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Diversity, and Some Population Parameters of Fishes inGilo and Duchi rivers, Baro-Akobo Basin, South West, Ethiopia

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Abstract

Ethiopia has a freshwater system thatcan be divided into six major drainage basins in relation to its ichthyofaunal distribution. Inland water bodies of Ethiopia are estimated to be about 7400 km^2 of lake area and about 7000 km of river length. However, its freshwater fish diversity is poorly studied. This study was conducted in Gilo (Bako) and Duchi rivers, Baro-Akobo Basin, with the objective of to identify fish diversity using some population parameters. Fish Samples were collected in dry (March-May, 2018) and wet (June-August, 2018) seasons using gill nets of 12, 16, 20 and 24 cm stretched mesh sizes, and hook. A total of 287 fish specimens that are categorized into seven species, four genera, two families and two orders were collected andidentified from these rivers during both seasons. The represented families were Mormyridae and Cyprinidae; the latter being the most diverse family with respect to number of species.Shannon–Weiner diversity index (H') of fish species in Gilo River (H' = 1.78) was greater than that of Duchi River (H' = 0.17). However, the fish diversity indexes recorded for Gilo and Duchi Rivers are relatively lower compared to the values reported for other rivers in the country. Labeobarbus intermedius, Labeobarbus nedgia and Labeobarbus degeni were the most abundant fish species both in terms of number and Index of Relative Importance (IRI), respectively. Overall, fish abundance in dry season was higher than in wet season. The length-weight relationships for these species were best fitted using power regression equation. The mean Fulton Condition Factor (FCF) for L.intermedius, L. nedgiaandL. degeniwere 1.85, 1.76 and 1.57, respectively, *inGilo and Duchi Rivers. There was significant variation (t-test, P<0.05) in FCF of L. nedgia in the both seasons and rivers. As observed during this study, the factors contributed to the differences in fish diversity of the two rivers include human intervention, channel flow and the altitude and climatic differences of the rivers locations.However, variations were not significant (t-test, P > 0.05) for the L. intermedius and L. degeni.Besides, basic fishery activities and habitat characteristics of both rivers were discussed and compared with other previous studies. It is,therefore, believed that this study has generated base-line data on fish diversity and some population parameters of fishes in the study area that would help in the proper and sustainable utilization of the resources.Detailed studies and investigations are required on socio-economic aspects of the two rivers.*

Key words: - Fish diversity, relative abundance, Duchi River, Gilo River, population parameters

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Acronyms

BoFED- Bureau of Finance and Economic Development

CSA- Central Statistical Authority

FL- Fork Length

GPS-Geographical Positioning System

IRI- Index of Relative Importance

FCF- Fulton Condition Factor

JERBE- Joint Ethio-Russian Biological Expedition

PAST- Paleontological statistics software

Tw – Total weight

TL- Total length

SL- Standard length

Chapter One

1. Introduction

1.1. Background

Fishes constitute more than 27,000 of the known 54,000 species of living vertebrates and are divided taxonomically into three major groupings as jawless fishes (Agnathans), cartilaginous fishes (Chondrichthyans) and bony fishes(Osteichthyans) (Nelson, 2006;Helfman *et al*., 2009).A major zoogeographic distinction canbemade between marine and freshwater fishes, with substantial overlap occurring where intermediate salinities occur. Many fishes are restricted to freshwater, others are restricted to normal oceanic salinity, some occur in both habitats at different times of their lives and some occur and are even restricted to areas of intermediate salinity, such as estuaries (Helfman, 2001).

Fishes occupy essentially all aquatic habitats. Their habitats include the deep sea to depths of 8000 m, high mountain streams and lakes to 5000 m altitude and just about every aquatic habitat in between. Freshwater fishes are the most diverse groups of fishes in the world, species make up 41% (covering < 1 % of Earth's surface), Marine fishes make up 58% of all species (covering 70 % of Earth's surface); and 1% of fishes move regularly between the ocean and fresh water (Helfman, 2001). Africa harbors a well-diversified fish fauna, resulting from a long history of complex climatic and geological events that resulted in geographic isolation followed by speciation for some populations, or extinction for others (Leveque, 1997).

Like many other forms of life, fishes are of immense value to humans. They have long been a staple item in the diet of many people; leading to the downfall of many species. Today they form an important element in the economy of many nations while giving incalculable recreational and psychological value to the naturalist, sports enthusiast and home aquarist. They are also used as general indicators or summators of pollution, partly to the direct benefit of humans and partly to protect what people consider a valuable and necessary part of their heritage and life (Nelson, 2006).

Ethiopia has a rich diversity of Ichthyofaunal in its lakes, rivers and reservoirs, although they are poorly known (Getahun and Stiassny, 1998) and especially the rivers, are not exhaustively explored (Getahun, 2007). The knowledge on the fish diversity and abundance of Ethiopian rivers is far from complete (Getahun, 2007). Gillo (Bako) and Duchi Rivers are among such rivers that are poorlyknown for their diversity and abundance of fish species. Moreover, streams worldwide are subject to human impacts that degrade habitat conditions (Malmqvist & Rundle, 2002) and Gillo (Bako) as well as Duchi Rivers are no exception.

1.2. Statement of the problem

Although Ethiopia presumably has high fish diversity, little work on has been done. Ethiopia appears to be the least explored for its Ichthyofaunal of all the regions of Africa (Golubtsov *et al*., 1995).Giloand DuchiRivers are among the tributaries of the Baro-Akobo Basin. These rivers are expected to have high diversities of fish fauna. According to Tedla(1973) only eight fish species were recorded from the Baro basin, whereas the joint Ethio-Russian Biological Expedition (JERBE) studies.(For instance, about113 species belonging to 26 families and 60 genera were identified by JERBE during the past 20 year studies (Golubstov and Darkov, 2008).Revealed diverse fish fauna including more than 90 species in this region but like other most rivers and reservoirs in Ethiopia are poorly explored. No prior study on the diversity, relative abundance, length-weight relationships, condition factors, andpopulation parameters of fishes has been undertakenin these rivers.

1.3. Objectives of the study

1.3.1. General Objective

- Toassess fish diversity using some population parameters in Giloand Duchi rivers, ShakaZone, Southwest Ethiopia

1.3.2. Specific Objectives

- To identify fish species composition in the study area.
- To determine the length-weight relationships and condition factors of the most abundant fish species
- To identify the potential anthropogenic activities in the rivers that could likely undermine fish diversity in the rivers
- To distinguish fishery activities and the extent of practices in the rivers

1.4. Significance of the study

This study focused on the investigation of fish species composition, their distribution, and abundance, local fishery practice of Gilo and Duchiriversto generatebase-line scientific information for further studies.Additionally, the study can also contribute to the proper and sustainable exploitation of the fish resources of the two river basins. The information generated could also be used for proper management of fisheries of the Study Rivers as effectiveknowledge of the number and distribution of species of any particular area.

1.5. Delimitation of the study

Due to time and resource limitation, this study wasdelimited toGilo and DuchiRivers in Shaka zone of South west Ethiopia mainly focusing on the identification of the different fish species composition, distribution and abundance and a few population parameters of fish species in the two rivers.

Chapter Two

2. Literature Review

2.1. Composition of Ethiopian freshwater fish fauna

Freshwater fish occur almost everywhere in rivers, streams, lakes, springs, swamps, and bogs and in every continent except Antarctica. Each continent, and often each river basin, has a distinct fish fauna that is primarily due to the physical barriers that limit freshwater fish dispersal. Generally, diversity is lower in temperate regions and higher in tropical areas. For freshwater fish, the tropical zones of South America, Africa and Asia are the most diverse regions on Earth (Berra, 2001).

Africa has several archaic and phylogenetic ally isolated taxa (e.g. The Bichirs, Polypteridae; lungfishes, Protopteridae) (Lundberg *et al*., 2000). In Africa, a large proportion of the inland fisheries are located along the shores of lakes, but the continent's vast river systems are also rich in fisheries and may produce up to one-half the total catch from inland waters (Welcomme, 1979). The African ichthyofaunal is also unique in that it includes surprisingly diverse speciesflocks that resulted from adaptive radiations (Lundberg *et al*., 2000). These include the species flocks of cichlids in the Great lakes of East Africa (Lakes Malawi, Tanganyika, and Victoria) and *Labeo barbus* in Lake Tana (Ethiopia).

At the beginning of the 20^{th}century, G.A. Boulenger undertook extensive work on African fishdiversity and described fish species including *Garra makiensis and Garra pleurogramma(*Boulenger, 1905; Getahun, 2007). The first review on Ethiopian freshwater by Tedla (1973) listed 93 fish species. Getahun and Stiassny (1998) identified 65 species belonging to 19 genera and 9 families with large proportion of the species coming from thecyprinid family and occurring in Abay (Blue Nile) drainage basin. A review by Getahun (2007) mentioned the occurrence of 152 valid indigenous fish species and subspecies in 25 and 24 families in Ethiopian freshwater systems respectively with 10 exotic species. About 40-41 species and subspecies are endemic to the country.

According to Getahun (2003), the freshwater fish fauna of Ethiopia is of particular interest since it contains a mixture of Nilo-Sudanic, East African and endemic forms. The Nilo-Sudanic forms are represented by a large number of species found in the Baro-Akobo, Omo- Gibe and Abay drainage basins (e.g. members of the genera *Alestes*, *Bagrus, Citharinus, Hydrocynus,Hyperopisus, Labeo, Mormyrus*etc.). The southern Rift valley (Lakes Abaya and Chamo) and the Shebele-Genale Basins have elements of these forms. It is believed that these lakes and river basins had former connections with the upper White Nile (through Lake Rudolf in the former case) as recently as 7500 years ago (Getahun, 2007). These Nilo-Sudanic forms are related to West African fishes and this is believed to be due to past connections of the Nile to Central and West African river systems (Boulenger, 1905).

The highland east African forms are found in the northern Rift Valley lakes (e.g. Lakes Hawassa, Zuway, and Langano), the highland lakes (e.g. Tana and Hayq) and associated river systems and the awash drainage Basin. These include members of the genera *Barbus, Labeobarbus, Clarias,Garra, Oreochromis* and *Varicorhinus.* They are related to fishes of eastern, northern and southern Africa. Some elements are shared with waters of western Africa. For example, *G.dembeensis*is a widely distributed cyprinid species found in six countries (Ethiopia, Kenya,Egypt, Tanzania, Cameroun and Nigeria). Nilotic fishes are almost entirely absent from the Awash and northern rift valley lakes (Getahun *et al*., 2008).

The ichthyofauna of Ethiopia does not seem all that numerous, considering the size of the country. No endemic species are known from the lowland waters, but endemism in the waters of the Ethiopian plateau is high (Getahun, 2008). Two genera of fishes *(Barbus* and *Garra*) dominate the fish ichthyofauna of these streams. A peculiar endemic fish of the Ethiopian plateau is *Afronemacheilus abyssinicus* (Getahun, 2008). In general, the endemic forms have unevenly distributed fish species in terms of number richness and diversity among the drainage basins. Unevenness of the species within the main drainage basins could be due to highly diverse and rich habitat variation among the drainage basins, high exploration chance due to the relative accessibility of the lakes and rivers. The highest species diversity was recorded from Baro Basin, followed by Abay, Omo-Gibe, Tekaze, Wabi-Shebele Basins, Rift Lakes (Golubstov andDarkov, 2008).

