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Fisheries Baseline Survey Describing Status of Fisheries in Lake Zeway, Ethiopia

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Abstract

Lake Zeway, the fourth largest lake in Ethiopia, is the most exploited lake for fishery, irrigation, recreation, and tourism. Fishery sustainability of this Lake is reported under threat because of fishing pressure among others. This survey was aimed to update the Lake's fisheries baseline information which will be used in fisheries management. The primary data was collected during intensive fishing, August 7-21, 2013 in all three districts bordering the Lake. Papers were reviewed to assess the change in fish species composition and total catch. The baseline survey included fishermen's socio-demographic, educational status, fishing experience, purpose of fishing, condition of employment, fishing activities, fishing boat and fishing gears inventory. Data were analyzed using Statistical Package of Social Science (SPSS). A total of 1021 fishermen (99.9% male), 43 major landing sites and 14 fishermen cooperatives operating on the Lake were observed during the survey. Among the respondent fishers, 494 (48.4%) were members of the cooperatives while 521 (51%) were not. The livelihoods of 4,632 people were known to directly depend on fishing activities on Lake Zeway including the interviewed fishers. Number of fishermen and all fishing gears operating on the lake increased except for gillnets as compared to the 1993 baseline survey report. However, secondary data shows that total fish landing from the lake is declining and fish species composition of the lake is also changing, threatening the fisheries sustainability. Hence the Lake's fisheries management system should be addressed for the sustainability.

Keywords: Fishermen; Fishing gears; Fish species; Lake Zeway

Introduction

Importance of fisheries base line survey

Fisheries base line survey is a census-based approach in which data is collected on all fishing vessels and fishing gears, which could be potentially operating on specific water bodies. Fisheries base line survey is conducted to establish a basic inventory of fishery resource in a given aquatic ecosystem [1]. It aims at collecting information on (i) the size and distribution by area of landing sites, (ii) the number and distribution by area of fishing craft and (iii) the number, type and distribution of fishermen and/or fishing communities. It can also be used to provide information on the socio-economic and demography of fishing communities. Information generated from the survey has paramount importance for planning and development activities in the fisheries sector, interventions for fishery management and also help in preparing fisheries management plans.

Previous baseline survey works on Lake Zeway

Fisheries base line survey on Lake Zeway was conducted some 20 years back in 1993 during Lake Fisheries Development Program (LFDP, 1993) after the first attempts of 1990 and 1992 by Zeway-FRDD team, where only the incomplete manuscripts were found. The 1993 survey documented total fishermen census on the Lake, the type, quantity and cost of fishing gears (boats, beach seine, gillnets, hook and line) operating on the Lake, purpose of fishing and intense of fishing activities. The survey also included the mesh sizes, total length, lateral length and cod end of beach seine and gillnets which have implications on the sustainability of the fisheries resource of the Lake. It urges both the government and local fishermen to regulate and control the legality of fishermen, type and quantity of their fishing gears. The report helped in providing basic information of the lake to many researchers who were interested on fisheries of the lake. However situations in the fisheries and the Lake environment keeps changing that updated information is required.

General description of study area

Lake Zeway (also spelled as Ziway, Zwai, or Zway in different literatures) is located at 7o 52' to 8o 8' N and 38o 40' to 38o56' E at an altitude of 1636 m a.s.l. in the Ethiopian rift valley. The Lake is found at about 160 km in South of Addis Ababa, the capital city, on the left side of Addis-Awassa road. Zeway is the fourth largest Lake of Ethiopia with an open water area of 434 km^2 and shore line length of 137 km but the shallowest of the rift valley lakes with maximum and mean depth of 8.95 m and 2.5 m respectively. It has a maximum length of 32 km and maximum width of 20 km [2]. The lake is fed by two major rivers, Meki from North West and Katar from East, and has one outflow in the South, Bulbula River which flows into Lake Abiyata. Lake Zeway (Figure 1) contains five main Islands namely Tullu Guddo (4.8 km^2), Tsedecha (2.1 km^2), Debresina (0.3 km^2), Funduro (0.4 km^2) and Gelila (0.2 km^2). Along with its aquatic animal diversity, fish, hippos, birds, and historical churches in the islands the Lake attracted local people and tourists' attention (Figure 1). Lake Zeway is bordered and hence controlled by three districts belonging to two administrative Zones of Oromia regional state. East Shoa Zone with two districts, Dugda (Meki as town) and Adami Tullu Jiddo Kombolcha (A/T/J/K, Zeway/Batu as town) bordering the Lake in North-west, and Western to South-Western part respectively while Arsi Zone with Zeway Dugda district (Habura as town) bordering the Lake in eastern to South-Eastern part.

