diversity index (H`) was the highest in multifilament gill net catches in the 3.5 inch (1.828) (**Appendix 5**), second highest was the 3.0 inch (1.536) (**Appendix 4**), 5.0 inch (1.055) (**Appendix 8**) was the third highest, the four being 4.0 inch (1.011) (Appendix 6) and 4.5 inch (0.659) (**Appendix 7**) had the lowest diversity. *Tilapia sparrmanii* was the only species recorded in multifilament but absent in monofilament catches. The species diversity of the fishermen gill nets measured as the Shannon diversity index (H`) in multifilament gill net overall catches was 1.814 and in monofilament gill net overall catches this value was 1.686 (Appendix 4) (**Appendix 1**). Shannon diversity index showed a high diversity in multifilament gill nets in 3.5 inch (1.828), 4.0 inch (1.011) and 5.0 inch (1.055), respectively, on the other hand, monofilament gill net showed a high diversity in the 3.0 inch (1.846) and in the 4.5 inch (0.891), respectively.

3.1.3 Experimental Gears

In experimental gears (Peel, 2012), the three most important species accorded (according to the IRI) belonged to the Characidae (58.84%), Schilbeidae (24.63%) and Cichlidae families (5.75%). Characidae family species that were recorded were *B. lateralis* (67.1%), *M. acutidens* (0.03%) and *R. maunensis* (5.95%); Schilbeidae family had one species recorded only, namely, *Schilbe intermedius*(24.63%) and the Cichilidae family species that were recorded were *O. andersonii* (0.42%), *Oreochromis macrochir* (0.26%),*Pharyngochromis acuticeps* (0.65%), *P. philander* (0.25%), *Sargochromis carlottae* (0.04%), *Sargochromis codringtonii* (0.34%), *Serranochromis macrocephalus* (1.25%), *Tilapia rendalli* (0.29%) and *Tilapia sparrmanii* (2.25%) (**Appendix 10**).

Clarias gariepinus (18.6 %) was the highest species in 2001 experimental gear catches with respect to biomass and *B. paludinosus* (16.9%) was the second highest species (Appendix 11). *Schilbe intermedius*(19.7%) was the highest recorded species in 1975-76 experimental gear with respect to biomass (Appendix 11), while *marcusenius macrolepidotus* (13.9%) was the second highest species caught and *O. andersonii* (11.7 %) was recorded in third place (**Appendix 11**).

Schilbe intermedius (38.9%) was the highest record species in 2011 experimental gear catches, with respect to biomass (**Appendix 10**). The list of the 5 most important species recorded in the experimental gear (2011) represented an IRI of 88.35% (**Appendix 10**). Sixteen species were caught with experimental gear only, and none of these species were recorded in gill net catches, namely; *M. altisambesi, Petrocephalus catostoma, P. castelnaui, B. barnardi, B. bifrenatus, B. paludinosus, B. poechii, B. radiates, B. unitaeniatus, L. cylindricus, Brycinus lateralis, M. acutidens, R. maunensis, P. acuticeps, P.philander,* and*S. carlottae*(**Appendix 10**).

3.2 Yield

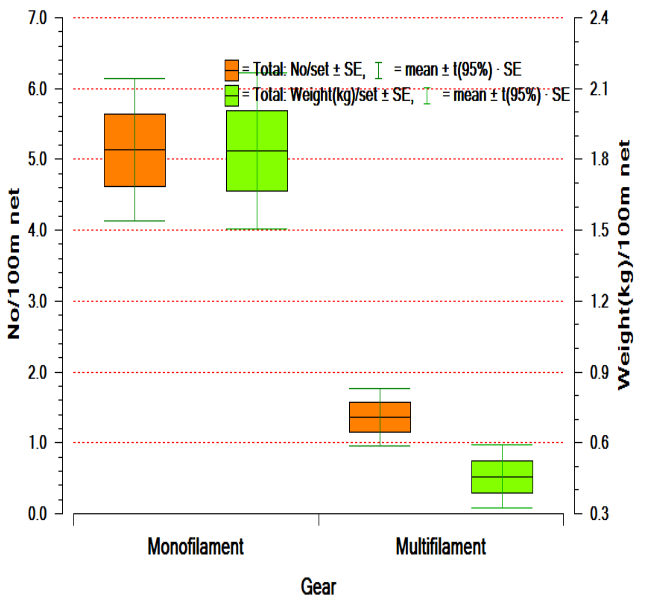
Table 3.2: **Yield from Shamauka landing site**, **recorded from June 2011 to June 2012.**

	Average catch per fishermen (tons)	Fishing day/days
A single fishermen	0.0331 per day	1 Day
	0.1655 per week	5 Days
	0.7172 per month	4.333 Weeks
	8.6 per Year	52 Weeks
300 fishermen	9.93 per day	1 Day
	49.65 per week	5 Days
	215.15 per month	4.333 Weeks
	2 581.8 per year	52 Weeks

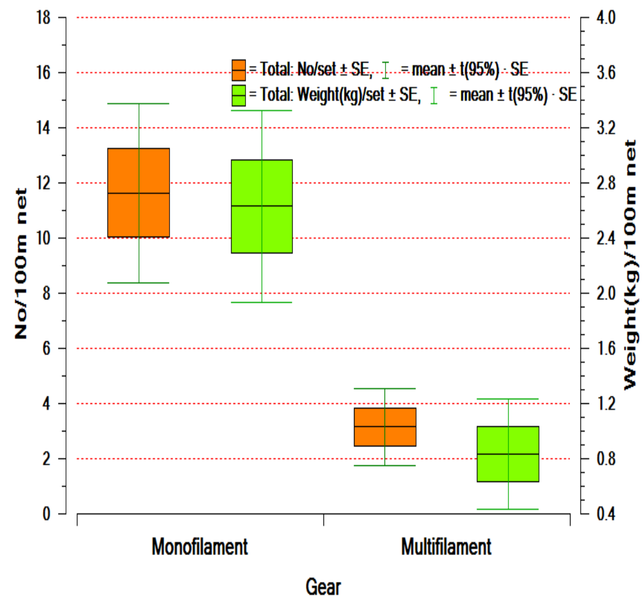
A single fisherman fished on average 5 days per week and can harvest around 165.5 kg (0.1655 tons), yielding a total estimated catch of 717.2 kg (o.7172 tons) per month, and an annual total estimated catch of 8.6 tons.

An estimated number of 300 (Simata, pres. Comm., 2012) fishermen fished from the lake on average 5 days per week and harvest around 49.65 tons, yielding a total estimated catch of 215.15 tons per month, and an annual total estimated catch of 2 581.8 tons. It was estimated that a single fisherman caught 33.1 kg (0.0331 tons) per day, while 300 fishermen yielded 9.93 tons per day.

