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Full Length Research Paper

Economic analysis of capture fishery: the case of Lake Babogaya, Ethiopia

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Abstract

The study was conducted in Lake Babogaya found at Debre Zeit town. It is situated some 45 km in the south east of Addis Ababa with the objectives of generating some baseline information for the economic analysis of capture fishery. Fishing of *Oreochromis niloticus* was conducted for the period of September 2005 to August 2006 using gillnets of 10 centimeter mesh sizes. The gear was set in the afternoon (05:00 pm) and lifted in the following morning (7.00 am). Then immediately after capture some biological parameters of the fish as well as all inputs that involved in the activities were recorded. After these steps the fish were processed and sold for local markets. The price of fish was varied from 1-3 Birr/head depend on the demand of the product. The result indicated that the total income of the fish was varied between months and. the demand was high between March - April and August 2006. Hence, the study declared that, profitability of capture fishery of the lake was relay with demand of the product in the area.

Keywords: *Oreochromis niloticus,* capture fishery economics, Lake Babogaya

INTRODUCTION

Agriculture being the main backbone of the country's economy, fishery has also considerable potential that could contribute to the economy in Ethiopia. It is becoming a valuable asset in the economy. Even though it is a land locked country, Ethiopia is endowed with a number of lakes and rivers, which are believed to be promising potentials of different fish stock.

The high potential of fish resource can contribute a significant amount to the economy, but it is not developed in human personnel and administrative structure. This would contribute to underexploitation of the resource in certain areas and management problems of the sector. For instance, resources in all the rivers are not interfered by resource users but some are used mainly for fishing (Tesfaye, 1998). Most Rift valley lakes harbour, African catfish (*Clarias gariepinus*), Tilapia nilotica (*Oreochromis niloticus*) and a few cyprinids mostly Barbus species (LFDP, 1998). But it is not the case for Lake Babogaya.

Annual fisheries potential of the major lakes, reservoirs, small water bodies and major rivers since 1993 is estimated to be 51 thousand tones and catch in the year 1993 was estimated 8 thousand tones (16% of the potential). In the year 1999 the total catch was estimated to be 17,000t from the estimated potential of more than 75,000t/yr. Nile Tilapia (*Oreochromis niloticus*) is the dominant fish species of the landings (FAO, 1995, LFDP, 1998, EARO 2002). Catches are still falling far below the estimated potential yields, although some lakes are heavily exploited (Ziway and Awassa) (LFDP, 1998). Hence the contribution of fisheries to the GDP is very low. Concerning the gears, gillnets are the most commonly used fishing gears also Long lines as well as beach seines are used depend on the structure of the water bodies to caught these species of fishes.

Since 1993 to 1999 the trend of Ethiopian fishery shows an increasing trend in production. Despite the increase in production, Ethiopians prefer meat to fish, which is mainly attributed to the high population of cattle. Inhabitants near to shore areas consume more fish, especially Tilapia which is the dominant species in the landings, (per head per year) than those living far from the resource area (LFDP, 1998).

In some part of the country, like Lake Babogaya, since, fishery industry has been of critical importance to the

