Research Article

iMedPub Journals
www.imedpub.com

Journal of FisheriesSciences.com
ISSN 1307-234X

2022
Vol.16 No.1:106

Assessment of Fish Production Potential in Bishoftu Crater Lakes, Bishoftu, E.Shoa Zone

Lemma Abera Hirpo*

Department of Fisheries Sciences, Batu Fish and Other Aquatic Life Research Center, Batu, Ethiopia

***Corresponding author:** Lemma Abera Hirpo, Department of Fisheries Sciences, Batu Fish and Other Aquatic Life Research Center, Batu, Ethiopia, Tel: 2510916820678; Email: negrofarm@gmail.com

Received: February 18, 2022, Manuscript No. IPFS-22-11620; **Editor assigned:** February 21, 2022, PreQC No. IPFS-22-11620 (PQ); **Reviewed:** March 07, 2022, QC No. IIPFS-22-11620; **Revised:** March 11, 2022, Manuscript No. IPFS-22-11620 (R); **Published:** March 18, 2022, DOI:10.36648/1307-234X.22.16.106

Citation: Hirpo LA (2022) Assessment of Fish Production Potential in Bishoftu Crater Lakes, Bishoftu, E.Shoa Zone. J Fishsci com Vol:16 No:1

Abstract

Bishoftu crater lakes, economically important lakes in the country. However, the physico-chemical parameters of the lake seem to be threatened by anthropogenic, which in turn affects biotic factors as reflected in fish catch. A study was made to assess the current physico-chemical characteristics, to assess the composition and production potential of the fishes and to assess the constraints that affects the production of the fishes in the lakes during July 2018-June 2021 in the waterbodies. Temperature ranged from 20.06 ± 0.3 0 C (L. Hora-Kilole) to 21.3 ± 1.5°C (L. Hora-Arsedi) whereas pH ranged from 8.4 ± 0.8 (L. Koriftu) to 9.1 ± 0.1(Hora-Kilole). Dissolved oxygen varied from 6.4.31 ± 0.8 to 7.9 ± 0.9 mg/l. Low dissolved oxygen was measured at Lake Koriftu categorized as heavily impacted sites. Conductivity varied from 345.1 ± 2.4 in L.Koriftu to 967 ± 36 µS/cm (L.Babogaya). Soluble Reactive Phosphate varied from 39.36 ± 0.3 (H.kilole) to 51.13 ± 5.2 µg/l (Koriftu) and nitrite ranged from 31.2 ± 5.4 (Babogaya) to 44.05 ± 0.6 µg/l (Koriftu). Five species of fishes in the Families Cyprinidae, Clariidae and Cichilidae were identified from the lakes. The species were *Cyprinus carpio*, *Labeobarbus intermedius* from the Family Cyprinidae, *Clarias gariepinus* from the Family Clariidae and *Oreochromis niloticus* and *Tilapia zillii* from the Family Cichilidae. *Oreochromis niloticus* and *T. zillii* were more abundant in all lakes as compare to other fish species. The estimated mean annual catch in tons per gear type was 2.3, 2.8, 1.1 and 1.6 for Lake H.kilole, H.Arsedi, Koriftu and Babogaya, respectively. Open access to the resource and pollution the major problems in the lakes. Thus, as a recommendation management tools like mesh size regulations, gear restrictions and limits on the number of fishers has to be for sustainable exploitation of the stocks and needs to develop aquaculture technologies like cage culture in the lakes.

Keywords: Bishoftu crater lakes; Fish catch and fishery constraints

Introduction

Ethiopia is a land-locked country that depends on the inland waters for the supply of fish as a cheap source of animal protein. The country's water bodies have an estimated surface area of 7,334 km² of major lakes and reservoirs, and 275 km² of small water bodies, with 7,185 km of rivers within the country (FAO, 2015). According to different sources of information, the bulk of the fish catch (approximately 75 percent of the total) originates from the six main water bodies: Tana, Ziway, Langano, Awasa, Abaya and Chamo. The remaining production (approximately 25 percent) originates from minor lakes (Hora, Beseka, Ligo, Hyke, Hashengie, and Small Abaya), reservoirs and dams (Koka, Fincha-Amerti, Denbi, Melka-Wakena, Alwero, Tekezé, Gigel Gibe I) and rivers include Abay, Wabi-shebelle, Awash, Genale, Dawa, Omo, Tekezé, Gibe, Mereb, Baro, Akobo, Angereb and their tributaries (Moreau and Scullion in ACP Fish II, 2013). Riverine fishing activities are mostly performed on the Baro River near Gambela in the western part of the country and the Omo River in the southern area near the border with Kenya [1].

