EFFECTS OF THE WATER HYACINTH ON THE FISHERIES INDUSTRY IN KISUMU MUNICIPALITY.

BY

SALOME N. WAWIRE

A THESIS SUBMITED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF ARTS AT THE UNIVERSITY OF NAIROBI.

2000

DECLARATION

This thesis is my original work and has not been presented for a degree in any other University.

SALOME N. WAWIRE

This thesis has been submitted for examination with my approval as the University supervisor.

DR. WANAKAYI K. OMOKA

INSTITUTE OF AFRICAN STUDIES

UNIVERSITY OF NAIROBI.

DEDICATION

This thesis is dedicated to my late sister Jessicah B. Wawire whose academic vision will always be an inspiration to me.

ACKNOWLEDGEMENTS.

I wish to acknowledge my supervisor Dr. W. Omoka who tirelessly gave guidance and encouragement throughout the study. I would also like to thank my academic colleagues and lecturers at the Institute of African Studies for their support during the entire study.

Special thanks go to my family, especially my parents E. Wawire and T. Wawire, whose support, both financially and morally, has enabled me to achieve my academic goals.

ABSTRACT

This study is divided into five chapters. The first chapter provides an introduction to the study in terms of background, statement of the problem, justification of the study, study objectives and research questions. Chapter two presents literature review related to the study and theoretical framework. In chapter three, the methodology of the study is discussed. Chapter four presents the data analysis, findings and discussion of these findings. Chapter five concludes the study and various recommendations are proposed.

The study addresses itself to the effects of the water hyacinth in Lake Victoria on the fisheries industry in Kisumu municipality. The study focuses on fish-based activities in the area and both qualitative and quantitative data were collected from residents whose livelihood is based on these activities.

This being a survey study, quantitative data were collected, with the questionnaire as the main tool of data collection. Qualitative methods of data collection were also used to get information from fishermen/women, traders, boat operators and industrial fish processors. The out data gathered was analyzed using basic statistics both qualitatively and quantitatively.

Data analysis indicates that the presence of the water hyacinth in Lake Victoria affects the lives of the residents of Kisumu Municipality in many ways. Fish production has drastically fallen and therefore income for those whose income generation activities revolve around fish production has fallen

too. Some fish processing plants have closed down and water transport operators are almost out of business. The people's food habits have changed, inclining towards the production, consumption and marketing of grains and vegetables rather than fish and other sorts of meat that were favored before the infestation by the water hyacinth of the lake.

The findings therefore suggest that the lifestyle of the people living near Lake Victoria and depend on it, in one way or another, has changed considerably. On the basis of the findings, it is generally recommended that the government, NGO's and other interest groups should involve the local residents in both policy making and practical removal of the weed from the lake. It is also recommended that this be treated with urgency as the effects of the weed are growing with time.

TABLE OF CONTENTS

CHAPTER THREE

CHAPTER FOUR

CHAPTER FIVE

LIST OF TABLES

CHAPTER ONE

1.0 RESEARCH PROBLEM

1.1 INTRODUCTION

The water hyacinth, *(Eichornia crassipes)* is a free- floating fresh water plant with beautiful lilac violet flowers. Though a native of tropical America, this aquatic weed has adapted exceedingly well to almost every area to which it has been dispersed. It now exists as a stable component of the tropical and sub-tropical regions.

The history of the distribution of the water hyacinth is only about a century old before which it was not known to occur anywhere outside the neotropics. However, today it occurs in fresh water lakes, dams, reservoirs, streams, rivers, irrigation channels and paddy fields. Enough evidence is now available to prove that human beings have either willingly or unintentionally aided in the dispersal and present distribution of the water hyacinth (Matthew and Manson, 1969). Scott (1968) suggests that human beings, fascinated by the enchanting beauty of the flowers, carried the plant outside it's native home to other places. The plant soon grew at an alarming rate to such explosive proportions that all efforts to bring it under control have failed. Control measures employed in many countries are always under review, as most of them are effective only to a certain extent. The constraints are due to labour requirements, high capital expenditure and environmental considerations that go with their application.

The water hyacinth is a very prolific aquatic plant, which spreads at an alarming rate. For instance, in Louisiana, U.S.A, a single plant of the water hyacinth produced the incredible number of 248,000 daughter plants in just ninety days (Yadurajan and Mani, 1979), and under experimental conditions, multiplication rate was found to be six new plants per week (Ghosh *et al*, 1984). This creates problems for the inhabitants of the areas around the infested water bodies.

1.2 PROBLEM STATEMENT.

The water hyacinth, due to its vegetative propagation and extremely high growth rate, clogs drainage, irrigation canals and waterways. Specifically, the flow of water (turbulence) is reduced by 40-95 % (Holm *et al.*, 1969) in irrigation channels and this may cause flooding. The water hyacinth also causes tremendous problems to water transport by way of damage to boats and ships, delays due to reduced speed of the boats and ships, reduced carrying capacity and excesses in fuel consumption.

Conversely, water loss by evapotranspiration is very high in weed-infested water surfaces compared to those from weed-free, open water surfaces. Additionally, its presence does not only make fishing difficult, but also does not allow fish to hatch and spawn, possibly as a result of lowered oxygen content in the water. Low oxygen content reduces water quality and reduces fish production, subsequently affecting the ecosystem and the people who depend on the water mass for a livelihood. It adversely affects other aquatic fauna, which support waterfowls. The aquatic fauna is also affected by drifting water mats of the water hyacinth, which tear up beds of submerged plants and defoliate them (Tabitha and Woods, 1962).

The water hyacinth provides a suitable habitat for aquatic vectors of human diseases such as mosquitoes and fresh water snails. This leads to contamination of the water and rapid spread of water borne diseases such as cholera, typhoid, diarrhea and bilharzzia.

The problems in the aquatic environment consequently affect the people who live near the affected water mass and also generally depend on the water mass, its flora and fauna. These effects are environmental, political, social and economic. However, this study is focused on the impact of the water hyacinth on the fisheries industry among the people of Kisumu municipality. The study addresses the following questions: -

1. What are the consequences of the water hyacinth for the economic activities of the people of Kisumu municipality?
2. How does reduced fish production affect the food habits of the people of Kisumu municipality?
3. What is the impact of the water hyacinth on the social interaction of the people of Kisumu municipality?

1.3 OBJECTIVES OF THE STUDY.

1.3 .1 GENERAL OBJECTIVE.

To find out how the water hyacinth infestation of Lake Victoria affects the lives of the people of Kisumu municipality.

1.3.2 SPECIFIC OBJECTIVES

1. To determine the consequences of the water hyacinth for the economic activities of the people of Kisumu municipality.
2. To establish how reduced fish production affects the people's food habits in Kisumu municipality.
3. To establish the impact of the infestation by the water hyacinth of Lake Victoria on the social interaction of the people of Kisumu municipality.

1.4 JUSTIFICATION.

The problem of the water hyacinth is widespread, not only among the people around Lake Victoria but in East Africa as a whole. Though believed to have originated in the Neotropics, especially Southeast Brazil, the plant is now widespread in most other tropical and sub-tropical fresh water bodies. These are Brazil, Guyana, Venezuela, Costa Rica, West Indies, India, Bangladesh, Egypt, Congo, Sudan, Ethiopia, Botswana, Zambia, (Evans, 1963), and most recently Kenya, Uganda and Tanzania.

In Kenya, the increasing abject poverty levels coupled with persistent food crises and diseases, especially among the rural population and the people living around Lake Victoria is alarming. The findings of this study may be used by the government and other interested organizations to address those crises in the context of the infestation of the water hyacinth of Lake Victoria.

Lake Victoria is valued not only for its economic importance, but also for its transport and recreational importance. Economically, the fisheries industry has made tremendous contribution by providing Kenya with export earnings and a base for industrial commercial growth. This sector also provides employment to Kenyans. However there is a lot that could be done to improve the sector. The government and other policy makers in the improvement of the fisheries sector may use findings of this study. A large population living near Lake Victoria, and that partly or wholly depends on the lake for a livelihood, is affected by the infestation by the water hyacinth of the lake. As a result, many on-going activities in environmental campaigns are focused on this problem. Efforts to curb the menace are made by Non-Governmental Organizations (NGO's), The United Nations Environmental Programme (UNEP), other environmental organizations such as "Osienala" (Friends of the lake), research institutions such as the Kenya

Agricultural Research Institute (KARI) and The Kenya Marine and Fisheries Research Institute (KEMFRI) and the government, among others. Many different groups, due to its broad social, economic, health, political and environmental implications, consider the water hyacinth menace important yet, very little, if any has been published in the Kenyan context. This study therefore intends to contribute to the scanty knowledge of the problem in the Kenyan context, on which other interest groups could base their studies in an effort to curb the severity of the problems caused by this weed and the magnitude of the area under its cover.

1.5 SCOPE OF THE STUDY

The study covers the impact of the water hyacinth in Lake Victoria on the fisheries industry in Kisumu Municipality. The aspects examined are the economic implications at both small scale and industrial fish production levels, with the patterns of fish production, distribution and subsistence production as the main focal point, food habits as a result of reduced fish production and social interaction in terms of exchange of goods such as food, gifts and services such as transport along the existing social institutions. The nutritive value of foods being consumed is not considered since such depth would be out of the scope of this study.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 THE WATER HYACINTH: ORIGIN AND DISTRIBUTION.

The water hyacinth, characterized by its beautiful lilac violet flowers and shining bright green leaves, is a native of the Neotropics. Though the first description of the plant was based on a collection from Southeast Brazil, it was already widespread in occurrence in Central and South America. Hooker (1829), reported on several collections from Brazil; Demerara river, Guyana, Venezuela, Ecuador, Colombia, Panama, and considered the water hyacinth to be native to Brazil. Some have designated South America as the origin. Swartz considered Puerto Rico as the main center of dispersion (Swartz, 1797). It seems, however, appropriate to treat the Neotropics as the native place of the water hyacinth without referring to a specific geographical region.

In Africa, the water hyacinth was first seen in Egypt between 1879 and 1892 and in Natal, South Africa, in the early years of the twentieth century (Tackholm and Drar, 1950; Wild, 1961). It consequently, spread to other countries in Southern Africa and in the Zaire River in 1937 and in Brazzaville, Congo, in 1952 (Evans, 1963). It is through the tributaries of River Congo that the water hyacinth spread rapidly through the region. It was first seen in Khartoum, Sudan, in 1958 where it appears to have entered through the floodwaters of River Congo at the Nile-Congo divide (Gay and Berry, 1959). The weed's existence along River Nile has led to its wide spread in at least fifteen countries in Africa, including recent entries like Kenya, Uganda and Tanzania where it has been used as an ornamental plant since at least 1957 (Crul, 1995).

In the Riparian countries of Kenya, Uganda and Tanzania, the weed, apart from being ornamental, was first seen in Lake Naivasha between 1982 and 1983 where it seemed to be out-competed by the water fern (*Salvinia molesta*). In Uganda, reports indicated the presence of the weed east of Lake Kyoga in 1988, and later the same year in Lake Victoria. In Tanzania, the weed was reported in 1990 (GOK. 1997)

In Lake Victoria, the water hyacinth was first reported in the Uganda side in 1988 and has since spread to all corners of the lake, including other waterways of Lake Victoria Basin area, inland lakes and rivers in Rwanda and Burundi (GOK, 1997). The Kenyan side of Lake Victoria, which covers 6% of the lake, had the weed originally occurring in sheltered bays but now it has extended to the open lake. Visits by officials from the fisheries department to various beaches along the shoreline in 1995 proved that the water hyacinth had heavily infested Karungu Bay, Usenge Bay, Yala swamp, Sio Port, Nzoia and Yala deltas. Smaller mats of the weed were reported at Bukoma beach, Kendu Bay, Homa Bay, Mbita Point and Marenga beach. In these less infected areas, the water hyacinth is blown away and eventually clears off to the open lake (GOK, 1997).

The water hyacinth is not a problem in Africa alone. In Latin America, Central America, Pacific and tropical countries across Asia, it is a troublesome pest (Hearne, 1966). To date, no effective means have been devised to eradicate it. Mechanical and manual measures only bring temporary respite. The benefits of chemical measures are uncertain when weighed against the possible wider environmental impact of extensive use of herbicides. In the long term, biological measures may help to contain or reduce the extent of the water hyacinth rather than eradicate it.

2.2 LAKE VICTORIA FISHERIES AND THE KENYAN ECONOMY.

Lake Victoria is Kenya's most important fishery. According to O'Riordan (1996), some 20,000 to 30,000 fishermen and women using 2,500 to 3,000 boats, produce more than 90% of Kenya's fish catch. Given that one fishing boat generates 3-5 jobs in such auxiliary activities as processing, marketing, transporting, boat-building, net making and repairing, etc., a total population of some 200,000 to 300,00 people depend for all or part of their livelihoods on the Kenyan Lake Victoria fishery (O'Riordan, 1996). A modest estimate of 50,000 to 100,000 tones of Nile perch landed annually in Kenyan waters over the period of 1993-1995, with a beach price of 20-30 Kenyan shillings (Ksh) per kilo, would translate into some Ksh 2-3 billion annually.

In more recent times, the beach price for good quality fish, especially the Nile perch, has shot up to between 50-60 Ksh per kilogramme, indicating even higher earnings for Kenyan fishermen and women and the economy as a whole. In the last ten years the production of fish from Lake Victoria has represented about 25% of the annual total catch from Africa's inland fisheries (FAO, 1990).

