ST.MARY'S UNIVERSITY

SCHOOL OF GRADUATE STUDIES

DETERMINANTS OF FISH PRODUCTION IN LAKE ZIWAY, ETHIOPIA

BY

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Contents

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Acronyms

ADLI	Agriculture Development Led Industrialization
AJKFEDO	Adamitule Jido Kombolcha Finance and Economic Development Office
ANOVA	Analysis of Variance
COMESA	Common Market for Eastern and Southern Africa
EDF	European Development Fund
EFASA	Ethiopian Fisheries and Aquatic Sciences Association
ETB	Ethiopian Birr
EU	European Union
FAO	Food and Agriculture Organization
FGD	Focused Group Discussion
GDP	Gross Domestic Product
LFDP	Lake Fishery Development Project
m.a.s.l	Meter above sea level
MOARD	Minister of Agriculture and Rural Development
MSY	Maximum Sustainable Yield
OLS	Ordinary Least Square
SD	Standard Deviation
USAID	United Sates Agency for International Development
USD	United States Dollar

List of Table

List of Figure

Abstract

The potential yield of all species of lake Ziway were estimated between 3,000 - 6680 tons per year, even though the actual production of the lake goes down from 2300 tones/year to 1127 tones/year with in not more than ten years; furthermore, its contribution to the national fish amount were more than the biggest lake Tana but within ten years its contribution became lower than lake Tana even together with lake Langano. Noting this, the study had attempted to investigate the determinants of fish production in lake Ziway using cross-sectional household survey. Analysis of descriptive statistics, bi-variate and multivariate regression model were used to analyze the data. And it was found that fishers produced 3.33 – 125.54kg per effort; In addition to this, age of fishers, education level and market access contribute significantly to increase fish catch. In contrast, availability of additional income other than fishing was linked to reduce catch. The study also confirms that fishing time is highly explicated fish catch, and consequently, night time fishers catch more fish irrespective of the capture technology they employed. The study also found that the type of fishing instrument is the most important factors in fishery production. Furthermore, limited government support, market chain problem, lack of place for post fishing activities, and illegal fishers were found the main problems of the fishers. Further, the study tries to explore problems encounter the lake, regarding this the study revealed that open access, below standard mesh size, and wastage comes from surrounding are the main critical problems letting the lake and its habitat to danger. In addition to the importance of controlling illegal fishers, the study is also indicative to direct and encourage the existence of follow up to the lake, also suggest efficient government support based on clear understanding of the socio-economic conditions and better organized cooperatives to reduce the problem and enhance current catch levels that maintain a higher yearly potential yield.

Key words: Lake Ziway, production, small-scale, fishery, determinant

CHAPTER ONE INTRODUCTION

1.1.Background

Ethiopia is a land-locked country which has approximately 7400 Km^2 surface area of major lakes and 7185 Km long river network (Dejen & Mintesnot 2012). The aquatic ecosystem includes major rivers and lakes that are of great national and international importance. There are about 30 major lakes located in different ecological zones ranging from about 150 meters below sea level up to 4,000 meters above sea level (USAID 2008).

The country has a number of international rivers, beautiful lakes, and reservoirs which have political, ecological and economical importance. So far, there are 180 different species of fish in Ethiopia and over 30 species are endemic to the country (Golubstov & Mina, 2003). The total annual fish potential production of the country's major inland water bodies is estimated to be 51,481 metric tons per year on a maximum sustainable yield basis (Anteneh 2013). However, only 20-30% of this resource is utilized due to different reasons (Senbete 2008). The per capita fish production is less than 240g per annum, but if population as a factor is taken into account the total annual fish demand is more than 65,344 tons per year, which is approximately equivalent to 1 kg/person per annum (Abera & Tadesse 2008). The national demand for fish is continuously increasing. It is currently estimated at 85,000 tons per year, and would increase to about 100,000 tons and 120,000 tons by the years 2010 and 2015 respectively (ibid).

Despite its potential, the sub sector is still underdeveloped and its contribution to the economy is negligible. The total productions in 2011 was 24041tons (FAO 2011), which is 40 percent of the estimated exploitable potential (51,481tones/year) mentioned above. For the year 2012 the country's import and export was 2138 and 477 tons respectively (FAO 2012). Furthermore, several factors are affecting fish production at national level; these include lack of recognition, lack of trained personnel, poor coordination among stakeholders, poor enforcement of decrees, high turnover of the fishery staffs into other sectors, and weak extension services and linkage (EFASA 2012).

Furthermore, the production of fish is constrained by a lack of fingerlings (small fish), hatchery and storage facilities. Pollution from waste disposal and effluent discharge pose increasing pressure on the fisheries sector and livelihoods of fishermen. The fish breeding sites are being destroyed by the removal of macrophytes shores and river mouths along the lake (Heide 2012).

Destructive fishing gears threaten some species for instance *Labeobarbus* having caused a 75 % stock decline in the 1990s. River regulation by dam constructions will lead to environmental degradation and further decline of the fish stocks (ibid). In addition, lack of awareness, input supply, skill and knowledge about fishing, processing and marketing are major constraints of the fish sector in Ethiopia. Different natural and socio economic factors, land and water use activities directly or indirectly affect the fish population or community and thereby the harvestable fish yield (Abegaz et al. 2010)

According to Mitike (2013) the demand for fish products in Ethiopia is seasonal and inelastic because fish is considered as a substitute of other fasting foods like meat which is not consumed during fasting seasons. A large part of the population consumes fish during the fasting periods commonly practiced in the Coptic Orthodox Church religion. The main fasting period lasts two months during Yekatit and Megabit (February and March), and a short fasting period for two weeks in August. Furthermore, he concluded that demand is higher than supply during fasting season and vice versa in non-fasting seasons. The price of fish per kg is higher in fasting season and lower in the other seasons. As the law of economics, as price increases the quantity demand of commodities decreases but, in the case of fish supply and demand it is not governed by the law of demand. This is because fish is the only meat consumed during fasting season and demand does not decrease even though prices are high.

The lakes in the Ethiopian rift valley contribute much of the fish supply in the country and lake Ziway is one of them. Lake Ziway is a large open and shallow lake and it is known to be dominated by Tilapia nilotica (*Oreochromis niloticus*), but for the last ten years the African catfish (*Clarias gariepinus*) and Crucian carp (*Caracius caracius*) are increasingly become part of the catch (Spliethoff et al. 2009). The composition of the stock is estimated to be about 70% Tilapia, 20% carp and 10% catfish and the potential yield of all the fish species of Lake Ziway is estimated between 2,500 and 6,680 tons/year (ibid).

The existence of additional current information on fishery resource utilization is regrettable because it is the sort of evidence the government appear to be required if they are to support resource sensitive admission policies. Therefore, the study attempts to contribute to the knowledge base by exploring the determinants that influences the utilization of fishery resources.

1.2.Statements of the Problem

Following the secession of Eritrea in 1993, Ethiopia lost access to an estimated 1,011 km of Red Sea coastline (Dessalegn et al. 2013). Since then Ethiopia is a landlocked country and its main fish resources are from lakes, rivers and reservoirs. Despite being considered as the "water tower" of horn of Africa and endowed with huge water resource potential, the current status of the Ethiopian fishery sector contribution to GDP is considered as marginal. And yet, aquaculture is recognized as an alternative means of achieving food security and poverty reduction in rural areas, and is now considered an integral part of rural and agricultural development policies and strategies in Ethiopia (ibid).

The lakes which exist in the rift valley contribute much of fish supply. From rift valley lakes lake Chamo, Abaya and Ziway are exploited at about greater than 80% of their potential. But lake Tana, the biggest lake in the country seems to be exploited only at about 12% of its potential. Lake Ziway the smallest lake of all these lakes produces more than the two biggest lakes (Lake Tana and Abaya) (Yohannes 2003). Furthermore, the bulk of the fish catch originates from 4 lakes, namely: lake Tana (25%), Ziway and Langano (19%), Chamo (18%) and Abaya (12%) of the national total production(ACP 2012). This may indicate the contribution of lake Ziway together with lake Langano became less than lake Tana within ten years; which is the actual production of the lake goes reduced year to year.

The potential yield of all species of lake Ziway were estimated between 3,000–6680 tons per year (Yohannes 2003). In the early 90s lake Ziway was exploited close to its MSY, implying that increasing the fishing effort would end up in overfishing of the parents stocks (Spliethoff et al. 2009). Furthermore, the actual production of the lake Ziway were 2300 tones/year in 2003 (Shado 2006) and it goes down to 1127 tons/year in 2011(Hailu 2011).

There is little research done to find out the poor performance of small scale fishery in lake Ziway. The studies that have been done focused on biological aspect and development and management plan of the fishery sector. Moreover, due to the overexploitation of the resources, commonly attention is centered on the management issue (Kelil 2002; Yohannes 2003; Hellegers et al. 2008; Hailu 2011). Moreover, challenges of small-scale fishing in the case of lake Ziway is not well studied and this study tries to address this gap. Therefore, the purpose of this study is aimed at identifying determinants of fish production in lake Ziway using both quantitative and qualitative research approach

1.3.Research question

The study aimed to answer the following questions.

Main research question:

- What are the key determinants that affect the utilization of fishery resources to enhance the scanty fish production?

Sub-Research Questions:

- What are the determinants of fish production?
- What are the challenges and opportunities of small scale fishermen operating in lake Ziway?

1.4.Definition of Terms

1.4.1. Conceptual Definition of Terms

Fishery - is defined generically as a system composed of three interacting components: the aquatic biota, the aquatic habitat, and the human users of these renewable natural resources. Each of these components influences how the fishery performs. Understanding the entire system and its parts is often essential to successful management of a fishery (Lackey 2005).

Catch - The total number or weight of fish captured from an area over specified period of time. This includes fish that are caught but released or discarded instead of being landed. The catch may take place in an area different from where the fish are landed. Note: Catch, harvest, and landings are different terms with different definitions (Wallace & Fletcher 1996).

1.4.2. Operational Definition of Terms

Legal fisher – legal fishers are fishers who are member of cooperatives.

Illegal fishers – illegal fishers are fishers who are not member of cooperatives but who are still in fishing.

1.5. Significance of the Study

Identification of the challenges, opportunities and determinants of fish-catch by small-scale fishermen provides background information for improved management system and enables to utilize the Lake's fish resources efficiently. The researcher also believes that the output of the research will contribute to our knowledge on better resource utilization and fisheries management of the lake. Of course, there is fishery resource conservation and management system in lake Ziway like gear regulation even if the implementation of those rules by all the fishermen are in question; but this alone is not enough, making every decision based on scientific investigation is very crucial. Understanding what factors are significantly contribute for the fluctuation of fish catch and exploitation of the resource helps and add a little knowledge in managing and conserving the fish resource.

Such information will have also its own value from the point of view of managers, researchers, small scale fishermen's and other stakeholders. Fishery managers can use the findings of this study for developing strategies, implementing and evaluating their managerial duties and responsibilities regarding the fish resource. Also researchers may use the results of the study as an input for further investigation and small scale fish farmers get awareness through fishery authorities to conserve the fish resource.

1.6. Scope and Limitation of the Study

The study is mainly focused on investigating the determinants of fish production and challenges and opportunities of small scale fishers in Lake Ziway. Accurate, reliable, sufficient and good quality data were the critical problems that were encountered during the study because maintaining records by fishery cooperatives were not commonly practiced. To fill this gap the study employed primary data based on the recall of the fishermen and this may not be accurate. Moreover, because of time and financial resource constraint it was difficult to cover the whole and the study was limited to the western part of the lake. In addition to this, Additional information (biological) that could refine the thesis work was not manageable to find, largely due to time limitation.

1.7.Organization of the Paper

The paper is divided in to five chapters. Chapter one gives background information including the objectives, significance and limitations of the study subsequently to the introduction part. Chapter two highlights on some of the available literature and deals with an overview of the small-scale fishery in Ethiopia. The methodology employed, model specification and empirical strategy are provided in chapter three. The findings along with the discussion and analytical explanation are presented in chapter four. And the last chapter gives to summary of the key findings and conclusion.

CHAPTER TWO LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

In this chapter the working definition of small scale fishery adopted for this study is discussed briefly and presents relevant existing literature on the development of small scale fisheries; based on previous studies the chapter winds up the discussion by providing analytical framework for the study of determinants of small scale fish catch level and for the identification of the challenges and opportunities of small scale fisheries in Lake Ziway.

2.1. Small scale Fishery

Bene et al. (2007) states, it is difficult to give a precise definition to small-scale fisheries. According to the authors because it is a relative term that means a small scale fishery in one country might be considered "industrial" in another and encompasses a wide variety of fishery types. Literatures use the name small scale and artisanal interchangeably some are not. For the purpose of this research let us consider they have the same meaning.

However, the definition of FAO (2004, 23) seems the best to describe the sector on the basis of the range of characteristics likely to be in a particular small-scale fishery:

> Small-scale fisheries can be broadly characterized as a dynamic and evolving sector employing labor intensive harvesting, processing and distribution technologies to exploit marine and inland water fishery resources. The activation of this sub-sector, conducted full-time or part-time or just seasonally, are often targeted on supplying fish and fishery products to local and domestic markets, and for subsistence consumption. Export-oriented production, however, has increased in many small scale fisheries during the last one to two decades because of greater market integration and globalization. While typically men are engaged in fishing and women in fish processing and marketing, women also known to engage in near shore harvesting activities and men are known to engage in fish marketing and distribution. Other ancillary activities such as net-making, boat-building, engine repair and maintenance, etc. can provide additional fishery-related employment and income opportunities in marine and inland fishing communities. Small scale fisheries operate widely differing organizational levels ranging from

> self-employed single operators through informal micro-enterprises to formal sector businesses. This sub-sector, therefore, is not homogenous within and across countries and regions and attention to this fact is warranted when formulating strategies and policies for enhancing its contribution to food security and poverty alleviation.

