Addis Ababa University

College of Natural and Computational Sciences

Department of Zoological Sciences

Species composition, relative abundance and socio-economic value of fishes in Ribb and Gumara River, eastern Lake Tana

A thesis submitted to the Department of Zoological Sciences, College of Natural and Computational Sciences, Addis Ababa University, in Partial Fulfillment of the Requirement for the Degree of Master of Science in General Biology.

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Declaration

This is to certify that this thesis entitled "Species composition, relative abundance and socio-economic value of fishes in Ribb and Gumara River, eastern part of Lake Tana" submitted in partial fulfillment of the requirements of Degree of Master of Science in General Biology to the Graduate Program of the Department of Zoological Sciences, College of Natural and Computational Sciences, Addis Ababa University by Yeshizerf Shumye Kokeb (ID. No. GSK/0882/2004) is an authentic work carried out by her under my guidance. The matter embodied in this thesis has not been submitted earlier for award of any degree or diploma to the best of our knowledge.

Yeshizerf Shumye _____ _____

Signature Date

Dr. Abebe Getahun (advisor) _____ _____

Signature Date

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Abbreviations:

ET	Ethiopian birr
FPME	Fish production and marketing enterprise (Ethiopia)
LFDP	Lake fisheries development project
LTFDP	Lake Tana development program (Ethiopia)
MoA	Ministry of Agriculture
NGO	Non- Governmental Organization

ABSTRACT

This study was carried out in the eastern part of Lake Tana (Fogera Woreda) covering both post-rainy and dry seasons, from October 2015 to April 2016, with the objective to identify and assess species composition, relative abundance, socio-economic and marketing system of fish and fisheries in that locality. Field sampling, personal observation, structured questionnaire and interview were employed. Shannon diversity index was used to compare species diversity in all sampling sites between seasons. Correlation analysis and paired T- test were used to test species composition and abundance between seasons. Descriptive analysis and two ways ANOVA were used to analyze the collected data. Generally eight fish species were identified and Cyprinidae are the dominate one. Species composition of the fishes during the post- rainy and dry seasons was different. Mean Shannon diversity index showed highest H' value (1.06) in dry than post-rainy (1.04) season. The relative abundance score of species during the post-rainy and dry seasons was variable in all sampling sites and in dry season higher numbers of species were recorded (114). However, the most abundant species was *Labeobarbus crassibarbus* in weight (43.1) and *Labeobarbus intermedius* (46.7%) in number. Relation of fishing categories to boat and daily catch was analyzed by two way ANOVA and daily catch of fishers to the type of boat showed a significant difference ($P<0.05$). The fish price was influenced by marketing site, season and demand of customers. The Univariance analysis showed that there is significant difference ($P<0.05$) in price around landing site and Woreta city as well as in fasting and none fasting

periods. The finding of this thesis indicated that, training on fishing management, availability of infrastructure (road), access to credit and minimizing illegal fishing would promote effective fish resource utilization and sustainable market.

Keywords: Fish price, Gumara River, Lake Tana, Relative abundance, Ribb River, Socio-Economics, Species composition.

CHAPTER ONE

1. Introduction

Fishes are important elements in the economy of many nations as they have been essential components in the diet of many people for a long period of time. Food system of most Ethiopians depends on cereals, although Ethiopia has high aquatic resources which haven't been exploited properly. Therefore, it's necessary to use our aquatic resources especially fish, for our nutrition because the fishery resources are an inexpensive source of animal protein (Shibru Tedla, 1973; Tesfaye Wudneh, 1998). Ethiopia has a number of lakes that support a variety of fish species and one of these is Lake Tana, which is the largest lake in the country with a total surface area of 3200 km^2 (De Graaf *et al*., 2010) .

Lake Tana is found in the north- western part of Ethiopia with high production potential and diversity of fish fauna with a unique fish species including the Families Cichlidae, Clariidae and Cyprinidae. Both families of Cichlidae and Clariidae are represented by only one species: *Oreochromis niloticus* and *Clarias gariepinus*, respectively. On the other hand the family Cyprinidae is represented by four genera: *Barbus* (Eshete Dejen *et al*., 2003), *Garra* (Abebe Getahun. 2000), *Labeobarbus* (Negelkerke & Sibbing, 1996, 2000) and *Varicorhinus*.

Fogera Woreda (district) is one of the ten Woredas bordering Lake Tana and is found in South Gondar Administrative Zone. Fogera floodplains are the largest wetlands of the country and border Lake Tana in the eastern part. Welala and Shesher wetlands are located in the Fogera floodplain and contribute the most to the fish diversity and existence next to Ribb and Gumara tributary rivers. Ribb River is one of the inflow water sources of Fogera flood plains and Lake

Tana, which originates from Gunna Mountains, at an altitude of above 3000m and has a length of 130 km and drainage area of about 1790 km^2 (RIDP ESIA. 2010). In its lower and middle reaches, the river flows over the extensive alluvial Fogera Floodplains. The river meanders and flows slowly over this floodplain, and this resulted in river channel deposition, overflowing of riverbanks and charging water to Welala and Shesher during the rainy season.

1.1. Fishing activity in Fogera Woreda

The fishery resource has significant socio-economic contribution through generating income, employment and used as a cheap protein source for local people in developing countries including Ethiopia (Sewmehon Demissie, 2003). Similarly in Fogera Woreda, the fishery activity has been of critical importance to the local economy and to the social well-being of communities and provides a vital source of food. The fishing activity of Fogera is grouped into two, regular and seasonal depending on seasonal rivers, ponds and shore of Lake Tana. Nabega and Wagetera kebele fishermen collect fishes predominantly in wet and dry seasons whereas Shina, Bebekis and Abakiros kebele fishermen collect fishes only in wet season. Fishermen in that locality largely uses two types of fishing boats (Motorized and reed boat), and most of the fishermen were use monofilament gillnet were as some illegal fishermen (fishermen they were used un recommended gillnet) use under sized gillnet which export from Sudan (Gelabat) market and use some posing material like birbirra tree (Naglkerke and Sibbing 1996).

1.2 Research questions and objectives

1.2.1 Research questions

The following research questions were formulated before the initiation of data collection.

1. What is the species composition and relative abundance of fishes in eastern part of Lake Tana (Ribb and Gumara Rivers)?
2. What are the fishing categories, fishing boats and marketing system of the fisheries in Fogera Woreda?
3. How are the fishing boats and categories related to the income and daily catch of fishers?

1.2.1 Objectives of the study

1.2.2 General objective

The general objective of this research is to assess the status of fish and fisheries on the eastern part of Lake Tana for proper management of the fisheries.

1.2.2.1 Specific objectives

- To assess the species composition and estimate relative abundance of fishes in the eastern part of the lake in Gumara and Ribb Rivers.
- To assess the socio- economic value and marketing of fish in Fogera Woreda.

1.3. Arrangement of the thesis

This thesis was organized in five chapters. The first chapter deals with the introduction and description of the objective of the study. The second chapter deals with the literature review including the species diversity, relative abundance of fish and the socio economic, marketing and fishing system of eastern part of Lake Tana. The third chapter describes the research method (sampling techniques, data collection, analysis and interpretation of data). The fourth chapter is about results and discussion. Finally, the fifth chapter closes with conclusions & recommendations.

CHAPTER TWO

2. REVIEW OF RELATED LITERATURE

2.1 Composition and relative abundance of fish

Lake Tana which is found in the north-western highlands of Ethiopia contains three main families of fish: Cichlidae, Clariidae and Cyprinidae. Cichlidae and Clariidae are represented by single species each: *Oreochromis niloticus* and *Clarias gariepinus*, respectively. The largest family, however, is Cyprinidae and it is represented by four genera:

-***Barbus***: represented by three species: *B. humilis, B. pleurograma* and *B. tanapelagius* (Eshete Dejen *et al*., 2003)

-***Garra***: represented by four species: *G. dembecha, G. tana, G. regressus* and *G.* small mouth (unidentified species) (Abebe Getahun, 2000).

-***Labeobarbus****:* which is the most abundant genus of the family and consists of 15 species forming a unique species flock in Lake Tana (Nagelkerke and Sibbing, 1996, 2000)

-***Varicorhinus:*** represented by one species, *V. beso*

The family Cyprinidae is the most widespread and has the highest diversity (>2000 species) among all freshwater fish families and even among vertebrates (Nelson, 1994). Although cyprinid fishes are the most abundant fishes throughout the world's freshwater systems, the *Labeobarbus* species of Lake Tana became the only remaining intact species flock of large cyprinid fishes, after the one in Lake Lanao in the Philippines, has practically disappeared because of anthropogenic activities (Kornfield and Carpenter, 1984).