The introduction of the Nile perch in Lake Victoria has led to the establishment of fish factories near the lake for the purpose of filleting and exporting the perch. There are about twelve Nile perch processing factories in and around Kisumu and about twenty-five altogether in Kenya (Nairobi and Mombasa). The export industry earns Kenya millions of shillings in terms of foreign exchange and production of fishmeal, which is made from the leftover frame of the Nile perch after filleting. Frame business is catching hundreds of thousands of tones annually of key raw material for animal feed factories as far apart as Nakuru, Nairobi and Mombasa. In 1982, some 9,500 tones were extracted from the Kenyan fishery and in 1994 and 1995, some 100,000 and 150,000 tones respectively, were taken from Kenyan waters (Abila and Jansen, 1997)

2.3 THE FISHERIES INDUSTRY AND SOCIO-ECONOMIC DEVELOPMENT.

Large populations of the people living near Lake Victoria partially or wholly depend on the lake for a livelihood. This dependence is mainly economic and is almost entirely on the fishery. The fishery includes such activities as harvesting, fish processing, marketing, boat and net making and distribution (Abila and Jansen, 1997).

People in the harvesting sector are composed of mainly the local community. They go to the lake and harvest fish using small boats, hooks and nets. The day's catch is sold at a beach price of 20-30 Ksh per kilogramme (O'Riordan, 1996). Their sales are mainly to local consumers, except for those who have tenders with fish processing factories or are hired by these factories to harvest for them. The earnings from these sales constitute most, if not all, of their income. The fishermen and women have a varying degree of involvement in the fisheries. According to Francis and Hodinott (1993), 80% of the fishermen/women around Lake Victoria derive their primary income from fishing.

In the processing sector, factories have been established within and outside Kisumu to meet the demands of fish both locally and internationally. A study by Abila and Jansen (1997) shows that processing factories in Kisumu employ between 1,500 and 2,000 people, with a recorded increase in women since 1997. However, it is argued that since the average daily processing of Nile perch is about 135 tones, it means each factory employee handles 70-90 kilogrammes of fish. In contrast, an ordinary fishmonger handles 10-20 kilogrammes per day. It would, therefore, seem that for each job created in the industrial fish-processing sector; there could have been 4-9 jobs in the traditional sector. Although some assumptions have been made, there is no doubt that for each ton of fish transferred to the export market, many jobs are being lost in the fishing communities around Lake Victoria largely because of the water hyacinth (Abila and Jansen, 1997).

In the marketing and distribution sectors, the local community is very much involved. The local fishermen/women have formed co-operative societies, which provide specified services to the members. For instance, Dunga fishermen/women's society provides such services as marketing of fish, negotiating and fixing the fish price and providing security to fishing boats and many others. For those who do not belong to any co-operative society, their activities are done individually. They buy the fish from the market, where many own stalls. Those with tenders for supply also get the fish at considerable prices on the beach then supply it to their respective clients. With the current situation, characterized by poor organization and lack of storage facilities, many fishmongers are involved in informal fish processing, where they smoke and dry fish for preservation. Most of these informal fish processors are women (Riedmiller, 1994). Many part-time processors and fishmongers have become full-time in addition to new women recruitment in the trade (Yongo, 1993 and

1994). They construct simple mud and fibre (twigs) ovens/kilns (lunyu) on the beaches, in which they smoke the fish. In other areas, the fish is fried for preservation. However, smoking and frying fish for preservation has its disadvantages. It consumes considerable quantities of fuel wood and cooking oil, which lead to a high production cost (Riedmiller, 1994).

2.4 LAKE VICTORIA FISHERIES AND INDUSTRIAL DEVELOPMENT IN KISUMU.

Due to the introduction of the Nile perch in Lake Victoria in 1979, the total catch of fish increased from about 100,000 tones in 1979 to about 500,000 tones in 1989 (FAO, 1995). Since 1989, the annual production has remained at a level four or five times higher than what was achieved during the late 1960's and 1970's.

Linked to this rapid growth of fish production, a market for fish developed beyond the three countries sharing the lake, to the industrialized countries like Japan, U.S.A and certain European countries. In order to satisfy this market, processing factories have been established along the shoreline of Lake Victoria and other parts of Kenya like Nairobi and Mombasa. There are about fifteen fish processing factories in and around Kisumu and thirty to fourty altogether in Kenya. The processing factories are especially meant to handle the Nile perch (Abila and Jansen, 1997). Originally most fish processing plants were located in Nairobi and Mombasa. In order to cut on transport cost, horizontal integration was introduced and companies opened subsidiary plants in Kisumu, Homabay and Migori, which do the bulk of fish processing.

Fish processing plants in Kisumu buy fish from fishmongers on the beach. However, a number of them employ their own fishermen/women who use the factories' fishing gears like nets, boats, motor boats and trawlers. Despite participating in fish harvesting, these factories still rely greatly on local fishermen/women to supply the greater volumes of wet fish (Abila and Jansen, 1997). All the fish processing factories in Kisumu produce fillet for export as the main product (Werimo, 1994). Kenya's fillet is sold in several countries, mainly in Europe, the Middle East and Asia. However, these factories also market trimmings (leftover frame of filleted Nile perch) and oil in the local market. These products have potential uses and their markets are now well developed. The skeleton is an important nutritional source for the lower income groups that may not afford to buy fish. It is also used in the industrial manufacture of animal feed (Ogunja, 1994). Frame business is catching hundreds of thousands of tones annually, of key raw material of animal feed factories as far apart as Nakuru, Nairobi and Mombasa. In 1982, some 9,500 tones were extracted from the Kenyan fishery and in 1994 and 1995, some 100,000 and 150,000 tones respectively, were taken from Kenyan waters (Abila and Jansen, 1997).

2.5 SMALL SCALE FISH PRODUCTION:

2.5.1 FISHING METHODS.

There are currently estimated to be 7,500 Lake Victoria fishermen/women participating directly in the fishery in the three riparian countries (O'Riordan, 1996). Together with dependent family members, and including people employed in auxiliary industries, there are more than 1 million people who depend totally or partially on the fishery for their livelihood. These estimated one million people participate in the fishery only on small scale. Their participation ranges from processing, transportation, boat and net making, marketing and fishing.

Although in principle there has been open access to fish in the lake, the local fishing communities around the lake have all through this century developed rules which regulate the fisheries (Geheb, 1996; Ogutu, 1994). These rules stipulate who may fish, in what season, in what area, what type of fishing gear are acceptable and what type or size of fish may be caught. Institutions have been developed in the local communities to enforce these regulations. These rules and regulations vary from one area to another and they have also changed over time.

This system of local management has been operational among small-scale fishermen/women but now it is being threatened by increased commercial fishing. With the exception of a few trawlers, whose operators have little knowledge of these rules, or feel free to disregard them, fishing in the Kenyan section of Lake Victoria is still relatively small scale. Most small-scale fishing is done on boats, whose design, construction technique or size, have not changed for years. The boats are plank built and powered by sail and/or oar (O'Rioardan, 1996). Mechanized (or motorized) propulsion is hardly used.

There are two main types of fishing boats. The "Yiae" and "Mataruma", are generally used for different fishing activities. The former generally fish for Nile perch and tilapia, using sail with a crew of two or more. The latter use oar with a crew of four or five, and generally fish for "omena" (*Rasteneobola largentum).* These two types of fishing boats, the "Yiae" and the "Mataruma", whilst having economic advantages, have several limitations. In cases of bad weather, the boats may capsize, flood or fracture. Their insubstantial construction renders them inappropriate for motorization. Lack of relatively adequate space also limits carrying capacity.

As is the case with fishing boats, different fishing gears are designated for different types of fish. Nile perch gears include long lines and gill nets. Also, mosquito nets, beach seines and small meshed surround nets are also used to catch immature Nile perch. Tilapia gears include gill nets, hooks and lines. However, as Nile perch net mesh size and ply decreases, Nile perch and tilapia gears may become interchangeable. "Omena" (*Rasteneobola largentum*) are mainly fished by mosquito nets.

2.6 THE WATER HYACINTH AND SMALL SCALE FISH PRODUCTION.

The severity of the problems caused by the water hyacinth and the magnitude of the area under its cover can be judged by the fact that high technological techniques and scientific techniques are now being employed to survey and monitor this weed (Scott, 1968).

In the fisheries industry, the water hyacinth has become a major nuisance. Due to its vegetative propagation and extremely high growth rate, the water hyacinth creates vast mats of aquatic weed, which reduce phytoplankton as a result of removal of phosphorus from the water. Thick mats of the water hyacinth cause complete depletion of dissolved oxygen and consequently kills fish (MC' Vea and Boyd, 1995). The most vigorous growth occurs in warm and humid climate where it grows to a height of about 120 centimeters. When the temperature and relative humidity decrease, the growth rate slows down resulting in short plants with ball shaped floats. These thick mats of the water hyacinth create serious damage to spawning and nursery areas in shallow water where they not only deplete oxygen but also warm the water and deposit detritus. Decaying detritus beneath these mats further depletes oxygen and reduces spawning of fish.

The extremely high growth rate of the water hyacinth does not only affect the fish but other aquatic fauna and flora too. Aquatic plants, due to depleted oxygen content in the water, grow and multiply very slowly. This limits their availability to the fish, which feed on them. Consequently, the fish is reduced to a number that can survive on the available fauna for food.

Fishermen/women in some areas around Lake Victoria complain that the water hyacinth does not only reduce fish in the water but also limits their access to the beach and blocks their nets (O'Riordan, 1996). The fishermen/women have boats whose design, construction and size are inappropriate in weed-infested water surfaces. The boats are powered by sail and/or oar and therefore do not have the power to override the thick mats of the water hyacinth on the water surface. This results in catch delivery times being increased on average by 2-3 hours daily and sometimes by as much as three days. These delays have at times resulted in deterioration of fish quality and at most in complete spoilage of the catch, rendering it unsuitable for consumption. To avoid spoilage, operators have had to carry additional ice, resulting in higher costs. The fishing nets are blocked by the water hyacinth on the surface before they can get to the deeper parts of the water where fish can be found.

The water hyacinth affects the composition of fish species in the water. Recently, fishermen/women around Lake Victoria have noted that in areas where there is much hyacinth infestation, the water is still and warm and fish disappear. Also that catches of Nile perch and tilapia have declined since the water hyacinth first appeared. Catches of the mudfish, which had initially disappeared, are increasing (Oduor-Noah and Ligunya, 1995). This change in composition of fish species in the lake can be attributed to the adaptation of the mudfish in shallow and muddy water with low oxygen content, an environment made favorable by the water hyacinth. Tilapia and Nile perch are on the decline because of their large size and large oxygen intake, which is not favorable in the shallow muddy water infested with the water hyacinth.

Changes in species composition of fish in the lake calls for changes in fishing technology. The technology employed to fish one species may not be best for another species. Fishermen/women around Lake Victoria have had to change their fishing technologies from those that were used during the pre-weed period when the Nile perch was the main species in the lake, to other suitable technologies at this time, after the water hyacinth infested the lake, and the mud fish is becoming the prevalent species.

The water hyacinth through its surface cover and shading drastically reduces light penetration and water turbulence. This in turn retards recreation and hinders thermal water currents, prevents mixing and accelerates local stratification (Pantulu, 1984). Due to the shallow nature of Lake Victoria, until recently when it was infected with the water hyacinth, wind induced mixing of the surface layers with the deeper water resulted in the deeper bottom water being regularly oxygenated. The infestation by the water hyacinth has contributed to the causes of poor water quality, with the lake remaining stratified throughout the year. Water below the oxycline is deoxygenated, uninhabited by fish and poor for human consumption.

The floating mats of the water hyacinth provide a good habitat for aquatic vectors and fresh water snails. A study by Oduor-Noah and Ligunya (1995) revealed that the invasion by the water hyacinth has not only favoured the breeding of mosquitoes and snails but snakes and crocodiles too. In Uwaria, Siaya district, it was reported that since 1995, the community has lost five people killed by crocodiles and three by hippos along the beach. This has instilled fear among the fishermen/women who now venture less into the lake to catch fish.

2.7 THE WATER HYACINTH AND WATER TRANSPORT.

The water hyacinth causes tremendous problems to water transport. The dense growth of the weed obstructs water flow in irrigation channels, canals, clogs waterways and interferes with navigation and hydroelectric power generation. The flow of water is reduced by 40%-95% in irrigation channels and this may cause flooding as is frequent in Malaysia and Guyana (Garg, 1968). Problems caused to water transport are mainly by way of damage to the boats/ships, delays, reduced carrying capacity and excesses in fuel consumption. In Nigeria, Alimi and Akinyemiju (1991) studied the economic impact of the water hyacinth infestation on water-borne transportation. They compared a weed-free and a weed-infested area in Ilaye-Ese Odo. Fuel consumption and the frequency and cost of boats repair were higher in weed-infested areas than in weed-free areas (73.3 Vs 28.4 litres per 100 km; 6.1Vs 2.0/ month and N 436.0 Vs 274.1 respectively) and the estimated life span of boats was lower in weed-infested areas. In weed-infested areas, the number of trips made by boat operators had decreased from 5.3 before infestation to 2.1 after infestation and the number of months worked per year had decreased from 10.1 to 6.3. Boat fares, which were equal in both areas before infestation, increased in weed-infested areas by approximately double the initial rates. Such interference alone causes economic losses of millions of shillings in terms of transport and control for better navigation.