According to the FAO (2014) glossary defining small scale and artisanal fisheries is a challenge as the terms have been used for decades by fishery politicians and administrators, legal officers, biologists, economists, sociologists, engineers, fishers, non-governmental organizations and the media to represent different points of view and socio-economic dimensions in different national contexts. Trying to combine all the characteristic dimensions of these fisheries, it indicates that artisanal or small scale fisheries are:

> traditional fisheries involving fishing households (as opposed to commercial companies), using relatively small amount of capital and energy, relatively small fishing vessels (if any), making short fishing trips, close to shore, mainly for local consumption. Artisanal fisheries can be subsistence or commercial fisheries, providing for local consumption or export. They are sometimes referred to as small scale fisheries"(FAO 2014, 20)

On the other hand, Bonfiglioli & Harari (2004) defined small scale fisheries as the various activities of the fisheries (i.e., fish catching, processing, distribution, and marketing) that are undertaken by migrant, part-time, and full-time fishers, with specialized associate stakeholders (auctioneers, wholesalers, transporters, retailers, etc.). Moreover, they have a specific feature of low level of income and investment, small amounts of capital and energy, strong dependency on the services provided by a number of external people (auctioneers, traders, transporters, retailers, carpenters, mechanics, etc.), ownership (or rental) of relatively small fishing open-deck vessels (< 20 meter long), with outboard (less often inboard) engines, strong dependency on seasonality, because of the climate (monsoon) and migratory patterns of some fish stock, they have relatively modest levels of production and they use simple technology and equipment..

Small-scale fisheries can also be characterized as a highly variable activity. The fishing intensity and the fishing strategies show very rapid fluctuations in space and time. The activity and gear employed varies according to the variation of accessibility of the different main target species and seasons, the meteorological conditions, the tourist seasons and other factors (Farrugio 2013).

In contrast, according to Kurien (1998) the practice of fisheries development and management sector of the fish economy which is alluded to by a variety of appellations is the small scale fishery. The adjectives 'subsistence', 'traditional', 'peasant', 'artisanal', 'inshore', are the most widely used terms, either separately or in combination in the conceptualization of small scale fishery. While each of these terms highlights a certain characteristic of small scale fishery, none of them adequately define the concept. He also argues that the issue of scale in defining small scale fishery as unsettled and mentioned that the ambiguities linked to scale is attributed to the fact that small scale fisheries have evolved in time and space from specific ecological, and changing socioeconomic and cultural contexts which are marked by diversity rather than homogeneity. Moreover, he mentioned a statement of World Bank working group which approaches the issues by stating that:

> Definitions are not universally applicable and that which may be called small scale in one situation may be large-scale in another. It was felt that distinctions were not necessary for the purposes of discussion. With regard to any particular project, however, researchers may need to make precise definitions suitable to the situation. (World Bank, 1991 cited in Kurien 1998: 6)

Further, Kurien provided different characteristics that help to differentiate small scale fishery from medium and large-scale fishery as follows (Table 2.1):

Table 2.1 Rough estimates of characteristics of different scales of operation in global marine fishery.

Characteristics	**Large-scale**	**Medium-scale**	**Small-scale**
Estimated number of units	5000 - 5500	30,000 - 32,000	3,200,000 - 3,500,000
Investment range per unit (USD '000)	10,000 - 40,000	300 - 4,000	1 - 80

Crew range per unit	40 - 60	25 - 30	1 - 5
Range of fish harvest per unit per annum (tones)	5,000 - 8,000	200 - 1200	2 - 100
Range of fuel consumption per unit per annum (tones)	1600 - 1800	400 - 450	1 - 60
Range of fish harvest per ton of fuel (tones)	3 - 4	2 - 3	2 - 3
Range of value of output per crew per annum (USD)	Over 15,000	Over 8,000	200 to 1500

Source : Kurien (1998)

Operationally, in this study, small scale fishery is defined as fishing activity by local traditional fishermen mainly practiced using local boat wooden and reed. This involves a crew range of 1 - 5, an investment outlay of 1– 80 USD and fish harvest of 2 - 100 tons per annum according to the classification of Kurien (1998). Here boats are small with fishing gears including gillnets, beach seine and long line and low technological investment, and with limited fishing grounds concentrated and scattered within 20-30km from the main shore.

2.2. Challenges of Small Scale Fishery Development

Owing to resources over-exploitation, most countries are increasingly concerned and give due attention to the sustainable management of fishery resources.

The production of small scale fisheries is constrained by a number of factors. Small-scale fishers are poorly organized in many countries that hindered their participation in fishery governance. In instances where small scale fisher associations do exist, they are often manipulated by the fishing industry, elite groups in the community and the authorities and fail to represent the interest of the fishers. Furthermore, the lack of reasonably accurate information about small scale fisheries has in part resulted in the sector to be undervalued and not given sufficient attention by policy makers. Traditionally, small scale fishers have maintained their livelihoods without specific needs to form strong organizational structures (Cox 2012). Fish is a globally traded commodity.

Destruction of marine ecosystems due to unsustainable fishing practices is threatening sustainable production of small scale fishery globally (Eggert & Greaker 2009). Others also pinpointed that low level of production of small scale fisheries resulting from the use of low level technology. Chowdhury & Maharjan (2000) in Bangladesh; Rajan et al. (2013) in India and Kehinde et al. (2009) in Nigeria stated the use of low level of technology and shortage of capital among the factors contributing to low level of small scale fishery production.

Challenges related to processing and marketing of small scale fish catches are another important factors worth mentioning. Poor infrastructure, lack of standard processing techniques, absence of financial support are among the factors that contributed to the poor processing and marketing of small scale fishery (Agboola 2011). Small scale fishers are economically inefficient in the utilization of their production inputs such as feed, fingerlings and hired labor (Njagi et al. 2013).

Christy, 1997 (cited in Demena 2011) suggested that improvements in landing and processing facilities, transportation networks, provision of low cost ice and fuel, efficient gear, and enhance marketing situation can increase small scale fish catch level. As Mwima (2012) stated that providing supportive policies and regulations, improving capacity of service providing institutions, increasing access to funding sources and credit facilities for start-up capital, improving access to processing facilities and markets for aquaculture products, which include hatcheries, transport, communication, water and electricity supply, appropriate technologies, and promotion of private public sector partnerships are among the critical conditions for increased production and enhance the development of small-scale fishery sector.

2.3 An Overview of Fishery in Ethiopia and Lake Ziway

Ethiopia's extensive inland rivers and lakes contain substantial proven reserves of fish and other aquatic resources. The fish supply in most cases comes from the major lakes such as Fincha, Hawassa, Tana, Chamo, Ziway, Koka, Abaya, and rivers in the country. The fish production from these water bodies is supporting the livelihood of poor farmers living around water bodies in providing inexpensive, but high quality protein and diversifying sources of income (Gebrekidan et al. 2012).

According to the report of EU (2011) the fish catch in Ethiopia in 2008 was estimated approximately 17,000 tons; The bulk of (74%) originated from the six main lakes (Tana, Ziway, Langano, Awassa, Abaya and Chamo) and a further 26% from other water bodies. As fish potential is estimated at 45,000 - 51,500 tons per year, accordingly less than 38% of this potential is exploited, demonstrating considerable room for expansion through proper management. However, the sector challenged by a number of problems: environmentally unsustainable and illegal fishing practices (such as small mesh size nets, seeds and use of poisonous plants to intoxicate the fish); low participation of the fishing communities in fisheries management; Lack of information on most water bodies and their catch and potential, given that no systematic fish stock assessment has been carried out so far; limited institutional, technical and financial capacity, especially in the areas of resource monitoring, control and surveillance, planning and coordination of activities; and low research and development capacities (ibid)

Lake Ziway fishery was the most fishery contributor lake having a maximum contribution of all lakes in Oromia Region. This is because of the support it received from phase I (1981 – 1984) and phase II (1991 –1998) fishery development projects of the EDF (Yohannes 2003).

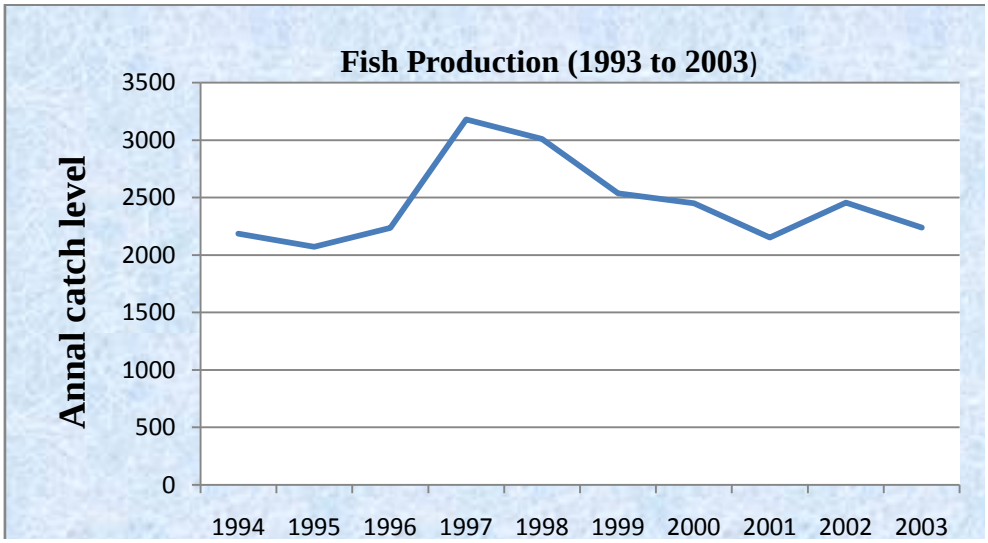
Lake Ziway harbors the indigenous African catfish, *Clarias gariepinus*, and other commercially important fish species (*Oreochromis niloticus*, exotic *Carassius carassius*, *Cyprinus carpio* and *Labeobarbus intermedius*), in which some are native and others exotic that were introduced into the lake by the Ministry of Agriculture with the aim of fishery development (Abera et al. 2014).

There are 30 known landing points on the lake divided over 20 fishing communities. Fishermen of one community shift frequently between landing sites of that community but rarely to those of another. Three types of gears are commonly used: beach seines, gill nets and hook and lines (CEC 1997). Also according to Hailu (2011) the fishing activity of lake Ziway is operated by three types of gears: beach seine, gillnet and long line.

The landings of lake Ziway are highly dominated by Tilapia nilotica (*Oreochromis niloticus*), but recently African catfish (*Clarias gariepinus*) and Crucian carp (*Caracius caracius*) are appearing in small amounts in the total landings (Mitike 2013).

The potential yield of all species of lake Ziway is estimated between 3,000 - 4500 tons per year (Mitike 2013). The total production in 1987 was estimated at 2070 tons in which 1944 tons of the

landing were composed of Tilapia. The report of LFDP, 1996 (cited by Yohannes 2003) stated that the estimated MSY of Tilapia in Lake Ziway is estimated at 2,100t/year Hence, lake Ziway is exploited close to MSY. Increasing fishing efforts therefore will end up in over fishing rather than a significant increase in production (Yohannes 2003). The report of COMESA, 2004 (cited by Shado 2006) indicated that the fish production from lake Ziway from the 1993 - 2003 is presented in figure 2.1 (fresh weight in tones).



Source: Authors own illustration from Shado (2006)

Fig 2.1 Fish production of lakes Ziway from 1994 to 2003

As observed in the graph the maximum production level was harvested in 1997 which indicate that the lake was highly exploited in that year. Furthermore, the increased demand for fish and the favorable prospects of the sector induced a considerable influx of fishers and gears. Fishing effort increased in a few years to such an extent that the fish stocks soon reached and even surpassed the level of MSY. With an estimated annual production potential of 67 kg/ha, the fish production of lake Ziway is high compared to other lakes in Ethiopia. This is mainly due to its favorable ecological conditions, but which may partly also be attributed to the presence of a viable market outlet like Addis Ababa (Spliethoff et al. 2009). The composition of the stock is estimated to be about 70 % tilapia, 20 % carp and 10% catfish The potential yield of all species

of lake Ziway, that is the fisheries 'resource rent' which can be tapped without damaging the parent stocks is estimated to range between 2,500 to 6,680 tons/year (ibid).

Fishing is carried out with beach seine, gill nets and hook and line. Fishing has seasonal pulse on lake Ziway, as it is in most other lakes in the country, with high fishing activity and increased landings during January - March. This is influenced by the high demand for fish during the fasting period of Orthodox Christians and the apparent increase in catch rate. The increase in the catch rate during this season could be associated to the spawning aggregation of the tilapia to the shallow inshore grounds becoming easily vulnerable to the beach seine fishing practices (Tariku 2008). Hailu (2011) also indicated that the fishing activity of lake Ziway is operated by three types of gears: beach seine, gillnet and long line. Moreover, he stated that the total annual catch from lake Ziway was estimated at 1127 tons per year. The value of total yield was categorized into the respective fish groups. Based on the calculated fishing mortality of each species, was estimated at 0.27, 1.28 and 1.09 tons km^{-2} for carp, tilapia and catfish, respectively.

Landings of fish in Lake Ziway generally increase during January – March due to the high demand for fish during the fasting period. In other words fishing effort increases during the vulnerable stages in the life cycle of both the parent and the juvenile tilapia fishes (Spliethoff et al. 2009).