The *Labeobarbus* species of Lake Tana had been previously classified under the genus *Barbus*, by adding the prefix 'large'. However, large, diverse, hexaploid African *Barbus* are renamed as *Labeobarbus* (Berrebi and Tsigenopoulos, 2003; Snoeks, 2004). The larger species of the genus *Barbus* of Lake Tana include several distinct morphological varieties. Based on morphological appearance of the fish, local names such as 'gobit', 'afe-dist', 'afe-muti', 'lonte' which means respectively 'big hunch', 'big-mouth', 'pointed mouth', 'big lip', are used to identify the different types (de Graaf *et al*., 2004).

Apart from *Labeobarbus* species, *Clarias gariepinus*, and *Oreochromis niloticus* contribute to the majority of the catches. Traditional fishermen mainly catch *O. niloticus* and the smaller sizes of *L. tsanensi*s, *L. surkis* and a few other species inhabiting the littoral zone. *Oreochromis niloticus* is most abundant in the shallow littoral zone, while *C. gariepinus* and the piscivorous *Labeobarbus* species are found mainly in the deeper open water areas of the lake. These larger species are mainly exploited by the motorized boat fishery. The catch from the reed boat fishery, confined to the littoral zone, consists mainly of *O. niloticus* and *L. tsanensis*. The breeding activity of all major species is associated with the rainy period and increase in Lake water level (de Graf et al., 2005). *Clarias. gariepinus* has a short breeding period in July whereas *O. niloticus* and *L. tsanensis* show extended activity with peak breeding during July and September-October, respectively. They are fully recruited to the fishery at 2 - 4 years of age well beyond the age of maturity. During the breeding period a higher catch rate is observed for *Labeobarbus* species. The sustainable potential yield of 32 kg /ha/yr estimated for the Bahir Dar Gulf area. The shortage in fish storage, distribution and marketing facilities, the limited local market and lack of fishing tradition are major constraints to the development of the fishery (Sewmehon Demissie. 2003).

2.2 Fishing activity of Lake Tana

Lake Tana supports a large fishing industry, mainly based on the large *Labeobarbus* species, Nile tilapia (*O. niloticus*) and African catfish (*C. gariepinus)*. Before 1986, Lake Tana fisheries was composed of two predominantly subsistence traditional fisheries. The first is a subsistence papyrus reed boat fishery, operated by the Woito people and the other poor members of the communities gradually adopted the activity. This type of fishery is limited to the shore areas and targets the native *O. niloticus* using locally made fish traps and small gillnets (length 15-20 m). Secondly, seasonal fishermen (farmers) traditionally target *Labeobarbus* on the upstream spawning grounds between August and October each year. These seasonal fishermen use a variety of fishing techniques like barriers, basket traps, hooks, scoop nets and even poisoning of the shallow water upstream using the dried and crushed seeds of the Birberra tree (Nagelkerke and Sibbing 1996). This seasonal fishery has been occurring for at least 200 years, and most probably for hundreds of years more, as fishing with poison was already observed and described around 1770 by the Scottish explorer James Bruce during his travels around Lake Tana (Moorhead, 1962).

The lake fisheries in Lake Tana is clearly very important to the local population, employing more than 6,000 people in fishing, marketing, and processing (Aytegeb Anteneh. 2013). Traditionally, fisheries in Lake Tana consisted of papyrus reed boats, which are produced locally available papyrus, which grows around the south-western part of Lake Tana at a low cost and with a two-year life span. Their carrying capacity, lower durability and smaller size made the reed boats inefficient as seen and compared to the physical condition of the lake. Based on the above fact,

the number of crew per trip in the reed boat is limited to be one and all reed boat fishermen do not go for fishing far from the shore of the lake (Chalachew Aragaw, 2010).

In 1986 motorized boats and modern, nylon gillnets were introduced as part of the Lake Tana Fisheries Resources Development Program (LFDP), which was EU sponsored and initiated by the Ethiopian Ministry of Agriculture, the Ethiopian Orthodox Church and two Dutch NGOs (ISE-Urk and ICCO-Zeist). This created new opportunities for the fishermen, extending their fishing area from the shore to deeper, offshore waters and, more importantly, to distant river mouths and to fulfill the increasing demand for fish from Addis Ababa (Reyntjes and Tesfaye Wudeneh, 1998).

The social and economic importance of fish production in the region can be explained by the different types of producers engaged in fishing. Based on their fishing methods and their purpose of fishing, fish producers around Lake Tana can be categorized into two major groups. These are: indigenous people who catch fish using traditional fishing gears that are used primarily for household consumptions, and formal and informal co-operatives who catch fish using relatively modern methods and equipment and supply their products to the near-by markets. The commercial gillnet fishery of Lake Tana is known to have developed rapidly, total catches increasing from 39 MT in 1987 to 360 MT in 1997 (Tesfaye Wudneh, 1998). Similarly fishery on *Labeobarbus* species is highly seasonal and mainly targets the spawning aggregations, as more than 50% of the annual catch is obtained in the river mouths during August and September (de Graaf *et al*., 2006).

While the catch size of all species has fallen, recruitment of tilapia and catfish seems unaffected. However, recruitment of the *Labeobarbus* species has fallen by 75 % in 10 years time (MoAR,

2004). The major cause appears to be the destructive fishing at the river mouths while the fish are in their way to their spawning grounds upstream (Abebe Ameha, 2004). The boats currently number 400 reed boats and 25 motorized boats (Brook Lemma, 2012). The reed boat fisheries account for about 40 %, whereas the motorized fishery comprises about 60 % of the catch (Sewmehon Demissie. 2003). There are also seasonal fishermen with minimal contribution to the catch.

2.3. Marketing and Distribution of Fish

The Ethiopian domestic fish consumption pattern at and around water bodies is no different from what is observed globally. People with frequent contact with water bodies understand the value of fish as food (Brook Lemma, 2012). In Bahir Dar there are three main suppliers of the Lake Tana fish product. Roughly 15% of the supplies from the Fish Production and Marketing Enterprise (FPME) go to the local market and nearby town. FPME is the main supplier of fish from Lake Tana to Addis Ababa. An estimated 40% of the fish handled by FPME nationally is sourced from Lake Tana. This represents about 600–700 tons. The main source of FPME supplier is Tana Haik number one Fishing Cooperative This cooperative estimated that 45% of its catch is sold on local market (Aytegeb Anteneh, 2013). A local trader organization named “Saint Georg”, with a collector boat, has been known to sell estimated 40% of the catch principally to local restaurants and hotels including those in the small towns north of Bahir Dar and Gondar (Aytegeb Anteneh, 2013). The urban fish market is highly grown and has recently seen the opening of new retail outlets. The price of fish varies by fish species, type of product and place of market (Sewmehon Demissie, 2003). Seasonal pattern of fish consumption affects fish marketing around Lake Tana.

Consumption of fish varies in intensity both in a year, month and a week, influenced by various factors (tradition, habits, and religious customs). Consumption varies during some months of the year, as well as some days of the week. For example, most of the Orthodox Christians in Amhara Region do not eat any animal protein during the major fasting days including Wednesdays and Fridays (Sewmehon Demissie, 2003). Lake Tana has more than eight fish landing sites, all of them are not officially recognized and hence illegal fishing takes place at these sites.

CHAPTER THREE

3. MATERIALS AND METHODS

3.1. Description of the study area

Lake Tana, is the largest lake in Ethiopia with an area of about 3200 km^2, it is located in the northwestern highlands of Ethiopia at an altitude of about 1800 m with an average depth of 8 m and maximum depth of 14 m and it is the only source of the Blue Nile River and constitutes almost half of the freshwater bodies of the country (Reyntjes and Tesfaye Wudneh 1998; de Graaf *et al*., 2004).

Fogera Woreda is one of the ten Woredas bordering Lake Tana and is found in South Gondar Administrative Zone. It is located at 11°58′00″ N latitude and 37°41′00″E longitude. Woreta, capital of the Fogera Woreda, is found 620 km from Addis Ababa and 55 km from Bahir Dar. To its west, the woreda comprises a plain that floods by water from the lake during the rains, making it an important and extensive wetland area. The woreda is drained by two main rivers, one on its northern border with the next woreda (Ribb River) and the other in the south (Gumera River). The population of the woreda is 26,317. Ribb and Gumara Rivers are two of the seven most significant inflow waters of Lake Tana and they are located on the eastern part of the lake (Fig 1). Ribb River originates from Guna Mountain in south Gondar and flows in to Lake Tana across Addis Zemen and Fogera Woreda.