Water transport is an important aspect of Lake Victoria. Although there has not been a detailed study as the one done (above) by Alimi and Akinyemiju (1991), there is evidence that a similar situation is being experienced around Lake Victoria, with the infestation by the water hyacinth. The recently expanding fisheries sector (with the introduction of the Nile perch), requires fast and reliable delivery systems from the lake to the shore to ensure freshness of the fish. This is particularly important because most fishermen/women have no preservation facilities on their boats. Weed infestation therefore delays the fish deliveries and leads to quality loss, thereby lowering fish prices at the market and causing higher costs in boat operation.

There have also been increasing water transport activities involving movement of people and goods between the islands and the mainland and also within islands. Infestation by the water hyacinth of the lake disrupts and often cuts off these movements , most of which are operated by sail and/or oar. Although this state of affairs does not involve goods worth lots of money, it is important to the people who use it as it represents supply and livelihood lines for them.

Lake Victoria is also an important route for the riparian countries' import-export trade. Besides passenger ships and wagons, motor boats carry such goods as beans, maize and bananas from Uganda to Kenya and beer to Tanzania and return carrying such consumer goods as cooking fats, toilet soap and perfumes in the cross boarder trade. Mats of the water hyacinth cause motor boats to take longer as they (boats) meander round trying to avoid them. This also increases operating costs. Such transport vessels also incur heavy costs during docking. The vessels have to push through the thick mats of water hyacinth, running a risk of damaging their engines. Many have had to incur even more costs by hiring labour to clear their way of the weed for docking. In such cases, docking time is increased from the usual twenty minutes to two hours and sometimes up to three days.

2.8 THEORETICAL FRAMEWORK.

This study adopted the cultural ecology theory to explain the impact of the water hyacinth on the fisheries industry in Kisumu municipality.

The principle meaning of ecology is "adaptation to environment". Since the time of Darwin, environment has been conceived as the total web of life wherein all plant and animal species interact with one another and with physical features in a particular unit of territory (Steward, 1955). Although initially employed with reference to biotic assemblages, the concept of ecology has naturally been extended to include human beings since they are part of the web of life in most parts of the world. Man enters the ecological scene not merely as an organism in terms of his/her physical characteristics but also as a cultural creature.

The theory of cultural ecology seeks to explain the concept of ecology in relation to human beings as a heuristic device for understanding the effect of the environment upon a peoples' way of life. According to the holistic view, all aspects of culture are functionally interdependent. The degree and kind of interdependency however are not the same with all features of culture-environment interaction. Cultural ecology pays primary attention to those features which empirical analysis shows to be most closely involved in the utilization of the environment in culturally prescribed ways.

The term environment includes three main components. Firstly, there is the physical environment including weather factors, climate and geography; secondly, the biological environment; and thirdly the human/social environment which includes occupation, location of home, age, sex etc (Coe, 1970). In general, the theory of cultural ecology holds that the state of human life, whether health, economic, cultural or social, is largely, if not totally, affected by the forces of the physical environment.

2.8.1 RELEVANCE OF THE THEORY TO THE STUDY.

The theory of cultural ecology focuses on all aspects of culture, which are interdependent and are involved in the utilization of the environment in culturally prescribed ways. This approach enables us to learn how individual manifestations of culturally prescribed behaviours contribute to the adaptation to the environmental changes in Lake Victoria. Within this framework, it can be expected that if people have changed their way of life, occupation, location of home, etc., to adopt to the changing environment in Lake Victoria, a major component to their environment.

The approach combines physical conditions, biological conditions, social conditions, and cultural conditions, which are important variables in this kind of social study. Functional adaptation to the physical environment would call for the acquisition of requisite knowledge and the motivation to apply the knowledge to the changed (or changing) environmental factors.

2.9 HYPOTHESES.

The following hypotheses were formulated for this study

1). There is an inverse relationship between the infestation by the water hyacinth of Lake Victoria and the fish-based activities of the people living in Kisumu Municipality.

11). Reduced fish production negatively affects the food habits of the people living in Kisumu Municipality

111) The social interaction of the people of Kisumu Municipality has been adversely affected by the infestation by the water hyacinth of Lake Victoria.

2.10 OPERATIONAL DEFINITIONS OF VARIBLES.

2.10:1 INDEPENDENT VARIABLES.

2.10:1 a) THE WATER HYACINTH

The water hyacinth is an independent variable in this study. This involves the emergence, growth and spread of the weed in Lake Victoria.

2.10:1 b) FISHING.

The variable means the pattern of fish production, distribution and subsistent consumption that has emerged as a result of the water hyacinth infestation of Lake Victoria. It also involves patterns of fishing methods that have emerged.

2.10:2 DEPENDENT VARIABLES.

2.10:2 (a). ECONOMIC STATUS

Economic status of the people living in Kisumu Municipality was measured by income per month, material liabilities, assets, education level and general wealth. The current economic status was contrasted with the status prior to the infestation by the water hyacinth of Lake Victoria. The main point of interest was how the infestation contributes to the current economic status.

2.10:2 (b) SOCIAL INTERACTION.

Focus of this study was on interpersonal and inter-group interaction in terms of exchange of goods such as foods (especially fish), gifts and services such transport along the existing social institutions

This variable also includes the interaction of people through any other way of sharing the available social amenities. It also means the resultant attitudes they have developed towards or against the water hyacinth infestation of Lake Victoria.

2.10:2 c). FOOD HABITS.

The variable means the pattern of food consumption habits that has emerged after the infestation by the water hyacinth of the lake. The main focus was on other types and sources of food consumption, besides the fisheries industry. The current food habits were contrasted with those prior to the water hyacinth infestation of Lake Victoria. The nutritive value of consumed foods was not considered as such depth would be outside the scope of the study.

CHAPTER THREE

3.0 METHODOLOGY

3.1 BACKGROUND INFORMATION ABOUT KISUMU MUNICIPALITY AND ITS ENVIRONS.

3.1:1 KISUMU DISTRICT.

The area of study was Kisumu municipality in Winam division of Kisumu district. The district is situated along the Lake Victoria shoreline and is bordered by Vihiga district and Siaya district. The district has a long shoreline along Lake Victoria, which is ninety kilometers and has more than seventeen beaches, all of which are fish landing bays. There are three major rivers flowing into the Nyanza Gulf namely the Nyando, Kibos and Sondu. They are heavily silted, resulting in the extensive formation of lakeside swamps (GOK,1997).

The mean annual rainfall is 1280 mm. The area has two rainy seasons, with the long rains occurring in April/May while the short rains occur in August/September. During the short rains, the average annual rainfall ranges between 450 mm and 600 mm. Reliability of the rains is low and distribution is over a long period, making cultivation of second crops difficult (GOK, 1997): hence the crucial importance of fishing for food and cash.

The mean annual maximum temperatures range from twenty five degrees to thirty degrees centigrade and the mean annual minimum temperatures range from nine degrees centigrade to eighteen degrees centigrade. The altitude is between 1144m above sea level and 1525m above sea level.

3.1.2 KISUMU MUNICIPALITY.

The municipality of Kisumu is the largest and most important urban center in Western Kenya, being the nerve center of various commercial activities. It is in Kisumu Town constituency and has seventeen electoral wards.

In 1997, Winam division had the highest population in the district (GOK, 1997). The high population is attributed to urbanization. Kisumu, which is the third largest town in Kenya, attracts people mainly from Nyanza, Western and Rift Valley provinces. This population is expected to increase as more industrial and commercial activities are undertaken. Population density is also highest in Winam division with 1197 persons/km^2 in Winam division as compared to other divisions in the district, which had a density below 400 persons/km^2 each. This high density in Winam is attributed to the urban status of the division and its being the district and the provincial headquarters. Kisumu municipality had 245,600 households in 1997 compared to other municipalities in the district in the district which had below 1,300 households each (GOK, 1997).

3.1.3 RESOURCES.

Kisumu municipality is endowed with high fisheries potential, due to the presence of Lake Victoria. Also, the municipality has enormous water resource potential for development of hydroelectric power generation, irrigation, fish industry, water transport, sporting and tourism attraction. Lake Victoria, if well harnessed, can, apart from relieving the population of water shortage problems, support industrialization, commerce, trade activities and livelihood, directly or indirectly.

3.1.4 TRANSPORT AND COMMUNICATION.

Roads in Winam are mostly tarmac. The maintenance of these roads is done by the Ministry of Public Works, Kisumu municipality and the County Council of Kisumu (GOK, 1997).

There is a major railway line connecting Kisumu to Nairobi through other towns like Nakuru and Naivasha. Services provided include passenger and cargo.
There are steamship services to Siaya, Rachuonyo and Homabay and also Tanzania and Uganda. This allows for regional and international communication (GOK, 1997).

The airport in Kisumu is the fourth largest in Kenya. The services provided are for commercial flights operating locally. This makes for tourist-related business activities that bring certain benefits to some residents of Kisumu and in the environs of Dunga beach who are directly or indirectly adversely affected by the infestation of the beach and beyond by the water hyacinth.

3.1.5 RESEARCH SITE.

Kisumu municipality is quite expansive in spatial terms. By conventional indicators it is not unproblematic to differentiate clearly between urban and peri-urban Kisumu. Although most, if not all, residents of all Kisumu municipality's locations eat fish and some of the residents across the locations are involved (directly or indirectly) in the fish business, it is not the case that all the locations are appropriate for a study like mine. Therefore, by virtue of my basic research question and objectives as well as hypotheses, it was imperative to zero in on Kibuye and Kilimani sub-locations, which are located in the central trading area and Dunga beach respectively. From Kibuye, the respondents were mainly businessmen/women while in Dunga they were mainly fishermen/women.

3.1.6 POPULATION

The population of study comprised of men and women who reside in Kisumu municipality and who engage in fishing as an occupational undertaking (not necessarily the only one at the time of this research) as well as those who regularly buy fish for sale and/or domestic use. All respondents in the survey were of eighteen years and above, economically self-dependent and therefore in a position to discuss, for example, their economic status, which pertains to one of the specific objectives of the study. The respondents had to have been in the research site before the infestation by the water hyacinth of Lake Victoria in order to afford a means to determining whether the water hyacinth's infestation of the lake has made a difference to their social interaction and economic activities in terms before- and -after infestation comparison. Their economic activities did not have to be the same as before the infestation by the water hyacinth of the lake, but they had to be connected to the fisheries industry in Kisumu municipality.

3.2 SAMPLING AND DATA COLLECTION

Before sampling, I designated, defined and characterized the population of my research interest as specified above. It was from this population that a probability sample of 170 sample elements was selected. It stands to reason by standard probability expectation criteria that by virtue of being random the sample was representative of the population. Accordingly, it is undoubtedly the case that the data obtained from the sample were, in terms of their derived statistical values by which to accept or reject the posited hypothesis, just as accurate as the data that could have been gathered from the entire population. There were a number of obvious advantages of sampling, especially savings in time and money.

Saving on time allowed for the research to be carried out at a single point in time so that the opinions of all the respondents were comparable while the situation remained unchanged. Also, the problem of inaccuracy, which may have come about as a result of employing many interviewers to study the whole population, was minimized. Fewer interviewers need less supervision and therefore attention can be drawn to all the necessary details (Babbie, 1973).

To be sure of successful sampling, the population was not homogenous with respect to characteristics of culture, social class, sex, gender, age and modes of economic and/or occupational activities. However, a pilot survey carried out in the same site assured that the range of data on the variables under study was reflected in the sample. Therefore, the research subjects were not only fishermen/women and businessmen/women but also included other economic activities, which were related to the fisheries industry in Kisumu municipality.

3.2.1 SAMPLING FRAME

A sample cannot be more accurate than the sampling. In theory, the sampling frame is simply a list of defined population elements from which a sample regarded to be representative of the population, is selected. Of course being representative presupposes being random, but this presupposition does not invariably mean that a random sample is invariably representative of the population. A probability sample, like a non-probability sample, can be unrepresentative of the population from which it was selected. The chances of my sample being unrepresentative were minimal and negligible. Nevertheless, it is virtually impossible for an investigation to list all the people in a town at one point in time. The researcher must often depend on one or more existing lists. However, most lists are compiled for non-survey purposes and will invariably contain omissions and repetitions that may cause serious or gross biases. In this study, a list of members of Dunga Co-operative Society was considered to be the best available register of men and women in the fisheries business and, therefore, used as the major proportion of the sampling frame. This was because some members of the society had migrated to other beaches where prospects were higher and could not be reached at the time. To fill the gaps, fishermen/women on the beach, not members of the society, were randomly included in the sample. These included fishermen/women from other landing beaches in Kisumu municipality. In order to complement Dunga Co-operative Society's list of members, I had recourse to a list of Kisumu municipal market's tenants who are involved in the fish trade and in this way, I ended up overall with a sampling frame which was definitely complete, as it were, as far as selecting a sample that adequately mirrored the population was concerned.

3.2.2 STRATIFIED RANDOM SAMPLING.

The correct sample size for any study depends on the nature of the population and the purpose of the study. Some studies deal with small, esoteric populations, in which case 100 percent sample is desirable. Although according to Champion (1970), general rules are hard to make without knowledge of the specific population, many researchers regard 100 cases as the minimum. The main reason is that there are often several sub-populations the researcher needs to study separately or several variables to be controlled for.