Depending on 'good' and 'poor' production seasons, earnings from the fishery range between 25 and 500$ per month and sometimes below and above the two extremes (Kelil 2002). Furthermore, Garoma et al. (2013) stated that the total revenue from the sales of fish caught was ETB 984,515.20. Moreover, the fishing household has realized average gross revenue of ETB 5500.10. The variable cost items comprises of the expenses of labor, fuel lubricant, repair and maintenance, fish processing sanitation and transportation, food & drink or entertainment and the like, which is worked out to be ETB 2476.70. Thus, gross margin for each fisherman was calculated as the difference between the gross revenue and variable costs. Accordingly, the average gross margin per fishing house-hold was ETB 3,023.40. Consequently, the net income as the difference between the gross revenue and total costs was ETB 1,899.00. In addition to this he claim that fishing household gets less income from fishing taking the average family size. This could be partly explained by the lower price offered in the local market and at the landing site,

and less quantity of fish catch as compared to the fishery potential of the two lakes due to increased number of fishermen. Furthermore, most of fish product sources are fishery cooperatives (Mitike 2013).

In the lake there are about 114 beach seines, 229 gill-net and 104920 hooks which are used for long line. These instruments are used both by the legal and illegal fishers using 318 local boats (reed boats) (Ziway Animal Science Agency 2014). Furthermore, there are two types of local boats used by the small scale fisheries in Lake Ziway. Both types are manually hand propelled boats. The reed boat which is made of local tree called bofofe is manipulated only by single individual/fisher because of its small size, Moreover; this reed boat is mostly used by gill net and long line users and it is mostly constructed by the fishers themselves. The second one is made of wood/wood boat and mostly made by crafts men; it has the capacity to hold three fishers/crew and all beach seine users use this boat for their fishing activities. In-addition, wood boat is more preferable for prolonged fishing and distant trips because they are large in size.

2.4.Previous Empirical Studies

Garoma et al. (2014) employed a descriptive statistics and a propensity score matching method to examine the contribution of fishery cooperatives to its members as opposed to the non-members around lake Ziway and lake Langano. In particular, the research objectives were to examine fishery cooperative's income performance on its members in considering their catch level as compared to the non- members. As per the analysis they concluded that cooperatives are effective at providing marketing services to their members. The significant impact of fishery cooperatives on fish income reveals that cooperatives do serve their role on income improvement through monitoring of fishing efforts by creating better market opportunities, making higher bargaining power, or reduced transaction costs.

Demena (2011) followed descriptive statistics, bi-variate, multivariate OLS and probit model to investigate determinants of fish catch levels in artisanal fishing in Eritrea. He concluded that there is positive and significant association between boat type, crew size, fishing experience, household size, and access to ice and catch level; whereas access to credit, fisher’s age and non-fishing income are linked to reduce fish catch. The investigation also showed that the means of

boat propulsion significantly explain fish catch level. Subsequently, the study confirmed the relevance of adopting and use of in-board fishery to boost artisanal production.

Raufu et al. (2009) applied descriptive approach to investigate determinants of yield performance in small scale fish farming in Alimosho local government area of Lagos state, Nigeria. The researchers consider yield in kg as dependent variable and independent variables such as sex, marital status, age, education, fixed cost, hired labor, family labor, and variable cost, and their findings confirmed that these variables significantly determined yield performance at small scale level.

Njagi et al. (2013) in Kenya followed a descriptive approach and found out that access to market, access to technical information, predators and inadequate extension services as the main challenges of the small scale fishers despite substantial government support. The study also concluded that the government needs to provide technical capacity building, market accessibility to fish farmers in their localities.

Adebayo (2012) cited a descriptive and propensity score matching analysis technique used to investigate determinants of extension service needs of catfish farmers in Nigeria and found out that poor weather, lack of credit facilities, inadequate extension contact are the major problems encountered by fishers. The study recommended that provision of effective extension service to disseminate relevant and timely technologies to catfish farmer should be encouraged.

Oluwemimo & Damilola (2013) employed a regression and budgetary analysis to identify the socio-economic and policy issues in determining sustainable fish farming in Nigeria. The result showed that experience of farmers in fish farming, quantity of feed used, access to credit and size of pond were significant determinants of fish farm production. Moreover, lack of access to credit, high cost of inputs and poor extension services are major challenges confronting fish farming in the study area.

Bonfiglioli & Hariri (2004) follow a descriptive approach to investigate social assessment and development perspectives of small scale fishers in Yemen and they found out that the major internal and external constraints faced by fisheries are government's influence and control, unfavorable environment and weak economic basis, variety of social and economic objectives, limited member ownership, weak leadership, lack of focus, dichotomy between individual and

collective interests, etc. The section also analyze the major variables affecting the livelihoods of fishermen, such as environmental degradation (depletion of fish stocks, rapid coastal development, destruction of coral reefs, etc.), low and/or inappropriate technology, lack of training and skills, and lack of enforced regulations.

Such review is very important in identifying missing gaps of the earlier studies and suggests hypothesis that can be tested empirically. Changes are taking place on the extent of determinants of catch level over time. Hence, conducting such studies in different localities at different times is very useful to capture the extent and effects of the changing situations on the production level.

CHAPTER THREE METHODOLOGY

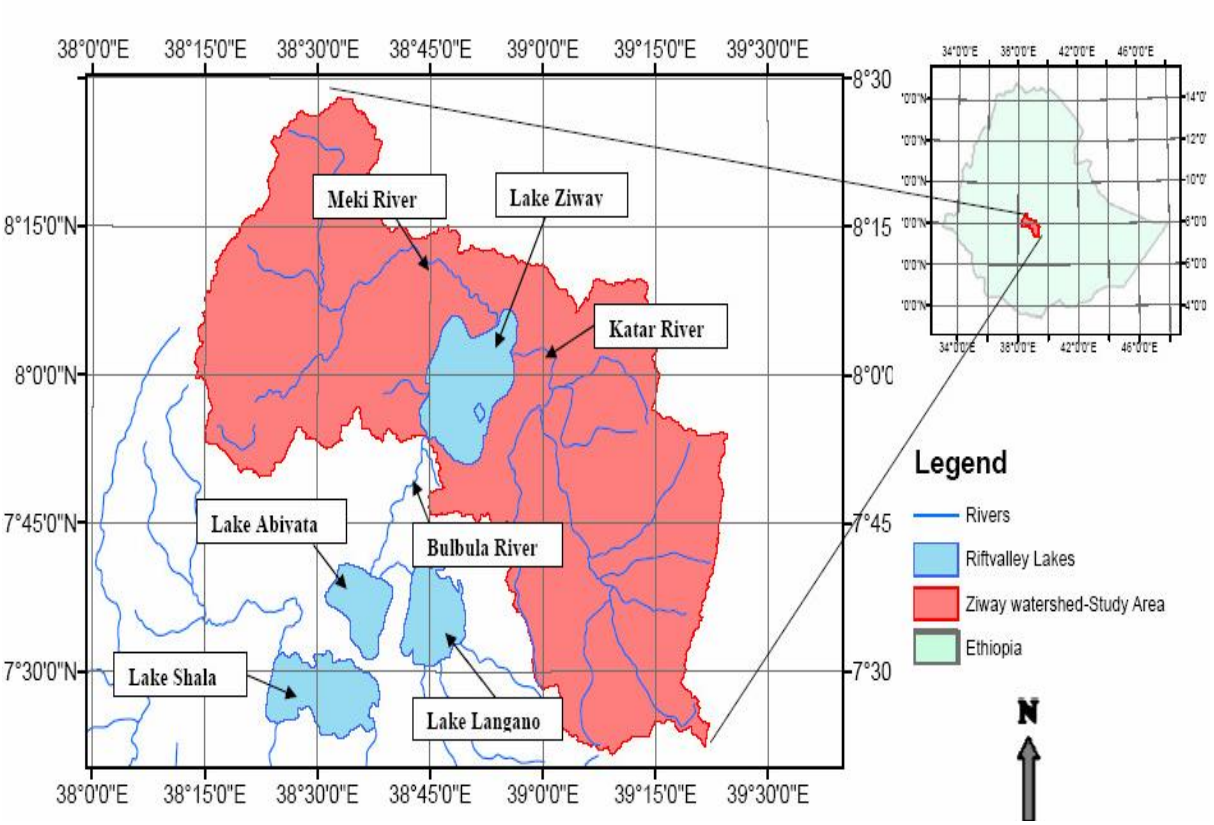
3.1 Description of the Study Area

The study is conducted in Adami Tulu Jido Kombolcha district on Lake Ziway. The district is located in the central Rift Valley of East Shewa Zone bordered by Arsi Negelle, SNNPR, Dugda and Ziway Dugda district (Arsi Zone) Zone in the south, west, north and east respectively. The district is sub-dived in to 43 rural and 4 urban kebeles, with its total surface area of 149166.21 hectares. Adami Tulu Jido extends between $7^0 37^- 8^0 04'$N latitude and $38^0 32'$–$39^0 04'$E longitude. Adami Tulu Jido Kombolcha is the5^{th} largest district in the zone. The main semi-urban and urban localities of the district are Abosa, Bulbula, Jido and Adami Tulu.

Lake Ziway is located in the great east African rift valley lakes of Ethiopia and 175km southeastern of the capital Addis Ababa. It is located 1636 m.a.s.l and covers total area of 434 km^2, an average depth of 2.5 m. The Ziway watershed falls in between 7°15'N to 8°30'N latitude and 38°E to 39°30'E longitude covering a total area of about 7300 km^2. The climate is characterized by semi-arid to sub-humid with a total precipitation and mean temperature of 650 mm and 25°C respectively. Lake Ziway covers three administrative districts Dugda, Adamitulu Jido Kombolcha and Ziway dugda. Its catchment is bordered to the west by Dugda and Adamitulu Jido Kombolcha and to the east by Ziway dugda district. Five islands are located in Lake Ziway. These are Tulu Gudo (4.8 km^2), Tsedecha (2.1 km^2), Funduro (0.4 km^2), Debre Sina (0.3 km^2) and Galila (0.2 km^2). Currently Tulu Gudo Tsedecha, Funduro and Galila are inhabited by people (AJKFEDO 2006).

Lake Ziway, with its tributaries river Meki and Ketar and its out let river, the Bulbula, form a unique and vital fresh water resource in the central rift valley lakes system. Together with the lakes Abiyata, Langano and Shala, a high altitude drainage basin is formed, which is referred to as the Ziway-Shala basin. Despite their common history and geographic proximity, the lakes have different chemistry, morphometry, hydrology and different development prospects. The water level and chemistry of the four lakes are largely determined by rainfall and experience significant inter-annual variability. Because the rift floor is a rainfall deficit zone (evaporation exceeds rainfall), the lakes depend largely on surface water and groundwater inflows from the adjacent plateaus and escarpments. Lake Ziway is a large open and shallow lake with a

catchment of about 6834 km^2, a shoreline length of 137 km and a mean and maximum depth of 2.5m and 9m respectively (Spliethoff et al. 2009).



Source: Mazengia (2008)

Figure 3.1 map showing lake Ziway, Ethiopia

3.2 Research Design and Approach

The study employed a mixed approach and generated both qualitative and quantitative data. The qualitative approach is adopted to get more insight on the quantitative data, to generate explanations for relationship among variables and to identify the major constraints of small scale fish production. The quantitative research approach is adopted to identify the key determinants of production at household level.

In terms of time frame, the study adopted across-sectional research design in which data from the subjects were collected in a snap shot between August and September 2014. In followed both

descriptive and causal research design. The descriptive design is meant to explain and discuss the major challenges of small scale fishery production in the study area and the causal research design is adopted to explain the variables that affected fish catch level at household level.

3.3 Population and Sampling Design

The target populations of this study are the households of fishermen living around lake Ziway and who fish. There are a total of 25 Kebeles adjacent to lake Ziway of which 9 Kebeles are in Dugda, 11 Kebeles are in Adamitulu Jido Kombolcha and the rest 5 Kebeles are in Ziway Dugda district. There are 5 fishery cooperatives around lake Ziway and constituting a total of 243 members (table 3.1).

For the purpose of this study 4 cooperatives are selected purposely. The criteria of homogeneity in selecting the cooperatives were considered in two ways, first it is assumed based on year of establishment of the cooperatives, hence cooperatives with more than ten years of experience are selected; second since they are legal fishers and there is also follow up on their fishing activities it is assumed that there is no significant difference on their gear type, mesh size, and other activities.

Yamane (1967:886) (cited by Israel 2013) provides a simplified formula to calculate sample sizes (equation 3.1). Moreover, using this formula he develops a calculated sample size table.

$$n = \frac{N}{1 + N(e)^2} \quad \text{---------- 3.1}$$

Where n is the sample size, N is the population size, and e is the level of precision. Using these formula 107 fishery households were selected and 4 key informants were interviewed. Based on this a total of 111 samples are taken for the purpose of this thesis. Furthermore, due to the very difficult nature of the fishing job all of the fishers were males. The key informants were two local fish traders and two experts from Ziway Fisheries Resource Research Center and Ziway Animal Science bureau. The sample size from each cooperative is decided based on proportional sampling technique. Hence, the proportion from each cooperative is done, first the sample size is

divided by the total population and secondly the determined ratio is multiplied by each of the total member of the cooperatives; based on this, 33, 27, 21 and 26 households/members were taken randomly from Ziway, Bochesa, Abosa and Kontola fishery cooperative respectively.

Table 3.1: Composition of Members in the Cooperatives

District	Lake	Name of fishing cooperative	Members			Sample size = (n/N) * A, where A = total member of a single cooperative
A/T/J/Kombolcha			Male	Female	Total	
	Ziway	Ziway/Batu	61	1	62	33
	Ziway	Bochesa	51	-	51	27
	Ziway	Abosa	41	-	41	21
	Ziway	Kontola	49	-	49	26
	Total		202	1	203	107

Source: Ziway Animal Science Agency, 2014

3.4 Data Collection

Both primary and secondary data were gathered. Primary data are collected from fishing households using interview guideline, FGD (Focused Group Discussion), key informant interviews and systematic observation. The observation was made in five landing sites; the observation is made early in the morning near the Lake on the moment when the post fishing activities starts taking place. The household survey was conducted by using structured and semi-structured questionnaire. Furthermore, four FGDs were conducted, each having participants that ranges from 4 to 10.

