JIMMA UNIVERSITY

School of Graduate Studies

College of Natural Sciences

Department of Biology

Assessment of Fish Composition and Indigenous knowledge on Fishing Activities in Gilo River, Jor woreda, Anywaa Zone, Gambella Regional State, Ethiopia

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A Research Thesis Submitted to Department of Biology, School of Graduate Studies, College of Natural Sciences, Jimma University in Partial Fulfillment of the Requirement for the Degree of Master of Sciences in Biology (Ecological and Systematic Zoology).

December, 2021

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Declaration

I, the undersigned, hereby declare that this thesis is my original work, it has not been presented for a degree in any other University and all sources of materials used for the study have been duly acknowledged.

Gnigwo Deng: _____ _____

Signature Date

This is to certify that this thesis entitled "Assessment of fish composition and indigenous knowledge on Fishing Activities in Gilo River Jor woreda, Anywaa Zone, Gambella Regional State, Ethiopia, submitted in partial fulfillment of the requirements for the award of Degree of Master of Science in Ecological and Systematic Zoology to the Graduate Program of the College of Natural Sciences, Jimma University by Gnigwo Deng is an authentic work carried out by him under our guidance. The matter embodied in this work has not been submitted earlier for the award of any degree or diploma to the best of our knowledge and belief.

Advisor: Mulugeta Wakjira (Ph. D) _____ _____

Signature Date

Co-advisor: Worku Jimma (Ph. D) _____ _____

Signature Date

Acknowledgement

First, my appreciation goes to my principal advisor Dr. Mulugeta Wakjira (Ph. D) and Co-advisor Dr. Worku Jimma (Ph. D) for their intellectual contributions, constructive, immeasurable assistance and further advice towards the accomplishment of thesis work.

Secondly, I would like to thank Jimma University for admitting me to the program and Anywaa zone educational office for their sponsorship and Jor district for allowing salary payment to follow after me.

Thirdly, I would like to express my love and gratitude to my beloved wife Ajulu Aballa and her two daughters Ariet Gnigwo and Muyi Gnigwo who is always in my mind for her love, understanding, and encouragement throughout my study.

It is my greatest pleasure to thank my friends back home for supporting me with different things, and finally, I want to thank my elder brother Gale Deng and Odwol Deng for financial support and other things

All in all, I want to put God on top of everything for giving me strength, health that I might be able to complete my thesis work, cause without him I would not do it!

Abstract

Fishes are the most diverse of all the vertebrate taxa. They constitute more than 27, 977 of the 54, 711 extant vertebrate species. In Sub-Saharan Africa, fish is a crucial food for over 400 million people. Ethiopia is rich in inland water bodies with diversified fish species, consisting of more than 200 species, composed of Nilo-Sudanic, East African, and endemic forms. The entire area of lakes and reservoirs in the country is about 7000 - 8000 km2 and the important rivers stretch over 7000 km. Fishing in the country is artisanal, especially in the Baro-Akobo basin and its floodplains. Indigenous knowledge encouraged regeneration and sustainable utilization of fish. The knowledge systems have been conserved and passed on from generation to generation through oral talk. Thus, this study aimed to assess fish composition and indigenous knowledge on fishing activities in Gilo River, Anywaa Zone, Jor Woreda, Gambella Regional State. A cross-sectional survey was used as a research design. Fish specimens were collected exhaustively from traditional diverse fishermen catch that used gears of diverse types. The study population for the assessment of indigenous knowledge included inhabitants who mainly depend on fishing in the study area. A purposive sampling technique was used to select the study participants. Questionnaires, focus group discussions, and observation were used to collect the required data for the indigenous knowledge. A total of 768 fish specimens, belonging to 14 species in 12 genera, 12 families, and 7 orders were identified from Gilo River at the study area during the present study and more than 17 traditional fishing gears and techniques were recorded during the study. As part of the indigenous knowledge related to fishing, two poison fishing plants and two ways of preserving fish after harvesting fish, such as drying in the sun (Peetø) and fish smoking on fire (Nginynyø), were identified. Poor sharing, management, and conservation of indigenous knowledge on fisheries might be due to the highest impact of modernization. So, government, non-government and local people should take care of awareness creation on indigenous knowledge of fishing, through conducting lots training program about the importance of indigenous knowledge of fishing activities with the local fishermen to keep their knowledge in work

Keyword: Fish composition, Indigenous knowledge, Gambella region and Riverine fishery.

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Acronyms

IK	Indigenous Knowledge
KM	Knowledge Management
FAO	Food and Agricultural Organization
MOFA	Minister of food and agriculture
UNICEF	United Nation International Children Environmental Fund
WFC	World Fish Center

Chapter One

1. Introduction

1.1 Background of the study

Fishes are the most diverse of all the vertebrate taxa. They constitute more than 27, 977 (> 50 %) of the 54, 711 extant vertebrate species (Nelson, 2006). Freshwater fishes comprise until now almost 13,000 species and 2,513 genera (including only freshwater and strictly peripheral species), or about 15,000 if all species occurring from fresh to brackish waters are included (Nelson, 2006). The precise number of extant fish species remains to be determined. About 28,900 species were listed in FishBase worldwide in 2005, but some experts feel that the final total may be considerably higher.

As of 2015, the searchable catalog contains entries for about 58,300 fish species names, about 33,400 of which are currently accepted (valid), and for some 10,600 genera (5,100 valid) (Eschmeyer and Fong, 2015). In recent times, the number of fishes is increasing. According to FishBase, 34,300 species of fish had been described as of September 2020 (Froese and Pauly, 2020). But in most recent times, 35,797 species were listed in the Catalog of fishes (Fricke *et al*., 2021). According to (Leveque *et al*., 2008) South America is the leading continent in terms of freshwater fish by possessing 4,035 species belonging to 74 families. While Asia and Africa are the second and third next to South America with 3,553 and 2,945 species in 85 and 48 families, respectively.

In Sub-Saharan Africa, fish is a crucial food for over 400 million people, contributing essential proteins, minerals and micronutrients to their diets (Tesso *et al.*, 2017). Ethiopia is a rich with inland water bodies with diversified fish species composed of Nilo-Sudanic, East African, and endemic forms (Melaku *et al.*, 2017). Ethiopian fish diversity identified more than 200 fish species in Ethiopia, 191 valid indigenous species, 46-54 species are endemic to Ethiopia 9-10 exotic species and 18 species synonymized, uncertain and undescribed species (Habtesilassie, 2012). It's variety of lakes and rivers with substantial quantity of fish stocks (Mebrat, 1993). The

entire area of the lakes and reservoirs stands at about 7000 to 8000 km^2 and the important rivers stretch over 7000 km within the country (Mebrat, 1993).

Even though Ethiopia is endowed with large bodies of inland waters and contains edible fish species, the Baro-Akobo basins and its floodplains, the most important flood plains within the country, fishing is especially artisanal. The main river systems of the basin include: Alworo, Gilo, Baro, Akobo, Baro Kela, Sore, Gabba, Birbir, Ganji, Bonga and Jejebe Rivers. The foremost commercially important fish species of the river systems are *Oreochromis niloticus, Clarias sp., Polypterus bichir, Heterotis niloticus, Gymnarchus niloticus, Malapterurus sp., Lates niloticus, Alestes spps., Hydrocynus spps., Mormyrops spps., Bagrus spps., Barbus spps*. and *Labeo horei* (Getahun, 2003).

Major riverine fishing activities are mainly occurred on Baro River around Gambella and Gilo River near Pinyudo town in Gambella (Tesso *et al.*, 2017). The potential yield of fish is estimated to be between 30,000 tonnes and 40,000t/year for the most water bodies and about 25,000tones/year from Baro River alone and an outsized potential from other rivers (FAO, 1995). As compared to the lower catchments, there's little fishing within the upper catchments of Baro River. Fishing occurs on the Baro, Sore, Waber, Yabi, Didu, and Uka rivers, but this is often purely on a subsistence basis using traditional gears. Generally, fishing within the region is especially on a subsistence basis and used for family consumption while a little amount is sold at an area market to urge extra cash income.

Most of the population that lives on the brink of water bodies meets more of their animal protein requirements through fish consumption. The fishery is practiced during a traditional technique and tools as a relaxation activity. Ilu Abba Bora zone is presented with inland water bodies which are rich in faunal diversity like fishes (Tesso *et al.*, 2017). A recent study identified nine fish species from rivers Sor and Gabba only which are economically important by (Melaku, 2013). Riverine fishery, fishing activity, and marketing systems of the Baro- Akobo Basins especially within the Gambella Regional state were roughly assessed by (Hussein *et al.*, 2010).

To harvest these fishery resources, knowledge of gear, crafts, and fishing methods is extremely essential for scientific and judicious exploitation and management of fishery resources. Fishing nets and gears are referring to those devices having different shapes and sizes are utilized in the

aquatic bodies to capture different sizes of fish species (Azam *et al.*, 2014). Fishing techniques employed during a geographic area generally depend upon various behavioral characteristics and microhabitat sort of the fish fauna available therein area. Fishing crafts and gears utilized in India are mostly primitive and non-mechanized (Khanna and Singh, 2003).

Gear is any kind of equipment, implement, tool, or robot used to catch, collect or harvest fish on the opposite handcrafts are used to carry the fishermen and gears to fishing grounds. Various sorts of materials are wanting to make these fishing gears include netting, twine, plastic structural and fasteners, clips and swivels, ropes, steel wire ropes, combination wire ropes, purse rings, polyester, polyethylene, nylon, cotton, polypropylene, mixed fibers, floats and sinkers, bamboo, wood (Hameed and Boophendranath, 2000). Seasonal changes, physiography of the water body, sorts of fish available, the efficiency of the gear, characteristics of the fabric used for the preparation of drugs are the important factors that determine the selectivity of the gear used. A radical understanding of fishing craft and gear is crucial for understanding this exploitation mechanism of natural fishery reserves and conservation and also for creating suitable improvements of valuable fish resources. Several researchers documented various indigenous fishing methods utilized in various parts of India (Laxmappa and Ravinderrao, 2014).

Indigenous knowledge (IK) in Jor Woreda, Anywaa Zone around Gambella regional state inhabitants is typically enclosed within cultural values and practices and is not recorded or documented as 'knowledge'. As a result, the IK of the community is on the brink of loss as reported by (Fanthun 2016) necessitating the need for the timely documentation of this knowledge. Therefore, this study attempts to answer the following questions:

- What is the fish's composition available in the study area?
- What are the indigenous fishing methods and fish post-harvest activities in the study area?
- What is the IK on biological attributes and ecological distribution of fish in the study area?
- What is the transfer of IK on fishing practices among the community members?

1.2 Statements of the problem

The riverine fishery in Ethiopia is not well developed due to a lack of access to suitable fishing grounds and the culture of most communities (Urga *et al.*, 2017). Although there are a considerable number of studies that have been done on fisheries in Ethiopia, it seems the majority of them tend to focus on diversity (Hussien *et, al.*, 2010; Getahun, 2003) and biological aspects of the resource (Zenebe, 1998; Getachew, 1993) while others relate to the management of fishery resources (Felegeselam, 2003; Gordon *et al.*, 2007). Gilo River located in the southwestern part of Ethiopia is a tributary of Baro (Openo) within the Baro-Akobo (White Nile) basin. The river has not been exhaustively explored for the fish diversity, and indigenous knowledge related to fishing activities mainly due to difficult accessibility, security, and harsh geographical features of the area. Therefore, the present study was conduct to collect baseline data on the composition of fish fauna and indigenous knowledge related to fishing activities along the course of Gilo River in Jor Woreda, Anywaa Zone, Gambella Regional State.

1.3 Objectives

1.3.1 General objective

To assess and document fish composition and Indigenous knowledge on Fishing Activities in Gilo river at Jor Woreda, Anywaa Zone, Gambella Regional State in southwest Ethiopia.

1.3.2 Specific objectives

- To identify and document fish species composition in the study area
- To explore the indigenous fishing methods and fish post-harvest activities in the study area.
- To explore the existing indigenous knowledge on biological attributes of fishes and ecological distribution of fish in the study area.
- To explore the transfer IK of fishing practices among the community members

1.4 Significance of the study

The findings of this study would serve as baseline data on fish composition and indigenous knowledge practices related to fishing activities at the study area for further similar works covering wider geographical extents in the Baro-Akobo Basin.

1.5 Definition of Local Terms

Akupa: is when a more than two dry fish product (peetø) pack together for transports to market or another place.

Dweeta: is a local salt (Anywaa-salt) that made from plants material.