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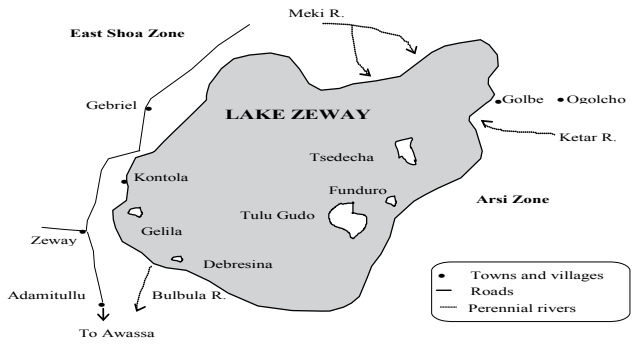

Figure 1: Lake Zeway.

Generally, Lake Zeway being near to road and accessible to central market, becomes the most economically and socially utilized lake for fishery, irrigation, recreation, tourism, domestic water supply for local people and livestock, threatening its sustainability. The current fisheries base line survey is done to generate updated information on trends in fishers fishing activities, socioeconomic conditions of fishers, fishing gear, boat, fish price, fish catch and species composition, information of which will be used in designing proper fisheries management plan.

Materials and Methods

Secondary information was reviewed to assess the status of fisheries in Lake Zeway. The baseline survey was carried out in the three districts bordering the Lake, Dugda and A/T/J/K of East Shoa Zone and Zeway-Dugda district of Arsi Zone. A total of 32 kebeles bordering Lake Zeway have been considered for survey where by 30 development agents of respective kebeles were engaged on data collection. Data collection was carried out in collaboration with livestock development and health agencies of the three districts. Staff comprised of Oromia Livestock Development and Health Agency (OLDHA) and Zeway Fisheries Resources Research Center (ZFRRC) were involved in monitoring and supervising the data collection process. Training on method of data collection was given to local development agents (DA) for two days. The DAs were engaged on data collection from August 7-21, 2013, the time when most fishermen go for fishing due to high fish demand following the fasting season of Orthodox Christians in Ethiopia. For the survey purposes, structured and semi structured questionnaire was prepared. Based on the prepared questionnaire, personal information (age, sex, educational status and family size), whether they are member of fishery cooperative or not, fishing experience, condition of employment, purpose of fishing, fishing boat inventory (steel, planked and bofofe), fishing gears (beach seine, gill nets, long line and hook and line) and other source of income if any. The data were coded as 1 to 1021 identification number. Respondents were segregated to their landing sites in heir residential kebeles. All filled information is fed into Statistical Package of Social Science (SPSS). Data were analyzed using descriptive statistics and displayed as (Sum, mean, graph and pie chart). The fisheries status was then compared against the status of the Lake documented in the past.

Finding of the survey

Fish species composition

Lake Zeway is endowed with different kinds of indigenous fish species Nile Tilapia (Oreochromis niloticus), Labeobarbus intermidus, Barbus paludinosis and two Gara dembecha, and exotic fish species African Catfish (Clarias gariepinus), Crucian carp (Carassus carrassus), Common carp (Cyprinus carpio) and Tilapia zillii [3]. Among these species Nile Tilapia, African Catfish, Crucian carp and Common carp are commercially important ones [4]. The current annual fish production from Lake Zeway is declining [5]. Nile Tilapia was the major composition of the catch accounting 94% [6]. However, the composition of Nile Tilapia has been gradually declining to 89.3% of total catch during 1994, 50.9% of the total catch during 2010 (Figure 2), 42% of the catch 2013 [5] and 31% in exploratory catch [4]. In contrary, the catch composition of Africa Catfish was 8.1% in 1994 and increased to 41.8% in 2010. The catch composition of Carp and Barbus had slightly increased from 2.6% in 1994 to 7.4% in 2010. The exotic Carps (Crucian carp and Common carp) are increasing in the catch composition. Particularly, the Common Carp is appearing to be an important commercial catch in the major landing sites since the last two years (personal observation during baseline survey [2,4,5,7,8] (Figure 2). Yield estimates of the Lake for the year 2002 to 2008 and 2011 onwards were missing due to the reason that the yield was not extrapolated from collected catch per unit effort (CPUE) data (Figure 2) above shows that, the decline in total catch and the change in fish species composition has been occurring through time which indicated the sustainability of the fishery resources of Lake Zeway are being jeopardized.