3.5.Variables and Research Hypotheses

The problem of determining either quantity/yield or price/value of output as a dependent variable is considered. The fisheries productivity of an inland aquatic system is commonly measured in terms of kilograms of fresh fish per effort (kg/effort) or per kilometer of river stretch annually. Productivity (in kg/effort) has, therefore, the same dimension as yield in agriculture (Lemoalle 2008). Furthermore, Nguyen, 2010 (cited in Demena 2011) stated that the precise choice of

independent variables differs among studies and is largely valid on data availability, fisheries characteristics and the anticipation to capture the complete scope of inputs. Therefore, for this study the size of the catch (catch per day) is taken as a dependent variable and the independent variables were selected based on the available data and past studies. The variables and the expected sign of influence on fish catch level were identified based on past studies and theory (Table 3.2).

Table 3.2: Description of variables and their expected effect

No	Variable	Description	Measurement	Expected effect
1	Y_{qty}	Quantity of fish catch per day	Kg	
2	FmSize	Family size of the respondent	Number	+
3	LeEdu	Level of formal education	Number	+
4	Exp	Fishing experience	years in fishing	+
5	AgeHh	Age of house hold	year	_
6	FiIns	Type of fishing instrument (reference: 3)	1= long line, 2 = gillnet, 3= beach seine	_
7	FiTi	Fishing time (reference: 2)	1= morning, 2 = day, 3 = night	_
8	NnIn	Income other than fishing	Dummy variable; 1 = yes 2= otherwise	_
9	AcTr	Access to training and extension	Dummy variable 1= yes, 2 = otherwise	+
10	MaA	Market availability	Dummy variable 1= yes, 2= otherwise	_
11	BoOwn	Boat ownership (reference: 1)	Dummy variable 1= yes, 2= otherwise	_
12	AcCr	Access to credit	Dummy variable 1= yes, 2= No	+
13	Tybo	Type of boat (reference: 1)	Dummy variable1= wood boat 2 = Bofofe/yebela	+

Source: own computation

According to Abegaz et al. (2012) the variability of catch level comes due to limited technological innovations. This means there is inadequate/absence of fishing gear supply, inadequate technological know-how on fish handling, and weak fish market due to poor consumption habit among urban dwellers. Moreover, post harvest and marketing constraints also exist like lack of transport facilities from landing site to market. It is also mentioned age may have both positive and negative relationship with efficiency level of the fisherman. It is assumed that younger people with a lot of energy have the capacity to catch more fish than older men with

feeble hands. As the fishermen grow older, their performance drops and so does the general fish catch levels; and the higher the number of contacts with the extension agents, the higher the tendency of the fisher folks to be informed/educated on the importance of using technologies furthermore, the effect of experience and household size, is not significant in the probability of fisher folk's use of modern technologies which has indirectly impact on the catch level (Akanni 2008)

Inputs that employed in fishery are the most important factor in determining the catch level; one of the most important factors is fishing instrument. Gillnet with stretched mesh size has got maximum catch by weight of the total catch recorded from gillnet and Hook size has got maximum catch by weight of the total catch recorded from long line (Senbete 2008).

According to Berihun & Dejenie (2012) catch per unit effort among months are highly variable; the highest catches is observed in may after the April and mid of may and the least catches were done during the very cold month in January. Furthermore, lack of awareness, input supply, skill and knowledge about fishing, processing and marketing are the major constraints. Different natural and socio economic factors, land and water use activities directly or indirectly affect the fish population or community and thereby the harvestable fish yield (Abegaz et al. 2010).

Training and credit access significantly influenced fish resource utilization. It is also educational level, training on fishery resource management and utilization, access to credit, establishment of sustainable market, construction of roads and expansion of sea transportation system would promote fish resource utilization. Furthermore, distance of farmers' home from the lake is significantly associated with fishery resource utilization. This was related with the problem of lack of access to transport and transport facilities around the lake. In addition market access is the critical problems of fish resource utilization. One of the main causes that prohibit fishers to invest in fishery was the lack of market access (demand) for fish (Anteneh 2013).

According to Tessema et al. (2010) there are fisher men who are fully dependent on fishing activities who has no other occupation which means the only income they generate is from the fishing activities; and there are also fishers who are engaged in fishing activities as part time to get additional income. They also discussed the mean income they generate from fishing has direct relation with fishing experience. Because fishermen knowledge in fishing and fishing site selection will be improved though experience. Furthermore, lack of adequate government

support, unequal resource access, conflict over resource, lack of participation, little alternative employment opportunities, and poor saving behavior are the challenges on the sustainable livelihood of the fishing communities (Shado 2006).

3.6.Data Analysis Technique

The study utilized both quantitative and qualitative data analysis techniques. To identify the average fish catch level and the challenges faced by fishermen, descriptive statistics such as mean values, percentage and frequency tables were used. Inferential statistics was used to test the hypotheses of factors that affect fish catch level by smallholder fishermen. bivariate analysis and Ordinary Least Square Estimation (OLS) method of multiple regression technique was used to identify the factors that determine fish catch.

3.5.1 Model Specification

Given economic theory and existing literature, the study used the catch level per day as dependent variable, and the factors that are expected to affect catch level as independent variables. The functional form of the regression equation is presented as:

$$Y = f(X_1, X_2, X_3, X_4 \ldots\ldots\ldots\ldots\ldots X_{13}) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.2)$$

Where, Y is the average catch level per day given as a function of the independent variables, X's. For functional form expression, I used X_{ij} to indicate the variable X_i with the value of the j^{th} observation. Base on this the conditional mean $E(Y \mid X_i)$ is a function of X_i, where X_i is a given value of X. Symbolically,

$$E(Y \mid Xi) = f(Xi) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.3)$$

Where $f(Xi)$ denotes some function of the explanatory variable X. Equation (3.3) is known as population regression function (PRF) or population regression (PR) for short. It states merely that the expected value of the distribution of Y given X_i is functionally related to X_i. In simple terms, it tells how the mean or average response of Y varies with X and the derived equation is:

$$E(Y_j) = B_0 + B_1X_{1j} + B_2X_{2j} + B_3X_{3j} \ldots\ldots\ldots\ldots + B_kX_{kj} \ldots\ldots\ldots\ldots\ldots\ldots \quad (3.4)$$

Where B_1, B_2, B_3… B_k signifies coefficients of the X's variables indicating population parameters. The interpretation of B_i represents the expected value of Y due to a unit change in X_i given all other explanatory variables assumed constant. However, qualitative regressor coefficients interpretation is quite different. It is the expected change in the value of Y owing to the variation in dummy variables within the sub-groups relative to their reference; While B_0 is a constant term (Gujarati 2003). Moreover, Y_J individual observation is assumed to be estimated and determined by an equation with an error term and represented as:

$$Y_j = B_0 + B_1X_{1j} + B_2X_{2j} + B_3X_{3j}\ldots\ldots\ldots\ldots + B_kX_k + \varepsilon_j\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.5)$$

The term ε is a random disturbance, so named because it "disturbs" an otherwise stable relationship. The disturbance arises for several reasons, primarily because we cannot expect to capture every influence on an economic variable in a model. The net effect, which can be positive or negative, of those omitted factors is captured in the disturbance term (Green 2003). For our case the error term represents the value of Y_j deviation from its mean. The error term can be imputed to either the effect on the level of fish catch (Y) from the variables which are not included in the model or a random residual element in the regressand. Since population parameters are not easy to determine directly, their values can be estimated from finite sample size taken from the population. Thus, equation (3.4) which is population linear regression equation can be expressed as sample linear regression model written as follows:

$$Y_j = b_0 + b_1X_{1j} + b_2X_{2j} + b_3X_{3j}\ldots\ldots\ldots\ldots + b_kX_k + e_j\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.6)$$

Estimating the sample linear regression function, as the most common method, is to use the OLS regression given that OLS assumptions are satisfied. Therefore, the general model of fish catch per day will have a form of:

$$Y_{qty} = B_0 + B_1\text{FmSize} + B_2\text{LeEdu} + B_3\text{Exp} + B_4\text{AgeHh} + B_5\text{FiIns} + B_6\text{BoOw} + B_7\text{FiTi} + B_8\text{NnIn} + B_9\text{AcTr} + B_{10}\text{MaA} + B_{11}\text{AcCr} + B_{12}\text{Tybo} + e_{ij}\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.7)$$

CHAPTER FOUR RESULTS AND DISCUSSION

4.1 Determinants of Fish Catch

4.1.1 Descriptive Statistics

The level of fish catch in Lake Ziway ranged from 3.33 to125.54 kg per day. The mean catches were 30 kg with a standard deviation 15 kg; this implies in Lake Ziway the average catch of fishers fall between 15 and 45 kg. For wooden boat the fishers had a maximum catch of 125.54kg per day while fishers who had used reed boat had a maximum catch of 123.33kg per day. The mean catch of fishers who used wooden boat was 41.59kg whereas for reed boat it was 13.56kg per day (Table 4.1).

Table 4.1 Fish catch based on boat types in Lake Ziway.

Boat type	Proportion in %	Average catch	Total catch		Ownership	
Wooden boat	39.6%	41.59 kg	Max	Min	Yes	No
Reed boat	60.4%	13.56kg	3.33kg	125.54kg	72.3%	27.7%
	100%					

Source: Own computation

Furthermore, the mean catch of fishers who used reed boats was very low compared to those who used wooden boat. Out of the total sample 60.4% of the respondent used reed boats where as the rest 39.6% used wooden boat. Less numbers of fishers used wooden boat compared to reed boat even if it had better catch. This is because the wooden boat is more expensive and need more capital to earn it; whereas reed boat can be easily prepared by the fishers without any cost. In addition to this, fishers who use wooden boat can cover a long distance manually.

In Lake Ziway two types of boat are used for fishing activities: wooden and reed boat (Fig. 4.1). 72.3% of the respondents are boat owners and the rest (27.7%) are employee. More than 80% of the employee operators had their own boat but unfortunately they all sold the boats below one third of the original price because the boats were quite old; furthermore, they were unable to buy a new one. And the rest were joining the business as new comers to the lake fishery.

Source: Own field survey

Figure 4.1 Commonly used fishing boats on lake Ziway

In addition to this, it was found that there was statistically significant difference between boat type and catch level as determined by one-way ANOVA *(F (2, 104) = 17.50, p* < 0.001). A Tukey post-hoc test revealed that reed boat operators were found statistically and significantly had lower catch (13.56 ± 8.9 kg, *p* < 0.001) compared to wooden boat operators (41.59 ± 21.07 kg, *p* < 0.001).(Table 4.2)

Table 4.2 ANOVA analysis result showing the mean catch difference between wooden and reed boat

		N	Mean	Min	Max	F	Sig.
Catch	wooden	61	41.5901	4	125.54		
	Reed	40	13.5615	3.33	123.33	17.5	.000

The mean difference is significant at 0.01 and 0.05 level

Source: own Computation

The age of the fishers in the sampled survey ranged from 18 to 68 years, with mean age of 35 years. The average age of the fishers who used wooden boat was 38 years while it was 31 years for those who used reed boats. In terms of proportion, about 67% of those fishers who use wooden boats were aged less than 40 years while about 90% of them in a similar age use reed boat. This implies that older fishers use wooden boat to increases the fish catch level (Table 4.3).

Table 4.3 Description of age category versus boat type

Age category	Boat type		Average age		Max	Min
	Wooden	Reed	Wooden	Reed	68	18
18-30	36.7%	51.3%	38 years	31 years		
31-40	36.6%	41%				
41-50	10%	2.6%				
>50	16.7%	5.1%				

Source: Own computation

Moreover, reed boat users are relatively younger; this may be because of the nature of the operating system of the boats. In the case of reed boat the operation is made standing on the boat while it is done sitting comfortably on the middle of the boat in the case of wooden boat; and also it is expected to stand on the boat for long period of time (sometimes more than a couple hours) keeping their balance which is somehow difficult for older age. In addition to this, a chi-square test was also performed and a relationship was found between age of fisher and catch level, X^2 (2, N = 107) = 2802.96, p < .001.

Household size is relatively medium this is because the majority of the fishers are youth who are just married having only one child. The average family size was found 3 persons per household with 29.7% of the fishers had families between 1 and 3, 27.7% had between 4 and 5, 12.9% had between 6 and 8 and 5.9% of the respondent had more than 8 families. The rest 23.8% of the respondents had no any dependant family (Table 4.4). Further, a chi-square test was performed and a relationship was found between household size and catch level, X^2 (2, N = 107) = 912.15, p = .034.

Table 4.4 Description of household size

Family size	Frequency	Percentage	Average	Max	Min
1-3	32	29.7	3	1	11
4-5	29	27.7			
6-8	15	12.9			
>8	7	5.9			

Source: Own computation

The level of fishers' education averages about 6.12 years of schooling. In terms of proportion, the majority (62.4%) of the fishermen finished their primary schools, 28.7% of the fishers were high school graduates and the rest 8.9% had no formal education (Table 4.5). Oluwemimo & Damilola (2013) stated that years of schooling enables fishers understand the technical requirements of fish farming. Conversely, according to Mwakubo et al. (2007), the level of education is not likely to be a major determinant for the level of catch as it is not a source of the skills required in fishing. Nonetheless, education may influence fishing practices through a better understanding of government policy implications and a facilitated collaboration with concerned institutions. Generally, education creates awareness among fishermen about fishery management strategies of the fishing sector. The most educated fishermen are more likely to use the recommended fishing gears.