Ngienynyø: is a fried-dry fish product

Ongana: is the place were fish smoke

Peetø: is a dry fish product

Pëëm: is a self-wooden on ongana used put fish on for smoking

Chapter Two

2. Literature Review

2.1 Fish species composition

Among the organisms, fishes are the best-known species of aquatic organisms and they are the only food source harvested from natural populations. Furthermore, fishes exist at or near the top of the food chain and can serve as an indicator of a balanced aquatic ecosystem (Gorman and Karr, 1978). Fish diversity comprises of species richness (number of species in a defined area), species abundance (relative number of species) and phylogenetic diversity (relationships between different groups of species) (Gorman and Karr, 1978). Fishes constitute more than 27,000 of the known 54,000 species of living vertebrates and are divided taxonomically into three major groups: jawless fishes (Agnathans), cartilaginous fishes (Chondrichthyans), and bony fishes (Osteichthyes) (Helfman *et al*., 2009; Nelson, 2006). According to (Leveque *et al*., 2008) South America is the leading continent in terms of freshwater fish by possessing 4,035 species belonging to 74 families. While Asia and Africa are the second and third next to South America with 3,553 and 2,945 species in 85 and 48 families, respectively.

Fish is an important source of essential proteins, minerals, and micronutrients for over 400 million people in Sub-Saharan Africa (Tesso *et al*., 2017). Despite its high reliance on fish as a source of animal protein Sub-Saharan Africa has the lowest fish consumption in the world. By 2015, the continent will need an additional 1.6 million tons of fish just to keep up with current consumption. By 2030, demand will have increased by 2.6 million tons per year. The majority of wild catch fisheries, on the other hand, have reached or are overfished. The rapid increases in fish supply that will be required in the coming decades will only be possible if these fisheries are sustained and improved while fish farming is developed at the same time (WFC, 2009).

Ethiopia is rich in inland water bodies with diversified fish species composed of Nilo-Sudanic, East African, and endemic forms (Melaku, *et al*., 2017**)**. Later on, reviews by (Getahun, 2007) listed up to 153 valid indigenous fish species and subspecies in 25 families for the Ethiopian freshwater systems. A more recent survey by (Golubstov and Darkov, 2008) provided a basin-wide summary of the nation's ichthyofaunal diversity. According to this work, the nation's major

basins, namely, Baro-Akobo (White Nile within Ethiopia), Abay (Blue Nile within Ethiopia), Omo-Turkana, Tekeze-Atbara, Shebelle-Genale, and Rift Valley basins, respectively, have 113, 77, 76–79, 34, 33, and 28–31 fish species. According to work of (Habtesilassie, 2012) annotated checklist on Ethiopian fish diversity and identified more than 200 fish species in Ethiopia, 191 valid indigenous species, 46-54 species are endemic to Ethiopia 9-10 exotic species.

2.2 The Nature of Indigenous Knowledge.

Indigenous knowledge (IK) is in danger of extinction around the world, particularly in developing countries in Africa, Asia, and Latin America. Modernization, urbanization, and globalization pose a threat to IK. Most indigenous knowledge is not documented and is shared through traditional speech systems in most communities around the world. Personal communication and demonstration are the most common methods of transmission: from master to apprentice, from parents to children, from neighbor to neighbor, and from priest to parish (World Bank, 1998). Regrettably, normal oral communication channels have been disrupted, and other people have not slept in inhomogeneous community blocks. (Kothari, 1995).

Traditional communication systems are being disrupted, putting IK at risk in most communities around the world. Furthermore, IK subjects or modules are not included in the curricula of modern education systems in developing countries. As a result, IK is not passed down from one generation to the next. Modern education systems are found to be anti-IK in the majority of cases, and learners rarely value IK as highly as their parents or elders did (Kothari, 1995). Unless various concerned and affected communities in developing countries take deliberate steps to preserve IK, IK systems in these countries will soon become extinct.

In recent years, this mindset has evolved to include indigenous knowledge as cultural knowledge that produces and reproduces mutual understanding and identity among farming community members, where local technical knowledge, skills, and capacities are inextricably linked to non-technical cultural, ecological, and sociological factors (Moock and Rhoades, 1992). As a result, ITK has become ingrained in the minds of rural residents (RPK). This shift has resulted in the emergence and/or modification of methodologies for examining and supporting local knowledge as well as changes in professional attitudes and behavior toward the capacities, practices, and values of local people (Scoones and Thompson, 1994).

As a result of this stream of research, a jumble of terms such as local knowledge, lore, indigenous knowledge, and farmers' knowledge have emerged, which are frequently used interchangeably. All or any of these terms have one thing in common: they all refer to knowledge developed and held at the grassroots level or by rural people. The debate over whether IK is misguided, unscientific, or incorrect is over: instead, the discourse and discussion over the last half decade has focused on the power and means by which information from various epistemologies can be combined to provide sustainable management strategies. According to (Chambers 1992), there was a lot of overlap between the popular and knowledge domains. (Fairhead, 1993) also felt that farmers knowledge is more empirical and dynamic than he imagined. Others, however, (Scoones and Thompson, 1994) are less convinced by the similarities.

2.3 Overview of Indigenous Knowledge

In Africa, indigenous knowledge (IK) is almost identical to that of other indigenous societies around the world, in that it is traditionally applied in accordance with the natural and unseen world. These traditional or cultural practices were developed to address local ecological constraints by ensuring the long-term use and protection of commonly shared natural resources (Warren, and Michael, 1991). The wisdom and skills of the "keepers of indigenous knowledge" are supported by a dynamic and complicated understanding of their local surroundings as applied within the traditional practices of farmers, hunters, gatherers, master fishermen, artisans, and others. Change in the way this data is used isn't random; it's the result of people's deliberate efforts to define their problems and seek solutions through local experiments and innovation, which includes evaluating and learning from appropriate technologies elsewhere (Warren, and Michael, 1991).

Although African lore systems may not be better suited to predicting long-term change, indigenous knowledge as seen in traditional survival strategies may have some advantages in recognizing the onset of change and developing indigenous ways to accommodate and mitigate it at an early stage, within the community decision making structure. Perhaps more importantly, global human rights movements are becoming more united and determined in their efforts to protect the world's remaining indigenous societies, particularly those living in fragile ecosystems

such as rainforests, and their traditional livelihoods, cultures, and knowledge systems (Warren, and Michael, 1991).

In Ethiopia, IK refers to local knowledge that is specific to a culture or society. It's ingrained in the practices, institutions, relationships, and rituals of the community. It is a person's entire knowledge and skills, particularly in a geographic area, that allows them to get the most out of their natural environment. Early Ethiopian civilization's achievements are proof of the culture's lore. Domestication of crops such as coffee, teff, and enset, as well as the Konso community's development of the bench terrace system, are examples of significant agricultural achievements (Fenta, 2000). Despite the aforementioned issues, IK consensus and debate have progressed significantly over the last 20 years. The interactions of actors, and thus the institutional setting within which such information is placed, have been analyzed, scrutinized, and debated from every possible angle since Paul Richards' groundbreaking works. The populists' first focus was on ITK, with emphasis on local people's knowledge and skills in agricultural production, for the reasons stated above (Richards, 1985).

2.4 Indigenous fishing gears and crafts

(Tsai and Ali, 1997) provided an excellent overview of Bangladesh's indigenous fishing technologies. People use a variety of tackle, including their hands, spears, traps, and nets. Many of these are technologies that were developed as part of one of the many fisheries projects that began in the 1980s and have since been adopted by the local population. The research also sheds light on a number of management strategies for the various water bodies used by the agricultural Community. During the survey period, the study discovered a total of 51 different types of tackle in use. The type of tackle used varies with the seasons, depending on flood conditions, target species, and fish size. There are 11 different types of traps, each with a different shape, size, and mode of operation. For example, the polo could be a bell-shaped trap with an open bottom and a small opening at the top. During the months of December through May, this type of trap is used all over Bangladesh. In shallow water, the trap is pressed into the mud. In comparison, the charai appears to be a rectangular box, similar to a trap. A door runs the length of the trap, from the bottom of the front to the apex at the back. There is a gap at the top for the removal of fish. The trap is near the surface, hidden beneath floating vegetation. Snail meat is frequently used as bait.

A fisherman may operate up to 100 traps, which are set in the evening and checked the following morning. The use of bamboo, date palm, palmyra, or areca nut trunk tubes that are placed in ponds, canals, and rivers. The ends are covered after a few days, and the logs are raised and the fish inside are removed. In Naogaon, Bangladesh, (Hossain and Alain, 1993) discovered that the aquatic weed is tied in a bunch and hung from a rope into the water to catch freshwater shrimp. Crab harvesting from rice field bunds is one of several resource poor people's food production systems in rice-based farming systems in south India. (Rajasekaran and Whiteford, 1993) conclude that local people have a thorough understanding of crabs and their ecology, and that sociocultural factors influence crab catching and consumption.

They also emphasize the significant contribution crabs make to the protein intake of low-income families. (Jansen, *et al*., 1989) provide a thorough examination of the country's boating industry, including descriptions of the many different types of boats that can be found in Bangladesh. The operational purpose and logistical requirements dictate much of the variation in boat type. The work also gives a quick overview of the methods and techniques used in the construction of country boats. Fishing is popular in Ethiopia's water bodies, and various fishing gears are used. For example, fishing is conducted in Ethiopia's valley lakes, such as Lake Awassa, Langano, Chamo, and Abaya, with gear ranging from hand hooks to motorized fisheries associations. Fisheries support the livelihood of many people in the Baro (Openo) Akobo basins, particularly within the Gambella region's water bodies (rivers, lakes, and floodplains), and fishermen use over 15 different types of gear that vary in season, method of fishing, and materials used (Hussien, *et al*., 2010).

2.5 Role of IK on management of Fishery

Obtaining knowledge about the biology of fish species is one of the most difficult management challenges. Fish reproduction varies by location, as do diets, which are influenced by local prey availability and other factors. Fish behavior is typically an area feature as well, and knowing what a species eats, where it's located, if it aggregates, migrates, and reproduces is crucial for management. This is especially difficult for data poor small-scale fisheries, which characterize the majority of those in Latin America, but particularly those along the Brazilian coast. Fish migration and reproduction are two aspects of fish biology that biologists and anglers are least familiar with (Silvano and Begossi, 2002), so research in these areas should be prioritized to

enable successful management. The primary cause appears to be destructive fishing within river mouths as the fish migrate upstream to their spawning grounds (Kebede, *et al*., 2017). Closed seasons, closed fishing areas, number of fishers restrictions, catch quotas, mesh size restrictions, beach seines restrictions, and beach seines prohibitions are preferred by the majority of fishermen in Lake Ziway (Kebede, *et al.,* 2017). It's also been recognized that the effectiveness and ability to implement management measures are frequently dependent on the support received from interested parties. (Kebede, *et al.,* 2017). Integrate upstream forest and wet land protection and rehabilitation activities into the conservation, development, and management of water resources, as well as the protection of water land interfaces such as lake shores, river banks, and wet land, according to the report (Kebede, *et al*., 2017).

2.6 Indigenous fish handling and preservation

IK has been studied by a wide range of researchers, including anthropologists and ecologists working in the fields of cultural ecology and demography. IK has been studied in a variety of systems, including small-scale agriculture, horticulture, and fisheries (Johannes, 1981). Fisheries were one of the first to use IK. The important sphere of preservation remained traditional, and the vast majority of fish caught in Ghanaian waters was sold fresh or refrigerated and sold later, or was preserved through smoking, salting and drying, and frying. Canning necessitated a larger financial investment than most Ghanaian entrepreneurs could afford. Canning also adds a lot of value to the raw material (MOFA, 2004).

2.7 Fish Utilization

Ethiopians are traditionally meat eaters, and fish consumption is seasonal, meaning that both demand and supply are concentrated within an 80day period each year. However, in areas and communities where there is a consistent and sufficient supply of fish, eating habits are shifting in favor of fish, suggesting that fish consumption in the country is also heavily influenced by supply factors (FAO, 2003-2015). Despite the fact that demand for fish has increased over the years, the seasonal pulse in fishing intensity and demand Ward and Wakayo in (ACP Fish II, 2013). The caught fish is sold fresh, chilled, frozen, and cured. The majority of landed fish is gutted and filleted at the landing sites, though this varies from place to place. The majority of the fish landed is sold fresh in nearby markets, leaving the rest to be chilled or frozen in 26% of cases, or dried and smoked in 1% of cases, to reach distant consumers (FAO, 2003-2015).

