FACTORS INFLUENCING CHOICE OF FISHING LOCATION IN NANKUMBA PENINSULA: A Case of Study of Gillnet and Chilimira fisheries

BY

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THESIS SUBMITTED TO THE FACULTY OF ENVIRONMENTAL SCIENCES IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE MASTER OF SCIENCE DEGREE IN AQUACULTURE AND FISHERIES SCIENCE

UNIVERSITY OF MALAŴI

BUNDA COLLEGE OF AGRICULTURE

AUGUST 2009

DECLARATION

I, **Mvula Thosi Wales Stanley**, declare that this thesis is a result of my tireless effort and that the findings presented herein have never been presented to the University of Malaŵi and/or elsewhere for the award of an academic qualification. Where other sources of information have been used, acknowledgement has been made by means of references.

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CERTIFICATE OF APPROVAL

We hereby declare that this thesis is a result of the student's own effort and that it has been submitted with our approval to the University of Malaŵi as a partial fulfillment for the award of the degree of Master of Science in Aquaculture and Fisheries Science (Natural Resource and Environmental Economics).

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DEDICATION

This thesis is dedicated to God Almighty; your love never ceases to amaze me.

To all artisanal fishers in Malaŵi.

To my mum and all relatives for their love, care and support.

ACKNOWLEDGEMENT

So many individuals in various institutions have supported and helped me during the process of conducting this study, such that it may not be possible to mention you all by name. My most sincere gratitude goes to Assoc. Prof E.K.W. Kaunda, Dr. T.O. Nakhumwa, Mr. F. Njaya and Mr. F. Maguza-Tembo for the unique way in which they guided and helped me to bring out this work to its present level. My profound gratitude also goes out to all artisanal fishers and people in the research sites that gave their time and freely and willingly gave information. I would like to thank the local leaders that welcomed my team and made us feel at home, anytime we worked in their areas. Gratitude also goes to Dr. G.G. Matiya, Dr. S. Khaila and Professor Ng'ong'ola for their patience in reading the manuscript.

From the Department of Fisheries a number of people helped in a number of ways. At the Fisheries Research Unit in Monkey-bay, I would like to thank Dr. M.M. Banda, Mr. G. Kanyerere, Mr. Mhango and the Library Assistant. The Fisheries Assistants in all the sites also proved to be helpful to the team. I also would like to thank Mr. Nkhoma, Mr. Sodzapanja, Mr. Maulidi and Mr. Mataka for being such a wonderful and cooperative research team who shouldered the labour of interviewing the fishers and other people who were the focus of this research. In Institute of Fisheries Management and Coastal Communities Development (IFM), Denmark, I would like to acknowledge Ms. Anne Sofie-Christensen for providing me with publications that helped to shape this research.

Gratitude goes to the library staff at Bunda College who provided prompt services regarding literature. My fellow MSc. Students; Alexander Kefi and Albert Nsonga (Zambia), Elizabeth Ndivayele (Namibia), Godfrey Kubiriza (Uganda), Moses Limuwa, Petros Chigwechokha, Horace Phiri, Madalitso Tsakama and Dalo Njera (Malawi), it was a pleasure and experience to have acquainted with you all.

Last but by no means least, I would like to thank in a special way Ms. Lusungu Sinda for being a source of inspiration and encouragement throughout the entire period of my studies. I am greatly indebted to Icelandic International Development Agency (ICEIDA) for the financial support rendered to me. Thank you very much.

ABSTRACT

This study was carried out to identify factors that influence choice of fishing location and carry out profitability analysis of Chilimira and Gillnet in different fishing locations. A survey using semi-structured questionnaire was administered to 99 Gillnet and 101 Chilimira fishers in Nankumba Peninsula in Mangochi District. The logit model was used to determine the factors influencing choice of fishing location among the fishers. The study showed that 92.1% of Chilimira fishers are operating in offshore areas while 69.7% Gillnet fishers are operating in inshore areas. Chilimira offshore fishers have higher daily average gross margins than their inshore counterparts and Gillnet fishers. However, they incurred more operating costs than the inshore Chilimira and Gillnet fishers. Furthermore, they find their fishing occupation more rewarding as evidenced by the higher returns to labour. The factors that influenced fisher's choice of fishing location were Age of the fisher, type of fishing vessel and gear, possession of motor sail engine and access to information about previous day's catch rates. Finally the study concluded that artisanal fishers in Malawi use different criteria in deciding where to fish. The criterion involves a complex interaction of biological, technological, personal and economical factors and time. However, the resource constrained artisanal fisher will need support to enable him exploit offshore fishery resources. Consequently the study recommends that appropriate fishery development interventions by the government and other stakeholders must adapt to the economics and lifestyles driving the artisanal fishers to fish in particular locations and therefore, build on this foundation to improve the existing fishing technologies.

"Any system is a set of interrelated components. In a fishery system, one of the primary, most dynamic components of the system are the people and their behaviours." Orbach (1980: p. 149)

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CHAPTER ONE

INTRODUCTION

Fishing has been one of the major economic activities of human beings since ancient times. Although it may today be a small sector of the world economy (Food and Agriculture Organisation, 1991), it is making an ever-growing contribution to supplies of food, employment, income and well-being of coastal, riverside and lakeside communities (Tvedten and Hersoug 1992, Pomeroy and Williams 1994, Friedman 1998). The inland fisheries in Africa provide a major source of subsistence and income in many countries including Malawi. The fisheries sector in Malawi plays an important role to Malawi's population, currently estimated at 11 million people. Recent studies in the rural areas on the shores of Lake Malawi have highlighted the fact that the fisheries sector is one of the few economic activities that generate economic gain hence playing a vital role. Agriculture comparatively, in many of these areas is underdeveloped and has been problematic due to limited farming inputs, (Townsley, 1998). In Malawi, the small scale fishery contributes over 90% of total landings in Lake Malawi (Ngochera, 1999).

Small-scale fisheries dominate in many developing countries and contribute more than 25% of the world catch [Food and Agriculture Organization (FAO) 2001]: Through mechanization, modernization and use of fabricated materials, small-scale fisheries have grown rapidly. Uncontrolled rapid expansion of small-scale fisheries has led to problems of overcapacity and over fishing; hence there is need to reduce excessive effort. Fisheries productivity has decreased causing poverty among small-scale fishers (Berkes, Mahon, McConney, Pollnac & Pomeroy 2001).

Small-scale fisheries, especially in tropical coastal waters, are characterized by great spatial-temporal variation, high diversity of gears and target species, wide dispersal of fishing activities along the coast, and uncertainty of landings (van Oostenbrugge, Bakker, van Densen, Machiels & van Zwieten 2002). This makes fisheries management complex and difficult (Pauly 1979; Food and Agriculture Organisation, 1994).

Multi-species – multi-gear fisheries that use a wide diversity of gears to capture a diversity of species, involve complex interactions between the technology used, the fishing grounds targeted (Rijnsdorp, van Mourik Broekman & Visser 2000b) and the resources exploited (Ulrich, Gascuel, Dunn, Le Gallic & Dintheer 2001). Hence, measurement of fisher behaviour in allocating effort in small scale coastal fisheries is important to management. Major problems in the analysis of effort dynamics are determined by how fishers adapt their effort to changes in external factors (Hilborn & Walters 1992; van Oostenbrugge, van Densen & Machiels 2001; Ulrich et al. 2001), and competition between fishers (Jennings, Kaiser & Reynolds 2001).

For efficient utilization of fisheries resources, to achieve economic, social and nutritional benefits, governments and scholars have been working both on the development and management of the sector. Most attention is being paid to management issues due to overexploitation of the resources (Gordon 1954, Hardin 1968, Emerson 1980, Young 1999). While most of the highly valuable stocks of fish in the world are actively fished,

there are still unutilized resources and resources that have very low exploitation rates (Anderson 1986).

Specifically, under-exploitation of fisheries resources is prevalent in some developing countries. The main reason for this is that, most of the fishermen in these countries operate under small-scale or artisanal fishing activities. Small-scale fisheries are virtually the sole suppliers of fish protein to several hundred millions of people in these countries. However, the rate of supply is still low when compared with the demand for fish. Recent studies on the fisheries of Southeast Asian countries show that there is some potential to develop new fisheries and expand currently under-exploited resources in the region (Limpus, 2001).

Nevertheless, great care needs to be taken for sustainable use of the available resources before these resources are also vulnerable to the problem of overexploitation. A number of articles written on this subject discuss development strategies, problems and management issues of African and Asian artisanal fisheries (Lawson 1980 and 1984, Lindqvist and Molsa 1992); however, few studies have focused on the factors regarding the fisher allocation of fishing effort with reference to small scale fisheries.

1.1 The Importance of Fisher Behaviour in the Context of Effort Allocation

Most research in fisheries economics has focused on longer term, investment type of decisions, particularly related to entry or exit. For the most part, economists have not paid much attention to the shorter-run decisions made in the fishery. In reality, fishers face a range of choices continuously, just as do decision makers in more conventional occupations. For example, at various points within a season, fishers must decide which species to target and whether to change gear or not. For example, Chilimira fishers during certain times of the fishing season must decide whether to engage in Kauni (light attraction) fishing or not, the consequences are that target species also differ. During kauni fishing they target *Engraulicypris sardella* while during the other times they target *Copadichromis spp* as earlier on noted by Hara, (2003). Bockstael (1977) and Bockstael and Opaluch (1983) examined species choice decisions in New England fisheries and found that fishers respond, although with some sluggishness, to changes in expected profit opportunities. Where a fishery involves two or more groups of participants, models involving game theory have been suggested for allocation of quotas (Sumaila, 1995; 1999).

Once gear and target species have been chosen, fishers face subsequent decisions regarding whether to fish in a given day and if so, where to fish. In many fisheries, this decision is the most critical decision and one on which a fisher is identified as a bad or good entrepreneur. Surprisingly, there has not been much analysis of the location-choice decision process except by a few sociologists who are interested in group dynamics (Orbach, 1977; Gatewood, 1983; Eales and Wilen, 1986) and anthropologists (Acheson,

1981). The general lack of interest by economists in the broader spectrum of fishermen decision making has several consequences that go beyond the academic arena.

This is because the open access inefficiency problem cuts across all aspects of decision making in fisheries, not simply the longer run entry/exit decisions. It is conceivable, for example, that a large portion of the real resource rents that are dissipated may be due to inefficient species targeting, loss of quality, or excess effort expended in searching activities, rather than on excess number of boats per se. A better understanding of the whole process of decision making behaviour would help in pinpointing policies that might improve efficiencies associated with the common property nature of fishing. This study therefore, examines short run decision making behaviour among artisanal fishers where fishing location is the central issue. The analysis is aimed at examining the various factors (fisher specific and technological characteristics) that influence the choice of fishing location. This is followed by a daily profitability analysis that seeks to establish the economic profiles of the Gillnet and Chilimira fisheries in Nankumba Peninsula.

1.2 Problem Statement

The fish stocks of Malawian waters are, undoubtedly among the most important natural resources of Malawi. Out of the 120,000-km^2 area covered by Malawi, 20% is water (Weyl, 2001). There is therefore little doubt that a large number of Malawi's population depends directly or indirectly on the fishery as a source of food security, livelihood and income. The value of fish does not lie only in their scientific interest, but also in their primordial nutritional status. Malawian small scale fishery is the main economic activity

of the lakeshore people. This sector is mostly characterized by an open access regime in some areas where there is crowding of effort in the inshore waters while in other areas there are informal controls restricting outsiders from accessing a particular fishing area (Hara, 2006). This, in part, has been attributed to the lack of technical skills and capital on the fishermen side to explore beyond the inshore waters. Furthermore, the overall relative fish prices have risen significantly faster than the prices of other goods agricultural commodities, which has attracted more effort. Fishermen, like any other economic agents, are driven by the profit maximization objective at least in the short run (Conrad and Clark, 1987). Therefore, fishermen and fishing efforts have increased in the inshore waters in response to the lower barriers of entry and the high prices of fish (profitability) on the market.

For effective development of artisanal fisheries, special consideration must first be placed on understanding their behaviour and economic perspectives to provide an insight into their fishing effort and resource allocation as economic agents (Habteyonas and Scrimgeour, 2001). The decision of where to fish is central to artisanal fishing activity. Fishers targeting the same species typically have dramatically different net returns depending on their fishing location choice (Mistiaen and Strand, 2000). Beliefs about profitability of different locations are most important determinants of fishing location choice in artisanal fishing, however, they are unobservable. This implies that fishers, sometimes rely on their instincts in determining where to fish. Differences in profitability are driven, in part, by spatial heterogeneity of the resource (Smith, 2000). In artisanal fisheries, fishers make individual discrete fishing location choices among various

available alternatives during the fishing trip on a daily basis. This study, therefore, addresses the connections that bridge factors that influence choice of fishing location behaviour and profitability of the chosen location where the artisanal fishers normally operate, using the two prominent fishing gears (Chilimira and Gillnet).