Hence, Ethiopia in general and Oromia region in particular has high production potential and composition of fish fauna, accurate fishery investigation has been carried out only in a few of the numerous freshwater bodies, and relatively a large number of small and medium water bodies have not been well studied and explored. This is the case with the fish fauna of Bishoftu crater Lakes in particular. Thus, the lakes are among such freshwaters that have received no adequate attention on the fishery in general. Therefore, the importance of fish exploration of Ethiopian freshwater systems on one hand and the absence of adequate study on fish composition, production potential on the other hand, justifies this study on Bishoftu Crater Lakes to contribute for food security of the country. Therefore, the objective of this paper was to assess the current physico-chemical characteristics, to assess the composition and production potential of the fishes and to assess the constraints that affects the production of the fishes in the lakes [2].

Materials and Methods

Study areas

Lake Hora-Kilole: is one of the Bishoftu crater lakes that a small and shallow water body (Figure 1). It was once grouped among the unique saline lakes of East Africa, along with lakes

Abijata, Arenguade, Chitu and Shalla in Ethiopia [3]. The volume of the lake is not much affected by irrigation, as there was not much such activity. Most of the agricultural practices were focused on food crops that mainly depended on seasonal rains. However, this anthropogenic effect has turned L. Hora-Kilole from a highly saline-alkaline hypertrophic lake into a highly diluted typical oligotrophic tropical freshwater system. The phytoplankton community, which was almost exclusively dominated by *Arthrospira fusiformis*, the zooplankton community, which was dominated by *Paradiaptomus africanus* and the flamingoes that thrived on these species of plankton completely disappeared as the essential preconditions of saline-alkaline nature of the lake was altered by the inflow from River Modjo [1]. The lake supports a commercial fishery, based largely on *Oreochromis niloticus.*

Lake Hora-Arsedi: It is one of the Bishoftu crater lakes (Figure 1), was believed to be created around 7000 years ago by volcanic collapse above zone of fractured rocks. The lake is a double crater with a maximum depth of 38 m (North crater) and 31 m (South crater) and a mean depth of 17.5 m, located 47 km away from Addis Ababa in the south eastern direction at 8°50’ and 39°E at an altitude of 1850 m [4].The vertical distance from the crater rim to the lake surface is about 80 m. Lake Hora-Arsedi receives 43% of its total inflow from groundwater, but almost all water lose (97%) is by evaporation. The lake has a surface area of about 1.03 km 2 (Table 1). The region around the lake characterized by moderate rainfall, varying around about 850 mm per annum high incident solar radiation and low relative humidity. The region has two rainy periods, the minor one extending roughly from February to April and the major one beginning in June and ending in September. The temperature of its surface water was frequently found to be about 22°C with a maximum of 24.5°C and minimum of19.2°C, while the bottom temperature was almost constant (19.2°C-19.4°C) Its seasonal cycle of stratification and mixing is probably similar to that of the nearby Lake Babogaya, which mostly resembles hydrochemically [5].

Lake Kori tu: Lake Kuriftu is another lake found in the town of Bishoftu (Figure 1). It is found at an altitude of 1860 m, some 47 Km southeast of Addis Ababa. The lake is located at 8°47’ N and 39°00’E. It is a shallow around 6 m maximum depth [6]. The region around the lake is characterized by moderate rainfall, varying around about 850 mm per annum [7], high incident solar radiation and low relative humidity. The region has two rainy periods, the minor one extending roughly from February to April and the major one beginning in June and ending in September [8].