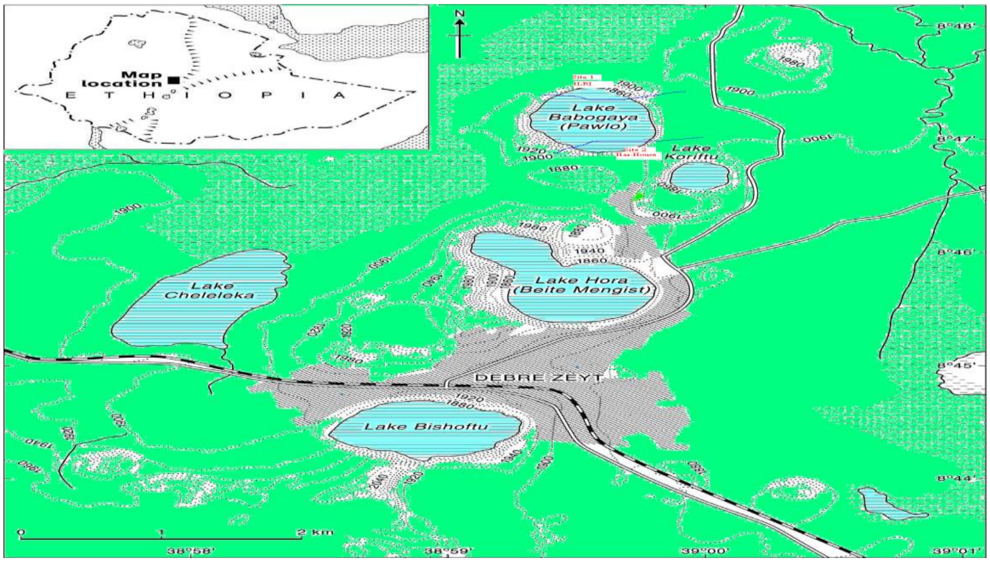


Figure 1: Location of Lake Babogaya in relation to the other Bishoftu Crater Lakes (Lamb, 2001)

economy and to the social well-being of humanity and provides a vital source of food, employment, recreation, trade and economic well being for the people. It must be given great attentions to the industry to utilize the resource appropriately. Hence, prior to the beginning of the present study, there was limited fishing activity on Lake Babogaya. The lake was mainly used for recreation and domestic water-use purposes. The reason for limited fishing activity in the lake could be due to lack of fishing gears and lack of knowledge on the fishery resource utilization. Therefore, this study intends to generate baseline information on the profitability of capture fishery of the lake for the appropriate utilization of the resources for then managements.

METHODOLOGY

Description of the Study Area

Lake Babogaya is one of the volcanic crater lakes found in the vicinity of Bishoftu town at about 45 Km East of Addis Ababa (Figure 1). The lake is small, roughly circular and fairly deep, and is found at an altitude of 1870 m and at about 9^0N latitude and 39^0E longitude (Prosser *et al.,* 1968; Wood, *et al*., 1984). Like the other volcanic crater lakes of the area, it is a closed system surrounded by very steep and rocky hills. The vertical distance from the lake's surface to the crater rim is 20 m, and this affords moderate protection from wind (Baxter, 2002). The lake is fed primarily by precipitation falling directly on its surface and run-off from its small catchment area (Prosser *et al*., 1968), which was formed from volcanic rocks of basalt, rhyolite and tuff (Mohr, 1961). Limnological studies made on Lake Babogaya described its bathymetry (Prosser *et al*., 1968) (Table 1), water chemistry (Prosser *et al*., 1968; Wood *et al.,* 1984; Rippey and Wood, 1985; Zinabu Gebre-Mariam, 1994; Baxter, 2002; Zinabu Gebre-Mariam, 2002), thermal stratification and mixing (Baxter and Wood, 1965; Wood *et al*., 1976; 1984), chlorophyll *a* and phytoplankton (Wood and Talling, 1988; Zinabu Gebre-Mariam, 1994; Zinabu Gebre-Mariam and Taylor, 1997), bacterial abundance (Zinabu Gebre-Mariam and Taylor, 1997) and zooplankton associations (Green, 1986).

Lake Babogaya is a dilute lake with Na^+ as the dominant cation and carbonate-bicarbonate as the dominant anion (Table 1). The lake water is alkaline, with the erosion of basaltic and hyper-alkaline rocks surrounding the lake playing an important role in increasing the alkalinity of the water (Wood and Talling, 1988). The phytoplankton community is dominated by blue-green algae, particularly *Microcystis aeruginosa* (Kutz.) (Wood and Talling, 1988), while the zooplankton is composed of copepods (*Afrocyclops gibsoni*, *Lovenula africana*), rotifers (*Asplancha sieboldi*, Brachionus *calyciflorus* and *Hexarthra jenkinae*) (Green, 1986), and cladocera (Yeshimebet Major, 2006). The fish community found in Lake Babogaya is composed of *O.niloticus*, *C.gariepinus* and *Tilapia zilli*. From these, *O.niloticus* is the most dominant species.

Meteorological Data

Data on mean total monthly maximum and minimum air temperature, and monthly total rainfall of the lake region were obtained from Debre-Zeit Agricultural Research Center (Ethiopian Agricultural Research Institute). According to the data, this plotted in Figure 2.