1.3 Justification

The artisanal fisheries of Malawi constitute an important socioeconomic component of the Malawian lakeshore communities, currently the fishery employs 55, 296 fishers (Banda *et al*., 2005). The two major problems confronting the Malawian fisheries sector are: i) overexploitation of the inshore fishery stocks and ii) lack of resources and capacity to target proven offshore stocks (SOFTDP, 2005). Overexploitation is a complex issue and is certainly due to a combination of factors including excessive fishing effort and choice of fishing location among others. Information about the choice of fishing location and the subsequent factors provide insights about the fishers' allocation of effort, their reaction to fishery management plans and successful stewardship of the fishery resources. More than 90 percent of the catch in Lake Malawi is landed by the artisanal fisheries sector; and it is estimated that about 250,000 to 300,000 people from the primary and secondary sectors depend on the fisheries industry (Ngochera, 1999).In Malawi, there are various types of fishing crafts and gears used in the small-scale fishery that exploit a variety of resource fronts. Different technologies used by the artisanal fishers' exhibit different labour demand, capital investment and fuel demands. As a result, different technologies display different levels of profitability. Despite the important role played by the artisanal fisheries in the Malawi economy, regarding its high contribution to the

overall landings, the economics driving the artisanal fishers are not well documented (Management priorities for Lake Malombe workshop report, 2001).

Though the artisanal fisheries have experienced declining catches, it is surprising that as economic agents with profit maximisation objective (Conrad & Clark 1987) have not shifted their operation away from inshore to offshore waters. The artisanal fishers continue to fish in the already overexploited inshore waters, using the same gears. Therefore, it is important and timely to examine the economics driving the artisanal fisheries and to determine the factors influencing choice of fishing location. Such information will provide insights into understanding the behaviour of the artisanal fishers and provide for informed policy formulation.

1.4 Objectives

1.4.1 Main Objective

- The objective of the study was to investigate how economics of fishing (profitability) influence decisions about fishing location through economic profiles of two of the most important artisanal fishing gears in Malawi.

1.4.2 Specific Objectives

1) To determine the key factors influencing the choice of fishing location in artisanal fisheries.
2) To assess and compare profitability of artisanal fishing operations between gillnet and chilimira fishing gears.

1.5 Hypotheses

- There is no relationship between the following factors and fishers' choice of fishing location.
    - Age of the fisher
    - Fishing experience of the fisher
    - Access to information by the crew leader
    - Availability of fish
    - Type of Fishing Vessel
    - Possession of an engine
    - Type of Fishing gear used by the fisher
- There are no significant differences in profitability between fishers using Chilimira and Gillnet fishing gears in Nankumba Peninsula.

CHAPTER TWO

LITERATURE REVIEW

This chapter reviews the factors influencing artisanal fishers' choice of fishing location. The characteristics and economics involved in artisanal fishery operations are also discussed. Finally the chapter ends with a description of study objectives and hypotheses.

2.1 Factors Influencing Fisher's Choice of Fishing Location

A number of factors are believed to influence artisanal fisher's choice of fishing location between the offshore and inshore areas of a water body (Gatewood, 1983). They include the degree of poverty, access to information about good fishing grounds, nature of target species, possession of a motor board engine, type of fishing gear and fishing vessel more generally. These factors influence choice of fishing location, the behaviour of fishers both within and among fishing areas and over time.

2.1.1 Poverty and Choice of Fishing Location

There is a debate regarding the influence of poverty and choice of fishing location behaviour. Some authors argue that poverty motivates fishers to allocate their fishing effort in the areas that they constantly fish even when they experience declining catches due to pressures of daily subsistence (Sampson, 1990; Defeo *et al*., 1993; Pelletier and Ferraris, 2000;).

On the other hand, other authors argue that poverty induces risk averse behaviour which hampers the fishers from choosing alternative fishing grounds that are far from their usual fishing grounds (Defeo, 1989; Sampson, 1993; Seijo and Defeo, 1994). The Artisanal fisher's ability is not limited by lack of motivation or interest but by a reduced capability to meet the requirements of trying out new fishing locations which may demand a change in technology i.e. changing fishing vessel and gear which has financial implications. Holland and Sutinen (2000) found that skippers who had better fishing technology (fish aggregation devices, gear and vessels) better exploited new fishing locations than those that didn't have, hence they went further offshore. Risk has an influence on choice of fishing location. Van Oostenbrugge, van Densen and Machiels (2001) reported that risk and choice of fishing location are separate factors on which fishers' daily decisions about effort allocation were based to minimize risk and operational costs and not necessarily to maximize catch per unit effort (CPUE).

2.1.2 Availability of Target Species

Short term decisions of fishers related to choice of fishing location and availability of target species are associated with different societal, economic and biological factors. Some authors suggest that fishers' decisions depend on economic incentives, i.e. expected returns and its variability (Bockstael and Opaluch, 1983; Lane, 1988; Wilen et al. 2002), but others reject this hypothesis, especially for small scale fishers (Jacobson and Thomson, 1993; Smith and Hanna, 1993). Eales and Wilen (1986) suggested that in

some fisheries a large portion of economic rent may be dissipated because of inefficient species selection, e.g. increase in fishing costs may be due to spending more time in search for certain target species rather than a real increase in the number of boats or days fishing.

In multi or mixed species fisheries, these issues are especially relevant as changes in biological or economic conditions alter the relative profitability of particular fish species resulting in the redistribution of fishing effort (Holland and Sutinen, 1999).

2.1.3 Fishing experience

Fishers' experience is crucial in deciding where and what to fish. Holland and Sutinen (2000) reported that skippers in trawl fisheries of New England kept records of fishing locations and corresponding catches in a particular season of the year. They further pointed out their experiences in detecting the patterns of movements of the fish played a significant role in their choice of fishing location in the subsequent days (Holland and Sutinen, 2000).

2.1.4 Fishing technology

The fishing technology (fishing gear and vessel, sail engine) significantly influences a fishers' choice of fishing location. In both artisanal and commercial fisheries, larger boats are found to have better fishing opportunities because they are more mobile (Abrahams and Healey, 1990; Pet-Soede, 2000) and better equipped to fish during rough weather (Hilborn and Ledbetter, 1985). Within a chosen fishing location or resource space,

allocation of effort is determined through optimization of the economic outcome of the fishery (Gordon, 1953). This call for use of technology that will maximize catch from the resource space, for instance, use of a motor sail engine will ease the manouvreability within a resource space or use of fishing gear that will tap several types of fish species (Bènè and Tewfik, 2001).

2.2 Artisanal Fisheries

2.2.1 General Characteristics

In most cases small scale fisheries are scattered and they include large numbers of fishermen and fishing units over a large physical area. This pattern of distribution of small scale fisheries is similar among water bodies in Africa e.g. Lakes Tanganyika, Bangweulu, Malawi, Mweru (Lindqvist & Mikkola, 1989). Generally, the fishermen in the artisanal fisheries obtain relatively low incomes, although the average income level may not deviate much from the local rural averages. Artisanal fisheries are owner-operated (i.e. most gear owners do not go out fishing; they employ crew members (Hara and Jul Larsen, 2003; Hara, 2006)) and labour-intensive, employing rudimentary technologies. Artisanal fishers harvest from comparatively small vessels powered by sail, paddles, or outboard motors of limited power and have limited fishing range.

The low average incomes and low catches make it possible for the fisheries to absorb large numbers of fishermen (Lindqvist & Hayward, 1985). Scattered distribution also works as a constraint to the development of artisanal fisheries (Mikkola, 1986). This leads to high mobility of fishermen, either on a daily, seasonal or annual scale (Mvula,

2002). Small scale fishermen are often generalists in their fishing strategy (Smith & McKelvey, 1986), implying that their overall costs of switching from one mode of fishing gear operation to another, or from area to area, are lower than those of specialists among industrial fishers. Artisanal fisheries are often overcapitalized, and fishing capacity is far in excess of that required to take the maximum sustainable yield. It may also be in excess of that required for economic efficiency (Smith & McKelvey, 1986). These problems are compounded by lack or incomplete property rights and conflicts with large scale, industrial vessels.

2.2.2 The Artisanal Fisheries in Malawi

Artisanal fisheries are open access, highly complex, scattered in all water bodies (refer to fig. 1) and mainly operate between 0-20 m from the shore in Lake Malawi (FAO, 2005), However, there are challenges in defining locality among the artisanal fishers due to lack of equipment to aid them determining the depth at a particular fishing location, while in other water bodies like Lakes Malombe, Chilwa and Kazuni all depth ranges are covered. The artisanal fisheries comprises of a wide range of fishing units, ranging from traditional fishing gears and crafts, such as fish traps and handlines operated from dugout canoes to relatively modern gears and crafts. These include seine nets operated from planked boats powered by outboard motors that employ many people. The main target fish species for the artisanal fisheries, depending on the fishing gear, are chambo (*Oreochromis* species), Kambuzi (*Haplochromis* species), Usipa (*Engraulicypris sardella*), Utaka (*Copadichromis* species), Kampango (*Bargrus meridionalis*) and Mlamba (*Clarius gariepinus*).

The main fishing gears are gillnets chambo seine nets, kambuzi seine nets, nkacha seine nets, Chilimira seine nets, longlines, handlines and fish traps. The 2003 Frame Survey results indicated that there were 15 542 gear owners and 42312 crew members that fished, with 15 316 crafts. Of the total fishing crafts, 493 were plank boats operated with engines, 2 999 were plank boats operated without engines, and 11 824 were canoes (FAO, 2005).

2.2.3 Economic role of fisheries in the national economy

The fisheries sector in Malawi is an important source of employment, rural income, food security and allows for import substitution. In 2002, fish had a beach value of about MK1.5 billion (approx. 21 million US$), and significantly contributed to the national economy. The fishing industry supports nearly 1.6 million people in lakeshore communities and makes substantial contributions to their livelihoods, by supporting approximately 9 percent, 18 percent, 15 percent, nine percent and 30 percent of the people in Karonga, Nkhata Bay, Nkhota Kota, Salima and Mangochi districts, respectively. Furthermore, 13 percent of the people in Zomba, Machinga and Phalombe districts, and 6 percent in the Lower Shire Valley derive their livelihood from fishing (FAO, 2005).

Figure 1: Showing the artisanal fishers at Nkope landing site within Nankumba Peninsula area.

Photo: *Steve Donda*

2.3 Economics of Fishing Gear Operation

The small scale fishery is gradually becoming more dependent on outside inputs just like the industrial sector. These inputs may be local (e.g. timber for boat building) or carry a heavy foreign exchange component (e.g. paraffin, nylon gill netting material, fuel etc). Thus small scale fisheries have been drawn into the national economy for a while, although the fishery may still be far removed from pure market economy (Anderson, 1981). This has several consequences; first, the cost of fishing tends to follow changes in the price of external inputs, which may heavily be influenced by the overall economic situation of the country. Revenues and costs mainly determine the economics of fishing operations. Revenues depend on the type of species quantities caught, prices obtained, which in turn depend on marketing channels, seasonal fluctuations and other factors. The main cost factors are capital investment and operation costs, which can be divided into labour, running and vessel costs. The major components of labour costs are wages. Running costs are principally composed of fuel, lubricants, food and supplies for the crew.

The major elements of vessel costs are the vessel itself, gear repair and maintenance expenses. In addition, fishing operations also carry external costs which are difficult to quantify. External costs are defined as costs which are created by a fishing enterprise for others, i.e. other enterprises in society. For example, through depletion of fish stocks or destruction of the shore ecosystem. Anderson (1981) reported that fishers often prefer to work with their relatives or to have economic dealings with them, which helps to spread the risks and uncertainities, and that fishers' relation with fish traders comes in many

forms, but often involves many social and economic dimensions in addition to exchange of fish for money or barter.

This causes small scale fisheries to exhibit many behavioural features that are based on tradition, established habits or local culture, related to skills in catching fish, information sharing and command of marketing channels. These tend to cover complex social and economic web within the fishery itself and its relations with outsiders. The structure may be very dynamic but may also be quite simple involving fishers and fish traders' high mobility and extensive information network.

2.4 Description of the Fishing Gears

2.4.1 Chilimira Fishery

The two most important gears in Lake Malawi operated within the small scale fisher folk are Gillnets and Chilimira nets. This importance has been determined by examining the amount of catch that each gear contributes to catches from Lake Malawi. These two gears contributed over 75% to the total Lake Malawi catch, Gillnet 43.1% and Chilimira 32.9% (Weyl, 2000). Kambuzi seine, long-lines, chambo seines, mosquito nets, fish trap and hand-lines are of intermediate importance. The Chilimira net fishery is the most important small-scale fishery in Mangochi District, Lake Malawi fishery (Weyl, 2000).