It appears that this high diversity is partly attributable to the presence of highly diverse and rich habitats, but probably also to relatively high level of exploration and collections done in these relatively accessible water bodies. However, endemicity seems to be highest in Abay and A wash Basins. This is due to the endemic "species flock" of Lake Tana and the presence of some endemic fishes adapted to localized habitats in small streams in the highlands of north and central Ethiopia. Lake Tana has 28 species and one sub species of which 20 species and one sub species are Ethiopian endemics18 species are endemic to Lake Tana (Getahun *et al*., 2008).

The Endemic forms have unevenly distributed fish species in terms of number richness and diversity among the drainage basins. According to (Habteselassie, 2012) 40 endemic fish species are known to occur within Ethiopian waters. Unevenness of the species within the main drainage basins could be due to highly diverse and rich habitat variation among the drainage basins, high exploration chance due to the relative accessibility of the lakes and rivers. The highest species diversity is recorded from Baro Basin, followed by Abay, Rift Lakes, Wabi Shebele and Omo-Gibe Basins (Golubstov and Darkov, 2008). It appears that this high diversity is partly attributable to the presence of highly diverse and rich habitats, but probably also to 5 relatively high levels of exploration and collections done in these relatively accessible water bodies. However, endemicity seems to be highest in Abay and Awash Basins. This is due to the endemic "species flock" of Lake Tana and the presence of some endemic fishes adapted to localized habitats in small streams in the highlands of north and central Ethiopia. Lake Tana has 28 species and one sub species of which 20 species and one sub species are Ethiopian endemics. 18 species are endemic to Lake Tana (Getahun *et al*., 2008).

The Nilotic species, Nile tilapia, *Oreochromis niloticus*, *Bagrusdomac*and Nile perch, *Latesniloticus*, are abundant and common in lakes Turkana, Abaya and Chamo (Hughes &Hughes, 1992). No endemic species are known from this watershed (Getahun, 2008). The fishes of Ethiopia are dominated by cyprinid fishes, which account nearly 30% of the native fishes occurring in the country followed by Mochokids and Mormirids. Excluding Lake Turkana endemics, Ethiopian waters harbor 40 endemic fish species that are so far known within Ethiopian waters only. Out of the 40 endemic fishes of the country, 33 are cyprinids (Habteselassie, 2012).

The fish species diversity and composition varies within the Ethiopian geographical areas. Thefreshwater Biology Group of the Joint Ethio-Russian Biological Expedition (JERBE) was conducting a fish-sampling programme covering most of Ethiopian main drainage systems since1984. According to JERBE's (current estimate) the fish fauna of Ethiopia includes 29 families, 70 genera, and about 180 species. A more recent listing puts this number to 200 species, with 194 indigenous fish in 75 genera, 31 families, 12 orders and 6 exotic species (Habteselassie, 2012).

2.2. Fish diversity and the drainage Basins

Based on similarities of the fauna (especially the fish fauna) and following the model of freshwater ecoregions of Africa Getahun (2008), the freshwater systems of Ethiopia can be conveniently placed under five freshwater ecoregions. These are the Ethiopian High lands (includes streams, rivers and lakes in the highlands of Ethiopia, but excluding Lake Tana, because of its unique fish fauna). The Northern Rift (rift valley lakes excluding, Lakes Abaya and Chamo because of the Nilo-Sudanic affinities of their fish fauna) the Lake Turkana (includes the Omo River and its tributaries as well as Lakes Abaya and Chamo).The Shebele-Jubacatchments (includes tributaries of Wabi - Shebele, Genale, Dawa and Fafan) and the Red Sea coastal (the Awash system and the saline lakes of northern Ethiopia that includes Lakes Abbe, Afambo, Afdera and Asale) drainage basins.

According to (Golubtsov and Darkov 2008), these freshwater ecoregions can further be divided into six major drainage basins. These are Tekeze-Atbara, Blue Nile, White Nile (Baro-Akobo), and Omo-Gibe-Turkana, Shebele-Juba, and Rift valley. The drainage pattern in Ethiopia is the result of the uplifting during the Tertiary period, which created the Rift Valley and consequently the two separate highlands (Westphal, 1975;Getahun and Tewabe, (2012).The river systems of the country harbor more fish species than the lakes and reservoirs. The diversity of fish species in major river systems of the country is negatively correlated with the altitude of river system (Habteselassie, 2012).Ethiopia's drainage basins receive an annual runoff volume of 122 billion m^3 of water and an estimated 2.6-6.5 billion

m^3 of ground water potential (Bekele *et al*., 2007). Apart from the Awash and Rift Valley Lakes Basin, the river basins are trans-boundary. Thus, Ethiopia could be described as the water tower of Eastern Africa in a continent, which is for the most part, arid. The inland water body of Ethiopia is estimated at about 7400 km2 of lakes and reservoirs and a total river length of about 7000 km (Wood and Talling, 1988), with over 180 species of fish and numerous other aquatic resources in Ethiopian drainage systems (Tewabe, 2012).

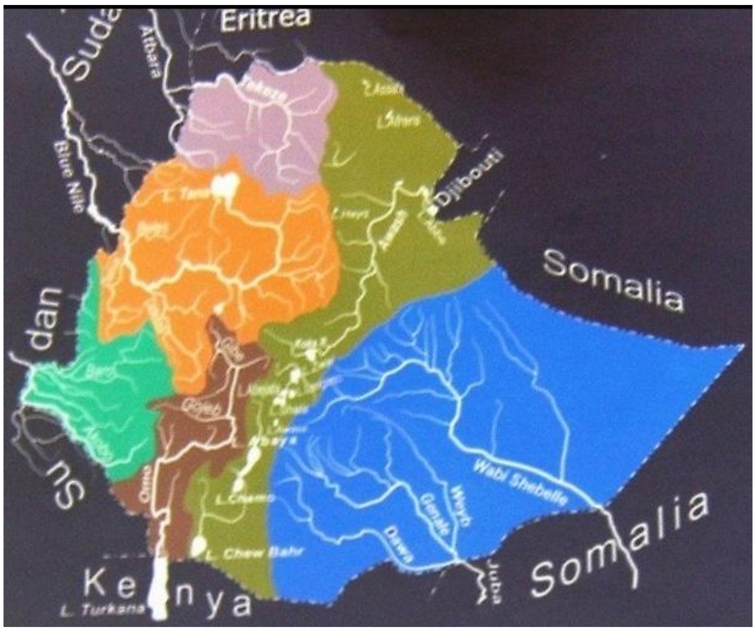


Figure:1. Drainage basin of Ethiopia (From: Golubstov and Darkov, 2008).

2.2.1. Baro-Akobo Basin

According to Getahun (2003), the southwestern highlands, south of the Abay trough, are relatively small mountain remnants rounded in form, with few areas above 2500 m and dissected by mature river valleys. Many of the tributaries of Baro-Akobo Basin arise from these mountains and hills. The major river systems of the Basin include, Alwero, Gilo, Baro, Akobo, BaroKela, Sore, Geba, Birbir, Bonga and Jejebe Rivers. The Sobat, as the Baro-Akobo is named outside of Ethiopia, derives its water supply mainly from the southern Ethiopian plateau. The Sobat carries a fine mineral (volcanic) sediment of whitish color which persists in the White Nile downstream and may be one of the reasons for the color difference between the White and Blue Nile (Rozska,1976).

Tedla (1973) indicated that only eight fish species were recorded from the Baro Basin. Golubtsov and Mina (2003) reported about 107 fish species belong to 54 genera and 23 families in the White Nile system within the territory of Ethiopia. Getahun (2007) indicated that there were 87 fish species of which only one (*Afronemacheilus abyssinicus*) was endemic to this basin. More recently, Golubtsov and Darkov (2008) indicated that 113 fish species included in 60 genera and 26 families from the same basin. The White Nile system within the territory of Ethiopia accommodates the most diverse fish fauna.There are six families (Anabantidae, Channidae, Cromeriidae, Nothobranchiidae, Notopteridae and Protopteridae) which are absent in other drainage systems (Golubstov and Darkov, 2008). According to Mina (2001) in the upper part of this basin, the diversity of fish decreases drastically like in other Ethiopian basins. The most commercially important fish species are *Oreochromis niloticus*, *Clarias*sp and *Polypterusbichir, Heterotis niloticus, Gymanrchus niloticus, Malapterurus*sp. *Lates niloticus*, *Alestes*sp.,*Hydrocynus*sp.,*Mormirids* sp.,*Bagrus*,*Barbus* sp. and *Labeo horei*. There are about six endemic species and there is no data on exotic fish species in this drainage basin. The diverse fish fauna of the lowland part of this drainage basin is an extremely valuable resource for fish culture development in Ethiopia (Golubstov and Darkov, 2008).

2.2.2. Blue Nile Basin

The Blue Nile, which arises from Lake Tana, drains to the central and northwestern plateaus ofEthiopia. According to Getahun (2003), it is the major river of Ethiopia with a length of1000 km between Lake Tana and the Sudan border and its annual discharge is around 50 billion cubic meters. Its system includes the Dinder River, which joins the Blue Nile far below the reservoir in the Sudan and a number of basins that include Jemma, Dabus, Beles, and Didessa Rivers as well as Fincha and Koga basins and the largest lake in Ethiopia, Lake Tana and its tributaries (Habteselassie, 2012). Although the total drainage area is relatively small, 324,000 km2, it supplies 58 % of the total water of the Nile system, and almost all the sediment that has built up the alluvial river valley and the Delta in Egypt (Rzoska, 1976). The majorsupply of the Blue Nile flood is derived from the lower part of the basin especially from the Jamma, Guder, Didessa and Dabus Rivers. Didessa and Dabus on the left bank, rise in the high rainfall region of the southwest region of the country (Tudorancea *et al*., 1999). The other major tributaries include Belessa, Dabena, Anger, mugger, Beshilo and Wonchit.From the Blue Nile, drainage within the limits of Ethiopia 30 fish species was reported (Tedla, 1973) while JERBE recorded 77 fish species belonging to 16 families and 37 genera. The family Cyprinidae is the most diverse group of fish. The Blue Nile drainage basin is characterized by high percentage of endemic species (which is at least 24 endemic species). A quarter (19 species) of the total number of species recorded consisted of the cyprinids endemic to Lake Tana sub-Basin.

Golubstov and Mina (2003) demonstrated that three fish species as introduced into Ethiopia part of the Blue Nile drainage system.Three families are represented by single species each. These are Cichlidae, Claridae and Balitordae represented by *Oreochromis niloticus*, *Clariasgariepinus*and *Afronemacheilus abyssinicus*respectively. The largest fish family in the lake is Cyprinidae, represented by four genera, *Barbus, Garra, Varicorhinus*and *Labeobarbus*(Getahun, 2008).TheLabeobarbusspecies of Lake Tana have previously been classified under the genus *Barbus.* However, large hexaploid African *Barbus* are renamed as *Labeobarbus*(Skelton, 2001).

The new genus name better reflects their phylogenetic distance from other members of the overly lumped genus *Barbus. Labeobarbus species* differ not only in their resource partitioning (feeding) also in their reproductive strategies (De Graff *et al.*, 2005). The genus *Barbus* includes the "small" barbs and is represented by three species, namely, B. *humilis, B. pleurograma*and *B.tanapelagius* (De Graff *et al.*, 2000). *Varicorhinus*is represented by a single species, *V. beso.* The genus *Garra* is represented by four species; G. *dembecha*, *G.dembeensisis*, *G. regressus*and *G.Tana*(Stiassny and Getahun, 2007). There are 15 species of *Labeobarbus*forming a unique species flock in Lake Tana, the only cyprinid species flock in the world, after the ones in Lake Lanao vanished because of overexploitation.