Mean monthly minimum air temperature ranged from 11.2 to 13.5^0C, while the maximum mean monthly air temperature varied from 21.6 to 31.5 ^{0}C. Monthly total rainfall

Table 1: Some morphological, physical and chemical characteristics of Lake Babogaya ([d] Prosser *et al*., 1968 ; [c] Zinabu Gebre-Mariam, 1994 ; [b] Yeshemebet Major, 2006)

Parameters	Values
Latitude	9^0N and 39^0E [d]
Altitude (m)	1870 [d]
Surface area (Km^2)	0.58 [d]
Volume (Km^3)	0.022 [d]
Maximum depth (m)	71 [b]
Mean depth (m)	38 [d]
Conductivity,K_{25} (μscm^{-1})	900 [c]
Alkalinity (meq l^{-1})	10.2 [b]
pH	9.2 [b]
Salinity (gl^{-1})	0.9 [b]
SiO_{-2} (meq l^{-1})	< .1 [b]
Alkalinity (meq l^{-1})	10.80 [b]
Na+ (meq l^{-1})	5.50 [b]
Cl^- (meq l^{-1})	0.90 [b]
Sum of cations (meq l^{-1})	11.7 [b]
Sum of anions (meq l^-)	11.4 [b]

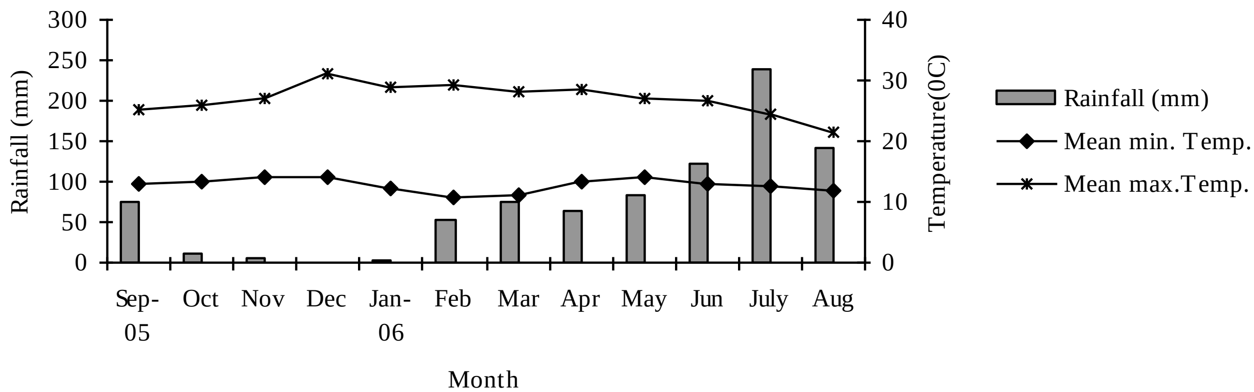


Figure 2: Monthly total rainfall, mean minimum and maximum air temperature of the lake region.

varied from 2.1 mm (January 2006) to 239.5 mm (July 2006). Although the region was described by Baxter and Wood (1965) as having two rainy periods, the minor one extending roughly from February to April and the major one between June and September, appreciable quantities of rainfall were recorded throughout from February to August, 2006 including September, 2005, and peaking in July. Rippey and Wood (1985) also documented that the lake area has moderate rainfall, varying around about 850 mm per annum. The present meteorological data also show an annual mean rainfall of about 877.2 mm.

Surface water temperature of the lake is reported to be mostly between 22^0C and 24.5^0C while the bottom temperature was almost constant (19.2^0C-19.4^0C) (Wood, *et al*., 1976 and 1984). In a recent study (Yeshemebet Major, 2006), the water temperature and dissolved oxygen of the lake range from 23^0C to 27^0C and 7 mg l^{-1} to 14 mgl^{-1}, respectively.

Capturing of Fish and Measurement

Species of *O.niloticus* were collected monthly between September 2005 and August 2006 using gill net. The gear (10 cm stretched mesh size) of 300 m long was set parallel to the vegetation. The gear was set in the afternoon (05:00 pm) and lifted in the following morning (7.00 am). Then immediately after capture, total length (TL) and total weight (TW) of sample fish were measured to the nearest 0.1 cm and 0.1g, respectively and sexes of each specimen were determined by pressing the abdomen and/or dissected the gonads.