Length at first maturity and length frequency distribution of Nile Tilapia

Nile Tilapia matures at about 10 to 12 months and 350 to 500 grams in several East Africa lakes, but environmental conditions has influence on sexual maturity of this species [9]. Tilapias are known for their ability to sexually mature at a small size, around 8-10 cm (3-4 in.) in body length, and a young age (sometimes when 2-3 months old). The size at which 50% of the fish population become sexually mature (L50) and start reproducing themselves is an important parameter in fisheries management. For Lake Zeway, this size for Nile Tilapia is known to have come down significantly from 18-19 cm, 18 cm [10] to 15.7 cm [2]. However, [11] reported the L50 of Tilapia in the Lake was increased from 15.7 cm to 18.1 cm (Female) and 19.6 cm [8] (Figure 3).

The length distribution pattern of the Tilapia catch in 2012 was almost similar with the length distribution patter in 1996. However, the larger sized Tilapia appeared in the catch of 1996 was 40 cm while the maximum length landed in 2012 was 35 cm. The changing pattern in fish composition, the reduction in total yield, the reduced length at a first maturity for Tilapia and the disappearance of larger sized Tilapia from the catch indicates that the fishery resource is vulnerable to change. These changes could be due to various reasons among which controllable anthropogenic impacts like fishing pressure, reduced mesh size of the fishing gears, Lake pollution and sedimentation are the major ones.

Major landing site around Lake Zeway

Major landing sites around the Lake through which the fishermen bring their catch to the land are considered in this survey though several small temporary landing sites also exist. Totally 43 major landing sites were observed during the survey in the three districts surrounding the Lake. Fishermen in minor landing sites were counted under major landing sites next to them. During the survey, it was also observed that there were some fishermen who were irregularly changing their landing sites as there is no restriction on fishermen movement to other sites. Some fishermen are permanently using landing sites out of their residential administrative Kebeles especially in Adami Tullu Jiddo Kombolcha District (Table 1). Adami Tullu Jiddo Kombolcha District has relatively many major landing sites (18) than Dugda (13) and

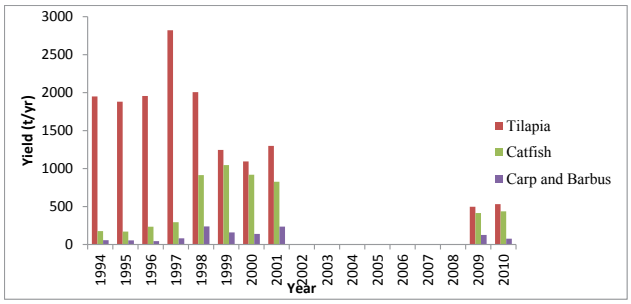

Figure 2: Fish species composition of Lake Zeway.

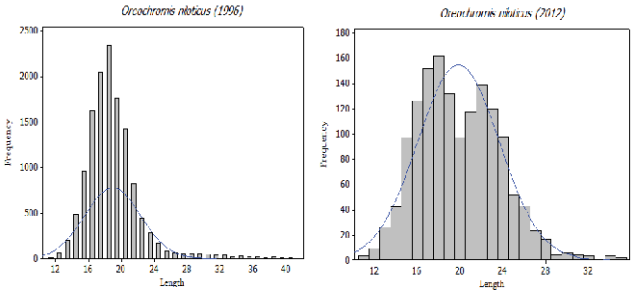

Figure 3: Tilapia length frequency distribution in 1996 and 2012.

Adami T/J/Kombolcha district		Dugda district		Zeway Dugda district	
Landing site	**Frequency**	**Landing site**	**Frequency**	**Landing site**	**Frequency**
Awaroftu	25	Badgosa	12	Burkitu	22
Bojiti	5	Girisa	15	Chopha Minchi	38
Cinca	11	Gotu Derara	19	Dibayu Chifa	41
Demsa	4	Ido Kalo	32	Dolcha	11
Dulota	7	Koli	30	Funduro	7
Gabawo	5	Mekdela	72	Katara	6
Hara Daka	4	Melka Aba Obse	4	Koli	12
Ilka Badha	12	Melka Dalana	25	Malkagoda	4
Kobo	7	Melka Gebru	10	Malkatabala	4
Kontola	39	Melka Kofe	48	Tabala	5
Korokonch	67	Melka Oda Takiti	30	Tsedacha	70
Malka Reo	15	Melka Ogobi	9	Tullu Guddo	82
Menafesha	32	Melka Walda	14	**Total (12)**	**Total(302)**
Shallo	29	**Total (13)**	**Total(320)**		
Tagano	27				
Wabe	6				
Wamicha	23				
Woranto	81				
Total (18)	**Total(399)**				

Table 1: Fish landing sites and number of fishermen using the landing sites by districts.