According to Mendenhall *et al* (1971), a stratified sample is obtained by separating the population elements into non-overlapping groups called strata, and then selecting a simple random sample from within each stratum. Although the word "strata" implies rank order, the method of stratified sampling can be applied to any mutually exclusive (non-overlapping) groups regardless of whether or not they are rank-ordered. By mutually exclusive, it is meant that no sampling unit appears in more than one group. Stratified sampling consists of listing units in different homogenous groups after which a random or systematic sample is drawn within each group. Stratification is not limited to only one variable. One can stratify on two or more variables simultaneously. In this study, stratification was based on economic activities, mainly fishing, transportation and business. Further stratification was based on sex, resulting in six strata of fishermen, fisherwomen, male transporters, female transporters, businessmen and businesswomen. After the six strata were formed, a disproportionate stratified simple random sample was drawn from all the strata. That is to say, variable sampling fractions were used to draw the sample because the total number of population elements in each stratum was different. This kind of sampling ensured representation of groups of similar economic activities and simultaneously of different sexes within the population. It also saved time as the two variables being stratified were correlated.

3.2.3 THE QUESTIONNAIRE INTERVIEW.

Many social scientists have been highly critical of the survey in general, the interview survey in particular, as a data-gathering instrument and have expressed pessimism about the possibility of biased data collection via the method (Williams, 1959). In addition to errors caused by an inadequate sample or an inadequate questionnaire, there are other ways in which the interview may affect the data. Respondents may lie deliberately because they do not know the answer, the question is too sensitive or he/she does not want to give a socially undesirable answer. Also, data may be affected when unconscious mistakes are made, such as a respondent believing he/she is giving an accurate account of his/her behavior when he/she is not. This occurs most frequently when the respondent has socially undesirable traits that he/she will not admit even to himself/herself. Thirdly, data may be affected through accidental errors, as when the respondent simply misunderstands or misinterprets the question. Also data may be affected when the respondent accidentally errs, as when he/she misunderstands or misinterprets the question. Lastly, on the part of the respondent, data may be affected by memory failures, when the respondent does his/her best to remember but can not remember or is not sure (Williams, 1959).

The interviewer's physical appearance and manner most easily affect the first and second errors. An interviewer who seems to be prestigious, of high status, very formal or otherwise intimidating may arouse the informant's caution in answering. For that matter, two research assistants were recruited to administer the questionnaire. The assistants were from the locality and infact members of the fishing community in Dunga. One of them was the secretary of Dunga Fishermen Society, while the other owns a stall at the Kisumu municipal market. With that in mind, the author considered them (research assistants) appropriate for the job for they could not in, any way, bias the responses by the respondents by intimidating them. Prior to this they were given a two-day training session by the author on how to collect questionnaire survey data. Indeed, thereafter they participated in the pilot study to give them practical experience before they embarked on the actual research. The third and fourth errors are more likely to be caused by a faulty questionnaire than by the interviewer, although an interviewer who does not speak very clearly or speaks very softly or very fast can cause errors of the third type if the respondent does not understand him/her. To make sure that errors caused by a faulty questionnaire were minimized, a pretest was done on twenty randomly sampled individuals from Dunga beach, as part of the two-day training session given to the research assistants. The pretest responses were generally accurate and therefore proved that most respondents had no difficulty understanding the questionnaire. However, the pretest uncovered all sorts of unanticipated responses, which called for interviewers to be trained on what to do when each of these responses, or similar situations, were encountered.

At the end of each day, they recounted to the researcher their field experiences in addition to handing in their field notes and, most certainly, the completed questionnaires. At times the researcher accompanied each research assistant on alternate days but at other times she went out in the field alone and administered the questionnaires, observed a cross-section of direct and indirect fish-trade transactions, interaction and behavior. Typically, it was not practical to write all the aspects of the observation in the field notebook but soon after returning to the research base, what had been observed was recorded while it was still vivid in the memory. The researcher's observations were in line with those of the research assistants throughout the field research period. The research assistants were from the area of study and spoke fluent English, Swahili and Luo. They were both secondary school graduates and had sound knowledge of the population, in that, one worked as the secretary of Dunga Fishermen Society and the other was a stall owner in Kisumu municipal market. These assistants knew the population well and were not in any way intimidating to the respondents.

To avoid other types of errors caused by the interviewer, the research assistants were interviewed using the same questionnaire they were expected to use, to illustrate what was expected during the interviews. Emphasis was laid on the need to avoid altering the questionnaire by omitting certain questions or changing question wording, especially when translating from English to Luo. This was to standardize the questionnaire, with every respondent asked the same question. This allows comparison of answers from all respondents and facilitates the computation of summary statistics. It was therefore imperative that questions be asked or read exactly as worded for all respondents. The interviewers also made sure that they clarified a question when the respondent simply could not understand or saw two possible meanings to a question and asked the interviewer which one was meant. Also, attention was drawn to proper question order during the interview. Every question was asked, even if the respondent had apparently already answered it. The interviewers also guarded against biasing or leading the respondent. They did this by reading the question as stated and not unnecessarily attempting to interpret the question, according to their own understanding, to the respondent. They too were very careful to be neutral before asking a particular question so as not to lead the respondent and guard against facial reactions and other body language, such as nods of agreement, frowns or arching of eyebrows, after the question is answered. While the reaction cannot bias the answer already given, it can give the respondent a clue to the interviewer's general ideology and thus influence subsequent responses. Also, they avoided unnecessary probing to lessen irrelevant and inadequate data.

Some respondents are unsure of what they think so they end up with vague or general responses, no answer at all, or a statement that they do not know. In such a situation, probing is necessary to lead the respondent to answer more fully and accurately, or at least to provide a minimally acceptable answer. Also probing helps to structure the respondent's answer and make sure that all topics of interest to the researcher are covered and the amount of irrelevant information reduced. Probe questions were developed in the pretest phase for questions to which respondents gave incomplete answers. The probes generated were general and neutral and could be used in all questions. Rather than being unique to a single question, the probes were used whenever the respondent hesitated in answering or gave an unclear answer. The probes were not printed on the questionnaire but were taught to the interviewers during training. These probes included repeating the question whenever the respondent hesitated or appeared not to understand. Repeating the answer given by the respondent was one way of the interviewer ensuring that he/she understood the respondent's answer correctly and recording it correctly. It also gave the respondent an opportunity to think about elaborating it further. Also, the interviewer stimulated the respondent to continue in cases of incomplete answers by indicating understanding and interest, and showing that he/she heard the answer and approved of it. A pause was also utilized as a good way of stimulating the respondent to answer the question completely. Pausing and saying nothing if the response is obviously incomplete indicates that the interviewer knows that the respondent has begun to answer and is waiting for him/her to finish.

They also avoided recording errors and flagrant cheating which occurs mainly when an informant fails to answer. If a respondent refused to answer a question, the best procedure was merely to record the lack of response and continue to the next question. There were not many cases of refusals but the few that were recorded were attributed to the respondents' numerous participation in such surveys and getting no intervention in those situations. They generally felt that such surveys were not worthwhile.

Some informants filled the questionnaire for themselves. Questionnaires were given to such informants who could clearly understand the questions and therefore needed no help interpreting. But the researcher and her two assistants administered most of the questionnaires, which were over 95%.

3.2.4 OBSERVATION.

The observational method of research is the primary technique for collecting data on non-verbal behavior. Although observation most commonly involves sight or visual data collection, it could also include data collection via the other senses such as hearing, touch or smell. Use of observational methods does not preclude simultaneous use of other data-gathering techniques. Infact, they are complimentary to each other. Observations are often conducted as a preliminary to surveys, but may also be conducted jointly.

There are two chief types of observations: participant and non-participant. A participant observer is a regular participant in the activities being observed and his/her dual role is generally not known to the other participants. A non-participant observer, on the other hand, does not participate in group activities and does not pretend to be a member. Observation may be either covert, with subjects unaware that they are being observed, or overt, with the observer visible to the subjects and the subjects aware that they are being observed. The main problem with overt observation is that it may be reactive. That is, it may make the subjects ill at ease and cause them to act differently than they would if they were not being observed.

Observation is preferred when one wants to study in detail the behavior that occurs in a particular setting or institution. It is particularly preferred when studying covert activities in that particular setting. However, it is certainly not limited to covert activities and is useful any time one desires a comprehensive in-depth picture of behavior (including non-verbal behavior) in a particular setting over a long period of time. Observation is infact superior to survey research, experimentation, or document study for collecting data on non-verbal behavior, and it takes place in it's most natural environment.

In this study, direct non-participant observation was used. Observations focussed on activities on the beach (Dunga) and its environs for two hours per day, for two weeks. These activities included those at the beach fish market, boat/ship hire section, the Dunga Fishermen Society office, the lake and the neighbouring shopping centre. This was done between 9.00 am and 12.00 p.m. because it is at this time that many activities take place. An equal amount of time was spent observing activities in the Kisumu municipal market. The activities included fish smoking, drying, frying, cleaning, filleting and selling and other activities that were not necessarily fish-related, such as the opening and closing of the market. This was done mainly in the morning and evening when activities were at the peak.

During observation, field notes were taken, with extra caution accorded to remaining inconspicuous. This was to avoid making the subjects self-conscious and cause them to act abnormally. The jotted notes consisted of key words, important quotes and phrases. The notes were expanded later, but on the same day, when the events were still vivid in the author's memory.

3.2.5 KEY INFORMANT INTERVIEWS.

Key informant interviews were carried out with three directors of different fish processing and exporting companies within Kisumu municipality. These interviews were detailed and covered most aspects of industrial fish processing and exporting in Kisumu Municipality, in relation to the infestation by the water hyacinth of Lake Victoria.

3.2.6 DOCUMENTARY SOURCES OF DATA.

Another major source of data for this study was the analysis of documents. The documents analyzed were written materials that contained information about the water hyacinth. Data were collected from primary documents where the accounts documented were by eyewitnesses, who actually experienced the particular event or behavior. Other sources were secondary documents by people who were not present on the scene but who received the information necessary to compile the document by interviewing eyewitnesses or by reading primary documents.

In this study, most of the documents used were written for the purpose of social research. However, some of the documents were written continuously by organizations and the government to keep a running record of events deemed important but cannot be memorized. The exercise of obtaining data from secondary sources involved going through and reading relevant documents available: books, journals, papers, reports, statistical abstracts, magazines among others, obtained from libraries, research centers, government offices and many more. The published data obtained from these secondary sources is considered as supplementary to primary data obtained from the actual fieldwork. Such secondary data may be accurate and comprehensive but if relied upon exclusively, they deny the researcher a chance to appreciate real life situations of the population under study. Data from the secondary sources may be partial, discontinuous or lack homogeneity. Nonetheless, this study has made use of it in the best possible ways to supplement data obtained from primary sources. However, this method was very difficult to use because of the unavailability of data about the water hyacinth in the Kenyan context. It was apparent that research has been done on this topic yet very little has been documented.

3.3 PROBLEMS ENCOUNTERED DURING DATA COLLECTION.

During data collection, there were many problems encountered. While some problems were anticipated, others were not. The study was done during the *el nino* rains so the daylong wet weather was expected. However, this continuous rain obstructed research activities such as observations. Also, it caused flooding and made movement, mainly footing (as most other means of transport had been curtailed by the poor state of the roads) very difficult for both the researchers and the informants. This led to having to reschedule interviews and sometimes replacing informants who did not show up during the period of study. It therefore cost a bit more, in terms of money and time, to carry out the study.

The water hyacinth is known to float in the direction of the wind. At the time of the study, thick mats of the weed had been blown towards Dunga beach and there was absolutely no possibility of any activity on the beach waters. This led to many fishermen/women migrating to less infested beaches to carry out their fishing activities. The researchers found it difficult and time consuming to trace the sampled informants to other possible beaches. The same was experienced for key informants (representatives of fish processing and exporting companies) who had, either temporarily or permanently, closed down. Only three out of seven could be reached.

There was a problem with communication. Most of the fishermen/women and traders understood and spoke very little, if any, English or Swahili. This proved to be a problem for the researcher who could not speak or understand the native Luo language. Such informants always had to be interviewed by the research assistants.

Dunga beach, with its recreational facilities and good view of Lake Victoria, attracts tourists, both local and international. These tourists are usually very generous especially when small favors such as a boat ride or even a photo session with the local people, is done for them. They generously part with tokens (in the form of money) for the people, and make contributions to the fishermen's co-operative society. The same was expected of the researchers after the interviews, making interviews with every informant difficult.

There has been a lot of research in Dunga, especially concerning the water hyacinth, and the residents are now weary of interviews. This is especially so because they do not see any efforts by these research groups or the relevant authorities, to curb the menace. Some informants have become so hostile that they do not accept to be interviewed and even try to influence others to do the same.

CHAPTER FOUR

4.0 DATA ANALYSIS

The preceding chapter has described and explained the technique and process by which data were obtained from respondents. The data are field observations. Making the observations was guided by the study's hypotheses. This chapter is concerned with the issue of correspondence between reality (i.e. the field observations) and the hypotheses. The chapter is an exercise in data analysis – that is, a search and identification of meaningful patterns in the data as a function of the hypotheses' variables. To accomplish the data analysis task, two different data analytic quantitative techniques are used. These techniques are cross-classification and correlation. The use of these two techniques is necessitated by the nature of the relationships posited by the hypotheses. The first hypothesis posits an inverse relationship between the water hyacinth of Lake Victoria and fish – based economic activities; the second hypothesis posits a negative relationship between reduced fish production and food habits; the third hypothesis posits an adverse relationship between social interaction and the water hyacinth infestation of Lake Victoria. The variables involved in these relationships are five, namely water hyacinth infestation of Lake Victoria, fish – based economic activities, reduced fish production, food habits and social interaction. The first hypothesis has an economic slant, the second hypothesis has an anthropological slant, and the third hypothesis has a sociological slant. However, the three hypotheses, by criteria of their variables' measurement, are not mutually exclusive for they are about separate but related aspects – or consequences, if you will, of the infestation of Lake Victoria by the water hyacinth.