Determination of Breeding Season

The breeding season of *O.niloticus* was determined from the percentage of fish with mature gonads taken each month. The sexes of all fish and the maturity stages of

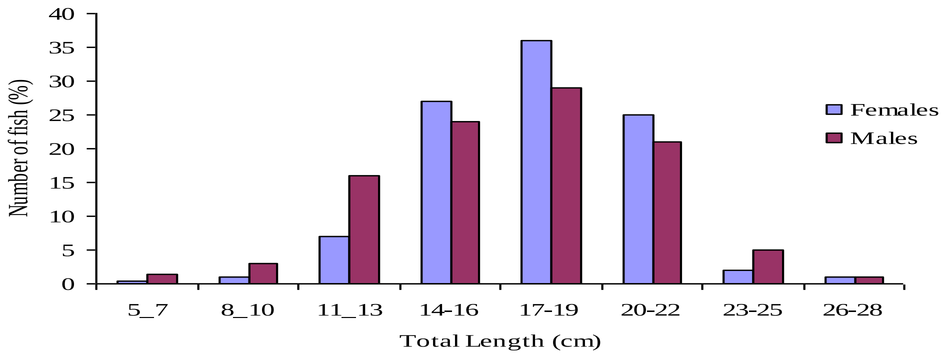


Figure 3: Length-frequency distribution of *O.niloticus* in Lake Babogaya

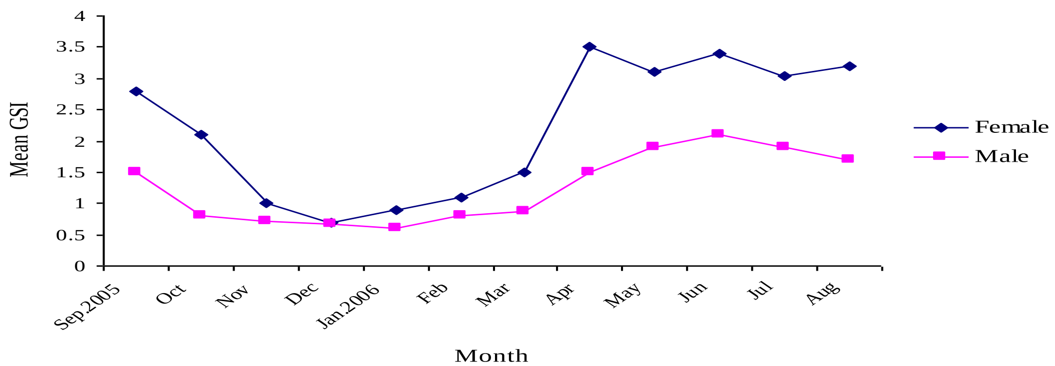


Figure 4: Temporal variation in gonadosomatic index (GSI) of *O. niloticus* from Lake Babogaya

the gonads were determined. The maturity level of each gonad was determined by visual examination using maturity keys. A five-point maturity scale was used for this purpose (Holden & Raitt, 1974) and all examined maturity stages were recorded for the determined GSI. Therefore, the breeding season of *O.niloticus* was determined based on the frequency of fish with ripe gonads and on Gonadosomatic index (GSI). The GSI for each fish was computed as the weight of the gonads as the percentage of the total body.

GSI = (GW/TW) X100

Where, GW: Gonad weight in gram

TW: Total weight in gram

Fishing Gear Effort

In each month of yields of the fish was recorded in relation to the fishing gears were exerted. In addition to this the price that the fish were sold in all months were recorded for the analysis and the products were transported for local markets.

Revenue

Fish production in the lake is mainly supplied for domestic markets. The average price of the fish in each month were calculated to asses the variation across months. Therefore, the total revenue from the fish was calculated as price of fish multiplied by quantity harvested:

TR = P * Y

And Profit was calculated as the difference of total revenue and cost encored

PR = TR - C

Where, TR - Total revenue

P - Price

Y - Yield

PR - Profit

C - Cost

RESULTS AND DISCUSSIONS

Composition of the Fish

A total of 28,437 *O.niloticus* individuals were caught for each month. The total length of the fish ranged from 4 to 28 cm and the corresponding total weight ranged between 6 and 680 grams for both sexes.