Chapter Three

3. Materials and Methods

3.1. Description of the Study Area

Jor is one of Woreda in Anywaa Zone, Gambella Regional State located in the south-western part of Ethiopia (Figure 3.1). The Woreda is bordered with Jikawo Nuer Zone on the north, on north-east by Abwobo, on the east by Gog, on south-by-South Sudan, on the west by Akobo. The Woreda is located 145 km away from the regional town of Gambella. The terrain of Jor Woreda is predominantly flat, with the elevation ranging between 400 to 600 meters above sea level. A major water body of the Woreda is the Gilo River and 30% of the Woreda is forest (CSA, 2007). It extends between 7'N to 8.20'N latitude and 33'E - 36.02'E longitude. The study area receives an average annual rainfall of 645.3 mm and annual temperature ranges from 33.71-40.32OC.

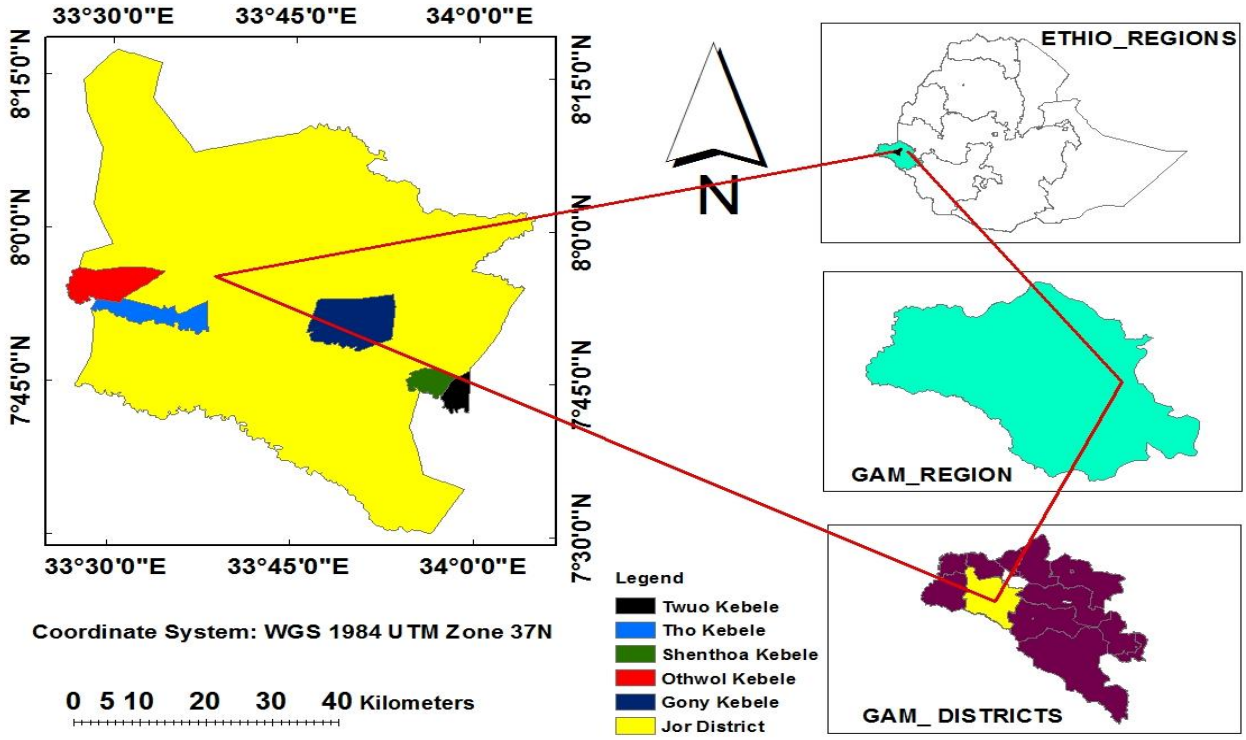


Figure 1. Map of the study area 'Gam' in the map is stand for Gambella region and Gambella districts (Source ArcGIS).

3.2. Study Design

Preliminary and a cross-sectional survey was used a research design to collect data on fish composition and indigenous knowledge related to fishing activities in the study area.

3.3 Fish specimen collection and identification

Fish specimens for species identification were collected exhaustively from diverse fishermen catch using gears of diverse types. The diverse traditional fishing gear are listed based on how they catch fishes, wounded gears are Bidhi (Waragöy), Obeec (Othöödhi), Arøøc, Acwiiyi (Lwiiyø) and Gøølø. Trapped gears are: Rwök (Gälöw), Döör, Dipaw, Awara (Bøøyi), Olïtu, Thwøøyi, Abuul, Dak, Ajwaaya, Akaang, Këëk and Diemma and two poisonous plants such as Obëër and Obïnthor. Identification would be made to species level using standard reference keys (Habtesilassie, 2012; Getahun, 2017).

3.4. Data sources and Population for the indigenous knowledge

The study involved both men and women elder and local people as a source of data. The primary data for the study was collected from indigenous people in Jor Woreda. This site was used as population source for data because they are living close to Gilo River and perform fishing activities through indigenous knowledge. The respondents of this study were selected purposively from people who are being engaged on riverine fishing activities frequently.

3.5. Sample size and sampling techniques

Among the existing five Woreda in Anywaa Zone the researcher selected one (1) Woreda name, Jor Woreda using a purposive sampling technique based on fishing activities along the rivers. From Jor Woreda, fishermen and households along or nearer to riverine water bodies were selected purposively. Accordingly, five representative samples were selected and from each site individuals who undertake riverine fishing activities regularly, were selected purposively. Moreover, five focus group discussions were conducted in all the sites.

3.6. Data Collection tools

Data were collected using, questionnaires (Appendix 1), focus group discussion (Appendix 2) and observation (Appendix 3) with some selected elderly fishermen. Fish specimen were collected from local fishermen which are catch from diverse traditional gear and identification was done through standard key into species level. The questionnaires were developed in English and then translated into Dha-Anywaa so as to obtain information from indigenous people and elderly fishermen. The sample size for questionnaire includes elder people, fishermen experts and 5 Focus group discussions were determined purposively by the researcher. In selecting individuals for key informant interview and focus group discussion as (Flick *et al.*, 2000) stated that gaining adequate qualitative data requires pre-selected individuals that should be selected based on their level of knowledge and experience. In order to elicit the necessary data, questionnaire was constructed based on the review of related literatures. This would be constructed in keeping with the main themes of research guiding questions as well. There would be two sets of questions, some of them comprise close-ended while most of them consist of open-ended questions which, the researcher believes, would help the respondent to write their real feeling about the phenomena they were asked. To satisfy the need for confidentiality, respondents informed not to put their names on the questionnaires. Instead, they were kindly requested to indicate their sex, age, qualification and experience as far as the background characteristics are concerned. The questionnaires were examined by English teachers to avoid errors related to accuracy, fluency, and contents and to validate the frame items.

3.6.1. Questionnaire

Multiplicities of data gathering instruments are used to maximize the worth of the data use in the study. The questionnaire type for this study was a researcher administered that is in the form of an interview. Questionnaire was design to request the quantitative and qualitative data from Jor Woreda selective rivers Pilot-test of the instruments was done before using it to collect data. The questionnaires included Likert-scale items measuring the practices of indigenous knowledge on riverine fishing activities whereby respondents were asked to rate each item based on a five-point Likert scale. Content validity of the questionnaire was carrying out by the pilot test that is conducted in Jor Woreda selective river before the actual survey to reduce the difficulties of

ambiguity and reduces effect of bias conclusion and interpretation happening in the other methods.

3.6.2 Focus Group Discussion

Focal group discussion (FGD) was another data collection technique that was used through the use of audio/videotape recording which would be checked parallel to interview data files so that the researcher able to compare the actual facts of putting the indigenous knowledge for riverine fishing activities in order to brain storm indigenous knowledge, which is tacit knowledge in nature. For this purpose, a group of 6 fishermen were participate on the discussion. One focus group discussion was done for each site and thus there were a total of 5 FGD.

3.6.3 Observation

Observation of the working environment were made using a check list of items (see appendix 3). Moreover, document analysis is used to collect appropriate information to assess Fish diversity and indigenous knowledge on fishing activities in Gilo river Jor Woreda.

3.7 Data Analysis

Fish composition in the river were computed by using Shannon-Weiner Diversity Index. (Shannon and Weiner, 1963) H, as follows

$$H = \sum_{i}^{n}{}_{=1}(n_i \div N\,[\log]\,(n_i \div N))$$

Where, H =Shannon-Weiner Index of Diversity

n_i =Total no. of individuals' species

N =Total no. of individuals of all species

In this study both quantitative and qualitative analytical procedures were employed. Hence, questionnaires items were analyzing by SPSS software using descriptive statistics. In addition, qualitative data was analyzed by summarizing responses of the open-ended items in the questionnaire, focus group discussion (FGD) and observation.

Finally, the data were analyzed and discussed to reach certain finding which in turn would be used to give conclusion and possible recommendations.

3.8 Ethical consideration

Permission to carry out this study was obtained from Jimma University. A formal letter was submitted to all the concern bodies to obtain their co-operation. Moreover, all participants of the study were informing verbally about the purpose and benefits of the study just to secure their consent agreement. Furthermore, all the participants were reassured of confidentiality by explaining to them that their names and other clues of the status are not documented in the study. Any data and information given by them are kept confidential and the data and information they provided is not use for anything other than for this research purpose only.

Chapter Four

4. Results

4.1. Fish composition

A total of 14 species belonging to 12 genera, 12 families, and 7 orders were identified from Gilo River during the present study. Among these, 14 species in 12 families and 7 orders were identified during the study. The number of fish specimens collected, values of Shannon-Weiner diversity indices of fish species are summarized in Table 1

Tables 1. Species composition indices of the Gilo River during study period.

Parameters	Values
Species richness (S)	14
Abundance (N)	768
Shannon-Weiner Diversity Index ($H^{'}$)	2.24

Table 2 presents fish composition and distribution by family, genera, and species under 7 orders. As far as the genera and families to different orders are concerned order *Osteoglossiformes* and *Perciformes* consists of 3 genera under 3 families followed by order *Siluriformes* consist of 2 genera under 2 families while *Characiformes, Polypteriformes, Cypriniformes* and *Lepidosireniformes* of single genus under single-family each. Among fish Families, families *Mockokidae* and *Polypteridae* are the highest number of fish species with two (2) species in each representing family respectively. *Osteoglossidae, Gymnarchidae, Cyprinidae, Anabantidae, Alestidae, Mormyridae, Clariidae, Protopteridae, Latidae,* and *Cichlidae* has only one (1) species.

Table 2. Fish composition by Order, Family, Genera and Species

Order	Family	Genus	Species	Local name
Characiformes	*Alestidae*	*Brycinus*	*B. nurse*	Apiidha (Gurcuk)
Cypriniformes	*Cyprinidae*	*Labeo*	*L. niloticus*	Okuura
Lepidosireniformes	*Protopteridae*	*Protopterus*	*P. aethiopicus*	Luuth
Osteoglossiformes	*Osteoglossidae*	*Heterotis*	*H. niloticus*	Olwak
	Gymnarchidae	*Gymnarchus*	*G. niloticus*	Wïïth
	Mormyridae	*Mormyrus*	*M. kannume*	Nøødø (Døølø)
Perciformes	*Anabantidae*	*Ctenopoma*	*Ct. muriei*	Amuuyö
	Cichlidae	*Oreochromis*	*O. niloticus*	Orwëëdhö
	Latidae	*lates*	*L. niloticus*	Guur
Polypteriformes	*Polypteridae*	*Polypterus*	*P. senegalus* *P. bichir*	Otweel Odwëëla
Siluriformes	*Clariidae*	*Clarias*	*C. garipenus*	Agwiela
	Mockokidae	*Synodontis*	*S. schall*	Okook
			S. filamentous	(Aracarac) Okook

A total of Fourteen species of fishes in the Families *Alestidae, Cyprinidae, Protopteridae, Osteoglossidae, Gymnarchidae, Mormyridae, Anabantidae, Cichlidae, Latidae, Polypteridae, Clariidae,* and *Mockokidae* were identified from the different landing sites on Gilo River (Table3). The species were *Brycinus nurse, Labeo niloticus, Protopterus aethiopicus, Heterotis niloticus, Gymnarchus niloticus, Mormyrus kannume, Ctenopoma muriei, Oreochromis niloticus, Lates niloticus, Clarias garipenus, Synodontis schall* and *Synodontis filamentous* from family *Mockokidae* and *Polypterus senegalus* and *Polypterus bichir* from family *Polypteridae* and there is variation high diversity within different areas Twuo (H'=2.22), followed Shenthoa (H'=2.21), Gony (H'=2.08), Othwol (H'=2.03) and Tho (H'=1.81) (see appendix, 5).