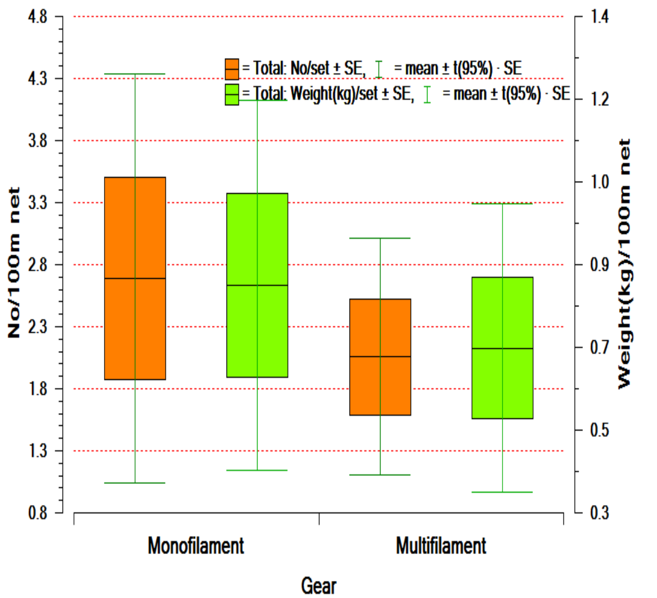
3.2.1 Catch per unit effort



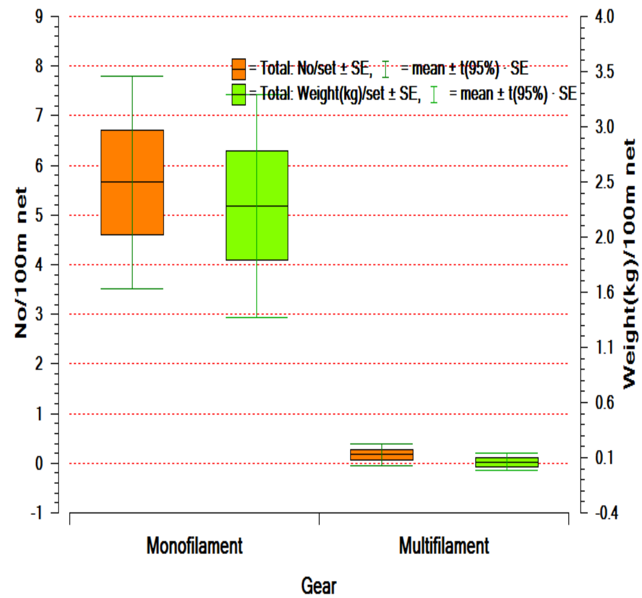
a) 3.0 to 5.0 inch



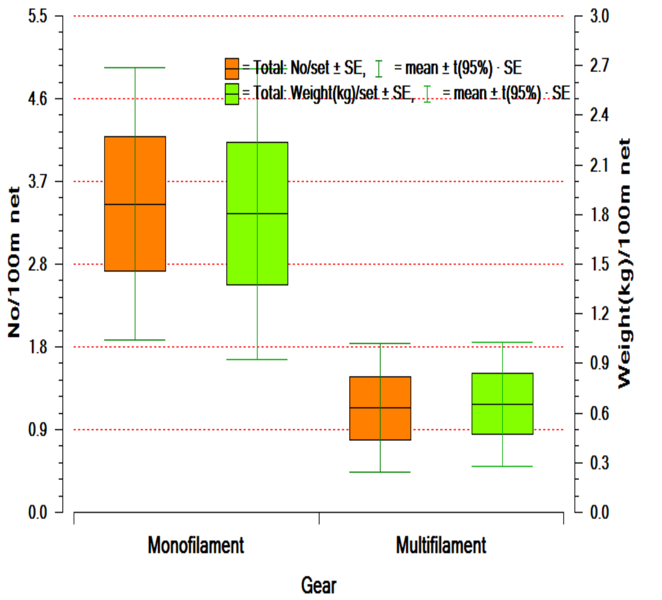
b) 3.0 inch



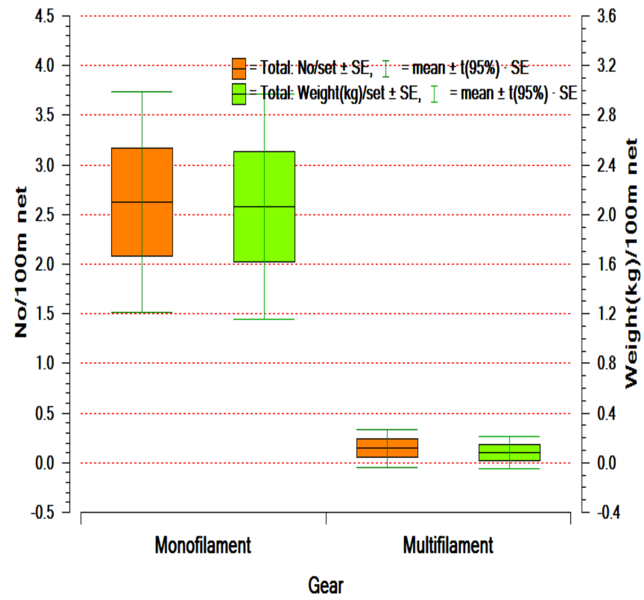
c) 3.5 inch



d) 4.0 inch



e) 4.5 inch



f) 5.0 inch

Figure 5: **Comparisons in mean standard CPUE (percentage number and weight) with 95% confidence limits for monofilament and multifilament gill nets (3.0 to 5.0 inch), between April and September 2012. A single day of fishing with standard gill nets (100 meter gill nets).**

Figure 5 is reflecting the number and weight of fish caught in a single day of fishing for a 100 meter gill net. Absolute number values are given on the left x-axis, while absolute weight values are given on the right x-axis. The values from the figure above are given in mean CPUE as number or mean CPUE as mass per setting.

The 3.0 to 5.0 inch mesh size monofilament gill nets recorded a mean CPUE of 5.18 fish per setting and recorded a mean CPUE of 1.82 kg per setting with respect to weight (**Figure 5a**). The 3.0 inch mesh size caught the largest number of fish per setting (11.7 fish per setting) (**Figure**

5b). The 3.0 inch also had the highest catch with respect to weight per setting (2.65 kg per setting) (**Figure 5b**).

Reading from figure 5, the 3.0 to 5.0 inch mesh size multifilament gill nets caught 1.39 fish per setting and recorded a catch of 0.48 kg per setting with respect to mass (**Figure 5a**). The 3.0 inch mesh size caught the largest number of fish per setting (3 fish per setting) (**Figure 5b**) and also recorded the highest catch with respect to mass per setting (0.81 kg per setting) **(Figure 5b)**.

Mean CPUE given as a number of fish caught per setting decreased with increasing mesh size, from 11.7 fish per setting in the 3.0 inch mesh size to 0.1 fish per setting in the 5.0 inch mesh size. The only exception is in the 4.0 inch monofilament (5.6 fish per setting) that recorded more fish per setting than the 3.5 inch monofilament (2.7 fish per setting) and another exception is also noted in the 4.5 inch multifilament that recorded more fish per setting the 4.0 inch multifilament mesh size. This trend in mesh size catches is clearly demonstrated in **figure 6**, below. A similar trend was also observed when CPUE was given as mass per setting.

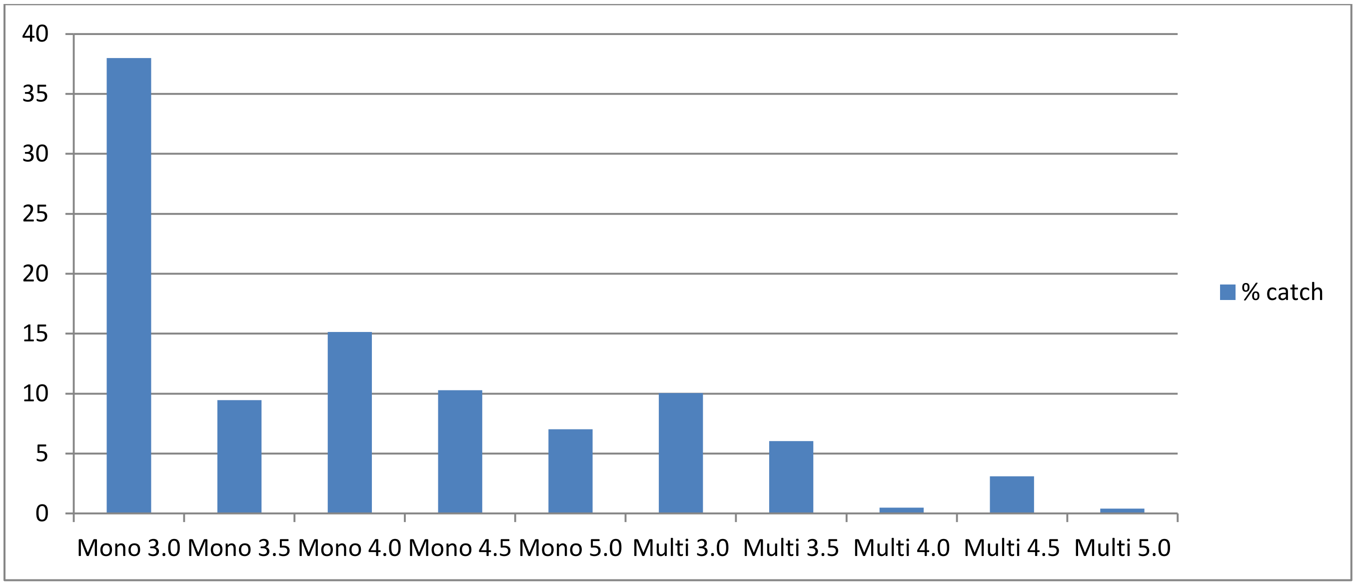


Figure 6: **Percentage catches of each mesh size (Fishermen gill net data), 2012**

Three inch monofilament recorded the highest percentage of fish caught by a single mesh size fishermen gill net (37.99%), with the four inch monofilament recording 15.15% in second position (figure 6). Three inch multifilament gill net recorded the highest number of fish caught (10.04%) for multifilament fishermen gill nets, and recorded the four highest number of fish caught, overall.

This is the order of catches with respect to mesh sizes for both monofilament and multifilament fishermen gill nets, starting with the highest recorded catch; 3 inch monofilament (33.99%), 4 inch monofilament (15.15%), 4.5 inch monofilament (10.29%), 3 inch multifilament (10.04%), 3.5 inch monofilament (9.46%), 5 inch monofilament (7.03%), 3.5 inch multifilament (6.03%), 4.5 inch multifilament (3.1%), 4 inch multifilament (0.5%) and lastly 5 inch multifilament (0.42%) (**Appendix 14**).