4.1 THE WATER HYACINTH AND FISH–BASED ECONOMIC ACTIVITIES.

Lake Victoria is a critical economic asset of people who live in its environs and beyond. People who live around the lake depend on its fish for food and cash. It is in the light of this state of affairs that I advanced, as my first hypothesis posits, that there is an inverse relationship between the infestation by the water hyacinth of Lake Victoria and the fish – based economic activities of people living in Kisumu Municipality (the research site of this study). The variables of this hypothesis are the infestation of Lake Victoria by the water hyacinth and fish – based economic activities. In ideal terms, testing of this hypothesis would need diachronic data collected at two points in time. That is to say, data on fish – based economic activities before the water hyacinth infestation of the lake and data on these activities after the infestation. However, doing so was not possible for reasons that have to do with time and financial resources, among other things. In practical terms, data on before - and - after the water hyacinth were obtained by observing research subjects in the course of their economic activities and having them answer questions about the activities before the hyacinth infestation. To subject this hypothesis to empirical testing I used cross-tabulation and simple regression. Variable fish – based economic activities was regarded to be a factor and, as such, desegregated into different components that were then cross-classified with the water hyacinth infestation of Lake Victoria.

Fish – based economic activities depend on catching fish. However, it differs from other such economic activities in the sense that it is basic. Indeed, catching fish is the sole determinant, so to speak, of all other fish – based economic activities. Various methods are used by men and women to catch fish. Thus, I reasoned that the water hyacinth infestation of the lake has affected fish catching in terms of the various methods employed by men and women to catch fish. Consequently, I cross-classified the effects of the water hyacinth with fishing methods. The statistical values yielded by the cross-classification of the two variables are displayed in table 1.

TABLE 1: EFFECTS OF THE WATER HYACINTH BY FISHING METHODS

EFFECTS OF THE WATER HYACINTH

FISHING METHODS	*None*	*Positive*	*Negative*	*Total*
Hooks	0	4.1% (7)	16.5% (28)	20.6% (35)
Nets	0	3.5% (6)	26.5% (45)	30.6% (51)

Baskets	0	0	5.9% (10)	5.9% (10)
Hooks, Nets, Baskets	0	5.3% (9)	31.2% (53)	36.5% (62)
Others	0	0	2.4% (4)	2.4% (4)
Not applicable	0	0	4.7% (8)	4.7% (8)
Total	0	12.9% (22)	87.1% (148)	100.0% (170)

Chi-square (x^2) = 8.618 (First column cell values not included in calculation)

Degree of freedom = 6

Significance = .117 Contingency coefficient = .220

The first column of the above table (that is, response category "none") shows that all the different methods of catching fish were affected by the hyacinth infestation of Lake Victoria; and the effect is overwhelmingly negative (87.1%). The 12.9% for positive effects is most plausibly a function of interaction of simultaneously utilized methods (hooks, nets, baskets). Be that as it may, it is obvious from the table's cell values that the negative effects far exceed the positive effects for all fishing methods. The table's chi-square of 8.618 with 6 degrees of freedom reaches a significance value of .117. This significance level is greater than .01 probability level. It follows, therefore, that there is a relationship between the water hyacinth infestation of Lake Victoria and the different methods that are used to catch fish. The magnitude of the relationship between the infestation by the water hyacinth of Lake Victoria and methods of fishing in the lake is indicated by a contingency coefficient of .220. The statistical values fielded by the cross-tabulation of effects of the water hyacinth by fishing methods support the hypothesis that there is an inverse relationship between the infestation by the water hyacinth of Lake Victoria and fish – based economic activities. This is unproblematically evidenced by the last cell of the third column of table 1 where the 87.1% representing negative effects of the water hyacinth on fishing methods implies diminished economic activities on the part of the respondents.

The statistical values of Table 1 lend credence to the hypothesis in question, in a sense, in an indirect way. This is seemingly so because the inference concerning support for the hypothesis is measurably a function of the pattern of cell percentage values based on responses subsequent to the hyacinth infestation of the lake. The foregoing point does not diminish in any way the chi-square value of 8.61 and it's significance level (.117) as the determinant of the inference that the statistical values of Table 1 support the hypothesis; for a given chi-square is a chi-square regardless of whether it was calculated from directly or indirectly measured variables. However, in ideal terms, one would want to ground one's inferences pertaining to chi-square in direct measurement rather than indirect measurement of the variables of research interest because the former measurement has more merit in terms of methodological vigour. In this vein, therefore, it was considered appropriate to look at the relationship between the water hyacinth infestation of the lake and the quantity of fish harvested.

The scale of fish – based economic activities is invariably determined by the quantity of fish caught by men and women who are involved in fishing. Thus, in the study, the quantity of fish harvested was considered to be the most direct indicator of the effect of the water hyacinth infestation of Lake Victoria on fish – based economic activities. To find out the extent to which the water hyacinth has affected fish – based economic activities, data was collected on the quantity of fish harvested before the water of Lake Victoria was infested with the hyacinth and the quantity of fish harvested after the water was infested. Thus, there came to be two sets of data on the quantity of fish harvested, pre-hyacinth and post-hyacinth. Cross-classification of each of these sets of data with the hyacinth infestation of Lake Victoria was done. Results of the cross-classification are displayed in Tables 2 and 3.

TABLE 2 (BEFORE HYACINTH INFESTATION): EFFECTS OF THE WATER HYACINTH BY QUANTITY OF FISH HARVESTED.

EFFECTS OF THE WATER HYACINTH

QTY(Kg) OF FISH	*None*	*Positive*	*Negative*	*Total*

HARVESTE D				
0-499	4.1% (7)	0	0	4.1% (7)
500-999	13.5% (23)	.6% (1)	0	14.1% (24)
1000-1499	19.4% (33)	.6% (1)	0	20.0% (34)
1500-1999	24.1% (41)	0	0	24.1% (41)
2000 +	37.1% (63)	.6% (1)	0	37.7% (64)
Total	98.2% (167)	1.8% (3)	0	100% (170)

Chi-square (x^2) = 9.722 Significance = .007

Degrees of freedom (df) = 4 Contingency coefficient (c) = .232

TABLE 3 (AFTER HYACINTH INFESTATION): EFFECTS OF THE WATER HYACINTH BY QUANTITY OF FISH HARVESTED

EFFECTS OF THE WATER HYACINTH

QTY(Kg) OF FISH HARVESTED	*None*	*Positive*	*Negative*	*Total*
0-499	1.2% (2)	8.8% (15)	48.2% (82)	58.2% (99)
500-999	0	1.8 (3)	18.8% (32)	20.6% (35)

1000-1499	.6% (1)	1.2% (2)	10.6% (18)	12.4% (21)
1500-1999	0	0	6.4% (11)	6.4% (11)
2000 +	.6% (1)	.6% (1)	1.2% (2)	2.4% (2)
Total	2.4% (4)	12.4% (21)	85.2% (145)	100.0% (170)

Chi-square (x^2) =17.632 Significance = .105

Degrees of freedom (df) = 4 Contingency coefficient (c) = .307

The hypothesis under consideration asserts that the water hyacinth infestation of Lake Victoria and fish – based economic activities are not independent events. That is to say, the outcome of one event, hyacinth infestation of Lake Victoria, has effect upon the probabilities of the outcome of the other event, fish – based economic activities; and the effect is inverse. The expectation is that there is substantial probability that the association between the water hyacinth infestation of Lake Victoria and fish – based economic activities is not a chance occurrence and, as such, sample results can be used as evidence to support the idea (hypothesis) that there is a relationship between the variables (that is, the water hyacinth infestation of Lake Victoria and fish – based economic activities) in the population from which the probability sample of 170 respondents was drawn. Tables 2 and 3 above could be subjected to this standard logic of contingency analysis, but that would fall short of demonstrating whether or not the association between hyacinth infestation of Lake Victoria and fish – based economic activities is actually inverse. Since chi-square and contingency coefficient are always positive values, neither the second table's contingency coefficient of .232 nor the third table's contingency coefficient of .307 can be used as evidence for the existence of an inverse relationship between the variables in question. However, if the statistical values of tables 2 and 3 are, in a sense, construed in time-series, thereby becoming legitimate and methodologically warrantable to compare these tables for the purpose of establishing whether or not there exists an inverse relationship between the water hyacinth infestation of the lake and fish – based economic activities. Comparison of the two contingency tables (i.e., 2 and 3) now follows below.

To begin with, the observed values of the cells of the last column of table 2 as well as the observed values of the cells of the first column of table 3 were excluded from the calculation of the chi-squares, 9.722 and 17.632 respectively. That is why degrees of freedom for both tables are 4-set and the tables themselves are 3*5 (three-by-five) which gives eight degrees of freedom. The columns specified above were excluded from computation of chi-square values in order to minimize the number of less than five cases, thereby avoiding getting chi-squares that are misleading and meaningless. But no data (observations) were lost in the exclusion of the last column of table 2. Similarly, the observations of the cells of the first column of table 3 were considered to be respondent/observer error and negligible (about 2% of the sample).

According to table 2 almost all research subjects (98.2%) responded as expected (that is, the water hyacinth did not affect fish harvesting precisely because the lake was infested by it). But in table 3 the pattern of responses by research subjects changes (that is, 85.2% of the sample said that the water hyacinth infestation of Lake Victoria has had negative effect on fish harvesting). Clearly, 98.2% and 85.2% represent – or indicate, an inverse relationship as posited by the first hypothesis of this study. The pattern of distribution of cell frequencies of the two tables (2 and 3) under comparison unproblematically demonstrate the existence of an inverse association between hyacinth infestation of Lake

Victoria and the quantity of fish harvested. In table 2 the cell values of the first ("none") column, which takes 98.2% of the sample, increase as the quantity of fish increases; whereas in table 3 the cell values of the last ("negative") column, which takes 85.2% of the sample, decrease as the quantity of fish harvested increases.

Both tables 2 and 3 are of the same size, which of course, legitimizes this comparison. However, the chi-square of table 3 (17.632) is almost twice as much as the chi-square of table 2 (9.722). Since the size or magnitude of a given chi-square value is partly a function of the difference between observed frequencies and expected frequencies, and since the degree of association between variables in a contingency table depends on this difference (that is, the greater the difference the stronger the association), it follows that there is more association between the variables in table 3 and less (practically negligible) association between the same variables in table 2. Table two pertains to pre-hyacinth infestation of Lake Victoria while table 3 pertains to post-hyacinth infestation. Indeed, for table 2 at .01 probability level there is no relationship between effects of the water hyacinth and quantity of fish harvested because the chi-square (9.722) with 4 degrees of freedom reaches a significance of .007, which is less than .01; whereas for table 3 there is a relationship between effects of the water hyacinth and quantity of fish harvested because the chi-square (17.632) with 4 degrees of freedom reaches a significance of .105, which is greater than the .01 probability level.

It is in order at this juncture to compare the contingency coefficients of tables 2 and 3 – the fact that a contingency coefficient never reaches unity even when there is a perfect association between the cross-tabulated variables notwithstanding. A significant chi-square at a chosen probability level (.01 in this analysis) means rejection of the null hypothesis of no difference and acceptance of the alternative hypothesis that the cross-tabulated variables are associated. Since the contingency coefficient- a measure of the degree of association between the variables cross-classified in a contingency table- is calculated from the chi-square, it follows that if a given chi-square is not significant at a chosen probability level, the contingency coefficient has to be considered trivial or negligible. This state of affairs holds for the contingency coefficient of .0232 yielded by table 2. The contingency coefficient of table 3 (.307) is not only derived from a significant chi-square value at .01 probability level but it is also greater than the contingency coefficient of table 2. The contingency coefficient of table 3, unlike that of table 2, indicates the existence of a high degree of relationship between effects of the water hyacinth and quantity of fish harvested. The difference between these contingency coefficients as explained above is in line with the nature of the relationship posited between the variables of the first hypothesis of this study.

Thus far, tables 2 and 3 have been compared in terms of patterns of cell percentages, distributions, chi-square values, and contingency coefficients. And, as clearly demonstrated above, findings of these three kinds of comparison are invariably consistent with the posited relationship between the variables of the first hypothesis. Indeed, these comparative findings constitute, in effect, very strong and direct evidence for the hypothesis that water hyacinth infestation of Lake Victoria is inversely associated with fish – based economic activities. In comparative terms the quantitative and statistical values of tables 2 and 3 obviously support the hypothesis.

In the preceding pages of this chapter, two things have basically been done. First, one point in time data has been used to show that hyacinth infestation of Lake Victoria affects various methods utilized to catch fish. Second, two points in time data have been used to demonstrate that the water hyacinth infestation of Lake Victoria affects the quantity of fish harvested. And in both cases, the demonstrated effects are in the direction predicted by the hypothesis. In the next couple of paragraphs diachronic data has been used to show variation in the effects of the water hyacinth on fish harvesting technologies.

The effect of the water hyacinth on fish harvesting is not invariant or the same across all the different forms of technology employed by the men and women in the environs of Lake Victoria to catch fish for food and/ or cash. Indeed, if one were to assist these men and women in the fish catching business to increase the quantity of fish that they harvest, one would first and foremost want to know the forms of fish harvesting technology that they use and the extent to which each form is affected by the infestation of the lake by the water hyacinth, among other things. The data of table 1 have demonstrated that the water hyacinth affects fishing methods; but a limitation to the validity of that demonstration is that the data used to demonstrate the existence of the effect are cross-sectional, and as such lack a time dimension. The activity of fish harvesting is a process in space and time. This implies that adequate account of how the activity is affected by the water hyacinth's blanketing of the waters in which it takes place must incorporate time as a factor of this effect. Tables 4 and 5 together present time-dimension data pertaining to differential effects of the water hyacinth on fish harvesting technologies.