Table 4.5 Description of education level of respondents

	Frequency	Percent	Average
No formal education	10	9.34%	6.12
1-4	25	23.36	
5-8	42	39.25%	
>9	30	28.03	
	107	100%	

Source: Own computation

Fishing experience ranged between 1 and 30 years, with the mean of 15 years. In fact, 30.7% fished for about 1 to 5 years. 18.8% of the fishers had 6 to 10, and 11.9% had 11 to 15 years fishing experience; the rest 21.8% of the fisher had 16 to 20 and 16.8% had over 20 years of fishing experience (Table 4.6). Moreover, from the total reed boat operators only a very small proportion (7.5%) of fishers had more than 20 years of fishing experience the rest majority had below 20 years of experience. While in case of wooden boat operators out of the total wooden boat users 24.1% of fishers had more than 20 years of experience. This may indicate that more experienced fishers mostly own the wooden boat.

Table 4.6 Description of fishing experience of fishers.

Experience	Boat type		Total	Average	Max	Min
	Wooden	Reed		15 year	30 year	1 year
1-5	25.9%	32.5%	30.7%			
6-10	5.2%	40%	18.8%			
11-15	13.8%	10%	11.9%			
16-20	31	10%	21.8%			
>20	24.1	7.5%	16.8%			

Source: Own computation

Currently, in Lake Ziway three type of fishing instruments/gears are used (Table 4.7). These are long line (28.03%), beach seine (51.41%) and gill net (20.56%). Beach seine (78.7%) is the dominant gear type used by fishers that use wooden boat. Those fishers who used reed boat commonly used the long line (42.5%) and the gill net (50%). This is because of the financial capability of fishers, all of the reed boat users make their own boat using a local wood grown around the lake without any cost because of they don't have the capacity to buy the other type of boat. Furthermore, the price of the hook (used to make the long line) is very cheap compared to gill net and beach seine. Also the price of gill net is relatively much cheaper than beach seine.

Table 4.7 Description of type of fishing gears used by the fishers

Fishing instrument	Frequency	Percentage	Boat type		Ownership	
			Wooden	Reed	Yes	No
Long line	30	28.03%	19.7%	42.5%	89.7%	10.3%
Beach seine	55	51.41%	78.7%	7.5%	51%	49%
Gill net	22	20.56%	1.6%	50%	100%	0%
Total	107	100%				

Source: Own computation

89.7% and 100% of long line and gill net operators are owners of the instrument whereas, only 51% of beach seine operators own the gear ; this is because beach seine is relatively expensive

than the former one. Furthermore, there was a statistically significant difference between groups of fishing instrument on catch level as determined by one-way ANOVA *(F (2, 98) = 29.16, p <* 0.001). A Tukey post-hoc test revealed that beach seine users statistically and significantly had higher catch (48.63 $\pm$ 32 kg, $p < 0.001$) compared to gillnet (10.87 $\pm$ 7 kg, p < .001) and long line (12.78 $\pm$ 11.07 kg, $p < 0.001$). There were no statistically significant difference between long line and gill-net fishing instrument type (p =.959) (Table 4.8).

Table 4.8 ANOVA analysis results showing the mean catch differences between gear types.

		N	Mean	Min	Max	F	Sig.
Catch	long line	29	12.7875	3.33	53.33		
	beach seine	51	48.6316	4.00	125.54	29.16	.000
	gill-net	21	10.8765	3.45	29.00		

The mean difference is significant at 0.05 level

Source: Own Computation

Close to half of the fishers (46.73%) responded that they prefer night time fishing to morning time fishing, which was the preference for 35.52% of the fishers. The rest 17.75% do their fishing activity in the afternoon (table 4.9). Majority (82.4%) of those fishers who use beach seine did their fishing activities during night time, while most of gill-net (71.4%) and long line (58.6%) users did their fishing activities during morning time. This may depend on the nature of the fishing instrument beach seine is an active gear; meaning fishing gears are actively moved to catch fish since it is night and not visible to the fishes. Whereas gill net is a passive gear, which are kept in the water and catches those fishes which try to pass through the nets set. Likewise, long line also has the same characteristic with gill net the difference is it select specific type of fish; mostly the fishers use long line to catch *Clarias gariepinus* (local name Ambaza).

Table 4.9 Gears used by the fishers in the lake and time of fishing.

Time of fishing	Frequency	Percentage	Fishing instrument/gear		
			Long line	Beach seine	Gill net
Morning	38	35.52%	58.6%	7.8%	71.4%
Afternoon	19	17.75%	27.6%	9.8%	23.8%
Night	50	46.73%	13.8%	82.4%	4.8%
Total	107	100%			

Source: Own computation

Moreover, there was a statistically significant difference between groups of fishing time on catch as determined by one-way ANOVA *(F (2, 98) = 6.499, p* = 0.002). A Tukey post-hoc test revealed that night time users statistically and significantly had higher catch (38.9 $\pm$ 30 kg, $p < 0.001$) than afternoon (28.79 $\pm$ 16.07 kg, $p < 0.001$) and morning time (17.5 $\pm$ 14.4kg, $p < 0.001$). There were no statistically significant difference between afternoon and morning time (p = .455).

Table 4.10 Result of ANOVA analysis showing the mean catch difference between fishing time.

		N	Mean	Min	Max	F	Sig.
Catch	morning	38	17.5076	3.33	123.33		
	afternoon	4	28.7950	4.17	83.34	6.499	0.002
	night	59	38.9658	3.45	125.54		

The mean difference is significant at 0.05 level

Source: own Computation

Majority (46.72%) of the respondents confirmed that they had maximum production between January and April; and average catch in September to December which is confirmed by 46.73% of respondents. On the other hand greater parts (71.03%) of the respondents agree that they had minimum production in May to August (Table 4.11).

Table 4.11 Seasonal variations in fish production.

Month	Production rate					
	High		Average		Low	
	Freq	Per	Freq	Per	Freq	Per
Sep to Dec	42	39.26%	50	46.73%	11	10.28%
Jan to April	50	46.72%	42	39.25%	20	18.69%
May to August	15	14.02%	15	14.02%	76	71.03%
Total	107	100%	107	100%	107	100%

Source: Own computation

Furthermore, 48.3% of fishers who use long line produce maximum production in September to December; and also 51% of fishers who use beach seine got the maximum production in January to April. Whereas, gill-net users confirm that they had maximum production in both September to December and January to April. 81%, 76.5% and 55.2% gill-net, beach seine and long line users respectively confirm that they had minimum production May to August (Table 4.12).

Table 4.12 Comparison of production period versus fishing gears used in Lake Ziway.

Month	Fishing gear								
	Long line			Beach seine			Gill net		
	High	Average	Low	High	Average	Low	High	Average	Low
Sep to Dec	48.3%	41.4%	10.3%	35.5%	51%	9.8%	47.6%	42.9%	9.5%
Jan to April	27.6%	37.9%	34.5%	51%	39.2%	13.7%	47.6%	42.9%	9.5%
May to August	24.1%	20.7%	55.2%	13.7%	9.8%	76.5%	4.8%	14.3%	81%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%

Source: Own computation

The majority of the fishers (77.59%) are full timers throughout the year. Only 22.41% had additional income from other sources, such as farming, animal husbandry, and fish trading. Those who had additional income undertake the fishing business because they earn less income from their primary job. Very small proportion of fishers (17.76% and 27.11%) had access to finance to buy boats, spare parts and nets for the fisher had access to fishing related training respectively. Due to financial constraint most of the fishers are unable to change their boat and net; as observed in the field most of the fishers gears and their boats are very old as a result of

serving for long period of time and this may constrained the fishers from better production. In addition to this about 59.81% of the fishers had no marketing problem, meaning, according to the interviewed respondent after they catch the fish they get fair price for fish caught(Table 4.13).

Table: 4.13 Table showing Description of dummy variables used in the study.

variables	Frequency		Percent	
	Yes	No	Yes	No
Access to credit	19	88	17.76%	82.24%
Access to market	64	43	59.81%	40.19%
Non fishing income	24	83	22.41%	77.59%
Access to training	29	78	27.11%	72.89%
Boat ownership	78	29	72.89%	27.11%

Source: own computation

4.1.2 Results of Multivariate Regression Analysis

4.1.2.1. Model Performance

Before discussing the results of the multiple regression analysis, it is important to see the performances of the model in terms of test of multicollinearity and hetroscedasticity. And also it is important to test whether the model is fit or not.

Test of Multicollinearity

The data were subjected to the analysis of tolerance and variance inflation factor (VIF) following Gujarati (2003) to examine if the presence of multicollinearity inflates the variance of an estimator. The results of the test indicates the highest VIF is 4.052 or tolerance, 0.247 with R^2 = 0.527; which indicates the model performed with no major multicollinearity problem among the explanatory variables (table 4.14).

Table 4.14 test of multicollinearity

Model	Unstandardized Coefficients	t	Sig.	Collinearity Statistics	
	B			Tolerance	VIF
(Constant)	33.058	1.233	.221		
Age of fisher	.466	.980	.330	.247	4.052
Level of education	.133	.138	.890	.732	1.365
family size of fishers	.133	.089	.929	.452	2.213
fishing instrument	4.206	.893	.375	.738	1.355
type of boat	-26.686	-3.210	.002	.487	2.052
Ownership	6.742	.781	.437	.553	1.810
Experience	-.347	-.712	.479	.267	3.742
fishing time	2.527	1.223	.225	.811	1.233
Access to training	1.692	.196	.845	.525	1.904
Access to Credit	-9.310	-1.019	.311	.667	1.498
Non fishing income	-1.231	-.162	.872	.770	1.298
market access	.839	.125	.901	.744	1.344

Source: Own computation

Test for Hetroscedasticity

One of the important assumptions of the classical linear regression model is that the variance of each disturbance term u_i, conditional on the chosen values of the explanatory variables, is some constant number equal to σ^2 (Gujarati 2003). Although there are different ways and techniques to check the existences of hetroscedasticity, for the purpose of this research this was done using the White's General test the results of the test showed that 85.47 and 74.39 are the calculated and tabulated value respectively. Since the former exceeds the later one the null hypothesis is rejected which indicate the presence of Hetroscedasticity. This confirms that the error variance is not constant; consequently, it has been employed weighted least squares to estimates the reasonably accurate test statistics (More on Hetroscedasticity in Appendix A).

Furthermore, determinants of fish catch level were estimated using the OLS method. The coefficient of determination (R^2) for the model is 0.768 (F= 20.429, $p < 0.001$) showing that the model explained 76.8% of the variation in the level of fish catch level and the overall model is statistically significant. In addition to this Cronbach's Coefficient Alpha method was also used to test the reliability of the data, therefore, the data was 68% reliable.

4.1.2.2. Estimation results

The results of the econometric model estimation revealed that age of fishers, education level, family size, and experience and market access were found to increase fish catch level (Table 4.15). In contrast, type of boat, boat ownership and existence of non fishing income are linked to reduce catch.

Table 4.15 Table showing estimated parameters and their effect

Variables	Coefficients	Beta	t	Sig.
AgeHh	1.683	.840	3.423	.001
LeEdu	10.894	.221	2.198	.031
Fmsize	6.695	.804	4.236	.000
FiIns	13.313	.293	.720	.474
TyBo	-3.300	-.072	-.171	.865
Ownship	-9.660	-.110	-.892	.375
Exp	5.215	2.205	6.957	.000
FiTi	23.445	1.128	4.709	.000
AcTr	7.405	.163	.556	.580
AcCr	-28.832	.631	1.565	.122
NnFiIn	-15.329	-.401	-4.944	.000
MaAcc	16.217	.578	2.203	.031

* The mean difference is significant at the 0.05 level.

$R^2 = 0.768$

(F= 20.429, p = 0.000)

Age and experience had a positive and significant effect ($p<0.05$) on fish production, indicating that as the age increases fish catch also increases. Furthermore, the analyses indicate as the age and experience of fishers increase by one year their harvest would also increase by 1.7 and 5kg respectively (table 4.15). The result is also consistent with the findings of Adepoju et al. (2009) who concluded that the age of fishers is directly related to their catch. This is due to the fact that as age increased, years of experience also increases which had a positive contribution to fish catch level. In contrast to this, Garoma et al. (2014) argue that as the fishermen grow older, their performance drops and so does the general fish catch. Furthermore, they claimed that as compared to the younger age groups, the aged ones show fewer tendencies to stay in fishing activities since fishing demands more energy and more time to stay on a water body searching for fish.

Household size also exerted a positive and significant ($p<0.05$) impact on fish production. The estimation result revealed that as the number of household size increased by one unit, the fishers' catch also increased by 6 kg (table 4.15). According to Agboola (2011) families with large family size had higher fish catch than families with smaller family size. Labor is a very important factor in traditional agriculture. Family labor is very important in fish production and as the size of the household increases availability of labor also increases hence positively

contributes to increased fishing effort. According to Kudi et al. (2008) family labor is a major source of labor in developing countries to carry out various operations in fish production.

Non-fishing income, i.e. the income which comes from sources other than the fishing activity had a negative and significant ($p< 0.05$) impact on fishers' harvest. This is because the existence of alternative sources of livelihood is a key factor in supporting fishery resources under-utilization (Demena 2011). Furthermore, the regression result shows the existence of additional income reduced the catch of the fishers by 15kg (table 4.15).

Education was also found to have a positive and significant ($p<0.05$) effect on fish catch. The estimation result revealed that as the fishers education increase by one their harvest would also increased by 10 kg (table 4.15). According to Forde, 1994 (cited by Akanni (2008)) the low level of fishing education and social status of the artisanal fishermen were some of the constraints to their fish catching and indeed their development. Enlightenment training workshops on fisheries are contended to enhance the operations and fortune of the fishermen (Forde 1994). Fishermen who had better education use highly qualified technologies that need technical skills and scientific knowledge (Olaoye et al. 2013). The finding of this study is also consistent with the observation of Henri-Ukoha (2012) who found that the coefficients of education were positive and significant at 5% .

