

COPING STRATEGIES FOR FISHERS TOWARDS INVASIVE ALIEN PLANT
SPECIES (*Salvinia molesta*) AT LUKANGA SWAMP, CENTRAL ZAMBIA.

By

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A dissertation submitted to the University of Zambia in partial fulfilment of the
requirements of the degree of Master of Science in Environmental and Natural
Resources Management.

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DECLARATION

I, Jimmy Njobvu, declare that the dissertation which I hereby submit for the Master of Science Degree in Environmental and Natural Resource Management at the University of Zambia, is my own independent work and where other works have been incorporated, they have adequately been referenced and acknowledged herein. I further declare that this work has not been submitted previously for any other degree at the University of Zambia or any other institution.

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CERTIFICATE OF APPROVAL

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ABSTRACT

Lukanga Swamp in Zambia, is one of the major fisheries which has been invaded by the aquatic invasive species commonly known as Kariba weed (*Salvinia molesta*). Generally, studies show that in areas where aquatic weeds occur, fish populations and catches are reduced and this problem is not restricted to a particular geographical area but is common to all water bodies where aquatic weeds have invaded. A fundamental problem facing fishers at Lukanga Swamp, is therefore, how to maintain satisfactory levels of fish catches with the presence of *S. molesta*. This study, therefore, investigated how the fishers are coping with the presence of *S. molesta* at Lukanga Swamp. The study focused on identifying major coping strategies of fishers towards the presence of *S. molesta* and the effectiveness of the identified coping strategies. The study used both qualitative and quantitative methods of collecting and analysing data. The target population were the fishers and residents of Waya a nearby village. 41 fishers and 4 key informants were purposively selected and interviewed whereas 150 residents of Waya village were randomly selected and interviewed. An interview schedule and interview guides were used to collect qualitative data from fishers and key informants, whereas a questionnaire was used for quantitative data from Waya residents. Qualitative data were analyzed using content analysis whereas quantitative data were analyzed using descriptive statistics comprising frequencies and means. The effectiveness of the coping strategies was assessed using a 5-Point Likert Scale Method. To determine how different the ratings of the effectiveness of the coping strategies were, an ANOVA test was conducted.

The results of the study showed that the presence of *S. molesta* at the swamp led to a number of challenges to fishers which included; difficulties in boat navigation (28.8%), and swamping of fishing grounds (22%). For the survey, results also indicated that fishing related activities have decreased due to the presence of the weed at the swamp. The major coping strategies for fishers identified in this study among others included; manual removal of the weed in infested routes (39%) and shifting to open waters which are less affected by the weed (26.8%). For the survey, those involved in fishing related activities such as fish traders have resorted to farming (66.5%) as coping strategy. Results further show that most of the coping strategies of the fishers at Lukanga Swamp were rated as either ineffective or fairly effective. The ANOVA test showed that the rating of the coping strategies of respondents were more with ineffective ratings (Mean=53) than with other ratings. Therefore, statistically, it can be concluded that the respondents felt the coping strategies were ineffective. In conclusion, the study has shown that the presence of the weed at Lukanga swamp has affected the livelihood of the fishers and how they are struggling to cope with its invasion effectively. The study has also highlighted that effectively dealing with invasive species is a costly exercise which the lower income earning Lukanga fishers cannot afford. The study, therefore, recommends the need for responsible institutions such as ZEMA to develop relevant measures, policies, regulations and effective institutional and operational responsibilities for addressing invasive species. There is also need for follow up studies to further understand the ecological effects of the presence of *S. molesta* on the natural resources at Lukanga Swamp.

DEDICATION
To my family and friend

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LIST OF ABBREVIATIONS AND ACRONYMS

CABI	Center for Agriculture and Bioscience International
GDP	Gross Domestic Product
DFID	Department for International Development
ECZ	Environmental Council of Zambia
FAO	Food Agriculture Organization
FDG	Focus Group Discussion
FISP	Farmers Input Support Programme
GISD	Global Invasive Species Database
GISP	Global Invasive Species Program
GRZ	Government of the Republic of Zambia
IAS	Invasive Alien Species
IAPS	Invasive Alien Plant Species
IAPRI	Indaba for Agriculture Policy and Research Institute
IPM	Integrated Pest Management
IUCN	International Union for Conservation of Nature
MA	Millennium Ecosystem Assessment
MT	Metric ton
NGO	Non-Governmental Organization
NISSAP	National Invasive Species Strategy and Action Plan
NOAA	National Oceanic and Atmospheric Administration
OAG	Office of the Auditor General
SADC	Southern African Development Community
UNEP	United Nations Development Programs

USA	United States of America
USD	United States Dollars
UK	United Kingdom
SLF	Sustainable Livelihoods Framework
WWF	Worldwide Wildlife Fund
ZAWA	Zambia Wildlife Authority
ZEMA	Zambia Environmental Management Agency

CHAPTER ONE INTRODUCTION

1.1 Background

In Zambia, wetlands occupy more than 20 per cent (150 520 km²) of the country's total area (FAO, 2017; GRZ, 2018). Wetlands contribute to economic development through supporting various economic sectors such as tourism, agriculture, fisheries, forestry among others (GRZ, 2018). The principal natural resource utilization in many wetlands are fishing, livestock grazing and cultivation. Wood *et al.*, (2013), argues that wetlands were estimated to contribute around 5 percent of Zambia's Gross Domestic Product (GDP) annually. Despite the many benefits they offer, wetlands continue to be among the world's most threatened ecosystem, owing mainly to overexploitation, water pollution, and invasion by alien species. While threats may vary between regions and even within wetlands, the invasion of invasive species in wetlands is considered to be the most significant threat. A study by Kohl (2011), revealed that whereas only about 6 percent of the world's land mass is covered in wetlands, 33 percent of the world's most *Invasive Alien Species* (IAS) are wetland invaders. Wetlands are particularly vulnerable to species invasions mainly as a result of their position which is at the interface between terrestrial and aquatic environments which makes them susceptible to invasion from both spheres.

Lukanga Swamp in Zambia, is one of the wetlands of high economic and ecological value which was also designated as a Ramsar Wetland of International Importance in 2004. The swamp is the largest permanent water body in the Kafue basin and is among the eleven (11) main fisheries in the country. It is estimated that about 60,000 people live in, or close to the swamp and that products, derived from fishing and agriculture, support a population of some 6.1 million people (Kachali, 2007; McCartney *et al.*, 2011; Mapedza *et al.*, 2012). In recent years, the swamp has been invaded by aquatic invasive species commonly known as Kariba weed (*Salvinia molesta*). According to Birdwatch Zambia (2017), since 2009, the swamp has been infested by the invasive Kariba weed and the weed is currently occupying a significant proportion of about 2000 km² (over 60% surface area) of the swamp. *S. molesta* is floating aquatic weed native to Brazil

which is characterized by dense mats that block sunlight and limits the ability of native species to grow including fish (GISP, 2015). Like most of the invasive alien plant species, wherever *S. molesta* has been introduced outside of its native range, it has caused both economic and ecological damage.

The presence of aquatic weeds in water bodies affects the fisheries negatively as the weeds tend to reduce oxygen and limit the ability of fish species to grow, restricts fishing and access to fishing spot and also causes difficulties in using long lines and nets, which in turn, reduces fish catches (ECZ, 2004; GISP, 2015; Kurugundla *et al.*, 2016). For example, United Nations Environmental Program (2013) indicated that in Lake Victoria, fish catch rates on the Kenyan section decreased by 45 percent because water hyacinth mats blocked access to fishing grounds, delayed access to markets and increased costs (effort and materials) of fishing and Kurugundla *et al.* (2016) reported that the thick surface coverage of *S. molesta* in the Okavango Delta of Botswana reduced fish yields by 40-50 percent in 1986, 1992, 1998 and 2010. This problem is not restricted to a particular geographical area but is common to all water bodies where aquatic weeds have invaded.

Therefore, a fundamental problem facing fishers at Lukanga Swamp is how to maintain satisfactory levels of fish catches with the presence of *S. molesta*. This study was therefore, an investigation on how the fishers are coping with the presence and the effects of *S. molesta* at Lukanga Swamp. The study focused on identifying the major coping strategies of fishers towards the presence of *S. molesta* and the effectiveness of the identified coping strategies.

1.2 Statement of the Problem

Fishing is one of the most important livelihood activities at Lukanga Swamp which provides cheap source of proteins for local households and income for fishers. However, in recent years, the swamp has been invaded by *S. molesta*. Generally, studies show that in areas where aquatic weeds occur, fish populations and catches are reduced (Ciruna *et al.*, 2004; GISP, 2006; Kurugundla *et al.*, 2016). This problem is not restricted to a particular geographical area but is common to all water bodies where aquatic weeds

have invaded. Despite Lukanga being a Ramsar Wetland of International Importance, there has been very minimal interventions from the government in terms of eradicating and controlling the weed. This has compelled the fishers to come up with livelihood survival strategies amidst the presence of the weed. A fundamental problem facing fishers at Lukanga Swamp, is therefore, how to maintain satisfactory levels of fish catches with the presence of *S. molesta* at the swamp.

There is enough evidence on how aquatic weeds affect the fisheries through reduced fish populations and catches (ECZ, 2004; GISP, 2015; Kurugundla *et al.*, 2016), however, what is not well documented is how resource users cope with the presence of invasive species. At Lukanga Swamp, most previous studies have focused mostly on human induced pressures on the ecosystem and conflicts in resource use and management (McCartney, 2011; Mapedza *et al.*, 2012; Hunink *et al.*, 2017) and also on the hydrological and habitat structure of the swamps (McCartney, 2007 and 2011; Chabwela *et al.*, 2017). There has been very little information with regards to how the weed has affected the fishers at the swamps and how they are coping towards its presence. Therefore, this study focused on investigating the coping strategies of fishers towards the presence of *S. molesta* at Lukanga Swamp.

1.3 Aim

The aim of the study was to investigate the coping strategies by fishers at Lukanga Swamp towards the effects of *S. molesta*.

1.4 Objectives

- i. To find out how *S. molesta* has affected the fishers at Lukanga Swamp.
- ii. To identify the major coping strategies used by the fishers at Lukanga Swamp in dealing with the effects of *S. molesta*.
- iii. To assess the effectiveness of the major coping strategies used by the fishers in dealing with the effects of *S. molesta* at Lukanga Swamp.

1.5 Research Questions

This study aims at answering the following questions

- i. How has the presence of *S. molesta* affected the fishers at Lukanga Swamp?
- ii. How are the fishers responding to the presence of *S. molesta* at Lukanga Swamp?
- iii. How effective are the major identified coping strategies used by the fishers in dealing with the effects of *S. molesta* at Lukanga Swamp?

1.6 Significance of the Study

Invasive Alien Species (IAS) are the second greatest known threat to biodiversity after direct anthropogenic factors globally (ECZ, 2004; GISP, 2015; National Oceanic and Atmospheric Administration (NOAA), 2014). However, GISP (2007) observed that IAS are more often perceived as an environmental or biodiversity issue, and consequently (especially in developing countries) do not receive due recognition by policy-makers and yet the reality is that they are a major threat to human livelihoods, especially to agriculture, fisheries and food security. In Zambia, they are also recognized as a major threat to biodiversity. A survey by ECZ (2008) indicated that invasive species were well established in most water bodies in the country. Despite this recognition, very little effort has been made in terms of programmes aimed at preventing, mitigating, controlling and eradicating invasive species in the country. This study is significant because it intends to highlight how the livelihoods of the fishers at Lukanga Swamp have been affected by the presence of *S. molesta* and their coping capabilities.

Adequate knowledge on the effects of invasive species and coping strategies is important as it will provide a better understanding on the effects of *S. molesta* on the Lukanga fisheries, ongoing adaption measures and the effectiveness of these measures. It is hoped that the research would serve as a valuable source of information to stakeholders responsible for wetlands management (Fisheries Department, ZEMA and ZAWA) and also anyone seeking information regarding invasive alien plant species and the fishery. It is also hoped that the findings can be used by other researchers as a starting point for further studies in relation to plant invasive species and wetland resources.

1.7 Organization of the Dissertation

This dissertation comprises of six chapters. Chapter one highlights the introduction of the study by bringing out the background, statement of the problem, aim, objectives, research questions and significance of the study. Chapter two reviews the relevant Literature on fisheries and invasive species with special reference to Zambia. Chapter three presents a description of the study area by outlining the physical characteristics and the socio-economic characteristics of the study area. Chapter four discusses the research methodology by highlighting the selection and choice of the methods of data collection and analysis used in the study. Chapter Five provides an account of the results and discussion of the study and the chapter is organized in three main parts; (i) the first part establishes how the presence of *S. molesta* has affected the fishers at Lukanga Swamp, (ii) the second part identifies the major coping strategies of fishers at Lukanga Swamp toward the presence of the weed (iii) and lastly, the third part assesses the effectiveness of the identified coping strategies of fishers. Chapter Five is followed by Chapter Six that reflects on the main conclusions as well as the recommendations of the study.

CHAPTER TWO LITERATURE REVIEW

2.1 Introduction

This chapter presents literature reviewed on fisheries, invasive species and coping strategies. Firstly, literature on the general overview of the fisheries sector in Zambia with much emphasis on the Lukanga fisheries is reviewed. This is followed by a review on the general effects of aquatic weeds on the fisheries. Lastly, the chapter reviews literature on coping strategies.

2.2 Overview of the Fisheries Sector in Zambia

Fish is a popular part of the diet in Africa (FAO, 2009) and in Zambia, a study by FAO (2012) indicated that fish made up 53 percent of animal protein in the diet of Zambians. The fisheries sector is important in Zambia as it contributes 3 percent to the agriculture GDP which stood at 18 percent in 2015 (Office of the Auditor General, 2015) and also supports around one million people both directly and indirectly (GRZ, 2014). The fisheries sector provides employment through fishing, processing, trading and boat building. Studies have indicated that the number of fishers in the country is estimated at over 72, 000 (OAG, 2015; Shula and Mofya, 2015). The overall objective of the fisheries sector is to contribute to poverty reduction and economic growth through sustainable utilization of the fisheries resources (ECZ, 2008; FAO, 2009). According to ECZ (2004), the fisheries of Zambia are classified into major and minor fisheries (which include fisheries of small water bodies). There are eleven (11) main fisheries; four belong to the Congo River basin and seven to the Zambezi River basin (FAO, 2009). The fisheries in the Congo basin are Bangweulu, Mweru Luapula, Mweru Wantipa and Tanganyika, whereas, Kafue, Kariba, Luangwa, Lukanga, Upper Zambezi, Lower Zambezi, Itzhi-tezhi and Lusiwashi belong to the Zambezi basin (FAO, 2009; Shula and Mofya, 2015).

Generally, there has been a decline in the fish production in most of the fisheries in the country. For example, studies at Mweru Wantipa revealed that the fisheries' contribution to the annual fish production of Zambia declined from 24 percent in 1976 to 14 percent in 1985 and to only 5 percent in 1995 (FAO, 2009; OAG, 2015; Shula and Mofya,

2015). Similarly, at Lake Kariba, a study by GRZ (2015) for Kapenta catch, show a decline in capture from 177 to 72 kg/boat/night. The report by GRZ (2015), further indicates that at Kafue River in the 1990s, fish catches were averaging around 7, 000 tons but recent estimates are at an average of 4, 000 tons annually. Various studies have been conducted in relation to the decline of fish production in most of the fisheries in the country and their findings show that the major threats to sustainable fisheries production is due to; over fishing, use of destructive fishing methods and increased number of fishers (ECZ, 2004; FAO, 2009; OAG, 2015; Shula and Mofya, 2015).

A study by ECZ (2004) for example, revealed that one of the major threats to sustainable fisheries production in the country is over fishing which is caused by increased number of fishers exerting pressure on the fisheries resource and the use of bad and destructive fishing methods. The report further argues that other factors are poor enforcement, monitoring and management of fisheries caused by inadequate supervisory capacity, lack of data of fish stocks and guidelines. Similarly, FAO (2009) also reported that the drop in the per capita consumption of fish in Zambia is mainly due to the decline in fish stocks in some major fisheries as a result of excessive fishing and use of bad fishing methods, as well as an increase in demand due to the increase in the human population. As a result, impoverished rural fishing communities have become trapped in a cycle of declining individual catches resulting from increased effort, reduced mesh sizes and ultimately use of environmentally destructive fishing gears such as large beach seine nets lined with cloth to catch the few remaining small fish species that can survive the intense, unrelenting effort (Tweddle *et al.*, 2015).