TABLE 4: PRE-HYACINTH INFESTATION FISHING TECHNOLOGIES

EFFECTS OF WATER HYACINTH	*Hooks*	*Nets*	*Baskets*	*Multiple*	*Total*
None	22.4% (38)	31.85 (54)	7.6% (13)	38.2% (65)	100% (170)
Positive	0	0	0	0	0
Negative	0	0	0	0	0
Total	22.4% (38)	31.8% (54)	7.6% (13)	38.2% (65)	100% (170)

Relevant statistics could not be computed because the number of non-empty rows is one.

TABLE 5: POST-HYACINTH INFESTATION FISHING TECHNOLOGIES

EFFECTS OF WATER HYACINTH	*Hooks*	*Nets*	*Baskets*	*Multiple*	*Total*
None	.6% (1)	.6% (1)	.6% (1)	2.9% (5)	4.7% (8)
Positive	4.7% (8)	.6% (1)	4.1% (7)	3.5% (6)	12.9% (22)
Negative	28.2% (48)	17.6% (30)	7.1% (12)	32.4% (50)	82.4%(140)
Total	33.5% (57)	18.8% (32)	11.8% (20)	38.8% (66)	100% (170)

Chi-square (x^2) = 14.667 Significance = .158

Degrees of freedom (df) = 6 Contingency coefficient (c) = .282

The fourth column ("multiple") of table 4 encompasses all fish catching technologies (that is, those specified in column one, two, and three as well as those not specifically named in the table). Men and women who are in the business of fish catching tend not to depend on just one form of fish catching technology – hence the response category "multiple" in the table in question. The table (4) gives the percentage values representing the extent to which each of the different fishing technologies were used before the fishing waters were infested with the hyacinth. The cells of the second and third rows ("positive" and "negative" respectively) are empty by virtue of the fact that table 4 pertains to the time when the fishing waters were free of the water hyacinth. At that time, 38.2% of the respondents used multiple technologies, 31.8% used nets, 22.4% used hooks and 7.6% used baskets. A generalization fitting these percentages is that their magnitudes increase from left to right. And this pattern of increase is realistic because a hook is less efficient than a net, while a net alone in turn does not have the added advantages in terms of effectiveness and efficiency that accrue to using multiple technologies. In a sense, table 4 is a simple frequency distribution table because the number of non-empty rows is one and, as such, relevant statistics of a contingency table could not be computed. Nevertheless, the fundamental usefulness of table 4 in this data analysis exercise, is its depiction of the extent to which the different forms of fish harvesting technologies were utilized before the fishing waters got blanketed by the water hyacinth. The table is indispensable for determining, within the purview of time-dimension, the differential effects of the water hyacinth on fish harvesting technologies. This becomes obvious when it (table 4) is compared to table 5.

Table 5 displays the state of affairs after the fishing waters were infested with the hyacinth. None of the table's cells is empty. And, as a matter of fact, most of the cells have the expected frequencies that meet the conventional criterion for computation of meaningful statistics – given below the table. In comparative terms the cell values of table 5, particularly those of the third ("negative") row, are inversions of the cell values of the first ("none") row of table 4. Consider, to begin with, the marginal totals of both tables. In table 4 it is obvious that all fishing technologies were unaffected by the water hyacinth precisely because the fishing waters were free of it. That is why the marginal total is 100%. But in table 5 (third row) 82.4% of the respondents said that their fishing technologies have been affected (or were affected) by hyacinth infestation of the fishing waters. The rest, (17.6%) is accounted for by the first and second and rows and as such validates the direction of the posited relationship between the hypothesis' variables. According to table 4 and 5, nets constitute the technology most affected by hyacinth infestation of the lake – from 31.8% use before hyacinth infestation to 17.6% use after the hyacinth infestation. Thus, the use of nets decreased by 44.4% after the fishing waters got infested with the hyacinth. Practically speaking this is what one would expect – net technology requires waters free of obstruction whereas the water hyacinth is an obstruction – hence the great drop (44.4%) in the use of this technology after the water hyacinth infested the fishing waters.

Respondents who used hooks before the infestation by the water hyacinth of the fishing waters were 22.4% of the sample, but after the water hyacinth infested the lake the use of hooks increased (28.2%) of the sample) – an increase of 26.3%. This increase (26.3%) is partly explained by a decrease in the use of nets after the hyacinth infestation. That is to say, some net technology users abandoned it in favour of the hooks because they can be used where it is difficult, if not impossible, to use nets. Before hyacinth infestation 38.2% of the sample used multiple technologies, but after the water hyacinth infestation those who used multiple technologies were 32.4% of the sample – a decrease of 23% in the use of multiple technologies. This decrease of 23% can be explained by saying that the use of multiple technologies became increasingly not viable in economic terms, and so some of them were abandoned in favour of more viable ones, such as hooks. Indeed, it is more plausible that this is partly why the use of hooks increased by such a high percentage (44.4%) after the hyacinth infestation of the lake.

The data of tables 4 and 5 show that only basket technology was not affected by the water hyacinth infestation of the fishing waters. Thus, 7.6% of the respondents said that they used this technology before the hyacinth infestation, and 7.1% of the sample reported using basket technology after hyacinth infestation. Not only is the difference between pre-hyacinth and post-hyacinth use of baskets insignificant by any reasonable criterion but the proportion of users of this technology in both periods (that is, pre-hyacinth infestation and post-hyacinth infestation) is very small indeed (.07% of the sample).

In the preceding couple of paragraphs a demonstration of the differential effects of hyacinth infestation of fishing waters on fishing technologies by comparing the utilization of these technologies in terms of before – hyacinth infestation and after – hyacinth infestation has been done, thereby showing the inverse nature of the hypothesized relationship between the variables of the first hypothesis. Now, no inference can be made about table 4 because it lacks, as already explained, the statistics upon which to base the inferences. But table 5 is amenable to making inferences. The table has a chi-square of 14.667 with 6 degrees of freedom. This chi–square value reaches a significance of .158, which is greater than the .01 probability level. If follows, therefore, that the state of fishing waters after the hyacinth infestation is associated with the variation in the use of fishing technologies; and the degree of that association is indicated by the contingency coefficient of .282. Clearly, the quantitative and statistical values of table 4 and 5 as discussed above lend support to the hypothesis that there is an inverse relationship between infestation of lake Victoria with the water hyacinth and the fish – based economic activities of people living in Kisumu Municipality.

In the early part of this chapter it was mentioned that the first hypothesis – under testing now – has an economic slant. What amounts to a direct testimony to this slant, so to speak, is brought out by looking at respondents' income from a host of activities in light to fishing waters before and after hyacinth infestation. The data in this state are presented in tables 6 and 7 below:

TABLE 6: EFFECTS OF THE WATER HYACINTH BY INCOME BEFORE HYACINTH INFESTATION OF LAKE VICTORIA.

EFFECTS OF WATER HYACINTH

PRE-HYACINTH INFESTATION INCOME(Ksh)	*None*	*Positive*	*Negative*	*Total*
999 and below	0	10.0% (17)	4.1% (7)	14.1%(24)
1000-1999	0	11.2%(19)	.6%(1)	11.8% (20)
2000-2999	0	21.8%(37)	6.5%(11)	28.2%(48)
3000-3999	0	17.1%(29)	1.8%(3)	18.8%(32)
4000-4999	0	11.2%(19)	3.5%(6)	14.7%(21)
5000 +	0	9.4%(16)	2.9%(5)	12.4%(21)
Total	0	80.6%(137)	19.4%(33)	100%(170)

Chi – square (X^2) = 4.178 Degrees of freedom (df) = 5

Significance = .002 Contingency coefficient (c)= .155

TABLE 7: EFFECTS OF WATER HYACINTH BY INCOME AFTER HYACINTH INFESTATION OF LAKE VICTORIA.

	EFFECTS OF WATER HYACINTH			
POST–HYACINTH INFESTATION INCOME (Ksh)	*None*	*Positive*	*Negative*	*Total*
999 and below	.6%(1)	2.9%(5)	10.6%(18)	14.1%(24)
1000 – 1999	0	1.8%(3)	10.0%(17)	11.8%(20)
2000 – 2999	.6%(1)	3.5%(6)	24.1%(41)	28.2%(48)
3000 – 3999	.6%(1)	2.9%(5)	15.3%26)	18.8%(32)
4000 – 4999	0	1.2%(2)	13.5%(23)	14.7%(25)
5000-and above	0	.6%(1)	11.8%(20)	12.4%(21)
Total	1.8%(3)	12.9%(22)	85.3%(14.5)	100%(170)

Chi – square (X^2) = 11.212 Degrees of freedom (df) = 5

Significance = .284 Contingency Coefficient (c) = .249

Table 6 is, in terms of its columns, tricky to interpret because the column labels ("none", "positive", "negative") are not really measures of water hyacinth effects but reflections of perceptions of the different means and forms of livelihood before hyacinth infestation of the fishing waters. Therefore, only the second and the third columns are relevant and their respective cell values are valid reflections of the perceptions. Obviously, calculation of the table's statistics did not include cells of the first column. In table 7 the column labels ("none", "positive", "negative") are measures of the effects of water hyacinth and the cell values of these columns are valid reflections of perceptions of the different means and forms of livelihood in the face of hyacinth infestation of fishing waters. In this table the first column is relevant and its cell values valid even, as they are statistically insignificant and substantially unimportant. However the values were excluded from computation of the table's statistics because their inclusion would greatly increase the number of the table's cells with values of less than 5 cases, thereby rendering the computed statistics meaningless and misleading.

The hypothesized relationship between the variables of the first hypothesis (that is, hyacinth infestation of Lake Victoria is inversely associated with fish – based economic activities) is apparent in the second and third columns of both tables 6 and 7. In table 6 positive perceptions of the means and forms of livelihood represent 80.6% of the sample, and the rest (that is 19.4%) represents negative perceptions. But in table 7 this state of affairs is plainly reversed. Positive perceptions represent 12.9% of the sample (a decrease of 83.9%) while negative perceptions represent 85.3% of the sample (an increase of 39.4%). The range of the "positive" column of table 6 is 20, and the range of the "negative" column of table 7 is 24. These two measures of viability (that is, 20 and 21) are almost identical. Besides, the viability of the values of the "positive" column (table 6) very closely corresponds with the viability of the values of the "negative" column of table 7. And this holds also for the "negative" column of table 6 in relation to the "positive" column of table 7. Thus the cell values of table 7 are consistent inversions of the cell values of table 6. Undoubtedly, the posited inverse relationship between the variables of the first hypothesis is demonstrated.

As pointed out earlier, table 6 is really a cross-classification of perceptions of the means and forms of livelihood by income before the water hyacinth infested the lake. The cross-classification yielded a chi-square of 4.178 with 5 degrees of freedom. This chi-square value reaches a significance of .002, which is less than the .01 probability level. This means those pre-hyacinth infestation perceptions of the means and forms of livelihood and pre-hyacinth infestation income are independent – that is, there is no relationship between them. The table's contingency coefficient of .155 is, therefore, trivially insignificant. Table 7 constitutes a cross-classification of post-hyacinth income with perceptions of the means and forms of livelihood in the face of the hyacinth infestation of the fishing waters. It has been explained above the table's degrees of freedom are 5 rather than 10. The table's chi-square of 11.212 with 5 degrees of freedom reaches a significance of .284,which is greater than the .01 probability level. The variables of table 7 are not independent. They are related. The degree of their association is indicated by the contingency coefficient of .249. These statistical values uphold the hypothesis that the water hyacinth infestation of Lake Victoria is inversely related to fish-based economic activities of people living in Kisumu Municipality.

In the preceding pages of this chapter, patterns of cell percentage values, chi-squares, and contingency coefficients have been relied on in testing the hypothesis that there is an inverse relationship between the water hyacinth infestation of Lake Victoria and fish – based economic activities. Support or non-support of the existence of the hypothesized relationship has been mostly a function of the chi-square and its resulting contingency coefficient. These statistics (that is, chi-square and contingency coefficient) have certain limitations as measures of association. Thus the value (or magnitude) of a chi-square is influenced by the size of the cross-tabulation table from which it is computed and/or the number of cases in the sample. And it is impossible to tell from any given contingency coefficient whether the variables involved are perfectly associated. Besides, chi-square is a nominal scale statistic, but nominal measurement of variables is relatively crude and tends, among other things, to do violence to variability; thereby simplifying – even distorting – what is otherwise complex relationship(s) between variables involved.

It is against the background of the above limitations of the chi-square and the contingency coefficient, among others, that reasonable consideration was given, on grounds of analytical vigour, to the application of the best known and most widely measure of association – the Pearson product-moment correlation – to the data pertaining to the first hypothesis. The statistics of table 8 below are Pearsonian correlation coefficients between income and its influencing variables.