As shown in Figure 2, the greater proportion of the sampled fish for both sexes range in size between 14 and 22 cm. The peak being also between 17 and 19 cm for

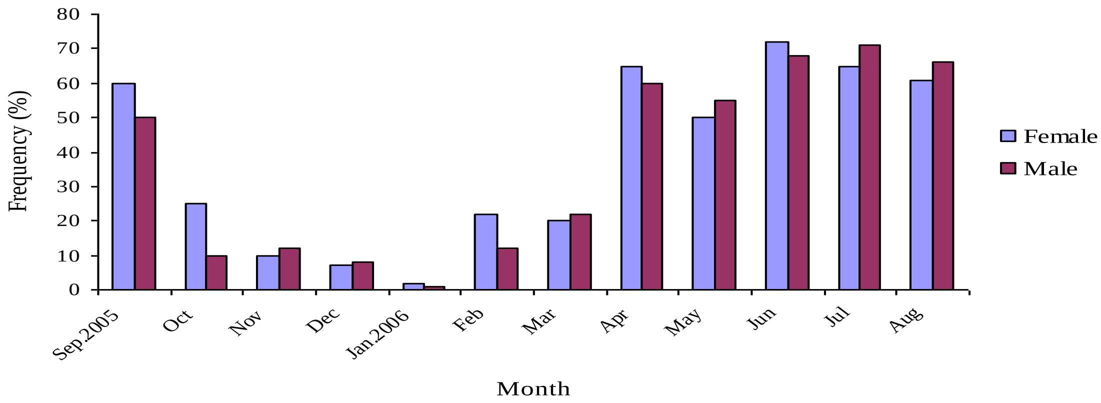


Figure 5: Temporal variation in frequency (%) of ripe female and male *O. niloticus* from L. Babogay

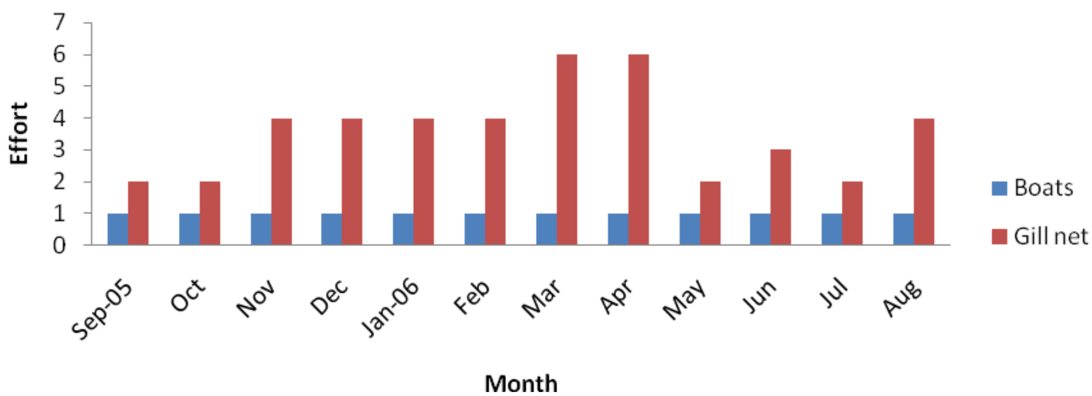


Figure 6: Trend of effort (total boats and gill net) in the Lake

the sexes. This length group alone was about 36% for females and 29% for males. Fish over 23 cm, and below 10 cm TL were least represent (Figure 3)

Breeding Season

Mean gonadosomatic index (GSI) ranged from 0.7 – 3.5 for females and from 0.6 - 2.1 for males. GSI values varied highly significantly between sampling periods for both sexes (ANOVA, P < 0.001). Temporal variation in GSI was remarkably similar between males and females (Figure 4). Thus, there was a biannual cycle in which GSI increased from March peaking in April for female and June for male (Figure 4). GSI values were lower between October to February.

The cycle in GSI was also reflected in monthly variation in the frequency of fish with ripe gonads (Figure 4 and 5). The frequency was found to be high between April to August including September for both sexes (Figure 5) which was coincides with the periods of peak GSI values. In addition, lowest frequency of ripe fishes was recorded at times of lowest GSI values.

Fishing Gears

A maximum of six gill nets and one timber bots were involved on fishing activities. The amount of nets that set was not constant. This is due to the demand of the fish on the local market. In March and April since the period was fasting periods for Christians the demand of the fish was high (Figure 6). Therefore, to increase the amount of the fish there were high number of efforts were conducted.