2.2.3. Tekeze- Atbara Basin

This basin includes rivers that drain the northeastern part of the country. The drainage system includes tributaries of the Guang River (the Atbara River in Sudan) and tributaries of the Tekeze River, which flows into the Nile after confluence of the Whit Nile and Blue Nile rivers in Sudan (Habteselassie, 2012). Its tributary sources are not far from the Blue Nile in the Ethiopian High Plateau east and west of Lake Tana (Getahun, 2003).

According to Tedla (1973) and before the JERBE surveys of the region nothing was known about the fish fauna of the Tekeze-Atbara drainage system. JERBE reported 34 fish species belonging to 10 families and 22 genera from the Tekeze-Atbara drainage system and the presence of three endemic species and two introduced (exotic) species in this system within the limits of Ethiopia.

2.2.4. Omo-Turkana Basin

The Omo begins in Kafa and drains into Lake Turkana in the south (De Graaf, 2003).The Omo River basin south from Ethiopia's humid highland to the semi-arid lowlands of the lower Omo where the river finally terminates in Kenya's Rift valley and in a climatically challenged area of extreme aridity. The Omo delta rich in biodiversity alters in response to varying lake level,carries 14% of Ethiopia's entire annual run off and provides about 90% of the lake's annual inflow (Avery, 2013). There is evidence that a connection between this basin and the Nile occurred more than once during wet periods in the course of pale climatic fluctuations (Beadle, 1981). The Lake Turkana catchment area is 130,860 km in both Ethiopia and Kenya. The lake is Africa's fourth largest lake, and the world's largest desert lake. The Omo basin is Ethiopia's second largest river system, being second only to the Blue Nile in runoff volume. Lake Turkana is a closed basin, hence the inflows are totally evaporated over time and hence the lake waters are almost saline, unfit for consumption and unsuitable for agriculture. However, the lake has a thriving and diverse fish population (Yu *et al*., 1994).

The Omo River flows south into Lake Rudolf (Lake Turkana) on the border with Kenya. Some rivers such as Gibe River in the Omo River watershed drain the southwestern part of the western highlands of the country (Roberts, 1975). Prior to the JERBE studies, only 13 species were reported from the Omo drainage system within the limit of Ethiopia (Tedla, 1973). The Omo-Turkana Basin comprises 76-79 fish species belonging to 20 families and 42 genera. Within the Omo River system there are up to eight endemic fish species which are almost a quarter of the fish fauna within the system and no introduced species have yet been recorded (Golubstov and Darkov, 2008).

2.2.5. Shebele-Juba Basin

Wabi-Shebelle and Dawa, Genale, Gastro originates in the Ahmar and Bale Mountains respectively and flows into a southeastern direction towards Somalia. According to Basnyat and Gadain (2009), the Juba River is known as the Genale- Dawa River within Ethiopia. Wabi Dawa, Genale and Wabi Gastro are the main tributaries of Juba River in its upper catchment, which all flow southeastwards. Gastro and Genale unite to form the Juba River just north of Dolo in Ethiopia and the Dawa joins the Juba River at Dolo having formed the Kenya-Ethiopia border and the Somalia–Ethiopia border in the area west of Dolo.

According to Tedla (1973), 14 fish species were reported from this Drainage system before JERBE. Wabi -Shebele and Juba Drainage Basins are the largest in catchment area andleast explored in respect to its fish fauna among basins of the country. The works of JERBEgroup have described 33 fish species within 21 genera and 12 families (Golubstov and Darkov, 2008). This region is inhabited with the most distinct ichthyofaunal species of theNiloticandEast Africa fish taxa (such as the Characid *Alestesaffinis*the Cyprinid *Neobolabottegoi*the Cichlid (*Oreochromis spilurus*). It is the only region of Ethiopia where a diadromous fish; the eel *Anguilla sp*., occurs (Golubstov and Mina, 2003). There are 2 – 3 exotic species (Golubtsov andMina, 2003) and 10-12 endemic species to Ethiopia (Golubstov and Darkov, 2008).

2.2.6. Rift Valley Basin

The Ethiopian Rift Valley, being the northern part of the East African Rift system, can be divided into 3 main zones differing in their geological structure; (1) the Afar Rift Systems, (2) the Main Ethiopian Rift of central Ethiopia, and (3) the broadly rifted zone of southwestern Ethiopia (Gabriel, 2002; Bonini *et al*., 2005). The Ethiopian rifts include the southern lakes (Chamo and Abaya), the northern lakes (Awassa, Shala, Abijata, Langano and Zuway) andthe saline northern lakes (Afambo, Gamari, Afdera, Asale and parts of Abbe).The crater lakes such as Bishoftu groups (Lake Hora, Bishoftu, Arenguade) and Chitu (Getahun and Stiassny, 1998).

The Awash River basin alone comprises 11 fish species, which is about 37% of the fish fauna in the Ethiopian Rift Valley and the southern Ethiopian Rift valley (Lake Abaya and Chamo)

Comprises the highest diversity of fish fauna, 20 fish species (Golubtsov and Mina, 2003). Generally, the Ethiopian rift valleys harbor 28-31 species in 11 families and 18 genera. It also includes at least five endemic species and four introduced species (Golubstov and Darkov, 2008).

2.3. Population parameters of fishes

2.3.1. Length–weight relationships

Length–weight relationships for fish were originally used to provide information on the condition of fish to determine whether somatic growth was isometric or allometric (Le Cren, 1951; Ricker, 1975). They are very useful for fisheries research because they, allow conversion of growth-in-length equations to growth-in-weight for use in stock assessment models, allow the estimation of biomass from length observations, allow an estimate of the condition of the fish, and are useful for between-region comparisons of life histories of certain species (Froese and Pauly, 1998; Moutopoulos and Stergiou, 2002).

2.3.2. Condition Factor

Condition factor compares the wellbeing of a fish and is based on the hypothesis that heavier fish of a given length are in better condition (Bagenal and Tesch, 1978). Condition factor has been used as an index of growth and feeding intensity (Fagade, 1979). Condition factor decrease with increase in length (Fagade 1979); and also influences the reproductive cycle in fish (Welcome, 1979). Condition factors of different species of cichlid fishes have been reported by Siddique (1977), Arawomo (1982), and Oni *et al.* (1983). Some condition factors reported for other fish species include; Alfred- Ockiya (2000), *Chanachana*in fresh water swamps of Niger Delta and Hart (1997), *Mugil cephalus* in Bonny estuary, Hart and Abowei (2007), ten fish species from the lower Nun River, and Abowei and Davies (2009), *Claroteslatеceps*from the fresh water reaches of the lower Nun river.

Chapter Three

3. Materials and Methods

3.1. Description of the study area

The present study was carried out on Gilo (also locally known as Bako) and Duchi rivers located in Yeki and Masha Districts of Shaka Zone in SouthernNationsNationalities and PeoplesRegional State (SNNPR). Sheka Zone is located at 698 km southwest of the capital Addis Ababa in the south-western part of Ethiopia. Administratively, it is bordered with Illu Ababor Zone of Oromia Region in the North & Northwest, Bench Maji Zone in South, and Kafa Zone in East and Gambella Region in southwest.It roughly lies at7°12'-7°89'N and 35°24'–37°90'E. Its altituderanges 1001mto 3000m above sea level (asl). The area has three different agro-ecological zones namely Dega (22.58%, highland), Woina-dega (59.81%, medium range altitude) and Kolla (17.61%, lowland).The mean annual temperature is about 15.1°C, ranging from a mean minimum of 25°C to mean maximum temperatures of 26.1°C.There is only a slight difference in temperature throughout the year. The mean annual rainfall of 2000 mm/year, with high variation from year to year, ranges from about 1,800 and 2,200 mm/year (Regional Atlas of SNNPR, BoFED, 2004).Duchi River is a tributary of Gilo River which itself is a major tributary of Baro-Akobo system in Ethiopia. It is deeper and wider in one area which reaches 20-40m depth.There is no well documented information on its ichthyofaunal diversity except for the local people’s information.

3.2.Sampling Sites

Sampling sub-sites were selected based on the flow type (i.e. pool/riffle) of the river, extent of human interference and suitability of access. A total of eight sampling sub-sites were selected, named and their locations fixed using Geographical Positioning System (GPS) (Table 1; Figure 2).Sampling sub-sites of Gilo1, Gilo 2 and Gilo 3 have relatively higher vegetation cover as compared with Gilo 4. Similarly, Duchi1, Duchi 2 and Duchi3 have better vegetation cover compared with Duchi.All sampling sub-sites are characterized by clear water with sandy, gravel, rocky substratum and other riparian vegetation’s cover.

Table 1:Summary of the sampling sub-sites

Site names	Latitude (N)	Longitude €	Altitude(m)	Depth (m)	Width (m)
Gilo 1 (Adisalem)	07°13.048'	035°24.778'	1217	15	20
Gilo 2 (Komi)	07°13.427'	035°24.743'	1075	10	25
Gilo 3 (Tadese Aga)	07°13.087'	035°24.771'	1716	6	20
Gilo4 (Mamo Dedabo)	07°13.048'	035°24.608'	1217	15	20
Duchi 1 (Gamahi)	07°46.527'	035°31.529'	1716	6	20
Duchi 2 (Yepo)	07°45.571'	035°33.441'	1708	3	14
Duchi 3 (Tikur Enchat)	07°45.527'	035°33.870'	1716	4	13
Duchi 4 (Duchi)	07°45.547'	035°33.144'	1719	3	12

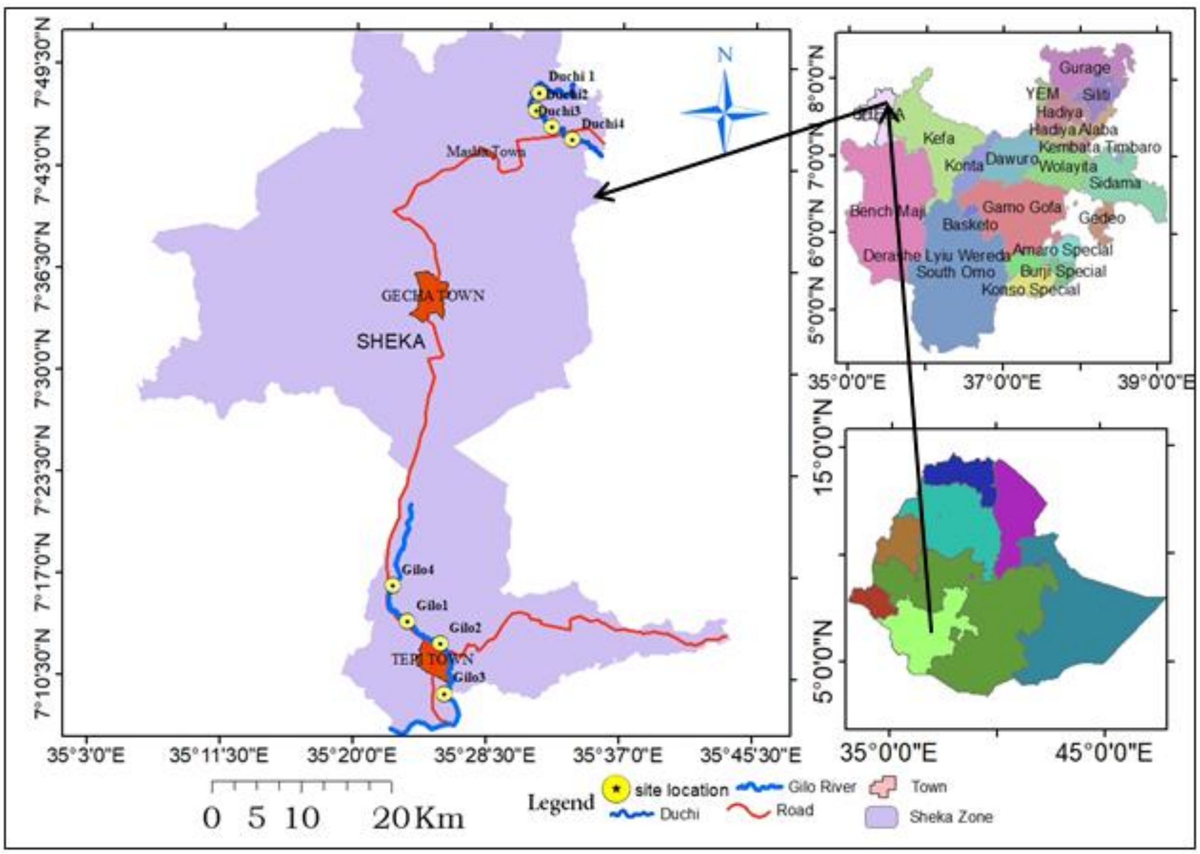


Figure 2:Map of the study sites

3.3. Data collection,Fish samplingand identification

A total of 287 fish specimens were collectedfrom each site inone dry season (March to May, 2018) and one wet season (June to August, 2018*)* (Plate 1). Gill nets of various mesh sizes (12cm, 16cm, 20cm and 24cm stretched mesh size) were set at each sitealways atevening (18:00 local time)and collected in the morningat (6:00 local time). Multiple hooksand line,single hook and line, long stick inserted with sharp needle,Kanta made locally and insect net were also used to samplefishes in areas where gill net setting was not suitable.