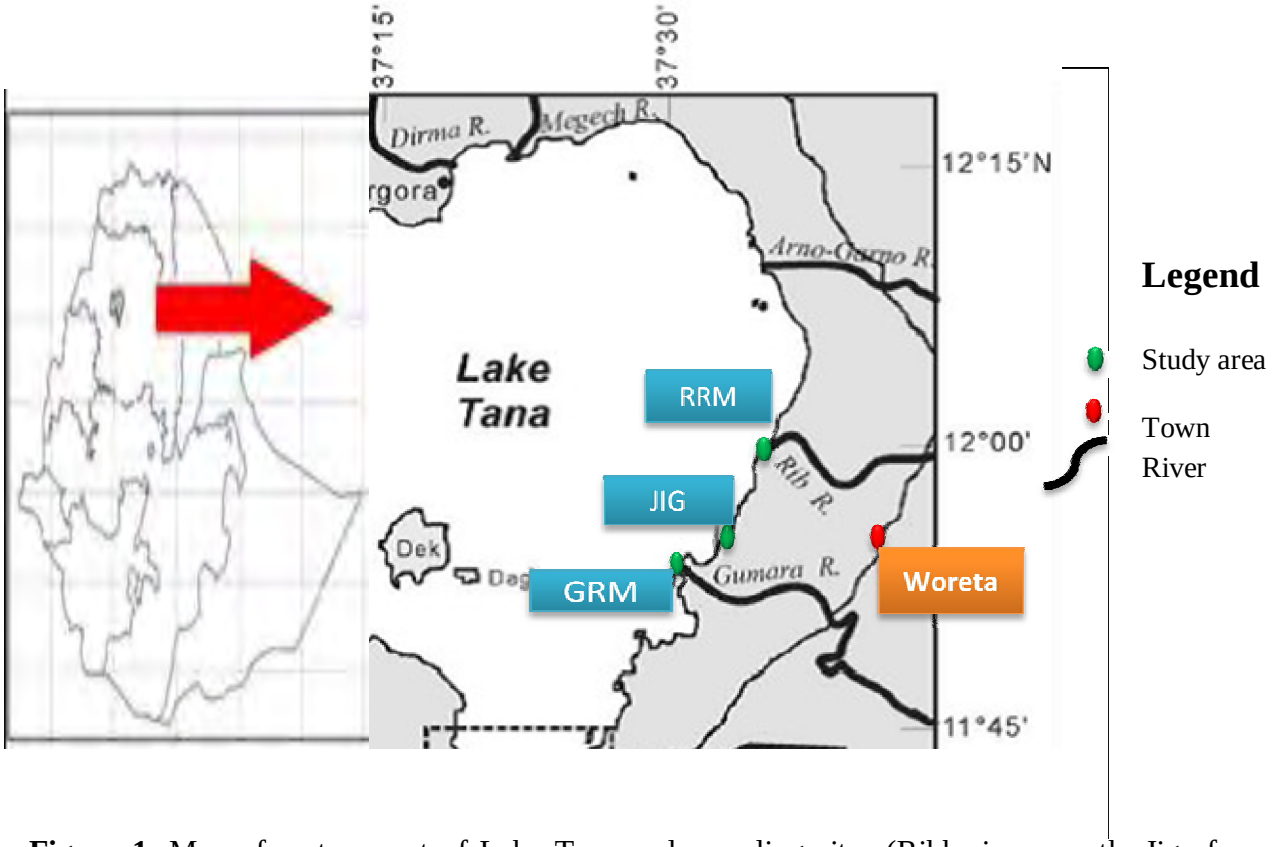

Figure 1. Map of eastern part of Lake Tana and sampling sites (Ribb river mouth, Jigerfa and Gumara river mouth) after Abebe Ameha, (2004).

3.2 Study methodology and approach

3.2.1 Data Collection

This study was conducted at the eastern part of Lake Tana, It involved gathering information; both primary and secondary, to find information on the current fish species composition, relative abundance and socio-economic status of the fisheries. Primary data were generated from field sampling, observation, interviews and questionnaires. Data were collected from the beneficiaries and fishers operating with motorized and papyrus boats. Fishing gears types and sizes were assessed at the fish landing sites. Data were analyzed using statistical software (SPSS version 16) and descriptive statistics.

3.2.2 Field sampling

Three sampling sites were selected (Gumara River mouth, Jigerfa and Ribb River mouth) based on the fishing activity and availability of fishes. The sampling sites are listed with their GPS location, Temperature and pH (Table 1). Data collection was carried out from October 2015 to April 2016 in two seasons, the post-rainy (October and December) season and dry season (February and April) in each site. Each sample was sampled 4 times (2 times in post-rainy and 2 times in dry months within 2 days) from all of sites including from the river mouths. Multifilament gill nets of 6, 8, 10 and 14 cm stretched mesh, having a length of 25 m and depth of 1.5 m were used to sample fish**.** Gill nets were set at the river mouth at an average depth of 1.2-2.8 m overnight. Fish species were identified after capture at the landing sites and their weight was taken on daily basis using a sensitive balance. Fish were identified to species level by experienced technical assistant from the laboratory of Bahir Dar Fisheries and Other Aquatic Life Research Center. The type and the number of individual species were recorded using direct observation. Photographs and videos were taken to justify the species type for those species which were difficult to identify.

Table 1. Sampling sites, depth, T^o and pH and coordinates (GPS).

Sampling sites	Code	Average Depth	Average T^o	Average pH	Coordinate (GPS)
Gumara River mouth	GRM	1.2m	24.3^{o}c	7.47	11^{o}53'N and 37^{o}31'E
Jigerfa	JIG	2.68	24.47^{o}c	7.23	11^{o}54'N and 37^{o}32'E
Ribb River mouth	RRM	1.6m	24.01^{o}c	7.02	11^{o}59'N and 37^{o}35'E

3.3. Relative abundance

Relative abundance is the number of organisms of a particular kind as a percentage of the total number of organisms of a given area or community (Kolding, 1999). Estimation of relative abundance of fishes in Gumara and Rib Rivers was made by taking the contribution in number and biomass of each species in the total catch for each sampling effort. An Index of Relative Importance (IRI) has been used to evaluate relative abundance. IRI is a measure of the relative abundance or commonness of the species based on number and weight of individuals in catches, as well as their frequency of occurrence (Kolding, 1989; 1999). IRI was used to find the most important species in terms of number, weight and frequency of occurrence in the catches from the different sampling localities. IRI gives a better representation of the ecological importance of species rather than the weight, numbers or frequency of occurrence alone (Sanyanga, 1996). Percent of IRI was calculated as follows:

$$\%\ IRI = \frac{(\%W_i + \%N_i) \times \%F_i}{\sum_{j-1}^{s-1}(\%W_j + \%N_J) \times \%F_j} \times 100$$

Where, %Wi and %Ni are percentages weight and number of each species of total catch, respectively. %Fi is a percentage frequency of occurrence of each species in total number of settings. %Wj and %Nj are percentage weight and number of total species in total catch. %Fj is percentage frequency of occurrence of total species in total number of settings.

The Shannon index of diversity (H'): H' is a measure of species weighted by the relative abundance (Begon, *et al.*, 2005, 1990). H' is calculated as follows:

$$H' = \Sigma\ pi \ln pi$$

Where, pi - the proportion of individuals in the i^{th} species. Shannon index is used to indicate diversity of fishes at different sampling sites or rivers.

3.4. Socio- economic activities of fishermen and marketing system:

Quantitative data were collected using structured questionnaires, interview and personal observation during the study period that included socio economic characteristics of the fishers types of fishing gears, fishers' boat (Fig. 2), asses the marketing chain, daily income and fishermen categories including organization into cooperatives (Appendix 1 and 2). The socio-economic and institutional characteristics of the respondents such as experience, fishing categories, daily catch, daily income, perception of fishery resource as livelihood of fishermen were analyzed.

Figure 2. Monofilament nets and boats of fishermen

3.5. Data Analysis

Descriptive statistics was used to analyze the mean value of the biomass weight during wet and dry seasons and also analyze the relation between type of boat and total catch, to category of fishermen and fishing experience of fishermen with category of fishing frequency. The significance of the differences of the relative abundance of the species during post-rainy and dry season was also analyzed. SPSS version 16.0 and Microsoft Excel sheet 2007 were used to analyze and manage the data.