3.4 Predator-Prey Relationship

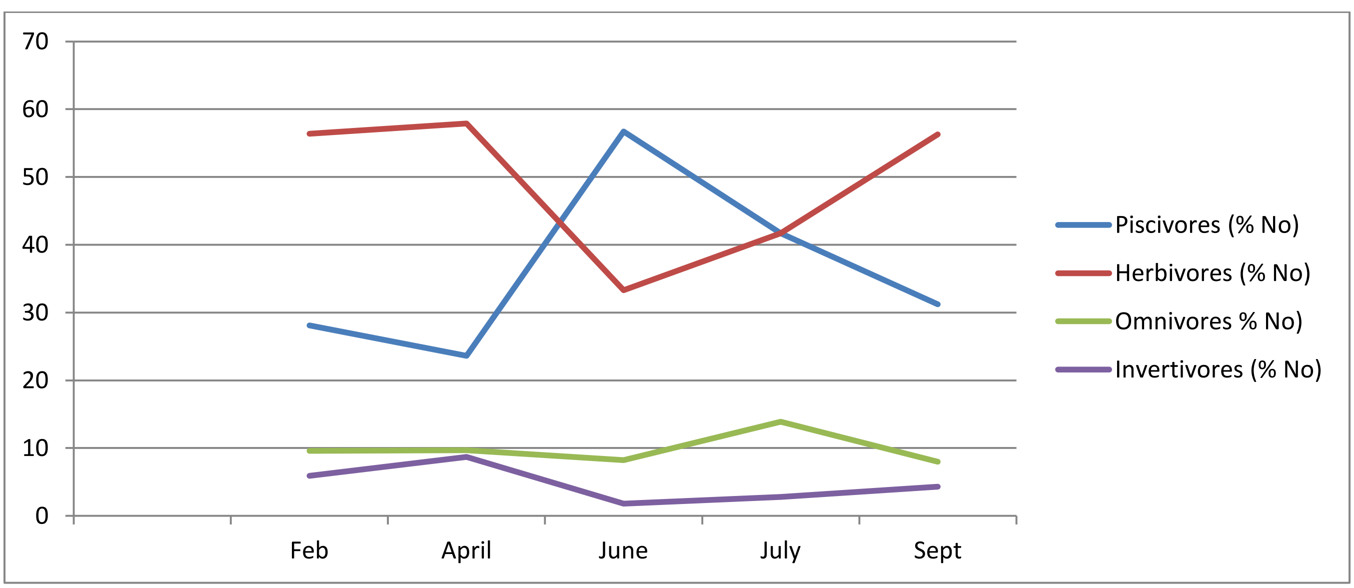


Figure 7: **The relationship between predators and prey number (%) for the year 2012 based on data from fishermen gill net.**

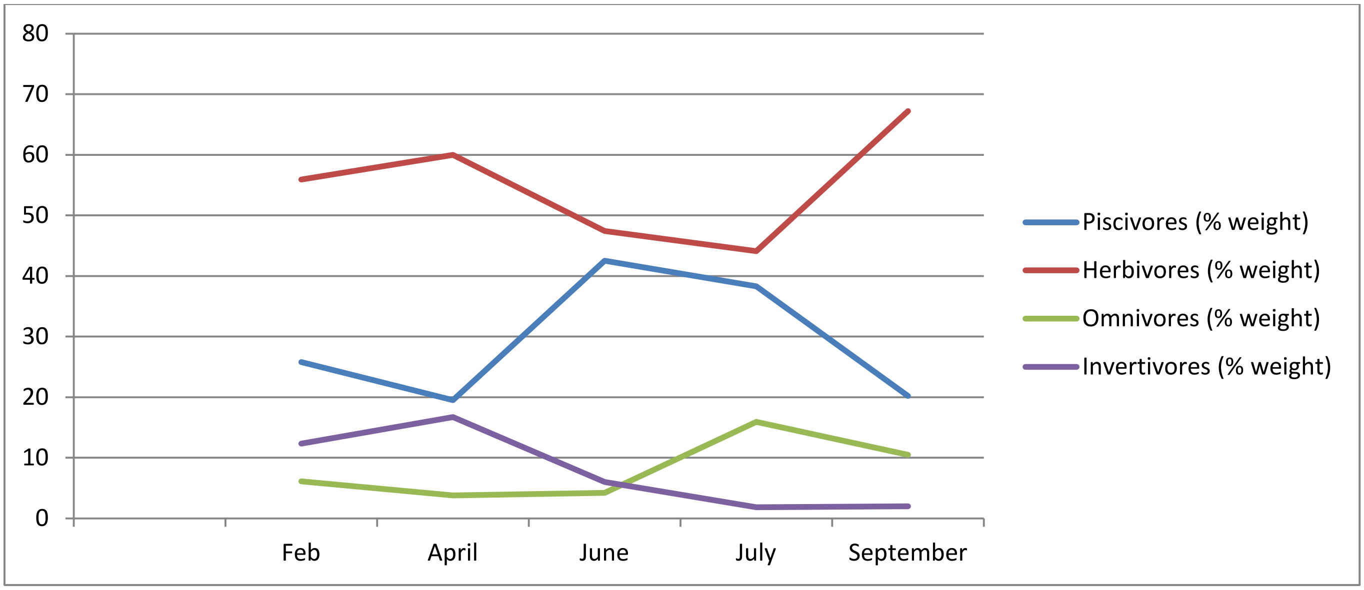


Figure 8: **The relationship between predator and prey weight (%) for the year 2012, based on data from fishermen gill net.**

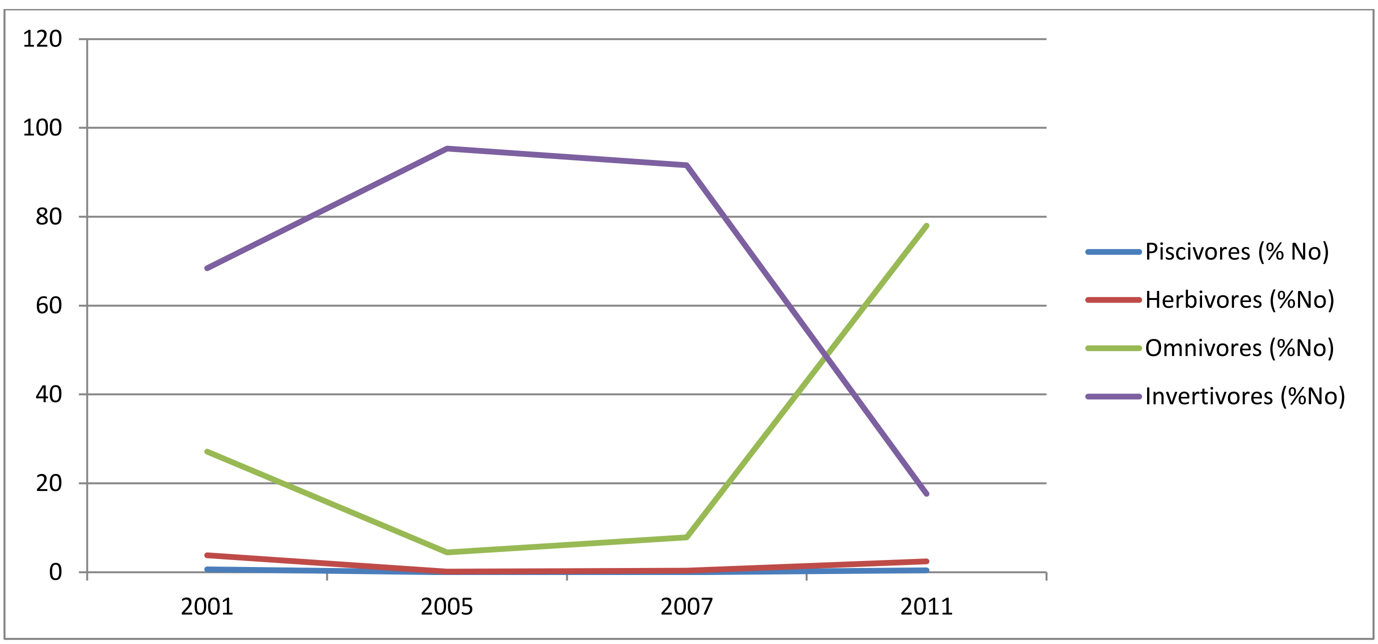


Figure 9: **The relationship between predator and prey number (%) from Lake Liambezi for the year 2001, 2005, 2007, and 2011 respectively, based on data from experimental gear**