The other variable which had significant ($p < 0.05$) and positive impact is the time of fishing. The regression result indicate that changing the time of fishing create a 24kg difference on fish production (table 4.15). Fishers who do fishing during night time are found to have higher catch than those who do fishing during day time (morning and afternoon). In lake Ziway, traditionally fishers believe that large number of fish can be caught during night time since the net and/or beach seine and gillnet is not visible for the fish. The fishers also contended that during night time, when the water body is quite, there is active movement of fish that increases the chance of catching fish; The other reason explained by considerable number of fishers was that if the direction of the wind is towards the town (Ziway) to the west, the probability of catching large number of fish is high. Jones et al. (2004) also presented the impacts of light on availability of fish. They contended that vertical migrations and resting behavior of different fish species vary between day and night time. The availability of fish will depend on their patterns of movement, which, although varying widely in scale, are rarely random. Routine activities such as feeding,

spawning, aggregating, resting, and predator evasion are usually linked to changes in the environment, such as season, tidal state and light levels. Moreover, they cited the findings of Beamish (1965) and Blaxter (1974) that stated the vertical migrations of many pelagic fish species is closer to the water surface during night than day time. They also cited the conclusion of Helfman (1993) and Nash et al. (2001) who stated as light levels change and fish cease to forage, they become less active, either forming resting aggregations or seeking hiding places. Such behavior may cause the vulnerability of the fish to fishing gear.

Marketing fishery products is a serious problem and had a significant ($p < 0.05$) effect on catch level. Thos who have no market problem had 16 kg difference in their catch from those having market problem (table 4.15). According to the fishing operators interviewed there is no market provided to their fish, all is delivered to local traders and directly to the consumer at the price set by the local traders. In addition fishers are not satisfied with the price as it does not allow them to cover their basic expenses. This finding is supported by Njagi et al. (2013), which stats fishers harvest is directly related with access to market. Furthermore, according to Kariuki (2011), to promote production and to ensure enough supplies of fish to the consumers at reasonable prices, quantities and with high quality, an efficient fish marketing system would be required. Three issues are thus important. These include storage, transport and processing. Storage will ensure that enough supplies will be available during the off-season. Transport is a service to transfer from surplus areas to deficit regions in the country. Finally, processing provides different kinds of finished products to meet the diversified demands of consumers. Price differences may reflect market functioning, while arbitrage in time, space, and form increases the value of the product.

The other variables such as type of fishing instrument, type of boat and boat ownership are not statistically significant and hence do not create difference on fish catch. Similarly, the other dummy variables such as access to training and access to credit were found to be statistically insignificant (table 4.15) and consequently do not create differences in terms of fish catch levels, which is mostly not theoretically supported.

4.2. Challenges and Opportunities of Small scale Fishery Production

4.2.1. Challenges of Fish production

According to Golubtsov *et al.*, 2002 (cited by Hailu 2011) there are six indigenous fish species in lake Ziway, which includes *Barbus ethiopicus, Barbus paludinosus, Labeobarbus intermedius, Garra makiensis, Garra dembecha* and *oreochromis niloticus.* Four exotic fish species such as T*ilapia zillii, Carassius carassius* and C*carassius auratu* which were introduced in to the Lake with the objective of enhancing the production of fish, while *Clarias gariepinus* is believed to have been slipped into the lake accidentally.

Even though all these fish species exist in the lake, only some fish species are commercially exploited, which includes tilapia (*Oreochromis niloticus* and *Tilapia zillii*), carp (*Carassius auratus* and *Carasius carrasius*) and catfish (*Clarias gariepinus*) (Hailu 2011).

O. niotucs is highly demanded by consumers and most fishers target to catch it. As a result it is the most exploited type of fish species in the area. According to the researchers observations in five landing sites the amount of catch of tilapia nilotica is very small compared to the catch of other types of fish. According to Abera *et al.* (2014) water is being diverted from rivers that feed the lakes and directly from the lake itself. This has contributed to the decline of the water level of the lake and to the destruction of fish habitat especially the breeding grounds of the fishes. This has reduced the stock of tilapia nilotica in lake Ziway. Tilapia also suffers from stunted growth caused by stress, probably due to a combination of low water levels / reduced breeding grounds and too high fishing pressure (Spliethoff et al. 2009).

The lake is freely open to everyone in the surrounding, and close to 50% of the respondents confirmed that anyone interested is free to join the fishing business (Table 4.16). The only criterion, at least in principle, to enter into the fishing business is to be a member of one of the fishing cooperatives legally recognized in the area. Therefore, membership to a cooperative is used as a license to join into the fishing business. This is supported by the findings of Spliethoff et al.(2009) who argued that entry into the fishing business in Lake Ziway is similar to the cases in other lakes and rivers in Ethiopia, and all the resources are exploited based on the principle of open access to the water resources. Due to free access to the water resource, over-exploitation of fishery is the challenges of the lake Ziway. Although most fishers are organized in cooperatives

at least in principles, a considerable number of fishermen are operating outside the framework of cooperatives in lake Ziway. Furthermore, Fishery cooperatives are structures supposed to implement community based management of the lakes and fish population. They were supposed to create market opportunity exclusive to their members to enable them benefit from sale of the fish output at competitive price. Despite the fact, their performance is loose which is perhaps limited to collection of the fish output from members at the lake site. The collected output was delivered to wholesalers, retailers, hotel and restaurants, and individual customers with low price. Hence, there were no clear demarcation of services provided to the member house-hold and the non-members. As a result, fishermen were reluctant to join fishery cooperatives. Different studies also (MOA (1997); Yohannes (2003); and Garoma et al. (2014)) also came up with similar findings in different lakes of Ethiopia.

Another challenge for optimal fish production in lake Ziway is the deposition of wastes and chemicals from flower farms and motors in the area. Close to 43% of the respondents reflected that lake pollution as one of the main reasons for the decline of fish production in the area (table 4.16). Details of the different types of factors that contribute to the decline in fish production in lake Ziway are presented below in table 4.16.

Table 4.16: Challenges of fish production related to the ecology of Lake Ziway.

Problems of the lake	Frequency	Percent
open access	55	49.5
Wastage/pollution	48	43.2
Over-exploitation by large number of fishers	14	12.6
Change in weather condition	6	5.4
Destruction of fishery breeding site	3	2.7
Excess water consumption for plantation	2	1.8
Deforestation	1	0.9

Source: Own survey

Table 4.17 Challenges of fish production related to small scale fisheries in Lake Ziway.

Type of constraint	Frequency	percent
Illegal fishers	85	76.6%
No fish processing place	84	75.7%
Limited government support and follow up	77	69.4%
Market problem	64	57.7%
Theft of fishing material	35	31.5%
Lack of modern fishing instrument	10	9%
Use of net below standard mesh size	5	4.5
Predators	4	3.6%

Source: Own computation

The most serious problem mentioned by the fishers in Lake Ziway is the operation of illegal fishers, which was mentioned by close to 77% of the respondents (table 4.17). Although it is difficult to know the exact number of illegal fishers, a report by Ziway animal science agency there are about 130 illegal fishers operating in the Lake (table 4.18); but according to the respondents the number is more than this and the number also fluctuates in off-farm and fasting seasons during which the number of illegal fishers increases tremendously.

Table 4.18 Boats and gear types used in Lake Ziway

Description	Type and number of gear used			Type of boat		Number of Fisher
	Beach seine	Gill-net	Long line	Wood Boat	Bofofe	
Legal	67	137	49,300	74	-	203
Illegal	4	98	62,620	23	85	>130
Total	71	235	111,920	97	85	

Source: Ziway animal science Agency, 2014

Absence of post-harvest processing place (eg. storage) is the second critical problem mentioned by close to 76% of the respondents (Table 4.17). Fishers don't have a place for storage with the

required storage facilities that can preserve the fish until it reaches to the consumers. It was also reported that lack of marketing is a critical problem that the fishers are eking out. The selling price of the fish is seasonal; if the time is fasting the selling price would be goes up where as it is low in other time. According to the assessment made mostly the beneficiaries are the local traders because of the market chain problem. Mostly the buyers are consumers and local traders. In the landing sites there are fixed local traders not more than 6; these local traders set a price and don't allow the fishers to communicate/contact directly with the merchants who came from other places especially from Addis. This makes the fishers always a victim of law price. Due to lack of storage facilities fishers sell at low prices during periods of high harvest. As shown in Figure 4:1 fishers prepare a fish fillet near the lake shore which is not clean enough and may cause hygienic problems.

Source: Own picture taken form field survey

Figure 4:1 Fishers' fillet fish in open air near the shore on the ground.

Lack of government support and follow up (69.4%) is the third critical problem of the fishers (table 4.17). After the cooperatives are established there should be continuous support and follow up until they could do things by their own. A visited paid by the researcher to the four cooperatives showed that they don't have any systematic recording of transactions, auditing and reporting mechanisms. Only one cooperative saves in Oromia saving and credit association. All the fishers, after being a member of the cooperative, use their own boats and gears, and there is no any common asset that belongs to the cooperative. Examination of records of the cooperatives revealed that most of the members do not contribute to the cooperative in terms of finance even though all members is obliged to contribute 10% of their monthly income as a saving. These further strengthen the argument presented above that membership is used as a mechanism of getting license to be a legal operator.

Except during period of fasting, government inspections are literary absent. In addition to this considerable number of the respondents replied that the fishing cooperatives never received financial support since they were legally recognized by the government. Due to this their performances are not significantly different from individual fishers who operate as independently. This has put also a setback on cooperative membership and some members also quite and starts operating as individual fishers.

Poor market linkage between fishermen and traders who supply fish to Addis Ababa market is another challenge that the fishers face in Lake Ziway. This was mentioned as a bottleneck by over 60% of the respondents (table 4.17). The small-scale fishermen mostly sell their fish directly to the local consumers and to the local traders. The local traders usually set the prices. The mean price of fish during fasting time in Ziway is ETB 20 birr per fish and it goes down ETB 3 to 5 during non-fasting period. According to the respondents there are hidden brokers who operate between the fishermen and the traders who come from Addis Ababa. The lion's share of the profit goes to the local traders and so far the cooperatives don't serve as institutions to increase the bargaining capacity of the members of the cooperatives. The fishing cooperatives have much to learn from coffee farmers cooperatives in Ethiopia that basically serve to increasing the benefits that accrues to their members.

Others factors that are mentioned by relatively small proportion of the respondents were theft of fishing material, lack of modern fishing instrument and predator (see Table 4.17). Because of the

passive nature of gill net and long line mostly they are a victim of theft. These fishing instruments are made to rest on the bottom to hang between the bottom and the surface, or to float on the surface due to this the fisher is oblige to let these fishing instruments in the middle of the lake alone the whole night till the next day, though letting the instrument alone has no any guarantee. Furthermore, the gear used by the fishers are too old especially the beach seine and gill-net; because of they don't have the capacity to replace the old one financially.

The gears, especially the beach seine and gillnet, used by the fishers are too old. Nor they had financial capacity to replace the old gears with new ones. Exacerbating the situation, fish nets are sometimes damaged by hippopotamus and in such circumstances the fish net could be completely out of function.

4.2.2. Opportunities of Fish Production in Lake Ziway

Lake Ziway creates job opportunity for the surrounding community. Depending on the season (good or bad) the fishers can generate ETB 20-500 per day. For the majority of the fisher (77.2%) fishing is the only income source for their livelihood, though the availability of the resource for long period of time is in question.

Oromia saving and credit institute open its branch in Ziway town. One cooperative out of the five starts to save some amounts of money monthly; this may give some insight to the fishers to become economically more influential.

Ziway Fisheries Resource Research Center is one of the known research center at regional level. This research center provides current information about the existing situation of the lake every time. The center tries to protect the ecology of the lake in different ways like introducing new variety of fish species to protect the existed variety stock, provide information on the existing stock level and depending on the necessity of the information it provide data on the water level and mixture. Furthermore, this center organizes trainings for the fisher men's. This training may contribute at least a little to the resource conservation of the lake.

The presence of fishery proclamation also may contribute to ban illegal fishing instruments and protect the fishery.

CHAPTER FIVE SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1.Summary of core findings

The results of the research elucidated positive and significant association/correlations between ages, education level, family size, experience, access to market and fishing time and fish production. Access to non-fishing income is linked to reduce fish catch. Types of fishing gears, types of fishing boats, boat ownership, access to training, and access to credit were not statistically significant in determining fish catch.

The econometric analysis indicates age and experience was positively and significantly related with fish catch. This elucidates that older fishers were more likely to be productive. This might be because older fishers become more experienced and increase their fishing ability as their age increases. Fishing time was also found to be the most important factors that affect catch. Fishers who fish at night time had better catch than morning and afternoon.

There was a significant effect of fishing gear on fish catch. The result suggests that, there were strong evidence that the type of fishing instrument really do have an effect on fish harvest. The analysis indicates that, on average those who employed beach seine and long line had higher and lower catch respectively. This suggests using beach seine is more effective than long line but unfortunately because of its destructive nature beach seine is not a recommended gear and it is also prohibited by law. The beach seine indiscriminately catches both juvenile and large fish. That is why it is destructive to the lake fishery.

Household size and education level of the fishers also exerted a positive and significant impact on fish catch. Further, the standardized regression coefficient, beta, has shown these are the most important variables in the fishery production function. All these evidence supports that level of education significantly explain the variation in small scale fishery catch. Given this result, the study confirmed the relevance of education in adoption and use of better fishery technology to increase and maintain higher catch. The econometric result also shows positive and significant relationship between market access and fishers catch.

The lake is open and gives service to any one throughout the year. In fact, the fishing is allowed only for those who are members of the cooperatives. In lake Ziway the fishing activity formally takes place by small scale fishers organized and licensed as cooperatives. The others who are not

members of the cooperatives but who are still in fishing activity are called illegal fishers. These illegal fishers are the major challenges of the small scale fishers. In addition, the discharge from the flower farm, car engine and motors which is used for irrigation are the other responsible factors affecting the lake fishery. Large number of fishers and implementation of small mesh size were the other critical problem in the lake fishery.