TABLE 8: PEARSONIAN CORRELATION OF INCOME WITH LIVELIHOOD ACTIVITIES BEFORE AND AFTER HYACINTH INFESTATION OF LAKE VICTORIA

	Pre-hyacinth income	*Post-hyacinth income*
Pre-hyacinth use of hooks	.240	_
Post-hyacinth use of hooks	_	.317
Pre-hyacinth use of nets	.592	_
Post-hyacinth use of nets	_	.261
Pre-hyacinth use of baskets	.247	_
Post-hyacinth use of baskets	_	.242
Pre-hyacinth use of multiple technologies	.423	_
Post-hyacinth use of multiple technologies	_	.236
Pre-hyacinth fish quantity harvested	.860	_
Post-hyacinth fish quantity harvested	_	.619
Pre-hyacinth fish quantity marketed	.818	_
Post-hyacinth fish quantity marketed	_	.747
Pre-hyacinth non-fish harvesting types of livelihood	.303	_
Post-hyacinth no-fish harvesting types of livelihood	_	.320
Pre-hyacinth volume of business	.659	_
Post-hyacinth volume of business	_	-.285

It is imperative for the reader to note that table 8 is not a contingency table. Before discussing the table's quantitative values, it is important to point out how they were arrived at since the Pearsonian correlation is appropriate only for higher levels (that is, interval and ratio) of measurement. As can be seen from the data collection instrument (appendix) the variables of this study were measured at nominal and ordinal levels. These levels of measurement are inappropriate for computation of Pearsonian correlation coefficient. This problem was solved through the use of dummy variables; thereby making the variables emenable to computation of the Pearsonian correlations given in table 8. It is important to point out too that it was needless to give, as table 8, the matrix of the inter-correlations among the eighteen variables named above because the focus of interest was the relationship between income (that is, column variables) and its determinants (that is, row variables) and not the inter-correlations among the determinants.

The hypothesis under testing now posits an inverse relationship between its variables. Table 8 gives the Pearsonian correlation coefficients between income and its influencing variables. Each influencing variable was correlated with income at two points in time, namely pre-hyacinth and post-hyacinth infestation of the fishing waters. The hypothesis predicts an inverse relationship between hyacinth infestation of Lake Victoria and fish-based economic activities. This implies that negative Pearsonian correlation coefficient would be expected when income data are correlated with influencing variables' data. However, in table 8 most of the correlation coefficients (particularly those of the post-hyacinth infestation column) are not negative. Does this observed fact imply that there is an inverse relationship between the variables of the hypothesis in question? No, it does not deny the nature (inverse) of the hypothesized relationship. This is because, to begin with, the coefficients of the pre-hyacinth infestation income column are mostly (75%) greater than their corresponding coefficients in the post-hyacinth infestation income column irrespective of whether this column's coefficients are positive or negative. Therefore it stands to reason, with respect to the positive correlation coefficients of this column, that the inverse nature of the relationship between the variables involved takes the form of one variable increasing at a decreasing rate while the other variable, with which it is correlated, is increasing at an increasing rate. For example, the increase of post-hyacinth infestation income is declining relative to post-hyacinth use of hooks, and if is this state of affairs continues beyond a certain point a negative correlation coefficient would likely result.

The small sizes of the correlation coefficients of the post-hyacinth infestation income column relative to the sizes of the pre-hyacinth infestation income column lend strong support to the hypothesis that there is an inverse relationship between the infestation by the water hyacinth of Lake Victoria and fish-based economic activities of the people living in Kisumu Municipality.

4.2.1 EFFECTS OF REDUCED FISH PRODUCTION ON FOOD HABITS

A majority, if not the major, component of the diet of people who live in the environs of Lake Victoria, specifically the site of the research, is constituted by fish. Thus what happens to the quantity of fish in the waters of Lake Victoria is highly likely to have consequences for the people who live in the environs specified above. It is in recognition of this relatively high dependence on fish as a food item on the part of those people that it was considered warrantable to advance, as a second hypothesis of this research, that reduced fish harvesting negatively affects the food habits of people living in Kisumu Municipality. Unlike the first hypothesis, this second hypothesis is causal. Reduced fish harvesting is the causal variable while food habits is the effect variable. And it is this effect variable that gives a particularly anthropological slant to this hypothesis. The effect variable was measured by the quantity of fish harvested and the harvesting technologies both before and after hyacinth infestation of the fishing waters. The causal variable (actually a factor), was measured by food source, food type, food consumption and visitation. Each of the effect variables was cross-classified with each of the causal variables. Results of the cross-classification exercise are presented and discussed below, subsequent to discussion of simple frequencies of pre-hyacinth quantity of fish harvested and post-hyacinth quantity of fish harvested as well as pre-hyacinth food sources and post-hyacinth food sources.

The variable food habits in this hypothesis preclude fish. The people of Kisumu Municipality (specifically research subjects) do not totally depend on Lake Victoria for food. Besides, for some people the dependence is direct while for others it is indirect. It follows, therefore, that these people have other sources of food apart from the waters of Lake Victoria. But these waters, as a source of food, have connection with the other sources of food that are not fish-based. It can be seen, in this connection, that a decrease in the quantity of fish harvested should be expected to affect the other sources of food. Tables 9 and 10 display simple frequencies of non-fish sources of food as well as quantity of fish harvested. The data of the tables, by virtue of being simple frequencies, are certainly not intended to show causation, which the hypothesis under discussion posits, but changes in non-fish sources and also quantity of fish harvested.

TABLE 9: SIMPLE FREQUENCIES OF PRE-HYACINTH AND POST-HYACINTH FOOD SOURCES.

Non-fish food source	*Pre-hyacinth*	*Post-hyacinth*	*Relative change*
Farm	26.5%(45)	25.3%(43)	-4.4% (-2)
Purchase	50.6%(86)	38.2%(65)	-24.4% (-21)
Borrowing	4.7%(8)	13.0%(22)	175.0%(14)
Farm, Purchase, Borrowing	18.2%(31)	23.5%(40)	29.0%(9)
Total	100%(170)	100% (170)	

TABLE 10: SIMPLE FREQUENCIES OF PRE-HYACINTH FISH QUANTITY HARVESTED

Qty of fish(kg) harvested	*Pre-hyacinth*	*Post-hyacinth*	*Relative change*
0-499	3.5%(6)	56.4%(96)	1600%(90)
500-999	13.5%(23)	20.0%(34)	47.8%(11)
1000-1499	19.4%(33)	11.8%(20)	-39.4%(-13)
1500-1999	23.5%(40)	5.9%(10)	-75.0%(-30)
2000 +	36.0%(61)	1.2%(2)	-96.7%(-59)
Not applicable	4.1%(7)	4.7%(8)	14.3%(1)
Total	100%(170)	100%(170)	

Table 9 gives data on non-fish food sources while table 10 gives data on the quantity of fish harvested. According to table 9, farm activity as a source of food has hardly been affected by the water hyacinth infestation of Lake Victoria. Most of the respondents (50.6%) said that before the hyacinth infestation they got some of their food through purchase but after the hyacinth infestation a minority of the sample (38.2%) said that they purchased some of their food. The change from 50.6% to 38.2% represents a drop of 24.4%, which is relatively considerable.

Before the fishing waters were infested by the water hyacinth, 18.2% of the respondents obtained some of their food through farm activity or purchasing or borrowing, but after the hyacinth infestation of the waters, 23.5% of the sample said that they obtained some of their food through this response category (that is, farm, purchase, borrowing). The change from 18.2% to 23.5% represents a relative increase of 29%. The drop in the food obtained through purchase (that is, 24.4%) can be attributed to diminished cash earnings from fish consequent upon hyacinth infestation of the fishing waters. After hyacinth infestation of Lake Victoria, some foods were either abandoned or the frequency of eating them dropped considerably. The 29% increase in the last response category (farm, purchase, borrowing) means that after the hyacinth infestation of the fishing waters relying largely on one source of non-fish food became considerably difficult to a degree that warranted resorting to multiple sources of non-fish food. In this respect, it stands to reason that the 23.5% in table 9 represents respondents whose access to only one source of non-fish food was rendered markedly uncertain by the water hyacinth infestation of Lake Victoria. The most plausible deduction from the above discussion of non-fish sources of food is that both, 24.4% (purchase) and 29% (farm, purchase, borrowing) translated into a shorter menu or a qualitatively different menu, relative to pre-hyacinth infestation of Lake Victoria, that in turn had consequences for the food habits of the respondents.

Table 10 shows that before the water hyacinth infestation of Lake Victoria, a very small portion of the sample (3.5%) harvested the smallest quantity of fish (0-499 kilogrammes), but after the hyacinth infestation of the fishing waters, 56.4% of the sample reported harvesting the smallest quantity of fish specified above. This change from 3.5% to 56.4% represents a relative increase of 1600%. Before the water hyacinth infested Lake Victoria, 36% of the sample harvested the largest quantity of fish (2000 kilogrammes and above), but after the infestation by the weed of the lake, only 1.2% of the sample reported harvesting the largest quantity of fish specified above. This change from 36% to 1.2% represents a relative decrease of –96.7%. Besides, and important indeed, before the water hyacinth infested the lake, the quantity of fish harvested increased as the percentage of fish harvesters increased. But after the weed infested the fishing waters, this state of affairs got inverted. That is to say, the quantity of fish harvested increased as the percentage of fish harvesters decreased. Both the increase (pre-hyacinth) and the decrease (post-hyacinth) are systematically consistent. According to table 10 the frequency distributions of the quantity of fish harvested are invariably inverted by the frequency distributions of post-hyacinth quantity of fish harvested. But it has been shown earlier in this chapter that the amount of cash earned from fish depends on the quantity of fish harvested, that is, the larger the quantity of fish harvested, the larger the amount of money earned, other things being equal. Therefore, it follows that after the water hyacinth infestation of the fishing waters of Lake Victoria, cash earnings from fish drastically dropped in accordance with the decrease of the quantity of fish harvested. Thus it is that most of the people interviewed (76.4% of the sample) said that they had to adjust to the situation of diminished cash earnings from fish, and that this adjustment included changes in their food habits, among other things. This, then, is the connection between table 9 and 10. The patterns of the data of these two tables have causal implications for the food habits of the people living in Kisumu Municipality in general and the research subjects of this study in particular.

Whether or not a causal hypothesis is true cannot be determined by simple frequency distributions (one variable). Such a hypothesis involves at least two variables; and subjecting it to empirical testing calls for, among other things, using data analytic techniques that are appropriate for situations in which two or more phenomena occurred at one and the same time. Cross-tabulation immediately becomes a handy technique. In this connection, the hypothesis that reduced fish production negatively affects the food habits of the people living in Kisumu Municipality implies, within the purview of pre-hyacinth infestation of Lake Victoria and post-hyacinth infestation of the fishing waters, at least two things. First, that there is an association between pre-hyacinth sources of non-fish food and post-hyacinth quantity of fish harvested. Second, that there is also an association between post-hyacinth sources of non-fish food and post-hyacinth quantity of fish harvested. Tables 11 and 12 present data bearing on these two implications. Table 11 displays the pre-hyacinth situation while table 12 displays the post-hyacinth situation. But the variables involved in both situations are the same, namely quantity of fish harvested and sources of non-fish food.

TABLE 11: PRE-HYACINTH SOURCES OF FOOD BY PRE-HYACINTH QUANTITY OF FISH HARVESTED.

QUANTITY OF FISH (kg) HARVESTED

Sources of non-fish food	0-499	500-999	1000-1499	1500-1999	2000 +	Total
Farm	4.7%(8)	4.1%(7)	5.9%(10)	4.7%(8)	3.5%(6)	23.0%(39)
Purchase	1.2%(2)	8.8%(15)	7.6%(13)	1.8%(3)	14.7% (25)	34.1%(58)
Farm and purchase	3.5%(6)	2.4%(4)	2.9%(5)	4.1%(7)	5.3%(9)	18.2%(31)
Other	4.1%(7)	2.9%(5)	6.5%(11)	5.3%(9)	5.9%(10)	24.7%(42)
Total	13.5%(23)	18.2%(31)	22.9%(39)	15.9%(27)	29.4%(50)	100%(170)

Chi-square (x^2) = 22.998

Degrees of freedom (df) = 12

Significance = .108

Contingency coefficient (c) = .3459

TABLE 12: POST-HYACINTH SOURCES OF NON-FISH FOOD BY POST-HYACINTH QUANTITY OF FISH HARVESTED

Sources of non-fish food	*0-499*	*500-999*	*1000-1499*	*1500-1999*	*2000+*	*Total*
Farm	4.7%(8)	3.5%(6)	2.4%(4)	5.3%(9)	2.9%(5)	18.8%(32)
Purchase	1.8%(3)	2.4%(4)	7.1%(12)	8.8%(15)	12.9%(22)	33.0%(56)
Farm and purchase	4.1%(7)	5.9%(10)	6.4%(11)	2.4%(4)	7.1%(12)	25.9%(44)
Other	9.4%(16)	5.3%(9)	2.9%(5)	2.9%(5)	1.8%(3)	22.3%(38)
Total	20.0%(34)	17.1%(29)	18.8%(32)	19.4%(33)	24.7%(42)	100%(170)

Chi-square (x^2) = 8.461

Degrees of freedom (df) =12

Significance = .092

Contingency coefficient (c) =218

By criterion of cell frequencies table 11 is a good cross-tabulation because most of the observations are 5 and above (that is 75% of the cells meet this criterion). However, there is no pattern in these frequencies row-wise or column-wise. One thing that stands out strikingly is that prior to the hyacinth infestation of Lake Victoria purchase was the dominant source of non-fish food, taking up 34.1% of the sample, and the purchase was mostly an activity of sample elements whose fish harvest was 2000 Kg and above.