Plate 1: during Fish sampling and Data collection of Gillo and Duchi River

Fish samples were identified to species level and described using relevant keys (Boulenger, 1909,1911,1915, 1916; Tedla, 1973; Golubtsov *et al.*, 1995; Darkov *et al*., 1995; Stiassnyand Getahun, 2007; Habteselassie,2012) (Plate 2). The specimens were also compared with figures and illustrations found in Internet sources such as www.fishbase.org.Following identification, samples were collected in plastic jars containing (10%) formalin and labeled with all necessary information and to Zoological Sciences Laboratory, Department of Biology, and Jimma University for further identification and storage.

Plate 2: Laboratory identification of fish Species

Standardlength (SL) and total weight (TW) were measured to the nearest 0.1cm and 0.1g respectively for each species identified. Fish specimens from each species were preserved in 10% formalin solution for further investigation in the laboratory. Concurrent with fish sampling, data on the human impacts and fisheriesactivities in the study sites werealso collected using formats provided in Appendix 3 and Appendix 4 respectively.

3.4. Data Analysis

3.4.1. Species diversity and relative abundance

The Shannon–Weinerdiversity index (H') was computed as follows:

$$H' = -\sum_{i=1}^{s}\left(\frac{\mathrm{ni}}{\mathrm{N}}\right) ln\left(\frac{\mathrm{ni}}{\mathrm{N}}\right)$$

Where:

N*i*= number of individuals in species "*i*"

N = total number of individuals in all species

S= species richness

Estimation of relative abundance of each fish species was made by its contribution to the total catch (sample). An Index of Relative Importance (IRI) was used to evaluate relative abundance of each fish species. An IRI is a measure of relative abundance of aspecies based on number and weight of individuals in catches as well as their frequency of occurrence (Kolding, 1989). An IRI gives a better representationof the ecologically important species than weight, number or frequency alone (Sanyanga, 1996).Percent of IRI was calculated as follows:

$$\% \text{ IRI} = \frac{(\%W_i + \%N_i) * \%F_i}{\sum_{i=1}^{s}(\%W_i + \%N_i) * \%F_i} * 100$$

Where, % W_i and % N_i are percentage weight and number of each species in the total catch, respectively; % F_i is percentage frequency of occurrence of each species in the total number of settings (i.e.the number of sampling events; Appendix 2a & b).

3.4.2. Length-weight relationship

The relationship between Standardlength (SL) and total weight (TW) of the dominant fish species wasassessed using power functionfollowing Bafenal and Tesch (1978) as:

$TW = aSL^b$

Where; TW= total weight (g);SL=Standard length (cm);a and b are intercept and slope of regression line, respectively. The line fitted to the data was described by the regression equation for each species.

3.4.3. Condition Factor

The well-being of each dominant fish species was investigated using Fulton's Condition Factor (Lecren, 1951; Bagenal and Tesch, 1978). Fulton's condition factor (FCF) was calculated by using the following formula:

$$\text{FCF} = \frac{\text{TW}}{\text{SL}^3} \times 100$$

Where, TW- total weight (g) and SL- standardlength (cm).

3.5. Statistical tests

Significant seasonal differences in the abundance of the fish species and FCF weretested using an independent t-test. Levene's test for equality of variance was used to check for uniformity of variance between groups. PAST software package (Version 3.08) was used to analyze the data.

Chapter Four

4. Result

4.1. Fish diversity and distributionin Gilo and Duchi rivers

During both the dry and wet seasons, 287 fish specimens were collected from the sampling sites.These were identified intoseven fish species infour genera, two families and two orders were identified from Gilo and Duchi rivers in the present study (Table 2). Among these fish species, *Labeo forskalii*, *Labeobarbus degeni*,*Labeo cylindricus*, *Garra* speciesand *Mormyrus kannume* were collected from only Gilo Riverwhere as *Labeobarbus intermedius and Labeobarbus nedgia*were recorded from both rivers.

Table2:Fish species composition and distribution inGilo and Duchi Rivers

Order	**Family**	**Species**	**GiloRiver**	**DuchiRiver**
Osteoglossiformes	*Mormyridae*	*Mormyrus kannume*	X	
Cypriniformes	*Cyprinidae*	*Labeobarbus nedgia*	X	X
		Labeobarbus degeni	X	
		Labeobarbus intermedius	X	X
		Labeo forskalii	X	
		Labeo Cylindricus	X	
		Garra ignesti	X	

The Shannon-Weiner diversity Index (H') was calculated for fishes of the Giloand Duchi Rivers. The H' value indicated that species diversity of the Gilo River (1.78) was greater than Duchi River (0.17). There was difference in species composition of Gilo and Duchi Rivers.Shannon–Weiner diversity index (H') for fishes of both rivers is presented in Table 3.

Table 3: Fish diversity index of Bako and Duchi Rivers (N = number of fish samples)

Parameter	Gilo River			Duchi River		
	Dry	**Wet**	**Total**	**Dry**	**Wet**	**Total**
Species richness, S	7	7	7	1	2	2
Abundance, N	131	83	214	38	35	73
Shannon–Weiner diversity index, H'	1.64	1.83	1.78	0	0.29	0.17
Shannon–Weiner evenness index, J	0.84	0.94	0.92		0.42	0.25

4.2. Description of Fish species of Gillo and Duchi Rivers

Detailed Diagnostic, Description characters, Color, Distribution and habitat of each species area presented below. While, an artificial identification key for the fish species of the two rivers identified in the present study has beengiveninAppendix-5.

1. *Mormyrus kannume Forskalii* 1775(Plate3)

Diagnosis: Mouthsmall, non-protractile and tubular, without barbells; head very long, tube like, naked and curved teeth present (present data)

Description: Eyes very small, covered with skin (4.89 - 10.68%HL); the inter-orbital length much greater than orbital diameter; head length greater than the body depth, head length greater than head depth (46.63-66.42% HL); mouth terminal with an average postorbital part of head and snout length (SNL=POOL); paired and unpaired fins present,57-75 dorsal fin, originating above the pelvic fin, Caudal peduncle narrow with depth (7.27 - 21.69% SL), Pelvic fin abdominal position; pre-anal length much less than pre-dorsal length; scales small and cycloid, lateral line complete; the caudal fin deeply forked; the number of dorsal rays 58 62, anal rays 18-21, pictorial fin rays 15 -17; lateral line scales 80 - 115, the maximum standardlength228.89mm(presentdata).

Color: Above the lateral line dark and light, but ventrally white in color for live specimen.

Distribution: (Blue Nile, White Nile, Atbara, Tekeze and Omo-Turkana), *Mormyrus* *kannume* is known from Nile basin; in present field study work, *Mormyrus kannume* were collected from Bako River.

Habitat: Freshwater

Plate3:*Mormyrus kannume* (From Bako River)

2.*Garra ignestii (Plate 4)*

Diagnosis: Two pair of maxillary barbell and pair of rostral barbell, Rostral cup/fold expanded, disc development-type C(Sensu Stiassay &Getahun,2007), the disc has central callus and well developed lateral&posterior, free margins with dense papillae, chest asquamatic and red spot near to operculum. 5 elongate black spots on basal membrane of dorsal fin. Length of caudal peduncle19.2-29.5%, SLupto103.1mm.

Description: Sub-terminal mouth. Two nostrils on each side of the snout.Rostrum folding down wards extensively covering the upper jaw. Well-developed disc. 34-36 scales in the lateral line. Pelvic fins abdominal in position and forked caudal fin. Total length 27cm; Standard length 22cm.

Coloration: Uniformly dark on flanks or brownish-black;contrasting dark and light color
Distribution: Known only from Ethiopia, where it occurs in the Tekaze and Abbay River drainages in northern Ethiopia. Specimen of the species was sampled from Gillo(Bako)River.

Habitat: Freshwater

Plate 4:*Garra ignestii*

3. *Labeo cylindricus* Peters, 1852 (Plate 5)

Diagnosis: Lips plicate; dorsal fin concave with 9 branched rays; eyes in super lateral position; genital orifice very far from origin of anal fin; body cylindrical, slightly elongated; snout truncate with deep transverse furrow and fleshy appendix directed upwards.

Description: Mouth is inferior and has more or less thick, swollen lips giving it a sort of suckerlike appearance. It has very much developed labial fold forming a sort of sucker around the mouth. The species has big horny tubercles on the snout. One minute barbells on each side of the head. The upper edge of dorsal fin always concave; the longest dorsal ray is long, often longer than head. Lateral line with 35-39 scales, Pelvic fin abdominal in position, Total length 28 cm; Standard length 23.5cm.

Coloration: Dark brownish above and on the sides; white beneath.

Distribution: Wabi-Shebelle, Omo-Turkana and Baro Basins; Abaya, Chamo and Chew Bahir basins in Southern Rift Valley. Large number of specimens of the species was recorded from Gilo and Duchi Rivers in the present study.

Habitat: Freshwater

Plate5:*Labeo cylindricus*

4. *Labeo forskalii*Rüppell, 1835 (Plate 6)

Diagnosis: Dorsal fin with 10 branched rays. 39 scales in the lateral line. Eyes are super-lateral entirely visible from the above. It has very much developed labial fold forming a sort of sucker around the mouth. The species has dot like tubercles on its snout.

Description: Mouth inferior, with small posterior barbells at corner of mouth and well developed labial folds; inner surface of lips with transverse folds. The upper edge of dorsal fin is long and concave in shape. Minute barbells concealed under the fold of skin in the corner of mouth. The species has abdominal pelvic fin. Dorsal fin with 10 branched rays.Total length 33cm; Standard length 25cm.

Coloration: Dark violet or bluish above and on the sides.

Distribution: Omo-Turkana, White Nile and Atbara Tekaze systems. Large numbers of specimens of the species were recorded from Bako River.

Habitat: Freshwater

Plate6:*Labeo forskalii*

5. *Labeobarbus intermedius* (Rüppell, 1835) (Plate 7)

Diagnosis: Moderately developed dorsal spine present. Body depth shallow, 30% of Standard Length. Mouth and body shape variable.