The Chilimira net is an open water seine used in Lake Malawi. It has a conical appearance and is used at night, mainly to catch Usipa (*Engraulicypris* spp), while during the day; the gear is used to target utaka (*Copadichromis* spp), refer to fig 2 below. The net is traditionally used as an open-water seine net (FAO 1993). The mesh size at the bunt ranges from mosquito netting to 1 inch (25mm) and the headline length ranges from

20 metres to 70 metres. The net is operated by two dugout canoes and one plank boat with a total crew of nine.

When a shoal of fish is located the net is laid by the dug out canoes. The net is towed in the opposite direction to the movement of the fish and finally hauled into the plank boat. It is used to target mainly pelagic fish species such as usipa (*Engraulicypris sardella*) and utaka (*Copadichromis* spp), neither of which are considered in need of precautionary management action (Bulirani *et al.* 1999).

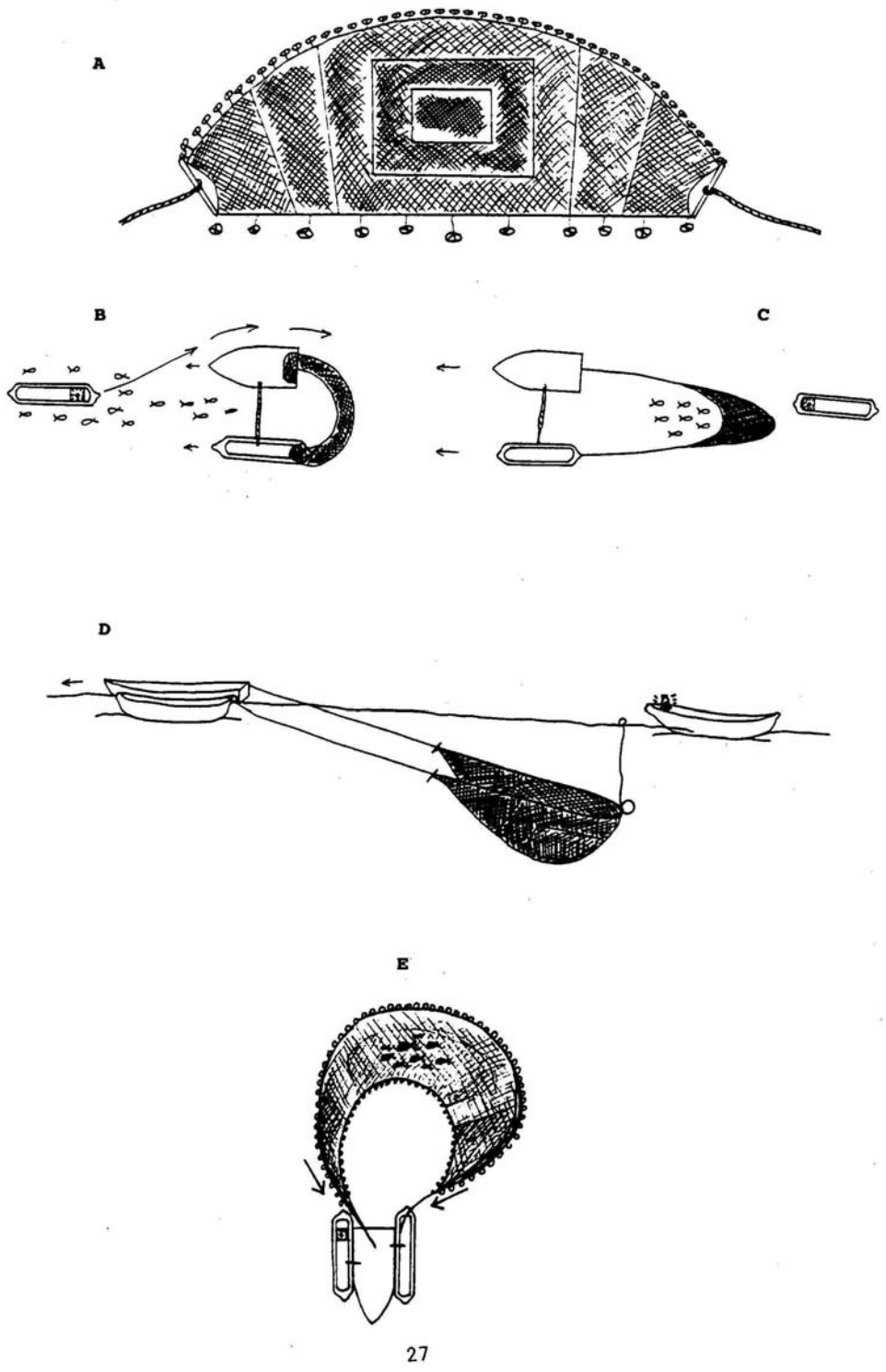

Figure 2: Chilimira net (A) shape and (B-E) operation (after FAO, 1993).

Since each chilimira net employs nine crew members, the 663 chilimira nets counted during the 1999 frame survey (Weyl *et al.* 2000) employed 5967 people, accounting for 58% of all crew members employed. Furthermore, Weyl (1999) estimated that in 1998, Chilimira nets in the southeast arm of Lake Malawi contributed over 70% to the annual small-scale fishery catch. In terms of annual yield, the Chilimira fishery is the most important on the lake as utaka are mainly caught by the Chilimira net and these fish comprise more than half of the fish yield from Lake Malawi. However, more recent reports have shown that, in certain localities, the Chilimira net is used to target chambo (*Oreochromis* spp.) using light attraction (kauni) (Banda 1996, Weyl 1999, Hara 2006), a stock which is considered to be declining and in urgent need of precautionary actions (Bulirani *et al.* 1999). It appears the fishers have modified the mesh sizes of the Chilimira net to target chambo species in the lake.

2.4.2 Gillnet Fishery

The gillnet fishery is one of the most important fisheries in Malawi. It has been in existence on Lake Malawi from as early as 1940 (Sipawe 1999). Gillnet is a rectangular fishing gear made from 4 or 6 ply twine. In general, there is one mesh size used in a gillnet fleet. The commonest mesh size used in Lake Malawi is 90mm with a range from 64 to 102 mm. The headline length can vary from 100 to 3200m and the depth from 5 to 25 m. They catch fish by entanglement and are highly selective. They usually have a mesh size designed to catch fish of a specific size range. It is normally used with a single planked boat (with or without engine) and a crew of four. The net may be surface set or bottom set, and is traditionally a passive gear. Gillnets contribute about 35% of the total

landings from Lake Malawi and the main species caught in this fishery are chambo (*Oreochromis* spp.), Kampango (*Bagrus meridionalis*), bombe (*Bathyclarias* spp.), cyprinids (*Barbus*, *Labeo* and *Opsaridium* spp.) and utaka (*Copadichromis* spp.). The number of gillnets has increased tremendously over the years: between 1993 and 1999 there was a three-fold increase in the number of gillnets used in Malawi's waters (Weyl et al. 2000; Hara 2006). In contrast, catches have remained stable registering a decline in Catch Per Unit Effort (CPUE). The decline in CPUE has been countered by a decrease in mesh size and the 1999 Frame Survey revealed that over 95% of all gill nets used in Mangochi were below the legal minimum mesh size (Weyl, 2000). These illegal meshed nets, locally known as Ngongongo, are used by local fishers to tap unexploited cichlid resources other than chambo (Weyl 2000).

CHAPTER THREE

METHODOLOGY

This chapter details aspects of site selection and reasons, sample framework, sampling design and sample size and data tools used. It also explains the statistical analysis used in this study.

3.1 The Study Area

This study was conducted in Nankumba Peninsula. This Peninsula is located in Mangochi District and lies between 14°02′S and 34°53′E with its northern tip dividing the southern end of Lake Malawi into South East Arm (SEA) and South West Arm (SWA). The Project area is administered by Traditional Authority Nankumba. The Nankumba Peninsula has an estimated population of 79,419 in 19,248 households; corresponding to an average density of 124 people per km^2, (GOM, 1999). The Nankumba Peninsula was selected for the study because there is more intense fishing activity than any other part of the lake and harbours a lot of artisanal fishers.

3.2 Sampling and sample size

A stratified sampling procedure was used to draw the sample, from which a total of 101 chilimira and 99 gillnet fishers were randomly drawn (Edriss, 2003). The sample size was determined using the following formula (Edriss, 2003);

$$\mathbf{n = [Z^2 (1-p) p] / e^2}$$

$$= [1.96^2 (1-0.112) 0.112]/0.05^2$$

= 153

Where **n** = sample size

p = percentage proportion of the prevalence of fishers (11.2%)

z = *z*-value yielding the desired degree of confidence (1.96)

e = error term (0.05)

Adding 5% non respondents, the sample size was 161 fishers. However, in this study, the sample size was 200. Upon arriving at a landing site, systematic sampling procedure was used to sample the fishers from the two categories of fishing units (Gillnet and Chilimira), i.e. the day of the month was used as sampling interval which was determined by the researcher and explained to the enumerators. This was done due to the unavailability of records at Department of Fisheries about the population of the fishers present at each landing site. Instead, the Fisheries Department has prevalence records of fishers in the various stratums of Lake Malawi.

3.2.1Questionnaire Pretesting

The questionnaire was pretested for a period of one week. This helped to modify the questionnaire through inclusion of more responses and detection of ambiguities in wording.

3.3 Data Collection

Data collection was done using a formal survey and substantiated by key informant interviews. 200 fishers (Both gear owners and crew members, i.e. for a particular questionnaire, the gear owner was asked about the economic part and the rest of the

questionnaire was administered to the crew members. This was a deliberately done in view of the fact that crew members have enormous influence of fishing decisions given that the benefit of the sharing systems are based on amount of catch (Hara, 2001; Hara and Jul Larsen, 2003; Hara 2006) were interviewed using a semi-structured questionnaire across the Nankumba Peninsula fish landing sites comprising, Mvunguti, Msaka, M'bwadzulu, Malembo, Namaso Bay, Nkope, Masasa, Chizale, Zambo, Madzedze, Nkhudzi Bay, Kholowere and Chembe (Cape Maclear).

The study was carried out by the researcher and with help from five enumerators during data collection. The questionnaires were checked for consistency during the night before the next days' trip to another landing site and where necessary, a landing site was visited again to cross check information with the fisher or key informant concerned. In addition, observations were carried out after the interviews to confirm the data that was collected through the questionnaire. This allowed further probing of the areas that were not clear to the researcher.

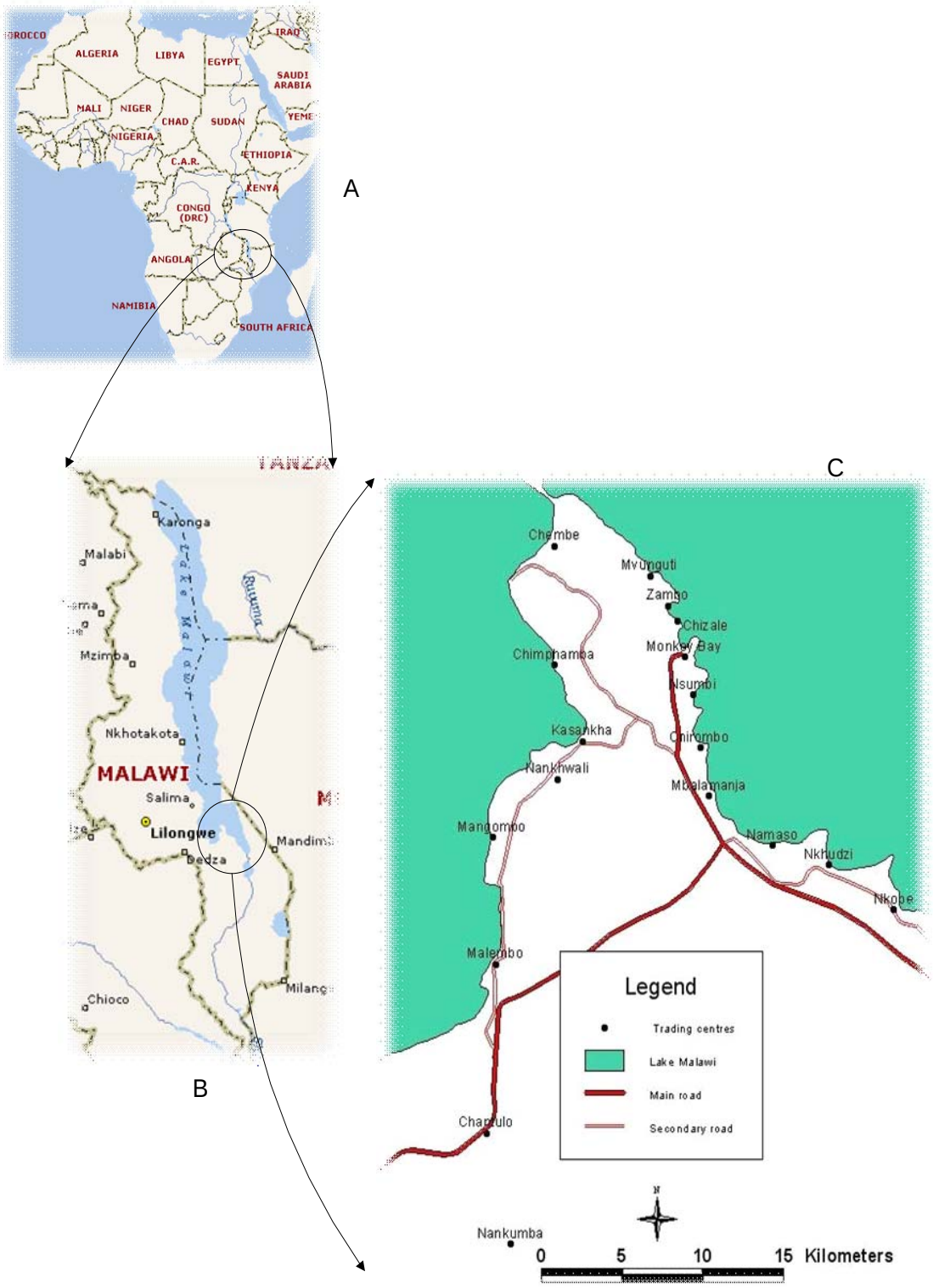

Figure 3: Map of the Study Area, Nankumba Peninsula(C) showing its location in Malawi (B) and Southern Africa (A).