Most of the studies conducted in relation to the challenges of the fisheries in the country, in their findings, did not highlight the critical role and effects of invasive alien species on the fisheries (ECZ, 2004; FAO, 2009; OAG, 2015; Shula and Mofya, 2015) and yet a survey by ECZ (2008) revealed that invasive species were well established in most of the main fisheries in the country. For example, a survey by ECZ recorded the following invasions of aquatic weeds in main fisheries: *Vossia Cuspidate* in Lake Mweru, Lake Tanganyika and Lake Bangweulu; *Salvinia molesta*, *Mimosa pigra* and *Eichhornia cassipes* in Zambezi flood plain; and Kafue River recorded the highest number of aquatic weeds (V.

cuspidate, *E. cassipes*, *M. pigra*, *S. molesta*, *Papyrus*, *Lantana camara* and *Striga sp.*). Generally, studies show that in areas where aquatic weeds occur, fish populations and catches are reduced (GISP, 2015; Kurugundla *et al.*, 2016). For example, GISP (2015), argues that fewer fish, by number and weight, are found in infested areas of water bodies and yet very little or no studies in Zambia have attributed the fish decline in the country to the presence of invasive plant species. It is therefore, evident that information with regards to fisheries and IAS in the country is still limited. There is still very little information connecting the fisheries and IAS especially on the declining fish catches and how fishers respond towards the presence of invasive species.

2.3 The Lukanga Fisheries and its Challenges

Fishing in Zambia is carried out by two distinct groups: industrial operators and traditional or artisanal fishers (Musumali *et al.*, 2009). The industrial operators are found mainly on Lake Kariba and Lake Tanganyika where they operate large fishing vessels exploiting the pelagic (open water), whereas, the artisanal fisheries are small scale fishers who produce fish enough to eat and sale locally with no ambitions to export (FAO, 2009; Musumali *et al.*, 2009; OAG, 2015). In Zambia the fisheries are largely artisanal (Musumali *et al.*, 2009). This study mainly concentrates on the artisanal fishers at Lukanga swamp. Artisanal fishers use simple crafts, nets, dug-out canoes and other traditional methods of fishing. They are located around each fishery in camps or villages (FAO, 2009) and count up to more than 70 000 in number (OAG, 2015). They dominate in terms of production out-put and labour and their fish is usually distributed by private and individual traders, mostly women (FAO, 2009; Musumali *et al.*, 2009; OAG, 2015). Thus, it can be argued that artisanal fishery from a rural development point of view is an important open employment sector.

Fishing at Lukanga Swamp began in the 1950s following immigration of Bemba fishers (Kachali, 2007). It is alleged that this migration was a result of depletion of fisheries in Luapula and Northern provinces (Kachali, 2007; McCartney *et al.*, 2011). Lukanga fisheries is comprised mainly of the fishers, Fisheries Department, and fish traders and fisheries committees. The Fisheries Department at Lukanga Swamp is the government institution that is mandated to manage fisheries and enforce fishing regulations within

the wetland (McCartney *et al.*, 2011). There are a number of regulations relating to the need to obtain fishing permits, restrictions on the minimum mesh size of nets as well as when and where fish may be caught, and rules on the marketing of fish so as to ensure sustainable exploitation (FAO, 2009; McCartney *et al.*, 2011). The Fisheries Committees, on the other hand, are mandated to work with Fisheries Department staff in spearheading sustainable fisheries education and also assist in the enforcement of fishing rules and regulations (Kachali, 2007).

The Lukanga Swamp has been one of the major fishing grounds in the country and much of the fish (mainly Tilapia) caught is processed within the swamp and transported to the Copperbelt and Kabwe (Kachali, 2007; McCartney *et al.*, 2011; Mapedza *et al.*, 2012; Chabwela *et al.*, 2017). The economy in the area is based on the fishing industry and most of its inhabitant being fishers (Mapedza *et al.*, 2007; Mapedza *et al.*, 2012; Chabwela *et al.*, 2017). It has been estimated that about 1,200 metric tons of fish are caught per year (FAO, 2009; McCartney *et al.*, 2011). In addition, much of the Lukanga Swamp is a fish breeding area and most of the streams leading to the swamp are important for breeding fish species (Mapedza *et al.*, 2012; Chabwela *et al.*, 2017).

Lukanga fisheries faces a lot of challenges which constrain it to effectively contribute to the overall objective of the fisheries sector. Studies at Lukanga indicate that there has been a decline in fish production at the swamp (Kachali, 2007; McCartney *et al.*, 2011; Mapedza *et al.*, 2012). For example, Kachali, (2007), reported that fish catches at Lukanga Swamp were not as large as they used to be and income from fishing has fallen over the last decades as a result of ever-increasing number of fishers and bad netting practices. Furthermore, a study by McCartney *et al.* (2011) revealed that the Fisheries Department lacked the human and financial resources to effectively monitor and enforce the regulations, and much of the fishing conducted within the wetland is strictly illegal. In addition, Kachali (2007), reported that at Waya fish camp, there were only 5 fisheries officers, one boat and little in the way of fuel and food supplies to police about one-fifth of the wetland area.

Studies at Lukanga Swamp have also largely attributed the decline in fish production and catches mainly to over fishing and use destructive fishing methods (McCartney *et al.*, 2011; Mapedza *et al.*, 2007) despite the presence of *S. molesta* at the swamp for over two decades (Birdwatch, 2017). In addition, studies have also focused very much on human induced pressures on the ecosystem and conflicts in resource use and management (Schuyt 2005; Kachali, 2007; Haller and Chabwela, 2009; McCartney *et al.*, 2011; Mapedza *et al.*, 2012). For example, studies by Haller and Chabwela (2009) revealed that the majority of fishers are immigrant Bemba fishers who have settled in fishing camps such as Waya and Kaswende. This had led to conflict particularly between predominantly Bemba fishers and the indigenous Lenje people who refer to the Bemba migrants as ‘enemies.’ Similarly, a study by Mapedza *et al.* (2012) examined the political ecology of the Lukanga Swamp and revealed that the designation of the Lukanga Swamp as a Ramsar site had given rise to competing ‘narratives’ by politicians and local community leaders over how Lukanga should be managed and used, and the resulting conflict was threatening its sustainability.

However, despite the presence of the weed at the swamp, very few studies, have been conducted in relation to fisheries and *S. molesta* at Lukanga Swamp. A case example, is a recent study by Chabwela *et al.* (2017) which examined the habitat structure of the Lukanga Swamp. In this study, Chabwela *et al.* (2017), highlighted the ecological condition of the swamp and the weed was captured in the report as shown in Figure 2.1 and yet the entire study does not mention or acknowledge the presence of the weed at the swamp.



Figure 2.1: *S. molesta* at Lukanga Swamp
Source: Chabwela *et al.*, 2017:417

2.4 General Impacts of Alien Invasive Species

Globally, invasive species are cited to be the second leading threat to biodiversity after habitat destruction worldwide (ECZ, 2004; MA, 2005; National Oceanic and Atmospheric Administration (NOAA), 2014). A report by NOAA (2014) indicated that the impacts of invasive species are second only to habitat destruction as a cause of global biodiversity loss and they are a greater threat to native biodiversity than pollution, harvest and disease combined. Similarly, Kuttunen *et al.* (2008), observed that IAS have been recognized as the second most important threat to biodiversity at the global level (after direct habitat loss or destruction) and they represent a serious impediment to conservation and sustainable use of global, regional and local biodiversity. For example, globally, it has been observed that IAS pose a significant threat to economic development and ecological integrity (Charles and Dukes, 2007; GISP, 2015; Kurugundla *et al.*, 2016).

On the general impacts of IAS, Charles and Dukes (2007), reported that IAS may alter community structure through exploitation competition (indirect interactions such as

resource use), and interference competition (direct interactions such as allelopathy in plants). Invasive impacts on other species interactions (such as predation, herbivory, parasitism, and mutualisms) can change the abundance of species with certain key traits that influence ecosystem processes (Ciruna *et al.*, 2004; Charles and Dukes, 2007). Changes in species and community structure can affect ecosystem services both directly (such as the decline in abundance of economically valuable species, in particular those used for food, fibre, fuel, or medicine) and indirectly (Charles and Dukes, 2007). Aesthetic values are commonly lost with the arrival of “nuisance species” such as invasive vines or aquatic floating plants and invasive species that disrupt mutualisms pose risks particularly for pollination and natural pest control services (Charles and Dukes, 2007; GISP, 2015).

Generally, invasive impacts or costs are often classified as economic, environmental, or social in nature (MA, 2005; Charles and Dukes, 2007; GISD, 2015). Economic impacts are those of direct consequence to humans, typically leading to monetary losses whereas, environmental impacts are those that affect ecosystem structure and function, often referring to loss of biodiversity or habitats (Charles and Dukes, 2007). Social impacts focus predominantly on human health and safety, but can also cover quality of life, recreational opportunities, cultural heritage, and other aspects of social structure. Invasive impacts on native biodiversity and community structure are well known (MA, 2005; Kuttunen *et al.*, 2008; GISD, 2015), however, very few studies have examined how resource users cope with their effects. According to a study by Ciruna *et al.* (2004), people are affected differently by IAS depending on where they live, their source of livelihood, and the range of control and eradication strategies available to them. IAS in water systems have variable impacts on different sectors of society; those within lower income brackets may experience more severe impacts from IAS than those at a higher income level. This study is an investigation focusing mainly on how the lower income sector with fewer options to manage and respond towards the presence of IAS.

2.5 The Effects of Alien Invasive Species on the Fisheries in Africa

The introduction of IAS is considered to be a leading cause of species endangerment and extinction in freshwater systems (Ciruna *et al.*, 2004). Freshwater ecosystems are

especially vulnerable to biological invasions and species extinctions because of their high degree of isolation and endemism (Zanden and Olden, 2008). The Invasive weeds cause a variety of problems in Africa that are broadly similar to those caused by aquatic weeds elsewhere in the world (Kurugundla *et al.*, 2016). A report by SADC (2004) revealed that there are five aquatic weeds which have been causing major problems in southern Africa namely; water hyacinth (*E. crassipes*), Kariba weed (*S. molesta*), water lettuce (*P. stratiotes*), parrot's feather (*M. aquaticum*), and red water fern (*A. filiculoides*).

In Africa, aquatic weeds interfere with water flow in rivers, canals and drains, thereby imperiling irrigation schemes and slowing drainage of water from floodplains; impede boat navigation, recreation and fishing; suppress indigenous vegetation by overgrowth and affects the light climate in the water; threaten hydroelectric power plants; increase water loss through evapotranspiration, and entrap sediment, thus decreasing the capacity of the reservoir for water resources (Ciruna *et al.*, 2004; GISP, 2006; GISP, 2007; Kurugundla *et al.*, 2016). Africa has particularly been affected by the introduction and spread of IAS, facilitated in part due to a lack of naturally occurring enemies (Kurugundla *et al.*, 2016).

The problem with the invasion of aquatic invasive species is that their effects on wetland resources is devastating. For instance, studies have shown that rather than adding to the diversity of a wetland, they tend to take over, creating plant monocultures and a decline in overall plant and animal diversity (Galatowitsch *et al.*, 1999; Jacono, 2003). Studies have also shown that wherever aquatic invasive species such as *E. crassipes* and *S. molesta* have been introduced outside of their native range, they have caused major problems (Ciruna *et al.*, 2004; UNEP, 2013) such as creating dense floating mats that restrict fishing and transport, reducing habitats for game birds, reducing the availability of water for drinking, irrigation and power generation and also blocking sunlight from reaching other aquatic flora and fauna causing them to die thus reducing biodiversity (Thomas and Room, 1986; Galatowitsch *et al.*, 1999; Jacono, 2003).

The effects of aquatic weeds on the fisheries in Africa are well documented. For example, UNEP (2013) indicated that in Lake Victoria, fish catch rates on the Kenyan section decreased by 45 percent because water hyacinth mats blocked access to fishing grounds, delayed access to markets and increased costs (effort and materials) of fishing. Similarly, Kurugundla *et al.* (2016) reported that the thick surface coverage of salvinia in the Okavango Delta of Botswana reduced fish yields by 40-50 percent in 1986, 1992, 1998 and 2010 and Chikwenhere *et al.* (1997), reported that the presence of aquatic weeds in Zimbabwe has resulted into a drop of fish catches to 30-95 percent because the weed has resulted into the reduction of the stock, difficulties throwing the net and difficulties transporting fish to market. Similarly, in Zambia, much of its rich biodiversity is threatened by invasion of invasive species and key among the IAS are aquatic weeds, which have had enormous economic and human health impacts as well as causing or potentially threatening to degrade many ecosystem properties (GRZ, 2015). For example, water hyacinth has been a major problem in the Kafue Flats which has led to local people struggling with access to the water for domestic use, transportation and fishing activities, regardless of whether they use dugout or powered boats (WWF, 2017).

In addition, a 1999 survey by Ciruna *et al.* (2004), in Benin demonstrated the economic impacts of water hyacinth on local fisheries before and after water hyacinth was controlled using biological control agents. The principle activities of the men surveyed were fishing and agriculture and they reported that water hyacinth impacted on fishing, whereas, the women, whose principle activities were transport and trading, reported that trade was the most affected. In addition, Ciruna *et al.*, further observed that many of the women reported that the time that it took to trade was increased because water hyacinth slowed river navigation, making it take longer to get to the market. According to Ciruna *et al.*, during the height of the water hyacinth infestation, men reported their annual income dropped from \$1,984 to \$607 USD. After the control of water hyacinth their income rose to \$1,160 USD per person. Women were most impacted in trading of fish; they saw their income drop from \$519 to \$137 USD per person during the major infestation.

Generally, studies by Ciruna *et al.* (2004), GISP (2007), Charles and Dukes, (2007) and Kurugundla *et al.* (2016) have shown that infestations of aquatic weeds impact on fishing revenues in a number of ways and these include; hampering fish breeding, reducing the stock of fish, access to water for fishing and for transport of fish to the market is also impeded, and some fishing methods such as gillnetting are not possible. This confirms the direct negative impacts of aquatic weeds on fisheries. However, information relating to how fishers respond towards the invasion of invasive species in water bodies is still not well documented and this study focuses on this knowledge gap.

2.6 Coping Strategies towards Shocks and/or Risks to Livelihoods Sources

Coping strategies are short-term measures used by households when confronted with unexpected events (Thomas *et al.*, 2007) or short-term practices adopted in response to sudden shocks or difficulties in accessing resources (Reenberg *et al.*, 2008). Further, Reenberg *et al.* (2008), argued that coping strategies are practical decisions made by an individual to permanently change the productive activities in which he/she is engaged. Wainwright and Newman (2011), indicate that vulnerability to shocks is a dominant feature of household livelihoods in developing economies and a fundamental problem facing rural households is how to maintain satisfactory levels of consumption in the face of adverse shocks. These shocks can affect a household's welfare by negatively impacting on household income, existing household wealth and the health of household members.

According to Tongruksawattana *et al.* (2010), concerning responses to shocks, existing studies found that in their choice of coping actions households take types of shocks and household resources into account. Tongruksawattana *et al.* (2010) has further highlighted that rural communities across the developing world use various coping strategies in response to poverty, food insecurity, conflict as well as environmental stresses. With reference to the fisheries, Allison and Horemans (2006) argue that shocks trends may include decreasing catch rates, increasing prices for fish, storm damage to shore facilities, toxic algal blooms, fuel-price hikes and currency devaluations that affect the costs and factors unrelated to fisheries that nevertheless impact on fishing households, such as rising costs of food staples or medicines. In the fisheries, livelihood

strategies may include fisheries intensification, livelihood diversification and migration. Risks that are often experienced by fishermen include; uncertainty of production and environmental fluctuations, access to fish resources, price risk from unstable supply conditions and the risk of losses on assets held, and risking their lives on water bodies (Allison and Horemans 2006; Tongruksawattana *et al.* 2010). All these risks can lead to economic shocks for fishers and in these conditions, fishers need to cope so that the situation can be controlled, restrained and resolved.

The choice of coping actions also depends on household characteristics, most importantly the diversity and stability of household income sources, household assets and education of the household head (Tongruksawattana *et al.*, 2010). It is argued that a better understanding of resource users' coping strategies and adaptation processes towards environmental change will enable more targeted and appropriate policies (Coulthard, 2008; Tongruksawattana *et al.*, 2010). Earlier studies have examined the effects as well as household responses to environmental change and climate change showing the importance of short-term labour switching, as well as longer term diversification (Reenberg *et al.*, 2008; Coulibaly *et al.*, 2015). The majority of these studies have focused on adaptation and coping strategies of either farmers (Coulibaly *et al.*, 2015) or fishers (Coulthard, 2008) towards climate change whilst a few have addressed strategies fishers used to cope with invasion of species with the latter remaining focused on the variety of strategies used at international level and national level (Kuttenen *et al.*, 2008; GISP, 2015; Kurugundla *et al.*, 2016) which has not accounted for the local contexts.