With the establishment of Kale Hiwot Children’s and Integrated Development Center in the proximity of the lake, plantation of trees, construction of utilities and establishment of livestock and agricultural farms were made around the southern shore of the lake. The trees found around the lake include Accacia abyssinica, Jacaranda mimosifolia and species of Eucalyptus and Juniperus. Macrophytes including Passifloraceae is observed. The zooplankton of Lake Kuriftu is composed primarily of rotifers, some cladocerans and a few copepods [2]. The piscifauna of the lake constituted by *Oreochromis niloticus* and *Cyprinus carpio*. Some birds (pelicans and ducks) are often seen on the lake (personal observation) [6].

Table 1: Some physical characteristics of the sampling sites.

Lake	Location	Altitude (masl)	Surface area (Km 2)	Maximum depth (m)
Hora-Kilole	8048' N, 39°5'E	1920	1.18	7.8
Lake Hora-Arsedi	8050'N and 390 E	1850	1.03	38
Lake Koriftu	80 47' N and 390 E	1860	0.4	6
Lake Babogaya	8051 N and 390 E	1870	0.58	71

Lake Babogaya: Lake Babogaya is one of the volcanic crater lakes found in Bishoftu town at about 45 Km East of Addis Ababa (Figure 1). The lake is small, roughly circular and deep, and is found at an altitude of 1870 m and at about 9°N latitude and 39°E longitudes [3]. 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. The lake fed primarily by precipitation falling directly on its surface and run-off from its small catchment area [3]. Which was formed from volcanic rocks of basalt, rhyolite and tuff (Mohr, 1961). The phytoplankton community is dominated by blue-green algae, particularly *Microcystis aeruginosa* [7] while the zooplankton is composed of copepods (Afrocyclops gibsoni, Lovenula africana), rotifers (*Asplancha sieboldi, Brachionus calyc iflorus* and Hexarthra jenkinae) and cladocera. The fish community found in Lake Babogaya is composed African catfish, *Clarias gariepinus,* and two tilapiine species (*Oreochromis niloticus* and *Tilapia zilli*), which were introduced in to the Lake by MOA (Ministry of Agriculture) with the aim of fishery development.

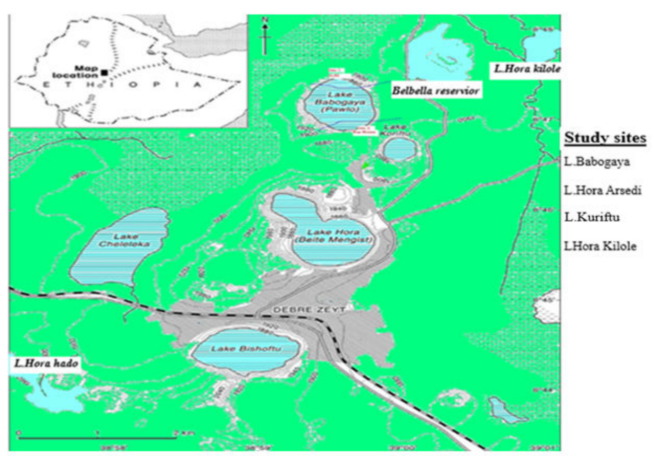

Figure 1: Location of Bishoftu Crater Lakes.

Site selection and sampling procedure

Physico-chemical parameters: To assess the physico-chemical factors of the lakes, six sampling sites were selected based on geographical proximity and/or habitat similarity, their distance from anthropogenic effects. Samples were collected monthly with a Van Dorn bottle sampler from the pre-selected sampling station during the period spanning from July 2018-June 2021. Samples were collected from selected depths distributed within the euphotic zone and mixed in equal proportions to produce composite samples. The composite samples were used for the analysis of inorganic nutrients, identification of phytoplankton taxa, and estimation of phytoplankton biomass as Chlorophyll a (Chl-a) production. For the identification and enumeration of zooplankton, separate samples were collected by towing upward using a tow net (55 µm).

