Determinants of Fish Production in Lake Ziway, Ethiopia

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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. 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.

Keywords: *Lake Ziway, production, small-scale, fishery, determinant*

1. Introduction

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 economic 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 (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 120,000 tons by the years 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; Moreover, for the year 2012 the country's import and export was 2138 and 477 tons respectively(FAO 2012). Furthermore, lack of recognition and 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 are the major problems affecting fish production at national level(EFA-SA 2012)**.**

Likewise, the production of fish is constrained by a lack of fingerlings (small fish), storage facilities, pollution from waste disposal increasing pressure on the fisheries sector and livelihoods of fishermen. The fish breeding sites are being destroyed by the removal of macrophytesshores 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(Abegaz et al. 2010).

The lakes in the Ethiopian rift valley contribute much of the fish supply in the country. From rift valley lakes Lake Chamo, Abaya and Ziway are exploited at about greater than 80% of their potential; Lake Ziway the smallest lake of these two (Chamo and Abaya) lakes produces more than the two biggest lakes; Lake Tana and Abaya (Yohannes 2003).In contrast, according to ACP (2012)the bulk of the fish catches originates from 4 lakes, namely: lake Tana (25%), Ziway and Langano together (19%), Chamo (18%) and Abaya (12%) of the national total production. It is possible to observe that the contribution of Lake Ziway together with Lake Langano became less than Lake Tana within ten years; which indicates the actual production of the lake were reduced year to year.

Also the potential yield of all species of lake Ziway were estimated between 3,000 to 6680 tons per year (Yohannes 2003). In the early 90s lake Ziway was exploited close to its maximum sustainable yield(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). Therefore, this study intends to find out the determinants of fish production in Lake Ziway.

2. Objectives of the study

The general objective of the study is to identify the key determinants that affect the utilization of fishery resources, in pursuit of this, the following specific objectives were addressed:

- To identify the determinants of fish production
- To investigate the challenges and opportunities of small scale fishermen

3. Research questions:

Main research question:

- What are the key determinants that affect the utilization of fishery resources?

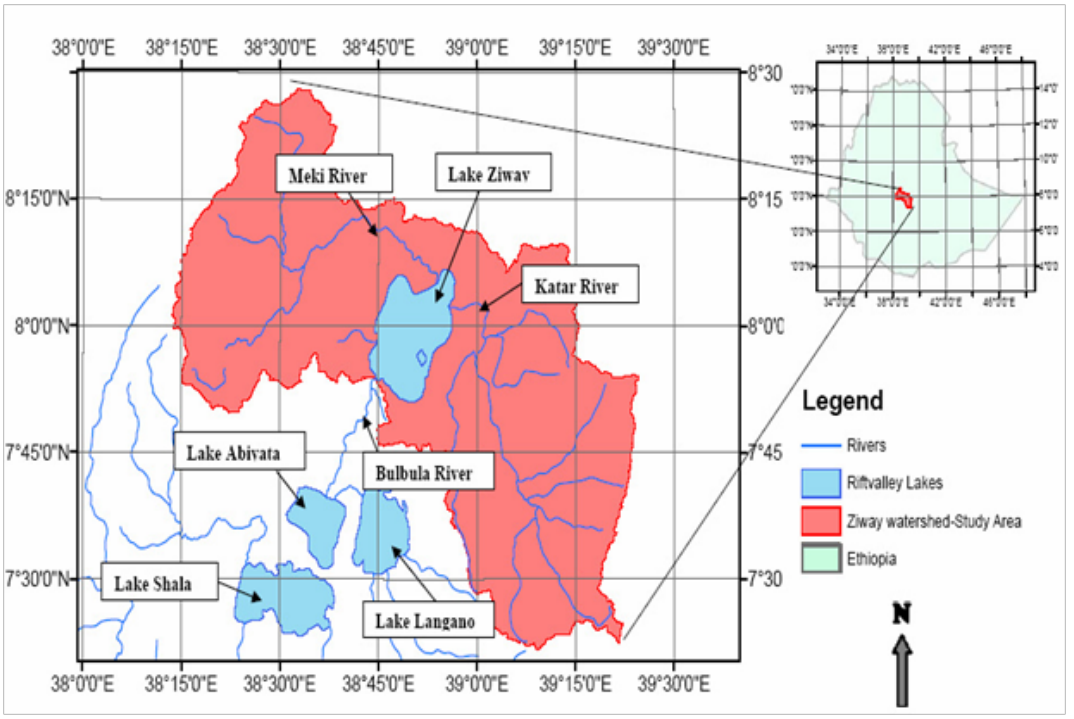
Sub-Research Questions:

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

4. Methodology

4.1 Description of the Study Area

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 lake 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.