3.4 Analytical Technique

Analysis included quantitative and qualitative methods. Qualitative information was mainly captured from key informant interviews. Quantitative analyses included descriptive statistics, cross tabulations and logit model analysis. This was done using SPSS 15.0 package. Gross margin analysis was done to determine and compare profitability of the two fishing gears, chilimira and gillnet.

3.5 Specification of the logit model

The dependent variable in this model is binary or dichotomous, since the fisher has two choices, to operate in the inshore (1) or offshore (0) waters. When a dependent variable is dichotomous, the standard ordinary least squares cannot be used because the assumptions made about the error term are violated. Maddala 1988 argued that the common models used for this type of regression analysis may include Linear Probability Models (LPM), Logit and Probit models. Maddala further points out that the Linear probability model has the demerit of predicted values falling outside the permissible interval (0, 1). In this model the fisher either exploits inshore or offshore fisheries. Inshore water zones refer to the fishing zones within the range of 0-50m deep while offshore water zones are those greater than 50m deep (SOFTDP, 2005; FAO, 2005). The logit model is accordingly specified as below;

$$L_i^* = \ln (P_i / 1-P_i) = Z_i = Y_i = \beta_o + \beta_i X_i + \mu_i \quad \text{.....(1)}$$

Where:

L_i* is the propensity of the fisher to go Offshore fishing, and is usually not observed; we therefore observe the dummy variable L_i defined by:

$L_i = \{0, 1\}$ if $Y^* \geq 1$ Offshore Waters

= 0 Otherwise

L the log odds ratio, which is a linear function of the explanatory variables (X_i)

(Pi / 1-Pi) The odds ratio in favour of choosing to exploit offshore locations

$Z_i = Y_i = \beta_o + \beta_i X_i$ represents the cumulative (logistic) distribution function

Where:

i = 1, 2… 200

Y_i = Fishers exploiting Offshore fishing locations.

β_o = the intercept, is the value of the log-odds in favour of Offshore fishing if the value of X is zero (0).

β_i = the slope, measures the change in L for a unit change in X, i.e. tells how the log odds in favour of Offshore fishing as the value of X changes by a unit.

X = is the vector of explanatory variables e.g. fishing experience

μ_i = is the error term

The following explanatory variables were used in the model:

1 Age of the fisher measured in years (continous variable)

2 DFishAv = Dummy for availability of target species of the fisher (Dummy; 1= readily available, 0 not readily available)

3 DFVess = Dummy for type of fishing vessel of the fisher (Dummy; 1 = Plank Boat, 0 canoe)

4 DFExp = Dummy for fishing experience of the fisher (>3years = Experienced, <3 years Inexperienced)

5 DInfo = Dummy for access to information by the fisher (1 = Yes, 0 no)

6 DGtype = Dummy for gear type used (1 = Chilimira, 0 Gillnet)

7 DEng = Dummy for possession of an engine (1 = Yes, 0 no)

3.6 Choice of Explanatory Variables

3.6.1 Dependent Variable

This is the propensity to choose an offshore fishing location area during a fishing trip by the artisanal fisher ranging from 0 (Inshore) to 1 (Offshore)

Age of fisher *(continuous variable)*

The role of fisher's age in explaining choice of fishing location is somewhat controversial in the literature. Older people are sometimes thought to be less amenable to change and hence reluctant to change old ways of doing things. In this case, age impacts negatively on choice of fishing location. On the other hand, older fishers may have accumulated capital, more contacts with fellow fishers, better preferred by credit institutions, larger family sizes all of which may make them more prepared to choose a particular fishing location than younger ones (Langyintuo and Mekuria 2005). Despite the type of effect age has on choice of fishing location it has proven to be a key determinant of choice in most studies as such it will be included in this study.

Years of experience as a fisher in fishing operations *(continuous variable)*

The reason why researchers sometimes prefer to use years of experience in fishing or the main decision making factor is that with increased fishing experience, fishers are generally better able to assess the relevance of new fishing technologies. This often comes from their interactions with fellow fishers and the outside world. Years of experience in fishing is expected to be related to the ability of the fisher to obtain process and use information relevant to choice of an appropriate fishing location among the available alternatives. A positive relationship is hypothesized between this variable and choice of fishing location.

Access to information about catch rates (*1 = yes, 0 = no*)

Fishers acquire new knowledge and technologies from a variety of sources. Not all fishers have equal access to nor are they equally active in seeking new information, discussing problems or sharing problems. Fishers make use of information generated by other fishers on the whereabouts of fish, but the amount, quality and distribution of information varies greatly among groups of fishers and circumstances (Durrenberger and Pálsson, 1986). A positive relationship between access to information from fishing trips of other fishers and choice of fishing location is hypothesized because fishers with access to information use it to allocate their effort in areas where there is high probability of realising catches.

Type of fishing vessel (*1 = plank boat, 0 canoe*)

In both artisanal and commercial fisheries, larger boats are found to have better fishing opportunities because they are more mobile (Abrahams and Healey, 1990; Pet-Soede, 2000) and better equipped to fish during rough weather (Hilborn and Ledbetter, 1985). These boats are able to go further to areas offshore than the dugout canoes that can only reach shallow areas near the shore (Anonymous, 1999). They also have larger capacity to handle relatively large amounts of catch than mere dugout canoes (Anonymous, 1999). A positive relationship between the two variables is expected because type of fishing vessel determines how far a fisher has to go during the fishing operation.

Type of fishing gear (*1 = Chilimira, 0 = Gillnet*)

Depending on the type of fishing gear being used by the fisher, choice of fishing location is limited by the characteristics of the gear i.e. not all fishing gear can effectively fish in all areas of the lake. Normally, the Chilimira gear operates in the deep or offshore areas of the lake and the opposite is true for the gillnet (Anonymous, 1999). Therefore, a positive relationship is postulated between type of fishing gear and choice of fishing location.

Possession of a motor engine (*1 = yes, 0 no*)

Within a chosen fishing location or resource space allocation of effort is determined through optimization of the economic outcome of the fishery (Gordon, 1953). This calls for use of technology that will maximize the catch from the resource space e.g. use of a motor sail engine that will ease the maneuverability within a chosen fishing location (Bènè and Tewfik, 2001). Therefore a positive relationship is expected between possession of a motor engine and choice of fishing location.

Availability of fish (*1 = yes, 0 no*)

Eales and Wilen (1986) suggested that, in some fisheries, a large portion of economic rent may be dissipated because of inefficient species selection, e.g. increase in fishing costs may be due to spending more time in search of certain target species rather than a real increase in the number of boats or days fishing. In multi species or mixed fisheries,

these issues are especially relevant, as changes in biological or economic conditions may alter the relative profitability of particular fish species resulting in the redistribution of fishing effort (Holland and Sutinen, 1999). It is from this perspective that a positive relationship is suggested between availability of target species and choice of fishing location.

3.7 Profitability analysis

3.7.1 Introduction

To understand the profitability of artisanal fishers' operations using Chilimira and Gillnets operating inshore and offshore areas of areas around Nankumba Peninsula, gross margin analysis was used.

Various types of fishing craft and gear are used in the Malawian small-scale fishery, which exploits a variety of resource conditions. The persistence of these various fishing technologies is partly the outcome of historical accident and partly the result of economic calculation. Different types of craft and gear are suitable for exploiting specific types of fishery resources. Furthermore, the different technologies used in the small-scale fishery have comparative advantages and disadvantages in respect of their fixed costs, fuel costs, internal and external costs, and labour costs (relative to total costs) and also in respect to earnings of craft owner and crew member-labourer (Panayotou, 1985). The different technologies also display different levels of profitability in small-scale fishing operations.

A clear assessment of costs, earnings, and profitability of different combinations of craft and gear in a comparative framework is required to guide the rational allocation of resources in the small-scale fishery within the parameters of national fisheries-development policy. A study of costs, earnings, and profitability in a comparative framework is required before rational decisions can be made as to which technologies to advocate for wide usage among the artisanal fisheries sector. Furthermore, to facilitate a rational allocation of different types of boat-gear combinations between different locations, locational variation in average daily revenue and profitability of each specific technology has also been analyzed.

3.7.2 Economic profiles of Chilimira and Gillnet

Table 1: Economic profiles of Chilimira and Gillnet

Gear Type	Average Gear Material cost	Average Craft Material cost	Average operating cost	Average Catch earnings	Fishing Location	Type of Vessel
Gillnet	**21,222.02**	**13,647.67**	**1,208.69**	**3,642.32**	Inshore	Canoe
Chilimira	**101,785.97**	**91,063.61**	**3,800.89**	**13,330.56**	Inshore	Plank Boat
Chilimira	**137,208.86**[1]	**351,987.92**[2]	**9,522.25**	**56,476.92**	Offshore	

From Table 1 above, Chilimira fishery is by far the most expensive to procure, let alone its accessories. This is not surprising today because firstly the prices of these accessories

[1] The gear material costs for chilimira fishing offshore is higher than the inshore one because they are slightly bigger in size.

[2] The average craft material cost for chilimira exploiting offshore areas are higher because of the cost of motor sail engine, plank boat and several canoes used by the sigina (signal).

have risen very fast over a short period of time and secondly, Chilimira is generally big in size unlike the Gillnet. The frequent use of motor sail engines also has brought in some costs of petrol to the fuel list which had paraffin only.

3.7.3 Fish Pricing

During data collection, fish prices and the mode of selling of fish around the study were established using observations on fish sales and key informant interviews.

3.7.4 Estimation of economic returns

Gross margin (GM) was computed in order to assess the economic returns of operating in each of the two fishing locations. Gross margin is the difference between total revenue (TR) and total variable cost (TVC) and it was estimated using the formula below (Johnson,1982):

GM= TR-TVC

(1)

Where: GM= Gross margin (MK/kg)

TR= Total revenue (MK/kg)

TVC= Total variable cost (MK/kg)

Total revenue refers to the value of product which is the product quantity produced multiplied by the product price. Mathematically total revenue can be expressed as (Johnson, 1993).

TR = Q * P (2)

Where: Q = Quantity of fish caught (number of fish/kg)

P = Price of the fish (MK/kg)

3.7.5 Costs estimates in the study

3.7.5.1 Estimate of variable cost

Variable costs are costs of production that change with the volume of output (Jolly and Clont, 1993; Panayotou, 1985). In this study these costs comprised mainly of fuel (petrol, paraffin and spirit) dye, mantles, net mending, food costs twine for net mending and crew wages or labour costs.

3.7.5.2 Estimate of fuel cost

The total fuel cost per fishing trip was obtained by summing up the cost of petrol used (quantity of petrol used multiplied by its price per litre), the total cost of spirit used and the total cost of paraffin used per fishing trip.

3.7.5.3 Estimate of food cost

The cost of the food consumed by the crew per fishing trip was estimated by calculating the total amount of food consumed and multiplied by its market price. i.e. most crew admitted that they took soft drinks and scones after eating their normal meal at home. All this was calculated and costed to find the estimate of food cost for the crew during the fishing operation.

3.7.5.4 Estimated labour cost

The two fishing gears used in the study employ crew members during the fishing operation. In the Malawian small-scale fishery, the share system is employed as the mode of payment to the crew members. The crew is always paid a share of the value of the catch and not a fixed wage rate. In addition to the share-basis of payment, each crew member receives a few kilos of fish after every fishing trip for home consumption and is also provided with food during the time the boat is out at sea. The value of all these items together comprises his total earnings. In the case of all types of mechanized craft like Chilimira, half the proceeds of the sale of catch, after deduction of the costs of fuel and food, is divided equally between the gear owner and crew members. The latter share their portion according to their roles, the fisher gets two portions while the rest of the crew get one portion of the total crew share, as reported by Hara and Jul Larsen (2003) and Hara (2006).