Table 3. Fish species identified from different study sites on Gilo River (present (+), absent (-)

Family	Species	Sampling Sites				
		Twuo	Shenthoa	Gony	Tho	Othwol
Alestidae	*B. nurse*	-	+	-	+	+
Cyprinidae	*L.niloticus*	+	+	+	-	-
Protopteridae	*P. aethiopicus*	+	+	+	+	+
Osteoglossidae	*H. niloticus*	+	+	+	+	+
Gymnarchidae	*G. niloticus*	+	+	+	+	+
Mormyridae	*M.kannume*	+	+	+	+	+
Anabantidae	*Ct. muriei*	+	+	+	-	-
Cichlidae	*O. niloticus*	+	+	-	-	+
Latidae	*L.niloticus*	+	-	-	+	+
Polypteridae	*P. senegalus*	+	+	+	+	+
	P. bichir	+	+	+	+	+
Clariidae	*C.garipenus*	+	+	+	+	+
Mockokidae	*S. schall*	+	+	+	+	+
	S. filamentus	+	+	+	-	-

4.2 Description of fish species composition sampled from Gilo River.

Order *Polypteriformes* -1family (F), 1genus (G), 1species (Spp)

Family *Polypteridae*-1Spp

1. *Polypterus senegalus*: Cuvier, (1829); Habteselassie, (2012); Wakjira, & Getahun (2017)

Diagnosis: Dorsal fin contains 9-11 finlets

Description: Mouth terminal; Snout acuminate and jaws of equal length; interorbital region convex A pectoral fin not reaching the first dorsal ray; 9 dorsal finlets; with ganoids‟ scales 5561 scales in a lateral line series; 34-40 around body in front of dorsal fin and 14-21 predorsal scales; lateral line scales simply perforated; Caudal articulated rays; pectoral fin rounded, not getting the level of the first dorsal ray; grayish body in color; TL up to 24 (in the present study)

Plate 1: *Polypterus senegalus* Sources Gilo river, 2021

Order *Osteoglossiformes* 2F, 2G, 2Spp

Family *Gymnarchidae* 1 species

2. *Gymnarchus niloticus*: Cuvier, (1829); Golubtsov et al., (1995) Wakjira, & Getahun (2017)

Diagnostic features: Dorsal fin occupies the whole length of the body, seem to be a cylindrical rat/ snake like tail.

Description: Mouth terminal, without barbells; narrow head with pointed snout; It has no anal, caudal and pelvic fins; Its dorsal fin extending the entire length of the back stopping short of naked tail without adipose fin, having dorsal fin rays up to 72, without spine; Lateral line scales at least above 200; It can grow to a least a total length of 1m (in the present study).

Plate 2: *Gymnarchus niloticus*, Sources Gilo river, 2021

Family *Mormyridae*- 1Spp

3. *Mormyrus kannume*: Forsskål (1775); Habteselassie (2012); Wakjira, & Getahun (2017)).

Diagnostic feature: Snout slightly curved downward

Description: Snout at least nearly as long as postorbital part of head, dorsal originating above or slightly in advance of base of ventral fins, with 57-75 rays, anal 18-21, 80-115 scales in lateral line Mouth terminal; proboscis-like snout slightly curved downward; TL up to 1000mm

Plate 3: *Mormyrus kannume*, Sources Gilo river, 2021

Order *Characiformes* -1F, 1G, 1Spp

Family *Alestidae*-1Spp

4. *Brycinus nurse*: Rüppell (1832); Habteselassie (2012); Wakjira, & Getahun (2017)).

Diagnostic features: Dorsal fin originating above base of ventral or just behind them, head not much flattened above.

Description: Dorsal fin above or only slightly anterior to pelvic fin; head slightly flattened; gill racker moderately long, 16-20 on lower part of anterior branchial arch, anal fin with 11-16 branched rays, 26-33 scales on lateral line, fish of moderate size usually with blackish spot above lateral line, behind gill opening, and another on caudal peduncle and teeth in outer row of

premaxilla 8; sides silvery; unpaired fins bright red; paired fins colorless to light orange; dorsal and sides of the body silvery; TL up to 230mm

Plate 4: *Brycinus nurse*, Sources Gilo river, 2021

Order *Cypriniformes* - 1F, 1G, 1Sp

Family *Cyprinidae* -1Spp

5. *Labeo niloticus*: Linnaeus, (1758) — Froese & Pauly (2016); Boulenger (1909); Habteselassie (2012); Wakjira, & Getahun (2017)).

Diagnostic features: Having rostral, large lips, two barbels on the rostrum and pair of barbels at rear edge of lower maxilla.

Description: No teeth on the jaws; inferior mouth with one pair of minute barbels; dorsal fin with more than 14 branched rays; upper edge of dorsal fin often concave; 41–45 scales in the lateral line; no transverse plicae of papillae on the inner sides of the lips; dorsal surface dark olive.

Plate 5: *Labeo niloticus*, Sources Gilo river, 2021

Order *Siluriformes* -2F, 2G, 3Spp

Family *Clariidae* –1Spp

6. *Clarias garipenus*: Burchell, (1822); Golubtsov et al., (1995); Habteselassie, (2012); Wakjira, & Getahun (2017).

Diagnostic features: Head is somewhat between rectangular and pointed out in dorsal outline, gill opening is wide

Description: Without scales on body; the eyes have a superior-lateral position and are relatively small; Mouth positioned sub inferior with 4 pair of barbells; dorsal fin long extending to the base of caudal fin and anal fin long extending to caudal fin; anterior edge of pectoral fin spine serrated. TL up to 74 cm (present study)

Plate 6: *Clarias garipenus*, Sources Gilo river, 2021

Family *Mockokidae* - 2 species

7. *Synodontis schall*: Bloch & Schneider (1801); Boulenger (1911); Habteselassie (2012); Wakjira, & Getahun (2017)

Diagnostic features: squeaker upside-down catfish

Description: scales absent; dorsal fin spine not extending into filament, feebly serrated posteriorly, smooth anteriorly, except for a few apical spines, also weak serration on lower anterior half in large individuals; first soft dorsal fin ray extends into short (rarely long) filament; no basal marginal membrane on maxillary barbel; body dark brown.

Plate 7: *Synodontis schall*, Sources Gilo river, 2021

8. Synodontis filamentous: Boulenger (1901): 10. — Boulenger (1911); Habteselassie (2012); Wakjira, & Getahun (2017)

Diagnostic features: squeaker upside-down catfish

Description: Scales absent; dorsal fin spine extends into very long filament approximately half the length of the spine; soft rays not extending into filament; Maxillary barbels are present with a broad marginal membrane in its basal third; humeral process rounded, movable mandibular teeth barely ¼ length of eye, 18-20 in numbers; body dark olive.

Plate 8: *Synodontis filamentous*, Sources Gilo river, 2021

Order *Perciformes*-2F, 2G, 2Spp

Family *Anabantidae* -1Sp

9. *Ctenopoma muriei*: Boulenger, (1906); and Habteselassie, (2012).

Diagnostic features: Ventral fin not extending much beyond origin of anal fin, no less than 8 branched rays in dorsal and in anal

Description: Dorsal XIV-XVI 8-10, anal, IX-XI 8-10, depth of body 2.75 to 3 time in TL, olive with numerous black spots, a blackish ocellar spot edge with yellowish at the root of and partly up on caudal fin; TL up to 100mm

Plate 9: *Ctenopoma muriei*, Sources Gilo river, 2021

Family *Cichlidae* -1Sp

10. *Oreochromis niloticus*: Linnaeus, (1758); Habteselassie, (2012); Wakjira, & Getahun (2017)

Diagnostic features: the species has caudal with small ventrical strips; gill rackers short at least above 20 on the lower part of anterior arch.

Description: Mouth terminal and moderately large; body compressed; a knob-like protuberance absents on dorsal surface of snout; Spinous and soft ray parts of dorsal fin continuous, with 16-17 spines and 11 to 15 soft rays; XVII-13 dorsal fin rays, and 9 anal fin rays; caudal fin truncated; dark ventrical bands on flank, and the caudal peduncle; TL 26-43 cm (in the present study)

Plate 10: *Oreochromis niloticus*, Sources Gilo river, 2021

4.3. Demographic and Personal information of the respondents

Table 4. Indicated the percent of the respondents based on their four measure of demographic respondent based on gender respondent male were the highest respondents 71.7% while the remaining 28.3% were from female respondents, based on their age group, 41-50 age were highest respondents with 68.3%, followed by age group 31-40 with 13.3%, next age above 50 with 11.7% and age group of 18-30 with 6.7% and marital status of the respondents married were the highest respondents with 86.7%, followed by divorced with 10% and unmarried with 3.3%. Finally, educational level of the respondents, illiterate was the majority respondents with 61.7%, followed elementary with 30%, next to the high school with 5% and other with 3.3%

Table 4. Summary of demographic characteristics of respondents

Demographic characteristic		Frequency	Percent's
Sex	Male	43	71.7
	Female	17	28.3
	Total	60	100.0
Age	18-30	4	6.7
	31-40	8	13.3
	41-50	41	68.3
	<50	7	11.7
	Total	60	100.0
Marital status	Unmarried	2	3.3
	Married	52	86.7
	Divorced	6	10.0
	Total	60	100.0
Educational level	Illiterate	37	61.7
	Elementary School	18	30.0
	High School	3	5.0
	Other	2	3.3
	Total	60	100.0

4.4 Fish post-harvest activities

4.4.1 Modes of IK on fish processing and preservation

The fishermen perform traditional fish processing such as scaling, gutting, and filleting. There are blades for doing fillets and using animal skin as a cutting board. Both men and women are involved in the process. However, women are mainly observed to prepare and sell processed fish such as cooked fish and fried cooked fish in the local market. Men were engaged in fishing mostly prepared dry fish (Peetø) and sometimes fillet preparation. Peoples use the fresh and cooked products of fish dishes at home and at a local hotel. To preserve fishes for a long time, fishes are prepared for the purpose of preserving for a wet season when the fishing is restricted due to the high pressure of rivers and floods. The widely used preserved methods are drying and fried-drying fishes. Drying is one of the traditional preservation methods that reduce weight and prolong shelf life. The common fish species for drying are *C. gariepenus* (Agwiela), *G. niloticus* (wïïth), and *H. niloticus* (Olwak).

Fried-dry fish Women processed fried–dry products. Mostly, they prepared for self-consumption during the wet season. They are also used as supplementary cash income. Fried-dry products are prepared mainly from African catfish (Agwiela) and processed as follows: head separated from the rest of the body, gutted and put on Ongana which is smoked on a wooden shelf locally called Pëëm which has fire burns under it. Sometimes the cooled flesh is mixed with a processed plant preservative locally known as *Dweeta* (Anywaa Salt). Fried dry fish products locally called Nginynyø. According to informants, these methods make fish meat stay for 3-4 months.

Table 5. Number of respondents on fish processing and preservation

Mode of IK on fish processing and preservation	No (60)
Drying fish product (Peetø)	43 (71.7%)
Fried-drying fish product (Ngienynyø)	17 (28.3%)

Figure 2. Mode of fish processing (**A**) a girl prepare fish for cooking at home, (**B**) a woman prepares fried fish, (**C**) Peetø (**D**) fish smocking on ongana used for prepared nginynyø, (**E**) people using different fish dishes at home, and (**F**) fried-dried fish (Nginynyø)

4.4.2 Modes of IK on transportation and marketing

After landing, the fishes were sorted on the shore and auctioned. Most fishes not sold at the shores are carried un-iced from the landing centers to nearby markets, their bare feet, and by the head load.