This study aims at providing empirical evidence that helps attribute preferred strategies of local fishers towards invasion of water bodies by invasive alien plant species, with a focus on understanding the fishers' coping strategies and their effectiveness. Understanding how people succeed or fail in sustaining their livelihoods in the face of shocks, trends and seasonality can help to design policies and interventions that can assist people's existing coping and adaptive strategies (Allison and Horemans, 2006). These may include improving access to education and health care facilities,

strengthening rights to land for settlement and agriculture (for instance, not just rights of access to fish stocks), reforming local tax and license systems, providing financial and enterprise development services (and not just credit for purchase of fishing gear) and promotion of diversification (Allison and Horemans, 2006; Coulthard, 2008; Tongruksawattana *et al.*, 2010).

2.7 Effective Measures Aimed at Responding to Invasive Species

Invasive species are a leading threat to native species and biodiversity (MA, 2005), are an important driver of global ecological and evolutionary change (Caffrey *et al.*, 2015) and have caused significant environmental, economic and social damage (Kettunen, 2008; UNEP, 2012; Caffrey *et al.*, 2015). In response, many governments are developing management strategies for prohibiting new introductions and reducing the impacts of invasive species (Zanden and Olden, 2008). Many tools and technologies are available for the management of IAS and in this context, GISP has produced a book entitled *Invasive Alien Species: A Toolkit of Best Prevention and Management Practices* (Wittenberg and Cock, 2001). The Toolkit provides a review of concepts, techniques, and best practices relevant to the prevention, eradication, and control of IAS.

According to Wittenberg and Cock (2001), effective management of invasive species include early detection and rapid response which aims to prevent invasive species from establishing and spreading. Should prevention measures fail in any particular case, then eradication which is the elimination of the entire population of IAS, is the key to successful management of IAS (Shine *et al.*, 2000; McNeely *et al.*, 2001). If eradication is found to be impractical, a control programme to reduce the population and contain its spread should be initiated (Macdonald *et al.*, 2003; GISP, 2007; Caffrey *et al.*, 2015). Control techniques of invasive species include: *Physical control*, such as removal by hand, mechanical harvesting, or the creation of physical barriers; *chemical control*, including chemical dosing, use of toxic baits, and application of herbicides and pesticides and *biological control*, which involves the introduction of natural enemies, such as pests and pathogens, from the invader's country of origin (Wittenberg and Cock 2001; Macdonald *et al.*, 2003; Kettunen, 2008; Caffrey *et al.*, 2015).

Action to effectively prevent and mitigate the effects of invasive alien species has been focused largely within developed countries (Shine *et al.*, 2000; ECZ, 2004). However, in developing countries, invasive alien species cause similar or worse problems, for development as well as conservation of biodiversity (Kettunen, 2008). But overall, national and international responses to the challenges posed by IAS in developing countries are insufficient to counter their increasing toll on natural resources and society (Wittenberg and Cock 2001; Kettunen, 2008). For example, studies show that although it has become increasingly clear that IAS pose a major threat to biodiversity, economies, and human health throughout the world (MA, 2005; GISP, 2006), the capacity of most countries in Africa to address this threat has remained quite limited (ECZ, 2004). In particular, it is evident that many tools and strategies adopted for prevention, eradication, and control of IAS, and the large body of scientific and technical information relating to IAS in other parts of the world, are not readily available in many parts of Africa (Shine *et al.*, 2000; Wittenberg and Cock 2001; GISP, 2007).

According to a study by Shine *et al.* (2000), there are more than 40 international agreements, as well as numerous codes of conduct that directly address IAS. However, few countries in developing nations consider IAS a top priority and have invested in the development of well-coordinated policies and programs to address the problem. Developing countries that recognize the gravity of the situation and want to take immediate action are hampered by a lack of scientific, technological, and financial resources (Shine *et al.*, 2000; GISP, 2007). Implementing effective prevention, eradication, and control measures can be costly and require new policy approaches, as well as significant advances in ecological knowledge and natural resource management (Shine *et al.*, 2000, McNeely *et al.*, 2001, Wittenberg and Cock, 2001). Therefore, studies in relation to IAS are cardinal for policy direction.

2.8 Knowledge Gaps

The impacts of invasive species on wetland resources have attracted worldwide attention (MA, 2005; Kuttunen *et al.*, 2008; GISP, 2015). Despite the overwhelming evidence of the impacts of IAS and a growing appreciation for wetland resources, however, researchers and policymakers rarely directly address the connection between invasions

and coping strategies of resource users especially the rural poor. Various attempts have been made to address the ecosystem processes that are affected by invasive species (Ciruna *et al.*, 2004; ECZ, 2004; MA, 2005; NOAA, 2014 Kurugundla *et al.*, 2016), but the links between invasive species and coping strategies are largely lacking in the literature. Wetlands despite being well known as hotspots of vulnerability to species invasions, has drawn less attention in this literature (ECZ, 2008; Kohl, 2011).

For example, despite the invasion of Lukanga Swamp by *S. molesta* from 2009 (Birdwatch Zambia, 2017), there is still little understanding on how the weed has affected the resource users. Most of the studies have mainly focused on human induced pressures on the ecosystem and conflicts in resource use and management (Haller and Chabwela, 2009; Mapedza *et al.*, 2012; Hunink *et al.*, 2017) and the hydrological and habitat structure of the swamps (McCartney, 2011; Chabwela *et al.*, 2017). For example, Mapedza *et al.* (2012), carried out a stakeholder analysis, group interviews and questionnaires, to better understand how decisions among stakeholders take place and influence each other. The study highlighted that an important part of achieving socio-ecological sustainability of the Lukanga Swamps should be obtained through building trust and the creation of stakeholder platforms.

Similarly, Hunink *et al.* (2017) examined the hydrological ecosystem services of Lukanga Swamp whereas Chabwela *et al.* (2017), highlighted the species composition and structure of the Lukanga Ramsar site and the need for concerted effort to sustain the ecological functioning of the Lukanga wetland and the need for further investigations. In addition, McCartney *et al.*, (2011) carried out social surveys in the area to assess use, conflicts and management of the Lukanga Swamps and concluded that currently there is little opportunity within the existing legislation to translate into practice a management regime that integrates in a sustainable way all ecosystem services. Therefore, this study aimed at filling the existing gaps in the literature on fisheries and invasive species by investigating 1) how the fishers have been affected by the presence of *S. molesta*, 2) how the fishers are coping towards the presence of *S. molesta* and, 3) the effectiveness of their coping strategies.

CHAPTER THREE THE STUDY AREA

3.1 Introduction

Chapter three describes the study area with a focus on the physical characteristics and the socio-economic characteristics.

3.2 Location and Size

The Lukanga Swamp is located approximately 60 km west of Kabwe town, in the Central Province of Zambia (Figure 3.1), within the catchment of the Kafue River. It is situated between latitudes $14^{\circ} 08'S$ and $14^{\circ}40'S$ and longitudes $27^{\circ}10'E$ and $28^{\circ}05'E$. The area of permanent swamp and open water at Lukanga is approximately $2,600 \text{ km}^2$ with a total catchment area of about $19,490 \text{ km}^2$ (Chabwela *et al.*, 2017; Hunink *et al.*, 2017)

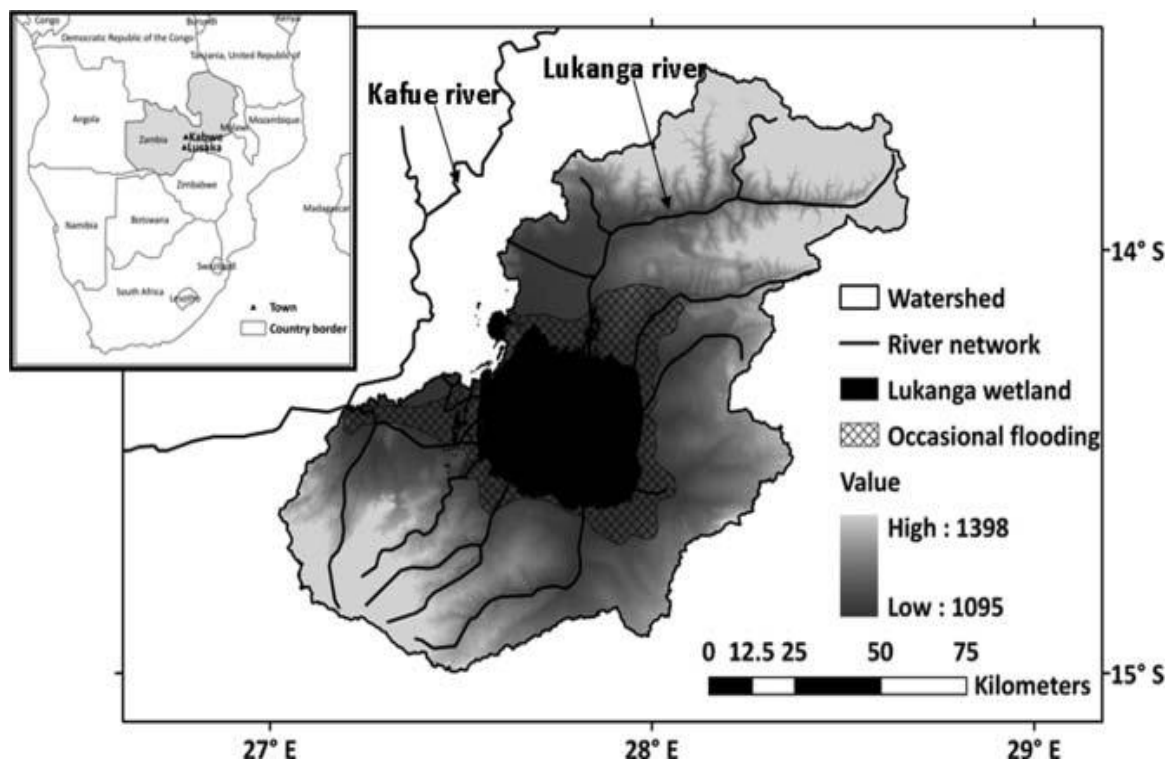


Figure 3.1: Location Map of Lukanga Swamp
Source: McCartney *et al.*, 2011:298

3.3 Physical Characteristics

3.3.1 Drainage and Topography

The Lukanga water system is drained by three main sources of water namely; direct rainfall into the swamp, inflow from tributary streams and spill from the Kafue River (Figure 3.2). When the Kafue River begins to flood, it spills into the Lukanga basin resulting in an inundation that extends up to 70-80 km wide and as flooding levels drop in the Kafue, the Lukanga drains back into the Kafue (Leonard, 2005). Thus, the hydrological conditions in the Lukanga Swamp are strongly influenced by a number of factors which include local rainfall and runoff, evapotranspiration and the exchange of ground water recharge in the Kafue River. The topography of the Lukanga watershed is a relatively flat area, with elevation levels varying between 1100 and 1400 m above sea level (Hunink *et al.*, 2017).

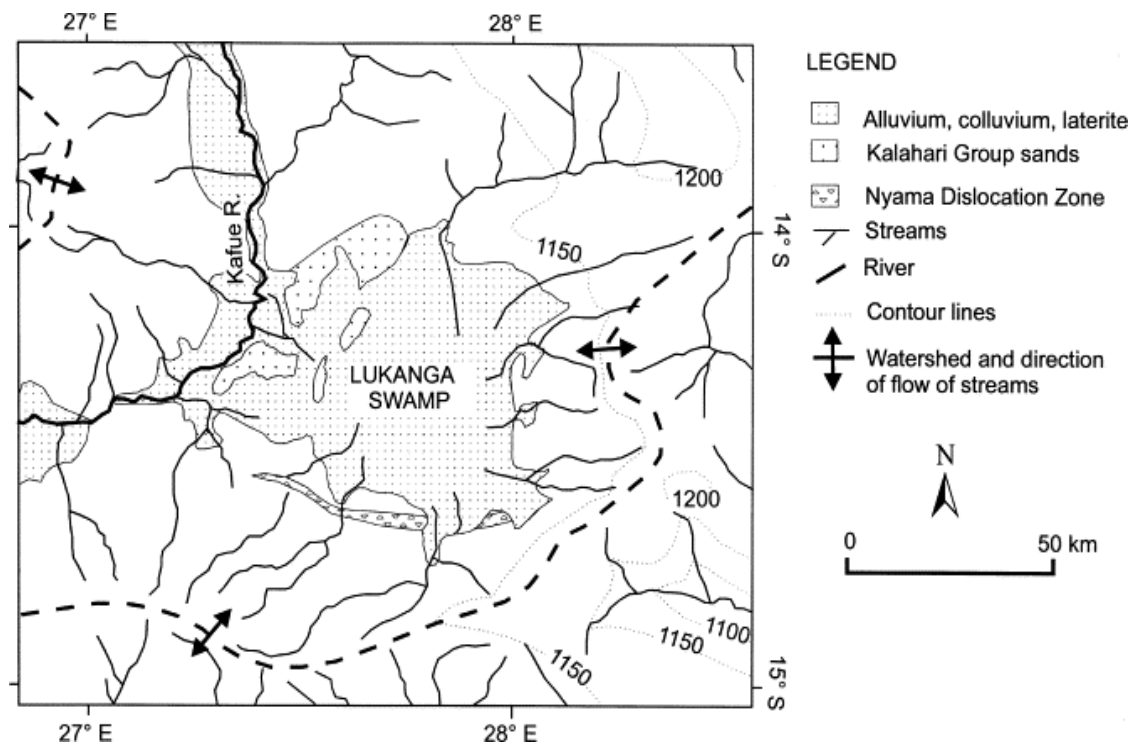


Figure 3.2: Drainage and Topographic Map of Lukanga Swamp
Source: Katongo *et al.*, 2002:368

3.3.2 Geology

The Lukanga Swamp region is generally covered by rock formations of the Pre-Cambrian assembly of the Gondwana super continent. This rock formation covers much of the eastern side of the Lukanga Swamp, whereas, much of the western part of the Lukanga Swamp and Chilwa Island is underlain by the Kalahari sands whose deposits consists of poorly consolidated sand stones, and unconsolidated windblown deposits (McCartney, 2007; Chabwela *et al.*, 2017; Hunink *et al.*, 2017).

3.3.3 Soils

The most widespread soil types in the Lukanga Swamp are the swamp soils which are organic soils and have very high content of vegetative matter, and the sand veldt soils which are loamy sands, coarse grained, with reasonable content of clay (Chabwela *et al.*, 2017; Hunink *et al.*, 2017). The sandy soils are generally yellowish-red to light yellowish-brown where well drained, but these change to grey-brown where poorly drained.

3.3.4 Climate

The Lukanga Swamp falls within Kabwe of Central Province which has a tropical climate. The area experiences three distinct seasons namely; (1) the wet/rainy season extending from November to March (2) cool dry season from April to August and (3) hot, dry season from September to October/November. The mean annual precipitation varies from approximately 900 mm in the vicinity of the swamps to 1,400 mm in the vicinity of the source of the Lukanga River in the north (Kampata *et al.*, 2013; Hunink *et al.*, 2017). The mean maximum temperatures of the Lukanga area are highest in October (31.8°C) while mean minimum temperature is 14.8°C in May to August (Kampata *et al.*, 2013; Chabwela *et al.*, 2017; Hunink *et al.*, 2017).

3.3.5 Flora and Fauna

The Lukanga swamp provides habitat for a wide range of both terrestrial and aquatic flora and fauna. The vegetation of the wetland is divided into three major classes namely; palustrine (marsh), lacustrine (open water) and riverine (McCartney, 2007 and 2011). The palustrine wetland covers approximately 95 percent of the area (permanent

swamp, termitaria grasslands and dambos), whereas the lacustrine wetlands cover about 5 percent of the wetland (Kamweneshe and Beilfuss, 2002). The riverine wetlands occur along the fringes of the Lukanga River (McCartney, 2007). The palustrine part of the wetland is dominated by stands of reeds (Phragmites) mixed grass, cattail/reed-mace (Typha), and termitaria grasslands which covers approximately 488km² adjacent to the permanent swamp (McCartney *et al.*, 2011). In recent years, the swamp has also been invaded by *Salvinia*. Figure 3.3 and 3.4 shows a water canal leading to Waya harbour within the swamp before the invasion and after the invasion by *S. molesta*.