Zuway Dugda (12) Districts (Table 1). Amount of fish landing is also higher in Adami Tullu Jiddo Kombolcha District than others because of the accessibility to market and main road at Zeway/Batu town (Personal observation). The fish catch harvested from Tullu Guddo (the biggest Island, residents' livelihood entirely depending on fish) and Bochessa is mainly transported to the biggest and known fish landing site, Korokonch site of Zeway/Batu town [12].

Fishermen census

The survey covered all the administrative Kebeles bordering the Lake. Respondents from the three Districts were interviewed using mixed structured and semi structured questionnaire. The interviewee comprised of 399 (39.1%) of Adami Tullu Jiddo Kombolcha district, 319 (31.2%) of Dugda and 303 (29.7%) of Zuway dugda. The majority of fishermen belong to Adami Tullu district because of the district's longer share of the shore line, accessibility in infrastructure and road, proximity to Zeway/Batu town, good market outlet and better prices paid for fish. Totally 1021 fishermen were found fishing on the Lake during this survey, This number showed the increase in number of the fishermen as compared to the 893 fishermen operating on the Lake twenty years ago [1].

Fishery cooperatives organized on Lake Zeway

Members of the fishery cooperative in Lake Zeway are legally registered and at least known to be fishermen while most, if not all, of the non cooperated fishers are not known by the administrative body to be a fishermen. Fourteen fishery cooperatives legally organized on Lake Zeway in the three districts (Table 2) were found during this survey. It was observed that 494 fishers (48.4%) were known to be members of these cooperatives while 521 (51%) were non-member fishers. Some fishers claim to be member of the cooperatives without possessing any fishing gear. Members of cooperative accounted 53% during LFDP (1993) that the current organization in to cooperative looks loose. Out of 399 respondents in A/T/J/K district, only 161 were members of the cooperatives, in Dugda district out of 319 only 116 were members and in Zeway Dugda district out of 303 about 217 were members. Non-cooperated fishermen were higher in A/T/J/K and Dugda districts due to the fact that fish traders economically encourage, lending the fishers fishing hooks, bait soap and twine nets for non-cooperated fishermen and then in turn buy the fish from the fishermen especially during Lent seasons when fish is highly demanded. Cooperatives member were always complaining about the importance of being member as value less because there is no advantage over those of non-cooperated fishermen.

Purpose of fishing

Fisheries can provide year round production and income for vulnerable households especially when crop production is stressed due to erratic rainfall or factors beyond national control. Fish is the rich source of protein with an amino acid composition very well suited to human dietary requirements, comparing favorably with eggs, milk & meat in the nutritional value of its protein. The survey report indicated that, 57.91% of the fishermen fish for the purpose of both selling and home consumption. Very small amount, 1.38% only fish for home consumption alone and 40.71% for selling and in turn to buy other food items for home Socio-demography and other characteristics of fishers in Lake Zeway.

Sex, age education status and dependents of fishermen: Unlike other economic activities where both male and female can engage, fishing activities is solely carried out by male due to the labor intensive nature of the work. Except for one female which claimed as fisherwoman

Zone	District	No.	Name of Cooperative	Number of members	Total number of members
East Shoa	Adami T/J/K	1	Ziway Batu Fishermen Cooperative	58	161
		2	Kontola Fishermen Cooperative	30	
		3	Bochessa Fishermen Cooperative	30	
		4	Abeyi Burkitu Fishermen Cooperative	17	
		5	Abosa Fishermen Cooperative	26	
	Dugda	1	Melka Koffe Fishermen Cooperative	25	116
		2	Abono Gabriel Fishermen Cooperative	8	
		3	Melka Fesasa Fishermen Cooperative	60	
		4	Warabo Fishermen Cooperative	13	
		5	Gotu Derara Fishermen Cooperative	10	
Arsi	Zeway Dugda	1	Dibayu Chaffa Fishermen Cooperative	31	217
		2	Tsedecha Fishermen Cooperative	69	
		3	Senberro kebele farmers lake and katar fishermen cooperative	30	
		4	Tullu Guddo Fishermen Cooperative	87	
Total	**3**	**14**	**14**	**494**	**494**