Fish parameters: Parallel to the physico-chemical sampling, every sampling periods the fishes were collected at all sites using variety of fishing gears. The gears include gill nets of various mesh sizes (6,8,10 and 12 cm stretched mesh size), monofilament nets with various stretched mesh sizes (5 mm to 55 mm stretched mesh size) and multiple long-lines with hooks of different size (9,10,11 and 12). The gears were set in the afternoon (4:00 pm) and were collected in the following day (7:00 am). Immediately after capture, some morphometric measurements were measured and the fish samples were put in plastic jars containing 10% formalin and labeled with all necessary information. Then the preserved specimens were soaked in tap water for many days to wash the formalin away. Then, the samples were transferred to 75% ethanol before species identification was conducted. The specimens were identified to species level using taxonomic keys of Witte and Wim, 1995; Stiassny and Abebe Getahun, 2007 and figures from Fish base [4].

Catch and effort: Estimation of catch composition of fishes in the lakes was made by taking the contribution in number and weight of each species in the total catch in each sampling effort. Yield of the fish were analyzed for better management of the fish in the lakes. In addition, secondary data were collected from published and unpublished sources to identify the major constraints that affect the production of the fishes in the lakes.

Data analysis: Fish species composition was presented as a numerical contribution by each species. This was determined by calculating the percentage of each species represented in the total catch for each station. Descriptive statistics were also used to analyze the remaining collected data using SPSS software (SPSS V.19.0).

Results and discussions

Physico-chemical factors that in luences the ish community structure of the lakes: The nutrients displayed relatively more variation among the lakes than did the physical parameters except secchi depth (Table 2). The lower level in Secchi depth reading in Lake Koriftu shows that turbidity in the lake is increasing, which can be attributed to catchment degradation, siltation and perhaps introduced bottom-stirring fish such as carp becoming more and more abundant in the lake (Figure 2).

Table 2: Mean and standard error values of physico-chemical variables of the lakes.

Lakes				
Parameters	**Hora-Kilole**	**Hora-Arsedi**	**Koriftu**	**Babogaya**
Temperature (°C)	20.06 ± 0.3	21.3 ± 1.5	21.15 ± 0.2	21.01 ± 0.6
Secchi depth (cm)	38.58 ± 0.4	110.54 ± 0.1	20.2 ± 0.4	98.7.0 ± 0.5
Nitrate (µg/L)	39 ± 9.3	41.11 ± 0.5	44.05 ± 0.6	31.2 ± 5.4
SRP (µg/L)	39.36 ± 0.3	49.14 ± 0.9	51.13 ± 5.2	44.15 ± 4.2
Dissolved Oxygen(mg/l)	7.9 ± 0.9	7.1 ± 0.2	6.4.31 ± 0.8	7.8 ± 1.7
Chl- a (µg/L)	35 ± 0.9	37.2 ± 6.1	47 ± 0.6	32.2 ± 1.3
pH	9.1 ± 0.1	9 ± 0.3	8.4 ± 0.8	8.5 ± 0.6
Conductivity (mS/cm)	510.1 ± 2.3	350 ± 1.2	345.1 ± 2.4	967 ± 36

Temperature ranged from 20.06 ± 0.3°C (L. Hora-Kilole) to 21.3 ± 1.5°C (L. Hora-Arsedi) whereas pH ranged from 8.4 ± 0.8 (L. Koriftu) to 9.1 ± 0.1(Hora-Kilole). Hence, the pH values of the lake water in all lake is suitable for normal biological activity set as 6.5-8.5 by the European Economic Community (EEC, 1980). Dissolved oxygen varied from 6.4.31 ± 0.8 to 7.9 ± 0.9 mg/l. Low dissolved oxygen was measured at Lake Koriftu categorized as heavily impacted sites.

Conductivity varied from 345.1 ± 2.4 in L.Koriftu to 967 ± 36 µS/cm (L.Babogaya). Soluble Reactive Phosphate varied from 39.36 ± 0.3 (H.kilole) to 51.13 ± 5.2 µg/l (Koriftu) and nitrite ranged from 31.2 ± 5.4 (Babogaya) to 44.05 ± 0.6 µg/l (Koriftu). Relatively an extremely high value of nitrate was recorded in

Lake Kori tu. Water quality testing is an important part of environmental monitoring. When water quality is poor, it affects not only aquatic life but also the surrounding ecosystem.