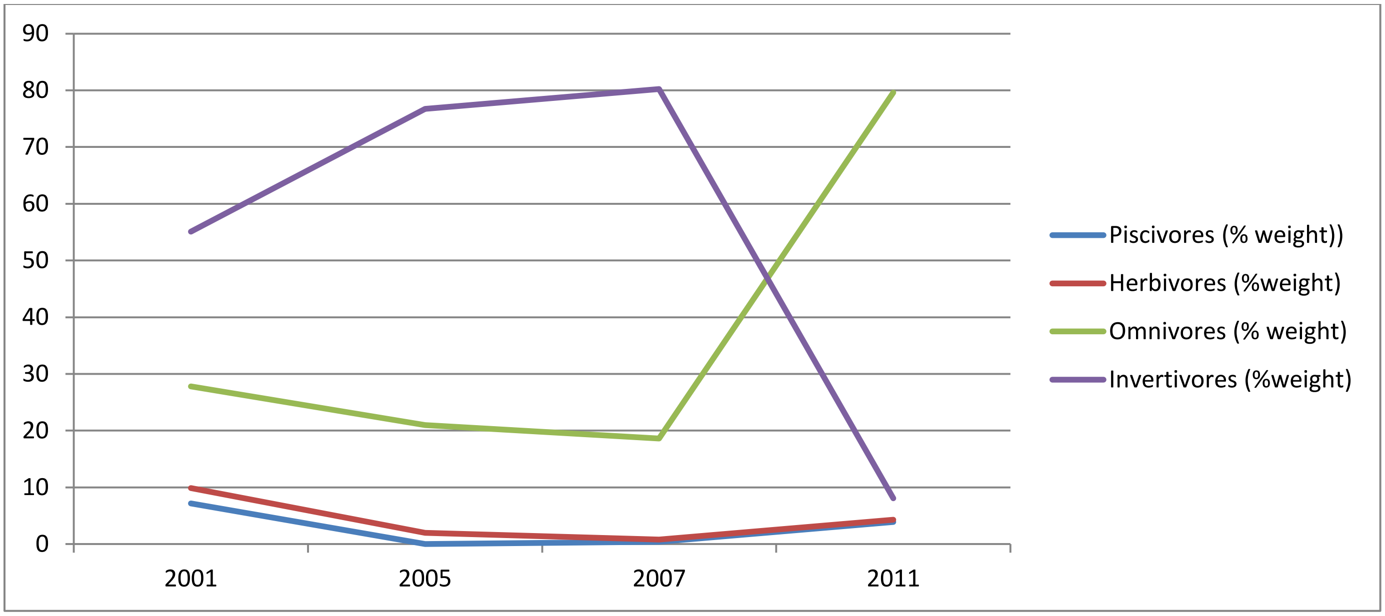


Figure 10: **The relationship between predator and prey weight (%) for the year 2001, 2005, 2007, and 2011 respectively, based on data from experimental gear**

The relationship between the different trophic level was studied using data collected with gill nets in February, April, June, July and September in 2012 (**Appendix 12**) and a combination of experimental gears data (**Appendix 13**) for 2001, 2005, 2007 and 2011, from Lake Liambezi. Three piscivores species, seven herbivores species, six omnivore's species and 19 invertivores species were recorded from the lake; since the inundation in 2001.

This study noticed a clear inverse relationship between herbivores and piscivores with respect to both percentage weight (**figure 7 and 8**) and number caught (**figure 7**). In fishermen gill nets, herbivores (60.1%) recorded the highest catches with piscivores (24.7%) recording the second highest value, with respect to weight caught.

Also an inverse relationship is evident between invertivores and omnivores, both in percentage number (**figure 7**) and weight (**figure 7 and 8**). The relationship between invertivores and omnivores is clear evident in the experimental gear data because most of this species sizes were below the given mesh sizes of gillnet fishery. Omnivores and invertivores accounted for 7.6% and 7.5% of the biomass, respectively. Experimental gear showed high invertivores catches in 2001, 2005 and 2007, respectively and omnivores were recorded highest with respect to number caught in 2010/11.

CHAPTER FOUR

DISCUSSION, CONCLUSION AND CONTRIBUTION TO KNOWLEDGE

4.1 Discussion

4.1.1 Species composition

Thirty five fish species were identified from Lake Liambezi experimental gear catches (Peel, 2011) (**Appendix 1**). This is in comparison to 28 species that were sampled by Van der Waal (1980) using experimental gear in 1975/76, before the dry period (**Appendix 11**). Results are compared between this survey and other study done by Peel (2012) and Van der Waal (1980). Cichlids area know to utilize floodplains for spawning, nursery, refuge or ranging movement (Bell-Cross and Minshull, 1988), and this is the main reason they are recorded in large number comparing to other families.

This study assumes that the absent of some species that were recorded before 1986, may have encourage the introduction of other species that were only recorded after 2001 i.e. the distribution of the various species found may be explained by species behavioural requirements, water quality, feeding mechanisms and avoidance of predators (Sinchembe, 2004), not ruling out other factors such as the probability of farming activities that were carried out on the lake during the dry period contribution to a higher productivity (nutrient levels) within the lake after inundation. Palmer (2001) notice a lower transparency during his study, significantly higher salinities, and high concentrations of ammonia and phosphate, compared to the values that were recorded by Van der Waal in 1975/76, and this lead him to belief that recently inundated organic material were undergoing decomposition. This may also help to explain the variety and relative abundance of species currently found at the lake, when considering the tolerance level of each species to the describe water quality.

Figure 11: Some of the sample species caught *(H. odoe, O. andersonii, S. codrigntonii, S. macrocephalus and O. macrochir)*

The *Synodontis spp*. were pooled and grouped as one species due to the current systematic difficulties, except for *Synodontis nigromaculatus* which can clearly be identified.

Large mesh sizes were more selective (as reflected by species diversity) compared to smaller mesh size gill net. The 3.0 inch was the most efficient mesh size, in terms of number of fish caught (n =454, 37.99%), while 5.0 inch mesh size was the less efficient in terms of number of fish caught (n=5, 0.42%), for the fishermen gill net fishery (multifilament and monofilament). The monofilament fishermen gill nets had higher catch rates than multifilament. All monofilament gill nets mesh size caught more fish (higher mean CPUE given as number per setting) than their corresponding multifilament mesh sizes (**figure 5**). The results showed that the catch decreases with increasing number of filament and that this may be linked to the visibility or friction of materials/twine (Faife, 2003).

Species diversity is defined as both the variety and the relative abundance of species (Hay *et al*, 2011). Experimental gear (fishery independent data) species diversity was statistically different from fishermen gill net (fishery dependent data) diversity. The reason for the statistically different may be attributed to the restriction imposed on fishermen gill nets, as experimental gears include all mesh sizes and can catch a variety of species. The species diversity of the fishermen gill nets measured as the Shannon diversity index (H`) was highest in multifilament gill net overall catches (1.814) than in monofilament gill net overall catches (1.686) (**Appendix 4**). The selectivity in fishermen gill net fishery may have been brought about by the catchability of gill net used, its selectivity and fishing effort deployed by fishermen (Hovgärd and Lassen 2000).

Monofilament gill net

Figure 12: Display of the monofilament gill net by KIFI staff member (Mr. E. Simasiku) and a member of the community.

The monofilament gill net was the most preferred gill net by the fishermen as it is the most efficient in terms of number of fish caught per 100 meter net (5.2 fish per setting), due to its camouflage effect in the water column. Pala and Yuksel (2010) concluded that in fishing with gill nets that is characterized with high selectivity, the more abundant size range (3 inch in the case of Liambezi) of target species in the environment is important for the fishermen.

Monofilament gill nets efficiencies is affected by several factors, such as the migration movements and behaviour of the targeted fish species, the depths of their localities, movements of water and the materials of the utilized gill nets, time and duration of fishing (Bjordal, 1981; Akamca et al., 2008).

Oreochromis andersonii (57%), *S. macrocephalus* (15.6%) *and O. macrochir* (8%) are three species with the highest index of relative importance (**Appendix 2**) as they are highly in demand by the locals and the general markets. In support of the above findings, Bell-Cross and Minshull (1988) found that cichlids were abundant in the upper Zambezi system. These species are important species in commercial and subsistence fishery. *Synodontis nigromaculatus* was recorded as the least important as it is non-preferred by the market and the locals (**Appendix 2**). *T. sparrmanii* was not caught in the monofilament gill nets. Hocutt *et al* (1993) suggested that Tilapia *rendalli* and *T. sparrmanii* undergo seasonal habitat separation, with the one out-competing the other for the limited, slow water areas. Another reason that may explain this situation was suggested by Yamaoka (1991), whereby he stated that cichlid species that have been regarded as sharing the same trophic requirements demonstrate minor but distinct inter-specific differences in feeding behaviour, habitat and feeding sites.

Figure 13: *Oreochromis andersonii*,most important species according to IRI.

Figure 14: Three inch monofilament gill net efficiency demonstrated by catching a *Serranochromis macrocephalus*.

Multifilament gill net

Figure 15: Student, NNF member and staff of MFMR were busy mounting a multifilament gill net.