Description: No teeth on the jaws. Body variable in shape, covered with cycloid scales. 29-30 scales in the lateral line. Two pairs of small barbells on each side of the snout. Both dorsal and anal fins are short. Pelvic fins abdominal. Forked caudal fins. Total length 26cm; Standard length 20cm.

Coloration: Light yellow.

Distribution: Widely distributed throughout in all drainage systems of the country including Lake Tana. Large number of L. *intermedius* was sampled from Bako and Duchi Rivers in this study.

Habitat: Freshwater

Plate7:*Labeobarbus intermedius*

6. Labeobarbus degeni Boulenger, 1902 (Plate 8)

Diagnosis: Upper lip lobe of *Labeobarbus degeni* not curling back over the snout that is lip and median lope hardly developed and lower produced into rounded median lobes, snout length 29.94 - 40.02% of head length, form a trigulardermal flap over hanging the lip

Description: Mouth inferior and protractile; lower lips no continues median lobe two barbell's on each side, Snout length approximately twice the orbital diameter observed; head length (HL) greater than head depth; number of branched dorsal fin rays 9 - 10 and un branched 1, Pectoral unbranched fin ray I and branched 15 fin rays, anal fin with spine 6, branched and unbranched 9 fin rays, pre-anal length longer than caudal pedicle length, pre-pelvic length 46.87- 50.68% of SL and body depth 27.30-30.71% of SL, pre-anal length greater than pre-dorsal length; number of lateral line scale 29-32 for all specimens were recorded(present data)

Color: Dark yellowish green

Distribution: Reported from tributary rivers of Lake Tana; however, large numbers of *Labeobarbus degeni* collected from Bako Rivers in the present study.

Habitat: Fresh water

Plate8:*Labeobarbus degeni* A. Lateral view, B. Ventral views of lip (trigular shape of
lower lip)

7. *Labeobarbus nedgia Rüppell 1836 (Plate 9)*

Diagnosis: Lower lip forming a distinct median lobe and upper lip well developed. Head length less than 1.2 times in body depth. It has flesh nose that curls back over the nose. **Description:** Lower lip highly developed with fleshy median lobe and large flaps of the upper lip. The mouth is sub-terminal and protractile. No teeth on the jaws. 30-32 scales on lateral line. Dorsal soft rays 11, a pair of barbells on each side of the snout. Total length 37cm, Standard length 29.33cm.

Coloration: White yellow.

Distribution: Endemic to Lake Tana (Nagelkerke, 1997).Though large number of specimens was collected from Bako and Duchi Rivers, Baro-Akobo Basin.

Habitat: Freshwater

Plate9: *Labeobarbus nedgia*

4.3. Relative abundance of fish species

4.3.1. Abundance by number and biomass

During the study period a total of287fish specimens were collected from eight sampling sub-sites (Table 4). *Labeobarbus intermedius* was the most abundant species in number both in wet and dry seasons followed by *L. nedgia,L.degeni, G. ignestii,M.Kannume,L.cylindricusand L.forskalii* respectively,thatcontributed 46.69%, 19.51%, 9.41%, 8.01%,6.27%,5.23% and 4.88% of the total catch in number. Of the total specimens collected, 169 specimens were caught during dry season while 118 specimens were caught during the wet season sampling. The total weight of fish specimens collected was also higher in dry season(28,023.25g) than during wet season (22,406.7g)(Appendix2a&b).Seasonal variation in the overall fish abundance was statistically not significant (t-test, $P < 0.05$).*L. intermedius,L.nedgia andsignificant L. degeni*were the most abundant species during both seasons in Gilo Riverwhile *L.intermedius* was the most abundant speciesduring both seasons in both rivers.

Table 4: Summary of abundance (number) and biomass (weight) of the fish species sampled from Gilo and Duchi rivers in both seasons

Species	Abundance (Number)						Biomass (g)					
	Gilo River			Duchi Rivers			Gilo Rivers			Duchi Rivers		
	Dry	Wet	Total	Dry	Wet	Total	Dry	Wet	Total	Dry	Wet	Total
L.intermedius	52	12	64	38	32	70	8407	2194	10601	5881	5110.2	10991.2
L. nedgia	29	24	53	0	3	3	6543	6758	13301	0	320	320
G. ignestii	20	7	27	0	0	0	428.25	189.5	617.75	0	0	0
L. degeni	7	16	23	0	0	0	1588	3539	5127	0	0	0
M. kannume	8	10	18	0	0	0	1428	1778	3206	0	0	0
L.cylindricus	6	9	15	0	0	0	1260	1485	2745	0	0	0
L. forskalii	9	5	14	0	0	0	2488	1033	3521	0	0	0

4.3.2. Index of Relative Abundance (IRI)fish species of Gilo and Duchirivers

Index of relative importance *L. intermedius* (39.16% IRI), *L. nedgia* (10.18%IRI) and *L. degeni* (3.41%IRI) were the most abundant fish species. Overall, fish abundance in dry season was higher than in wet season. The IRI values of all the seven species identified from both rivers during the present study is summarized in Table 5.

Table 5:Summary of Index of relative importance (IRI) for each fish species compared between the Giloand Duchi Rivers for each season

Gilo				Duchi			Overall total
Species	**Dry**	**Wet**	**Total**	**Dry**	**Wet**	**Total**	**Gilo and Duchi**
L. intermedius	48.27	17.29	35.68	100.00	98.09	99.55	39.16
L. nedgia	31.91	43.91	36.79	0.00	1.91	0.45	10.18
L. degeni	7.73	25.47	14.93	-	-	-	3.41
G. ignestii	3.67	1.93	2.96	-	-	-	0.66
M. kannume	2.60	4.74	3.47	-	-	-	0.79
L. Cylindricus	2.12	4.11	2.93	-	-	-	0.67
L. forskalii	3.71	2.56	3.24	-	-	-	0.74
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00

4.4. Length - Weight Relationshipof the dominant fish species

The relationship between Standard length and total weight was assessed for the most dominant fish species namely *L. intermedius*, *L. nedgia*and *L. degeni*.The line fitted to the data was curvilinear and best described by the power regression equation (Table 6; Figure5).

Table6: Length-weight relationship of the most abundant fish species of Gilo and Duchi Rivers

Fish species	Rivers	Regression equation	R2	N
L. intermedius	Gilo	$TW=0.03SL^{2.84}$	0.95	64
	Duchi	$TW=0.09SL^{2.46}$	0.79	70
L. nedgia	Gilo	$TW = 0.014SL^{3.08}$	0.92	53
	Duchi	-	-	
L. degeni	Gilo	$TW=0.84SL^{1.80}$	0.53	23
	Duchi	-	-	

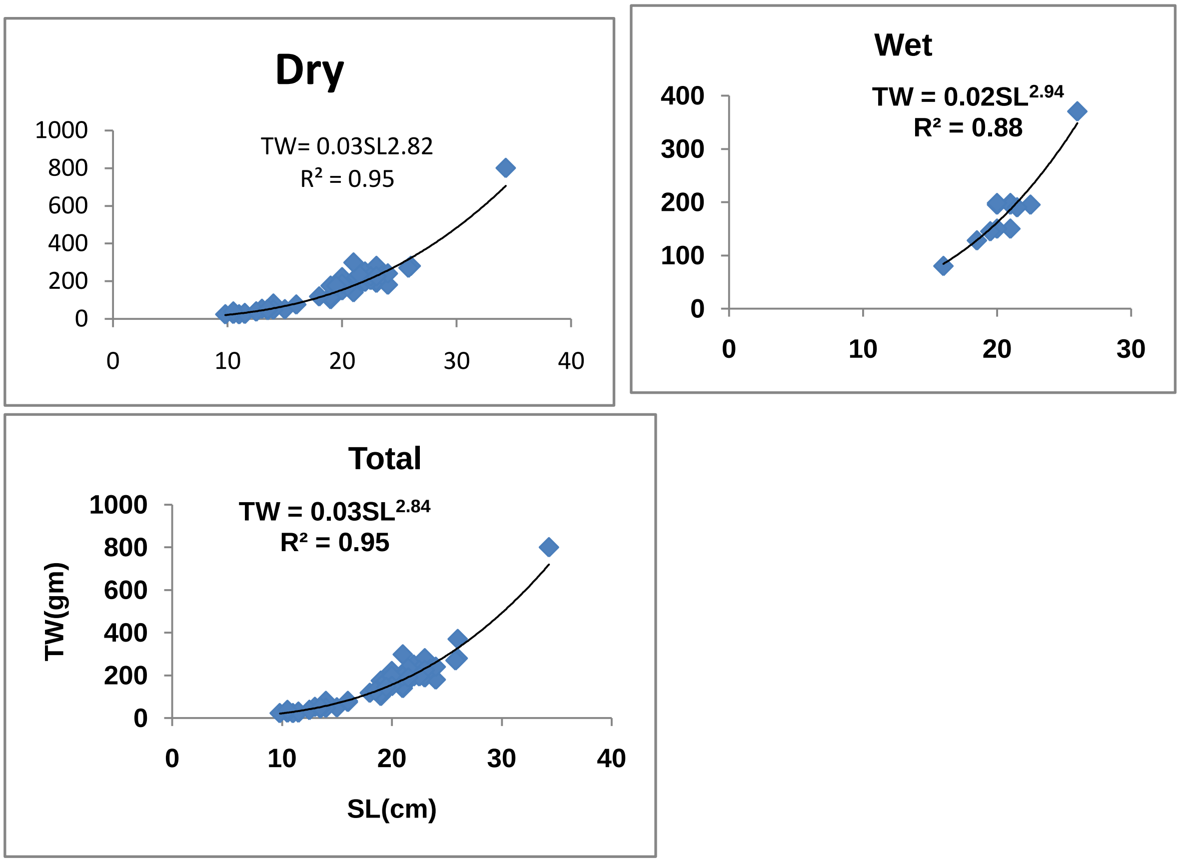
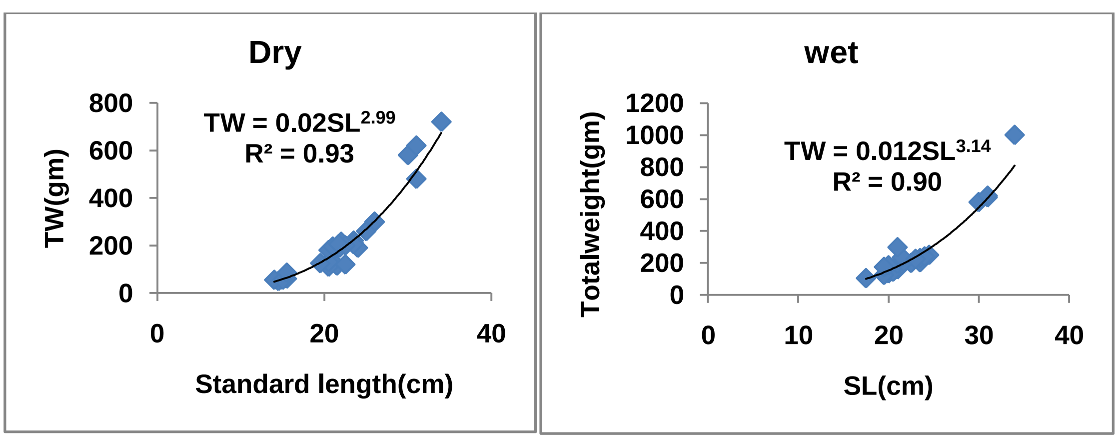


Figure3:Length-weight relationship for *Labeobarbusintermedius* from Gilo river for each season and overall