3.7.5.6 Total variable cost

Total variable cost is the sum of all variable costs. In this study, TVC was obtained by adding the cost of all variable costs.

3.7.5.7 Yield

Total yield was expressed based on daily fish catches after a fishing operation. Since catch is sold in pails after being weighed to find the equivalent weight for the fresh fish. Usipa (*Engraulicypris sardella*) were used in the gross margin analysis for Chilimira while Utaka (*Copadichromis spp*) were used for Gillnet. This was done because these were the main species caught by the two fishing gears respectively.

CHAPTER FOUR

RESULTS

This chapter gives an account of the fisher personal and technological characteristics using Chilimira and Gillnet in Nankumba Peninsula in relation to choice of fishing location. In addition, factors influencing choice of fishing location of fishers and profitability of fishing operations using the two fishing gears have also been analyzed.

4.1 Fisher characteristics

Artisanal fisher's choice of fishing location depends on the fishers' characteristics such as age and fishing experience. Studies by Gatewood (1983) indicated that these characteristics are of particular importance because they form a core part of the decision making process regarding allocation of fishing effort in order to catch as much fish as possible given the uncertainty nature of the amount of catch. Table 2 below gives a summary of the fisher characteristics operating the two fishing gears. It can be seen that the average age of the sampled fishers was 37.1years. Chilimira fishers had a higher average age 40.2 than gillnet fishers who had an average age of 33.9 years. Age of the sigina (signal) among the crew during fishing using is a very important factor in choice of fishing location as it relates to the accumulated knowledge of fish behaviour (Gatewood, 1983).

Table 2: Age and fishing experience of Chilimira and Gillnet fishers

Variable	Total Sample Mean	Gear Type (Chilimira)	Gear Type (Gillnet)	Mean Diff	t
Fisher's Age (years)	37.1	40.2	33.9	6.27	3.761
Fishing Experience (years)	8.8	10.8	6.7	4.3	4.861

4.1.1 Age and choice of fishing location

It is believed that age could serve as a proxy to experience, and more experienced fishers would be more likely to exploit offshore areas (Eales and Wilen, 1986). Furthermore, accumulation of knowledge related to fish behaviour is known to be positively correlated with age. Knowledge of fish behaviour increases the ability of a fisher to predict fish availability in a certain areas in a given time period. However, the results from the sampled fishers in Table 3 below, show that change in age group did not influence choice of fishing location ($P>0.05$).

Table 3: Age distribution by category (in years) between inshore and offshore fishing locations

Variable	Offshore	Inshore	Total
Age of Fisher (years)	**n**	**n**	**n**
Less than 30	38	26	64
30 – 39	42	17	59
40 – 49	24	10	34
50 and Above	28	15	43
Total	**132**	**68**	**200**

Pearson Chi-square 2.293 *P-Value 0.514*

4.1.2 Fishing Experience and Choice of Fishing Location

Fishing Experience of the fishers often provides better knowledge about location of fish, weather patterns, bottom conditions, currents and how best to catch the fish. The results in table 4 below show that most fishers, about 75% have at least accumulated some level of fishing experience and that most of them went offshore during their fishing operations. However, 25% of the sampled fishers do not have significant level of fishing experience and it is not surprising to note that most of them went inshore during fishing. Furthermore, the results indicate insignificant relationship between fishing experience category and choice of fishing location.

Table 4: Choice of fishing location by category of fishing experience

	Offshore	Inshore	Total
Fishing Experience	**n**	**n**	**n**
Experienced (> 3 years)	100	50	150
Inexperienced (≤ 3 years)	18	32	50
Total	**118**	**82**	**200**

Pearson Chi-square 0.119 *P-Value 0.730*

4.2 Time spent fishing

For the crew members (fishers), the amount of time spent fishing or fishery related activities depend on type of gear and mode of operation. For Chilimira fishers using kauni, who constituted a majority in this study, said that they spent 8 to 12 hours while Gillnets are usually set overnight for about 5 to 8 hours. However, due to increasing theft and entanglement with other Chilimira fishers, it has become a common trend to guard their nets, thus increasing their time spent fishing as earlier observed by Hara, 2001. It was observed in this study, that Gillnetters who used it as an active gear i.e. beating water to direct fish in the direction of the net or towing using two canoes spent up to 12 hours fishing. In this context, for Chilimira fishers, 72.3% of the fishers spent 10 to 12 hours fishing or fishery related activities in a given day while 17.8% spent 7 to 9 hours on fishing activities (Fig 4 below). 7.9% said that they spent 4 to 6 hours on fishing. For

Gillnetters, 67.7 % said that they spent 1 to 3 hours fishing while 18.2% spent 10 to 12 hours fishing (Figure 5 below). 12.1% said that they spent 4 to 6 hours fishing or on fishery related activities like net mending

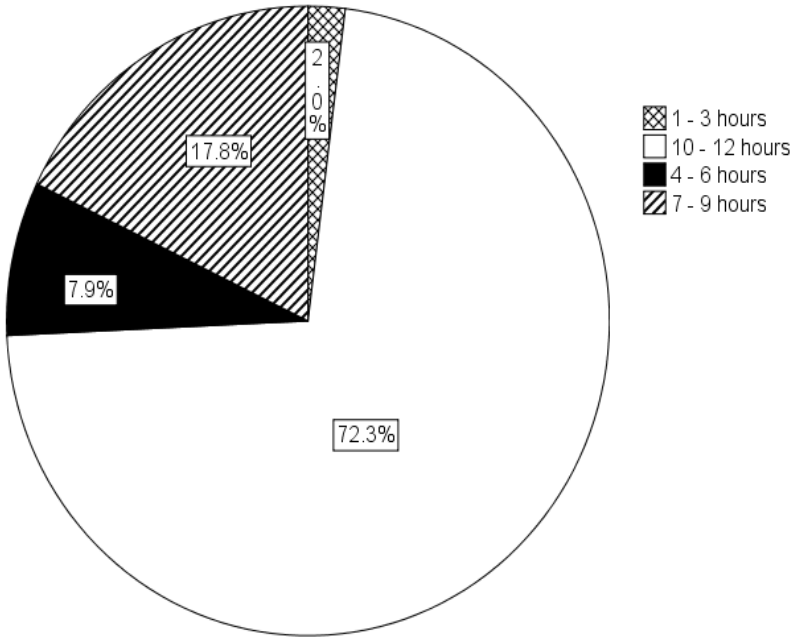

Figure 4: Proportion of time spent fishing among Chilimira fishers.

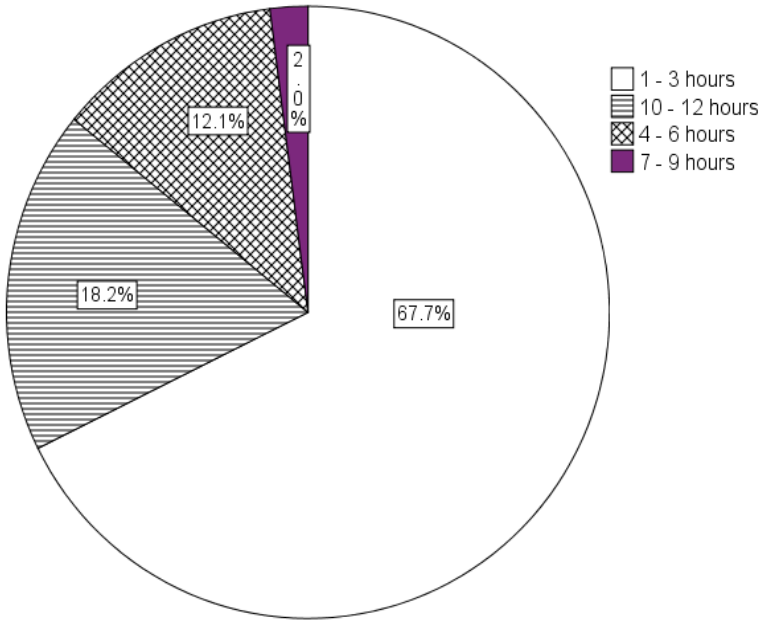

Figure 5: Proportion of time spent fishing among Gillnet fishers.

4.3 Choice of fishing location

Of the Chilimira fishers interviewed, 92.1% said that they chose offshore fishing locations during their fishing trips or operations (Figure 6 below) while 7.9% said that they chose inshore fishing locations. A further investigation revealed that the fishers normally used a rope to determine the depth of the chosen fishing location on that particular day. For Gillnet fishers, 69.7% said that they chose inshore fishing locations during their fishing trips or operations (Figure 7 below) while 30.3% chose offshore fishing locations. It was observed in this study that most of the Gillnet fishers who chose offshore fishing locations used the Gillnet as an active gear (as earlier on discussed).

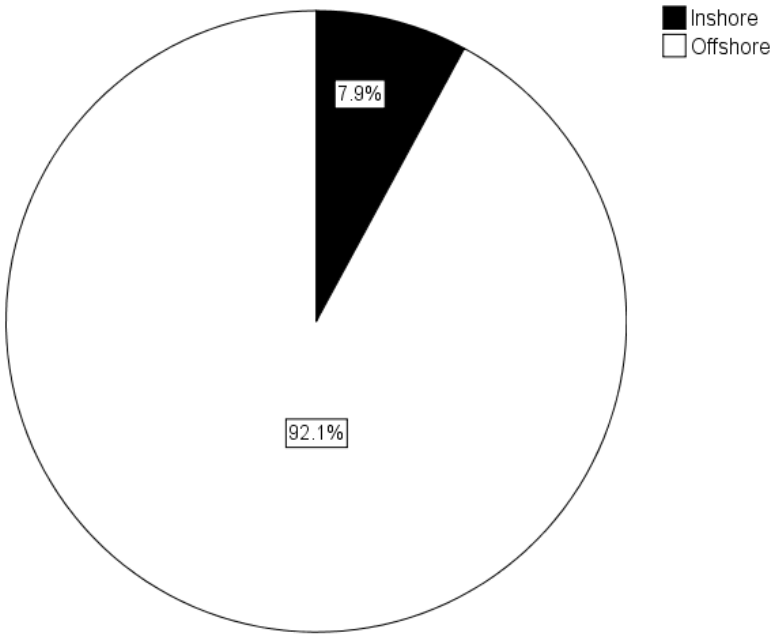

Figure 6: Proportion of fishing locations among Chilimira fishers.

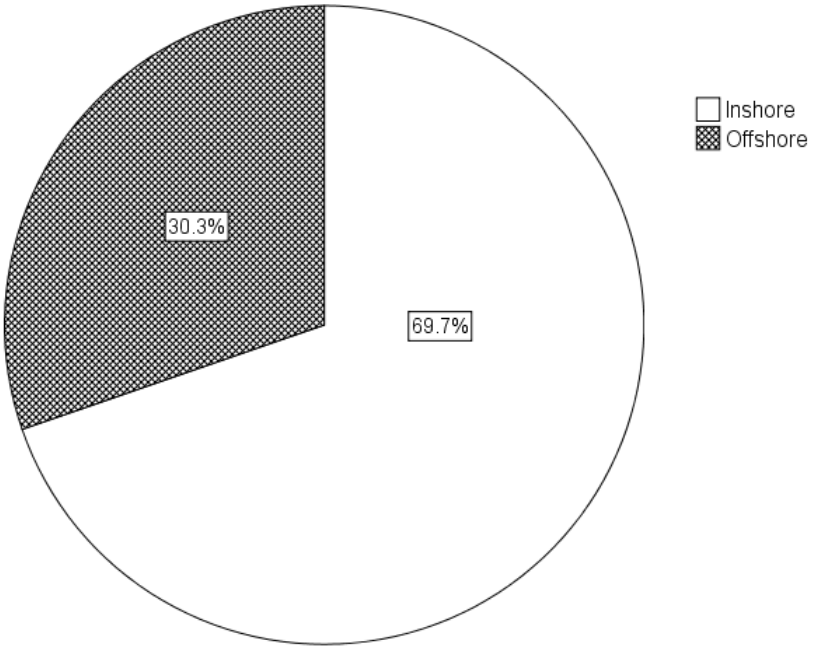

Figure 7: Proportion of fishing locations among Gillnet fishers.

The number of fishing trips in a month will depend on many factors some of which are the prevailing weather conditions, frequency of occurrence of obligatory activities like funerals, sicknesses of both the fisher and members of his immediate family and number of crews employed in a given fishing unit and whether one is attached permanently or employed on a casual basis as need arises as earlier on observed by Hara (2001). For example, Gillnet fishers, especially those that use it actively, are employing up to four members to one fishing unit to help in pulling the net and beating the water to chase the fish in the direction of the net. These people may be paid for the work they have done on that particular day immediately after selling the catch. Anonymous (1999), in her study of socio-economic context of natural resource management in Nankumba Peninsula, observed that most Chilimira fishers and a few Gillnetters went offshore during their fishing operations. This was further evidenced by the fact that in over 80 instances observed in this study; the fishing locations mentioned by the fishers were indeed verified as lying in the offshore parts of the lake by the key informants like fisheries staff within the study area. However, Hara (2006) reported that most fishers constantly switch areas of operation in search of the highly valued *Oreochromis spp* (locally known as Chambo) which are of high economic value implying that they also exploit the inshore parts of the lake.