**Figure 3.3. A Water Canal Before Invasion of *S. molesta* at Lukanga Swamp
Source: Google Pictures of Lukanga Swamp (undated)**



Figure 3.4. A Water Canal after Invasion of *S. molesta* at Lukanga Swamp
Source: Field Photo, 2017

In terms of fauna, the swamp is a suitable habitat for birds and a breeding ground for fish (OAG, 2015). There are about 316 species of birds, including cranes, storks, ducks, geese, pelicans, herons, egrets, and bitterns (Leonard, 2005; McCartney *et al.*, 2011). The majority of water bird populations are located in the periphery of the swamp and shallow open waters with few occurrences in the densely populated vegetation (Kamweneshe and Beilfuss 2002). The common fish species in the Lukanga Swamp are *Oreochromis niloticus* (Tilapia), *Cyprinus barbuis* (Barbus) and *Siluriformes* (Catfish) (Kachali, 2007). The swamp is an ideal habitat for birds and is also used as a breeding ground for fish thus classified as a highly sensitive area (Chabwela *et al.*, 2017; Hunink *et al.*, 2017).

3.4 Socio-Economic Characteristics

The socio-economic aspects of the study area are divided into socio factors that look at, the human environment and economic factors that focuses on livelihood activities.

3.4.1 Human Environment

According to McCartney *et al.* (2011), it is estimated that about 60,000 people live in, or close to the Lukanga Swamp and Kamweneshe and Beilfuss (2002) observed that this

has been attributed mainly to the availability of water, fertile soils and abundance of natural resources. Human settlements at the swamp is restricted to the margins of the floodplain and elevated lands on the swamp such as Waya, Chilwa and Chiposha (Mapedza *et al.*, 2012; Chabwela *et al.*, 2017). For example, McCartney *et al.* (2011), observed that most settlements at Lukanga Swamp are located around the edge of the wetland, although some fishing camps are situated on the larger islands located within it such as Chilwa and Chiposha Islands.

The Lukanga areas are settled by fishers who also practice subsistence agriculture on the upper lands (Mapedza *et al.*, 2012). The people of the area, predominantly from the Lenje and Bemba tribes, are mainly very poor with few formal job opportunities, inadequate medical and education facilities, poor nutrition, and low levels of health (Kachali, 2007; McCartney *et al.* 2011; Mapedza *et al.*, 2012). The Lenje people are mostly subsistence farmers. They keep small herds of cattle and goats while the livelihoods of immigrants, who are largely Bemba, are primarily based on fishing with little crop cultivation (Mapedza *et al.*, 2012).

3.4.2 Livelihood Activities of the Local People

The majority of the people in and around the swamp depend on it for fishing and agriculture (Kamweneshe and Beilfuss, 2002; Kachali, 2007). For example, Mapedza *et al.* (2012), pointed out that the local people practice subsistence agriculture, whilst others are fishermen and women trading in fish and other related activities. Crops grown are maize, groundnuts, sweet potatoes, beans and sometimes citrus fruits and vegetables grown for sale to residents of the nearby urban center of Kabwe (Kachali, 2007; Mapedza *et al.*, 2012). The government's free agricultural input policy in which government offers subsidized agricultural inputs to small scale farmers through the Farmers' Input Support Programme (FISP) has further enhanced crop cultivation in the area (Mapedza *et al.*, 2012)

However, fishing is the major economic activity, with the site supplying fish to three provinces (Lusaka, Central and Copperbelt) (Kachali, 2007; McCartney *et al.*, 2011). Lukanga wetlands are estimated to produce 1,710 tonnes of fish annually (McCartney *et*

al., 2011). There are two main types of fishers at Lukanga Swamp namely; the resident fishers and migrant fishers. Resident fishers live around the swamp all year round while migrant fishers merely come to fish during the open season. Most of the fishers participating in fishing activities are migrant fishers from Northern, Mchinga and Luapula province with most of the fish caught sold on the Copperbelt, Kabwe and Lusaka (Kachali, 2007; Leonard, 2005; Mapedza *et al.*, 2012). The seasonal migration by fishers has increased the human population to the extent that villages that should only hold a few hundred have a thousand of people (Kachali, 2007). Consequently, the need for economic development is acute, and as the human population expands, the wetland is increasingly under pressure to support development that will improve the livelihood and general health of the local people (McCartney *et al.*, 2011).

CHAPTER FOUR RESEARCH METHODS

4.1 Introduction

This chapter presents the research approach, sampling methods, methods of data collection, analysis and presentation.

4.2 Research Approach

This study applied both qualitative and quantitative approaches of collecting and analysing data in order to investigate the coping strategies for fishers towards the effects of *S. molesta* at Lukanga Swamp. Combining qualitative and quantitative methods as a practical tool particularly in examining livelihoods strategies have been suggested from previous studies as the mixed approach provides enhanced understanding of the issues at hand (DFID, 2010). The qualitative approaches enabled the researcher to understand the experiences of fishers toward the presence of *S. molesta* at Lukanga Swamp. The purpose of the survey was mainly to get views from a larger representation of the locals on the effect of *S. molesta* on their different related fishing activities and their coping strategies. Quantitative approaches enabled the researcher to capture numerical data of the villagers in terms of demographic data, main fishing activities and how the presence of *S. molesta* has affected their fishing related activities which helped the researcher to get views from a larger representation.

4.3 Target Population and Sampling Methods

The target population for this study were the fishers at Lukanga Swamp, particularly fishers camping within the swamp from Waya harbour. This is because Waya is the main harbour of the swamp and the weed is most prominent in this part of the swamp. Villagers from Waya were also part of the target population. Waya village was purposively selected as it is within 5km of Lukanga Swamp and the majority of the villagers in Waya are involved in different fishing related activities (McCartney *et al.*, 2011; Mapedza *et al.*, 2012). Key informants from Department of Fisheries and Fisheries Committees at Lukanga Swamp, Department of Water Affairs (Kabwe) and Zambia Environmental Management Agency (ZEMA) also formed part of the target population.

Lukanga Swamp has a total of about 902 fishers (GRZ, 2015) and approximately 200 fishers are found within the fishing grounds near Waya harbour (Lukanga Fisheries Department). The target sample size for the fishers was 50 representing 25 percent of about 200 fishers from Waya fishing grounds and this sample size was deemed adequate because of the high mobility of fishers and difficulties of accessing them within the swamp. During data collection, a total number of 41 fishers was reached. The 41 fishers were conveniently selected and interviewed on the basis of availability and convenience, meaning that subjects were selected according to their presence and availability at the site when the data collection occurred. For the survey, out of 301 households from Waya village, 150 households (representing 50 percent) were randomly selected using a household list from Lukanga Department of Fisheries. Simple random sampling was used to select respondents for the survey in which the first house was selected through a lottery using the household list from Lukanga Department of Fisheries to avoid biasness in the result and initial selection of respondents.

The sample of 150 households for a village with 301 households was seen as adequate for this study as the survey was mainly aimed at complementing and cross checking the fishers' responses. A 50 percent representation is also a good sample size whose results could be inferred onto the whole population (Bless and Achola, 1991) of Waya village. The sample sizes of 41 fishers and 150 households were felt to be adequately representative of the study area both in terms of the number and the sampling sites from which respondents involved in the study were picked. For focus group discussions, the researcher engaged two fishing committees, Waya Fishing Committee and Ntumba Lyombe Fishing Committee. The fishing committees were purposively selected as they comprise members engaged in different fishing related activities (fishing, fish trading and fish transporting) at Lukanga Swamp. The gender and the number of participants for the FGDs was determined mainly by the turn up rate from the invited members of the fishing committees. For the two FGDs conducted, 7 members participated from Waya Fishing Committee of which 5 were men and 2 women and for Ntumba Lyombe Fishing Committee, 8 members participated for the FGDs of which all were men.

4.4 Data Collection Methods

4.4.1 Secondary Data Sources

Secondary Data were obtained mainly from archival sources. This also covered an extensive review of existing literature; both published and unpublished, on invasive species and fisheries.

4.4.2 Primary Data Sources

Fieldwork for this study took place during three visits to the study area: First visit was in August 2016 for a week to carry out a reconnaissance survey. Secondly, four weeks between October and November 2016 for data collection and one week in March 2017 for validation of results.

Primary data were collected through triangulation of some qualitative and quantitative techniques using the following data collection tools; interview-schedule for fishers, questionnaire for household survey, and interview guides for key informants and focus group participants.

4.4.2.1 Interview Schedule

The interview schedule (Appendix I) as a data collection tool was mainly used to collect information from the fishers regarding how the aquatic weed has affected their fishing activities, how they were coping with the presence of the aquatic weed and the effectiveness of their identified coping strategies. The interviews were carried out with the help of two research assistants who were trained on how to ask questions to ensure uniformity in how the questions were phrased. The researchers purposively interviewed the fishers who were found at Waya harbour and Waya fishing grounds within the swamp to solicit their views and experiences towards the presence of *S. molesta*. Two officers from the Lukanga Fisheries Department and two members of the Lukanga fishing committees were part of the research team and helped in navigating and locating different fishing camp sites within the swamp. A total number of 41 fishers were reached during the interviews.

4.4.2.2 Questionnaire

The household survey was carried out in Waya village using a questionnaire (Appendix II). The survey targeted the head of households and the questions covered specific

information on demography data, fishing activities, and the effects of *S. molesta* on related fishing activities. In order to minimize on the low return rate of questionnaires from respondents, the questionnaires were administered to the respondents by the researcher with the help of two research assistants. The purpose of the survey was mainly to get views of the local people on the effect of *S. molesta* on their different related fishing activities and their coping strategies.

4.4.2.3 Key Informant Interviews

Interviews with four key informants from different institutions were conducted. The four institutions were as follows; Department of Fisheries (Lukanga), Fisheries Committees, Department of Water Affairs in Kabwe, and ZEMA. Key informant interviews were performed as a way of getting information on the rules and regulations regarding fishing practices, cultures, values and attitudes of the local people towards the presence of *S. molesta* at Lukanga Swamp and also as a way of getting an insight on government's role and policy with regards to invasive species. This technique enabled the researcher to gather more detailed and expert knowledge on the objectives of the research. The interviews were unstructured with open ended questions which allowed the gathering of more complete and detailed data and also provided opportunities for probing and more in-depth discussion (Appendix III). Details of key informants and information collected are presented in Table 4.1

Table 4. 1: List of key informants

Key informants	Information
Fisheries Department	Expert knowledge on the fishing activities and the effects of the presence of <i>S. molesta</i> on the fishing activities at Lukanga Swamp
Water affairs	Project of the Department of Water Affairs (Kabwe), on the removal of the weed at Lukanga Swamp.
ZEMA	Policy issues on prevention and management of IAS in Zambia.
Fisheries Committee	Fisheries committees' involvement at Lukanga Swamp and the local perception and views on the presence of <i>S. molesta</i> .

4.4.2.4 Focus Group Discussions

Two focus group discussions were conducted with two different fishing committees namely, Waya Fishing Committee and Ntumba Lyombe Fishing Committee. Selection of the two committees for focus group discussions was based on their knowledge and involvement in the Lukanga fisheries. Each fishing committee has at least 20 members which include both men and women. The gender and the number of participants for the FGDs was determined mainly by the turn up rate out of all the invited members of the fishing committees. On the day of the discussion, at Waya Fishing Committee, 7 members were present of which two were women fish traders and 5 men comprising of 2 fish traders, 2 canoe owners and 1 fisher. At Ntumba Lyombe, 8 members of the committee were available for the discussion comprising of 3 fishers, 3 fish traders and 2 canoe owners of which all were men as no women showed at the time the discussion was conducted.

The purpose of the FGDs were to collect data from multiple individuals simultaneously. The FGDs technique was important as it enabled the researcher to cross check with the fishers' responses and also gather additional information. The discussions started with a brief presentation about the aims of the research and the topics for discussion. The

audience were encouraged to express their opinion and experience about relevant issues on how the presence of *S. molesta* has affected their fishing related activities and their coping strategies. The researcher was the facilitator and guided the focus group discussion and the discussion was recorded using a digital recorder. Permission was sort to record the discussions which were conducted in bemba with the help of the translator. The duration of the two FDGs was approximately an hour and half (1hr:30mins) each.

4.4.3 Data Analysis

The data collected were analyzed using both qualitative and quantitative methods. The collected data were first coded and summarized. The qualitative data on how the fishers have been affected and how they are coping towards the presence of *S. molesta* at Lukanga Swamp were analyzed using content analysis. The qualitative data were reduced to manageable forms by transcribing recordings from focus group discussions and interviews. The process also involved the categorizing and indexing of responses on fishers' coping strategies and other field notes into common theme. The quantitative data were analyzed using Descriptive Statistics. Descriptive Statistics comprising frequencies and means were used to analyze responses from questionnaires. The data on the effectiveness of the fishers' coping strategies were assessed using a Likert-type five-point scale with 1=Ineffective, 2=Fairy effective, 3=Undecided, 4=Effective and 5=Very effective. To analyze quantitative data from the survey on the effectiveness of the coping strategies, a statistical test was carried out to determine how the ratings of effectiveness on the coping strategies on a Likert-type five-point scale were different. The ANOVA was used to test for the difference in ratings of the effectiveness of coping strategies.

For easier interpretation, the findings of this study were presented using field photos, narrations, tables, cross-tabulations and charts. In addition, the identified coping strategies of fishers towards the presence of *S. molesta* at Lukanga Swamp were compared to the Global Invasive Species Programme (GISP) Framework on best strategies for effective prevention and management of IAS for crosschecking their effectiveness. GISP Framework outlines three major options (or better, steps) for dealing with established invasive alien species 1) *Eradication*: Killing the entire population of

IAS, 2) *Containment*: restricting invasive species to a limited geographical range, and 3) *Control*: The process of long-term management of the IAS' population size and distribution when eradication is no longer feasible.

4.4.4 Limitations of the Data Collection

In terms of data collection, it was difficult to reach some fishing camps within the swamp where fishers were temporarily camping because movements within the swamp were very difficult and tiresome due to the presence of the weed. For example, a distance of 2km with an engine boat which would normally take 45mins in the absence of the weed took 3hrs which had an implication of the fishers' sample size as the researcher had intended to interview more than the 41 fishers which were interviewed within Lukanga Swamp.

CHAPTER FIVE PRESENTATION OF RESULTS AND DISCUSSION

5.1 Introduction

This Chapter presents and discusses the results of the study. It starts by presenting and discussing how fishers at Lukanga Swamp have been affected by the presence of the weed and how they are coping with it. The chapter also presents and discusses the effectiveness of the fishers' coping strategies and their suggested solutions towards the presence of *S. molesta* at Lukanga Swamp.

5.2 The Effects of *S. molesta* on the Fishers at Lukanga Swamp

The study identified how the presence of *S. molesta* is affecting the fishing activities of fishers at Lukanga Swamp. The results on how the weed is affecting the fishers at Lukanga Swamp are depicted in Figure 5.1.

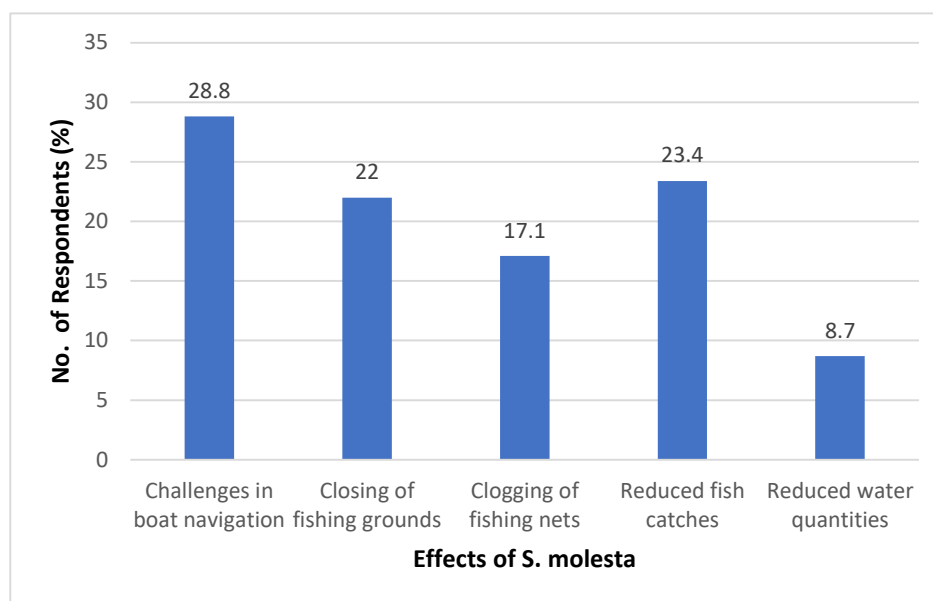


Figure 5.1. Effects of *S. molesta* on Lukanga Fishers
Source: Field Data, 2017

For the household survey, the respondents were also asked to indicate on how the presence of *S. molesta* at Lukanga Swamp is affecting their fishing related activities. The results are shown in Table 5.1.