In the lake fishers after they catch the fish they don't have any place for fillet, storage, selling of their product. This means in general they don't have any legal place for post harvest fishing activities. They are organized in cooperatives but they don't have specific address and place. In addition to this there is no continuous follow up and support to the fishers from concerned bodies mainly from the Oromiya breau of agriculture. Moreover, gill net and long lines are the main fishing gears which are mostly vulnerable to theft. In addition, depending on good and bad time they generate maximum and minimum 20 and 500 birr per day respectively. For majority of the fisher fishing is the only income source for their livelihood.

5.2.Conclusion and Recommendation

For sustainable fish production and conservation of the resource the

Fishing gears used by the fishers should be controlled by the concerned authorities. In Lake Ziway the restricted fishing gear beach seine is employed for fishing activities; this instrument has a distractive nature so the concerned body should follow and stop the application of this fishing instrument.

The small scales fishers in Lake Ziway were economically poor and majority of them do not have alternative means of livelihood. Also their educations were very low in which it contribute for their low production. Thus, since small scale fishers are contributing to the economy some form of support is required, for example, creating markets chain and the provision of credit. Furthermore, since the fishers had poor background in terms of knowledge and finance there should be continuous support and follow up tile they could do things by their own self. In addition to this a place should be provided/given for their fishing activities.

Lake Ziway is open to anyone who wishes to join the fishing business and this leads to overexploitation of the resource. Hence, rights and responsibilities should be bestowed on fishing communities to restore, protect and manage local aquatic and coastal ecosystems on which they depend for their well-being and that they have used traditionally for their livelihoods. In order to eliminate illegal or inconsiderate activities and practices threatening livelihoods and resource sustainability, participatory stewardship regimes involving small-scale fishing communities should be promoted.

As to the conclusion of further work, apparently there are issues that the study draws attention to and based on findings of the current study and relating to previous works, the following recommendations are forwarded.

1) It is necessary to conduct well-organized further studies on determinants of the production which consider the type and biological nature of the fishes. In addition to this, data limitation on access to credit facilities for instance restricts to identify the type of loan so as to treat them accordingly in our model.

2) Due to time and other resource limitation the study conducted only on the westerns side of the lake; given the basic shortfalls of cross-sectional data which is the inability to control for unobserved heterogeneity and the small sample size, inference to the entire artisanal fishing population may not be valid. Though further study may require which consider the whole surrounding of the lake may show and identify the gap clearly

3) Monitoring of the *O. niloticus* and other fishes in and around lake Ziway need be strengthened for conservation as well as production purposes; fatherly, even if beach seine is not allowed for fishing purpose due to its destructive nature, but still in lake Ziway fishers use this gear to catch fish, so the municipality or concerned office should stop this.

4) Enforcement of management measures, effective training and extension work should be implemented which incorporate active participation of the fisher community including the so called illegal fishers. Moreover, continues support for organized fishery cooperatives should be done in terms of finance and training.

Reference

Abegaz, H., Tesfaye, G. & Cheffo, A., 2010a. *Riverine Fishery Assessment in Gambella Peoples ' Regional State*,

Abegaz, H., Tesfaye, G. & Cheffo, A., 2010b. *Survey on fish resource potential and Socio-economics of Tendaho Reservoir , Afar National Regional State*,

Abegaz, H., Yalew, A. & Mengistu, E., 2012. Fish Resource Survey in Benishangul-Gumuz Regional State based on Fish Resource Survey in Benishangul-Gumuz Regional State. In *The Fourth Annual Conference of the Ethiopian Fisheries and Aquatic Sciences Association*. Addis Ababa, Ethiopia: EFASA.

Abera, L., Getahun, A., Lemma, B., et al., 2014. Composition of commercially important fish species and some perspectives into the biology of the African Catfish Clarias gariepinus (Burchell), Lake Ziway, Ethiopia. , 2(1), pp.864–871.

Abera, L., Getahun, A. & Lemma, B., 2014. Composition of commercially important fish species and some perspectives into the biology of the African Catfish Clarias gariepinus (Burchell), Lake Ziway, Ethiopia. *International Journal of Advanced Research*, 2(1), pp.864–871.

Abera, L. & Tadesse, Z., 2008. The potential and prospect of aquaculture development in Ethiopia. In *Commercialization of Livestock Agriculture in Ethiopia*. Addis Ababa, Ethiopia: ESAP.

ACP, 2012. African, Caribbean and Pacific Group of states (ACP) Fish II project. Available at: http://acpfish2-eu.org/index.php?page=ethiopia&hl=pt [Accessed March 13, 2012].

Adebayo, O.O., 2012. Determinants of Extension Service Needs Of Catfish Farmers in Oyo State , Nigeria (A case study of Ido local Government Area .). *IOSR Journal of Humanities and Social Science*, 1(4), pp.54–58.

Agboola, W., 2011. *Improving Fish farming Productivity towards Achieving Food Security in Osun State , Nigeria : A Socioeconomic Analysis*,

AJKFEDO, 2006. *Annual Report on Wereda Profile*,

Akanni, K.A., 2008. Catch Levels and Capital Investment of Artisanal Fishermen in Lagos State , Nigeria. *Turkish Journal of Fisheries and Aquatic Sciences*, 368, pp.361–368.

Anteneh, A., 2013. *Management and Livelihood Opportunity of Lake Tana Fishery, Ethiopia The need for co management*. University of tromso.

Bene, C., Macfadyen, G. & Allison, E.H., 2007. *Increasing the Contribution of Small-scale Fisheries to Poverty alleviation and Food Security*, Rome.

Berihun, A. & Dejenie, T., 2012. Population Dynamics and Condition Factor of Oreochromis niloticus L. in Two Tropical Small Dams, Tigray (Northern Ethiopia). *Journal of Agricultural Science and Technology*, 2, pp.1062–1072.

BONFIGLIOLI, A. & HARIRI, K.I., 2004. *Small-scale Fisheries in Yemen Social Assessment and Development Prospects*, Yemen.

CEC, 1997. *LAKE MANAGEMENT PLANS*,

Chowdhury, M.H. & Maharjan, K.L., 2000. Increasing Efficiency of Pond Fish Production in Rural Bangladesh. In *IIFET*.

COMESA, 2004. *Development of East and Southern Africa Inland Fisheries Industry in a More Sustainable Way: Trade Aspect,Case Study of Inland Fisheries in Burundi, R.Congo, Dijibuti, Erteria,, Ethiopia, Ruwanda, and Sudan*,

Cox, J., 2012. *ASSESSMENT REPORT ON SMALL-SCALE FISHERIES IN AFRICA*,

Dejen, E. & Mintesnot, Z., 2012. A generic GIS based site suitability analysis for pond production of Nile Tilapia (Oreochromis niloticus) in Ethiopia. In *The Fourth Annual Conference of the Ethiopian Fisheries and Aquatic Sciences Association*. Addis Ababa, Ethiopia: EFASA.

Demena, B.A., 2011. *Determinants of Fish Catch Levels in Artisanal Fishing in Eritrea*. International Institute of Social Studies.

Dessalegn M. Ketema , Nickolas G. Chisholm, P.E., 2013. Exploring governance of Lake Tana fishery: Interactive perspective on governance. , 5(2).

EFASA, 2012. A generic GIS based site suitability analysis for pond production of Nile Tilapia (Oreochromis niloticus) in Ethiopia. In Addis Ababa.

Eggert, H. & Greaker, M., 2009. *Effects of Global Fisheries on Developing Countries Possibilities for Income and Threat of Depletion*,

EU, 2011. *Final Technical Report Training for Fisheries Management Planning in Ethiopia Ethiopia*,

FAO, 2011. *Fishery and Aquaculture Statistics*,

FAO, 2012. *Fishery and Aquaculture Statistics*,

FAO, 2004. *REPORT OF THE FAO-WORLDFISH CENTER WORKSHOP ON SMALL-SCALE AQUACULTURE IN SUB-SAHARAN AFRICA: REVISITING THE AQUACULTURE TARGET GROUP PARADIGM*, Rome.

FAO, 2014. Small-scale and artisanal fisheries. Available at: http://www.fao.org/fishery/topic/14753/en.

Farrugio, H., 2013. *SITUATION OF SMALL-SCALE FISHERIES IN THE MEDITERRANEAN AND BLACK SEA : STRATEGIES AND METHODOLOGIES FOR AN EFFECTIVE ANALYSIS OF THE SECTORE*,

Garoma, D. et al., 2013. Analysis of determinants of gross margin income generated through fishing activity to rural households around Lake Ziway and Langano in Ethiopia. *Agricultural Sciences*, 04(11), pp.595–607. Available at: http://www.scirp.org/journal/PaperDownload.aspx?DOI=10.4236/as.2013.411080.

Garoma, D. et al., 2014. Analysis of the Impact of Fishery Cooperatives on Fishing Activity of Rural Households Around Lake Ziway and Lagano in Ethiopia. *Middle-East Journal of Scientific Research*, 19(2), pp.144–162.

Gebrekidan, A., Berhe, M. & Weldegebriel, Y., 2012. Bioaccumulation of Heavy Metals in Fishes of Hashenge Lake, Tigray, Northern Highlands of Ethiopia. *American Journal of Chemistry*, 2(6), pp.326–334.

Golubtsov, A. S. and Mina, M. V. (2003) Fish species diversity in the main drainage systems of Ethiopia: Current state of knowledge and research perspectives. Ethiopian Journal of Natural Resources 5 (2): 281–318.

Green, W., 2003. *Econometric Analysis* 5th ed., Dorling Kindersley Pvt.Ltd.

Gujarati, D.N., 2003. *BASIC ECONOMETRICS* FOURTH EDI., New York: McGraw-Hill/lrwin.

Hailu, M., 2011. *Ecosystem structure , trophic link and functioning of a shallow rift valley lake : the case of Lake Ziway (Ethiopia)*. Addis Ababa University.

Heide, F., 2012. *Feasibility Study for a Lake Tana Biosphere Reserve, Ethiopia*, Bonn,.

Hellegers, I.P. et al., 2008. *Preconditions for a Payment for Environmental Services establishment at Central Rift Valley , Ethiopia*. Wageningen University.

Henri-Ukoha, A., 2012. Profitable Fish Farming Towards the Attainment of the Millennium Development Goals (MDG): A Case of Catfish Farmers in ABA Agricultural Zone of Abia State , Nigeria. *ARPN Journal of Science and Technology*, 2(7), pp.581–585.

Israel, G.D., 2013. *Determining Sample Size*,

Jones, E., Glass, C. & Milliken, H., 2004. *THE REACTION AND BEHAVIOUR OF FISH TO VISUAL COMPONENTS OF FISHING GEARS AND THE EFFECT ON CATCHABILITY*

IN SURVEY AND COMMERCIAL SITUATIONS EMMA JONES, CHRIS GLASS AND HENRY MILLIKEN., Gdynia.

KARIUKI, M.J., 2011. *ANALYSIS OF MARKET PERFORMANCE: A CASE OF "OMENA" FISH IN SELECTED OUTLETS IN KENYA*. EGERTON UNIVERSITY.

Kehinde, A. et al., 2009. Towards boosting aquaculture production: An identification of key determinants of catfish (clarias gariepinus) consumption in Ibadan metropolois of Oyo state, Nigeria. In *Food Security, Natural Resource Management and Rural Development*. Tropentag.

Kelil, A., 2002. *USERS ' ATTITUDES TOWARD FISHERIES MANAGEMENT ONLAKE ZEWAY, ETHIOPIA*. University of Tromsø.

Kudi, T.M., Bako, F.P. & Atala, T.K., 2008. ECONOMICS OF FISH PRODUCTION IN KADUNA STATE NIGERIA. *ARPN Journal of Agricultural and Biological Science*, 3(5), pp.17–21.

Kurien, J., 1998. SMALL-SCALE FISHERIES IN THE CONTEXT OF GLOBALISATION. In Tromso, pp. 1–47.

Lackey, R.T., 2005. *Fisheries : History , Science , and Management*,

Lemoalle, J., 2008. *Water productivity of aquatic systems*,

Mazengia, A., 2008. *ASSESSMENT OF LAKE ZIWAY WATER BALANCE*.

Mitike, A., 2013. Assessment of fish products demand in some water bodies of Oromia , Ethiopia. *International Journal of Agricultural Sciences*, 3(8), pp.628–632.

Mitike, A., 2014. Fish Production , Consumption and Management in Ethiopia. *Research Journal of Agriculture and Environmental Management*, 3(9), pp.460–466.

MOA, 1997. *LAKE FISHERIES DEVELOPMENT PROJECT , PHASE II LAKE MANAGEMENT PLANS*, Addis Ababa, Ethiopia.

Mwakubo, S.M., Ikiara, M.M. & Abila, R., 2007. Socio-economic and ecological determinants in wetland fisheries in the Yala Swamp. *Journal of Wetlands Ecology and Management*, pp.1–14.

MWIMA, H.K., 2012. *REGIONAL ASSESSMENT OF FISHERIES ISSUES, CHALLENGES AND OPPORTUNITIES FOR EASTERN AFRICA REGION TOWARDS THE FORMULATION OF THE POLICY FRAMEWORK AND REFORM STRATEGY FOR FISHERIES AND AQUACULTURE IN AFRICA*,

Njagi, K.A., Njati, I.C. & S, G.H., 2013. Factors Affecting Profitability of Fish Farming Under Economic Stimulus Programme in Tigania East District , Meru County , Kenya. *IOSR Journal of Business and Management*, 15(3), pp.25–36.

Olaoye, O.. et al., 2013. Assessment of Socio-Economic Analysis of Fish Farming in Oyo State, Nigeria. *Global Journal of Science Frontier Research Agriculture and Veterinary*, 13(9).

Oluwemimo, O. & Damilola, A., 2013. Socio-economic and policy issues determining sustainable fish farming In Nigeria. *International Journal of Livestock Production*, 4(January), pp.1–8.