Most predators are caught by the multifilament (49%), compared to the monofilament (19%) (**Appendix 1**).The reasons for higher piscivores catches in multifilament are currently unknown, but the assumption is that it may have something to do with twine of multifilament gill nets. *Serranochromis macrocephalus* was the largest caught species in terms of number caught, *a*s it is demanded by the market and has been adopted by the locals as an important food source. A Study done by Bell-Cross and Minshull (1988) report a large number of this species caught and concluded that they were fairly distributed in the Zambezi (fitting the lake through the Bukalo channel). This species is highly targeted by the gill nets fishery. Another species that was highly caught in this net was *Hepsetus odoe.* To support this high number of *H. odoe* recorded at the lake by this study, Bell-Cross and Minshull (1988) observed that this species was found to be very abundant in areas that have no *H. vittatus*.

Sargochromis codringtonii was the lowest recorded species in fishermen multifilament gill net catches (**Appendix 3**), assumingly due to its low vulnerability to the fisherman gill nets.

Figure 16: *Hepsetus Odoe*, third highest recorded species in 3.0 to 5.0 inch multifilament gill nets.

Figure 17: Entangled: a juvenile *Oreochromis macrochir* caught in a 3.0 inch multifilament gill net.

Experimental Gear

Schilbe intermedius was the highest recorded species in 1975-76 experimental gear with respect to biomass (**Appendix 11**), and studies done by Bell-Cross and Minshull (1988) assumed that this might have been caused by the absence of *H. vittatus (*preying on *S. intermedius)*. *Schilbe intermedius* prefers slow or stagnant water, such as that of the Lake Liambezi.

Figure 18: *Schilbe intermedius*, was the most abundant species in experimental gear of 1975/6 (represented 30.5% of all catches with respect to number of fish caught, Appendix 11).

Clarias gariepinus (highest caught species in 2001) is the most widely distributed of the freshwater fishes in the Namibia Rivers system (Hay, 2008). This species has a wide habitat use and is found in almost any habitat types, but mostly prefers slow moving waters such as that of the lake. *Clarias gariepinus* is an important species in subsistence fishery in the Caprivi. *Clarias ngamesis* and *C. gariepinus* are probably common in the lake than the represented value, and were basically not well represented in this survey due to gear selectivity. *Barbus paludinosus* was recorded second in catches, as this was the first development stage of the fishery and so *B. paludinosus* may have been dominating in number prior to the arrival of other species. This species is widely distributed and has been recorded in several temporary rivers in Namibia (Hay et al., 1999). *Barbus paludinosus* is a multiple spawner and can feed on a variety of small organisms as well as detritus. *Serranochromis angusticeps* was not recorded in the experimental gears, and was recorded in small number in fishermen gill nets fishery. The assumption is that it does not appear highly in the lake fish communities, due to irregular occurrence and their usual small numbers recorded in a variety of other studies. This species was also recorded in diminutive number in Bell-Cross and Minshull (1988) study and so this let them to a conclusion that this species was generally not abundant in the Zambezi.

4.1.2 Yield

A subsistence fisherman in Mayuni village belief that there is plenty of fish for him and his fellow community member's (Heider, 2012). Fishermen in the Sikunga, argued that the more fish they are able to catch the more income they can generate (Heider, 2012).

In support of the above statements, an increase in the yield (2 581.8 tons) from the lake is evident (**Table 3.2**), comparing to between 600 and 800 tons that was recorded by Van der Waal (1990), when the stage of the lake fishery was matured enough. Higher yield from the lake can not necessarily be judge as being an unsustainable way of managing the fishery, but may be attributed to the productivity of the lake (Hay, pers. Comm.., 2013). Lake Baringo reported a different case scenario, were fishery yield dropped from 240 tons in mid 1970s to 14 tons by 1995 and the number of fishermen reduced from 4600 to 200 (Ogutu-Ohwayo and Balirwa, 2004). The increase in yield from Lake Liambezi may be attributed to an increase in fishermen population at the lake and the effectiveness of the modern fishing gears comparing to previous fishing gears. On Lake Victoria, the fishing effort in the Uganda part of the lake increased from 3200 canoes in 1972 to 8,674 canoes in 1990 to 15,452 canoes in the year 2000 (Ogutu-Ohwayo and Balirwa, 2004). The percentage of fulltime fishermen was reported to be on the increase on the Chobe/Zambezi Rivers (nearly doubled from 2002 to 2008), according to Van der Waal *et al*., (2008), and their study assumed that this increase and the increase recorded for Lake Victoria may have been due to high demand for fish. In addition, it is clear that the objectives of most fishermen have shifted from mainly harvesting fish for own consumption to primarily commercialization, as supported by the estimated revenue that may be generated from the lake fisheries resources (N$102 million). All the above phenomena indicated a proportional relationship between yield and fishermen population. Lake Liambezi has been filled up for about 11 years now (since 2001,), and if not sustainably managed, a similar case scenario as the one of Lake Baringo may be experienced in years to come.

The gross income from the fishery was estimated to be around N$102 million if all fish caught were sold as dried fish by vendors at the Ngweze market in Katima Mulilo. Interestingly, Alexander (2012) found the average accept fishermen’s price of fresh fish per kg to be N$ 9.00, at the lake itself. According to Alexander the fishermen price, the gross income from the lake will then be around N$23 million and almost N$ 77 000 for a single fisherman. Prices changed between species and seasons, and for dried or fresh fish. The market price for this study was averaged at N$39.47 for dried fish at the Ngweze market in Katima Mulilo, and N$ 9.00 was considered to be the fishermen average price at the lake. Fish price vary from one fisherman/vendor to the next, and so market prices may not reflect the true value of the lake fishery, but will surely produce a rough estimate.

It will be quiet challenging for this to indicate that whether the current catch is sustainable or not, since the lake fishery is still at its initial stage. The efficiency of the monofilament gill nets remain questionable when it come to the maintainance of maximum sustainable yield from the lake, especially the three inch mesh size**.** Heider (2012) carried out an interview at Sikunga village and Ngweze market in which vendors belief that the decline in fish supplies are exclusively accounted to strong winds, full moon or seasonal variation (such as surface temperature), but ruled out the possibility of stock's being overfished. This study is in agreement with the above factors reported by vendors, but may not rule out other factors such as the efficiency and selectivity of the gill nets in catching the important species according to IRI. Therefore more development, knowledge and awareness are necessary on the state of management and the stage of exploitation of Lake Fishery, as more information on the lake will prohibit the above stated output (2 581.8 tons) to be underestimates or overestimates.

4.1.3 Predator-Prey relationship

If the system is removing more predators than what is required, a raise in density dependent competition may be experienced. Alteration in fish species composition may alter the biotic interaction between species (Peel, 2012). On the other hand, more predators will result in prey population avoiding predation by aggregating in habitats that are providing better sanctuaries from predators (Jackson *et al.,* 1961). This will generate intra and inter-specific competition for food resources and space in the heavily populated area of the lake (Jackson *et al.,* 1961). Increased competition result in a decline in food security for the fish, and hence leading to a reduced growth rates, smaller size at maturity, increased mortality and reduced fecundity (Jackson *et al.*, 1961).

Since the introduction of *Lates niloticus* in Lake Victoria, about 200 species of haplochromine fish have disappeared or became severely endangered (Dobson and Frid, 1998), a simple demonstration in which a dominant predator can restructure the community of an aquatic system, such as the lake. The above case scenario may not necessarily be expected at the lake, since all the species found at the lake are native and not exotic as *L. niloticus*, but may only serve to demonstrated the extended of a predator-prey relationship.

Studies on the limnological characteristics of the lake found that the basic direction of energy transfer within the lake was from the decomposition of aquatic macrophytes to herbivorous invertebrates to insectivorous fish species (primarily cichlids) to humans (Seaman *et al*, 1978). It is very hard for this study to proof that the fishermen preferences and catches may alter the biotic interaction of the lake, but with the current large gap in percentage catches in terms of number between trophic levels (**Appendix 12**), the prediction is that more piscivores, invertivores and omnivores will be excepted from the lake in the future if no other addition of species due to flooding is recorded

Relationship between herbivores and piscivores was clearly visible in fishermen gill nets, as they are highly target by this fishery (considered to be large and important species) (**figure 7**). This relationship may be affected by other factors such as seasons, fishermen preference and any changes in the biota of the lake (starting the smallest invertebrates all the way to the top predators). Productivity may have be a factor during 2010/11, as omnivores can feed on generally any food type. Generally in any system, herbivores numbers are generally larger then piscivores number and so this may also be another reason that may help in explaining why fishermen are catching more predators than piscivores. On the other hand, gear selectivity may be the reason most invertivores and omnivores were not caught in fishermen gill nets.