CHAPTER FOUR

4. RESULTS AND DISCUSSION

4.1.1 Species composition and relative abundance

During the study period a total of eight species were identified, namely: *Labeobarbus intermedius, L. crassibarbis, L. nedgia, L. tsanensis, L. megastoma, L. truttiformis* from family Cyprinidae and *Clarias gariepinus* and *Oreochromis niloticus* from Family Clariidae and Cichlidae, respectively (Table 2). The freshwater fish fauna of the studied rivers contained East African fish forms. *Labeobarbus intermedius, C. gariepinus* and *O. niloticus* were found in most of the sampling sites in both seasons. The number of fish species was low at Jigrefa and Rib river mouth as compared to Gumara river mouth and *L. truttiformis, L. nedgia,* and *L. tsanensis* are found only in Gumara River mouth. In dry season *Labeobarbus* was totally absent in Ribb River mouth the probable reason is *Labeobarbus* species are mostly bread in the lake and adjacent floodplain wet lands (de Graaf et al., 2005), accordingly in dry season such floodplains become shrinking, and in the same season *C. gariepinus* was totally absent from Gumara river mouth (Table 2). Generally, these species are adapted to most of the sampling sites and their ubiquitous occurrences are probably due to the connection of Ribb and Gumara Rivers to Lake Tana. But from 15 endemic *Labeobarbus* species of described in Lake Tana in previous studies (de Graaf *et al*., 2008) only 6 are sampled, some of *Labeobarbus* species were not sampled from Ribb River and *C. gariepinus* was also not sampled from Gumara River mouth and this may be due to limitations of sampling date, relatively short period of sampling and selectivity of the gears used.

Table 2. Species composition and fish distribution during dry and post-rainy seasons

(NB: present, + and absent, -)

Sampling Sites	Seasons	Species							
		L. intermedius.	*L. crassibarbis*	*L. tsanensis*	*L. megastoma*	*L. nedgia*	*L. truttiformis*	*C. gariepinus*	*O. niloticus*
Gumara river mouth	Post-rainy	+	+	-	+	-	-	-	-
	Dry	+	+	+	+	+	+	-	+
Jagrefa	Post-rainy	+	-	-	+	-	-	+	+
	Dry	+	-	-	+	-	-	+	+
Ribb river mouth	Post-rainy	+	+	-	-	-	-	+	+
	Dry	-	-	-	-	-	-	+	+

Figure 3. The most abundant species from study sites (A,B,C,D,E,F from Ribb river mouth and I,II,III,IV,V from Gumara River mouth)

I. Shannon diversity index and abundance

Shannon diversity index (H') was highest at Gumara river mouth with the values of 1.33 followed by Jigrefa (H' = 1.21), Rib river mouth (H' = 0.63) during dry season (Table 3). The H' was highest at Rib river mouth with the values of H' = 1.27, followed by Jigrefa (H' = 1.05) and Gumara river mouth (H' = 0.81) during the post- rainy sampling period (Table 3). Mean Shannon diversity index (H') value was generally higher in dry season (1.06) than post-rainy season (1.04) in all the sampling sites (Table 3).

Table 3. Shannon diversity index (H') and number of fish species (N) in post rainy and dry season

Season	H'/N	Sampling Sites			
		Gumara river mouth	Jigrefa	Rib river mouth	Mean H'
Dry	H'	1.33	1.21	0.63	1.06
	N	7	4	2	4.3
Post Rainy	H'	0.81	1.05	1.27	1.04
	N	3	4	3	3.33

II. Species abundance in number

A total of 184 fish specimens were collected from all the study sites (GRM, JIG, and RRM). During the study period in all sampling sites dry season showed higher values than post- rainy season in terms of number of specimens of fishes (Table 4). Of the total specimens collected, 70 were caught during the post-rainy season and 114 specimens were caught during the dry season (Table 4). In the post-rainy season, a total number of 30 (43.5%) specimens of *L. intermedius* were collected from all the sites, which was the most abundant in terms of number. *Labeobarbus*

crassibarbis and *O. niloticus* were the second and third abundant species, respectively, while *C. gariepinus* and *L. megastoma* are the fourth abundant in number in the total catch. In the dry season, the total number of specimens of *L. intermedius* from all the sites was 56 which is 48.36% of all the specimens of the species and, therefore, is the most abundant during the dry season. The second most abundant species in number (20) in the dry season was *L. crassibarbis,* the third abundant was *O. niloticus and L. megastoma* with 10 specimens each. *Clarias gariepinus, L. nedgia* and *L. truttiform* showed the least number of specimens (6, 2, 2) respectively. The species abundance between seasons is shown in Table 4; and there was significant variation ($P < 0.05$) in abundance between post-rainy and dry seasons, know higher value were recorded in dry season (114).

Table 4. Total number of specimens of fishes in dry and post rainy seasons (GRM-Gumara River mouth, JIG- Jigerfa and RRM- Ribb River mouth)

Fish species	Post-Rainy season					Dry season					Overall	
	GRM	JIG	RRM	Total	%	GRM	JIG	RRM	Total	%	Total	%
L. intermedius	13	8	9	30	43.5	47	9	0	56	48.6	86	46.7
L. crassibarbis	7	0	6	13	18.8	20	0	0	20	17.4	33	17.9
L. tsanensis	0	0	0	0	0	8	0	0	8	6.95	8	4.3
L. megastoma	1	4	0	5	7.24	7	3	0	10	8.7	15	8.2
L. nedgia	0	0	0	0	0	2	0	0	2	1.73	2	1.1
L. truttiformis	0	0	0	0	0	2	0	0	2	1.73	2	1.1
C. gariepinus	0	1	4	5	7.24	0	2	4	6	5.2	11	5.97
O. niloticus	0	1	16	17	23.2	4	4	2	10	8.7	27	14.7
Total	**21**	**14**	**35**	**70**		**90**	**18**	**6**	**114**		**184**	

Table 5: **Paired sample T-test result between post-rainy and dry seasons species abundance**

Season	Mean	N	Std. Deviation	Mean difference	T-value	P- value
Post-rainy	8.62	8	10.555	0		
Dry	14.38	8	17.776	0		
Post-rainy* dry	11.5	8	10.757	5.76	0.24	0.002**

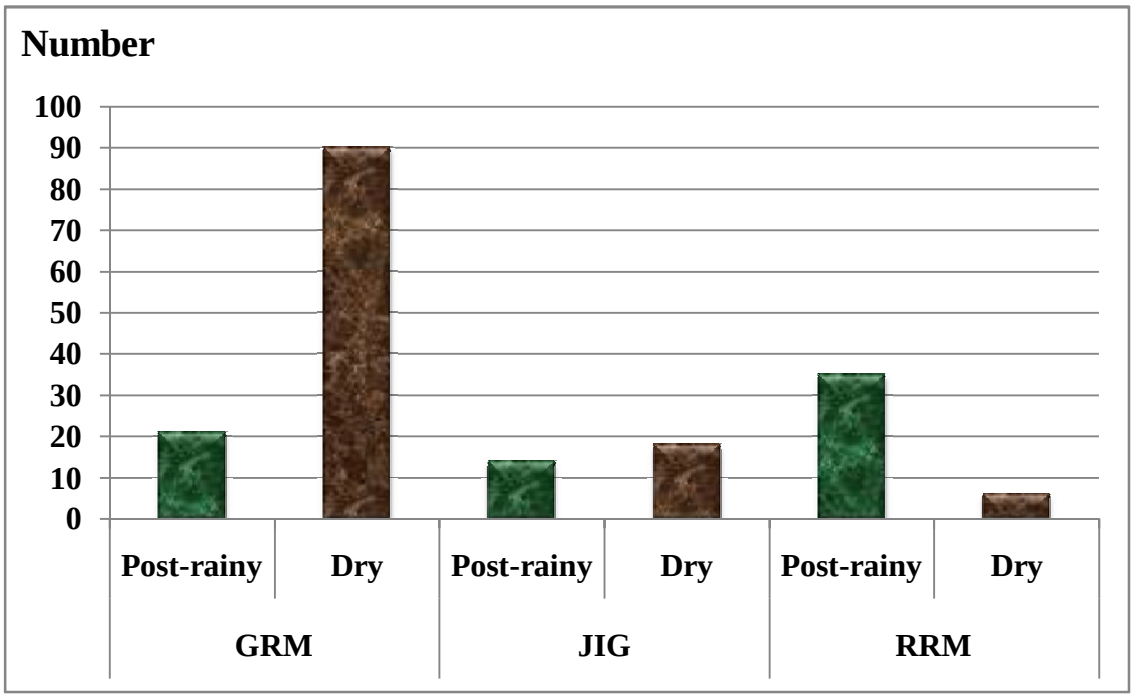

Figure 4. The number of specimens in all sampling sites between seasons (NB; GRM- Gumara River mouth, JIG- Jigerfa and RRM- Ribb River mouth).

In this study**,** the species composition was found to be similar to what has previously been described (de Graaf, 2003, Oumer *et al*., 2011) in which the fish species identified were dominated by the cyprinids. The fish species composition in dry season was higher than post-rainy season. Probably the reason of this variation could be: in post-rainy season, there is high flow of water or discharge and hence water from tributary rivers could wash the eggs that are

being laid, destroy fish habitats and the fishes become dispersed therefore, the fishes became difficult to catch. Whereas In dry season, the flow and level of water becomes low and the fishes are trapped easily in shallow pools.