Table 2: Legally organized cooperatives and their members by administrative Zone and districts.

in fact a member of Zeway Batu cooperative, 99.9% (1020) of the respondents were found to be male. Age of the respondents was grouped into teenager (<18), youth (18-35), adult (36-50) and elder (>50). According to the survey, majority were youth 69.8%, followed by adult 22.5% while teenager consist 4%, and elder 3.3%. This has an implication on the potential of fishers to apply and adapt modification on the management system if any. The educational status of fishermen was classified into four categories, illiterate who did not go to school consists of 56 (5.5%), first cycle primary school 345 (33.8%), second cycle primary school 415 (40.6%), high school complete 161 (15.8%) and above high school 29 (2.8%). Hence, 94% of the fishermen can at least read and write to ease any awareness creation and training given to the fishermen. From the survey, the livelihood of 4,632 people (fishers and their dependants) is directly dependent on fishing activities. There are also other communities whose livelihoods directly dependent on fishery related activities like people engaged in supplying fishing materials (twine nets, hooks, and soap as fishing bait), net making, boat making, fish processing (filleting), fish transporting and fish vending.

Fishing experience of the respondents: The history of fishing on Lake Zeway is dated back to around 1946/47 when merchants from Debrezeit who knew operating with gill nets and beach seine introduced these fishing techniques to the area. Islanders started fishing activity during that old day. Most of the fishermen have long experience on fishing activity (Table 3). The fishing experience of the respondents ranges from zero years (young respondents) to fifty years (mostly old respondents from Islands). Most respondents have involved in fisheries activity in the last ten years (Figure 4). Many of the young fishermen are children of the old fishermen inheriting their parents' fishing materials and being members in the fishery cooperatives. The majority of the experienced fishermen feel sense of ownership for fisheries resources better than the less experienced youth fishermen.

Employment condition of the fishermen: Usually gill net and long line users operate their fishing gears without employing assistants. Majority of the fishermen in Zeway use reed or bofoffe boats which are operated by a single fisherman. In spite of this, 817 (81.1%) of the fishermen were found to operate their own raft without employing assistants, while 134 fishermen, majorly beach seine owners (operated by three persons at a time) were found to employ assistant fishers and 56 (5.6%) were employed as assistant fishers operating the crafts in the absence/presence of the owners (Table 3). The number of crew members required during beach seine operation is three. However, 42% of beach seine owners employed six crew members to use in alternative shifts of fishing.

Other source of income for fishermen of Zeway: There are few fishermen who diversify their income to other activities in addition to fishing. The activities include gear making, crop farming and cattle rearing. Tsion Handcraft Association, organized in 2010 with the support of USAID/ESTA - Ethiopian Sustainable Tourism Alliance at Tullu Guddo Island in basket making and textile weaving. The association has 23 members with 65% women; most of them were artisans/fishermen that totally relied on fishing before they joined the association. Currently, the members started selling handmade personal and home accessories and earning income, becoming less dependent on the fishing sector. Such activities need to be practiced in other parts of the lake to minimize the fishing pressure.

Fishing activities

Some fishermen owned more than one fishing gears as an option o target different fish species. In many cases, fishermen from Tsedecha, Tullu Guddo and Funduro have both gill nets and long lines while few fishermen have beach seine, in addition to the gill nets and long line (Table 4). Fishing activities of the fishers in Ethiopia is basically affected by consumers' demand which is normally high during Orthodox Christians' Lent seasons. Weather conditions, religious and social factors affecting fishing activities. Taking these factors into account,

Condition of employment	Frequency	
Work for him self	817	81%
Employs assistant fisher	134	13%
Employed by others	56	6%

Table 3: Employment condition of the respondent fishermen.

the interviewee responded the number of days they go for fishing in a month. Most of the fishermen (77%) were regularly fishing on the Lake, of which about 464 (45.9%) for 10-20 days in a month and 311 (31.1%) for more than 20 days in a month (Table 4). They are using either beach seine, gillnet, long line or the combination of two or three. Occasional and seasonal fishermen account about 23% of the fishermen using all type of the fishing gears. During the Christian fasting season which last for 55 days (Fasika) and 16 days (Filsata), the number of fishermen on the Lake increases.