4.4 Fishers' criteria for choice of fishing location

A majority of the fishers (90%) gave a range of criteria for choice of fishing location namely, amount of catch, gear size, amount of capital, target species, fishing experience, access to information, distance to fishing location, operational costs, time spent fishing

and easiness of gear operation. However, not all these criteria are equally important as can be seen in Table 7 below.

Table 5: Fisher's criteria for choice of fishing location

Criteria	***Percent (Multiple response)***
Amount of catch	82%
Target species	55%
Fishing experience	36.5%
Access to information	15%
Gear type and size	13.5%
Operational costs	10%
Fishing location distance	8%
Time spent fishing	6.5%
Easiness of gear operation	4.5%

82% of the fishers interviewed gave amount of previous day's catch as the first criterion of importance while 55% gave target species as the first or second choice criteria. Fishing experience, access to information about catch rates, gear type and size, distance to fishing location featured prominently among criteria mentioned spontaneously by fishers being important in evaluating fishing locations. Gatewood (1983 and 1984), reported that amount of catch, access to information about catch rates fishing experience and distance to fishing locations featured prominently among criteria that Alaskan salmon skippers judged as being important in deciding where to fish.

4.5 Regression results

Table 6 below present's results of a logit model which was run to establish factors that influence the choice of fishing location by the artisanal fishers. The dependent variable (fishing location) assumed a value of zero for fishers that operated in the inshore areas, and for those that went offshore it was assumed to be one. A single model was run; aimed at analyzing the decision making during the fishing operation by the artisanal fishers. The model was then evaluated using bivariate correlation analysis of the independent variables and checking assumptions of multiple regressions (Multicollinearity, homoscedasticity, normality and independence of residuals). Correlation between independent variables ranged from 0.205 – 0.578, suggesting that no significant correlation was present and tolerance ranged from 0.599 – 0.895, again showing the absence of multicollinearity among the independent variables, (Tabachnick and Fidell 1996). Scatter plot and normal probability plots were run in SPSS to check homoscedasticity, normality and linearity.

The results presented in the Table 6 below show that the age of the fisher, the type of fishing gear and vessel used by the fishers, the possession of a motor board engine and access to information about catch rates in particular fishing locations have significant influence on the choice to fish in a particular location.

Table 6: Regression results

Dependent Variable: Fishing Location (1= Offshore, 0 = Inshore)

Variable	**Coef.**	**Std. Err.**	**P>|z|**
Age of the fisher**	0.032	0.016	0.050
Gear type**	0.031	0.017	0.050
Type of Fishing Vessel***	1.781	0.465	0.000
Availability of Fish	0.498	0.440	0.258
Fishing Experience	0.031	0.032	0.339
Possession of an Engine***	2.049	0.633	0.001
Access to Information*	0.762	0.454	0.093
Constant	0.300		
-2 Log likelihood	187.805		
Prob > chi-square	0.00		
Chi-square (Goodness of fit)	68.610		

*** significant at 1%, ** significant at 5%, * significant at 10%:*

4.5.1 Age of the fisher (continuous variable) and choice of fishing location

Age of the fisher was also found to have significant influence on the choice of fishing location (P=0.050). The positive sign indicates that with an increase in age, there is more propensity of the fisher going offshore which results in their willingness to try out new fishing grounds in the offshore areas which are under exploited (Thompson and Allison, 1997). Similar results were obtained by Gatewood 1983, who reported that increase in age induced the salmon seiners in Alaska to exploit offshore areas where they realized more catches.

4.5.2 Gear type (1= Chilimira, 0= Gillnet) and choice of fishing location

The type of fishing gear was found to have significant influence on the choice of fishing location during a fishing trip (P<0.05). This meant that probability of a fisher going offshore during a fishing trip is positively dependent upon the type of fishing gear being used by the fisher. Similar results were reported by Wiyono *et al*., 2006 who found out that allocating fishing gear in a given location was dependent upon the type of gear being used by the small scale coastal fishers of Indonesia.

4.5.3 Type of Fishing Vessel (1 = Plank boat, 0= Canoe) and choice of fishing location

As expected, the type of fishing vessel used by the fisher was found to significantly influence on the choice of fishing in the offshore areas (P<0.05). The positive coefficient exhibited by this variable, signals a positive relationship. This implies that most artisanal

fishers who have plank boats have a high probability of going offshore during their fishing operation as opposed to those who use dugout canoes. This supports the finding of Anonymous (1999), who reported that most artisanal fishers with plank boats went offshore during their fishing operations as opposed to those with canoes.

4.5.4 Availability of fish (1 = yes, 0= no)

The availability of fish was found to have insignificant influence on the choice of fishing location ($P>0.05$). However, positive sign entails that fish availability in a given location increases the probability of a fisher choosing that particular location, which indeed seems rather obvious. This stems from the fact that offshore areas have been proven to contain underexploited stocks of fish populations than inshore areas in Lake Malawi (Thompson and Allison, 1997), so the general expectation is that fishers will exploit the offshore areas as long as they have the capability to do so. This finding also supports the general notion that presence of fish patches in particular locations will attract more fishing gears being set in those areas as widely reported by Wiyono *et al*., (2006); Gatewood, 1983; (1984); Wilson, (1990); Eales and Wilen, (1986).

4.5.5 Fishing experience (continuous variable) and choice of fishing location

As expected, fishers' experience in fishing operations has shown a positive relationship with the choice of fishing location. This entails that increase in the number of years in fishing increases the accumulative effect of a wealth of knowledge about fish availability in different locations in different times of the year in a fisher. Given the declining catches

from the inshore areas of the lake and the need to increase the catches so as to improve the economic returns on the catch fishers are compelled to go offshore during their fishing operations. However, this variable was not significant (P>0.05).

4.5.6 Possession of a motor engine (1= yes, 0= no) and choice of fishing location

Out of the 200 fishers interviewed, 131 did not own motor engines while 69 had motor engines, representing about 65% and 35% of the sampled fishers respectively. The results in Table 7 below, shows presence of a significant correlation between possession of a motor board engine and choice of fishing location. Fishers who possessed motor engines admitted going offshore during their fishing trip. These results are in accord with Gatewood (1983), who reported that fishers consider the type of technology (fishing gear, vessel and other equipment like a motor sail engine) in deciding where to fish.

Table 7: Possession of motor engine and choice of fishing location

	Offshore	**Inshore**	**Total**
Possession of an Engine	**n = 107**	**n = 93**	**n = 200**
No	38.4%	97.8%	65.5%
Yes	62.6%	2.2%	34.5%
Total	100	100	100

Pearson Chi-square 37.340 *P-Value 0.000*

4.5.7 Access to information about catch rates (1= yes, 0= no) and choice of fishing location

Results suggest that the probability of a fisher going offshore is higher if the fisher has access to recent information about catch rates. This stems from the fact that there was a positive and significant correlation between this factor and choice of fishing location ($P<0.093$). Since fishers and fish marketers are a small closely connected group, information tends to spread very rapidly today's information is basically yesterday's landings information. Hence a decision of where to fish uses current information. Similar results were reported by Eales and Wilen (1986), who found out that fishers tend to make their choices about fishing locations based on information derived from previous fishing activities. Furthermore, Durrenberger and Pálsson (1986) also reported that fishers use a wealth of detailed knowledge to decide both when and where to fish. They further pointed out that fishers use their past observations and information from other fishers to make predictions.

4.6 Profitability analysis of fishing operations

One of the most pertinent issues in this study was whether the fishers' decisions about where to fish are economically motivated or are just random. A clear assessment of costs, earnings and profitability is currently not established among the various types of fishing gears or units exploiting various fishery resources in different locations. Therefore, gross margin analysis was carried out with the aim establishing the extent of fishing income differentials among the artisanal fishers using the two gears in different fishing locations where they normally operate.

4.6.1 Gross margin analysis for Chilimira fishers by fishing location

The results from Table 9 below show that Chilimira fishers that exploit offshore areas have higher daily average gross margins (MK 19, 450.02) than those fishing inshore areas (MK 8, 279.33). The returns to labour are also higher and significant *(P< 0.05)* for Chilimira fishers operating in offshore areas (MK 180.09/Man hour) than those operating in inshore areas (MK 91.99/Man hour). This can be attributed to the fact that the fishers operating in the offshore areas of the lake have higher catch rates on average than their inshore colleagues (Table 9 below).

Table 8: Profitability comparison of Chilimira and Gillnet

	Chilimira	**Gillnet**	**t-test**	**P - value**
Gross Margin	K 34,753.68*	K 2,529.09*	7.288	0.000
Operating costs	K 7,482.95*	K 1,208*	12.577	0.006
Gross income	K 42,236.63*	K 3,713.03*	8.244	0.001

*mean values

Table 9: Gross margin analysis for Chilimira fishers by fishing location

	FISHING LOCATION			
	Inshore	**Offshore**	**T-test**	**P-value**
Benefits				
Average Fish catch (5 litre pail = 7kg)/trip	259 kg	595 kg		
Average Price of fish (MK/kg)	MK 78.57	MK 78.57		
Gross Income	**MK 20,350**	**MK 46,750**	**7.661**	**0.000**
Variable Costs				
Petrol	0	2415		
Paraffin	1800	2400		
Dye	361	500		
Crew Wages	8,209.67	19, 328.99		
Mantles	300	456		
Spirit	200	200		
Food Costs	300	600		
Labour Cost for Net mending	500	800		
Twine for net mending	400	600		
Total Variable Costs	**12, 105.50**	**27, 299.99**		
Gross Margin/fishing trip	**8, 279.33**	**19, 450.02**	**6.858**	**0.001**
Labour (Man hours)	**90**	**108**		
Returns to Labour (MK/man hours)	**91.99**	**180.09**	**4.132**	**0.002**

Note: US$1 = MK140

However, it was noted in this study that variable fishing costs increase with choice of fishing category, i.e. fishers going offshore incurred more costs (fuel, food, labour and net mending costs) than those fishing inshore and this is attributed to the fact that fishers going offshore locations move long distances in search of fish as well as the higher number net hauls which account for the increased labour and net mending costs (Tables 9 and 10).

4.6.2 Gross margin analysis for Gillnet fishers by fishing location

The results in Table 10 below indicate that higher gross margins are obtained from Chilimira fishery than gillnet fishery in both fishing locations in the study area (inshore and offshore areas). This implies that fishers who have the financial muscle to buy capital items such as the motor sail engine, plank boat, lamps and the Chilimira net might find fishing using Chilimira in the offshore areas of the lake (MK 19,450.02/day) more attractive in terms of profitability compared to inshore fishing using either Chilimira or Gillnet (MK 8,279.33 and MK1, 589.72 respectively). The offshore fishery resources in Lake Malawi are currently underexploited as reported by Thompson and Allison (1997). Therefore, it is not surprising to note the highest gross margins for fishers using Chilimira and Gillnet in the offshore areas of the lake.

Table 9: Gross margin analysis for Gillnet fishers by fishing location

	FISHING LOCATION			
	Inshore	**Offshore**	**T-test**	**P-value**
Benefits				
Average Fish catch (5 litre pail = 10 kg, when packed with fresh fish)/trip	50 kg	80 kg		
Average Price of fish (MK/kg)	MK 66	MK 66		
Gross Income	**MK 3, 300**	**MK 4, 400**	**2.953**	**0.000**
Variable Costs				
Petrol	0	0		
Paraffin	0	0		
Dye	250	300		
Crew Wages	1,060.36	1,557.28		
Mantles	0	0		
Spirit	0	0		
Food Costs	200	200		
Labour Cost for Net mending	400	400		
Twine for net mending	300	353		
Total Variable Costs	**2, 210.36**	**2, 810.28**		
Gross Margin/fishing trip	**1, 089.65**	**1, 589.72**	**2.867**	**0.004**
Labour (Man hours)	**12**	**16**		
Returns to Labour (MK/Man hours)	**90.84**	**99.36**	**2.762**	**0.002**

Note: US$1 = MK140

When all total variable costs are included, fishing using gillnet in the inshore areas proved even much more unprofitable than fishing using the same gear in the offshore area (Lowest gross margin MK 1,089.65). This is further proof that fishing in the inshore areas which are already overexploited will not profit the artisanal fishers unless they move further offshore.

Although the difference is small for Gillnet fishers operating in the inshore and offshore fishing locations in terms of gross margin, it is apparent that in the long run the difference is bound to grow.