Table 5.1: Effects of *S. molesta* on Fishing Activities at Lukanga Swamp

Fishing Activities	Effects of <i>S. molesta</i> on Fishing Activities (%)			
	Increased	Stable	Decreased	Total
Fishing	0	8.1	91.9	100
Fish Trading	0	13.6	86.4	100
Canoe Paddling	0	0	100	100
Canoe hiring	0	0	100	100

Source: Field Data, 2017

Survey results indicated that fishing and fish trading at the swamp have decreased due to the presence of the weed as shown in Table 5.1. For example, those involved in fishing activities reported that the fish catches at the swamp were reducing due to the presence of the weed, whereas, those in fish trading have indicated that their fishing activity were decreasing as a result of the fish becoming too expensive to buy due to reduced fish catches that have resulted in fish supply reducing.

Details on the effects of *S. molesta* at Lukanga Swamp are discussed in the following sections.

5.2.1 Difficulties of Boat Navigation

Boat navigation at Lukanga Swamp was a challenge with the invasion of the weed as shown in Figure 5.1. The fishers explained that the weed was blocking mainly the canals leading to different fishing grounds within the swamp which made it difficult for them to navigate around the swamp. The fishers further explained that with the presence of the weed at Lukanga Swamp, they were spending two or more hours to reach their destinations instead of canoe journeys of half an hour or less. A study by Terry (2011) indicated that dense mats of floating *S. molesta* form an almost impenetrable barrier to canoes and the weed covers fishing areas near the shore and necessitates long or time-consuming journeys to reach open waters.

Furthermore, Labrada (2013) reported that in Lake Victoria in particular, aquatic weeds affect the normal activities of fishers and transporters of goods. For example, Labrada (2013), argued that normally, transporters of goods and fishers consume two to three

more times when infestations are high and the fish catches are reduced by 50-75 percent. This implied that with the presence of the weed at Lukanga Swamp, fishers were taking additional hours reaching their destinations. Figure 5.2 shows an infested canal at Lukanga Swamp.



Figure 5.2. *S. molesta* blocking a waterway at Lukanga Swamp
Source: Field Photo, 2017

5.2.2 Closing up of Fishing Grounds

The presence of the weed at Lukanga Swamp was also resulting into swamping of a number of fishing grounds. According to the findings (see Figure 5.1), the presence of the weed was closing up some of the fishing grounds at the swamp. Consistent with a study by Thomas and Room (1986), under ideal conditions, giant *S. molesta* can completely cover water surfaces and form mats up to 1m thick. Similarly, GISP (2015) reported that in Kariba dam in the early 1960s, dense mats of *S. molesta* covered about 22 percent of the lake surface, threatening the operation of the hydroelectric power plant.

At Lukanga Swamp, respondents mentioned quite a number of fishing grounds that were closed up by the weed. These included; Tumba, Chilondo, Sasa, Kenya, Akaluko, Lungu, Mufuta, Zungula and Kashimbi. In addition, a key informant also explained that

the weed was not only closing up fishing grounds but also fish breeding areas. The key informant narrated that “*Chimbala fishing ground which was formerly reserved as a breeding site as well as a research site has also been closed up by the weed*”. The implication of swamping fish breeding areas and fishing grounds was that the weed did not only reducing the potential of the swamp for fishing, spawning and nursing but also the water surface area. Field observations show that the swamp was reducing in size as most of the water areas have been turned into thick dense mats by the weed. The swamping of breeding areas and fishing grounds such as Chimbala implied that fish production was also reducing thereby affecting fish quantities and fish catches. The findings of this study are in line with a study by Labrada (2013) at Lake Victoria, who observed that *S. molesta* affects fishing directly by covering the open water surface.

5.2.3 Clogging Fish Nets

The fishers reported that the weed was also affecting their fishing activities by clogging fish nets intended to trap the fish (see Figure 5.1). The presence of the weed at the swamp was making it difficult for the fishers in using fish nets and conduct their fishing activities effectively. One of the fishers narrated that when they set the fish nets to trap the fish, in most cases the nets were either clogged or entangled by the weed. This was more common in fishing areas near the shores where weed infestations were high. The fishers further explained that when the nets are heavily clogged with the weed, they easily get damaged which results in fishers abandoning the damaged fishing nets. The results were in line with Terry’s (2011) observation at Lower Shire that all types of nets are difficult to place where aquatic weeds are present. This signifies that with the presence of the weed at Lukanga Swamp, the fish nets were either damaged, abandoned or swept away thereby reducing fish catches and causing losses of fishing gear.

In addition, the fishers further indicated that the weed was also reducing the life span of the fishing nets by clogging and damaging them. The fishers explained that normally, the life span of fishing nets is between five to six months but with the presence of the weed, it was reduced to between two to four months. This has an implication on the fishers as they are forced to replace the fish nets at short intervals which is an additional cost of buying more fish nets. In line with the findings of this study, Terry (2011)

observed that it is indeed difficult to place fish nets in weed invaded areas. For example, Terry (2011) pointed out that with the presence of the weed, there is insufficient clear water for the use of cast nets and seine nets, clear patches in the weed needed to be cut for placement of gill nets and long lines and nets left in the water are swept away by the weed.

5.2.4 Reduced Water Quantities

The respondents also indicated that the presence of *S. molesta* at Lukanga resulted in reduced water quantities. However, it is important to note that although there were no scientific measures used in this study to ascertain the amount of water loss due to *S. molesta*, the fishers were able to directly link water loss and the presence of the weed at Lukanga as observed from the number of fishing grounds which have been closed up by the weed. The closing up of fishing grounds such as Tumba, Chilondo, Sasa, Kenya, Akaluko, Lungu, and Mufuta reduced the water surface areas of the swamp and this had a direct effect on the fish catches as there were fewer fishing spots within the swamp where fish can be caught from.

There are also quite a number of studies giving valuable information about the effects of *S. molesta* on water loss through formation of dense mats (Charles and Dukes, 2006; GISP, 2015). For example, GISP (2015) reported that very dense infestations of *S. molesta* result in an increased (25-40 percent) water loss. Similarly, Charles and Dukes (2006) reported that invasive plants use more water than do native plants, and thus decreasing the water levels.

5.2.5 Reduced Fish Catches

The respondents asserted that the presence of *S. molesta* at Lukanga was resulting in reduced fish catches. They noted that it was very difficult to carry out fishing activities at the swamp with the presence of the weed. The fishers explained that the weed was directly affecting fish catches at the swamp by swamping fishing grounds and breeding areas, clogging fish traps and making it difficult to navigate within the swamp (see Figure 5.1). These results are consistent with the study by Labrada (2013), who observed that fish catches were very poor in highly infested water bodies. Similarly, a study by

GISP (2015), reported that fewer fish, by number and weight, were found in areas infested by aquatic weeds. The plant decreases the oxygen levels in the water which adversely affects fish populations. Similarly, Terry (2011) revealed that in West Bengal, 45,000 tons of fish were lost due to aquatic weeds in the early 1990s. Therefore, it is widely accepted that in areas where aquatic weeds occur, fish populations and catches are reduced to (40-50 percent) by the weed (Kuttenen *et al.*, 2008; GISP, 2015; Kurugundla *et al.*, 2016).

5.3 Coping Strategies of Fishers towards the Presence of *S. molesta* at Lukanga Swamp

The fishers were asked to identify their major coping strategy towards the presence of *S. molesta* at Lukanga Swamp. The results are presented in Figure 5.3.

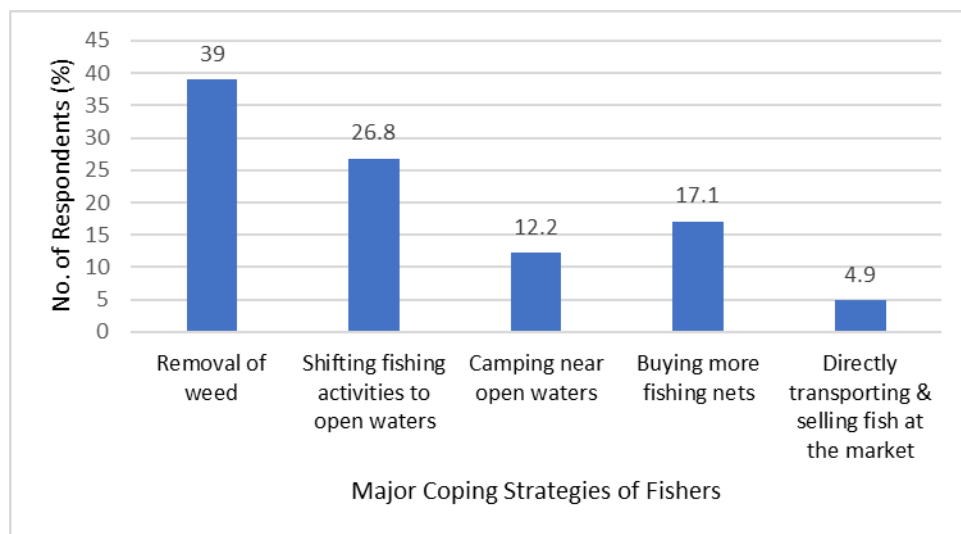


Figure 5.3. Major Coping Strategies by Fishers at Lukanga Swamp
Source: Field Data, 2017

The respondents for the survey were also asked to indicate how they were coping with the presence of *S. molesta* and several options for coping strategies were presented to them. The results are shown in Table 5.2.

Table 5.2: Major Coping Strategies for Survey Respondents Involved in Fishing Related Activities at Lukanga Swamp

Coping Strategies	Fishing Activity (%)			
	Fishing	Fish Trading	Canoe Paddling	Canoe Hiring
Removal of weed	44.0	0.0	55.6	0.0
Shifting to open waters	31.4	0.0	0.0	0.0
Buying more fishing nets	12.2	0.0	0.0	0.0
Increased charges for hiring canoe	0.0	0.0	0.0	55.5
Increased charges for transporting fish	0.0	0.0	33.3	0.0
Farming	2.9	66.5	11.1	43.4
Other ¹	9.5	33.5	0.0	1.1
Total	100	100	100	100

Source: Field Data, 2017

According to Table 5.2, the results showed that every household involved in fishing related activities adopted at least one coping option as a response to the effects of the weed towards their fishing related activities.

The following section discusses the coping strategies of fishers and survey respondents towards the effects of *S. molesta*.

5.3.1 Manual Removal of the Weed

The results of this study showed that one of the ways in which the fishers were coping with the presence of the weed at Lukanga Swamp was by manually removing the weed. The study revealed that the fishers together with the fisheries committees and canoe paddlers were voluntarily removing the weed in infested routes which leads to open waters within the swamp. The respondents explained that the removal of the weed in infested areas was done manually with the use of simple tools such as shovels, slashes and hoes. In line with a study by Charudattan (2010), manual removal of aquatic weeds with simple hand tools is probably the most widely practiced strategy of control

¹ Others include alternative sources of income to supplement fishing activities mainly beer brewing, grocery and reed mat making.

for poor communities. Manual removal of aquatic weeds with simple hand tools involves removing the weed from the sites using efficient hand tools and protective covers such as rakes with long handles, ditchbank knives, spades, forks, wheelbarrows, gumboots and hand gloves. Figure 5.4 depicts manual removal of the weed at Lukanga swamp using simple hand tools. The removed weed is carried to dry ground, dehydrated and burnt.



Figure 5.4: Manual Removal of *S. molesta* at Lukanga Swamp
Source: Birdwatch Zambia, 2017

Studies showed that although manual removal demands a high labour force, if systematically implemented it may be of great value to reduce a moderate stand of the weed (Charudattan, 2010; Terry 2011; Labrada, 2013). For example, Charudattan (2010) observed that manual removal of weed is a very labour intensive method of control but it can be practical for small lakes, narrow streams or canals and for removing small infestations on large water bodies.

At Lukanga Swamp, manual removal of the weed was the most commonly used method targeted to control the weed. The fishers were organized by the fisheries committees to clear infested routes which leads to different fishing grounds within the swamp. Although it was a voluntary exercise, those who did not participate in the exercise are

required to pay a minimum fee of ZMK10. There was no fixed interval as to when the clearing should be conducted although the respondents indicated that the exercise is mainly carried out when infestations were very high in canals in such a way that they were forming almost impenetrable barriers to canoes especially after the fish ban. This implied that a fisher at Lukanga Swamp do not only deal with reduced fish catches and difficulties in navigating within the swamp as a result of the weed, but also increased fishing efforts through clearing the weed or additional fishing costs through payments for clearing the weed.

5.3.2 Shifting to Open Waters

One of the ways in which fishers were responding towards the presence of the weed was by concentrating their fishing activities in open waters. The fishers have explained that fishing in open waters was more convenient compared to areas near the shores which were highly infested with the weed. The findings were in line with Charudattan (2010), who reported that the invasion of the weed was high in bays and shores where the water levels are low, which also causes the fish to migrate to open waters. *S. molesta* is found in the slow-moving edges of rivers and streams, in dams, ponds and lakes and in wetlands such as reed and sedge swamps. Surveys and updates by GISP (2004) revealed that as much as 90 percent of the shorelines of the affected water bodies in Africa are covered by aquatic weeds. For example, maximum cover of stationary mats of weeds along the banks of River Nile was estimated in 1994 to fringe about 80 percent of shoreline length.

The invasion of areas near the shores by the weed reduces their potential for fishing, spawning and nursing (Charudattan, 2010; GISP, 2007). The covering of fishing areas near the shores at Lukanga Swamp implied time and energy consuming journeys to reach open waters. There is a general consensus that costs associated with artisanal fishing tend to be lower due to lower fuel consumption and running costs for boats, which tend to make shorter trips close to the shore (FAO, 2009; Musumali *et al.*, 2009; OAG, 2015). On the contrary, the findings of this study showed that the presence of the weed at Lukanga Swamp made fishing more costly and time consuming.

5.3.3 Camping Near Open Waters

The fishers were also resorting to settle on islands and areas which were very close to open waters during the fishing open season as a response mechanism to difficulties in movements caused by the weed. The fishers narrated that normally they used to spend the whole night or day fishing on water and back to their respective fish camps located in nearby villages or larger islands. The fishing effort consisted mainly two round trips to a netting ground and to a fish camp (one for setting nets and the other for removing the fish and nets). With the invasion of the weed, there was an increase in the fishing efforts in form of long and time-consuming journeys to reach open waters. As a response mechanism, the fishers resorted to building permanent makeshift houses in areas near open waters. The implication of this strategy was that it has reduced fishing efforts of fishers by reducing the time-consuming journeys to reach open waters caused by the presence of the weed.



Figure 5.5. A Makeshift House near Open Waters at Lukanga Swamp
Source: Field Photo 2017

However, there was an observation that permanent camping within the swamp was increasing the fishers' vulnerability to water borne diseases such as cholera. The

respondents of this study revealed that the presence of the weed at the swamp was increasing the number of fishers who die from cholera at the swamp. The respondents explained that it was taking too much time to transport fishers who were victims of cholera from their camps to the harbour because of the challenges of boat navigation posed by the weed, as a result, a number of fishers have died on their way to the clinic. This impact poses additional burden on the limited health services and facilities available to the poor rural communities.

A study by Murebwa *et al.*, (2017) reported that in September of 2016, a total of 27 fishers were admitted at Lukanga health center for cholera cases. Murebwa *et al.* (2017), attributed cholera cases of fishers to permanent camping at the swamp which lacks proper sanitary services. Consistent with the findings of this study, Lungu and Hüsken (2010) reported that cases of deaths from preventable diseases such as cholera, diarrhoea and dysentery often occur due to poor water quality and a general low hygiene status in fishing communities.

5.3.4 Buying More Fishing Nets

This study also showed that the weed clogs fish nets set to trap the fish which results in damaging or losing the fish nets as well as reducing their life span. As a response mechanism, the fishers indicated that they were buying more fishing nets as a coping strategy. According to the fishers, this strategy helped them to quickly replace the fish nets clogged or damaged by the weed. The fishers explained that on average, each fisher owns up to 30 fishing nets. This is in agreement with a survey by Central Statistical Office (2004), which reported a fisher-fish net ratio of 1 to 20 in most water bodies in the country. However, at Lukanga Swamp, interviews with the fishers revealed that with the effects of the weed, each fisher now has between 40 and 70 fishing nets (Figure 5.6).