Fishing gear inventory

Fishing boats: Three types of fishing boats, steel boats, planked boats and raft/bofofe/yabala boats are operating on fishing activities in the Lake. Though there was no steel boat registered on the Lake in LFDP, 1993, the number of planked boats was 104 and raft/bofoffe was

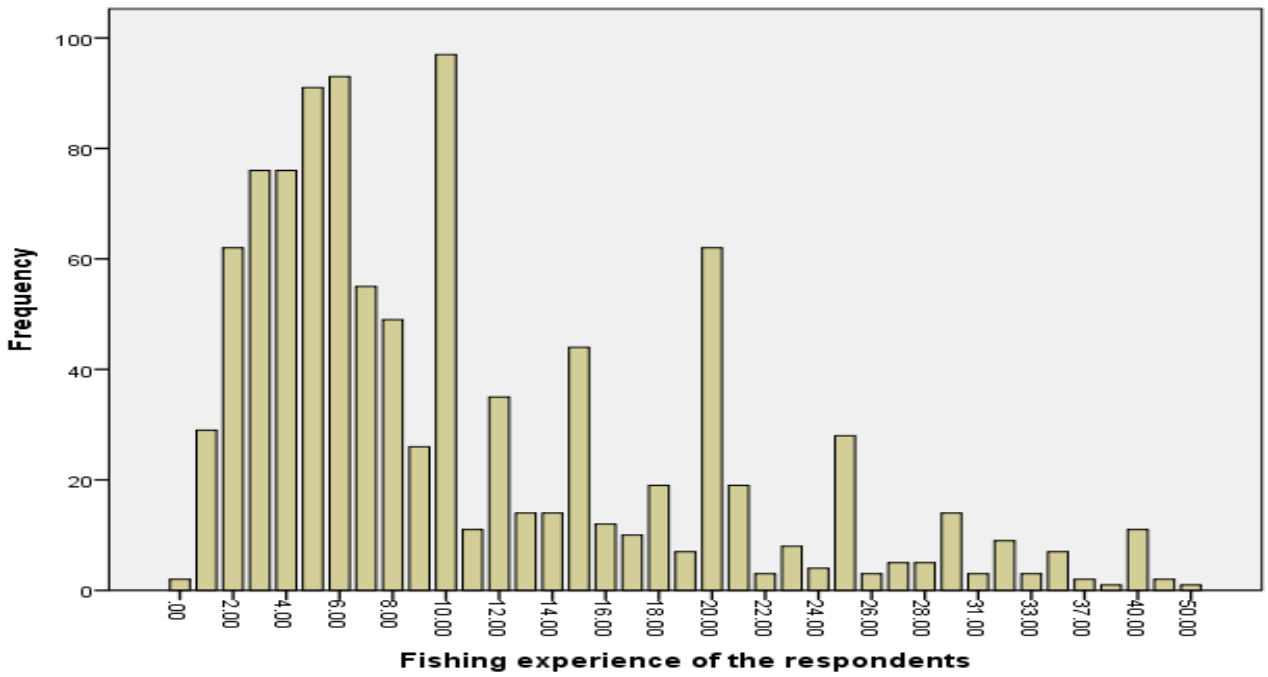

Figure 4: Fishing experience of the respondents in years.

Fishing activities	No. of fishermen	Beach seine quantity			Gill net (in 50m)			Long line (qnty of hooks)		
		Owned alone	Owned with other gear	Total	Owned alone	Owned with other gear	Total	Owned alone	Owned with other gear	Total
Full time, >20 days/month	311	41	21	**62**	218.6	459.5	**678.1**	70670	52 930	**123600**
Regular, 10- 20 days/month	464	50	7	**57**	168.4	363.9	**532.3**	130170	81480	**211650**
Regular, but <10 days/month	43	0	0	**0**	11	23.2	**34.2**	14330	3550	**17880**
Only during fasting season	163	7	0	**7**	79.4	54	**133.4**	45440	4900	**50340**
Occasionally	29	0	0	**0**	24	4	**28**	8215	1250	**9465**

Table 4: Fishing activities pattern of fishermen.