Table 6. Number of respondents on where they sell their fishes

Places number of respondents	(no= 60)
On the shores	6(10%)
Local markets	54(90%)

Sources: field survey

According to fishermen, the price for fish differs per species and fluctuates depending on the fish availability period. In general, fish of the whole fish catches a better price on the market than on the shore. The price of catfish depends on the place of selling. As indicated in Table 5 above, fewer (10%) of the fishermen compel to sell their fish near the shore. Others, 90% of them sell their fish in local markets. Unlike others, catfish is a preferred fish species in all study areas. This

is due to catfish having various options preparation it could prepare dry fish, and fried drying fish (personal communication).

a  b 

Figure 3. Modes of transformation and marketing (a) a boy carried fishes by head load, (b) Women carried fishes by head loading from landing site to local market,

4.5 Indigenous knowledge on biological attributes of fishes

4.5.1 Sex categorization

Fishermen in study areas differentiated male fishes from the female through the following characteristic features:

Table 7. Distinguishing features used by fisher folks to identify sexes of fishes

Characters	Males	Females
Color	Pale dark and attractive	looked slime, whitish color
Size	Long, thin and heavy	thicker than males but lighter
Genitals	Out growing	in growing (thin holes)
	Emits a sort of urine if pressed	stuff eggs on her mouth when caught
Behavior	Dig holes near to shores	move around the holes

As described above in Table 6, male fishes are identified by their heavy body mass, thin and long, pale attractive color, outgrowing reproductive parts. When they looked at a typical fish dig holes near to shores of the river, they assume it was a male. On the other hand, local fishermen believed that males emit a sort of urine when pressed. They identify females as they looked

slimy, thicker than males. They believe the stuffed mouth of females as they are ready to lay eggs

4.5.2 IK on identifying healthy vs. unhealthy fish

Local peoples developed some morphological characteristics that helped them to identify healthy fish from unhealthy ones. They imagine that when fishes are sick, their belly becomes bulged, distorted or smooth body scales, slim or thinnest body with a big head and their gill become white in color, but the normal fishes have a gill bright red color.

4.5.3 IK on feeding habit identification

Examining the food and feeding habits of a species is important for evaluating the ecological role and position of the species in the food web of ecosystems (Hajisamae *et al*., 2003). Information also provides further support for fishers to know different fishing practices. In this study, fisher folks have categorized the fishes under herbivorous and carnivorous. This categorization is based on hooks and line fishing. According to this, fishes that are hooked are carnivores whereas; those that are not hooked are herbivores. If they have targeted to fish African catfish and lungfish, they use hooked gears and for others gill nets. But others estimate that there is no demarcation in their feeding and they consume whatever they found like birds excrete, cow dung, worms, tadpoles, grasses, etc.

4.5.4 Fish as a folk medicine

The reliance on traditional uses of animals as food and as medicine by communities around the world highlights the need for further interdisciplinary research in ethnozoology (Alves, 2013). In addition to the importance of fish as food, it was known that the use of fish in traditional medicine. In communities around the Gilo River, the use of animals, including fish, as medicinal resources are a fairly widespread and ancient phenomenon. In all sampling areas, questioners cited four fish species used as medicine, the tilapia (*Oreochromis niloticus) (Gymnarchus niloticus)* and *(Polypterus* species). These fishes are used to treat bile disease, headache, and fatigue (asthma) they treat these through consumption. They also used their fat, which is warmed and rubbed if their body parts are accidentally cut. These fish are targeted as a medicine because of historical adaptation to the species by the local people.

4.6 Indigenous knowledge on species distribution

This knowledge is important to the organization and success of fishing activities. The fishers were found to have a broad knowledge of the distribution of fish species in the environment and their position in the water column, i.e., the depth the animals usually inhabit. Gilo River fishermen know the distribution of different fishes in the water column of the river (Table 7).

Table 8. The response of fishermen on ecology of fishes

Species	Numbers of respondents on ecology of fishes in the rivers	
	Edge or sore of the river.	Bottom of the River
C.garipenus	42(70%)	18(30%)
H. niloticus	12(20%)	48(80%)
G. niloticus	8(13.3%)	52(86.7%)
P. bichir	60(100%)	
P. senegalus	60(100%)	
P. aethiopicus	60(100%) in wetland	
S. schall	55(91.7%)	5(8.3%)
S. filamentus	56(93.3%)	4(6.7%)
B. nurse	60(100%)	
L.niloticus	60(100%)	
L.niloticus	3(5%)	57(95%)
M.kannume	45(75%)	15(25%)
O. niloticus	58(96.7%)	2(3.3%)
Ct. muriei	59(98.3%)	1(1.7%)

As indicated in Table 7 above, most fishermen argued that four fish species such *as P. bichir, P. senegalus, B. nurse,* and *L. niloticus* 100% dwell in the edge of the river. *C.garipenus, Ct. muriei, O. niloticus M. kannume, S. schall,* and *S. filamentous* dwell in the edge of the river while a few claimed that these species live at the bottom of the river. On the other hand, most fishermen appealed that three fish species such as *G. niloticus, H. niloticus,* and *L.*

niloticus dwell at the bottom of the river, while a few claimed that these species live at the edge of the river and fishermen argued that 100% *P. aethiopicus* is dwell in the wetland.

4.6.1 Indigenous knowledge on how fishermen know best fishingtime and grounds for their successful catch

This is one of the most important skills required by fishermen to capture more fishes and satisfies their needs. This skill is learned through experience. They know when to go fishing to get more fish. Most fishermen go fishing when the sun is very hot at mid-day. Others go fishing when there are no wind waves at any time of the day and others go at midnight when the river is quiet. Some of the indicators they used to locate the best fishing grounds are described in Table 8 below.

Table 9. Number of fishermen using indicators to a successful fish catch

Number of respondents using this as an indicator	(n=60)
Shoal of small fish or fingerling	26(43.3%)
Flocks of birds	21(35%)
Rain	13(21.7%)

Source: Field survey

4.6.1.1 Presence of shoal small fish indicates abundance of fishes

Looking for the location of other river small fish is an important indicator of best fishing areas by fisher folks. Traditional fishermen in some study sites believe that presence of small fish is an indication of abundance of large fishes. When there is abundance of shoal of small fish or fingerling in the coastal waters. The fishermen believed that the fish follow to feed on small fish fingerling in area where they found. Then they prefer fishing in these areas to get more fishes. As indicated in the table 8 above, 43.3% of the fisherfolks use fingerling as an indicator for successful catch.

4.6.1.2 Presence of flock of birds as an indication of fish abundance

The traditional fishermen take the presence of large flocks of birds as an indication of fish. When fishes approach the water surface near the shore, fish-eating birds like *Marabou stork,* Fish Eagle, Great White Pelicans (*Pelecanus onocrotalus*), and Gaint kingfisher fly in large numbers over the waters in attempts to catch the fish. The appearance of these birds scooping into the water frequently indicates the presence of fish. This is why fishes gather birds' litter as their food

and approach where there is a flock of birds. Then the fishermen take considerations to catch around these areas for the next days. As indicated in Table 8 above, 35% of the fisherfolks use a flock of the bird as an indicator for a successful catch.

4.6.1.3 Rain as an indicator of fishes

Rain is used as an indicator of some fish species. After a heavy rain, catfishes Polypterus species come out to the shores of the river to search for their food. Fisherfolks go to the shores of the river after rainfall so that they have the knowledge they already know Agwiela and Odwëëla come out after heavy rain. Fishermen simply look out for these fishes and fishing through spears. As indicated in Table 8 above, 21.7% of the fisherfolks use rain as an indicator for a successful catch.

4.7.1 The sharing of indigenous knowledge on fishing activities among the community members

The percent of the respondents on sharing indigenous on fishing activities, items 1, 41.7% of the respondents strongly agreed, 50% agreed, and 8.3% of the respondents neutral. On item 2, 13.3% of the respondent were neutral, 55% disagreed and 31.7% of the respondents are strongly disagreed. On item 3, 6.7% strongly agreed, 13.3% agreed, 25% neutral, 38.3% disagreed and 16.7% strongly disagreed. On item 4, 25% of the respondents were neutral, 53.3% disagreed and 21.7% were strongly disagreed. On item 5, 15% were agreed, 18.3% were neutral, 40% disagreed and 26.7% were strongly disagreed. On item 6, 20% strongly agreed, 68.3% agreed and 11.7% were neutral. On item 7, 5% were agreed, 20% were neutral, 50% disagreed and 25% were strongly disagreed. On item 8, 35% were strongly agreed, 40% were agreed, and 20% neutral and 5% disagreed. Finally sharing indigenous knowledge on fishing activities among the community was poor.

Table 10. Summary of respondents on sharing indigenous knowledge on fishing activities.

No	Statement	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Mean value	Std Deviatio
		1	2	3	4	5		
1	IK is accessed and used easily by the local communities	41.7 %	50%	8.3 %	0	0	1.67	.629
2	There is a forum for IK sharing, like face to face (example, meeting)	0	0	13. 3%	55 %	31.7%	4.18	.651
3	IK is shared informally at individual level	6.7%	13.3 %	25 %	38. 3%	16.7%	3.45	1.126
4	Everybody has interest to share IK	0	0	25 %	53. 3%	21.7%	3.97	.688
5	Old and Knowledgeable people in the community feels responsible to share IK	0	15%	18. 3%	40 %	26.7%	3.78	1.010
6	No one is concerned to share IK	20%	68.3 %	11. 7%	0	0	1.92	.561
7	Younger generation are learning about IK from the elders with interest	0	5%	20 %	50 %	25%	3.95	.811
8	The negative impact of modernization/technology on sharing IK is high	35%	40%	20 %	5%	0	1.95	.872

4.7.2 Barriers to management of IK on fisheries activities.

The percent of the respondents on the factor that affect the management of indigenous knowledge of fisheries activities. On item 1, 36.7% strongly agreed, 40% agreed, 18.3% neutral and 5% disagreed. On item 2, 26.7% strongly agreed, 63.3 agreed, 6.7% neutral and 3.3 disagreed. On item 3, 40% strongly agreed, 50% agreed, 6.7% neutral and 3.3% disagreed. On item 4, 31.7% strongly agreed, 43.3% agreed, 15% neutral and 10% disagreed. On item 5, 50% strongly agreed, 35% agreed, and 15% neutral. On item 6, 26.7% strongly agreed, 70% agreed, and 3.3% neutral. On item 7, 35% strongly agreed and 65% agreed. The overall factors that affect the management of indigenous knowledge of fisheries activities were high.

Table 11. Summary of respondents on factors that affect management of IK on fisheries activities

No	Statement	Strongly agree	Agree	Neutral	Disagree	Strongly agree	Mean value	Std Deviatio
		1	2	3	4	5		
1	Poor knowledge sharing culture	36.7%	40%	18.3 %	5%	0	1.92	.869
2	Poor recognition of IK	26.7%	63.3 %	6.7 %	3.3 %	0	1.87	.676
3	Lack of IK records	40%	50%	6.7 %	3.3 %	0	1.73	.733
4	Lack of trust	31.7%	43.3 %	15%	10 %	0	2.03	.938
5	No interest to receive IK by younger generation	50%	35%	15%	0	0	1.65	.732
6	Oral transfer of IK	26.7%	70%	3.3 %	0	0	1.77	.500
7	Change of life style	35%	65%	0	0	0	1.65	.481

4.7.3 Existence and format of IK on management and conservation of fishing practices

The percent of the respondents on the existence and format of indigenous knowledge on management and conservation of fishing practices. Item 1, 25% strongly agreed, 31.7 agreed, 28.3% neutral, and 15% disagreed. On item 2, 36.7% strongly agreed, 58.3% agreed, and 5% neutral. On item 3, 5% agreed, 11.7% neutral, 71.7% disagreed and 11.7% strongly disagreed. On item 4, 30% strongly agreed, 65% agreed, and 5% neutral. Finally, indigenous knowledge on management and conservation of fishing practices was poor.

Table 12. Summary of respondents on IK management and conservation of fishing practices

No	Statement	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Mean value	Std Deviatio
		1	2	3	4	5		
1	There is different IK on management and preservation of fishing activities	25%	31.7%	28.3%	15%	0	2.33	1.020
2	IK on management and preservation of fishing activities is available in tacit form	36.7%	58.3%	5%	0	0	1.68	.567
3	IK on management and preservation of fishing activities is available in explicit form	0	5%	11.7	71.7%	11.7%	3.90	.656
4	IK on management and preservation of fishing activities is important and should be documented	30%	65%	5%	0	0	1.75	.541

4.7.4 Sharing of indigenous knowledge of fishing practices

The percent of the respondents on sharing of indigenous knowledge of fishing practices. Item 1, 10% strongly agreed, 41.7% agreed, 33.3% neutral, and 15% disagreed. On item 2, 20% strongly agreed, 50% agreed, 16.7% neutral, and 13.3% disagreed. On item 3, 8.3% agreed, 11.7% neutral, 66.7% disagreed, and 13.3% strongly disagreed. On item 4, 18.3% strongly agreed,

71.7% agreed, and 10% neutral. On item 5, 6.7% agreed, 11.7% neutral, 66.7% disagreed, and 15% strongly disagreed. On item 6, 16.7% strongly agreed, 28.3% agreed, 30% neutral, and 25% disagreed. On item 7, 16.7% agreed, 20% neutral, 30% disagreed, and 33.3% strongly disagreed. Finally, the respondent on sharing of indigenous knowledge of fishing practices was poor.