Figure 5.6. Fishing Nets Hanged after being Clogged by the Weed at Lukanga Swamp

Source: Field Photo 2017

The fishers also explained that they were sometimes servicing the clogged fish nets by hanging them to allow the weed to dry so that they can easily remove it from the nets. However, the fishers complained that the process of servicing the fish nets clogged by the weed takes too long as they have to wait for a long time for the weed to dehydrate and be easily removed without causing damage to the nets. As a result, the fishers are forced to keep extra fishing nets so as to quickly replace those which are either clogged and damaged or swept away by the weeds. This implied that there was an additional cost on the fishers at Lukanga Swamp of buying extra fishing nets.

5.3.5 Directly Transporting and Selling Fish at the Markets

A small percentage of the fishers (4.9 percent as shown in Figure 5.3) indicated that they were directly transporting and selling fish in the central markets of Kabwe town as a coping strategy to reduced fish catches due to the presence of the weed. According to the fishers, the presence of the weed reduced fish catches and also made fishing more costly that there was very little profit that being realized when the fish is sold at a wholesale price to traders at the swamp. The fishers explained that they were engaging their relatives or wives to take the fish to urban markets where they were selling the fish at

retail prices. This is in line with the study by Coulthard (2008) who observed that during lean fishing periods, shifting to fish trade by engaging family members is the most common alternative livelihood strategy of fishers. According to Coulthard (2008), often times, most of the fishers spent more time fishing with the assistance of other family members in fish trading since they are unable to hire workers and their livelihood were solely dependent on the proceeds of the fishery.

This strategy has an implication on the people who derive a livelihood out of taking the fish to urban markets as fish traders which is the only main fishing related activity most women engage themselves at Lukanga Swamp. According to the findings of this study, all the 41 fishers who were interviewed within Lukanga Swamp were men whereas survey results as presented in Table 5.3 show that there were no women at Lukanga Swamp who have taken up fishing as a source of livelihood but a large population at 49.1 percent were into fish trading compared to 28 percent of men. This is mainly because women were not allowed to enter the swamps or to participate in fishing activities. Respondents alluded this to a general belief among the local communities that women tend to bring bad luck to fishing activities within the swamps which may result into reduced fish catches.

Table 5.3: Main Occupation of Heads of Household by Gender

Occupation	Gender of Head of Household			
	No.	Men Percentage	No.	Women Percentage
Fisher	37	39.8	0	0.00
Fish Trader	26	28.0	28	49.1
Canoe Paddler	7	7.53	0	0.0
Canoe Owner	9	9.68	0	0.0
Farmer	12	12.9	16	28.1
Beer Brewer	0	0.00	10	17.5
Other ²	2	2.15	3	5.26
Total	93 (62%)	100.0	57 (38%)	100.0

Source: Field Data, 2017

² Other include grocery and reed mat making.

According to the key informant, the exclusion of women from participating in fishing at Lukanga Swamp was one of the local rules and norms that regulate wetland use. The key informant narrated that “*the list of local rules and norms was produced to control, among others, water pollution, cattle from straying into cropping areas and hygienic practices in extracting wetland water for drinking*”. The key informant further explained that the banning of women from entering the swamp is mainly for hygienic purposes. This rule was also depicted among the fishing rules displayed at the entrance of Waya harbour where it is stated that women were prohibited from entering the swamps and if found they were charged a penalty fee of ZMK500 and summoned to the chief for further punishments (Figure 5.6). The finding echoes McCartney *et al.* (2011)’s observation that some of the rules at Lukanga swamp reflect the patriarchal nature of chiefs, which undermines access to some wetland resources by women.

Reducing women to access to natural resources can have an adverse implication on the household food security especially when faced with environmental threats such as invasion of alien species. A study by Bennett (2004) show that whilst in many societies fishers’ income is theirs to spend as they wish, income received by women from their fishing activities has to be spent on the upkeep of the household, thereby, providing a real economic and financial incentive for women to innovate in order to ensure that all their needs (housing, health, education and nutrition) are met.



Figure 5.6. Some Fishing Rules Displayed at the Entrance of Waya Harbour³
Source: Field Photo 2017

As women at Lukanga Swamp were already sidelined from fishing and were only involved in the fishery at fish trading level, fishers engaging in fish trading as a coping strategy implied that women who were largely involved in fish trading were deprived their source of income. This has a negative impact on the food security of the local communities because according to FAO (2015), in small-scale fishing communities, women are the main caregivers of the fishing household, responsible for food and nutrition security survival strategies in face of disasters. Similarly, Coulthard (2008) reported that whilst often overlooked, involvement of women in fishing may hold the key to successful adaptation and survival strategies in the face of disasters such as the invasion of species at Lukanga Swamp. For example, at Lukanga Swamp, although women are not allowed to fish, they have been key in the manual removal of the weed from infested canals as depicted in Figure 5.4. This is a contradiction with the rule that prohibits women from entering the swamp. Thus, there is an urgency to revise the local

³ Rules displayed at the entrance of the Swamp include; prohibition of women from entering the swamps, no alcohol drinking within the swamps, and no use of destructive fishing gear.

rules and norms so that women are also granted access to resources at the swamp just the way they are allowed to participate in managing the weed. Increasing women's access to natural resources plays a vital role on their ability to be active agents of change and the dynamic promoters of social transformations that can alter the lives of both women and men (FAO, 2015).

5.3.6 Increased Canoe Hiring and Transporting Charges

The fishers are not the only resource users who have been affected by the invasion of *S. molesta* at Lukanga Swamp as shown in Table 5.1. As earlier indicated, it is difficult and time consuming to navigate around the swamp with weed infestation. For example, an estimated distance of 2km which normally takes about an hour is now taking 3hrs with the presence of the weed. The canoe paddlers have complained that transporting goods is now time consuming and it is now difficult to realize any profits when they charge a normal price. The canoe owners have equally complained that the normal period of hiring a canoe is two weeks, but because of the presence of the weed, those who rent a canoe tend to go beyond the stipulated period. As a result, both the canoe paddlers (33.3 percent) and canoe owners (55.5 percent) have resorted to increasing charges for transporting goods and hiring a canoe respectively (Table 5.2). The hiring of a canoe per fortnight was at K100 but went up to between K150 and K200. This has an implication on the fishers who were renting canoes for their fishing related activities and who also engage canoe paddlers to transport their fishing goods.

5.3.7 Alternative Sources of Income

Survey results also show that those involved in fishing related activities have resorted to alternative sources of income as a way of supplementing the reduced income from their fishing related activities. The majority of the fish traders (66.5 percent) and canoe hirers (43.4 percent) have gone into farming whereas 24.4 percent have resorted to other alternative sources of income such as beer brewing, grocery and reed mat making to supplement their fishing related activities (Table 5.2). With regards to the fishers, a very small percentage of 2.9 percent are also practicing farming as a supplement to reduced income from fishing. However, the fishers narrated that they mainly fully engage in farming practices during the fish breeding season when there is a fish ban.

The findings of this study showed that there is very little livelihood diversification among the fishers as they have adopted strategies which allows them to continue their fishing activities amidst the presence of the weed. The findings are in line with earlier studies at Lukanga Swamp such as the study by Kachali (2007) which revealed that the general trend among fishers at Lukanga Swamp was their inability to diversify their livelihood strategies and or reinvest their earnings from fishing into other activities. Similarly, Mapedza *et al.* (2012:1) also cited one of the fishers at Lukanga Swamp saying *we came here to fish. This takes up most of our time..... I don't see how we can abandon this livelihood to start herding cattle.*

Lack of diversification among the fishers at Lukanga has a direct impact on their livelihood in the face of the invasion of the weed. For example, Tweddle *et al.* (2015) argues that lack of diversification among rural fishing communities makes them become trapped in a cycle of declining individual catches resulting from increased effort, reduced mesh sizes and ultimately use of environmentally destructive fishing gears such as large beach seine nets lined with cloth to catch the few remaining small fish species that can survive the intense, unrelenting effort. Similarly, Birdwatch Zambia (2017), has also reported that reduced fish catches that at Lukanga Swamp has forced fishers to use more gear and, in some cases, use incorrect fishing gear such as Mosquito nets and poisons to increase catches. According to Coulthard (2008), diversification is important as it reduces the risk of livelihood failure by spreading it across more than one income source and also helps to overcome the uneven use of assets (principally labour) caused by seasonality, to reduce vulnerability, to generate financial resources in the absence of credit markets, and it confers a host of other advantages in the presence of widespread market failures and uncertainties.

5.4 The Effectiveness of the Coping Strategies of Fishers in the Presence of *S. molesta* at Lukanga Swamp

Table 5.4 shows the assessment of the effectiveness of the fishers' identified coping strategies towards the presence of *S. molesta*. The effectiveness was assessed using a Five-Point Likert Scale where 1=Ineffective, 2=Fairly effective, 3=Undecided,

4=Effective and 5=Very effective. The fishers were asked to rate their major identified coping strategy.

Table:5.4: The Effectiveness of the Fishers' Identified Coping Strategies

Major Coping Strategy	Rate of the Effectiveness of Fishers' Identified Major Coping Strategies					No. of Respondents/ Percentage
	1.Ineffective	2. Fairly Effective	3.Undecided	4. Effective	5.Very Effective	
Removal of weed	2(4.8%)	9(22%)	0(0%)	5(12.2%)	0(0%)	16(39.0%)
Shifting to open waters	3(7.3%)	5(12.2%)	0(0%)	4(9.8%)	0(0%)	11(26.8%)
Camping near open waters	4(9.8%)	1(2.4%)	0(0%)	0(0%)	0(0%)	5(12.2%)
Buying more fishing nets	5(14.6%)	1(2.4%)	1(2.4%)	0(0%)	0(0%)	7(17.1%)
Directly selling fish	1(2.4%)	1(2.4%)	0(0%)	0(0%)	0(0%)	2(4.9%)
Total	17(41.5%)	14(34.1%)	1(2.4%)	9(22%)	0(0%)	41(100%)

Source: Field Data, 2017

The findings of this study as shown in Table 5.4 indicated that only removal of the weed at and shifting to open waters at were rated effective coping strategies by the fishers towards the presence of the weed. The rest of the other coping strategies (camping near open waters, buying more fishing nets and directly selling and transporting fish to the markets) were rated as either ineffective or fairly effective. Figure 5.8, also shows the graphical presentation of the effectiveness of the fishers' major identified coping strategies towards the presence of the weed at Lukanga Swamp.

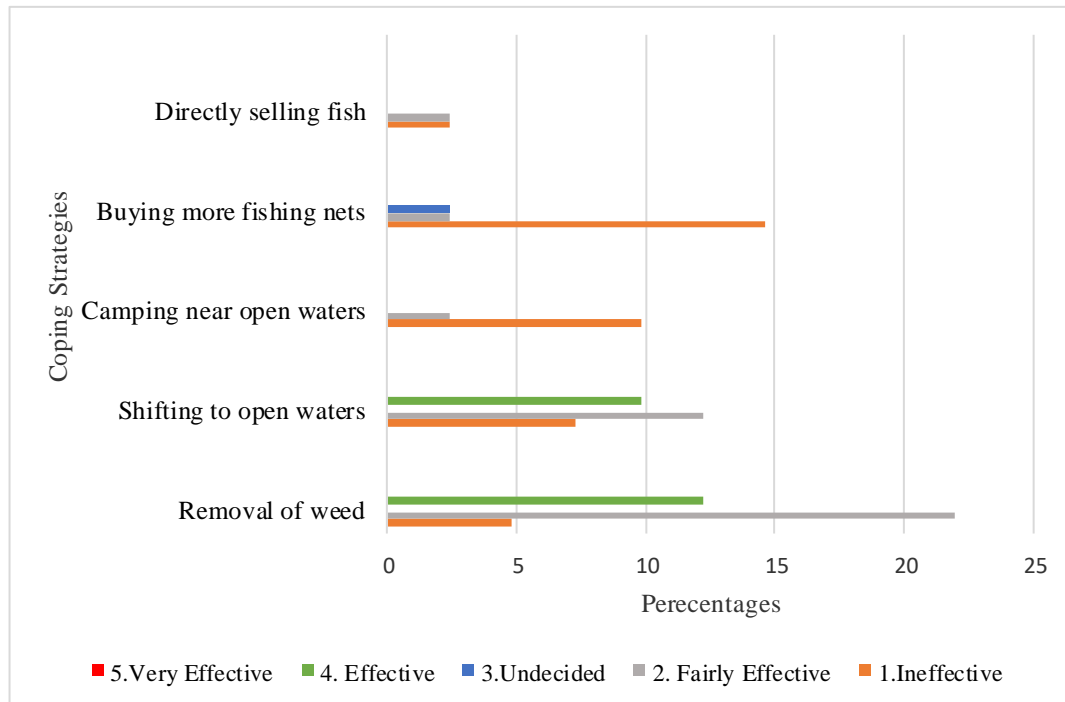


Figure 5.8. Effectiveness of Fishers’ Coping Strategies
Source: Field Data, 2017

Survey results also showed that removal of the weed, shifting to open waters and buying more fishing nets were rated as effective coping strategies with the presence of the weed at Lukanga Swamp as shown in Table 5.5.

Table: 5.5 Survey Results on the Effectiveness of the Identified Coping Strategies

Major coping strategies	Rate of effectiveness of major coping strategies					Total
	1.Ineffective	2.Fairly Effective	3.Undecided	4.Effective	5. Very Effective	
Percentages (n=150)						
Removal of weed	54.8	13.1	0.0	32.1	0.0	100.0
Shifting to open waters	42.8	33.4	9.3	10.5	0.0	100.0
Buying more fishing nets	56.7	23.1	9.1	11.1	0.0	100.0
Camping near open waters	72.3	27.7	0.0	0.0	0.0	100.0
Increased charges for hiring canoe	64.6	35.4	0.0	0.0	0.0	100.0
Increased charges for transporting fish	100.0	0.0	0.0	0.0	0.0	100.0
Farming	12.5	22.7	0.0	64.8	0.0	100.0
Other ⁴	24.7	51.7	3.4	20.2	0.0	100.0

Source: Field Data, 2017

For the survey, to determine how different the ratings of effectiveness of the coping strategies were, an ANOVA test was conducted and the results are presented in Tables 5.6 and 5.7 respectively.

Table 5.6: ANOVA Test Results

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	10965.738	3	3655.246	9.718	.000
Within Groups	10531.543	28	376.127		
Total	21497.280	31			

The ANOVA results show that the ratings were significant different (F=9.718; P=0.001).

⁴ Other include alternative sources of income to supplement fishing activities mainly beer brewing, grocery and reed mat making.

Table: 5.7 ANOVA Test for Effectiveness of Coping Strategies

Rate of Effectiveness	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Ineffective	8	53.550000	27.4531809	9.7061652	30.598566	76.501434	12.5000	100.0000
Fairly Effective	8	25.887500	15.4370091	5.4578069	12.981837	38.793163	.0000	51.7000
Undecided	8	2.725000	4.1654189	1.4726980	-.757377	6.207377	.0000	9.3000
Effective	8	17.337500	22.2525721	7.8674723	-1.266116	35.941116	.0000	64.8000
Total	32	24.875000	26.3336409	4.6551740	15.380710	34.369290	.0000	100.0000

The means as indicated in Table 5.7 showed that the rating of the coping strategies of respondents were more with ineffective ratings (Mean=53) than with other ratings. Therefore, statistically, it can be concluded that the respondents felt the coping strategies for *S. molesta* at Lukanga Swamp were not effective (Mean=53; F=9.718; P=0.001). The results on the ratings of effectiveness of coping strategies are also presented graphically in Figure 5.8.