Composi ion of the ishes in the lakes: A total of ive species of ishes in the Families Cyprinidae, Clariidae and Cichilidae were identi ied from the lakes (Table 3).

the species were Cyprinus carpio, Labeobarbus intermedius from the Family Cyprinidae, Clarias gariepinus from the Family Clariidae and *Oreochromis nilo icus* and Tilapia zillii from the Family Cichilidae.
The status (presence/absence) of the species from the sampling sites provided in Table 3.

Table 3: Fish species identified from the lakes present (+), absent (-).

Lakes					
Family	**Fish species**	**Hora-Kilole**	**Hora-Arsedi**	**Koriftu**	**Babogaya**
Cyprinidae	Cyprinus carpio	+	-	+	-
	Labeobarbus intermedius	+	-	+	-
Clariidae	Clarias gariepinus	+	+	+	+
Cichilidae	Oreochromis niloticus	+	+	+	+
	Tilapia zillii	+	+	+	+

A total of 11,254 ish specimens were recorded from the three families during the study period and the composition of the ish described in Figure 2. *Oreochromis nilo icus* and *T.zillii* were more abundant in all lakes as compare to other ish species (Figure 2).

The most abundant ishes (*O. nilo icus* and *T.zillii*) were also the most widely distributed in different water bodies, as they are highly tolerant to a wide range of environmental conditions In most ri t valley lakes, *O. nilo icus* is one of the ish species that are abundantly found in the littoral zones during juvenile stage and similar phenomenon has been observed in Lake Naivasha.

Currently, the littoral zone is being affected due to different anthropogenic factors, and the composition of the ishes will be changed as a result, progressive increase in the proportion of other ish species like *C. carpio*.

Currently, *Cyprinus carpio* was more capture in Lake H.kilole (10%) next to Kori tu (18%)

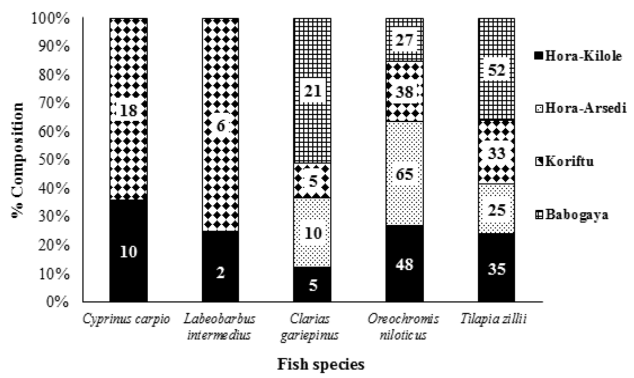

Figure 2: Fish species composition by number (%)

Fish catch of the lakes: The estimated mean annual catch in tons per gear type was summarized in Tables 4-7. The total CpUE were 2.3, 2.8, 1.1 and 1.6 for Lake H.kilole, H.Arsedi, Koriftu and Babogaya, respectively (Table 4-7). Gill net the most common gear that operated in all lakes as compare th the two gears (circular net and long line).

Table 4: Catch percentage and yield of fishes by species and gears for Lake Hora-kilole.

Total catch in tons						
Gear	***O. niloticus***	***C. gariepinus***	***C. carpio***	***L.intermedius***	***T.zillii***	**Total**
Gill net	1.02	0.115	0.23	0.046	0.655	2.066
Circular net	0.084	0	0	0	0.15	0.234
Long line	0	0	0	0	0	0
Total	1.104	0.115	0.23	0.046	0.805	2.3
Catch percentage	48	5	10	2	35	

Table 5: Catch percentage and yield of fishes by species and gears for Lake Hora-Arsedi.

Total catch in tons						
Gear	***O. niloticus***	***C. gariepinus***	***C. carpio***	***L.intermedius***	***T.zillii***	**Total**
Gill net	1.729	0.28	0	0	0.57	2.579
Circular net	0.091	0	0	0	0.13	0.221
Long line	0	0	0	0	0	0
Total	1.82	0.28	0		0.7	2.8
Catch percentage	65	10	0	0	25	

Table 6: Catch percentage and yield of fishes by species and gears for Lake Koriftu.