Source: Mazengia (2008)
Figure 1 map showing lake Ziway, Ethiopia

4.2 Research Design, Sampling and Data Collection

The study employed a mixed approach and generated both qualitative and quantitative data and used 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.

The target populations of this study were households of fishermen living around Lake Ziway and who fish. There are 5 fishery cooperatives around Lake Ziway and constituting a total of 243 members. For the purpose of this study 4 cooperatives are selected purposely (table 1); hence cooperatives with more than ten years of experience were selected; Yamane (1967:886) cited onIsrael (2013) provides a simplified formula to calculate sample sizes (equation 1).

$$n = \frac{N}{1 + N(e)^2}$$

Where n is the sample size, N is the population size, and e is the level of precision. Using these formula 107 fishery households and 4 key informants wereselected; totally 111 samples were taken. The fishery households from each cooperative were selected using proportional sampling; based on this 33, 27, 21, and 26 samples were taken from Ziway,Bochesa,Abosa andKontola cooperatives respectively. 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.

4.3 Data Analysis Technique and Model Specification

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 production. Bivariate analysis and Ordinary Least Square Estimation (OLS) method of multiple regression technique was used to identify the factors that determine fish catch. Given economic theory and existing literature, the study used the catch 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:

$$Y = f(X_1, X_2, X_3, \ldots X_{13}) \quad (1)$$

Where, Y is the average catch level per day given as a function of the independent variables, X's.

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:

$$Y_{qty} = B_0 + B_1\text{FmSize} + B_2\text{LeEdu} + B_3\text{Exp} + B_4\text{AgeHh} + B_5\text{FiIns} + B_6\text{BoOw} + B_7\text{FiTi} + B_8\text{NnIn} + B_9\text{AcTr} + B_{10}\text{MaA} + B_{11}\text{AcCr} + B_{12}\text{Tybo} + e_{ij} \quad (2)$$

5 Results and Discussion

5.1 Determinants of fish catch

5.1.1 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 reed boat users had a maximum catch of 123.33kg per day. The mean catch for wooden and reed boat was 41.59 kg and 13.56 kg per day respectively (Table 2). Furthermore, out of the total sample 60.4% of the respondent used reed boats whereas the rest 39.6% used wooden boat.

Table 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	Min	Max	Yes	No
Reed boat	60.4%	13.56kg	3.33kg	125.54kg	72.3%	27.7%
	100%					

Source: Own computation

In Lake Ziway two types of boat were used for fishing activities: wooden and reed boat (Fig. 1). 72.3% of the respondents were 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 of the boats gets quite old; and the rest were joining the business as new comers to the lake fishery. In addition to this, it was found that there was statistically significant difference between boat type and catch as determined by one-way ANOVA; the test revealed that reed boat operators were found significantly had lower catch compared to wooden boat operators ($p< 0.001$).(Table 2)

Table 2 ANOVA analysis result showing the mean catch d/c between wooden and reed boat

		N	Mean	Min	Max	F	Sig.
Catch	wood-en	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 reedboats. 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 (Table 3). In addition to this, a chi-square test was also performed and a relationship was found between age of fisher and catch level ($p < .001$)

Table 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%	38yrs	31yrs		
31-40	36.6%	41%				
41-50	10%	2.6%				
>50	16.7%	5.1%				

Source: Own computation

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 dependent family (Table 4).Further, a chi-square test was performed and a relationship was found between household size and catch level (p = .034).

Table 4 Description of household size

Family size	Frequency	Percentage	Average	Max	Min
1-3	32	29.7	3	11	1
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 (62.61%) of the fishermen finished their primary schools, 28.03% of the fishers were high school graduates and the rest 9.34% had no formal education (Table 5).Oluwemimo & Damilola (2013) stated that years of schooling enables fishers understand the technical requirements of fish farming. Education may influence fishing practices through a better understanding of government policy implications and a facilitated collaboration with concerned institutions; and the most educated fishermen are more likely to use the recommended fishing gears.
Fishing experience ranged between 1 and30 years, with the mean of 15years. 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 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.