Table 13. Summary of respondents on sharing indigenous knowledge of fishing practices

No	Statements	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Mean value	Std Deviatio
		1	2	3	4	5		
1	Sharing of IK on fishing activities is important and giving attention by the community	10%	41.7%	33.3%	15%	0	2.53	.873
2	Telling about IK to younger generation is important	20%	50%	16.7%	13.3%	0	2.23	.927
3	New generation is willing to learn from elders	0	8.3%	11.7%	66.7%	13.3%	3.85	.755
4	Elders are willing to transfer their IK	18.3%	71.7%	10%	0	0	1.92	.530
5	There is community host events where elders get a chance to share their IK/ There is a forum to exchange IK	0	6.7%	11.7%	66.7%	15%	3.90	.730
6	Sharing IK on preservation and management of fishing	16.7%	28.3%	30%	25%	0	2.63	1.041

	is well practiced in the community							
7	There are different IK sharing mechanisms of fishing practices in the community	0	16.7%	20%	30%	33.3%	3.80	1.086

4.8. Qualitative data results

Qualitative data analyses the data obtained from the open-end questionnaire and FGD. The acceptability of the people with IK is moderate and preservation values of indigenous knowledge are very important to use two different traditional preservation methods like dried fish filled in the sun and fried-dried fish or fish smoking on fire. In case socio-cultural and economic values, they discuss each other and go together at once to fishing in the group locally called maayi and the fish bring at home for their consumption and economically they sell fresh fish & dried fish in the local market for income generation. The knowledge of fishing practices with gears is known by a few individuals. They transmitted the knowledge through oral talk and practicals between the members and sometimes they share it by calling some individuals to show the way how fishing activities can be conducted by practicing them. Traditional fishing gears are Spears (Bidhi), Harpoon (Arøøc), (Obeec/Othödhi), Handhook (Gøølø), (Ajwaaya), Lwiiyø/Acwiiyi, Rwök/Gälöw, Dipaw, Döör, Dak, Akaang, Abuul, Bøøyi, Olïtu, Thwøøyi, Apiiri/Pur, Këëk, and Diemma and two poison plant Obëër and Obïnthor and some gears are easy to use them but other are difficult to use because they need energy and more than two people to carry out fishing activities with them and due to difficulties some cause physical injuries other causing death and problem of tiredness. To avoid overfishing the river fishermen will rotation fishing activities and when capturing small fish immediately they should return back to the river but differ from ready spawn fish care because these indigenous people have no more knowledge about how to take care of ready spawn fish. In case of the breeding season, the communities' fish through some fishing gear like (Bøøyi) and during the dry season, this is a special time to carry out fishing activities. Impact of modern fishing gears, such as gillnet with difference mesh size 10cm-14cm and hook and line with both long line and pole and line, some difficulties of fishing tool making

and ineffective traditional fishing gears than modern fishing gears the acceptances of the people decreasing.

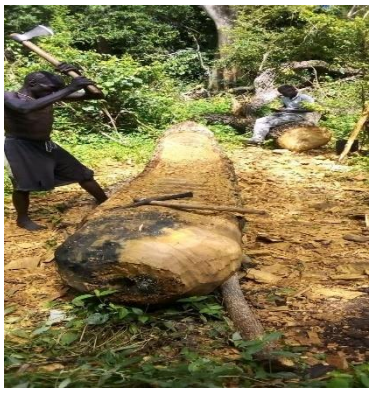
Figure 4. Respondents working on FGD at different study areas

4.9 Traditional craft and fishing gears

The present study reveals that there is one craft boat and seventeen (17) traditional fishing gears documented and also two poison plants. All fishers from rivers are operating traditional wooden dig-out canoe (Jää-naam) about 6-8 m in length with traditional fishing gears. Canoe used for transportation from one place to another place in Gilo River at Jor district. The canoe is made of various plant materials but mostly plant that are used by local people to make a canoe from its Cordia africana (Orøøgø) and Picus species plants by using dugout inside through axe and flathoe. Generally, no improved fishing boats were observed in the district.

Traditional fishing gears fall under three (3) categories: wounding gears, trapping gears, and a combination of wounding and trapping gears.

A 

B 

C 

Figure 5. Traditional wooden boat (Jää-naam) (A) canoe on services, (B) a man starting digout canoe by using axe, (C) a man finishing of digout canoe by using flathoe

4.10 Indigenous fishing gears

Fishing Spears and arrows (bidhi): It is made of about 2m long wooden stick with attached about 30cm long metal tip/spear. The attached spear can be hooked-shaped or spiral-shaped or smoothed.

harpoons (Arøøc): It is made of two combination pieces of wooden stick about 1.5m and 2.5 m long respectively. It is mainly used for catching Nile perch (Guur) in deep water.

Obeec: It is made of wooden sticks 1.5 – 2m long. At the end of the stick joined cone-shaped horn then attached a hook-like spear with the horn. The hook-like spear is tied with a 2-3 m rope to the other end of the stick. Obeec is used as a spear to catch fish. Obeec is used individually by experienced men.

Rwök/Gälöw is fish baskets or traps is set in a weir it is used catching fish throughout the year but most widely used during receding when flooding returns back to the river.

Döör is used by children. It is an active fishing gear and has similar uses to scope net. It sets at shallow and peripheral sites of the rivers and checks for caught fish.

Acwiiyi (Lwiiyø): It is also a modification of Obeec. The difference is that it has tied a rope about 3 meters long. It is mainly used for fishing crocodiles and sometimes use for fishing Nile perch

Hand hooks (Gøølø) have three parts. 20 – 30cm long large hook-shaped metal rode, 3-meter rope, and 30 – 50cm wooden handle. The metal hook was inserted at the hole of a wooden stick, and the rope was firmly tied both on the metal hook and handle. Fishing is done with diving in the following way. Fisher holds the stick and moves the stick in the water. When the fish hooks the metal, the rod detaches from the stick and moves freely with the fish, then the fisher pulls the rope to collect the fish.

Ajwaaya: it is the modification of Gøølø with a long line or rope of 4-5m long at end of the rope tied with a floating object called Abööpa.

Techniques: Fish bait such as small fish is attached to the hand hook and put into water and waiting until fish come to eat. When the fish catch the bait, the hand hook were swallowed with bait and captured the fish. Then, the fisher collects the rope that is tied to the hand hook.

Dipaw is fish baskets or traps and set in a weir. Dipaw is used for catching Døølø and Otwaa fish during the rainy season at the overflows channel. It has about 1.2 m length and 0.5 m and 0.3 m diameter at respective ends. The wider base of the trap is set opposite to the flow of water.

Bøøyi (Awara): it is a basketball net-like made of ropes/nets and used to catch Olwak fish at the breeding site.

Olïtu is a flat basket or elliptical colander trap with a handle whose longer diameter is about 0.8 - 1 m and is made of thin sticks or sticks with rope. It is used by women at shallow and flooded water bodies; it is immersed in the water and pulled out after a few minutes with both hands. About a hundred fish fries are caught at times.

Thwøøyi It is a small cone-like basket made of wood for direct putting on fish when it is visible. The size varies from place to place and is mainly about half-meter base diameter and 0.2m top and 1m high. It is mainly used by women.

Dak is used by women, setting a pot containing moistened flour in shallow water bodies for about 20 minutes. Then, the woman returns to cover the pot with its lid and takes out the pot containing up to 100 fries of fish.

Akaang it is fence like shape with only one gate open and made of small stick with 1-2 meter high. Technique, the fisher put the bait inside after a few minutes the fisher visit slowly and close the gate with a lid locally called Omeeyø and fished the fish inside by using a spear. It is mainly used by women.

Abuul is a sound generator to attract fish made of calabash. It has a number of small holes at the tip that produces sounds during immersing in water. When the fishes are attracted by sound the fisher fished using a spear.

Këëk made of logs is constructed across the river or in conjunction with the river and pond in order to capture the fish returning to the mainstream from downstream. Sometimes the junction surface can be filled by soil so that the fish moving near the water surface may jump onto it.

Fish indicator **(**Apiiri/Pur**)**: This is the method that the dried grass is planted in the shallow water as a fence to indicate when the fish passes through it. Then, the fisher fished using spears. It is used during the dry season in ponds.

Diemma is a horseshoe-shaped fence constructed in the river. Its length reached about 60 m with 2 m high and opens upstream. About 30 people participate in large Diemma fishing by beating the water surface with sticks to drive fish into the fence. Then, the fish are killed with fishing spears and sticks.

(A)  **(B)**  **(C)** 

(D)  **(E)**  **(F)** 

Figure 6. The various forms of traditional fishing gears used at different five site on Gilo River; (A) = Spear (Bidhi), B = Obeec, C= Rwök/Gälöw (D) = Dipaw, (E) = Bøøyi (Awara), (F)= Abuul.

Chapter Five

5. Discussion

A total of Fourteen (14) species of fish were recorded during the presents studies area thus exhibiting rich fish species diversity. The Shannon diversity index value for the present study was within the typical value range of 1.5 to 3.5 postulated by (Magurran, 2004). In the present study, Shannon diversity index value H'=2.24 was recorded. This value might relate to both its high species richness and a highly even relative abundance. Overall, 768 individuals of 14 species were included in 7 orders and 12 families were collected during the study period. The dominant species in terms of number and percentage composition of fish species were *Clarias garipenus* 215 (28%), *Heterotis niloticus* 139 (18.1%), *Polypterus bichir* 81 (10.5%) *Gymnarcus niloticus* 60 (7.8%), *Mormyrus kannume* 42 (5.5%) *Brycinus nurse* 40 (5.2%), *Synodontis schall* 37 (4.8%), *Oreochromis niloticus* and *Polypterus senegalus* were both are 36 (4.7%), *Protopterus aethiopicus* 27 (3.5%), *Ctenopoma muriei* 25 (3.3%), *Labeo niloticus* 13 (1.7%) *Synodontis filamentous* 12 (1.6%) and *Lates niloticus* 5 (0.6%) of the total number of catches. The above finding disagrees with that of (Teamer *et al*., 2016), who reported that *Oreochromis niloticus* (51.38%) are major dominant fish species bycatch in the Tekeze reservoir.

As far as the genera and families to different orders are concerned, Order *Perciformes* and Order *Osteoglossiformes* are the most diverse by having three families namely: *Anabantidae*, *Cichlidae and Latidae and Osteoglossidae*, *Gymnarchidae* and *Mormyridae* followed by Order *Siluriformes* by having two families *Clariidae* and *Mockokidae* and Order *Characiformes* (*Alestidae*), Order *Polypteriformes* (*Polypteridae*), Order *Cypriniformes* (*Cyprinidae*) and Order *Lepidosireniformes* (*Protopteridae*), were the least diverse. Taxonomically, the family *Cyprinidae* is the most diverse group of the Ethiopian ichthyofauna (Golubstov and Darkov, 2008). In contrast, there is no single family that represents the most diverse family in the present study in terms of species number. Family *Mockokidae* (*Synodontis schall* and *Synodontis filamentous*) and Family *Polypteridae* (*Polypterus bichir and Polypterus senegalus*) are represented by two genera. Family *Osteoglossidae, Gymnarchidae, Cyprinidae, Anabantidae, Latidae, Clariidae, Mormyridae, Cichlidae Alestidae,* and *Protopteridae* are represented by only

one species each namely: *H. niloticus, G niloticus, L. niloticus, Ct. muriei, L. niloticus, C. garipenus, M. kannume, O. Niloticus B. nurse and P. aethiopicus* respectively.

Assessment of fish diversity and indigenous knowledge on fishing activities were determined and fish diversity in the study area was shown high variation of diversity within different areas Twuo (H'=2.22), followed by Shenthoa (H'=2.21), Gony (H'=2.08), Othwol (H'=2.03) and Tho (H'=1.81) the statement agree with (Melaku *et. al.,* 2017*)*. There was variation in diversity between the two rivers as the Shannon diversity index was higher for Geba River (H'= 1.50) and lower for Sor River (H'= 1.10).

The fish specimen was collected from local fishermen which captured from a variety of traditional fishing gears and total 768 fish diversity were recorded from a total of 14 fish species with twelve (12) family and among these ten (10) different species with (9) family *Cichlidae* 1 species *(O.niloticus), Anabantidae* 1 species (*Ct.muriei*), *Mormyridae* 1 species (*M.kannume*), *Cyprinidae* 1 species (*L.niloticus*), *Clariidae* 1 species (*C.garipenus*), *Polypteridae* 1 species (*P.senegalus*), *Mockokidae* 2 species (*S.schall & S.filamentus*), *Alestidae* 1 species (*B.nurse*) and *Gymnarchidae* 1 species (*G.niloticus*) were transported from study area to Jimma University aquaculture and fisheries management laboratory by using formalin chemical with four (4) liter two liters for transportation and other two liters for preservation in the laboratory and dilute with water 36 liters of water and one liter of formalin diluted with nine liters of water and differentiate fish species within the single jar.