Catch patterns of the Fish

The dominant species in the yield of the lake seems to be *O.niloticus*. The catch was varies from month to month. Hence, high number of catch were may be related to the amount of gears operated (Figure 6 and 7). The higher

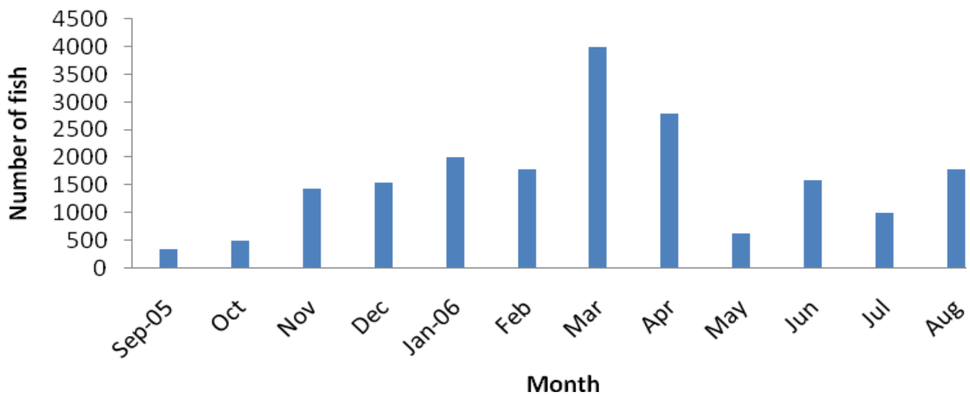
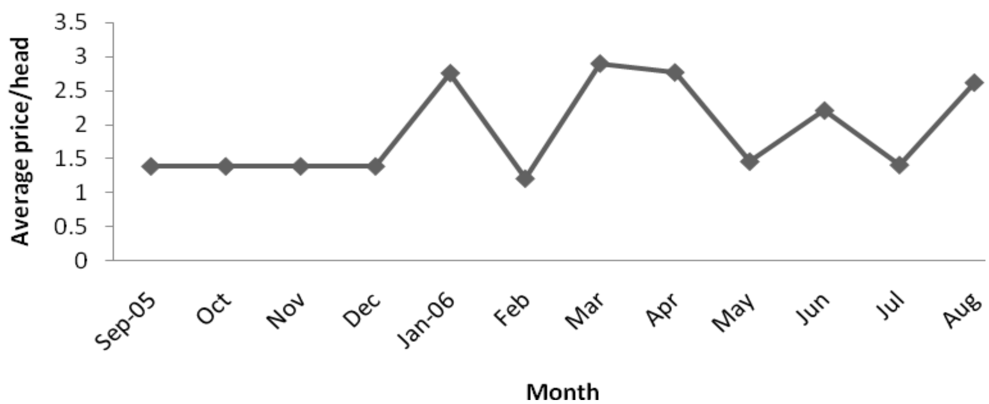


Figure 7: Catch trend of the fish in Lake



Figer 8: Average price of the fish

proportion of catch was conducted in January, March, April and August (Figure7). This could show its high socio-economic importance, which might include consumption, employment and others. Higher yield per unit effort might also give biological information for the lake.

Relatively lake Babogaya could probably be better habitat to harbour fish, which might include better photosynthetic activity as compare to Lake Bishoftu that are found the same ecology. This could trigger growth and recruitment. Higher growth rate and recruitment imply higher biomass and ultimately higher yield. Even though the general trend of the catch seems to be increasing in relation to effort, it is hardly possible to predict the pattern. There fore, some research in relation to special and temporal abundance of the fish as well as stock assessment studies of the particular fish species for the lake must be conducted.

Price of the Fish

The catch was sold principally to local markets (restaurants and hotels) in Debre Zeit and Addis Ababa. Fish sold to retail outlets and to hotels/restaurants is usually filleted. The availability of high market outlet, which might be attributed to relatively good infrastructure and vicinity of the production area, would have high probability of inviting more users to the fishery. The average price of the fish was varied between 1.20 birr (February) to 2.89 birr (March) (Figure 8). This variation of price was related to the demand of the fish in the market. Demand was strongly linked to the fasting traditions of the Ethiopian Orthodox church: most people consider that fish can be eaten on days when meat is not allowed (Wednesdays, Fridays and during the fasting months).

Lake Babogaya is considered a rich source of fish, which generally does not yet show signs of over-fishing. With tightening in the market and rising prices, take more time on fishing interest in the Lake. Current instability in the production and marketing system suggests that the system itself is relatively competitive and exerting pressure on prices.