538. These numbers increased in the current survey; 7 steel boats, 163 planked boats and 703 raft/bofofe types recorded. Increase in number of fishing gear indicates the increase in pressure on fishery. Price wise the current average cost of steel boat was 65,000 birr, planked boat 4,100 birr and raft/Bofoffe 241 birr. Poor fishermen can easily afford the rafts/bofoffe. Planked boats are usually employed along with beach seine while rafts/bofofe/yabala are mostly employed either with long line or gill net fishing activities. Steel boats are mainly used to collect/purchase fish from fishermen on landing sites or in open water to the nearest towns, either Batu/Zeway or Meki.

Beach seine: A total of 127 beach seines have been registered during the current survey; it was 108 in the LFDP 1993 report. The current average cost of beach seine is 15,554.62 Ethiopian birr. In most cases (96%) one beach seine owned by one fisherman and in rare case (4%) two beach seines owned by one fisherman. The average length of beach seine during the current survey was 308.5 m; the mean lateral length was 3.4 m. The recommended minimum beach seine mesh size in the cod end was 6 cm, minimum mesh size in the wings was 8 cm, and maximum allowed length 150 meters for Lake Zeway [2]. However, it was observed in the current survey that the beach seine under use is twice as long as the recommended length, about 56.3% of the fishermen use beach seine whose wing mesh size is less than 8 cm and 42% of the fishermen use beach seine whose cod end mesh size is less than 6 cm. The use of beach seines is restricted to shallow water areas without submerged vegetation or rocks [2]. Beach seine was registered in 21 kebeles, with the highest number in southern part of the Lake, Abeyi (24) followed by Tullu guddo (23), Batu-02 (17), Bochessa (12), Melka Kelina (9), Herera (8) and Abono Gebrel (6). The remaining 14 kebeles have registered four or less beach seines.

Gill net: During the current survey, 318 gill net users possessing 72,255 m long (equivalent to 1,445 standard gill nets of 50 m) have been enumerated, decreased from 1905 reported in LFDP (1993). The decrease in gillnet could be due to the decrease in tilapia catch in the Lake's fishery. In the management plan of Lake Zeway set during LFDP 1997, the minimum stretched mesh size of gillnet was 8 cm in the first year, 9 cm in second year and 10 cm thereafter, with maximum length of 60 m. Different research findings indicated that deployment of gillnets having less than 8 cm will harm the fish resources in Lake Zeway. Recruitment could be affected if the stretched mesh sizes are allowed drop below 8 cm. The present survey revealed that 41.9% of gill net users were confirmed to use gill nets whose mesh size is less than 8 cm. One fisherman who uses 17.5 cm stretched mesh size targeting Common carp (locally called Jape) has found exceptionally to use wider mesh size. The size of the gill net varies in length among the fishermen. The average price of a 100 m gill net is currently calculated to be 639 Br. The gill net users were distributed in all Kebeles surrounding the

lake. About 69.5% of the respondents using gill nets were cooperative members possessing 68% of the total gill net operating on the Lake.

Long line: No long line was registered on Lake Zeway during [1] other than 400 hook and line targeting tilapia. But currently a total of 408,561 hooks belonging to 77.6% of the total fishermen have been known to be deployed on the lake from which 51% belonging to legally cooperated fishermen. The average number of hooks per long line user is 533. The appearance of the long line and its expansion was after the boom of African catfish (Clarias gariepinus) which is exotic to the lake. The long line users are distributed in all the 31 Kebeles surrounding the Lake. However, the quantity of operating hooks is higher in Herera kebele (49,900 hooks), Eastern part of the Lake belonging to Zeway Dugda District followed by Waldiya Mekdala Kebele (48,000 hooks) Northern part of the Lake belonging to Dugda District.

Fish bait: Targeting to African catfish, long line users use different luring items on hooks. Most fishermen use zap or vista soap on their hooks to catch the fish, others collect small barbus (Barbus paludinosis) from the Lake using mosquitoes nets and use as bait on hooks, or termites by digging termite gallery, or even carp fillet and use as luring bait to catch the catfish (Table 5). Generally, the current distribution of the fishermen and the fishing gears over the administrative kebeles are given in Table 6 as a summary. It was proposed to allow licensing of 160 beach seines and 2900 gill nets in 1997 while no limits were put on the number of long lines or hook and lines (LFDP, 1997). From the present study, 127 beach seine (having a total length 37,330 meter), 1,445 gill nets (72,255 meter) and 408,561 hooks were recorded. If all these fishing gears are fully operational especially during Christian Orthodox Lent seasons, 9 hooks per 100 m2, 1.6 m gill net per 100 m^2 and 0.8 m beach seine per 100 m^2 is prevalent. This implies that there is no escaping room for all fish species in the Lake during this season.