Total catch in tons						
Gear	***O. niloticus***	***C. gariepinus***	***C. carpio***	***L.intermedius***	***T.zillii***	**Total**
Gill net	0.418	0.055	0.198	0.066	0.363	1.1
Circular net	0	0	0	0	0	0
Long line	0	0	0	0	0	0
Total	0.418	0.055	0.198	0.066	0.363	1.1
Catch percentage	38	5	18	6	33	

Table 7: Catch percentage and yield of fishes by species and gears for Lake Babogaya.

Total catch in tons						
Gear	***O. niloticus***	***C. gariepinus***	***C. carpio***	***L.intermedious***	***T.zillii***	**Total**
Gill net	0.382	0.336	0	0	0.832	1.55
Circular net	0.05	0	0	0	0	0.05

Long line	0	0	0	0	0	0
Total	0.432	0.336	0	0	0.832	1.6
Catch percentage	27	21	0	0	52	

Total annual fish catch from the lakes during the study period was described in figure 3. Relatively, high production potential of fish in Lake Babogaya next to H.Arsedi (Figure 3). The problem of Bishoftu Crater Lakes, fishery was that fishing is open to everyone who wishes to do so as source of income and food. Hence, the current annual fish production of the lakes declining due to overexploitation. There was a continuous decline in the fish species composition of some fish species, like C.gariepinus and O.niloticus from the lake Babogaya was the dominant in 2007, but in this study, there was an increase in T.zillii population which was also observed from the fishermen catches to some extent.

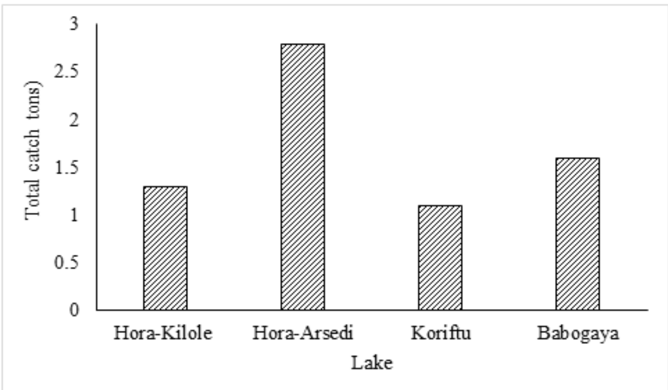

Figure 3: Total annual fish catch from the lakes during the study period.

Major constraints that affect the production of the ishes in the lakes: Fishing gears: Different fishing methods catch different types and sizes of fishes in the same area.

Gill nets (monofilament), circular net and long-line were the most common fishing gears that were being used in the lakes (Table 4-7).

The recommended minimum mesh size of the lake for *O. nilo icus* was 10 cm (LFDP, 1993) and currently that not practiced in the study areas. The fishermen utilize wooden boats for casting gillnets and long-lines and.

Change of water qualities: The physico-chemical and biological features of the lake were documented by various papers (Table 8). Currently the mean value of nutrients in all of the water bodies were increased (Table 8). However; values of physical parameters were decreased.

An increase in the conductivity in the present study in all water bodies may be explained by the concentration of ions accumulated from the surface runoff from the town and agricultural areas around the lake.

Table 8: Trends in some physico-chemical factors of the lakes.

Lake	**Parameters**	**Units**	**Previous study**	**Present study**	**Trends**
Hora Kilole	Secchi depth	cm	180	38	Decreasing
	pH	-	9.6	9.1	Decreasing
	D. Oxygen	mg/L	9.7	7.9	Decreasing
	Chl-a	µg/L	535	35	Decreasing
	Nitrate	µg/L	39 ± 9.3	42	Increasing
	SRP	µg/L	27	39	Increasing
	Conductivity	mS/cm	100	110	Increasing
Hora Arsedi	Secchi depth	cm	168	110.5	Decreasing
	pH	-	9.2	9	Decreasing
	D. Oxygen	mg/L	9.7	7.1	Decreasing
	Chl-a	µg/L	106	37	Decreasing
	Nitrate	µg/L	37.92	41	Increasing
	SRP	µg/L	58.84	60	Increasing
	Conductivity	mS/cm	319	350	Increasing