4.2 Conclusion

Fishing activities has intensified in the last twelve months, as there is an increase in numbers of fishermen at the lake and modernization of the fishing gear is clearly evident. The use of monofilament gill nets was reported as becoming famous in the Chobe/Zambezi area (Hay et al., 2008), and so this study assume that this may have encouraged fishermen from neighboring areas such as the lake to modernize their fishing gears, hence increasing catch efficiency. Traditional fishing methods and gear are considered old and less effective by current generation (Turpie and Egoh 2002) as indicated by the adoption of effective modern methods and monofilament gill nets at the lake. This study observed that there is currently a high demand for fish from the lake, generating more revenue from its output, therefore attracting a larger number of outsiders.

Species composition has been transformed by the dry period of the lake. As previously stated, the assumption is that the increase in species number may be attributed to the behavioral requirement, feeding mechanisms of the different species and avoidance of predators or search for preys. Total values and fish distribution of the lake may continue to change over time and so need to be studied and update with time. Inland fisheries are primarily considered important as a source of subsistence income, protein and employment, but more attention should also be placed on the reason that they provide a considerable contribution to the national economy (Turpie and Egoh, 2002).

One of the recommendations is that government should try to encourage the locals to combine different combinations of resource uses as this may reduce the pressure on the fishery. Traditional authorities should develop well defined punishment (e.g. three cattle for illegal fishing) for any given offence regarding fishing and the protection of the lake system, and should consider legal advice on situation beyond their control or jurisdiction (Transboundary conflicts). The freshwater fishery is selective in terms of both species composition and size and so current gear restriction should be thoroughly investigated and studied, in order to allow for management systems to come up with proper gears size that would harvest the entire fishery sustainably. No recommendation on any given mesh size at the current moment, as this study will require more knowledge on gill nets selectivity and for the stage of the fishery from the lake to move into a more mature stage, in a long-run. Another recommendation is that mulifilament gill nets or large mesh size (3.5 inch upwards) should be adopted were fisheries resources are believed to be near or over-exploitated and monofilament should be used in case were fisheries are more stable, due to their respective catching rates.

This study understanding showed that there may be factors contributing to a lack of effective action and listed these factors as, inadequate accessibility and application of understandable scientific information (e.g. fishermen at Kasika complained that they are not made aware of the report based on data obtained from their localities by the fish monitors, as it should be the case (Heider, 2012)); fisheries laws and regulations are not full accepted or understood by all stakeholders (e.g. fishermen at Kasika and Sikunga stated that they don't understand all these restrictions and in some cases the regulations are simply not compatible with their lives and therefore they cannot comply with them (Heider, 2012)); and inadequate enforcement of existing laws and regulations (limited number of fisheries inspectors (n= 6) are responsible for the enforcement of law in the whole of Caprivi, with lead to the ministry patrolling the lake occasionally). Understandable scientific information is one in which local knowledge and scientific languages are aligned (e.g. trends demonstrated by graphs and tables are easily understood by both parties) (Heider, 2012).

4.3 Contribution to knowledge

The researcher has gained knowledge in carrying out surveys and on the fish species of Lake Liambezi.

CHAPTER FIVE

5. References

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Appendixes

Appendix 1: The relative importance (IRI) and diversity (H’) of all species caught in surveys with gill nets in 2012. The IRI into the number (No), weight (kg) and frequency of occurrence (FRQ) of individual caught. Values are given in absolute values and percentage.

Species	No	% No	Weight(kg)	% Weight	FRQ	% FRQ	IRI	% IRI	H`
Oreochromis andersonii	466	39	215.592	51.1	120	58	5223	64.9	0.367
Serranochromis macrocephalus	332	27.8	75.182	17.8	78	37.7	1718	21.3	0.356
Oreochromis macrochir	133	11.1	29.7	7	58	28	509	6.3	0.244
Hepsetus odoe	56	4.7	27.097	6.4	36	17.4	193	2.4	0.143
Schilbe intermedius	53	4.4	7.606	1.8	45	21.7	136	1.7	0.138
Clarias ngamensis	35	2.9	21.475	5.1	27	13	105	1.3	0.103
Clarias gariepinus	27	2.3	23.598	5.6	22	10.6	83	1	0.086
Tilapia rendalli	30	2.5	8.221	1.9	22	10.6	47	0.6	0.093
Sargochromis codringtonii	21	1.8	3.874	0.9	10	4.8	13	0.2	0.071
Mormyrus lacerda	13	1.1	4.129	1	11	5.3	11	0.1	0.049
Synodontis sp.	15	1.3	2.014	0.5	12	5.8	10	0.1	0.055
Serranochromis angusticeps	7	0.6	2.211	0.5	6	2.9	3	0	0.03
Synodontis nigromaculatus	4	0.3	0.844	0.2	4	1.9	1	0	0.019
Tilapia sparrmanii	3	0.3	0.317	0.1	2	1	0	0	0.015

Total	1195	100	421.86	100	-	-	8054	100	1.77

Appendix 2: The relative importance (IRI) and (H') of all species caught in surveys with monofilament gill net (3.0 to 5.0 inch) in 2012. The IRI into the number (No), weight (kg) and frequency of occurrence (FRQ) of individual caught. Values are given in absolute values and percentage.

Species	No	% No	Weight(kg)	% Weight	FRQ	% FRQ	IRI	% IRI	H`
Oreochromis andersonii	417	43.7	194.662	57	99	69.7	7019	73.7	0.362
Serranochromis macrocephalus	232	24.3	53.382	15.6	45	31.7	1265	13.3	0.344
Oreochromis macrochir	123	12.9	27.454	8	50	35.2	737	7.7	0.264
Schilbe intermedius	43	4.5	6.229	1.8	36	25.4	160	1.7	0.14
Clarias gariepinus	20	2.1	19.639	5.8	17	12	94	1	0.081
Clarias ngamensis	24	2.5	11.33	3.3	17	12	70	0.7	0.093
Tilapia rendalli	27	2.8	7.713	2.3	19	13.4	68	0.7	0.101
Hepsetus odoe	21	2.2	10.732	3.1	17	12	64	0.7	0.084
Sargochromis codringtonii	20	2.1	3.719	1.1	9	6.3	20	0.2	0.081
Mormyrus lacerda	11	1.2	3.583	1	9	6.3	14	0.1	0.051
Synodontis sp.	12	1.3	1.667	0.5	9	6.3	11	0.1	0.055
Serranochromis angusticeps	3	0.3	0.918	0.3	2	1.4	1	0	0.018
Synodontis nigromaculatus	2	0.2	0.41	0.1	2	1.4	0	0	0.013
Total	955	100	341.438	100	-	-	9524	100	1.686

Appendix 3: The relative importance (IRI) and diversity (H') of all species caught in surveys with multifilament gill net (3.0 to 5.0 inch) in the Lake Liambezi between February and September 2012. The IRI into the number (No), weight (kg) and frequency of occurrence (FRQ) of individual caught. Values are given in absolute values and percentage.

Species	No	% No	Weight(kg)	% Weight	FRQ	% FRQ	IRI	% IRI	H`
Serranochromis macrocephalus	100	41.7	21.8	27.1	32	50	3439	52.5	0.365
Oreochromis andersonii	49	20.4	20.93	26	21	32.8	1524	23.3	0.324
Hepsetus odoe	35	14.6	16.365	20.3	19	29.7	1037	15.8	0.281
Clarias ngamensis	11	4.6	10.145	12.6	10	15.6	269	4.1	0.141
Oreochromis macrochir	10	4.2	2.246	2.8	8	12.5	87	1.3	0.132
Schilbe intermedius	10	4.2	1.377	1.7	9	14.1	83	1.3	0.132
Clarias gariepinus	7	2.9	3.959	4.9	5	7.8	61	0.9	0.103
Serranochromis angusticeps	4	1.7	1.293	1.6	4	6.3	20	0.3	0.068
Tilapia rendalli	3	1.3	0.508	0.6	3	4.7	9	0.1	0.055
Synodontis sp.	3	1.3	0.347	0.4	3	4.7	8	0.1	0.055
Tilapia sparrmanii	3	1.3	0.317	0.4	2	3.1	5	0.1	0.055
Mormyrus lacerda	2	0.8	0.546	0.7	2	3.1	5	0.1	0.04
Synodontis nigromaculatus	2	0.8	0.434	0.5	2	3.1	4	0.1	0.04
Sargochromis codringtonii	1	0.4	0.155	0.2	1	1.6	1	0	0.023
Total	240	100	80.422	100	-	-	6552	100	1.814

Appendix 4: Comparison in relative importance (IRI) and diversity (H’) of all species caught in surveys between monofilament and multifilament gill nets (3.0 to 5.0 inch) in the Lake Liambezi in 2012. The IRI into the number (No), weight (kg) and frequency of occurrence (FRQ) of individual caught. Values are given in absolute values and percentage.