Rajan, P., Dubey, M.K. & Khan, M.A., 2013. *Factors Affecting Knowledge of Fish Farmers Regarding Fish Production Technology*,

Raufu, M.O. et al., 2009. Determinants of yield performance in small scale fish farming in Alimosho local government area of Lagos state. *International Journal of Agricultural Economics & Rural Development*, 2(1).

Senbete, G., 2008. Participatory Evaluation of Gillnet and Long Line on Lake Beseka,Ethiopia. In *Commercialization of Livestock Agriculture in Ethiopia*. Proceedings of the 16th annual conference of the Ethiopian Society of Animal Production (ESAP) held in Addis Ababa, Ethiopia.

Shado, T., 2006. *Challenges of Sustainable Livelihood : the Case of Fishing Communities Around Lake Chamo*. Addis Ababa University.

Spliethoff, P. et al., 2009. *Past, Current and Potential Production of Fish in lake Ziway*,

Tariku, E., 2008. Age and Growth determination of Tilapia (Oreochromis niloticus L.) on Lake Zeway. In *Commercialization of Livestock Agriculture in Ethiopia*. Proceedings of the 16th annual conference of the Ethiopian Society of Animal Production (ESAP) held in Addis Ababa, Ethiopia.

Tessema, A., Mingist, M. & Dejen, E., 2010. Socio-economic assessment of the fishery in Rivers Borkena and Mille Awash Basin, Ethiopia. In The Fourth Annual Conference of the Ethiopian Fisheries and Aquatic Sciences Association (EFASA).

USAID, 2008. Ethiopia Biodiversity and Tropical Forests 118/119 Assessment.

Wallace, R.K. & Fletcher, K.M., 1996. *UNDERSTANDING FISHERIES MANAGEMENT*,

Yohannes, F., 2003. *MANAGEMENT OF LAKE ZIWAY FISHERIES IN ETHIOPIA*. University of Tromsø.

QUESTIONNAIRE 1: FOR FISHERMEN

Hello! dear respondent my name is Wubeshet, I am a masters student of Agricultural Economics at St. Mary's University Addis Ababa and the main objective of this questionnaire is to assess the determinants of fish production in lake Ziway. Since the reliability and credibility of the research outcome depends up on the information you render in this questionnaire, I request for your kind cooperation. Moreover, the information you give us is very confidential.

Sample No: _____

Interviewer's name _____

Name of Kebele administration (PA) _____

Village/landing site _____

Part 1: Respondent's Personal History

1. Sex of the fisher 1) Female 2) Male

2. Age of the fisher: (specify) _____Years.

3. What is your level of education? 1) Illiterate 2) Read and write only 3) Write the years of schooling if you have/had formal education_____

4. What is your religion? 1) Christian Orthodox 2) Christian protestant 3)Christian catholic 4) Muslim 5) Other (specify) _____

5. Marital status 1) Single 2) Married 3) Divorced 4) Separated

6. What is the total family size? _____

6.1. No. of dependent children<18yrs? _____

6.2. No of other dependants? _____

Part 2: Respondent Fishing Information

1. What is the type of fishing gear used? 1)Long line 2) Gillnet 3) Beach seine 4) Other (specify)_____

1.1.Mention the reason why you used the type of fishing gear you specified above? _____

2. What is the type of boat you use for fishing? 1) reed boat 2) wooden boat 3) Other (Specify) _____

3. Respondents are: 1) Owner 2) Operator 3)Owner and operator 4) Other (Specify) _____

4. How much fish do you catch per effort (in kilogram)?

4.1. When your catch very high _____ Kg

4.2. When your catch is average _____ Kg

4.3. When your catch is low _____ Kg

5. How long have you been involved in fishing? (Specify) _____ Years.

6. Which time is suitable for you to catch a fish mostly?/when do you fish mostly?

1) Morning 2)Day-time 3) Night time

6.1. What is the reason of your choice? _____

_____

7. In which month you produce maximum, average and lowest catch level?

7.1. Maximum _____

7.2. Average _____

7.3. Low _____

7.3.1.What do you think is the reason for this? _____

_____

8. Do you get training from extension agents? 1)Yes 2) No

8.1. Do you get materials support from the district agricultural office?

1) Yes 2) No

8.2. If yes, what was it? _____

_____

_____

9. Did you get credit from credit institutions for your fishing activities? 1) Yes 2) No

10. Why did you start fishing?(specify reason) _____

11. Were you involved with other work before fishing? 1) Yes 2) No

11.1. If yes, what was the work? (specify) _____

11.2. How much income you used to earn from your previous work?_____ per month/week (Underline the correct Unit)

12. What type of fish species you want to catch? _____

12.1. Why (specify reason)_____

13. How do you sell your catch/share of catch? /To whom do you sell most of your catch?

1) Fishing company 2) Consumer direct 3) Beach traders 4) Others (specify) _____

14. How much is the price of the fish? _____

15. What is the daily income from fish catch?

15.1. Maximum _____Birr/day

15.2. Minimum _____Birr/day

15.3. Average _____Birr/day

16. Are you involved in fishing on a full-time basis? 1) Yes 2) No

16.1. If your answer is no what is your additional work? _____

_____

17. During the past year, how much money did you earn from fishing during:

17.1. Income in Good months (specify amount)_____Birr/Month

17.2. Income in Bad/Poor month? (Specify amount)_____Birr/Month

Part 3: Other Income Generating Activities

1. What other work/business do you have besides fishing (Multiple answers possible)?

1) Crop farming and livestock production for family consumption only

2) Crop farming and livestock production both for family consumption and for market

3) Fish trading (specify details) _____

4) Wage labor (specify details) _____

5) Salaried job (specify details) _____

6) Petty trading/small business (specify details) _____

7) Others (specify details) _____

2. Rank the sources of income that you earn on average each month (1=Highest and 7=Lowest)

1) Fishing_____

2) Crop farming_____

3) Livestock production _____

4) Fish trading (specify details)_____

5) Wage labor (specify details) _____

6) Salaried job (specify details) _____

7) Petty trading/small business (specify details) _____

3. Do you own any land? 1) Yes 2)No

3.1.If, Yes, how many hectares? (Specify)_____

3.2.What did you cultivate last year? (Specify) _____

3.3.How much you cultivated? _____

4. Livestock ownership

4.1.Cattle _____

4.2.Sheep_____

4.3.Goat_____

4.4.Other (specify) _____

4.5.Other types of assets owned (Specify) _____

_____

Part 4: Identifying the Challenges and Opportunities/Respondents Opinions/views

1. If the fishing activity is undertaken by gill net, please specify the types and the size of the nets._____

2. What types of fish do you catch: _____

3. Do these types of fish species have market demand? 1) Yes 2) No

3.1.If no, what do you think is the reason? _____.

4. What are the purposes of fishing? 1) To get fish for sale 2) to get fish for own consumption 3) To get bait fish 4). Recreation 5) Others (specify)

5. Did you get any fishing trainings by the concerned experts when you started fishing practice? 1) yes 2) No

5.1.If yes, what was the g lesson you obtained during the training by the organizer? 1) The carrying capacity of the lake 2) types of instruments to be used 3)fish processing 4) The problems you are going to face if there is improper way of fishing 5) Others (specify) _____

6. Have you ever participated in experience sharing of fishing activity? 1)Yes 2) No

7. Have you ever attended fishing workshop? 1) Yes 2)No

8. Have you ever heard that Ziway lake is endangered? 1) Yes 2) No

8.1.If yes, from whom/where did you get this information for the first time? 1) Agriculture Office 2) Neighbors 3) Fishing Cooperatives 4) Radio 5) Written documents 6) Others (specify)._____

9. How did you start fishing activity for the first time? 1) Appreciating its benefit 2) Forced due to lack of alternatives 3)To support my family members as additional off- farm income 4)Others(specify) _____

10. Did you face any problems in the process of fish harvesting? 1) Yes. 2) No

13.1. If yes, what were the problems you faced? 1)High fish harvesting costs

2) Unavailability of fish resources 3) Organizational problem 4) Management problem 5) others (specify) _____

11. What was/were the method(s) that you undertook to solve the problems?

1. _____
2. _____.
3. _____.
4. _____

12. Do you know the fish production trend from lake Ziway? 1) Yes, it is increasing 2) No, it is decreasing 3) The same as before (No change)

12.1. If it is decreasing, what are the reasons? 1) Over fishing 2)The breeding site of fish resource have been disturbed 3) Siltation of the lake 4) Lack of natural resources conservation practice

13. What are the five important problems you face in your occupation as a fisher? (Rank response in order of importance from most serious to least serious)

17.3. Most serious: _____

17.4. Serious: _____

17.5. Medium _____

17.6. Less serious_____

17.7. Least series_____

QUESTIONNAIRE 2: FOR KEY INFORMANTS

Dear respondent's first of all thank you in advance for your kind cooperation! My name is Wubeshet Birhanu I was born, grown and learn in Ziway and currently I am a master's student of Agricultural Economics at St. Mary's University Addis Ababa; and the main objective of this questionnaire is to assess the peculiarity of the fishing business. Since the reliability and credibility of the research outcome depends up on the information you render in this questionnaire, I request for your kind cooperation.

1. In your opinion what do you think is the current statuse of the fishing around Lake Ziway? _____
   _____
   _____
   _____
2. What are the factors that determine the productivity/catch level of the fishers? Rank them from most series to least series _____
   _____
   _____
   _____
   _____
3. Are there any opportunities for improving fishers' fish catch level? _____
   _____
   _____
   _____
   _____
4. Do the fishers have access to credit facilities for the acquisition of fishing inputs in terms of keeping the operation running and/or buying fishing vessels? If yes, how is the utilization and re-payment of this loan? _____
   _____
   _____
   _____
   _____

5. Do you know how many fishers are involved in fishing activities? _____
6. If you say "yes" Are they fishing individually or organized as a cooperative? _____

_____

7. If not what are the reasons or obstacles why the fishers have not organized in cooperatives? Do you think being part of the cooperative improve the performance of fishing? If yes how? If no why? _____

_____

_____

_____

8. How is the marketing of fish products? _____

_____

_____

_____

_____

9. What are some of the major problems with respect to marketing of fish? _____

_____

_____

10. In your opinion what infrastructural facilities are needed that would contribute to enhancement of fishers' fish catch level? _____

_____

_____

_____

11. Is there any restriction policy by the government to enter or to leave freely the fishing activity for the individuals? _____

_____

_____

Thank you for your kind cooperation!!!

APPENDICES
Appendix A

Multicollinearity

The concept of multicollinearity was also considered. The term *multicollinearity* means the existence of a "perfect," or exact, linear relationship among some or all explanatory variables of a regression model (Gujarati 2003). The test has been done using the tolerance and variance inflation factor which shows how the presence of multicollinearity inflates the variance of an estimator. Accordingly, As R^2_j, the coefficient of determination in the regression of regressor X_j on the remaining regressors in the model, increases toward unity, that is, as the collinearity of X_j with the other regressors increases, the larger the value of VIF_j, the more "troublesome" or collinear the variable X_j. As a rule of thumb**,** if the VIF of a variable exceeds 10, which will happen if R^2_j exceeds 0.90, that variable is said be highly collinear. And also it is possible to consider TOL_j as a measure of multicollinearity in view of its intimate connection with VIF*j*. The closer is TOL*j* to zero, the greater the degree of collinearity of that variable with the other regressors. On the other hand, the closer TOL*j* is to 1, the greater the evidence that *Xj* is not collinear with the other regressors. The table below indicates the highest VIF is 4.052 or tolerance, 0.247 with R^2 = 0.527. The result inferred the absence of collinearity among the explanatory variables.

Test of Hetroscedasticity

Since the data employed is cross-sectional data, a test has been done in order to ensure and avoid the bias of the variance of the estimated parameters and to confirm the error terms are distributed equally. Although there are different ways and techniques to check the existences of Hetroscedasticity, for the purpose of this research this was done using the White's General test. In this test, the null hypothesis is formulated in such a way that there is no Hetroscedasticity or the error variances are equal, it can be shown that sample size (*n*) times the R^2 obtained from the auxiliary regression asymptotically follows the chi-square distribution with df equal to the number of regressors (excluding the constant term) in the auxiliary regression).

First, calculate the required value. Here the required value is the sample size ("n") multiplied by the R-square; and determine whether this value is higher than that in the standard table for the

relevant distribution (here the Chi-Square) at the recommended level of confidence (usually 95%) for the appropriate degrees of freedom (for the White's test, this equals the sample size "n") in the chi-square table.

Operation of Gillnet and Long line

Gillnets can be used in many ways. They can be set to rest on the bottom of the lake, hang between the bottom and the surface, or float on the surface. Gillnets can be set in one place with anchors. A gillnet catches fish that swims into it. It has a float line along the top and a lead line along the bottom. The net hangs straight up-and-down in the water like a good fence. A gillnet catches the fish on its gill. It works like this: the twine of the netting is very thin, and either the fish does not see the net or the net is set so that it traps the fish. The mesh of the net hangs wide open. When the fish swims to the net it is gilled right into one of the ages. If the fish is too small for the mesh it will swim right through the mesh. If the fish is too big for the mesh it might be untargeted. If the fish is the right size it pushes its head and body tightly into the mesh, but it is too big to pass through. When the fish tries to pull its head out of the mesh the thin get into the gill; its gills and fins get caught in the mesh. The fish stays in the net until taken by the fisher. Fish are also caught when the net wraps around them. Long line uses a long line, called the main line, with baited hooks attached at intervals by means of branch lines called snoods. A snood is a short line, attached to the main line using a clip or swivel, with the hook at the other end. Long lines are classified mainly by where they are placed in the water column. This can be at the surface or at the bottom. Lines can also be set by means of an anchor, or left to drift. Hundreds or even thousands of baited hooks can hang from a single line.