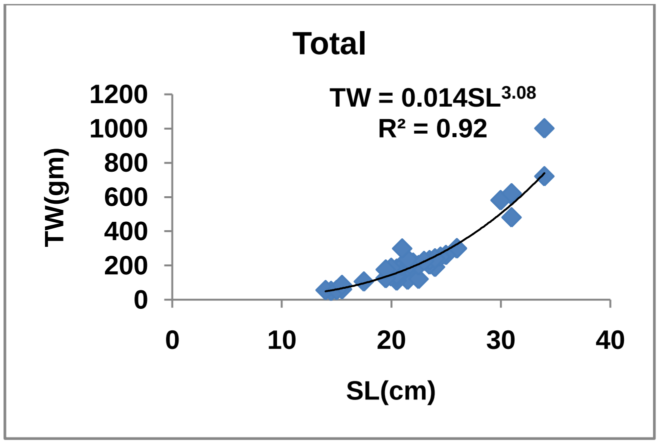
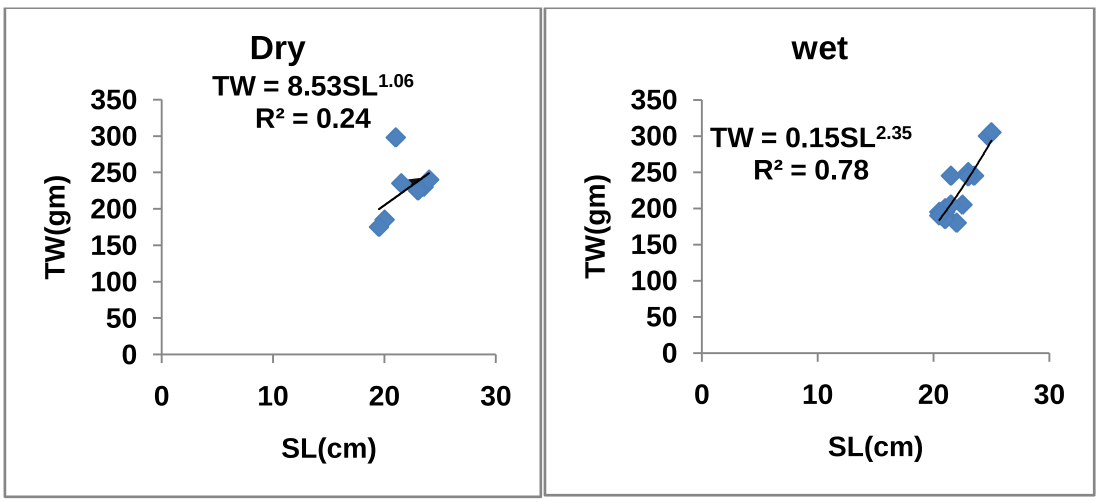


Figure4:Length-weight relationship for *Labeobarbus nedgia* from Gilo River for each season and overall



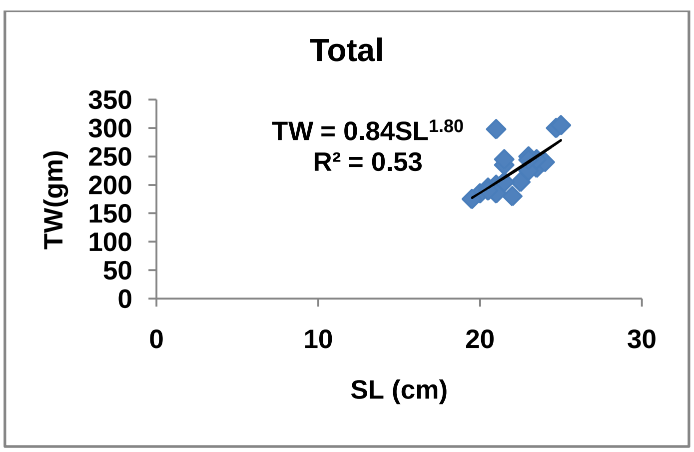


Figure5:Length-weight relationship for *Labeobarbusdegeni* from Gilo River for each season and overall

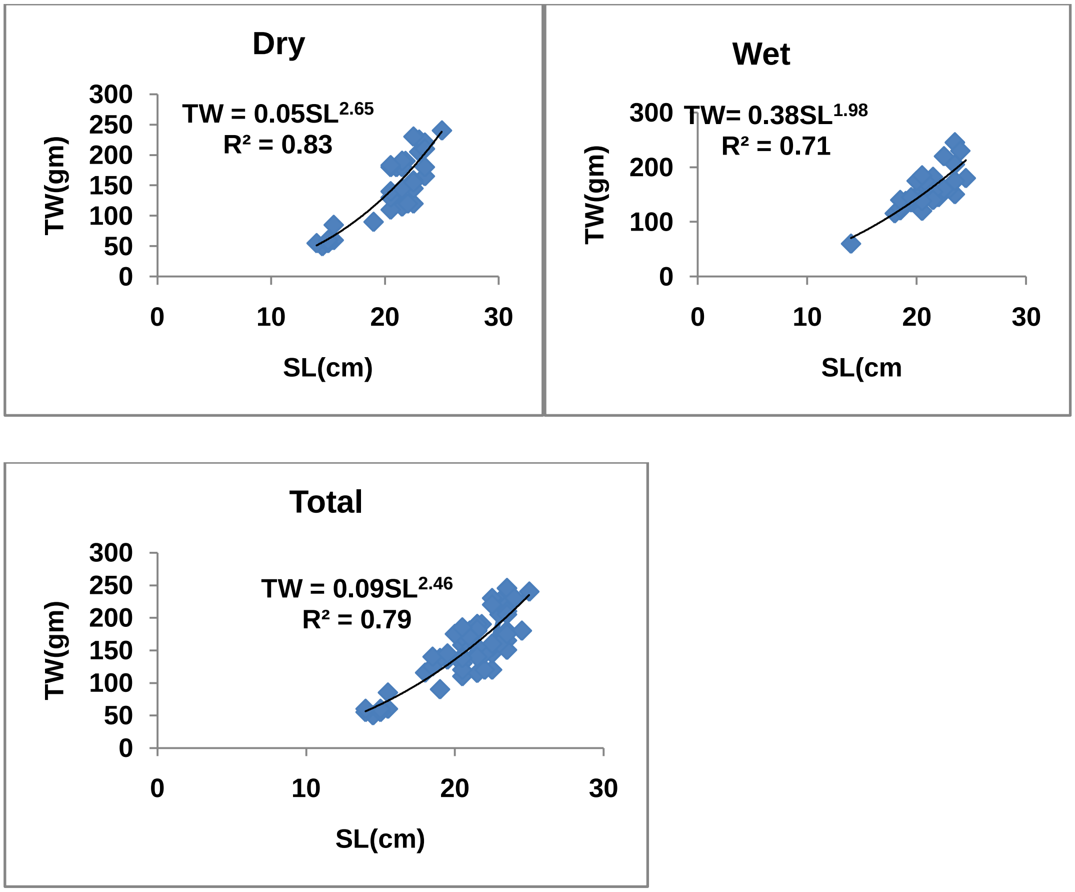


Figure6:Length-weight relationship for *Labeobarbusintermedius* from Duchi River for each season and overall

4.5. Fulton Condition Factor (FCF)

Fulton Condition Factor (FCF) was computed for the top three most abundant fish species namely (*L.intermedius, L. nedgia*and *L. degeni*).Summary of the FCF values are provided in Table 7 that indicate the statistical tests (t-test) of the seasonal variation in the condition factors of (a) *L. intermedius* in Gilo River and in Duchi River, (b) *L. nedgia* in Gilo River and in Duchi River, and *L. degeni* in Gilo River.

Table 7:Summary of Fulton Condition Factor (FCF) for the most abundant species ofGiloand Duchi rivers; SE = standard error

Species	**Gilo**			**Duchi**		
			Overall			Overall
	Dry	Wet	Mean±SE	Dry	Wet	Mean±SE
L.intermedius	1.99	2.03	2±0.13	1.66	1.74	1.69±0.07
L. nedgia	1.74	1.98	1.85±0.09	-	1.66	1.66±0.02
L. degeni	2.23	2.05	2.1±0.14	-	-	1.05±0.07

4.5.1. Fishing activities

Mostly fishing activity by local people occurs in both Gilo and Duchi rivers by part time fishermen mostly at the end of the rainy season and continues until the beginning of the rainy season.Fishing activities are conducted only for subsistence by individual fishermen. A few of them also carried fish to near rural town to sell for income. Fishermen targeted fish species like *L. nedgia, L. degeni, L. intermedius* (local name: Nachi asa*), L. cylindricus* and *L. forskalii*(local name: Tikur asa). Generally, in both rivers fishing is on subsistence basis.The fishermen lack any kind of fishing boats, and thus fishing is done manually without use of any navigation vessel. The most important fishing gears applied to catch the fishes were different sizes of single hook and line, long stick inserted with sharp needle, Kanta made locally and insect net (Plate10).Kanta is a fish basket or trap that can be constructed in 2-3 days by the fishermen. It is set in rivers by placing 5-7 bunches of corns, banana inside and inserted into deepest (pool) partof river while it is tied to a fixed object using a line to stabilize its position the bunchesof corns and banana are used to lure the fish into the traps. Kantais used for catching fishes mainly during dry season at deepest channel and carries up to 50-80 fishes. The wider hole of trap contains a horny (sharp) edge inside the opining in order to prevent the movement of fish to leave from kanta once entered into this traditional net.

Plate10:A. Long stick inserted with sharp pointed metal   B. Insect netC. kanta

4.5.2. Habitat characteristics

The main anthropogenic activities affecting rivers includes deforestation (i.e. clearing of riparian vegetation), agricultural development,swimming, washingvehicles, cloth,body and pollution from coffee mill on GiloRiver. The natural channel mainly had sandy and boulder substrates and diversities of riparian vegetation's (Plate11) in contrast to the diverted (flow altered) channel in which the reverse is true.The bank vegetation covers of bothrivers at the sampling sites includecoffee plants, very large trees such as *Croton macrostachyus* (Bakkanisaa), *Ficussur* (Harbuu),*Eucalyptus* (Baharzaf),*Vernonia amygdalina* (Eebicha),palm trees,various types of shrubs and grass. However, Gilo River relatively had sparsevegetation cover. Aquatic vegetation'swere observed at all sampling sites.

Plate11: Natural channels of GiloandDuchi rivers

Chapter Five

5. Discussion

A total of sevenfish species represented in two families and four genera were identified from Gilo and Duchi Rivers during the study period. The composition of fish species obtained during the study period was less diverse despite the highest fish diversity report for the entire Baro-Akobo Basin.The basin's fish diversity report increased from eight species in 1970s (Tedla, 1973) to 90 species in 1990s (Golubtsov *et al*., 1995) and 113 species in 2000s (Golubtsov and Darkov, 2008). On the other hand, there is no previous report on the fish diversity of Gilo and Duchi Rivers, as far as our knowledge is concernedrelated to the two rivers, there is still no previous data exist in the literature, or specific information on fish diversity. One of the reasons for the poor fish diversity recorded in the present study might be due to the short duration of the sampling period, i.e. sampling was carried out only in two seasons over limited sampling sites owing to resource and time limitation.

The local fishermen collect and avail all level of ages and both sex of fish for consumption. There is no culture of reserving female and young fish back to the revers. Moreover, the effect of chemicals (especially Malathion used as insecticides and crop pest control and DDT used for malaria control) used by residents around the revers were also thought to be affecting factors; since these chemicals freely eroded to the rivers by the yearlong rain around the study area.Other possible reasons for the recorded poor fish diversity might relate to the effect of flow variability on fish assemblage and altitude. High water flows can destroy fish habitat and wash eggs of fish. Previous studies (e.g. Golubstov and Mina, 2003) also indicated that fish diversity tends to decrease in the upper parts (i.e. higher altitude) of the Ethiopian basins in general.