Profits of the Fish

The total cost and profit analysis of the fishery for the lake were calculated from September (2005) to August

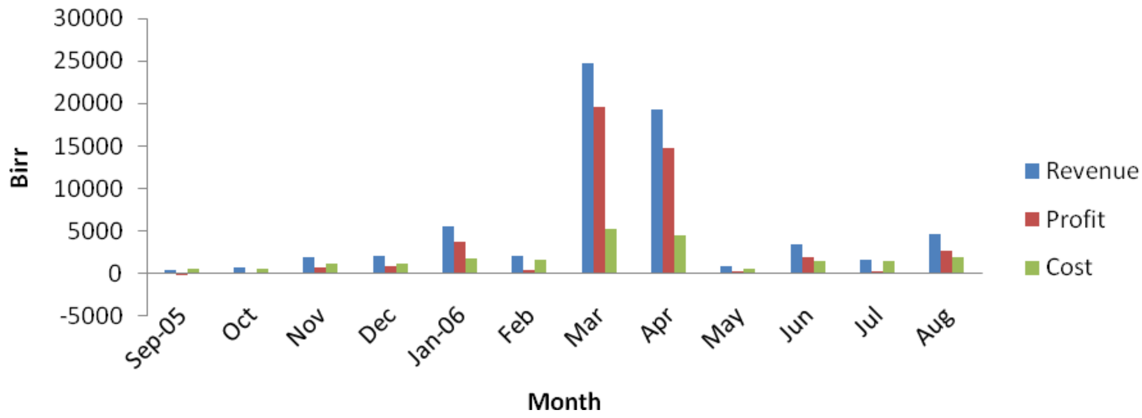


Figure 9: Average cost, profit and Revenu of the product

Table 3. Cost, revenue and profit of capture fishery in the Lake

Month	Fish Harvested (Number)	Cost (ET. Birr)				Sub total cost	Revenue	Profit
		Gill net	Boat and Labour	Processing fish	Transport			
September (2)	360	300	120	90	30	540	496.8	- 43.20
October (2)	500	300	120	125	30	575	690	115
November (5)	1440	500	300	360	40	1200	1987.20	787.20
December (5)	1560	500	300	390	45	1235	2152.8	917.80
January (10)	2000	500	600	500	150	1750	5500	3750
February (10)	1800	500	600	450	150	1700	2160	460
March (30	8575	800	1800	2143.75	450	5193.75	24781.75	19588
April (26)	6962	800	1560	1740.50	390	4490.50	19215.12	14724.62
May (2)	640	300	120	160	30	610	928	318
June (10)	1600	400	600	400	150	1550	3520	1970
July (10)	1200	400	600	300	150	1450	1680	230
August (10)	1800	800	600	450	150	2000	4698	2698
Total	**28437**	**6100**	**7320**	**7109.25**	**1765**	**22294.25**	**67809.67**	**45515.42**

(2006). The cost of the fishery were includes boat and gill nets rent, labours cost for fishing and processing and also transportation cost. Since the yield of the fish depend on the numbers of gill net, high yield were recorded in March (Figure 9 and Table 3). In addition to amount of gears, the numbers of days that operating the gears were also other factor (Fig ure 6).

The costs that exerted for the fishery were depending on the activity conducted. In March and April the cost were high, where as in September, October and May the cost were less (Table 3). This was due to in March and April the demand of the fish was high, hence it needs more costs to activate the activity of fishery soon for computing the market.

The revenue of the product were depends on the quantity of fish caught and the price of the fish on the market. Hence, in March and April there was high revenue of the product. The value was the least in September and increased order to March and April. Then it decreased in May and increased order when goes to August (Table 3 and Figure 9). The profit was also influenced by cost for the fishery activity and the product sold. Based on this the result declared that profit of the product directly related to the revenue (Figure 9 and Table 3).

CONCLUSION

According to the results of the study, its biological status may be able to produce more but economically it might need attention more. Maximum sustainable yield might be the most desirable equilibrium for a fishery in the absence of consideration of costs to harvest or discounting of future revenue from fishing. But fisheries management that may consider only biological factors might loose economic information, which could in turn have a valuable input and importance in management.

The maximum sustainable yield of the lake is unknown; hence, harvesting Lake Babogaya fishery with such

knowledge may disaster for the lake. Therefore, it needs such type of research to its management of the lake as well as in food self sufficiency programme of the country.
To meet the objective of the profitability enhancing revenue or reducing the cost of production is a must. With all the limitations in place, this study might give an insight to the need of further investigation for better outcome in the status of the lake by making use of full data. Even though it is worth to note lack of maximum sustainable yield data, the study has tried to address profitability of the fishery in relation to other related factors.

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