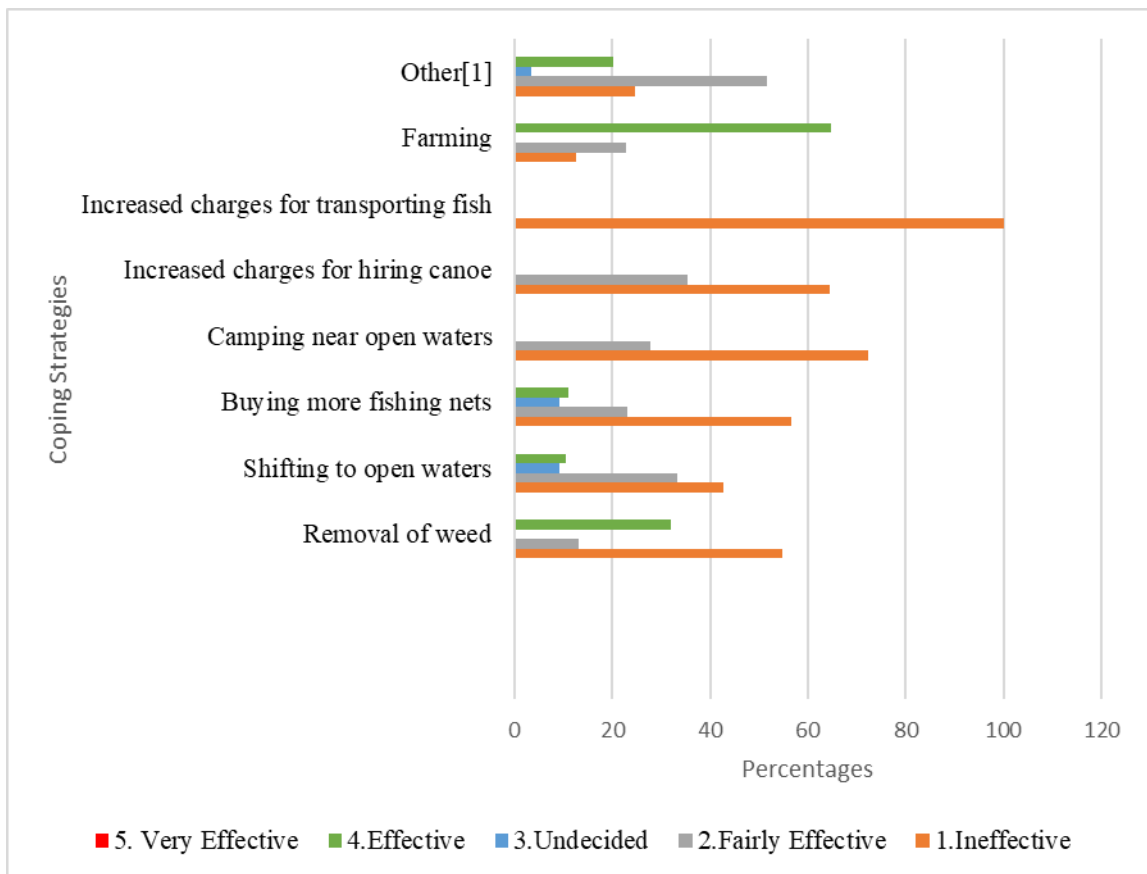


Figure 5.8. Survey Results on the Effectiveness of Identified Coping Strategies
Source: Field Data, 2017

Generally, the study revealed that most of the major identified coping strategies of the respondents were rated as ineffective. This implied that the majority of the identified coping strategies at Lukanga Swamp were not effective. For example, the respondents explained that manual clearing of the weed which was one of the highly adopted coping strategies at Lukanga Swamp was ineffective because the weed has a fast growth rate and the simple hand tools that the local people were using to remove the weed cannot cope with its growth rate. In line with a study by GISP (2015), *S. molesta* can be physically removed from a water body (by mechanical or human means) but it grows so fast that this is often not effective. Furthermore, GISP (2015) observed that the mobility of free-floating plants, rapid growth, and large biomass production combine to frustrate most physical control attempts.

Evidence from the literature also suggests that manual or mechanical control of *S. molesta* is difficult and costly (GISP, 2007; Labrada, 2013; GISP, 2015). For example, Labrada (2013) argues that in highly infested areas, manual removal does not seem to be a technically effective or economically feasible method as it requires a large labour force, and governments of the developing world do not always have the means to pay for this operation. A case example for manual removal of the weed was reported by GISP (2007) in Senegal which involved 200 people to clear 200ha of the weed and the exercise took 6000 hours of work and 5000 litres of diesel fuel but with unsuccessful results as the cleared water bodies were reinvaded after 2 months. Similarly, at Lukanga Swamp, a key Informant narrated that Birdwatch Zambia in 2013, attempted a manual control of the *S. molesta* where the community members were involved by using hands and rakes to remove the weed from the swamp. This method proved futile as the weed was difficult to clear, it came back into the swamp and re-germinated and was therefore not controlled. The rapid rate of increase of the weed in addition to the magnitude of its distribution makes manual method a very tiresome and a high labour demanding exercise and uneconomic, as it is a slow and inefficient process for large and heavy mats. In addition, manual or mechanical control does not eliminate all of the juvenile plants and because of the rapid rate of reproduction of *S. molesta*, physical control has to be intensive and regular.

According to the findings of this study, open waters were the only areas where the fishers were able to catch more fish with less effects of the weed within the swamp. As a result, fishers at Lukanga Swamp have settled near the open waters or concentrated their fishing activities in these areas. On the contrary, the majority of the respondents rated this strategy as either ineffective or fairly effective as shown in Table 5.5 and 5.6 respectively. According to the findings, this strategy was not effective as there were more fishers against the few remaining fishing grounds as quite a number of fishing grounds within the swamp were closed up by the weed. More fishers were competing over declining resources in the same fishing grounds. In addition, the respondents also explained that open waters were also sometimes affected by the weed especially in

windy days. The respondents explained that the wind would tend to blow the weed towards open areas from the shore which makes it difficult to conduct fishing activities.

The study also revealed that the coping strategy of permanent camping within the swamp as a response mechanism was not effective as shown in Table 5.5 and 5.6. The strategy of permanently camping within the swamp was ineffective because it had increased their vulnerability to water borne diseases such as cholera. The swamp lacked suitable sanitary facilities. This observation was also reported by Murebwa *et al.*, (2017) that increases in cholera cases of fishers at Lukanga Swamp is as a result of fishers camping permanently within the swamps which lacks proper sanitary services. In addition, studies show that infestations of *S. molesta* offer breeding sites for mosquitoes and bilharzia carriers as well as other vectors of disease organisms (GISP, 2007; Labrada, 2013). Therefore, this implied that, the presence of the weed at Lukanga Swamp has not only affected the fishers' fishing activities but also poses a high risk to their health.

In addition, as indicated in Figure 5.9., it is important to note that the majority of fishers had very little livelihood diversification compared to the others involved in other fishing related activities.

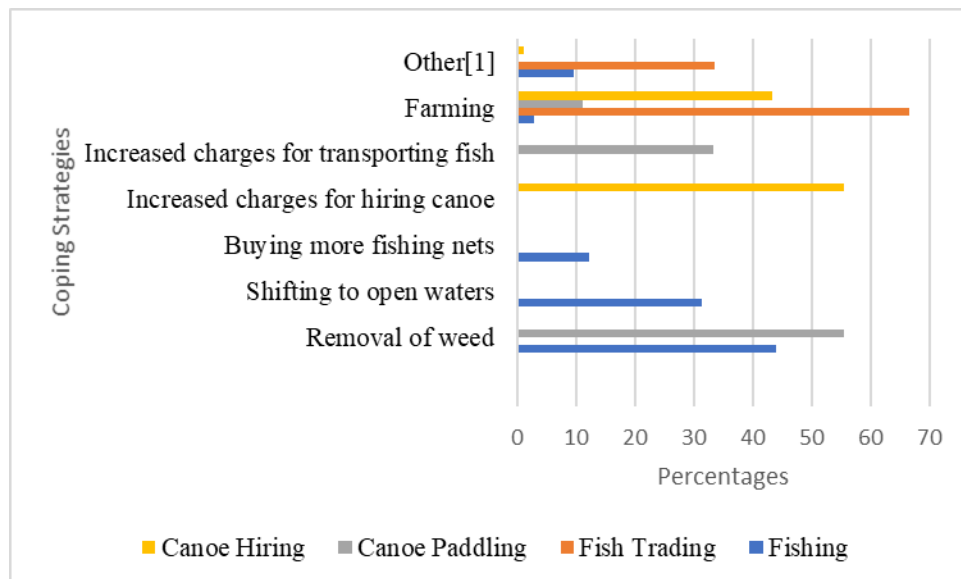


Figure 5.9. Major Coping Strategies by Fishing Related Activities
Source: Field Data, 2017

Reduced incomes from other fishing related activities has led the local people especially those engaged in fish trading to shift to other alternative sources of income of which farming is dominant (see Figure 5.9). One of the key informants narrated that *the locals are now resorting to alternative sources of income such as farming because of the challenges of the weed, and also because of the incentives in farming given to cooperative society members such as fertilizer and seeds*. The government through the Farmer Input Support Programme (FISP) provides 2*50kg top dressing, 2*50kg basal fertilizer, and 10kg of hybrid seeds to cooperative society members within Lukanga Swamp. This is perceived by the fishers as government favouring farming activities over fishing in the area as it is able to provide incentives to farmers and not willing to attend to the challenges of the fishers especially in controlling the weed.

Generally, the fishers' major coping strategies towards the presence of *S. molesta* are not effective as shown by this study. The strategies were either labour intensive and costly such as clearing the weed, and servicing and buying more fishing nets or poses a health risk to fishers such as permanent camping within the swamp. This implied that the presence of the weed was negatively affecting the fishers' livelihood. This situation was further exacerbated by the inability of fishers to diversify their livelihood strategies as shown in Figure 5.9. This observation is contrary to a study by Coulthard (2008) which showed that rural communities, which are dependent upon natural resources for sustaining a livelihood, often manage uncertainty by diversifying livelihoods and income sources as a means of spreading risk and reducing vulnerability.

In addition, the respondents were also asked to suggest possible solutions which can help the fishers to effectively deal with the presence of the weed. The results are presented in Table 5.9.

Table:5.9 Fishers’ Suggestion and Mitigation Measures Towards *S. molesta*

Suggestions for control	Responsible Agents			Totals
	Government n=41	NGOs Percentages	Local Communities	
Physical control	56.1	7.32	36.6	100
Chemical control	65.9	34.1	0.0	100
Permanent employing workers	75.6	17.1	7.32	100

Source: Field Data, 2017

The study revealed that the respondents identified three categories of suggestions as control measures of the weed at Lukanga Swamp (Table 5.9). According to the findings, respondents reported that either government or NGOs should come in and help as they have failed to effectively deal with the weed. The majority of the fishers (75.6 percent) suggested that it was the responsibility of the government to employ the locals on a permanent basis to be clearing the weed. The fishers expressed this view because government through the Water Affairs Department under the Ministry of Environment and Water Affairs had earlier engaged the locals to be clearing in return for payment to the fishers. Because of the payments involved, the fishers’ perception was that the method worked effectively well as the cleared path ways made fishing activities convenient at the Swamp. However, a key informant from Water Affairs suggested that this method proved futile and costly as the weed had a very fast growth rate and the simple hand tools, that the local people at Lukanga Swamp were using to remove the weed couldn’t cope with its growth rate.

In line with the findings, Ciruna (2004), observed that subsistence level producers have fewer options to manage IAS, and may value marginal prevention and control measures more than the wealthy. According to UNEP (2013), one of the most important barriers to effective invasive species management programmes is that funding for invasive species management and prevention is grossly inadequate. In addition, a key informant from ZEMA indicated that there has been very little progress from the government in implementing strategies or interventions aimed at managing invasive species. For example, the key informant reported that Zambia is yet to finalize and implement its

National Invasive Species Strategy and Action Plan (NISSAP) which has been in a draft form for over ten years. The key informant further revealed that there is still no institutional co-ordination mechanism for ensuring that IAS issues are addressed with the necessary broad, multi-sectoral ecosystem approach. In line with these findings, GRZ (2015) reported that, there are still gaps, overlaps and inconsistencies in existing policies, regulations, strategies and institutional arrangements concerning the management of IAS in Zambia. Furthermore, GRZ (2015) revealed that the relevant policies, laws and regulations, and the institutional and operational responsibilities for addressing IAS issues are still ill defined, and scattered between different ministries, hindering a coordinated approach and often delaying appropriate action.

Similarly, UNEP (2013) has noted that, the policy environment within which most countries in Africa are operating is fragmented and weak. In addition, Wittenberg and Cock (2001) argued that in most developing countries there is a weak policy and institutional environment, critical information is unavailable, there is inadequate implementation of prevention and control, and there is a lack of the necessary capacity. Under current trends, the situation in Africa will deteriorate because on one hand the pathways through which IAS invade are becoming more numerous, and on the other, there are a number of barriers that are constraining countries in Africa from addressing the problem effectively. Therefore, because of the range of pathways through which IAS might enter a country, and the many social, economic and biological impacts they can have, it has been recommended that effective IAS management requires a broad multi-sectoral approach (Wittenberg and Cock, 2001; UNEP, 2013). GISP has produced a book entitled *Invasive Alien Species: A Toolkit of Best Prevention and Management Practices* (Wittenberg and Cock, 2001). The GISP Framework recommends three main strategies for dealing with established invasive alien species;

1. *Eradication*: Killing the entire population of IAS. When prevention measures have failed, an eradication programme is considered to be the most effective action, because of the opportunity for complete rehabilitation of the habitat. Typically, this can only be accomplished when the organisms are detected early.

Eradication has been achieved using mechanical, chemical and biological control, as well as habitat management.

2. *Containment*: Containment is a specific form of control. The aim is to restrict an invasive species to a limited geographical range. The population can be suppressed using a variety of methods along the border of the defined area. Individuals spreading outside this area are eradicated, and introductions outside the area prevented.
3. *Control*: The process of long-term management of the IAS' population size and distribution when eradication is no longer feasible. Control and eradication methods can take one or more of three forms. Integrated pest management (IPM) is their combined application:
 - Mechanical control: The physical removal of organisms – pulling weeds, for example. The process requires a long-term investment of human resources.
 - Chemical control: Using chemicals to kill organisms – poisons for wildlife and herbicides for plants, for example. The processes can be quite costly and typically requires repeated applications
 - Biological control: The introduction of a highly specific predator, parasite or pathogen that will attack the IAS.

In addition to the strategies, GISP also recommends the development of the National Development Plan which is important for making a national commitment operational. According to GISP, the national strategy should include a strategy to build institutional support and engage all important stakeholders in the effort, particularly local communities (Wittenberg and Cock, 2001). GISP Framework also indicates that, for best prevention and management practices of IAS, implementing effective prevention, eradication, and control measures may require new policy approaches, as well as significant advances in ecological knowledge and natural resource management.

Therefore, at Lukanga Swamp, there was need for larger institutions such as ZEMA, to champion the integration of different methods/strategies based on ecological research, regularly monitoring, and co-ordination as a best way in achieving desired outcomes in managing IAS. An integrated approach which may consist of mechanical and/or systematic manual removal, the use of herbicides in particular infested sites and biological control is therefore, key to effectively deal with the weed at Lukanga Swamp.

CHAPTER SIX

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

This chapter presents the summary and conclusion of the findings of the study in relation to the aim and objectives of the research as well as recommendations arising from the findings of the study. It also presents the need for further studies.

6.2 Summary

The aim of the study was to investigate the coping strategies for fishers at Lukanga Swamp towards the effects of *S. molesta*. The study focused on three specific objectives which were (i) finding out how the presence of the weed has affected the fishers, (ii) identifying the major coping strategies of fishers towards the presence of *S. molesta*, and (iii) assessing the effectiveness of the fishers' identified coping strategies at Lukanga Swamp. Firstly, the results of this study had shown that *S. molesta* concentrations at Lukanga Swamp was affecting the fishers through; blocking waterways, swamping fishing grounds and fish breeding areas and impeding fishing activities, water quantities and fish catches have also reduced. This implied that the presence of the weed at Lukanga Swamp was a reflection of reduced level of production and rising costs of fishing operations.

Secondly, the study had shown that the major identified coping strategies for fishers at Lukanga Swamp towards the presence of the weed among others included; manual removal of the weed in infested routes, shifting to open waters which are less affected by the weed, and permanently camping near open waters to avoid difficulties in movements to and from the harbour. The study revealed that the fishers' coping strategies at Lukanga were mainly ex-ante options which have enabled them to continue fishing with increased fishing efforts rather than ex-post options such as finding alternative sources of income or livelihood diversification.

Lastly, the results of this study showed that most of the coping strategies of the fishers at Lukanga Swamp were rated as either ineffective or fairly effective meaning that the fishers' identified strategies were not effective to cope with the presence of the weed. This implied that the fishers at Lukanga Swamp failed to effectively deal with the

presence of the weed as this was also a costly exercise which the lower income sector such as the Lukanga fishers cannot afford.

6.3 Conclusions

Therefore, inconclusion, it is important to note that, implementing effective prevention, eradication, and control measures is a costly exercise which the lower income earning group such as the fishers at Lukanga Swamp cannot afford. This requires new policy approaches, as well as significant advances in ecological knowledge and natural resource management by larger relevant institutions such as ZEMA. There is also need to develop the National Development Plan for invasive species which is an important strategy for making a national commitment operational. Therefore, the significant ecological and socio-economic impacts of *S. molesta* on the Lukanga fisheries dictate that larger institutions such as government's efforts must be made to prevent, eradicate and control their further spread to other fisheries.