However, the fish fauna of Ribb River mouth was higher in post-rainy season than in dry season and, one of the possible reasons for this high species composition is the presence of floodplain areas in Fogera Woreda as Walela and Shesher flood plains are important in increasing food rich habitats and shelter from predators, this reasons were previously presented by C.A. Mills, (1991) Moreover, such flood plains prevent eggs from being washed during high water discharge. However in dry season the two flood plains lose their natural components and the water is drained by farmers for irrigation and as a result the fish fauna reduces (Wassie Anteneh *et al*., 2008). Differences of species diversity between sampling sites vary due to, probably, river width, distance from the lake, depth and type of gillnet.

III. Species abundance in weight

During the study period a total of 62.3 kg (62280g) of fishes was sampled and of this: 29.7 kg was sampled in the post-rainy season and *L. crassibarbis* was the most abundant in GRM and RRM, which accounts for 10.3kg and 3.2kg, respectively (Table 6). In the dry season the total weight of 32.6 kg was collected from all sampling sites. During this period *L. crassibarbis* was the most abundant in GRM, which had a total weight of 13.6kg and *L. intermedius* was the second most abundant which contributes 4.6kg. In both seasons *L. crassibarbis* was the most abundant species with a total weight of 26.8kg (43.1% in the total), where as *L. intermedius* was the second which accounts to18.9% of the total weight. Significant variation was observed in the abundance in weight of fish specimens ($P<0.05$) between the two seasons.

Table 6. The species abundance in weight (in gram) (NB: GRM- Gumara River mouth, JIG- Jigerfa and RRM- Ribb River mouth)

Fish species	Post-Rainy season					Dry season					Overall	
	GRM	JIG	RRM	Total	%	GRM	JIG	RRM	Total	%	Total	%
L. intermedius	1493	1339	2570	5402	18.2	4609	1774	0	6383	19.6	11785	18.9
L. crassibarbis	10241	0	3027	13268	44.6	13576	0	0	13576	41.6	26844	43.1
L. tsanensis	0	0	0	0	0	1533	0	0	1533	4.7	1533	2.4
L. megastoma	213	1524	0	1737	5.85	1841	815	0	2656	8.1	4393	7.1
L. nedgia	0	0	0	0	0	1885	0	0	1885	5.8	1885	3
L. truttiformis	0	0	0	0	0	543	0	0	543	1.67	543	0.8
C. gariepinus	0	110	3154	3264	11	0	2988	1058	4046	12.4	7310	11.7
O. niloticus	0	1024	4989	6013	20.3	813	844	317	1974	6	7987	12.8
Total	11947	3997	13740	29684	100	24800	6421	1375	32596	100	62280	100
Mean	1493.4	499	1718			3100	802.6	171.8				

In dry season the total catch of species in weight was higher than post- rainy season, which is probably due to the decrease in the water level which brings an increase in temperature and which may ultimately promote the growth of fish and increase the production. But in Ribb River mouth the total weight of the catch was higher (17.2kg) in post-rainy season than in dry season (1.7kg). This may be because of the discharge of nutrients that occurred as a result of flow of water from Ribb River and flood plains, which can support nutrient rich habitats, availability of food and growth of fishes (Wassie Anteneh *et al*., 2008)

4.1.2. Index of Relative importance (IRI) of fish during post-rainy and dry seasons

In the present study, the catch of *Labeobarbus* in Lake Tana was higher than that of Nile tilapia and catfish (C. *gariepinus*). The species composition of all catches both in dry and post-rainy seasons ranked based on the IRI value for different sampling sites are shown in Tables 7 and 8. *Labeobarbus intermedius* was the most important fish species in post-rainy season at Gumara river mouth, Jigrefa

and Ribb river mouth with %IRI values of 13.35%, 23.58%, and 23.58%, respectively, and which is important in Gumara river mouth and Jigrefa with an IRI value of 31.4% and 32.98%, respectively, in dry season but not found in Ribb river mouth. *L. crassibarbis* was the second most important fish species in post-rainy and dry seasons at Gumara River mouth with %IRI of 85.47%, and 56.89%, respectively, and found in Ribb river mouth with IRI of 10%. The third important species is *O. niloticus,* which was found in all sampling sites during post-rainy season and found in dry season in Jigrefa and Ribb River mouth with IRI of 6% and 52%, respectively.

Table 7: Index of Relative Importance (IRI) of fishes in all sampling sites during dry season.

Sites	Fish	N	%N	W	%W	F	%F	IRI	%IRI
Gumara river mouth	*L. crassibarbis*	20	22.22	13576	54.8	5	33.33	2567.07	56.89
	L. intermedius	47	52.22	4609	18.6	3	20	1416.4	31.4
	L. tsanensis	8	8.89	1533	6.19	2	13.33	201.02	4.45
	L. megastoma	7	7.78	1841	7.43	1	7.69	116.96	2.59
	O. niloticus	4	4.44	813	3.28	2	13.33	102.67	2.27
	L. nedgia	2	2.2	1855	7.48	1	7.69	74.44	1.65
	L. truttiformis	2	2.2	543	2.19	1	7.69	33.75	0.74
	C. gariepinus	0	0	0	0	0	0	0	0
	Total	**90**	**100**	**24,770**	**100**	**15**	**100**	**4512.04**	100
Jigrefa	*L. intermedius*	9	50	1774	27.63	2	20	1552.6	32.98
	O. niloticus	4	22.22	844	13.14	4	40	1414.4	30.05
	C. gariepinus	2	11.11	2988	46.53	2	20	1152.8	24.49
	L. megastoma	3	16.66	815	12.69	2	20	587	12.47
	Total	**18**	**99.99**	**6421**	**99.99**	**10**	**100**	**4706.8**	**100**
Rib river mouth	*C. gariepinus*	4	66.67	1058	76.9	2	66.66	9570.37	83.58
	O. niloticus	2	33.33	317	23.05	1	33.33	1879.14	16.41
	L. crassibarbis	0	0	0	0	0	0	0	0
	L. intermedius	0	0	0	0	0	0	0	0
	Total	**6**	**100**	**1375**	**100**	**3**	**100**	**11449.51**	**100**

Table 8: Index of Relative Importance (IRI) of fishes in all sampling sites during post rainy season.

Sites	Fish	N	%N	W	%W	F	%F	IRI	%IRI
Gumara river mouth	*L. crassibarbis*	7	33.33	10241	85.72	4	66.66	7935.87	85.47
	L. intermedius	13	61.9	1493	12.49	1	16.66	1239.33	13.35
	L. megastoma	1	4.76	213	1.78	1	16.66	108.95	1.17
	L. nedgia	0	0	0	0	0	0	0	0
	L. truttiformis	0	0	0	0	0	0	0	0
	C. gariepinus	0	0	0	0	0	0	0	0
	O. niloticus								
	Total	**21**	**100**	**11947**	**99.99**	**6**	**100**	**9284.15**	**100**
Jigrefa	*L. intermedius*	4	28.57	1524	30.19	3	42.85	2517.86	43.83
	L. megastoma	8	57.14	1389	27.52	2	28.57	2418.73	42.11
	C. gariepinus	1	7.14	1110	21.99	1	14.28	415.97	7.24
	O. niloticus	1	7.14	1024	20.29	1	14.28	391.70	6.81
	Total	**14**	**99.99**	**5047**	**99.99**	**7**	**100**	**5744.26**	**100**
Rib river mouth	*O. niloticus*	15	44.12	4989	36.31	5	35.71	2872.15	52.48
	L. intermedius	9	26.47	2570	18.7	4	28.57	1290.50	23.58
	C. gariepinus	4	11.76	3154	22.95	3	21.42	743.48	13.58
	L. crassibarbis	6	17.64	3027	22.03	2	14.28	566.48	10.35
	Total	**34**	**99.99**	**13740**	**99.99**	**14**	**100**	**5472.61**	**100**

4.2. Marketing system and socio economic value of fish

Of the total 30 respondents, 25 were regular fishermen, 3 were part-time and 2 were occasional fishermen. 19 respondents were using motorized boats while 11 were using "Tankua'' (Papyrus reed boat). Most of the respondents were males (90%) and females were few (10%). However, there are sizable female-headed households in the community. The age range was from 18 to 45 years. Almost all fishers (both reed boat and motorized boat) fishing pressure is mainly

concentrated during the breeding season from August to October (Wassie Antenh *et al*.,2008) and on the spawning ground of each species. *Oreochromis niloticus* fishing is carried out in the littoral regions, *C. gariepinus* in flooded areas, littoral and river mouths. *Labeobarbus* is mostly targeted at river mouths and a little distance towards upstream.