Fishing is a profitable and effective way of getting food since artisanal fishermen only harvest what they need. Most traditional fishing methods and management patterns are still applicable at the present time. Fishing gear is conveniently divided into two broad categories based on the method of capturing fish: wounded, trapped, and a combination of wounded & trapped gears. The total fishing gears recorded during study were seventeen (17) with two poison plant this agree with (Hussein. *et al.*, 2010) he stated that traditional fishing gears type in Gambella region are more than 15 and diversified in season, method of fishing and material made it and in contrast with (Hussein. *et al.,* 2010) he stated that nevertheless the use of either natural and artificial poison for fishing is not practiced.

Destructive fishing gears there is some traditional fishing gears that cause major destruction on fish like Bøøyi which applied fishing at breeding site and poison plant that agree with (Luomba j *et, al.*, 2016) who report two most damaging fishing-related activities, on Lake Victoria. The use of non-selective fishing gear and fishing in breeding areas and disagrees with (Sebastian. *et, al.*, 2016) from his study on fishing method, use of indigenous knowledge, and traditional practices in fisheries management of lake kolleru there is no evidence of destructive fishing gears and poisonous plants fishing has well-known fishes' species destruction in the world from different fish size and shape.

While the indigenous knowledge on fishing activities actually was poor in case of both three measurements, sharing indigenous knowledge on fishing activities among the communities' members, Existence and format of IK on management and conservation of fishing practices, and Sharing of indigenous knowledge of fishing practices it would reflect the result on the barrier to the management of indigenous knowledge of fisheries activities which show the highest impact on indigenous knowledge on fishing activities, might be due to impact of introducing modern fishing gears and lack of awareness to indigenous people about the importance of indigenous knowledge as a source modern knowledge, so here indigenous knowledge not recognize as grassroots for nowadays knowledge. Agree with (Senanayake, 2006) Most of the indigenous knowledge disappears due to the intrusion of foreign technologies and development concepts that promise short-term gains or solutions to problems without being capable of sustaining them.

Fishing tool making, preservation, and fish processing are the type of indigenous knowledge which are difficult to transfer manage them. The future of indigenous knowledge on fishing activities is on the way to lose due to the impact of modern fishing gears so it needs awareness creation in the communities to keep their importance indigenous knowledge of fishing activities and their traditional fishing gears and prevent the other which harmful for fishing. Agree with (Bruchac, 2014) Western practitioners posed a serious threat to the integrity of Indigenous cultural traditions and territory, by regarding them as public scientific property. Archaeologists conducted investigations in destructive and ethically questionable ways. The damage included: theft of cultural property; imposition of nationalist ideologies; interference with traditional activities; damage to local ecosystems; and general disrespect for Indigenous culture and property.

Chapter Six

6. Conclusion and Recommendation

6.1 Conclusion

A total of 768 fish specimens were recorded from the twelve families *Alestidae, Cyprinidae, Protopteridae, Osteoglossidae, Gymnarchidae, Mormyridae, Anabantidae, Cichlidae, Latidae, Polypteridae, Clariidae,* and *Mockokidae* during the study period. The species were *C. garipenus* (28%) from the family *Clariidae, H. niloticus* (18.1%) from the family *Osteoglossidae, P. bichir*, and *P senegalus* (15.2%) from the family *Polypteridae G. niloticus* (7.8%) from the family *Gymnarchidae, S. schall* and *S. filamentous* (6.4%) from the family *Mockokidae, M. kannume* (5.5%) from the family *Mormyridae, B. nurse* (5.2%) from the family *Alestidae, O. niloticus* (4.7%) from the family *Cichlidae, P. aethiopicus* (3.5%) from the family *Protopteridae, Ct. muriei* (3.3%) from the family *Anabantidae, L. niloticus* (1.7%) from the family *Cyprinidae* and *L. niloticus* (0.6%) from the family *Latidae.* The study reveals that there is existing high diversity of fish species in the study area with Shannon-Wiener diversity index (H'=2.24).

The present study also concludes that the ichthyofaunal resources of the Gilo River are an important component of the river's biodiversity and are an important source of food and income for fishermen communities. From the present study, there are some destructive fishing gears in this area, like Basketball net-like (Bøøyi) and the use of poison plants. Fishermen on Gilo River were using indigenous methods for fishing which is greatly contributing to the sustainability of the Riverine fishery. The overall results revealed that the indigenous knowledge on fishing activities was poor by saying like this is not mean that people does not used indigenous knowledge on fishing practices but, it might be due to impact of introducing modern fishing gears and lack of awareness to indigenous people about the importance of indigenous knowledge, whereas conservation of indigenous knowledge along with the introduction of technical knowledge can lead to overall growth and development of the fisheries sector of the area.

6.2 Recommendation

- Research programmed on ichthyofaunal diversity study and improvement of indigenous knowledge method of fishing should be initiated immediately.
- The concerned stakeholder should develop awareness creation that improves quality and care of Fish diversity and indigenous knowledge on fishing activities.
- The concerned stakeholder should take care of indigenous knowledge on fishing activities as a source of knowledge and so that they should be giving training to local fishermen to keep their knowledge in work and prevent the other gears that cause the destruction on fish.
- A seminar program should be organized on the merits and demerits of different indigenous fishing methods to select the most appropriate method and the importance of fish diversity conservation and socio-economic development of the native fishermen.

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Appendix 1a: Questionnaire in English

Personal Information

1. Gender: Male ☐ Female ☐
2. Age 18-30 ☐ 31-40 ☐ 41.50 ☐ Above 50 ☐
3. Marital status: singled ☐ Married ☐ Divorced ☐ Other ☐
4. Educational level: Illiterate ☐ Elementary school ☐ high scho☐

   Other, please specify.....

IK on fisheries

1. Are you aware about practitioners who possess good IK on fishing?

   Yes ☐ No ☐
2. How is their acceptance by the community members?
3. How can you best describe the value that IK adds to the practices?
4. How do traditional fishing practices relate to the socio-cultural values, economy of the community?
5. Is the knowledge behind the practice known to all members of the community or only to few individuals?
6. How is the knowledge behind the practice transmitted within communities (between members, between generations)?
7. Do you share IK of fishing activities from the communities?

   Yes ☐ No ☐
8. If question #7 is yes, by what means is used? (Please explain the strategies used).
9. If question #7 is NO, what are the reasons?
10. Which tools do you use for fishing activities? Please list them _____

11. Is it easy to operate/use them?

12. Are their risks associated to using these fishing tools? Yes/No

13. If yes, what are the risks?

    Please list them: _____, _____

14. Are they effective? Yes/No

15. Do you want to continue using these tools? Yes/No

16. If No, why? Please state _____

17. What are the traditional ways of post-fishing practices used to preserve the fish?

18. For how long can you preserve using these techniques?

19. Are they effective? Yes/no

To determine the nature and other Riverine fishery activities in study area

20. What problems do you face in this area when fishing? _____

21. How do you solve when facing such problems using IK? _____

22. How do you avoid over fishing using IK?

23. What will you do when you catch small fish?

24. What about when you catch a ready to spawn fish?

25. Do you fish at the breeding site of the fish?

26. Is there a special time of the day/year to go fishing/not to go fishing?

27. Why do you prefer the time/season for fishing? _____

28. Is there a concern about the sustainable use of the resources? Yes/No

29. If yes, what is/are the solution which is a traditional way? _____

30. Is there a regulation that the community is abide by to avoid overfishing? Yes/No

31. If yes please list them _____

32. Do you think that there are traditional fishing method/tool that is a threat to sustainable fishing of the river? Yes/No
33. If yes please list them _____
34. What is the trend of IK of fishing practices/activities in the community? Increasing/decreasing
35. What is the reason for it to increase?
36. What is the reason for it to decrease?
37. What is/are the advantage of IK fishing methods compared to modern fishing methods?
38. Why do you prefer IK over modern fishing methods or vice-versa?
39. What is/are the reasons in either case? _____
40. Do the younger generations use IK for fishing?
41. Is the trend of their acceptance of IK increasing or decreasing?
42. Can you give reason why it is increasing/decreasing?

The management of indigenous knowledge of fishing activities by the local communities

1. Are you aware about fishermen who manage indigenous knowledge?

   Yes [ ] No [ ] don't know
2. If yes, which age group and why? How is their acceptance by the community members?
3. Do you learn about indigenous knowledge from those individuals?

   [ ] Yes [ ] No [ ]

   If No, what are the reasons?
4. Which type of indigenous knowledge of fishing activities are difficult to transfer/manage?

   1= [] fishing tool making 2= [] Fishing 3 = Preservation []

4 = Fish processing [] 5= [] Other, please specify _____

5. What do you think is the future of IK of fishing activities _____?

The sharing of Indigenous knowledge of fishing activities among the community members

- ✓ **Please rate the following items.**

		Strongly Agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
1	IK is accessed and used easily by the local communities					
2	There is a forum for IK sharing, like face to face (example, meeting)					
3	IK is shared informally at individual level					
4	Everybody is interested to share IK					
5	Old and knowledgeable people in the community feels responsible to share IK					
6	No one is concerned to share IK					
7	Younger generations are learning about IK from the elders with interest					
8	The negative impact of modernization/technology on sharing IK is high					

Barriers to management of IK of fisheries activities

	Problem	**Strongly Agree**	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
1	Poor knowledge sharing culture					
2	Poor recognition of IK					
3	Lack of IK records					
4	Lack of trust					
5	No interest to receive IK by younger generation					
6	Oral transfer of IK					
7	Change of life style					

Existence and format of IK on management and conservation of fishing practices

Please indicate your answer for the following statements by ticking (√) in the appropriate column.

Thus, 1= strongly disagree, 2 = Disagree, 3 =Neutral, 4 = Agree, 5 = strongly agree

S.No.	Statement	1	2	3	4	5
1	There is different IK on management and preservation of fishing activities					
2	IK on management and preservation of fishing activities is available in tacit form					
3	IK on management and preservation of fishing activities is available in explicit form					
4	IK on management and preservation of fishing activities is important and should be documented					

Sharing of indigenous knowledge of fishing practices

Please indicate your answer for the following statements by ticking (√) in the appropriate column.

Thus, 1= strongly disagree, 2 = Disagree, 3 =Neutral, 4 = Agree, 5 = strongly agree

S.No.	Statement	1	2	3	4	5
1	Sharing of IK of fishing activities is important and giving attention by the community					
2	Telling about IK to younger generation is important					
3	New generation is willing to learn from elders					
4	Elders are willing to transfer their IK					
5	There is community host events where elders get a chance to share their IK/ There is a forum to exchange IK					
6	Sharing IK on preservation and management of fishing is well practiced in the community					
7	There are different IK sharing mechanisms of fishing practices in the community					

Appendix 1b: Questionnaire in local language

A, Pïëc kiper kwäännö

❖**Bëët ngato opëënynyi**

1, Ngïï. Cwøw. Dhak.

2, Cwiiri. 18-30. 31-40. 41-50. 50 ki maal.

3, Nyuöm. Kir nyöömö. Onyöömö. Geno opää.

4, Göör, Kir göödö Ogöödô 1-4 Ogöödö 5-8. Ogöödö 9-12. Ki møøk nø

❖ **Kwäänynyö mana dikwøng bäät bïth (maay) rec.**

1, Yi met ki man caanni gø jï jiy kiper man bïth rec ki jöö mo beer?

Kare Pathakare

2, Jïëc made nyïëdï ki bang jø paac?

3, Caanni gø nidïï køny mar kwänynyö mar bïth mana dikwøng ki jöö man kïthï bäät tïïc ki gø?

4, Yi jöör maay (bïth) rec mana dikwøng gääbë ki kööngngö, ki kwäärö mar jø paac nidïï?

5, kwäänyö mar maay(bïth) rec ngäc jø paac wala ngääya jiy no nøk?

6, kwäänyö mar maay(bïth) rec kwaayi nidïï yïtha kic jiy?

(yïtha kiic jiy keerge wala yïtha kiic beenhe)

7, Løny ki man caanni yi jöör maay (bïth) rec mana dikwøng yïtha kiic jiy?