	Monofilament					Multifilament				
Species	% No	% Weight	% FRQ	% IRI	H`	% No	% Weight	% FRQ	% IRI	H`
Oreochromis andersonii	43.7	57	69.7	73.7	0.362	20.4	26	32.3	22.9	0.324
Serranochromis macrocephalus	24.3	15.6	31.7	13.3	0.344	41.7	27.1	50.8	53.3	0.365
Oreochromis macrochir	12.9	8	35.2	7.7	0.264	4.2	2.8	12.3	1.3	0.132
Hepsetus odoe	2.2	3.1	12	0.7	0.084	14.6	20.3	29.2	15.6	0.281
Schilbe intermedius	4.5	1.8	25.4	1.7	0.14	4.2	1.7	13.8	1.2	0.132
Clarias ngamensis	2.5	3.3	12	0.7	0.093	4.6	12.6	15.4	4	0.141
Clarias gariepinus	2.1	5.8	12	1	0.081	2.9	4.9	7.7	0.9	0.103
Tilapia rendalli	2.8	2.3	13.4	0.7	0.101	1.3	0.6	4.6	0.1	0.055
Sargochromis codringtonii	2.1	1.1	6.3	0.2	0.081	0.4	0.2	1.5	0	0.023
Mormyrus lacerda	1.2	1	6.3	0.1	0.051	0.8	0.7	3.1	0.1	0.04
Synodontis sp.	1.3	0.5	6.3	0.1	0.055	1.3	0.4	4.6	0.1	0.055
Serranochromis angusticeps	0.3	0.3	1.4	0	0.018	1.7	1.6	6.2	0.3	0.068
Synodontis nigromaculatus	0.2	0.1	1.4	0	0.013	0.8	0.5	3.1	0.1	0.04
Tilapia sparrmanii						1.3	0.4	3.1	0.1	0.055
Total	100	100	-	100	1.68	100	100	-	100	1.81

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Appendix 5: Comparison in relative importance (IRI) and diversity (H') of all species caught in surveys with monofilament gill net (3.0 inch) and multifilament (3.0 inch) in the Lake Liambezi between February and September 2012. The IRI into the number (No), weight (kg) and frequency of occurrence (FRQ) of individual caught. Values are given in absolute values and percentage.

	Monofilament					Multifilament				
Species	% No	% Weight	% FRQ	% IRI	H`	% No	% Weight	% FRQ	% IRI	H`
Serranochromis macrocephalus	45.6	44.8	80.6	62.8	0.358	53.3	39.3	82.6	67	0.335
Oreochromis macrochir	15.4	10.6	55.6	12.5	0.288	3.3	2.4	13	0.7	0.113
Hepsetus odoe	3.3	6.5	30.6	2.6	0.113	23.3	38.3	52.2	28.1	0.34
Oreochromis andersonii	10.4	9	47.2	7.9	0.235	0.8	0.8	4.3	0.1	0.04
Schilbe intermedius	5.9	4.1	55.6	4.8	0.168	5	3	21.7	1.5	0.15
Clarias ngamensis	4.2	8.1	33.3	3.5	0.133	3.3	5.6	13	1	0.113
Clarias gariepinus	2.4	5.4	22.2	1.5	0.09	3.3	5.8	13	1	0.113
Tilapia rendalli	3.7	2.9	27.8	1.6	0.123	0.8	0.4	4.3	0	0.04
Sargochromis codringtonii	4.2	3.5	22.2	1.5	0.133	0.8	0.5	4.3	0.1	0.04
Mormyrus lacerda	2	2.6	19.4	0.8	0.078	0.8	0.9	4.3	0.1	0.04
Synodontis sp.	1.8	1.2	13.9	0.4	0.071	0.8	0.3	4.3	0	0.04
Serranochromis angusticeps	0.7	0.9	5.6	0.1	0.033	0.8	1.1	4.3	0.1	0.04
Synodontis nigromaculatus	0.4	0.4	5.6	0	0.024	0.8	0.7	4.3	0.1	0.04

Tilapia sparrmanii						2.5	1	8.7	0.3	0.092
Total	100	100	-	100	1.846	100	100	-	100	1.536

Appendix 6: Comparison in relative importance (IRI) and diversity (H') of all species caught in surveys with monofilament gill net (3.5 inch and multifilament (3.5 inch) in the Lake Liambezi between February and September 2012. The IRI into the number (No), weight (kg) and frequency of occurrence (FRQ) of individual caught. Values are given in absolute values and percentage.

	Monofilament					Multifilament				
Species	% No	% Weight	% FRQ	% IRI	H`	% No	% Weight	% FRQ	% IRI	H`
Oreochromis andersonii	57.5	51.4	68	79.8	0.318	19.4	23.5	28.6	18.2	0.318
Serranochromis macrocephalus	8	7.8	28	4.7	0.202	44.4	37	52.4	63.2	0.36
Hepsetus odoe	5.3	12	24	4.5	0.156	8.3	16	28.6	10.3	0.207
Oreochromis macrochir	19.5	14.5	24	8.8	0.319	5.6	3.6	14.3	1.9	0.161
Clarias ngamensis	1.8	4.1	8	0.5	0.071	4.2	5	14.3	1.9	0.132
Clarias gariepinus	1.8	4.6	8	0.5	0.071	2.8	5	4.8	0.5	0.1
Schilbe intermedius	2.7	1.2	12	0.5	0.096	2.8	1.1	9.5	0.5	0.1
Tilapia rendalli	1.8	1.6	8	0.3	0.071	2.8	1.6	9.5	0.6	0.1
Mormyrus lacerda	1.8	2.8	8	0.4	0.071	1.4	1.2	4.8	0.2	0.059
Serranochromis angusticeps						4.2	4	14.3	1.7	0.132
Synodontis sp.						2.8	1.1	9.5	0.5	0.1
Synodontis nigromaculatus						1.4	0.9	4.8	0.2	0.059
Total	100	100	-	100	1.376	100	100	-	100	1.828

Appendix 7: Comparison in relative importance (IRI) and (H') of all species caught in surveys with monofilament gill net (4.0 inch and multifilament (4.0 inch) in the Lake Liambezi between February and September 2012. The IRI into the number (No), weight (kg) and frequency of occurrence (FRQ) of individual caught. Values are given in absolute values and percentage.

	Monofilament					Multifilament				
Species	% No	% Weight	% FRQ	% IRI	H`	% No	% Weight	% FRQ	% IRI	H`
Oreochromis andersonii	77.3	81.7	85.7	94.5	0.199	50	60.1	66.7	57.8	0.347
Oreochromis macrochir	8.3	6.4	35.7	3.6	0.206	33.3	37.3	66.7	37.1	0.366
Serranochromis macrocephalus	6.1	4.9	10.7	0.8	0.17					
Schilbe intermedius	2.2	0.9	14.3	0.3	0.084	16.7	2.7	33.3	5.1	0.299
Tilapia rendalli	2.2	2.2	10.7	0.3	0.084					
Clarias ngamensis	1.7	2.1	10.7	0.3	0.068					
Synodontis sp.	1.1	0.3	7.1	0.1	0.05					
Clarias gariepinus	0.6	1.3	3.6	0	0.029					
Sargochromis codringtonii	0.6	0.2	3.6	0	0.029					
Total	100	100	-	100	0.919	100	100	-	100	1.011

Appendix 8: Comparison in relative importance (IRI) and diversity (H') of all species caught in surveys with monofilament gill net (4.5 inch and multifilament (4.5 inch) in the Lake Liambezi between February and September 2012. The IRI into the number (No), weight (kg) and frequency of occurrence (FRQ) of individual caught. Values are given in absolute values and percentage.

	Monofilament					Multifilament				
Species	% No	% Weight	% FRQ	% IRI	H`	% No	% Weight	% FRQ	% IRI	H`
Oreochromis andersonii	76.4	84.3	84	92.5	0.205	83.8	67.5	80	95.9	0.148
Oreochromis macrochir	10.6	8.3	40	5.2	0.238					
Schilbe intermedius	5.7	0.8	28	1.2	0.163					
Tilapia rendalli	3.3	3.9	16	0.8	0.111					
Clarias ngamensis						5.4	23.4	13.3	3	0.158
Serranochromis macrocephalus	1.6	0.9	8	0.1	0.067	5.4	2	6.7	0.4	0.158
Clarias gariepinus	0.8	1.5	4	0.1	0.039	2.7	4.6	6.7	0.4	0.098
Synodontis sp.	1.6	0.3	8	0.1	0.067					
Hepsetus odoe						2.7	2.4	6.7	0.3	0.098
Total	100	100	-	100	0.891	100	100	-	100	0.659

Appendix 9: Comparison in relative importance (IRI) and diversity (H’) of all species caught in surveys with monofilament gill net (5.0 inch and multifilament (5.0 inch) in the Lake Liambezi between February and September 2012. The IRI into the number (No), weight (kg) and frequency of occurrence (FRQ) of individual caught. Values are given in absolute values and percentage.