6.4 Recommendations

Based on the finding of this study, the following are the recommendations

1. The study has shown that most of the coping strategies of the fishers at Lukanga Swamp are not effective and sustainable as effectively dealing with invasive species is a costly exercise which the lower income sector such as the Lukanga fishers cannot afford. Time-consuming mechanical clearing is the only means of temporarily relieving their plight. Therefore, this study recommends that larger institutions such as government institutions (i.e. ZEMA, Ministry of Environment and Water Development) should intervene to eradicate the weed at Lukanga Swamp through an integrated approach which may consist of mechanical and/or systematic manual removal, the use of herbicides in particular infested sites and biological control.
2. The study has also revealed that the country has no national strategy or policy for IAS and yet, the reality is that invasive species are a major threat to human livelihoods such as fisheries as it can be noted in this study on the effects of *S. molesta* at Lukanga Swamp which are generally undermining human well-being.

Therefore, this study recommends key stakeholders such as ZEMA through the Ministry of Environment and Water Development should speed up the process of developing relevant policies, laws and regulations, and effective institutional and operational responsibilities for addressing IAS.

3. The Department of Fisheries and the fishing committees at Lukanga Swamp should also play a lead role in raising awareness amongst the local communities and all stakeholders at Lukanga Swamp on the inherent dangers of *S. molesta* infestation as there is a likelihood of the community to unintentionally spread the weed to other water bodies as most fishers in the country are highly mobile.
4. There is also need to revise the local rules and norms so that women are also granted access to resources at the swamp just the way they are allowed to participate in managing the weed. Increasing women's access to natural resources plays a vital role on their ability to be active agents of change and the dynamic promoters of social transformations that can alter the lives of both women and men.

6.5 For Further Research

Although the study contributes to policy direction to address complex socio-ecological issues of Lukanga Swamp, some information gaps and understanding still remain a challenge from this study.

- This study focused on identifying major coping strategies of fishers towards the presence of *S. molesta* at Lukanga Swamp and the effectiveness of the identified coping strategies. There is need to undertake a study to understand the ecological effects of *S. molesta* on the natural resources at Lukanga Swamp.
- Furthermore, in order for policy makers to make informed decisions, much more economic information is required on the costs and benefits of environmental programmes. It is frequently stated that there are insufficient resources to control aquatic weeds. Thus, the need to undertake a study comparing the costs of

prevention of *S. molesta* at Lukanga Swamp to the costs of decreased fish catches and the costs of increased water-borne diseases at Lukanga Swamp.

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APPENDICES

APPENDIX A: INTERVIEW SCHEDULE FOR FISHERS

Dear Respondent

You have been selected to participate in providing information for our research. This interview is intended to collect information on the coping strategies for fishers towards plant invasive species at Lukanga Swamp. The information to be collected is for academic purposes only. Kindly be assured that names of respondents will be kept anonymous to ensure confidentiality.

SECTION A: GENERAL INFORMATION OF RESPONDENTS

1. What is your sex?
.....
2. Age in years
.....
3. What is your highest level of education?
.....
4. For how long have you been involved in fishing?
.....
5. What is your monthly income estimate from fishing?
.....
6. Are you involved in other activities for your living apart from fishing?
.....
7. If Yes, please specify _____

SECTION B: EFFECTS OF SALVINIA MOLESTA ON FISHING ACTIVITIES

8. In which year did you notice the presence of *S. molesta*?
.....

9. Please explain how the presence of *S. molesta* is affecting your fishing activities.

.....

10. How would you compare your fish catches before and after the invasion of *S molesta*?

Before <i>Salvinia molesta</i>		After <i>Salvinia molesta</i>	
Worse		Getting worse	
Fair		Fair	
Better		Getting Better	

SECTION F: COPING STRATEGIES AND THEIR EFFECTIVENESS

11. Please explain how you have been managing your fishing activities with the presence of the weed (*S. molesta*).

.....

12. Among the coping measures above, which one is the major coping strategy?

.....

13. How would rate your major coping strategy?

Coping Strategies	Rate of the effectiveness of Coping Strategies (Tick in the appropriate box below)				
	1=Not effective	2=Fairy effective	3=Undecided	4=Effective	4=Very effective

14. How would you rate the level of difficulty in addressing the effects of *S. molesta* on the Lukanga Swamp?

1. Not difficult
2. Somewhat difficult
3. Very difficult
4. Extremely difficult

15. What are your perceived solutions or suggestions in dealing with *S. molesta*?

Proposed suggestions/solutions	Who should solve?

Thank you for your attention

END

APPENDIX B: HOUSEHOLD QUESTIONNAIRE SURVEY

HOUSEHOLD QUESTIONNAIRE SURVEY

TOPIC: COPING STRATEGIES FOR FISHERS TOWARDS ALIEN PLANT INVASIVE SPECIES
(*Salvinia molesta*) AT LUKANGA SWAMP

Instructions to Interviewer:

1. Do not write the name of the respondent on the questionnaire
2. Write in the space provided for open ended questions.
3. Do not omit any questions unless there is need to do so
4. Write all responses clearly.

INTRODUCTION

My name is..... I am conducting a research on the coping strategies for fishers towards invasive alien plant species at Lukanga swamp. I am asking questions to people who live in the villages surrounding and within the Lukanga swamp and are involved in fishing activities, chosen randomly to get their views. The information provided will be for academic purposes only and will be kept confidential and anonymous.

Thank you.

1.	Questionnaire Survey Number	
2.	Name of Village/Fishing Camp	
3.	Enumerator's Name	
4.	Name of Respondent	
5.	Date of Interview	
6.	Start time	
7.	Finish time	

SECTION A: DEMOGRAPHIC CHARACTERISTICS OF HOUSEHOLD HEAD

ID	Name of Household Head (Starting with HH)	Sex of Household Head 1=Male 2=Female	In which year was the Household Head born? 	What is the Marital Status of Household Head?	What is the highest level of education completed?	Main occupation of Household Head

				(see codes below)	(see codes below)	(see codes below)
HH	Name	DC01	DC02	DC04	DC05	DC06

Marital Status (DC04)	Education Levels (DC05)	Main Occupation (DC06)
1=Never married 2=Monogamously married 3=Polygamously married 4=Divorced 5=Widowed 6=Separating 7=Cohabiting 8=Other (specify).....	1=None 2=Primary 3=Junior Secondary 4=Upper Secondary 5=Tertiary	1=Child 2=School 3=Household Work 4=Fisher 5=Fish Trading 6=Canoe Paddler 7=Canoe Owner 8=Farmer 9=Beer Brewing 10=Retired 11=Other

SECTION B: HOUSEHOLD FISHING ACTIVITIES AND INCOME DATA

Which fishing activities are members of the Household involved in? 1=Fisher 2=Fish Trader 3=Canoe Paddler 4=Canoe Owner 5=None	For how long have you been engaged in the fishing activities? 1=Below 5yrs 2=6-10yrs 3=11-15yrs 4=16-20yrs 5=21-25yrs	What is your monthly estimate of your current income from fishing activities? 1=Below K1000 2=Between K1000 and K3000	With your current monthly income, are you able to meet your basic requirements? 1=Yes 2=No	In the last two weeks, how many meals have you been affording to take in a day? 1=One meal 2=Two meals 3=Three Meals 4=Four meals 5=Other (Specify)	How would you describe the current level of income in your household? 1=Low income 2=Middle
---	--	---	--	--	---

6=Other (specify).....	6=26-30yrs 7=Above 30yrs	3=Between K3000 and K5000 5=Above K5000		income 3=High income
HI01	HI02	HI03	HI04	HI05	HI06

SECTION C: FISHING ASSETS

<p>Fishing Assets</p> <p>Do you have access to any fishing assets? 1=Yes 2=No</p> <p>If yes, which type of fishing assets do you own or have access to?</p> <p>(Tick in the appropriate box below)</p>		<p>Type of Asset ownership</p> <p>1=Owner 2=Rent 3=Borrowed 4=Other (Specify)</p> <p>If owned, how many do you have?</p>		<p>Value of Fishing Asserts</p> <p>If owner of the asset, at how much would you sell your asset?</p> <p>.....</p>
Type of fishing assets	Tick	Type of asset ownership	Number of assets owned	Total price of assets in Kwacha
1. Canoe				
2. Engine Boat				
3. Fishing Nets				
4. Other (Specify).....				

**SECTION D: CONDITION OF THE SWAMP AND EFFECTS OF SALVINIA MOLESTA
ON LUKANGA SWAMP FISHING ACTIVITIES**

What is the perception of the current condition of the swamp	Condition of the swamp (Tick in the appropriate box below)			
Condition	1=Increase	2=Stable	3=Decrease	4=Not sure
1=Water Levels				
2=Fish Catches				
3=Aesthetic view				
4= Other (specify).....				

EFFECTS OF (*S. molesta*) ON LUKANGA SWAMP FISHING ACTIVITIES

How has the presence of <i>S. molesta</i> affected your fishing activity (ies)?	Effects of <i>S. molesta</i> on fishing activities (Tick in the appropriate box below)			
Fishery activity (ies)	1=Increase	2=Stable	3=Decrease	4=Not Sure
1=Fishing				
2=Fish Trading				
3=Canoe Paddler				
4=Canoe Owner				
5=Other (specify).....				

SECTION E: COPING STRATEGIES AND THEIR EFFECTIVENESS

<p>With regards to your fishing activities, what are your major coping strategies towards the presence of <i>S. molesta</i> and how would rate your major coping strategies?</p> <p>Fishing Activities 1=Fisher 2=Fish trader 3=Canoe Paddler</p>

	4=Canoe Owner 5=Other (Specify)				
Coping Strategies		Rate of the effectiveness of Coping Strategies to deal with <i>S. molesta</i> and sustain livelihood (Tick in the appropriate box below)			
1=Clearing of weed	1=Ineffective	2=Fairly effective	3=Undecided	4=Effective	5=Very effective
2=Shifting to open waters					
3=Camping near open waters					
5=Buying more fishing nets					
4=Increased charges for hiring canoe					
5=Increased charges for fish transporting (canoe)					
6=Farming					
7=Beer brewing					
8=Other (Specify).....					

1. How would you compare your standard of living before and after the invasion of <i>S. molesta</i> ?		2. How would you rate the level of difficulty in addressing the effects of <i>S. molesta</i> on the Lukanga Swamp? 1=Not difficulty 2=Somewhat difficult 3=Very difficult 4=Extremely difficult
1=Worse 2=Fair 3=Remained the same 4=Better 5= Other (specify).....		
Before	After	

SECTION F: FISHERS' SOLUTIONS/SUGGESTION TOWARDS THE PRESENCE OF *S. molesta*

Proposed suggestions/solutions	Who should solve?
1=Machanical 2=Biological 3=Chemical 4=Other (Specify).....	1=Government 2=Local Communities 3=NGOs/Civil Society Groups 4= Other (Specify).....

Thank you for your attention

END OF INTERVIEW

APPENDIX C: INTERVIEW GUIDE - POLICY MAKER (FISHERIES/WATER AFFAIRS)

Topic: Coping Strategies for Fishers towards Plant Invasive Species at Lukanga Swamp.

Instructions

Participants should read through, understand and sign the consent form provided before they participate in the interview. Remember to probe and get concrete examples. Let the informant speak at length and make sure that you use this only as a true guide in the interview process, and not as a list of questions to be covered one after the other.

There are no right or wrong answers in this discussion. Please feel free to be open and share your point of view. It is very important that we hear your opinion.

Introduction

1. Are there any policies at national level that talk about issues to deal invasive species?
2. Are there policy documents that have been designed specifically to deal with issues of *S. molesta* in wetlands found in Zambia?
3. In your department, are there strategies in place that deal with issues of invasive species with focus mostly on *S. molesta*?
4. If any, how are these policies being implemented at national, provincial and district levels?

Fishers Affected by *Salvinia Molesta*

5. How wide spread is the presence of *S. molesta* at Lukanga swamp?
6. How has *S. molesta* affected the fish catches at Lukanga swamp?
7. How has *S. molesta* affected the livelihoods of people surrounding the Lukanga Swamp?

Coping Strategies for Fishers

8. How have fishers been able to cope up with the presence of *S. molesta* at Lukanga swamp?
9. What have been their coping strategies to deal with *S. molesta*?
10. Are there any other strategies which you have not mentioned?
11. Of these strategies which one is so prominent with the fishers at Lukanga swamp?
12. Do you think these coping strategies which you have mentioned have helped the fishers to have better livelihoods?
13. Comparing then when *S. molesta* was not so much and now, which times are better in terms of economic activities for the fishers at Lukanga Swamp?
14. If now is bad in terms of economic activities, how are these coping strategies helping the fishers?

APPENDIX D: INTERVIEW GUIDE - POLICY MAKER (ZEMA)

Topic: Coping Strategies for Fishers towards Plant Invasive Species at Lukanga Swamp.

Instructions

Participants should read through, understand and sign the consent form provided before they participate in the interview. Remember to probe and get concrete examples. Let the informant speak at length and make sure that you use this only as a true guide in the interview process, and not as a list of questions to be covered one after the other.

There are no right or wrong answers in this discussion. Please feel free to be open and share your point of view. It is very important that we hear your opinion.

Introduction

15. Are there any policies at national level that talk about issues to deal invasive species?
16. Are there policy documents that have been designed specifically to deal with issues of *S. molesta* in wetlands found in Zambia?
17. In your department, are there strategies in place that deal with issues of invasive species with focus mostly on *S. molesta*?
18. If any, how are these policies being implemented at national, provincial and district levels?

Fishers Affected by *Salvinia Molesta*

19. Are you aware of the presence of *S. molesta* at Lukanga swamp?
20. If yes, what is your organisation doing about it?

Coping Strategies for Fishers

21. What are the best recommended measures to deal with *S. molesta* effectively?
22. What are your recommendations with regards to the presence of the weed at Lukanga swamp?

Generally, what do you think the government and its cooperating partners need to do to help fishers here at Lukanga swamp to better their livelihoods economically in relation the presence of *S. molesta*

APPENDIX E: INTERVIEW GUIDE - FOCUS GROUP DISCUSSION (FGD)
Topic: Coping Strategies for Fishers towards Plant Invasive Species at Lukanga Swamp.

Instructions

Participants should read through, understand and sign the consent form provided before they participate in the interview. Remember to probe and get concrete examples. Let the informant speak at length and make sure that you use this only as a true guide in the interview process, and not as a list of questions to be covered one after the other.

There are no right or wrong answers in this discussion. Please feel free to be open and share your point of view. It is very important that we hear your opinion.

Introduction

1. For how long have you been staying at this camp?
2. If not staying here then where do you stay?
3. Are there any people who don't stay here but come regularly for fishing purposes?
4. Are there people who come from very far distance places?

Fishers Affected by *Salvinia molesta*

5. How wide spread is the presence of *S. molesta* at Lukanga swamp?
6. How has *S. molesta* affected the fish catches at Lukanga swamp?
7. How has *S. molesta* affected the livelihoods of people surrounding the Lukanga Swamp?

Coping Strategies for Fishers

8. How have you been able to cope up with the presence of *S. molesta* at Lukanga swamp?
9. What have been your coping strategies to deal with *S. molesta*?
10. Are there any other strategies which you have not mentioned?
11. Of these strategies which one is so prominent at Lukanga swamp?
12. Do you think these coping strategies which you have mentioned have helped you to have better livelihoods?
13. Comparing then when *S. molesta* was not so much and now, which times are better in terms of economic activities at Lukanga Swamp?
14. If now is bad in terms of economic activities, how are these coping strategies helping you?

Generally, what do you think the government and its cooperating partners need to do to help you here at Lukanga swamp to better your livelihoods economically in relation the presence of *S. molesta*.

APPENDIX F: ANOVA TEST RESULTS FOR EFFECTIVENESS

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Ineffective	8	53.550000	27.4531809	9.7061652	30.598566	76.501434	12.5000	100.0000
Fairly Effective	8	25.887500	15.4370091	5.4578069	12.981837	38.793163	.0000	51.7000
Undecided	8	2.725000	4.1654189	1.4726980	-.757377	6.207377	.0000	9.3000
Effective	8	17.337500	22.2525721	7.8674723	-1.266116	35.941116	.0000	64.8000
Total	32	24.875000	26.3336409	4.6551740	15.380710	34.369290	.0000	100.0000

ANOVA

Responses

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	10965.738	3	3655.246	9.718	.000
Within Groups	10531.543	28	376.127		
Total	21497.280	31			