Koriftu	Secchi depth	cm	20	18	Decreasing
	pH	-	8.4	8.5	Decreasing
	D. Oxygen	mg/L	7.6	6.3	Decreasing
	Chl-a	µg/L	55.6	47	Decreasing
	Nitrate	µg/L	33.3	38	Increasing
	SRP	µg/L	41.5	51	Increasing
	Conductivity	mS/cm	319	345	Increasing
Babogaya	Secchi depth	cm	139	98.7	Decreasing
	pH	-	9.5	8.5	Decreasing
	D. Oxygen	mg/L	8.3	7.8	Decreasing
	Chl-a	µg/L	37	32.2	Decreasing
	Nitrate	µg/L	20	31.2	Increasing
	SRP	µg/L	5	42	Increasing
	Conductivity	mS/cm	900	967	Increasing

As described in Table 8, some of the physico-chemical trends of the lakes water were changed. Some of them may affect the aquatic organisms, such as fish kills occurring at the shore of the lake (personal observation in Lake H.Arsedi and Babogaya). Also evidence from other lakes in Ethiopia show that the longer term impact of human induced changes like deforestation increases the risk of flooding such as Hawassa Lake and Lake Ziway or even complete degradation of the lake like in the case of Haramaya [2].

According to population pressures and urbanization significantly affect cities near lakes and the lakes themselves were among the greatest potential causes of change in water quality and quantity. Therefore, the current population pressure around the lakes, cause pollution and water scarcity, and in turn impairing fish population and future development of the resources [4].

Conclusions and Recommendations

The nutrients displayed relatively more variation among the lakes than did the physical parameters. The fish fauna of Bishoftu Crater Lakes dominated by O. niloticus and T.zillii in all lakes as compare to other fish species. The estimated mean annual catch in tons per gear type was 2.3, 2.8, 1.1 and 1.6 for Lake H.kilole, H.Arsedi, Koriftu and Babogaya, respectively. The problem of Bishoftu Crater Lakes, fishery was that fishing is open to everyone who wishes to do so as source of income and food. Hence, the current annual fish production of the lakes declining due to overexploitation. Hence, the current fisheries management system in Ethiopia mainly consists of a fishing licensing system aimed at regulating access to the fishery and some technical conservation measures including mesh-size limitations for gillnets. The waste-disposal mechanisms of the adjacent businesses and or residential areas should be investigated to establish the exact source and nature of the pollutants. Those people responsible for the pollution should be encouraged to implement appropriate mitigating measures as soon as possible. The development of aquaculture and other related alternative fisheries (cage culture) to reduce the pressure on the natural system of capture fishery should be encouraged to utilize the resources appropriately.

References

1. Brook Lemma (2002) Contrasting effect of human activities on aquatic habitats and biodiversity of two Ethiopian lakes. EJNR 4:133–144
2. Brook Lemma, lake L. Hora-Kilole (1994) Changes in the limnological behavior of a tropical African explosion crater, Ethiopia. Limnologica 24:57–70
3. Prosser MV, Wood RB, Baxter RM (1968) The five Bishoftu crater lakes: a bathymetric and chemical study. Arch Hydrobiolo 65:309–324
4. Redieat Habteselassie (2012) Fishes of Ethiopia Annotated Checklist with Pictorial Identification Guide. 250
5. Talling JF, Lemoalle J (1998) Ecological dynamics of tropical inland waters. Cambridge: Cambridge University Press
6. Talling JF, Wood RB, Prosser MV, Baxter RM (1973) The upper limit of photosynthetic productivity of phytoplankton: evidence from Ethiopian soda lakes. Freshw Biol 3:53-76
7. Wood RB, Talling JF. 1988. Chemical and algal relationships in salinity series of Ethiopian inland waters. Hydrobiologia 15:29-67
8. Wood RB, Prosser MV, Baxter RM (1984) Seasonal and comparative aspects of chemical stratification in some tropical crater lakes, Ethiopia. Freshw Biol 14:551-573