Kare Pathakare

8, Ninäk mo pïëc mar raa 7 Kare A ki jöö no nyïëdï noo kønyi dëëri kigø caanni?

9, Ninäk mo pïëc mar raa 7 Pathakare A kiperngø caanni?

10, Ajap maay mwoe okønyi dëëri kige kanyo omääy cøør nyengge?

11, Jööt ki man køny dëël ki ge?

12, Dagïï mo riiyø mo tägö kanyo køny dëël kige?

13, Ninäk mo dagø, age gïïa riiyø, caar ge?

14, Ge tïïö ni beer?

15, Yi maanyø new bëëdë ni dëël dikønynyø ki jap maay mwøgø?

16, Ninäk mo raac, a kiperngø? Caanni

17, A jöö mo nyïëdï no otïïc køør maay rec nee ba räänyge (kwääkge)?

18, A kiperngø kany mo nyïëdï new rec ba räänyge (kwääkge)?

19, Ge tïïö ni beer?

20, Agïnë ni raac ni jwøri kanya määy?

21, Yi tiirø ki jöö mo nyïëdï kanya jwøri gïïa leth ni pïï bäät kanya kønyi dëëri ki jöör maay mana dikwøng?

22, A jöö mo nyïëdï ni omänö näk rec mo opöödhö kigø kanyo kønyi dëëri ki jöör maay mana dikwøng?

23, Agïne no tïï Ninäk mo yïnö omägö ki rëëö mo thiinh?

24, A ninäk mo yïno määgö ki rëëö mo mar cään ki nywøl agïne noo tïï?

25, Løny ki man bïdhï(maay) kar nywøl mar rec?

26, Dicaae mo opää nïne wala dwääde mo jøw bïthø ki rec wala mo jøw ba ci bang bïth rec yie?

27, A kiperngø ni dee caae wala dwäädë kiper bïth rec?

28, Jøw ocäännö kiper man køny dëël ki jap kwäärö ki jöö mo beer?

29, Ninäk mo Kare, age jöö man kønyge dëëtge kigø?

30, Di ciik mo ocïp jø-paac piny mo mäna bïth rec ki jöö mo raac?

31, Ninäk mo dagø, caanni piny many?

32, Jap maay mwoa acäängngë dagø mo räänyö kanyo bïdhö ki rec?

33, Ninäk mo dagø cøør nyengge?

34, Yi jöör bïth rec mana dikwøng bang jø-paac nyïëdï omëëtö wala odøpiny?

35, A kiperngø ni mëëtë?

36, A kiperngø ni døpiny?

37, Køny mar kwäänyö mar maay mana dikwøng nyïdïï noo pääri gø ki mar ennø?

38, A kiperngø ni tumë ni jiera kwäänyö mar maay mana dikwøng bäät mar ennø wala maay mar ennø bäät mana dikwøng?

39, A kiperngø caanni ki løøi ki løøi?

40, Obwöre mo nïrï dëëtge kønyge køny ki jöör maay mana dikwøng?

41, Jïëy marge bäät jöör maay mana dikwøng nyïëdï omëëtö wala odøpiny?

42, Løny man caanni tiere a kiperngø ni mëëtë wala ni døpiny?

- **Kädö mar kwäänyö mana dikwøng bäät bïth rec bang jø-paac**.

1, Jïrï Di wödö kiper ngato gwøk maay rec ki jöör kwäänyö mana dikwøng?

2, Ninäk mo Kare A cwiiri mwoe a kiperngø, jïëc marge nyïëdï ki bang jø-paac?

3, Yï kwäänynya bang jø gø ki jöör bïth rec mana dikwøng? nee Pathakare a kiperngø caanni

4, Yi jöör kwäänyö mar jø-paac Mar maay rec amane ni teek ki man caanni wala ki gwøk?

1: - tïïc jap maay 2: - maay 3: - göök mar rec 4: - jieng rec 5: - mør nee dagø caanni

5, Nee di gïn mør kiper kwäänyö mar bïth rec mana dikwøng caanni?

❖ **Jöö mano ö jø-paac ocäänge bäät maay rec yïtha kir ge keerge**

- ✓ Kwøc jappi ni piny kany en

Kwäänö	Pïëc	A jïï døc	Ajïï	Ena dïër	akweer	Akweer døc
1	Kwäänynyö mar maay mana dikwøng dwøng ni jööt man ö jø-paac okønyge dëëtge kigø?					
2	Dikar pïïn pïny yïtha kiic jiy mo løny man cäännö ni pwunynya røk ki jöör maay mana dikwøng?					
3	Kwäänynyö mana dikwøng caan yïtha kiic jiy no okanø?					
4	Jiy bëët yïthge met ki man caange kwäänynyö mana dikwøng jï jiy?					
5	jø-døøngngø ki jiy moa näk jöör kwäänynyö mar maay mana dikwøng ngäc yïthge met man nywakge gø ki jiy?					
6	Bäng dhaanhø mo yie met man caan gø jï jiy?					
7	Jiy moa thirø jöör maay mana dikwøng kwaanyge bang jø-døøngngø ni yïth met ki gø?					
8	Räänyö mar kwäänynyö mana nyään dwøng bäät kwäänynyö mar maay mana dikwøng?					

❖ **Jap oräänynyö ki kädö mar jöör kwäänynyö mana dikwøng mar bïth rec**

Kwäänö	Jap oräänynyö	A jïï døc	Ajïï	Ena dïër	akweer	Akweer døc
1	Bäng Kwäänynyö man caan kööngngö jï jiy?					
2	Bäng ngic Kwäänynyö mana dikwøng mar bïth rec?					
3	Bäng göör Kwäänynyö mana dikwøng piny?					
4	Bäng ngääth kwäänynyö mana dikwøng jï jiy?					
5	Bäng met ec jï obwörë mwoa thirø man kwaanyge kwäänynyö mar maay mana dikwøng?					
6	Caan Kwäänynyö mana dikwøng ki dhøk jaak?					
7	Wïïdö mar bëëtö?					

- **Nut mar kwäänynyö mana dikwøng mar maay rec ki jöö mano okääri gø ki göök mare**
    - ✓ Caan mana näk kare mana jieri o kwøyyi gø ya acanduk man ni piny kany en

Beeye 1=Akweer døc 2= Akweer 3=Ena dïër 4=Ajïï 5=Ajïï døc

Kwäänö	Gïna can	1	2	3	4	5
1	Da nying jïëthë mo opää mo løny man ö jiy okäärge kwäänynyö ki göök mar maay mana dikwøng kigø					
2	Kädö ki göök mar kwäänynyö mana dikwøng mar bïth rec nut ni kir caannø ni beer					
3	Kädö ki göök mar kwäänynyö mana dikwøng mar bïth rec nut no ocaannø ni beer					
4	Kädö ki göök mar kwäänynyö mana dikwøng mar bïth rec beer ni manynya man göori piny					

❖ **Caan jöör maay rec mana dikwøng jï jiy**

- ✓ Caan mana näk kare mana jieri o kwøyyi gø ya acanduk man ni piny kany en

Beeye 1=Akweer døc 2= Akweer 3=Ena dïër 4=Ajïï 5=Ajïï døc

Kwäänö	Gïna caan	1	2	3	4	5
1	Man caan kwäänynyö mar bïth rec mana dikwøng beeye gïr piny mo beer ni jø-paac yïthge met ki gø					
2	caan kwäänynyö mana dikwøng mar bïth rec jï-obwörë beeye gïr piny mo beer					
3	obwörë yïthge met ki man kwäänyge ki bang jø-døøngngø					
4	jø-døøngngø yïthge met ki man caan ge jöör kwäänynyö mana dikwøng mar bïth rec					
5	Di kany jiy gääbö yie mo løny man ö jø-døøngngø ocäänge jiy ki jöör kwäänynyö mana dikwøng mar bïth rec					
6	Kädö ki göök mar maay rec mana dikwøng jø-paac dëëtge kønyge kønynyø ki gø ni beer					
7	Di jïëthë mo opää mo jø-paac rige wïnyge wïnynyö kipper maay rec					

Appendix 2: Focus Group Discussion

Types of IK gear used for fishing activities in the selected local community

1) Please list the types of IK gear carryout fishing activities in the local communities?
2) Do you have the indigenous/traditional way of classification gear of local area? Why? How?
3) What is the source of local gear in your local area? How do you use/conserve it?
4) When do you engage in fishing activities, every times? Seasonally?

IK sharing practices mechanisms in the rural communities

1) From where/whom do you acquire IK practices of fishing activities?
2) When do you use IK practices of fishing activities? Why?
3) What are the sustainable ways of preservations of IK practices of fishing activities against all odds (challenges)?
4) How did you acquire IK practices from the past generation and how do you transfer it? What are the differences and similarities?
5) What are the differences and similarities of IK practices on fishing activities in the past and at the present?
6) According to your view what is the future of IK practices on fishing activities in your community

Perception of IK on fishing activities

1) What is the contribution of IK on fishing activities in your community?
2) What is the attitude of your community on IK of fishing activities?
3) What are your experiences on IK practices on fishing activities?
4) What are the practices that were done before and not done any more on fishing activities? If any what is the reason(s)?
5) What are your expectations from IK practices on fishing activities?
6) What is IK practice on fishing activities perceived in your community? By older people and by younger ones… Is there a difference in perceiving IK?
7) Any additional view/comments _____

Appendix 3: Observation checklist

Information about the local community

Site _____

Fishing practices

Traditional tools used for fishing

Traditional methods used for fishing

How and from what materials they make the tools

How they use the tools

Indigenous knowledge practices

IK fishing practice availability

IK fishing practice indicators

Cultural implication for IK fishing practices

Constraints to IK fishing practices

Post-fishing activities

Materials used to process the fish

Tools used to store the fish in

What they do or add to preserve the fish

How they consume/prepare the fish

What other ingredients they add to the fish when preparing

Fishing environment

Vegetation type

Substrate at fishing sites

Natural environment of the fish processing site

Animal types at fishing site

Sanitation of materials used for fishing activities

Fish species captured

Size of the fish captured (big, small)

What action the fishermen do when they capture small size fish

Any harmful practices to the resources

Any other significant observable activities

Appendix 4: Fishes species availability from five sample site study area within three (3) day

Species	Twuo			Shenthoa			Gony			Tho			Othwol			
	D1	D2	D3	D1	D2	D3	D1	D2	D3	D1	D2	D3	D1	D2	D3	Total
C.garipenus	11	12	15	7	4	8	20	9	9	24	23	18	19	21	15	215
H. niloticus	7	11	9	3	2	5	18	7	6	11	9	17	18	0	16	139
G. niloticus	6	7	1	3	2	3	5	2	1	5	4	7	5	5	4	60
P. bichir	7	3	9	1	1	1	19	4	2	4	7	10	7	0	6	81
P. senegalus	10	0	0	0	0	1	15	0	0	0	0	5	0	5	0	36
O. niloticus	6	7	0	12	0	0	0	0	0	0	0	0	2	9	0	36
B. nurse	0	0	0	9	6	12	0	0	0	1	0	4	1	4	3	40
S. schall	7	0	0	2	0	0	5	0	0	3	0	6	5	4	5	37
S. filamentous	0	2	0	5	0	0	0	5	0	0	0	0	0	0	0	12
M.kannume	3	2	4	2	0	0	12	1	0	0	5	0	4	3	6	42
Ct. muriei	0	3	0	6	5	7	0	3	1	0	0	0	0	0	0	25
L.niloticus	0	0	2	0	5	3	0	0	3	0	0	0	0	0	0	13
P. aethiopicus	1	4	3	0	2	0	5	1	0	3	1	4	2	0	1	27
Lates.niloticus	1	0	1	0	0	0	0	0	0	1	0	0	0	1	1	5
Grand total	59	51	44	50	27	40	99	32	22	52	49	71	62	53	57	768

Appendix: 5. Species diversity index in different study sites

Species	Twuo	Shenthoa	Gony	Tho	Othwol
C.garipenus	38	19	38	65	55
H. niloticus	27	10	31	37	34
G. niloticus	14	8	8	16	14
P. bichir	19	3	25	21	13
P. senegalus	10	1	15	5	5
O. niloticus	13	12	-	-	11
B. nurse	-	27	-	5	8
S. schall	7	2	5	9	14
S. filamentous	2	5	5	-	-
M.kannume	9	2	13	5	13
Ct. muriei	3	18	4	-	-
L.niloticus	2	8	3	-	-
P. aethiopicus	8	2	6	8	3
Lates.niloticus	2	-	-	1	2
N	154	117	153	172	172
H	2.22	2.21	2.08	1.81	2.03