In Fogera woreda there are three fishing categories: regular, part- time and occasional. The fisheries activity focuses at the mouth of the rivers in all seasons and on the rivers in post-rainy season. According to this study there are 529 fishermen who were organized in 30 associations with 15 -24 members in each and some fishers are illegal (fishermen that used un recommended gillnet. The Riverine fishing activities are minimized in dry season because the water body of Gumara and Ribb River are diverted into other agricultural values but in such tributary rivers the fishing activities are dominated by *O. niloticus* and *C. gariepinus* during rainy season (August-December). The Lake Tana fishery resource is using undersized monofilament gillnet imported from Sudan town (Gelabat) starting from 2008 (personal communication with fishers). It has become a common practice to set 5 cm up to 7 cm stretched mesh by all fishers. The fishermen collect their fishes some by motorized boats (up to 30) and largely are using Tankua (up to 42). Fishermen sell their fish at the landing sites for 15 birr per kg and sell in Woreta Town for 35 birr per kg.

I. The relation between fisher categories, boat and daily catch

According to Berihun Tefera *et al.* (2009), there are four categories of fishermen involved in Lake Tana and its feeder rivers. These are: full time (regular) fishermen, occasional fishermen, contractual fishermen and part-time fishermen. According to our observation in all sampling sites, the fishermen could be grouped into three categories: occasional, part- time and regular fishermen

and they use motorized and papyrus (Tankua) boats for fishing activities. During the sampling time all fishers use monofilament gill net. Both fishing categories and fishing boats do affect the amount of daily catch. Based on information obtained from respondents (Table 9), 56.66% of the respondents are regular fishers and use motorized boat, while 26.66% are regular fishers but use papyrus boat and the remaining 6.66% and 3.33% are part- time motorized and occasional motorized fishermen, respectively. Daily catch of fishermen is related to the type of fishing boat and there is significant difference (P=0.036) in the daily catch of fishermen between those using motorized boat and papyrus boat, whereas daily catch of fishermen is not influenced by the type of fishing and there is no significant difference (P>0.05) between fishers categories and daily catch. Similarly, the interaction of fishing boat and fishing categories (two way ANOVA) to income does not show significant difference (P>0.05).

Table 9. The relation between daily catch with fishing categories and fishing boat

Fishing type	Fishing boat	Mean daily catch /kg	Std. Deviation	N
Occasional	Motorized	21	.	1
	Tankua	2.5	.	1
	Mean	11.75	13.08	2
Part- time	Motorized	12.5	-	1
	Tankua	7.5	7.07	2
	Mean	9.17	5.77	3
Regular	Motorized	14.35	7.51	17
	Tankua	6.75	6.85	8
	Mean	11.92	8.02	25
Total	Motorized	14.61	7.26	19
	Tankua	6.5	6.29	11
	Mean	11.63	7.88	30

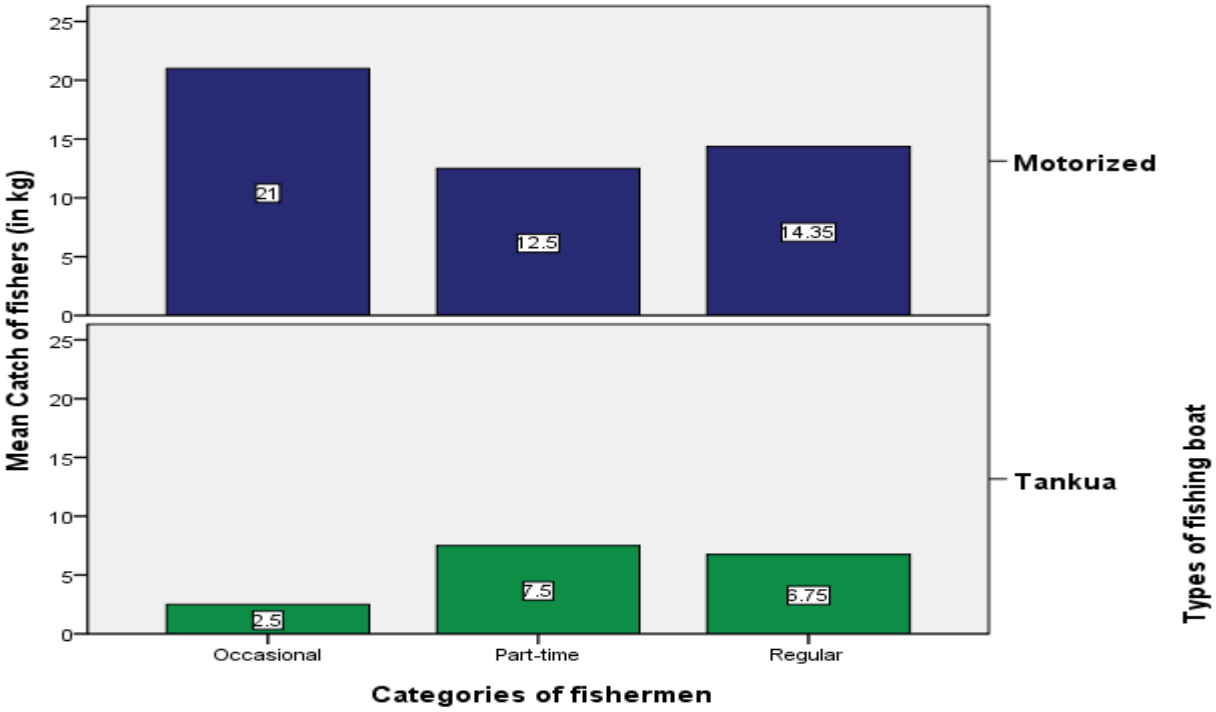

Figure 5. The relation between categories of fishermen's boat and daily catch

Fish production in the area is a major source of livelihood and income in regular and part-time fishers. In this study most respondents are regular fishers but they use Tankua and local fishing gears, which reduce the amount of the catch and, it was found that the type of boat brings significant variation in the daily catch of the different categories of fishermen. This implies that motorized fishers collect higher catch than traditional fishers and, the reason is that motorized fishers have high efficiency fishing gears and more fishing efforts and hence produce fish in all seasons. On the other hand, fishing categories did not show significant variation to daily catch. Since the daily catch appears to be dependent on fishing efficiency (type of fishing boat, fishing gear), and part-time fishers can collect more fish than regular fishers.

II. Fishing Experience, boat and daily income

The fishers have different level of experience. Of the respondents 3 years is the minimum and 18 years is the maximum fishing experience (Figure 6). 12 (40%) of them have 10 years fishing experience and a mean daily income of 250 Birr and a maximum of 500 Birr (Table 10) followed by 5years of fishing experience with a mean daily income of 200 Birr and maximum of 300 Birr (13.3%). The daily income is ranging from a minimum of 100 Birr up to a maximum of 600 Birr (Table 9 A.). The one way ANOVA indicate the daily income of fishermen related to their fishing experience ($P<0.05$) (Table 9 B.).

Table 10. The relation between fishing experience and daily income

Experience in year	N	Minimum	Maximum	Mean income per fishing day	Std. Deviation
3	1	200	200	200 ET	.
5	5	100	300	200 ET	.
6	2	400	600	500 ET	141.42
7	1	600	500	600 ET	.
8	3	300	500	383.3 ET	104.08
10	12	100	350	250 ET	124.31
12	1	350	200	350 ET	.
13	1	200	350	200 ET	.
15	2	300	400	325 ET	35.35
16	1	400	150	400 ET	.
18	1	150	600	150 ET	.
Total	30	100	600	290	139.2

Table 11. One way ANOVA analysis between experience and daily income.

	Sum of Squares	df	Mean Square	F	P. value
Between Groups	324083.333	10	32408.333	2.588	.036
Within Groups	237916.667	19	12521.930		
Total	562000.000	29			

According to table 11, the result showed that the fishing experience fishermen are close to their daily income because the value of P indicate, between fishermen experience, statically significant was observed at P=0.036. However fishermen develop fishing efficiency techniques if they are experienced.