The diversity of fish fauna identified from the studied rivers contains a mixture of Nilo-Sudanic (*L. forskalii, L. cylindricus,* and *M. kannume*) and East African forms (*L. intermedius, L. nedgia,*and *Garra* species). The NiloSudanic forms are the dominant forms in terms of diversity and are represented by a large number of species found in the Baro-Akobo Basin (Getahun, 2003). This could be probably because of the connection between the White Nile and the two rivers. Gilo andDuchiRivers are tributaries of Baro River which in turn is tributary of White Nile River. Golubtsov *et al*. (1995), Getahun (2007) and Golubstov and Darkov (2008) reported the occurrence of these forms of fish in Nile basin.

Diversity indices for the fish species indicated that there was variation in diversity between the two rivers. Shannon–Weiner diversity index (H') was higher for GiloRiver (1.78) than the Duchi River (0.17). As observed during this study, thefactors contributed to the differences in fish diversity of the two rivers include human intervention (since the Gilo river was less intervened and more surrounded with forest than the Duchi river), channel flow (since Gilo river has lower speed of water flow than the Duchi river) and the altitude and climatic differences of the rivers locations (described in the methodology part).

Numerically, cyprinid fishes, such as *L. intermedius*with 134 individuals, followed by,*L. nedgia* (56) and *L. degeni* (23), were the most abundant species.These were also the most important species inbiomass (weight) (Table 4).Besides abundance and weight, an index of relative importance (IRI), which isa compound index based on number and weight of individuals in catches as well as their frequency of occurrence, was used to identify ecologically the most important species (Kolding, 1989, 1999). In concordance with number and biomass measurements, IRI also identified *L.intermedius, L. nedgia* and *L. degeni*as ecologically the most important species,comprising52.75 % of the total IRI (Table 5).

In terms of season, the weight and number of fish specimens was higher in dry season than wet season for both rivers (Table 3). During wet season there is high turbidity, speedy run-off and rain that could attribute to less number of fish catch during this season.There is also high water discharge during wet season so fishes could be highly dispersed in the large volume of water than during dry season and it becomes difficult to catch those (Tesfaye, 2006).Moreover, leaves, logs, roots that were brought by flooding, could decrease the efficiency of gill nets during the wet season.The number and weight of fish specimens in Gilo River is higher than in Duchi River. The difference in number and weight of fish specimens in these rivers may have been attributed to the lack of good habitats might have also contributed to poor diversity and abundance of fish in Duchi River as the river does not have dense riparian and aquatic vegetation as compared to Gilo River.

According to Golubstov and Darkov (2008) family Cyprinidae is taxonomically the most diverse group of the Ethiopian ichthyofauna. Similarly, in the present study, this family is the most dominant group by having four genera and six species. The genus *Labeobarbus* was represented by *L. intermedius* and *L. nedgia* that were recorded from both Gilo and Duchi Rivers. The presence of *L.intermedius* in the Baro Basin has been reported by Golubtsov *et al*. (1995) and Golubstov and Darkov (2008), while *L. nedgia* was reported by Melaku *et al*. (2017) from the Baro Basin so far and may be the second report from the basin in this study. Genus *Labeo* was represented by two species *L. forskalii*and *L. cylindricus*. The former species was recorded only from Gilo River. The presence of the two *Labeo* species in the Baro Basin have been reported by Golubtsov *et al*. (1995) and Golubstov and Darkov (2008). The genus *Garra* was also represented by a single species (*Garra*species), while *Garra ignestii* was not reported by other workers from the Baro Basin so far and may be the first report from the basin and it was recorded only from Gilo River in the present study. Family Mormyridae was represented by a single genus and single species, *M.kannume*, from Gilo River. The species was previously reported from Baro Basin by Golubstov and Darkov (2008) and from Blue Nile (Golubtsov *et al*., 1995), Angereb River in the Tekeze Basin (Tesfaye, 2006).

The length-weight relationship of the three species, *L. intermedius andL. degeni*in the present study showed negative allometric growthwhile*L. nedgia* showedpositive allometric growth. The b-valuesof 2.84 and 2.46 obtained for *L. intermedius*,respectivelyfrom Giloand Duchi riversare lower than the values reported for the species from Angereb (b = 2.96) and Arno Garno (b = 2.95) rivers (Tesfaye, 2006). The b-value obtained for*L. degeni*(1.80) are lower than the values reported for the species from*L. degeni* (b=2.87, Genale; 2.45, Awata)rivers(Tadese, 2016).The b-value obtained for*L.nedgia*(3.08) were higher than the value reported forthe species from Angereb Riverfrom Angereb River(b = 2.94, b = 2.98) (Tesfaye, 2006) and from Arno Garno River Gebremedhin, 2011). The variations of results obtained byother studies in other rivers and in the present study are probably because of the differences innumber of samples, the differences in food availability and spawning period in the various rivers studied (Bagenal and Tesch, 1978).

The mean Fulton Condition Factor (FCF) values obtained for *L. intermedius* (1.85±0.1)) in the present study in Gilo and Duchi Rivers was higher than the result obtained for *L. intermedius* (1.23) from Borkena River,Awash Basin (Tessema et al., 2012). The mean FCF value obtained for *L. nedgia* (1.76±0.05) in the present study in Gilo and Duchi Rivers was higher than the result obtained for *L. nedgia* (1.48) from Rivers Angereb and Sanja, Tekeze Basin (Tesfaye, 2006). The mean FCF value obtained for *L. degeni*(1.57±0.11) in this studyGilo and Duchi Riversis less thanthe result obtained for*L. degeni* (2.21) from Genale River(Tadese,2016). The prior reason for the above differences in FCF might be due to the in-depth sampling in the present investigation and the anthropogenic activities around or in present study sites. Other factors include fluctuations in factors such as food quantity and quality, water level and flow rate, rate of feeding, health of fish and reproductive activity (Payne, 1986). In other words, the value of Fulton Condition Factor is influenced by age of fish, season, stage of maturation, fullness of gut, type of food consumed, amount of fat reserve and degree of muscular development (Barnham & Baxter, 1998). Condition factor was used for comparing the condition, fatness, or well-being of fish, based on the assumption that heavier fish of a given length are in better condition. Condition factor parameters depend on factors including biological and environmental, as well as geographical, age the season of year when samples are collected (Ferreira et al., 2008; Vaslet *et al*., 2008; Nowak et al., 2009).

Chapter Six

6. Conclusion and Recommendation

6.1. Conclusion

According to the present study, both Gilo and Duchi rivers, represented by eight sampling sites, turned to be poor in fish diversity. Seven species from Gilo River and two species from Duchi River were identified including one new unreported species(*G. ignestii*).The fish faunal diversity of both rivers is dominated by cyprinid fish species comprising 86% of the total species identified.Species diversity was also relatively higher in the Gilo River (H’=1.76) than in the Duchi River (H’=0.17).The number of fish specimens caught in the dry season was higher than the wet season during the study period. Labeobarbus intermedius (n=134, 46.69%), L.nedgia(n=56, 19.51%) and L. degeni (23, 9.41%) were the most dominant fish species in number, weight and IRI. The relationship between standard length and total weight of the dominant fish species showed slight negative allometricfor *L. intermedius*(i.e. virtually proportional length and weight)and high negative allometric for *L. degeni*(i.e. much longer than its thickness).On the other hand,*L. nedgia* had positive allometric growth (i.e. fatter than long). The mean Fulton condition factor (FCF) for*L.intermedius*(1.85) *L. nedgia*(1.76), *L. degeni*(1.57) in Gilo and Duchi Rivers,respectively. There was significant variation (t-test, $P<0.05$) in FCF of *L. nedgia*in the two seasons. However, variations were not significant (t-test, $P > 0.05$) for the *L. intermedius*and *L. degeni*.The main anthropogenic activities affecting rivers includes deforestation (i.e. clearing of riparian vegetation), agricultural development,swimming, washingvehicles, cloth,body and pollution from coffee mill on both Rivers.

6.2. Recommendations

Due to limitations in logistic and financial problems the present study was carried out in Gilo and Duchirivers (not including their tributaries) by using limited gears and sampling sites over relatively short period of time.

Therefore, extensivecollection and identification of the fish fauna has yet to be conducted.The subsistence local fishermen on both rivers should be materially and technically supported in order that they make a better livelihood out of the fisheries resources.

The anthropogenic activities wide spread in the study areas need to be addressed by the concerned body. Zone and higher concerned government officials before they further worsen the ichthyofaunal diversity in Gilo and Duchi rivers.

Detailed studies and investigation is needed on food and feeding and reproductive behaviors of fish species in Gilo and Duchi Rivers.

Destruction of the riparian vegetation is serious problems of conservation especially in Duchi River which could be destructive to the fish fauna and should be considered.

Detailed studies and investigations are required on prospects for sustainable fish resource utilization in Gilo and Duchi Rivers.

Detailed studies and investigations are required on socio-economic aspects of the two rivers. The use of undesired fishing techniques like the use of poisons in the different water bodies is threatening life in the water bodies and care should be taken.

In the present studysites, there were human interventions such as swimming, washing vehicles, cloth, body and pollution from coffee mill, disturbing the natural ecosystems in the rivers. As a result, washing vehicles and pollution from coffee mill may be found in Gilo and Duchi Rivers that can affect the fish diversity so human population inhabited near and around these rivers must be aware of/ trained to avoid the pollutions that can cause contamination to these water bodies.

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Appendix 1:Summary of distribution (occurrence) of fish species per sampling site for each river. Li = *Labeobarbus intermedius*; Ln =*Labeobarbus nedgia*; Gi=Garra ignestii; Ld; = *Labeobarbus degeni; Mk; Mormyrus kannume;* Lc=*Labeo* cylindricus; Lf=*Labeo* forskalii

	Gilo1	Gilo2	Gilo3	Gilo4	Duchi1	Duchi2	Duchi3	Duchi4
Li	X	X		X	X	X	x	x
Ln	X		x	X	X			
Gi	X							
Ld	X		X	X				
Mk		X						
Lc		X						
Lf		X						

Appendix 2a:Summary of % number (N) for each fish species ; N = 169 (dry season), 118 (wet season), 287 (overall),% frequency of occurrence (F) for sampling events for each fish species ; F = 4 (dry season), 4 (wet season) 8 (overall)and percent weight (W) for each fish species compared between the two rivers for each season; W = 28023.25gm (dry season), 22406.7 g (wet season, 50429.95gm (overall).Li = *Labeobarbus intermedius*; Ln =*Labeobarbus nedgia*; Gi=Garra ignestii; Ld; = *Labeobarbus degeni; Mk; Mormyrus kannume;* Lc=*Labeo* cylindricus; Lf=*Labeo* forskalii

	Gilo								
	Dry			**Wet**			**Total (Dry andWet)**		
	N	**Wt**	**f (4)**	**N**	**Wt**	**f (4)**	**N**	**wt**	**f (8)**
Li	52	8407	3	12	2194	3	64	10601	6
Ln	29	6543	3	24	6758	3	53	13301	6
Gi	20	428.25	1	7	189.5	1	27	617.75	2
Ld	7	1588	3	16	3539	3	23	5127	6
Mk	8	1428	1	10	1778	1	18	3206	2
Lc	6	1260	1	9	1485	1	15	2745	2
Lf	9	2488	1	5	1033	1	14	3521	2
Total	131	22142.25	4	83	16976.5	4	214	39118.75	8