Current fish price at landing sites

Fish price varies seasonally, among fish species, fish size (whole fish) and among landing sites (Table 6). The fish price is high during the Christian Orthodox Lent seasons (around March, April and August) and reduced in the non-fasting seasons. Fish price is relatively higher at the landing sites closer to the market access and lower in the remote landing sites. Tilapia valued higher price than other fish species because of the demands from the customers. The price for filleted Nile Tilapia ranges from 25 birr (at remote landing sites during no fasting seasons) to 60 birr (at landing sites near to town during fasting seasons). This trend holds true for the remaining three fish species. The price range for whole fish varies according to their size in addition to the factors mentioned above (Table 6).

Not	Kebele	Total number of respondents	Beach seine		Gill nets (in 100 m)		Long line (hook)	
			Coop	Non-coop	Coop	Non-coop	Coop	Non-coop
1.	Batu 02	60	16	1	51	23.8	18,601	2,975
2.	Batu 01	13	3	-	6	0.2	7,000	1,330
3.	Abine Garmama	20	-	-	-	6	-	5,150
4.	Abeyi Deneba	40	24	-	-	20	-	6,000
5.	Bochessa	63	11	1	38.2	91.2	17,400	7,800
6.	Iddo Kontola	41	-	-	120	14	2,100	2,250
7.	Negalign	34	3	-	2	51	2,300	17,500
8.	Kamo Garbi	6	2	-	3	-	500	-
9.	Aluto	27	-	-	-	-	-	5,101
10.	Walin Bula	21	1	-	-	16.4	2,000	10,000
11.	Warja Washgula	23	3	-	-	-	2,200	100
12.	Ilka Chelamo	21	-	-	-	73	-	6,749
13.	Abosa	29	1	-	2	6.2	10,300	4,900
14.	Tepho Choroke	27	-	1	-	-	-	12,250
15.	Burka Dembel	23	1	2	-	-	-	8,260
16.	Tuchi Dambel	12	-	-	-	30.4	-	2,830
17.	Dodota Dambel	16	-	-	-	4	-	11,400
18.	Abono Gabriel	30	6	-	2	18	400	9,550
19.	Wayo Gabriel	9	-	-	-	2	-	3,450
20.	Walda Mekidella	77	4	-	35	11	36,600	9,900
21.	Walda Kelina	46	9	-	4	13.4	2,900	18,450
22.	Derara Delecha	26	-	-	10	11	3,350	12,240
23.	Bekele Girissa	15	1	-	34	27.2	500	2,100
24.	Giraba Korke Adi	39	1	-	62.9	15.9	6,000	2,730
25.	Golbe	19	1	1	-	5	-	10,660
26.	Bashira Chafa	89	22	1	324.3	12	27,790	2,600
27.	Genale	41	2	-	16	3	7,600	2,700
28.	Herera	70	8	-	272	-	48,700	1,200
29.	Semboro	38	-	-	-	-	10,800	2,400
30.	Meja Shanan	11	-	-	-	-	-	2,880
31.	Burka Lemaffo	12	-	-	-	-	-	2,865
32.	Chafe Jila	22	-	1	-	8	-	5,100
Total		**1021**	**119**	**8**	**982.4**	**462.7**	**207,041**	**193,420**
			127		**1445**		**400,461**	

Table 5: Summary of fishing gear inventory by their administrative kebeles belonging to A/T/J/K, Dugda and Zeway-Dugda districts.

Fish species	Whole fish (Birr/fish)	Filleted (Birr/kg)
Nile Tilapia	3-10	25-60
African Catfish	4-20	10-30
Common carp	5-30	24-40
Crucian carp	2-8	15-24

Table 6: Current fish price at landing sites.

Conclusion and Recommendations

Species composition of the fish in the Lake is changing with the proportion of Nile tilapia declining and the exotic species to the Lake, the African catfish and common carp increasing. Number of fishermen, fishing boats and fishing gears increased in type and number. Though efforts increased, total annual catch of fish from the Lake decreased. Most fishermen are male, young and educated at least to the primary school, fishing regularly on the Lake to sell the fish. The current pressure on the Lake threatens sustainability of the fishery and hence management system of the Lake should be addressed.

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