Currently, in Lake Ziway three type of fishing instruments/gears were used (Table 5). 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 who used wooden boat. Those fishers who used reed boat commonly used the long line (42.5%) and

the gill net (50%). Furthermore, 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. In addition to this, there was a statistically significant difference between groups of fishing instrument on catch level as determined by one-way ANOVA (0.001); the test revealed that beach seine users statistically and significantly had higher catch compared to gillnet and long line There were no statistically significant difference between long line and gill-net fishing instrument type (p =.959).

Table 5 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%	100%	100%		

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 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 towards the fish 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-*Clariasgariepinus* (local name Ambaza). Moreover, there was a statistically significant difference between groups of fishing time on catch as determined by one-way ANOVA *(p = 0.002*); the test revealed that night time users significantly had higher catch than afternoon and morning time; there were no significant difference between afternoon and morning time (p = .455).

Table 6 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

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 11). 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 7 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

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. Very small proportion of fishers (17.76% and 27.11%) had access to finance to buy boats, spare parts and nets; and 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 fisher's gears and their boats are very old as a result of serving for long period of time. 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 13).

Table: 8 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	6443		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

5.1.2 Results of Multiple Regression Analysis

Model Performance

Before discussing the results of the multiple regression analysis, the performances of the model in terms of test of multicollinearity and heteroscedasticity was done. It is found that the model performed with no major multicollinearity problem among the explanatory variables. The heteroscedasticity test confirms that the error vari-

ance is not constant; consequently, it has been employed weighted least squares to estimates the reasonably accurate test statistics. And also a test is done whether the model is fit or not; accordingly, 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

Estimation results

The results of the econometric model estimation revealed that age of fishers, education level, household size, and experience and market access were found to increase fish catch level (Table9). In contrast, non-fishing incomes are linked to reduce catch.

Table 9Table 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 0.05 level.				

* The mean difference is significant at the 0.05 level; R2 = 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 15).The result is also consistent with the findings of {Formatting Citation}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 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.

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 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 fisher's education increase by one their harvest would also increase by 10 kg (table 15). According to Forde, 1994citedon 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. 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.

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 15). Fishers who did fishing during night time are found to have higher catch than those who do fishing during day time. In Lake Ziway, traditionally fishers believed 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. Those who have no market problem had 16 kg difference in their catch from those having market problem (table 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 15) and consequently do not create differences in terms of fish catch levels.

5.2 Challenges and Opportunities of Small scale Fishery Production

5.2.1 Challenges of Fish production

According to Golubtsov*et al.,*(2002) cited on Hailu(2011) there are six indigenous fish species in lake Ziway, which includes *Barbusethiopicus, Barbuspaludinosus, Labeobarbusintermedius,Garramakiensis, Garradembecha*and *oreochromisniloticus.* Four exotic fish species such as T*ilapia zillii, Carassiuscarassius*andC*carassiusauratu*which were introduced in to the Lake with the objective of enhancing the production of fish, while *Clariasgariepinus*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 (*Oreochromisniloticus*and*Tilapia zillii*), carp (*Carassiusauratus*and *Carasiuscarrasius*) and catfish (*Clariasgariepinus*)(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 niloticais 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 niloticain 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 10). 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 LakeZiway.
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 including Lake Ziway.

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 16).

Table 10: 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

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 11). 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 11); 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 11Challenges 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

Table 12Boats 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	Wooden	Reed	
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 to76% of the respondents (Table 11). Fishers don't have a place for storage with the required storage facilities that can preserve the fish until it reaches to the consumers. In addition to this, 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. 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 from field survey

Figure 2 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 11). 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. 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 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.

Other factors that are mentioned by relatively small proportion of the respondents were theft of fishing material, lack of modern fishing instrument and predator (Table 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. In addition to this, 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.

5.2.2 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; however, the sustainability 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. Likewise, the presence of fishery proclamation contributes to ban illegal fishing instruments and protect the fishery.

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.

6. 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.

- 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 tothis, 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.
- 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. Accordingly, further study may require which consider the whole surrounding of the lake and identify the gap clearly
- Monitoring of the *O. niloticus* and other fishes in and around Lake Ziway need be strengthened for conservation as well as production purposes; further, 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.

- 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

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.

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].

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

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.

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.

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

FAO, 2011. *Fishery and Aquaculture Statistics*,

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.

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,.

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.

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.

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*,

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

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