	Monofilament					Multifilament				
Species	% No	% Weight	% FRQ	% IRI	H`	% No	% Weight	% FRQ	% IRI	H`
Oreochromis andersonii	84.5	79.9	82.6	95.7	0.142					
Clarias gariepinus	6	16.2	21.7	3.4	0.168					
Serranochromis macrocephalus	3.6	1	8.7	0.3	0.119	40	11.7	66.7	27.6	0.367
Oreochromis macrochir	3.6	2.3	13	0.5	0.119					
Clarias ngamensis						40	83.5	66.7	65.8	0.367
Schilbe intermedius	2.4	0.6	4.3	0.1	0.089	20	4.8	33.3	6.6	0.322
Total	100	100	-	100	0.637	100	100	-	100	1.055

Appendix 10: Comparison in relative importance (IRI) of all species caught in surveys with experimental gears and gillnets in the Lake Liambezi between August 2010 and September 2012. The IRI into the number (No), weight (kg) and frequency of occurrence (FRQ) of individual caught. Values are given in percentage.

	Experimental Gear catch composition (%), by Richard Pillar				**Fishermen catch composition (%)**			
Species	% No	% Weight	% FRQ	% IRI	%No	% Weight	%FRQ	%IRI
Mormyridae								
Mormyrus lacerda	0	0.2	8.9	0.1	1.1	1	5.3	0.1
Marcusenius altisambesi	1.8	4	84.4	2.9				
Petrocephalus catostoma	3.8	1.5	93.3	2.66				
Pollimyrus castelnaui	0.1	0	15.6	0.05				
Cyprinidae								
Barbus barnardi	0	0	8.9	0.01				
Barbus bifrenatus	0.1	0	22.2	0.03				
Barbus paludinosus	0.3	0.1	53.3	0.2				
Barbus poechii	0.5	0.2	60	0.35				
Barbus radiates	0.8	0.2	77.8	0.48				
Barbus unitaeniatus	0	0	8.9	0.01				
Labeo cylindricus	0.1	0.1	20	0.09				
Characidae								
Brycinus lateralis	67.1	38.7	100	52.86				
Micralestes acutidens	0	0	4.4	0.03				
Rhabdalestes maunensis	10.8	1.1	84.4	5.95				
Hepsetidae								
Hepsetus odoe	0.1	1.7	26.7	0.9	4.7	6.4	17.4	2.4
Schilbeidae								
Schilbe intermedius	10.4	38.9	100	24.63	4.4	1.8	21.7	1.7
Clariidae								

Clarias gariepinus	0.1	3.3	28.9	1.67	2.3	5.6	10.6	1
Clarias ngamensis	0	0.8	13.3	0.42	2.9	5.1	13	1.3
Mochokidae								
Synodontis nigromaculatus	0	0.1	8.9	0.07	0.3	0.2	1.9	0
Synodontis sp.	0.5	1.1	62.2	0.83	1.3	0.5	5.8	0.1
Cichlidae								
Oreochromis andersonii	0.1	0.7	28.9	0.42	39	51.1	58	64.9
Oreochromis macrochir	0.1	0.5	20	0.26	11.1	7	28	6.3
Pharyngochromis acuticeps	0.6	0.7	77.8	0.65				
Pseudocrenilabrus philander	0.4	0.1	62.2	0.25				
Sargochromis carlottae	0	0.1	6.7	0.04				
Sargochromis codringtonii	0.1	0.6	28.9	0.34	1.8	0.9	4.8	0.2
Serranochromis angusticeps					0.6	0.5	2.9	0
Serranochromis macrocephalus	0.3	2.2	66.7	1.25	27.8	17.8	37.7	21.3
Tilapia rendalli	0.2	0.4	42.2	0.29	2.5	1.9	10.6	0.6
Tilapia sparrmanii	1.9	2.6	97.8	2.25	0.3	0.1	1	0

Appendix 11: Catches in percentage number and weight from lake Liambezi in the sampling period of 1975-76 (experimental gear), 2001 (experimental gear), 2010-2011 (experimental gear) and 2012 (Fisherman gear)

	Experimental Gear		Fisherman Gear		2001 Experimental gear		Van der Waal (1975-76)	
Species	% NO	%Weight	%NO	%Weight	%NO	%Weight	%NO	%Weight
Barbus paludinosus	0.3	0.1			44.2	16.9		
Barbus poechii	O.5	0.2			18.2	9.9	0.6	0
Schilbe intermedius	10.4	38.9	4.4	1.8	6.1	16.1	30.5	19.7
Brycinus Lateralis	67.1	38.7			21.1	10.7	0.7	0
Clarias gariepinus	0.1	3.3	2.3	5.6	0.7	18.6	1.4	9.9
Marcusenius macrolepidotus					2.9	6.9	22.1	13.9
Oreochromis andersonii	0.1	0.7	39	51.1	1.2	5.6	2.9	11.7
Tilapia sparrmanii	1.9	2.6	0.3	0.1	2.1	3.7	1.2	1.9
Serranochromis macrocephalus	0.3	2.2	27.8	17.8	0.6	7.2	3.2	4.7
Ctenopoma multispine					1.3	1.3		
Pharyngochromis acuticeps	0.6	0.7			0.4	0.7	0.9	0
Labeo cylindricus	0.1	0.1			0.5	0.6		
Clarias ngamensis	0	0.8	2.9	5.1	0.1	1	1	3.8
Pollimyrus	0.1	0			0.3	0.1		

castelnaui								
Mormyrus lacerda	0	0.2	1.1	1	0.1	0.7	0	0.2
Petrocephalus catostoma	3.8	1.5			0.2	0	5.3	0.3
Pseudocrenilabrus philander	0.4	0.1			0.1	0		
Synodontis woosnami							14.6	11.6
Hepsetus Odoe	0.1	1.7	4.7	6.4			2.9	5.5
Oreochromis macrochir	0.1	0.5	11.1	7			2.7	7.4
Synodontis macrostigma							3.7	1.7
Serranochromis angusticeps			0.6	0.5			1.1	2.2
Tilapia rendalli	0.2	0.4	2.5	1.9			1	1.9
Sargochromis codringtonii	0.1	0.6	1.8	0.9			1	1.2
Synodontis nigromaculatus	0	0.1	0.3	0.2			1.3	1.3
Serranochromis Longimanus							0.7	0.6
Sargochromis giardi							0.4	0.7
Serranochromis thumbergi							0.3	0.4
Sargochromis carlottae	0	0.1					0.1	0.1
Hydrocinus vittatus							0	0.6
Serranochromis robustus							0	0.1
Synodontis sp.	0.5	1.1	1.3	0.5			0.3	0.2
Barbus radiatus							0	0
Marcusenius	1.8	4						

altisambesi								
Barbus barnardi	0	0						
Barbus bifrenatus	0.1	0						
Barbus unitaeniatus	0	0						
Micralestes acutidens	0	0						
Rhabdalestes maunensis	10.8	1.1						

Appendix 12: Food chain analysis (Fishermen gill net data) percentage number and weight of piscivores, herbivores, invertivores and omnivores

Trophic level	February		April		June		July		September	
	%No	%W	%No	%W	%No	%W	%No	%W	%No	%W
Piscivores	28.1	25.8	23.6	19.5	56.7	42.5	41.7	38.3	31.2	20.2
Herbivores	56.4	55.9	57.9	60	33.3	47.4	41.7	44.1	56.3	67.2
Omnivores	9.6	6.1	9.7	3.8	8.2	4.2	13.9	15.9	8	10.5
Invertivores	5.9	12.3	8.7	16.7	1.8	6	2.8	1.8	4.3	2

Appendix 13: Food chain analysis (Experimental gear data) percentage numbers of piscivores, herbivores, invertivores and omnivores, data obtain for 2001, 2005, 2007 and 2011 respectively.

Trophic level	2001		2005		2007		2010 to 2011	
	%No	%Weight	%No	%Weight	%No	%Weight	%No	%Weight
Piscivores	0.6	7.2	0	0	0	0.4	0.4	3.9
Herbivores	3.8	9.9	0.1	2	0.3	0.8	2.4	4.3
Omnivores	27.1	27.8	4.4	21	7.8	18.6	78	79.6
Invertivores	68.4	55.1	95.3	76.7	91.6	80.2	17.6	8.1

Appendix 14: Percentage catches of each mesh size (Fishermen gill net), for February, April, June, July, September, 2012

Mesh sizes	Mono 3.0	Mono 3.5	Mono 4.0	Mono 4.5	Mono 5.0	Multi 3.0	Multi 3.5	Multi 4.0	Multi 4.5	Multi 5.0
% catch	37.99	9.46	15.15	10.29	7.03	10.04	6.03	0.5	3.1	0.42