Appendix 2a: (Continued)Li = *Labeobarbus intermedius*; Ln =*Labeobarbus nedgia*; Gi=Garra ignestii; Ld; = *Labeobarbus degeni; Mk; Mormyrus kannume;* Lc=*Labeo* cylindricus; Lf=*Labeo* forskalii

	Duchi								
	Dry			Wet			Total (Dry and Wet)		
	N	Wt	f (4)	N	Wt	f (4)	N	Wt	f (8)
Li	38	5881	4	32	5110.2	4	70	10991.2	8
Ln	0	0	0	3	320	1	3	320	1
Gi	0	0	0	0	0	0	0	0	0
Ld	0	0	0	0	0	0	0	0	0
Mk	0	0	0	0	0	0	0	0	0
Lc	0	0	0	0	0	0	0	0	0
Lf	0	0	0	0	0	0	0	0	0
Total	38	5881	4	35	5430.2	4	73	11311.2	8

Appendix 2a: (Continued)

	Total (Gilo	and Duchi)	
	N	Wt	f (16)
Li	134	21592.2	14
Ln	56	13621	7
Gi	27	617.75	2
Ld	23	5127	6
Mk	18	3206	2
Lc	15	2745	2
Lf	14	3521	2
	287	50429.95	16

Appendix 2b:Summary of Index of relative importance (IRI) for each fish species compared between the Gilo and Duchi rivers for each season

Li = *Labeobarbus intermedius*; Ln =*Labeobarbus nedgia*; Gi=Garra ignestii; Ld; = *Labeobarbus degeni; Mk; Mormyrus kannume;* Lc=*Labeo* cylindricus; Lf=*Labeo* forskalii

	Bako								
	Dry			Wet			Total(Dry+Wet)		
	N	Wt	f (4)	n	Wt	f (4)	N	wt	f (8)
Li	24.30	21.49	37.5	5.61	5.61	37.5	29.91	27.10	75.00
Ln	13.55	16.73	37.5	11.21	17.28	37.5	24.77	34.00	75.00
Gi	9.35	1.09	12.5	3.27	0.48	12.5	12.62	1.58	25.00
Ld	3.27	4.06	37.5	7.48	9.05	37.5	10.75	13.11	75.00
Mk	3.74	3.65	12.5	4.67	4.55	12.5	8.41	8.20	25.00
Lc	2.80	3.22	12.5	4.21	3.80	12.5	7.01	7.02	25.00
Lf	4.21	6.36	12.5	2.34	2.64	12.5	6.54	9.00	25.00
Total	61.21	56.60	50	38.79	43.40	50	100.00	100.00	100.00

Appendix 2b: continued

Duchi								
Dry			Wet			Total(Dry&Wet)		
N	Wt	f (4)	N	Wt	f (4)	N	Wt	f (8)
52.05	51.99	50	43.84	45.18	50	24.39	21.79	50.00
0.00	0.00	0	4.11	2.83	12.5	1.05	0.63	6.25
-	-	-	-	-	-	0.00	0.00	0.00
-	-	-	-	-	-	0.00	0.00	0.00
-	-	-	-	-	-	0.00	0.00	0.00
-	-	-	-	-	-	0.00	0.00	0.00
-	-	-	-	-	-	0.00	0.00	0.00

52.05	51.99	50	47.95	48.01	50	25.44	22.43	50.00

Appendix 2b:(Continued)

Total (Gilo andDuchi)		
N	Wt	f (16)
46.69	42.82	87.50
19.51	27.01	43.75
9.41	1.22	12.50
8.01	10.17	37.50
6.27	6.36	12.50
5.23	5.44	12.50
4.88	6.98	12.50
100.00	100.00	100.00

Appendix 2b:continued

	Gilo			Duchi			
	Dry	Wet	Total	Dry	Wet	Total	Total(Gilo&Duchi)
Li	1,717.13	420.60	4,275.46	5,202.38	4,450.69	2,309.26	7831.79
Ln	1,135.40	1,068.40	4,407.60	0.00	86.73	10.50	2035.33
Gi	130.51	46.94	354.90	-	-	-	132.91
Ld	274.89	619.63	1,789.04	-	-	-	681.77
Mk	92.36	115.23	415.17	-	-	-	157.86
Lc	75.31	100.02	350.66	-	-	-	133.37
Lf	132.07	62.21	388.57	-	-	-	148.25
Total	3,557.67	2,433.03	11,981.40	5,202.38	4,537.43	2,319.76	20000.00

Appendix 3: River physical habitat and water quality data collection format (After Harding et al., 2009)

	Rivers Name____________ Site name ____________ Site Code____________		Data collector______________ Date______________________			GPS	N_____________ E_____________
			Altitude (m)			Depth (m)	
Channel and bank information	Wetted channel width (m)		Vegetated bank width (m)		Site length (m)		Additional notes
	Channel shape	Artificially channelized	Straight	Weakly sinuous	Strongly sinuous		
	Flow types	Riffle	Run	Pool			
	Bank stability	Stable	Mostly stable	Highly unstable			Bank undercut: Yes/No
	Bank cover	Soil	Stony	Grass	Tussock	Bush	Trees
In-stream information	Bed substrate (mm)	Clay/silt/mud (<2)	Gravel (2-63)	Cobble (64-255)	Boulder (256-4000)	Bedrock (>4000)	Additional notes
	Macrophytes	Submerg	Marginal	Emergent	Floating	None	
	Wood	Absent	Sparse	Common	Abundant	Dominating	
	Leaves	Absent	Sparse	Common	Abundant	Dominating	
	Shading	Open	Partial	Heavily shaded		Overhanging vegetation: Yes/No	
Riparian andcatchmentinformation	Riparian width (m)	Left		Right			Additional notes
	Riparian cover	Soil	Gravel	Grass	Tussock	Wetland plants	
	Riparian vegetation	%Tree	%Shrub	%Herb	%Others		
	Adjacent land use	Conservative/r Crops	Short Horticulte	Long Road	Production Bridge	 Others	

	Catchment land use	Native forest ☐	Plantation forest ☐ ☐	Farming ☐	Urban ☐	Industry ☐	Mining ☐	Fishing ☐	Others

Appendix 4: Format to collect basic fishery characteristics of Gillo and Duchi Rivers

Date: ___________

Sex: Male ---------------- Female----------------- Age: _________

- Information about your fishing activity

1. Where do you live? __________________ Town___________

2. Legal status: Commercial business--------------- Non-profit organization ---------------

3. Do you have boats of your own? ----------- If you have how many? _________

4. When did you start this job (Fishing?)

5. Number of jobs (do you have other additional income).

  - ✓ Nature of job (from what activity) full time/per time as full time job------------
  - ✓ Number of months of work per year----------------

6. Do you have the use of other equipment? _____________

7. Detail of your fishing activity

Description by material to catch fish

Over all description Material 1 Material 2 Material 3 Average price in 1Kg

- Name of material to catch fish
- The main targeted fish species
- Name of species 1

- Name of species 2
- Name of species 3

8. How much of the fishing activity was supported by yourself/your family from year to year?

    - It increased____________
    - It remained unchanged___________
    - It decreased______

8a. if you are fishing activities decrease, do you now spend that time.

- On other activities related to fishing -----------,On non-fishing activities-------,please specify--------------

9. When do you fish? All year round in summer in winter only during holiday other (specify).Why?____

10. How long have you been fishing?

Less than one-year --------,1-5 years--------, 6-10 years-------,11-20 years ------more than this.

11. How many times do you fish per year? __________________, day's ____________.

12. Among the following materials, please rank the equipments you are using, from the most important (1) to the less (2, 3, 4…) leave a blank when you are not using one of these equipment's. Hook and Line----------, Nets----------, Spear fishing ----------, other (specify) __

13. What is your level of fishing expertise? Beginner----------, Medium---------------, Expert--

- ❖ The area you are fishing

14. This fishing area is:

- Your usual area------, One of your fishing area among others-------, not your usual area

15. How many times do you fish in this particular area, per year? _________/days/, ____.

16. How long did take you to travel to this fishing area? ________________________.

17. Why did you choose this fishing area? . Famous fishing area--------------, unprotected area -------------,Tourism area -----------, other (specify):_____________

- ❖ Personal information concerning the fisher

18. How many people live in the same household? ___________ Person.

19. Professional occupation:

- ➢ Farmer____________, Schoolteacher_____________
- ➢ Employee ______________, Student_______________
- ➢ Retired_________________

20. Apart from fishing, do you offer any other activities or products to your customers?

Yes--------------------, No--------------

21a.If yes, please indicates their nature:

- ➢ Sightseeing trips at river (without fishing) ______________
- ➢ Observation of different types of mammals and birds______________
- ➢ Fishing equipment rental_______________
- ➢ Others (please specify) ______________________

22. Who are your customers?

- ➢ Residents/local _______________
- ➢ Transported to other towns____________

Thank you for your kind cooperation!

Appendix5: Artificial key to fish families of Gilo and Duchi Rivers, Baro-Akobo Basin

1. Barbells when present one, two or four pairs; adipose fin absent or a moderately to strongly developed when present; maxillary barbell not reaching beyond dorsal fin……………………………………………………..…….…………………..2
2. No teeth on the jaws ………………………………………………….…......***Cyprinidae***
   Teeth on jaws; mouth small, with restricted opening; rayed dorsal fin long or short, but when short always in the posterior half and above anal fin……..…...…..***Mormyridae***

Appendix6: Artificial key to Fish species of Gillo (Bako) and Duchi Rivers, Baro Akobo Basin

1. a. Dorsal fin much longer than anal fin; teeth present on both jaws; mouth elongated and tubular...***Mormyrus kannume***

b. Dorsal fin not much longer than anal fin; jaw teeth absent; mouth not tubular…..2

2. a. Mouth with well-developed lips forming a sort of sucker and horny sheath on snout…..3

b. Mouth lips not forming a sucker…..4

3. a. Characters that distinguish *Labeobarbus nedgia* and *L. degeni* from the other two *Labeobarbus*species; mouth inferior and protractile; two barbell's on each side of Snout; body depth (27.30- 30.71%SL)..4

b. Body relatively deep and covered with cycloid scale; two pairs of barbell on each side of snout, anterior barbell length less than posterior one no teeth on the jaws; …....……4

4. a. Upper lip lobe not curling back over the snout that is lip and median lope hardly developed andlower produced into rounded median lobes, snout length (29.94 - 40.02 % of head length), form atriangular dermal flap over hanging the lip...........***Labeobarbus degeni***

b. highly developed lower lip continuous with large median lobe; large dermal flaps on upper lip andfleshy nose that curls back over the snout, lower lip not produced into round median lobes; head lengthless than 1.2 times in body depth…………………..***Labeobarbus nedgia***

5. Single pair of maxillary barbells ……………………………………….……………6

a. Two pairs of barbells (maxillary and rostral).Post-pelvic region scaled, pre dorsal region fully scaled, more than 34-36scales on lateral line,body depth less than 18.7%SL, disc well developed,body more or less uniformly dark on flanks,tubercles on snout, bellyasquamatic…………………………………………………..……………***G. ignestii***

6. Body depth shallow, 19-32% of standard length; moderately developed dorsalspine……………………………………….……….………..***Labeobarbus intermedius***

Body rather deep; body depth 31-38% standard length; the last unbranched ray on the dorsal fin is ossified into a massive spine………………………………...………….7

7. Dorsal fin with 9-11 branched rays 38- 40 scales on lateral line; dark violet above and on the sides ……….…………………………………………….…….……***Labeo forskalii***

Dorsal fin with 8-10 branched rays; 35 to 39 scales in lateral line; dark brownish above and on the sides………………………………..……………………. ***Labeo cylindricus***