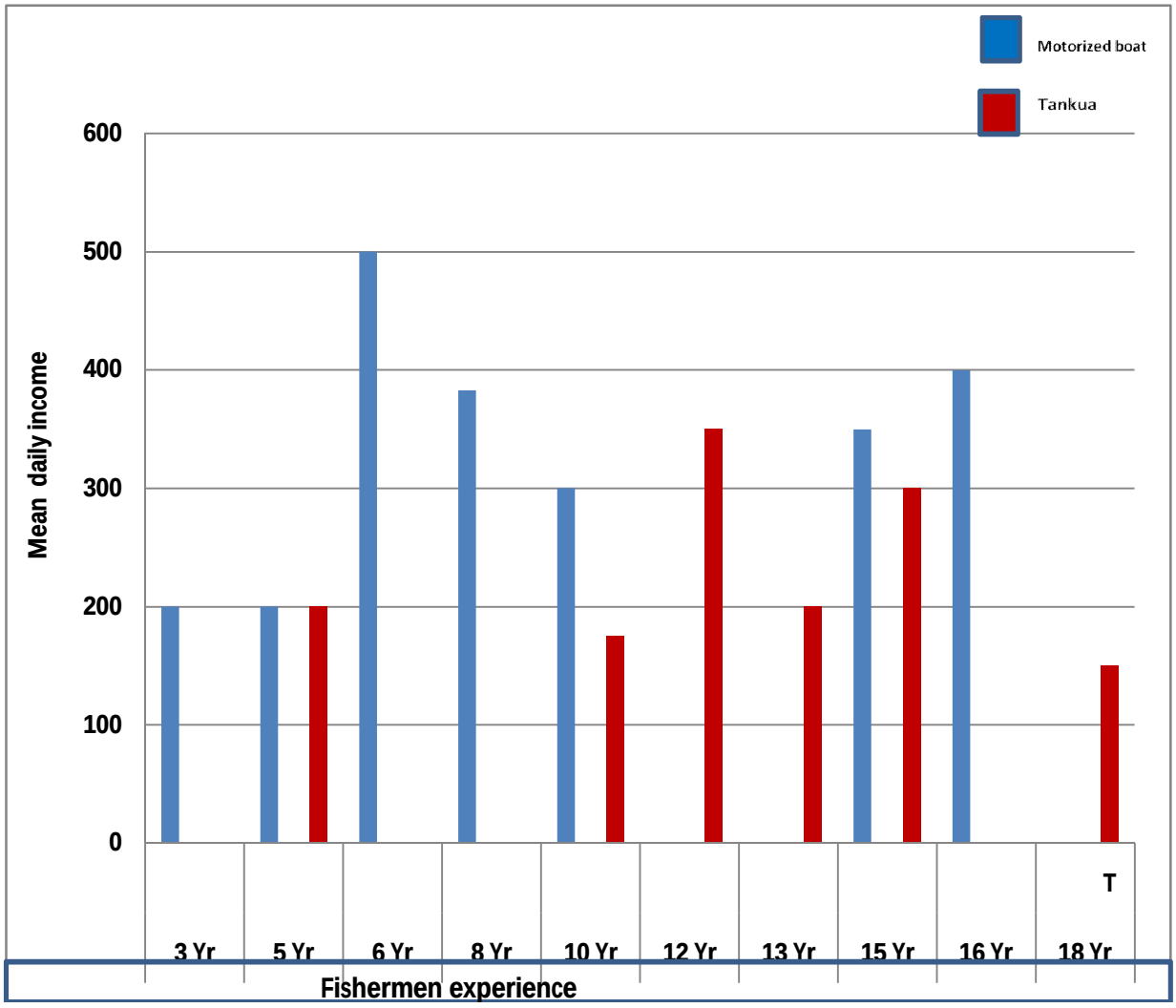

Figure 6. The relation between fishing experience and boat to daily income

III. Current fish price

The price of fish varies by fish species, demand and supply, condition of fish, and place of market. Seasonal pattern of fish consumption affects fish marketing in Fogera Woreda. There were two types of fish forms filleted and whole fish. There is price difference for these products based on where they are sold (landing sites and Woreta Town). Fish prices of whole and filleted fish at landing site and Woreta Town showed significant difference ($P<0.05$) as well as between post-rainy months and dry months ($P<0.05$). This is indicative that distance from the lake to landing site and to marketing center can affect the total price of fish. Tilapia has the highest price in landing site and in Woreta Town: there is 5 ETB difference between Tilapia with *Clarias* and *Labeobarbus* in post- rainy season. There is price difference between months in dry and post-rainy seasons (Table 12). In Dry months the total price of both whole and filleted fishes increase and the customer's demand is also increased (Fig 6).

Table 12. Current fish price in post- rainy and dry months (Birr/kg).

In post- rainy season (November, December and January)

Species	Fish Form	Marketing site	
		Price at landing site (Birr/kg)	Price at Woreta Town(Birr/kg)
Tilapia	Whole	20	25
	Filleted	38	43
Clarias	Whole	15	20
	Filleted	35	45
Labeobarbus	Whole	15	20
	Filleted	30	38
In Dry season (February, March and April)			
Tilapia	Whole	28	35
	Filleted	45	55
Clarias	Whole	25	33
	Filleted	41	48
Labeobarbus	Whole	20	28
	Filleted	35	38

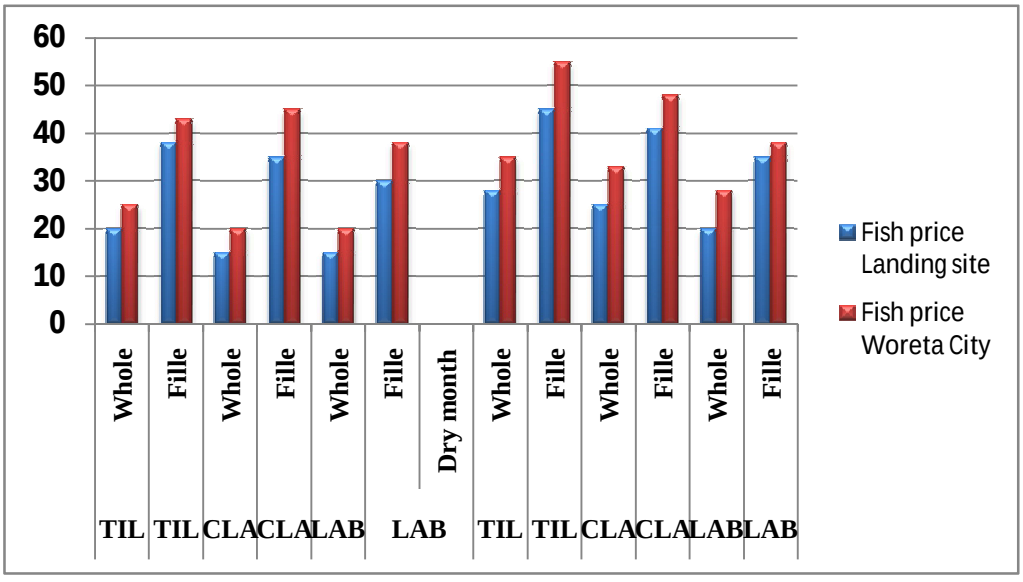

Figure 7. Fish price in landing site and Woreta Town during post-rainy months and dry months (NB: TIL-Nile Tilapia, CLA-Catfish and LAB- Whitefish)

Fish price is determined by the demand and supply condition of fish in the Lake Tana fisheries in general. This study showed that there is significant variation ($P<0.05$) between fish price in landing site and Woreta Town, the price is highly reduced around the landing sites. This may be due to lack of facilities like road, transport, problem of fish processing, lack of adequate preservation facilities around the two river mouths. Moreover there is also significant price variation ($P<0.05$) between none fasting period and fasting period, and this is associated to fasting period in Orthodox Christian followers. During the fasting period (February to April), the demand for fish increases because most Christians eat fish in their fasting period so the price is increased for both whole and processed fish (Sewmehon Demissie, 2003). Fishers can make more money by processing and selling filleted fish rather than whole fish. The second probable reason may be the increases in catch around Ribb River mouth during the fasting period, which may increase the supply and hence the price (from personal communication).

IV. Market chain

The restaurants and hotels have three main channels trough which they can get fishes: cooperative centers, traders and individual fishermen. Among the 21 people interviewed 66.7% (14) of the respondents think that the fish catch was brought from mobile traders, whereas 19% of the respondents believe that the product is coming from cooperative centers and the remaining 14.3% claim that the fishes are coming directly from fishermen.