CHAPTER FIVE

GENERAL DISCUSSION

The study aimed at determining the factors influencing choice of fishing location and profitability of Chilimira and Gillnet fisheries in Nankumba Peninsula. This chapter discusses results on the dynamics and the extent of influence of factors influencing fishing location choice between Chilimira and Gillnet fishers. The discussion provides an account of the socio-economic relations of fishing and the economics involved in production between the two fishing gears in relation to areas of operation within the Lake. This chapter also discusses and gives an interpretation of the statistical results that were observed in the study.

5.1 Proportion of time spent fishing

Results from this study have shown that fishers spent considerable time in fishing or fishery related activities (Figures 4 and 5). Fishing is an important social activity for most fishing communities. Hara (2001a), reported that fishing is an activity for most men in fishing villages and that the beach is usually the focal point for social meetings, debates of current events etc. while at these forums, they help repairing nets and fishing vessels (both canoes and plank boats) which in most cases earns them some fish to take home. Therefore, time spent doing these fishery related activities is worthwhile for those that did not actually go out fishing on the lake. For those that go out fishing, they spend time

exploring a variety of fishing locations with better patches of fish resources so as to maximize the catch. The fisher (usually the head of crew members), instructs his colleagues to set and haul (pull) the net several times at a chosen location in an effort to improve the size of the catch as well. This also accounts for more time spent time fishing out on the lake especially those using Chilimira.

5.2 The Proportion of fishing location choice among Chilimira and Gillnet fishers

Results from this study show that a majority of Chilimira fishers (92.1%) and a minority of Gillnet fishers (30.3%) exploited the offshore fishery resources in Nankumba Peninsula. Most fishers indicated that success or failure fishing comes down to where and when the fishing gear is in the water. Deciding these matters involves a delicate orchestration of efforts; fact finding, available information, and the final choice. Fishers undergo these processes in an effort to minimize uncertainty. Gatewood (1983) reported that the fishers further attempt to synthesize information they have collected and interpreted in order to produce an informed choice among alternative fishing locations. Given the knowledge of presence of underexploited fishery resources in the offshore parts of Lake Malawi, more fishers are likely to explore these areas in their quest to increase their catches and consequently their benefits from the catch with the gear owner. However, given the unstable weather conditions in the offshore areas as reported by those interviewed in this study, it is very difficult and risky for the Gillnet fisher to fish in these areas. However, they were quick to point out that they minimize this risk by going out in separate crews of four to five fishing in nearby locations.

5.3 Fisher's criteria for choosing of particular fishing locations

Results from Table 5 show that the biggest percentage of fishers preferred to use previous catch as first priority, followed by access to information, target species, fishing experience and gear type and size for those using Chilimira and Gillnet fishing gears. These criteria are crucial to the success of any fishing operation. Fishers commented that without careful consideration of these criteria, a fisher is bound to fail in his fishing exploits. Given the multiple sources of variability in fisheries, fishers diversify their activities by making optimal use of their knowledge of seasonal changes in resources and the environment. This adaptive response provides them with the flexibility needed to increase, or at least maintain their income through the various catches that they target within a particular fishing season: it also represents a way of life. The dominant and profitable fishing gears in Nankumba Peninsula are Chilimira and Gillnet at the moment. Due to the decline in fish in the inshore areas of the lake, most Gillnets have smaller mesh sizes than the recommended size being enforced by fisheries department. This was noted in almost all the landing sites in the study area. Coupled with their inability to go far in their fishing operations due to limiting fishing vessel and gear, the Gillnet fishers are faced with the challenge of maximizing catch within fishing locations that have fish resources that are already overexploited hence their switch of mode of operation to active type so as to catch as many fish as they can as reported by Hara (2003).

5.4Factors that influenced fishers to choose particular fishing locations

Logistic regression analysis was run to identify factors that significantly influenced choice of fishing location among the fishers. A discussion of the factors precedes this section.

5.4.1 Age and choice of fishing location

Logistic regression analysis showed that age of the fisher (also referred to as "signal") could be a determining factor for choice of fishing location among the fishers in the study area. It was noted that the age classes among the fishers were associated with choice of fishing location. The correlation coefficient showed that age was significant and positively related with choice of fishing location (Table 6). This implies that young fishers (<40 years old) are more likely to choose offshore fishing locations because they are energetic and willing to take the risk to try out these new fishing locations unlike older fishers (>40 years old). The better catches realized in the offshore fishing locations acts as an incentive for them to try out the new fishing locations. In addition, Gatewood (1983), reported that older Alaskan salmon skippers (>40 years old) chose inshore fishing locations as opposed to younger skippers who chose distant fishing locations in search of salmon hook off points and were more energetic to withstand fishing in these locations. Furthermore, the younger fishers are looking for other rewards like prestige (the public recognition of success) because there are attached benefits to those who have more prestige. For example, they may attract more skilled crew members and prolific gear owners. A similar assertion was made by Gatewood (1984) who reported that younger Skippers (<40 years old) are striving to gain prestige which accrues in direct proportion to the size of a boat's catch relative to the catches of other boats as opposed to older Skippers (> 40 years old) who may have already acquired this prestige. Thus prestige is won through catching a lot of fish and by fishing in offshore locations they are more likely to realize these catches because there are proven underexploited fish stocks as reported by Thompson and Allison, 1997.

5.4.2 Type of fishing gear and choice of fishing location

This study has also shown that type of fishing gear has an influence on choice of fishing location, as seen by the positive correlation coefficient (Table 6) between this factor and choice of fishing location. This implies that most Chilimira fishers have high probability of going offshore during their fishing operation unlike Gillnetters simply because the fishing gear is an interwoven framework of several meshes which can withstand the water currents and column of the offshore parts of the lake. This assertion was further supported by fishers perception that Chilimira fishing gear is more stable than the Gillnet in terms ability to withstand strong water currents and still maintain the shape required to be able to catch fish. Furthermore, most fishers who indicated that they went offshore in this study, were Chilimira fishers who possessed motor engines (Table 7) and plank boats, equipment which determines the ability of a fisher to operate in rough weather but also influences the ability to steer the Chilimira fishing gear within the water column and effectively set it to catch fish in these deep parts (> 50m) of the lake. This revelation is in accord with the findings of Banda and Weyl (2001), who reported that target species for Chilimira fishing gear are *Engraulicypris sardella* (Usipa), *Oreochromis spp* (Chambo) and other pelagic cichlids present both in the offshore and inshore parts of the lake that enable Chilimira fishers to go offshore during fishing.

5.4.3 Type of fishing vessel and choice of fishing location

The study also found out that type of fishing vessel would predict likelihood of a fisher in choosing offshore fishing locations especially in decision making, as shown by the positive correlation coefficient ($\beta = 1.781$) with choice of fishing location (Table 6). This implies that fishers with plank boats have high propensity of going offshore during their fishing operation unlike those using a mere canoe. This stems from the fact that plank boats are larger in size, more mobile and stable during rough weather. In addition, Anonymous (1999), reported that most Chilimira fishers using plank boats went offshore during their fishing operations in Nankumba Peninsula. This result is not surprising as one would expect Chilimira fishers who normally use plank boats and two canoes to go offshore during fishing as observed by Anonymous (1999). The other reason why Chilimira fishers are able to go offshore fishing with their plank boats and canoes is because of their innovative fishing method and risk loving behaviour to fish in offshore parts of the lake. Generally, it is not easy to operate a canoe in highly unstable areas of the offshore parts of the lake.

It therefore requires a lot of courage and the fisher's ability to take risks to fish in these areas alone in a canoe while giving directions to the rest of the crew members in a plank boat about how they should set the fishing gear in response to fish movements in the chosen location. It is also striking to note that fishing using plank boats in the inshore areas risks crowding conditions with Gillnetters, Nkacha nets and beach seines. It should be noted that type of fishing vessel is strongly related with choice of fishing location (Table 6), not only because travelling longer distances on the lake is risky for canoes but

also because of the belief by the fishers that there are underexploited fish resources lying in the offshore parts of the lake and that there is less competition for space for gear allocation in the chosen locations.

5.4.4 Availability of fish and choice of fishing location

Logistic regression results showed that availability of fish in particular locations could be one of the factors influencing choice of fishing location as evidenced by the positive correlation coefficient of this factor and choice of fishing location (Table 6). This entails that fish availability in a particular location increases the propensity of a fisher in choosing that particular location. Given the knowledge that the fishers have on availability of underexploited fish resources in the offshore parts of the lake, fishers are more likely to choose these locations (Figures 6 and 7).

Chilimira fishers interviewed in this study admitted that on average, they realized better catches each time they went offshore fishing when weather conditions permitted them unlike inshore fishing. This finding supports what was earlier reported by Anonymous (1999), that Chilimira fishers went into deeper areas (> 50m) of the lake around Nankumba Peninsula. However, Logistic regression results show that influence of fish availability on choice of fishing location in this study is not significant (Table 5). This can be attributed to the fact that in artisanal fisheries, in most circumstances, tend to redistribute their effort to minimize catch uncertainities in the areas they operate as noted by van Oostenbrugge *et al.,* 2002. This often leads to exploring a lot of fishing locations both inshore and offshore areas in search of areas with good fish patches of the targeted

fish species; otherwise, they redistribute their effort in an effort to get any catch other than the intended target species. In this study the fishers' behaviour was in full agreement with the classical theory and previous studies. Under the assumption that fishers have homogenous behaviour, Gordon (1953) suggested that the distribution of fishing effort was determined by the expected economic returns to individual fishers from fishing.

In this study, fishers revealed that choice of fishing location was dependent on previous catches and prevailing weather conditions, in which case the latter constrains fishers from fishing in offshore areas as fishers cannot afford to take excessive risks whilst fishing. The patterns of use of the two fishing gears followed the classical theory, in that dynamics of fishing gear employed (used) are influenced by fluctuations in resource abundance (Gordon 1953; Bènè and Tewfik, 2001; Charles, 2001). The decision of Chilimira and Gillnet fishers to fish in a particular location appears to depend on catch revenue in different times of the year, i.e. the high operating costs of Chilimira fishing (Table 1) governs fishers to consider previous day's catch in deciding where to fish. In addition, the ease in which Chilimira nets can be moved to new fishing locations and thus avoid risks caused by the uncertainty of availability of target species in these areas.

5.4.5 Fishing experience and choice of fishing location

Logistic regression analysis showed that fishing experience (number of years spent as a fisher) could be one of the factors influencing the fishers choosing where to fish. Most fishers usually start fishing around the age of the age between 13 and 15 and by the time they reach the age of 40, they usually have gained enormous experience in their fishing

endeavours. The positive correlation between this factor and choice of fishing location (Table 6) entails that fishing experience and not necessarily age impacts on choice of fishing location. Fishers with more fishing experience have better knowledge about location of fish, weather patterns, bottom conditions, currents, trends in catches of fish from different locations and how best to catch the fish. It is believed that this information is crucial in decision making about where to fish.

Gatewood (1983) reported that fishers synthesize information gained through a lot of years spent in fishing in predicting patterns of fish movement and availability in certain locations in different times of the fishing season. Furthermore, Durrenberger and Pálsson (1986) pointed out that the decision making process includes all the knowledge and theories fishers acquired to interpret information, they also consider its critical values in terms of the fishers' actions and the informal consequences of these actions to the fellow crew members accumulated over time through years spent fishing are crucial as regards the choice of fishing location. However results show that influence of fishing experience on choice of fishing location is not significant.

5.4.6 Possession of motor engine and choice of fishing location

The study showed that possession of motor sail engine by the fisher could influence choice of fishing location (Table 6). In addition, the correlation coefficient showed positive correlation ($\beta = 2.049$) between possession of motor sail engine and choice of fishing location. This implies that likelihood of choosing offshore locations where there

are proven offshore stocks by fishers who did not have motor sail engines was significantly less than those who had engines. Fishers who had engines admitted that they chose offshore fishing locations where they had a number of times realized more catch than the inshore locations. Similarly, Gatewood (1983) reported that fishers consider the type of technology (fishing gear, vessel and equipment like motor sail engines) in deciding where to fish.

This is most likely the case because accessibility of particular fishing distant fishing locations is partly dependent on the ability of the fisher to move with relative ease. As such those with motor sail engines have more likelihood of accessing these particular locations than those who don't have engines. Furthermore, Anonymous (1999) argued that fishing location choice is an economically motivated activity like any other business activity and therefore fishers are willing to go far in search of locations here they are likely to realize good catches of fish to compensate for the imposed costs of fishing like fuel.

5.4.7 Access to information about catch rates and choice of fishing location

The results have shown that access to information about catch rates could be one of the factors influencing choice of fishing location. This is in view of the positive and significant relationship between this factor and choice of fishing location (Table 6). This implies that fishers with access to information about catch rates have high propensity of choosing locations with better catch rates as opposed to those just randomly searching for location with patches of fish. Gatewood (1983; 1984), reported that fishers are a small

closely connected group, therefore information tends to spread very rapidly. Usually today's information is basically yesterday's landings information. Furthermore, it has been widely reported that fishers use current information in deciding where to fish (Gatewood, 1983; 1984; Wilson, 1990; Durrenberger and Palsson, 1986). Fishers use a wealth of detailed knowledge to decide both when and where to fish. They must choose times and places to fish on the basis of their knowledge of water currents, behaviour of different kinds of fish, past seasons and bottom features, feeding patterns, their ideas about fish breeding and their interpretations about weather reports from radios.