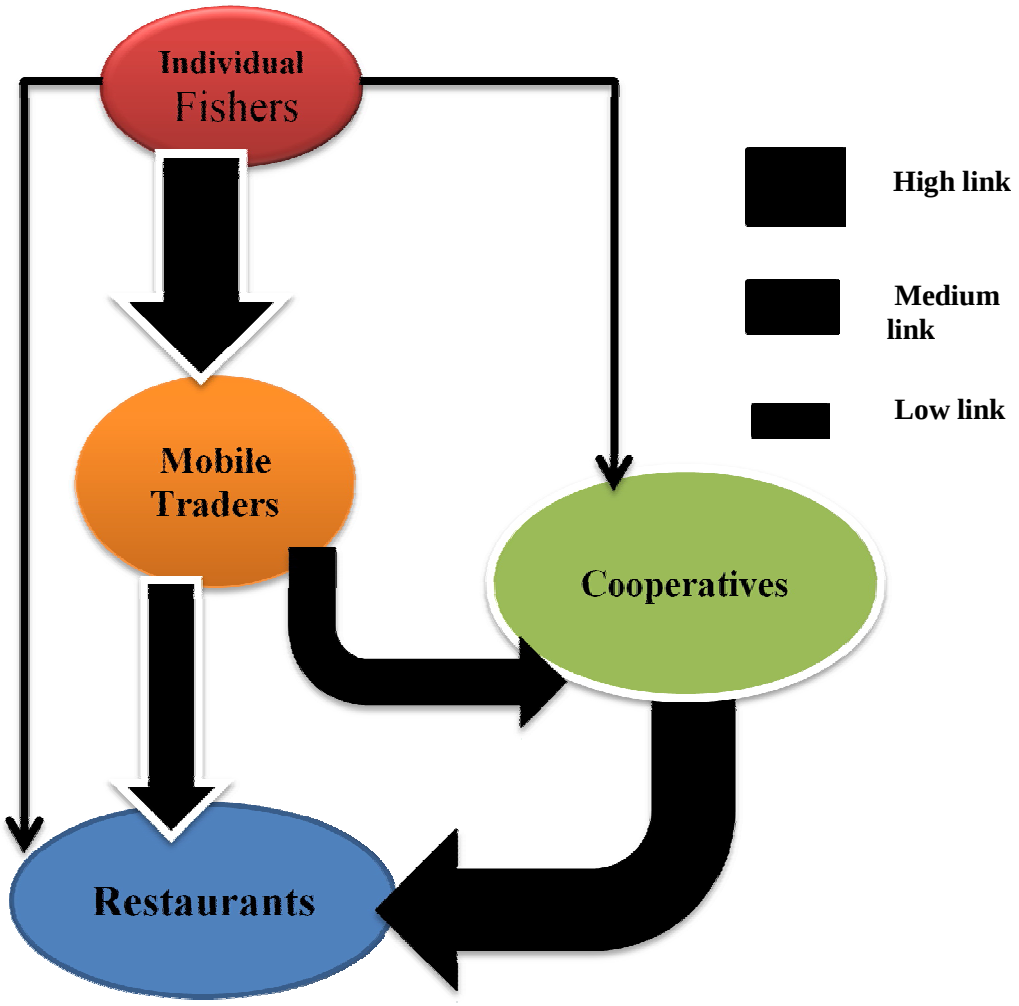

Figure.7. Market link between fishers, restaurants, traders and cooperatives

The result of this study showed marketing chain of fish between traders and consumers have 3 main routes (Fig 7). The primarily route involves individual fishers and mobile traders coming to their landing sites those found in Bahir Dar, Woreta and Addis Zamen then the mobile traders sell the fishes to cooperatives and restaurants. The volume of sale in this route is greater than others. The second involves individual fishers selling their directly to the cooperatives and the cooperatives distribute the fishes to restaurants and hotels in Woreta Town. The third route is a

condition in which the individual fishers sell their fishes directly to hotels and restaurants. It appears that distance from landing site affects the market chain and most of the individual fishermen sell their product mostly at the landing sites which reduces the income of fishers. Whereas, fishers organized in cooperatives mostly sell their products to hotels and restaurants directly and hence have higher income, as compared to individual fishermen.

CHAPTER SIX

6. CONCLUSIONS AND RECOMMENDATIONS

6.1. Conclusions

The following are conclusions made from this study:

- Out of the total 184 fish specimens collected during the study period from all sampling sites, 8 species were identified: six species belonging to the family Cyprinidae and genus *Labeobarbus* and the other 2 species (*O. niloticus* and *C. gariepinus*) belonging to the families Cichlidae and Clariidae, respectively.
- From the index of relative importance (% IRI) *L. intermedius* was the most dominant species, *L. crassibarbis* and *O. niloticus* were the second and third dominant species respectively.
- More number of fish specimens was caught in the dry season (114) than the post-rainy season (70) except at Ribb River mouth.
- Most fishermen (83.3%) are regular and use motorized boat and therefore have high daily catch.
- During the study period 30 fishermen were consulted and more than >50% of them are experienced (10yr) and have mean income of 290 Birr per day.
- *Oreochromis niloticus, C. gariepinus* and *L. intermedius* were the most marketed fish resources in the study area and *O. niloticus* had higher price than the others in all marketing centers.
- The price of all type of fishes is more in January, February and April than in the post-rainy season (October, November and December).

6.2. Recommendations

- Prospects for sustainable fish resource utilization and socio-economic aspects must be investigated in Ribb and Gumara Rivers and River mouths.
- Educate and control the fishermen to minimize illegal fishing activities for conservation of the fish species and also sustainable marketing and best fish production.
- Implements the regional proclamation, and crate awareness to fishermen to reduce their fishing activities during the breading season.
- The fishermen in their remote working place should be provided with necessary infrastructure services, like road access.
- The relevant local government bodies should promote credit and saving for co-operative and non- cooperative fishers so that they can use motorized boats.
- Organize the fishers in cooperatives around Ribb and Gumara River.
- Train the fishermen on aquaculture productions and facilitate the establishment of aquaculture farms.
- Promote market information systems, give awareness and introduce knowledge to fishermen about factors that influence prices.

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7. **Appendix 1**

Questionnaire prepared for socio- economic data collection

Addis Ababa University

College of Natural and Computational Sciences

Department of Zoological Sciences

"**Species composition, relative abundance and socio-economic value**

of fish in eastern part of Lake Tana at Fogera woreda

Duration: Oct. 2015-Apri. 2016

Dear respondent,

The following questions are intended to gather information on the socioeconomics of the fisheries activities in eastern part of Lake Tana including Gumara and Rib River in order to assess contribution of the fishing activity to livelihood of the local people. We assure that the information gathered is intended for research purpose only.

Part I: **For selected (sample of) fishermen respondents**

1. Sex: Male ☐ Female ☐ **2**. Age ☐

3. Education level:

3.1. No formal education ☐

3.2. Formal education

- Grade 1-4 ☐
- Grade 5-8 ☐

- Grade 9-12 ☐
- Other levels of education (Diploma, degree etc): ☐

4. Marital status: Married ☐ Single ☐ Widowed ☐

5. Family background (Father/mother): Fisherman ☐ Farmer ☐ Animal producer ☐ Trader ☐ Laborer ☐ Other ☐

6. What is your fishing experience (in years)? ☐

7. Which mode of fishing are you involved in?

7.1 Individual fisherman ☐ Organized/cooperative member ☐

7.2. Occasional ☐ Part-time ☐ Full-time (Regular) ☐

[Occasional fishermen: basically do not depend on fishing for livelihood; only rarely fish usually for subsistence/consumption; **Part-time fishermen**: have other major means of livelihood, but give up to 50 % of their time for fishing and fishing is important part of their income; **Regular fishermen**: fully devoted to fishing and their income is virtually dependent only on fishing activity].

8. Please give the number of fishing gears you possess:

Gillnet ☐

9. Please specify the type of gillnets you use

- Monofilament
- Multifilament

10. Please specify the type of fishing boats you possess:

Motorized ☐ Tankua ☐ Other ☐

11. Amount of fish harvested by a fisherman per day (**Kg/day**)? ☐

11. 1. Amount of income earned by a fisherman from selling fish (**Birr per day**)?

11.2. Market price of fish (**Birr per Kg**) ☐

12. How do you sell your fish? (Choose one more of the following);

A. whole fish (unprocessed) ☐

B. processed (filleted) ☐

13. Where do you sell your fish/fish product?

A. Direct to consumer ☐ B. To local outlets (restaurants, fish shops, etc) ☐

C. To fish trading organizations/individuals ☐ D. Other (please specify)

_____

_____

Appendix 2

Addis Ababa University

College of Natural and Computational Sciences

Department of Zoological Sciences

"**Species composition, relative abundance and socio-economic value**

of fish in eastern part of Lake Tana at Fogera woreda"

Duration: Oct. 2015-Apri. 2016

Dear respondent,

The following questions are intended to gather information on the socioeconomics of the fisheries activities in eastern part of Lake Tana including Gumara and Rib River in order to assess contribution of the fishing activity to livelihood of the local people. We assure that the information gathered is intended for research purpose only.

Part II: Interview & Focus group discussions of key informants

Part II A. Interview for Wereda restaurant workers

1. Sex: Male ☐ Female ☐

2. Education level:

- Grade 1-4 ☐
- Grade 5-8 ☐
- Grade 9-12 ☐
- Other levels of education (, Diploma, degree etc): ☐

3. Responsibility _____

4. Which type of fish is more interested for your restaurants?

- o Tilapia ☐
- o Catfish ☐
- o White fish ☐

5. Where you bought the fish?

- o From fisherman's ☐
- o From traders ☐
- o From cooperative centers ☐

6. Have you enough fish recourse regularly from fisherman's or other centers?

Yes ☐ No ☐