By memorizing past observations and monitoring recent catch rates, each fisher stores relevant information and uses it to make predictions about the relative productivity of different locations. Usually when a fisher and the rest of the crew members decide to fish, he has in his mind a location and a time. But should he receive new information about good catch rates elsewhere other than the intended fishing location, he usually switches to the locations being rumoured. This notion also partly explains the mobility nature of artisanal fishers on Lake Malawi as earlier on reported by Mvula (2002) and Hara (2006).

5.6 Profitability of fishing

The aim of profitability analysis was to provide an assessment of costs and earnings resulting from fishing using the two fishing gears between different locations, locational variation in mean daily revenues and profitability. The study revealed that Chilimira fishers exploiting the offshore locations of the lake have higher mean daily gross margins (Table 8), returns to labour and catches per fishing trip unlike those exploiting inshore

locations. Hara, (2001a), reported that most fishers' motivation for fishing was both subsistence and profit. He further pointed out that they took home a smaller portion of the allocation of the catch and sold the major part implying that fishing units provide an essential economic livelihood. In this context, fishers would be expected to exploit locations that are believed to contain more patches of resource available for fishing in an effort to maximize their catches. This finding supports the hypothesis that differences in profitability for fishers using the same gear and craft combination are due to differences in resource availability arising from difficulties associated with access to these particular locations.

However, the study showed that chilimira fishers who exploited offshore areas incurred more mean variable costs than their inshore counterparts. This is expected because fishers who normally exploit offshore (apart from the few Gillnet fishers observed in this study) have motor engines. Therefore, incur more fuel costs and consequently bear a lion's share of the mean daily variable costs (operating costs). Despite the increase in operational costs for the Chilimira fishers fishing offshore, the findings from this study indicate that fishing in the offshore is profitable and therefore, be encouraged among the artisanal fishers.

CHAPTER SIX

CONCLUSIONS, RECOMMENDATIONS AND POLICY IMPLICATION

6.1 Conclusions

The concept of fishing effort allocation was introduced in chapter one in which background to fishing location dynamics was explained. Emphasis was given to the importance of deciding where to fish and the profitability associated with the chosen locations in an effort to understand fisher behaviour and predict effort allocation among artisanal fisheries with heterogeneous fishing units. The Fisheries Departments' interest in promoting artisanal fishers to explore offshore fishing is commendable and of paramount importance in trying to reduce pressure exerted on the over fished inshore fishery resources, and therefore, encouraging the regenerative capacity of the inshore fishery resources.

This study aimed at understanding fisher's choice of fishing location by looking at the profitability of operating or choosing both inshore and offshore fishing locations. The study also sought to identify evaluation criteria that fishers used in their decision-making regarding choice of fishing location.

Regression analysis for fishers' choice of fishing location using logit model was applied with the aim of isolating factors that influence fishers in Nankumba Peninsula to decide where to fish during their fishing trips.

Results from fishers' interviews revealed that fishers are committed to their fishing occupation despite the risks and uncertainty associated with fishing. Results of time spent fishing show that fishers spent up to 12 hours fishing. Furthermore, the higher returns to labour realized by fishers in this study to compared to the minimum wage rate for casual labourers in rural areas means that fishers find their occupation more rewarding for their time spent fishing or doing fishery related activities. It is therefore concluded that fishing in Nankumba Peninsula is an important socio-economic livelihood activity for the fishers. The results also reveal that a majority of Chilimira fishers are exploring offshore fishing locations while the converse is true for Gillnet fishers. This result supports the finding of Anonymous, (1999), who reported that more Chilimira fishers were fishing in offshore locations during their fishing trips in Nankumba Peninsula.

Findings from this study indicate that fishers are reluctant to change fishing locations in the short term i.e. on daily basis more especially if they are realizing good catches and consequently benefitting economically. Results revealed that fishers used previous day's catch rates as first criteria in their decision making about where to fish during their fishing trips the next day. Fishers' criteria for deciding where to fish involved a complex interaction of biological, technological, personal, and economical factors and time. Biological factors included amount of catch and target species. Technological factors included fishing gear type and size and easiness of fishing gear operation. Personal factors included fishing experience and access to information about catch rates. An economical factor was operational costs. It can therefore be concluded that fishers in Nankumba Peninsula use different criteria to decide where to fish.

From the amount of capital invested in the fishing units, the study revealed that Chilimira fishers are by far economically better off and endowed with more resources than Gillnet fishers. This was in view of the fact that a majority of Chilimira fishers were in the highest capital invested bracket compared to Gillnet fishers (Table 1). Similarly, trends in fishing equipment and accessories was better off in Chilimira than Gillnet fishers, most of them possessed engines, lamps and plank boats while Gillnet fishers had canoes and paddles which are relatively cheaper to procure than those used by Chilimira fishers. It is therefore concluded that Chilimira offshore fishing is more capital intensive due to the nature of equipment associated with this fishing unit than Gillnet.

The study also revealed that Chilimira offshore fishers realize higher catches and consequently higher daily gross margins than their inshore counterparts (Table 8), this is due to the fact they are able to exploit the underexploited proven offshore stocks by Thompson and Allison, (1997). It is therefore concluded that Chilimira offshore fishing is more profitable than inshore fishing using the same gear.

Factors that influence fisher's choice of fishing location include: age of the fisher, type of fishing gear, possession of motor engine, type of fishing vessel, fishing experience, availability of fish and access to information about catch rates. However, it can be seen that age of the fisher, possession of motor engine, type of fishing gear, access to information about catch rates and type of fishing vessel have significant influence on fisher's choice of fishing location.

6.2 Recommendations

The study has revealed some interesting key findings from which the following recommendations have been drawn:

- Calculation of gross margin to resource outlay (fishing equipment and labour) indicate that Chilimira fishers should be encouraged and empowered financially or otherwise to exploit offshore areas of the lake which have proven offshore fishery resources to realize more catches claimed to be present in this zone. This will encourage an improved regenerative capacity of inshore stocks due to the lessened pressure on them. However, this must be carefully monitored by government and all stake holders in the area to ensure a healthy stock-recruitment relationship of the under-exploited offshore fishery resources.

- Importantly this was a pilot study aimed at investigating factors influencing choice of fishing location within the tropical artisanal and multi species fisheries as basis for understanding fisher behaviour and economics driving their fishing operations. This information is crucial to understanding location choice behavior and fishing gear allocation dynamics among Malawian artisanal fisheries sector. Therefore, it is recommended that similar studies be conducted on a wider scope to allow comparisons within the artisanal fishery of Lake Malawi and other water bodies.

- For future similar studies, there is need to calculate depreciation in order to generate net incomes which would give a stronger picture of the extent of profitability within the artisanal fishery industry due to an increase in the number

of capital assets being invested in the small scale fishing industry like engines, lamps and plank boats.

6.3 Policy Implication

One finding of this study is that Chilimira offshore fishers currently using capital-intensive fishing equipment are realizing higher daily gross margins and returns to labour. However, they are incurring higher operational costs per fishing trip. This means that the further offshore locations demand more fuel for the motor engines and therefore increased dependency on fuel, meaning that fish prices will be dictated by the current prevailing fuel prices as fishers will not allow operating below break-even point as economic agents. This implies that any development intervention should build and improve on the already existing technologies currently being used by the artisanal fishers otherwise new efforts will prove futile because as demonstrated in this study, the artisanal fishers are already have experience in operating these gears and profiting from offshore fishing.

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Appendix 1

FACTORS INFLUENCING CHOICE OF FISHING LOCATION IN NANKUMBA PENINSULA: A Case study of Gillnet and Chilimira fisheries

FIELD QUESTIONNAIRE

I. IDENTIFICATION INFORMATION

Date:……..

Enumerator:……...

Name of Beach:(1) Chizale (2) Masasa (3) Msaka (4) Malembo

(5) M'bwadzulu (6) Zambo (7) Mvunguti

Village:……..

II. DEMOGRAPHIC CHARACTERISTICS

1 Name of respondent:…….

2 Gear Owner: (1) Yes (2) No

3 Crew Member:(1) Yes (2) No

4. Sex: (1) Male (2) Female

5 Age:……

6 Marital Status:(1) single (4) divorced

(2) married (5) widowed

(3) Separated (6) polygamy

(7) Other (specify)……

7 Ethnic group: (1) Yao (2) Lomwe

(3) Ngoni (4) Chewa

(5) Tonga (6) Tumbuka

(7) Sena

8. Gear Type: (1) Chilimira (2) Gillnet

9. Gear Size:……

III. PROFITABILITY ANALYSIS

Item	Size (Ply/length/No.)	Unit Price	Quantity	Total Cost
Materials For Gear				
¼ inch netting				
1 inch nettings				
1.5 inch nettings				
2 inch netting				
2.5 inch netting				
3 inch nettings				
Head Rope				
Foot Rope				
Pulling Rope				
Floaters				
Sinkers				
Roll of twine connecting				
Chichiri				
Labour charge for construction				
Craft Material				
Plank Boat				
Engine Boat				
Paddles				
Anchor				
Anchor Rope				
Canoes				

Lamps				
Operational Costs				
Petrol				
Oil				
Paraffin				
Mantles/Trip				
Spirit				
Crew wages				
Food costs/day				
Labour cost for mending				
Roll of Twine for mending				
Dye (Frequency)				
Catch Earnings				
Catch sales/day				
Price/tin/kg				

(IV). FACTORS INFLUENCING CHOICE OF FISHING LOCATION

A. FISHING OPERATION

8. Where did you go fishing?

(1) Inshore area

(2) Offshore areas

8.1 How long does it take you to reach the fishing ground?

……
……

8.2. How and why did you choose this particular fishing location?

Fishing Location	Yes / Criteria used to choose Inshore area	No / Criteria used not to choose Inshore area

9. How do you operate your fishing gear (for Gillnet only)?

(1) Basic Gillnet operation (2) Chikwekwesa (3) Chiombera

10. What is the amount of catch (on average) for the gear per fishing trip?

(1) 1 – 20 pails (2) 21 – 40 pails (3) 41 – 60 pails (4) 61 – 80 pails (5) 81 – 100 pails (6) over 100 pails

11. What is the species composition of the catch?

(1) Utaka (2) Kampango (3) Nkholokolo (4) Chisawasawa (5) Usipa (6) Ncheni (7) Ndunduma (8) Sanjika (9) Jamisoni

12. What is the mesh size of the gear using the fishing operation in question?

……
……
……

13. How long do you stay fishing using the fishing operation?

(1) 1 – 3 hrs (2) 4 – 6 hrs (3) 7 – 9 hrs (4) 10 – 12 hrs (5) Overnight

14. How long does it take for you to replace the fishing gear?

(1) within 1 year (2) 2 – 4 years (3) 5 – 7 years (4) 8 – 10 years (5) 0ver 10 years

15. Why do you prefer the fishing operation in question?

……
……
……

16. What is the size of the crew using the fishing operation?

……
……
……

B. INSTITUTIONAL ARRANGEMENTS

17. What is the sharing arrangement of the landed catch?

……
……
……

18. Status of the crew: (1) Permanent

(2) Temporary

(3) Hired

19. Number of Fishing Trips: (1) Once a day

(2) Once every two days

(3) Once every three days

(4) Once every four days

(5) Once every five days

20. Number of pulls/sets per fishing trip

……
……
……

21. How long have you been in the fishing business?

……
……
……

22. Is your fishing business profitable? (explain)

……
……
……

23. What are the major constraints of your fishing business?

……
……
……

24. What was the source of your capital?

- Fishing
- Farming
- Remittances from relatives
- Credit/Loan
- Employment
- Casual Labour e.g. from fishing as crew members or ganyu in farming
- Other, please specify……

25. When did you buy your fishing equipment?

(1) Fishing gear……

(2) Fishing vessel…….

(3) Engine…….

26. When was the fishing net and craft constructed/procured?

- Fishing net……
- Vessel……...
- Engine Power and type……
- Accessories……..

27. Who constructed the boat (supplier and place)?

……
……
……

28. How do you compare fishing business as at present with the past (e.g. over 10 years

ago)?

1) More profitable now than in the past

……
……

2) More profitable in the past than now

……
……

3) No change observed

……
……

30. Have you heard about the fish resources in the offshore parts of the lake?

……
……
……
……

31. If you had access to capital to purchase improved fishing equipment, would you switch to offshore fishing?

(1) Yes

(2) No

32. If no why?

……
……
……
……

33. Who directs the fishing operation?

……
……
……