Respondents who harvested the smallest quantity of fish (0-499 Kg) hardly used purchase as a source of non-fish food. In any case, the marginal total of the 0-499 Kg column is the lowest (13.5% of the sample). All other columns have percentage values greater than 13.5%, with the last column (2000 Kg and above) having the highest number of cases (29.4%). But this increase from left (13.5%) to right (29.4%) is not consistent.

If the third column (1000-1499 Kg) is taken as the mid-point of table 11 and considered to constitute a large quantity of fish harvested, it is legitimate to conclude that before hyacinth infestation of Lake Victoria most of the respondents (columns 1000-1499, 15000-1999, 2000+) used purchase as a source of non-fish food, because of the more or less direct relationship between quantity of fish harvested and cash earnings from fish. Under the circumstances, one would expect these particular respondents to consume more different sorts of food than respondents who reported harvesting small quantities of fish. Table11 has a large chi-square of 22.998 with 12 degrees of freedom and reaches a significance of .108, which is greater than the probability level of .01. The meaning of these statistics (that is, chi-square and significance reached) is that there is a relationship between pre-hyacinth quantity of fish harvested and pre-hyacinth sources of non-fish food. Since chi-square's value size depends on the difference between observed values and expected values, and since 22.998 is relatively large, it is warrantable to regard the relationship between the variables of table 11 as marked. The magnitude or strength of that relationship is indicated by the contingency coefficient of .346. The statistics yielded by table 11 support the hypothesis that reduced fish production negatively affects the food habits of the people living in Kisumu Municipality. This conclusion is based on the chi-square and its derived contingency coefficient. In a sense, the hypothesis implies negative statistical values, but that is immaterial in this particular case because the chi-square and the contingency coefficient are always positive values.

As pointed out earlier, the variables of table 12 are the same as those of table 11. However, the distribution of cell values of table 12 is markedly different from that of table 11. In table 12, which is about the post-hyacinth infestation situation, the first column (from left to right) takes 20% of the sample compared to 13.5% for the pre-hyacinth infestation situation. This change represents a relative increase of 47.8% in the number of respondents who reported harvesting small quantities of fish (0-499Kg) after the water hyacinth infestation of the fishing waters. It is obvious from the two tables (tables 11 and 12) that this increase is by and large accounted for by respondents who harvested large quantities of fish (that is, 1000-1499, 1500-1999, 2000and above) before hyacinth infestation of Lake Victoria. The water hyacinth infestation of the fishing waters made it difficult, if not impossible, for them to sustain harvesting large quantities of fish. In sociological terms the 47.8% increase indicates downward social mobility. To put it differently, the 47.8% represents those who could no longer eat, on a relatively regular basis, all the sorts of food they used to eat before the water hyacinth infested the lake, and so they had to adjust their food habits- an adjustment which is negative for it is a function of diminished cash resulting from small quantities of fish harvested. Note that the second column in both tables is the least affected by the water hyacinth infestation of the lake.

That is to say, pre-hyacinth infestation marginal total is 18.2% for table 11 and the post-hyacinth infestation marginal total is 17.1%. The difference between the two marginal totals is patently negligible- it is a chance occurrence. This lends very substantial validity and credence to the statement that the 47.8% represents a downward slide in terms of social status and its consequent unpleasant adjustment. The difference between the row marginals of table 11 and the row marginals of table 12 come fairly close to showing the undesirable consequences of the water hyacinth infestation of the fishing waters, for the habits and practices of food among the residents of Kisumu Municipality.

Table 11 and 12 are of the same size and, therefore, amenable to being compared. In terms of cell values table 12 is as good as table 11 because 75% of the cells of each table have observed values of 5 or more frequencies. However, the chi-square of table 12 (8.461) is almost a third of the size of the chi-square of table 11 (22.998). This means that the difference between observed and expected values in table 12 is much less than the difference between observed and expected values in table 11. With 12 degrees of freedom, the chi-square of table 12 (8.461) reaches a significance of .009, which is less than the probability level of .01. Since the tabled probability value of .01 is greater than the observed value of .009, the conclusion about table 12 is that at .01 probability level there is no relationship between post-hyacinth sources of non-fish food and post-hyacinth quantity of fish harvested. The contingency coefficient of .218 yielded by the cross-tabulation of the variables in table 12 is a chance occurrence. This conclusion, which upholds the null hypothesis and, therefore, refutes the alternative hypothesis of the existence of a relationship between the post-hyacinth infestation sources of non-fish food and the post-hyacinth quantity of fish harvested, does not deny that the food habits of the people living in Kisumu Municipality have negatively been affected by reduced fish harvest. What it denies is that the quantity of fish when mediated by cash earnings from fish, as in the case of table 11, is associated with food habits. Nevertheless, three forms of a relationship pertaining to table 11 and 12 that lend support to the hypothesis that reduced fish harvest negatively affects the food habits of the people living in Kisumu Municipality, have been demonstrated above. They are association between pre-hyacinth infestation sources of non-fish food and pre-hyacinth infestation quantity of fish harvested; pre-hyacinth infestation quantity of fish harvested and post-hyacinth infestation quantity of fish harvested; and pre-hyacinth infestation sources of non-fish food and post-hyacinth infestation sources of non-fish food. These three forms of association are causal and, consequently, in line with the second hypothesis of this study.

The hypothesis under testing now posits negative effects of reduced fish harvest on food habits. These effects have less to do with the quality of food and more to do with culturally based perceptions. That is to say, there has occurred significant change in what is eaten after the water hyacinth infested of Lake Victoria and the change is negative insofar as it constitutes a disruption of culturally preferred food consumption practices.

Thus, the hypothesis does not pertain to the nutritional status of the people living in Kisumu Municipality but to their perception of the available foodstuffs before and after hyacinth infestation of the fishing waters. Harvested fish is either eaten by the harvester or sold. By virtue of being a general medium of exchange, money can be used as an indicator of not only what is eaten but what is sold as well as what is bought. In this respect it can be used as a factor in gauging the effects of the water hyacinth infestation of Lake Victoria on the food practices of the subjects of the research. To begin with, table 13 presents data on income.

TABLE 13: SIMPLE FREQUENCIES OF PRE-HYACINTH AND POST-HYACINTH INFESTATION MONTHLY INCOME.

Income(Ksh)	*Pre-hyacinth*	*Post-hyacinth*	*Relative change*
Below 999	3.5%(6)	14.1%(24)	300.0%(18)
1000-1999	8.2%(14)	11.8%(20)	42.9%(6)
2000-2999	12.4%(21)	28.2%(48)	128.6%(27)

3000-3999	27.1%(46)	18.8%(32)	-30.4%(14)
4000-4999	24.1%(41)	14.7%(25)	-39.0%(16)
5000+	24.7%(42)	12.4%(21)	-50.0%(21)
Total	100%(170)	100%(170)	

Table 13 is a one-way frequency table and, as such, no statement of causation can be made on the basis of it. Nevertheless, the table clearly shows that respondents with low income (that is, those making Ksh. 2999 and below) tremendously increased after the water hyacinth infestation of the lake whereas respondents with high income (that is, those making Ksh. 3000 and above) decreased more or less correspondingly after the hyacinth infestation. According to the table, it therefore follows that the overall income of the respondents went down subsequent to the hyacinth infestation of the lake. Since the hypothesis in question is about food, it is reasonable to ask whether or not income affected fish consumption after the water hyacinth infestation of the fishing waters. Table 14, which cross-classifies income with consumption of fish after the water hyacinth infested the fishing waters answers this question.

TABLE 14: POST-HYACINTH FISH CONSUMPTION BY POST-HYACINTH MONTHLY INCOME (Ksh.).

POST-HYACINTH FISH CONSUMPTION

INCOME	*Large extent*	*Small extent*	*Other*	*Total*
Below 999	8.8%(15)	10.6%(18)	4.1%(7)	23.5%(40)
1000-1999	11.2%(19)	11.8%(20)	4.7%(8)	27.7%(47)
2000-2999	8.2%(14)	9.4%(16)	0.6%(1)	18.2%(31)
3000-3999	4.7%(8)	7.6%(13)	0.6%(1)	12.9%(22)
4000-4999	3.5%(6)	7.1%(12)	1.2%(2)	11.8%(20)
5000+	1.2%(2)	1.8%(3)	2.9%(5)	5.9%(10)
Total	37.6%(64)	14.1%(82)	14.1%(24)	100%(170)

Chi-square (x^2) = 6.411 Degrees of freedom (df) = 10

Significance = .003 Contingency coefficient (c) = .191

Table 14 suggests that respondents in the low-income categories tend to consume more quantities of fish than respondents in the high-income categories. The table also suggests that in terms of extent of consumption, the difference between large and small consumption is not considerable. The table has a chi-square of 6.411; and with 10 degrees of freedom this chi-square value reaches a significance of .003 which is less than .01 probability level. The conclusion about table 14 is that income and post-hyacinth infestation fish consumption are independent events. Fish consumption is not contingent upon income. That is, there is no association between the two variables. Thus the hyacinth infestation of the fishing waters as measured by income has had no statistically significant effect on fish as a food item. In an earlier part of this chapter, it was demonstrated that the water hyacinth infestation of Lake Victoria has decreased the quantity of fish harvested. In the light of this demonstration, what the above conclusion means is that the post-hyacinth decrease of the quantity of fish harvested has not resulted in a decrease in the quantity of fish consumed in particular. This is so because fish constitutes a staple food item of the people living in Kisumu Municipality. In a sense, fish comes very close indeed to being an indispensable food item for these people. It is most likely that the average quantity of fish consumed has gone down but the extent of fish consumption in post-hyacinth infestation of Lake Victoria is comparable to the extent of pre-hyacinth infestation of fishing waters. With particular reference to fish consumption therefore, the quantitative values of table 14 do not lend support to the hypothesis that reduced fish harvest negatively affects the food habits of the people living in Kisumu Municipality. The soundness of this finding is underlined by the data of table 15 below.

TABLE 15: SIMPLE FREQUENCIES OF PRE-HYACINTH AND POST-HYACINTH FISH CONSUMED.

Extent of fish	*Pre-hyacinth*	*Post-hyacinth*	*Relative change*

consumed			
Very small	24.1%(41)	85.9%(146)	256.1%(101)
Small	35.3%(60)	6.5%(11)	-81.7%(049)
Moderate	19.4%(33)	2.9%(5)	-84.8%(-28)
Large	9.4%(16)	_	_
Very large	7.1%(12)	_	_
Not applicable	4.7%(8)	4.7%(8)	0%(0)
Total	100%(170)	100%(170)	

Table 15 gives before-and-after hyacinth infestation one-way frequencies of fish consumption. Before the water hyacinth infestation of Lake Victoria the quantity of fish consumed decreased with increasing extent of consumption; and the first three response categories (very small, small, and moderate) together took 78.8% of the sample. After the water hyacinth infestation of the fishing waters the same response categories came to take 95.3% of the sample. It is obvious from these very high figures (78.8% and 95.3%) as well as the patterns of before-and-after hyacinth infestation frequency distributions of the table that the vast majority of respondents retained fish as their regular fish item even after the fishing waters got blanketed by the water hyacinth. According to table 15, 95.3% of the of the sample reported consuming fish before hyacinth infestation of Lake Victoria as well as after the water hyacinth infestation of the lake, but smaller fish quantities were consumed after the hyacinth infestation than before the hyacinth infestation.

Note, in this connection, that for the first category column-wise the pre-hyacinth infestation consumption takes 24.1% of the sample whereas the post-hyacinth consumption takes 85.9% of the sample- a dramatic increase of 256.1%.

Because of the importance of fish in the diet of the people living in Kisumu Municipality, it was considered warrantable to treat it (fish) in relation to income. But it is a fact that these people eat other animal foods, apart from fish, although not as much as they consume fish. For purpose of simplified and better analysis these other animal foods as meat were lumped together. Table 16 displays one-way frequency distributions of before and after hyacinth infestation meat consumption.

TABLE 16: SIMPLE FREQUENCIES OF PRE-HYACINTH AND POST-HYACINTH MEAT CONSUMPTION.

Extent of consumption	*Pre-hyacinth*	*Post-hyacinth*	*Relative change*
Large	41.2%(70)	9.4%(16)	-77.1%(-54)
Small	7.6%(13)	23.5%(40)	207.7%(27)
Other	51.2%(87)	67.1%(114)	31.0%(27)
Total	100%(170)	100%(170)	

In the above table the last response category row-wise (that is, other) stands for those respondents whose probabilities of consuming meat are so low as to make reliable prediction highly problematic, if not impossible altogether. For these particular respondents the first and second response categories row-wise (that is, large, small) would be by and large trivially valid. Indeed, it stands to reason that these respondents are invariably very regular fish consumers to the virtual exclusion of meat. Table 16 clearly shows that there is a marked difference between pre-hyacinth infestation and post-hyacinth infestation consumption of meat. Before the water hyacinth infestation of Lake Victoria, large-scale consumption of meat took 41.2% of the sample, but after the hyacinth infestation of the fishing waters meat consumption dropped to 9.4% of the sample – a relative change of –77.1%. However, this state of affairs was reversed with respect to small scale consumption. That is to say, 7.6% for pre-hyacinth infestation of the lake and 23.5% for post-hyacinth infestation – an upward change of 207.7%. Meat consumption before the hyacinth infestation of the lake took 48.8% of the sample, but after the hyacinth infestation of the lake 32.9% of the respondents reported consuming meat. Could this difference between pre-hyacinth infestation consumption of meat and post-hyacinth infestation consumption be contingent upon income? Since no answer to this question could be gotten from table 16, I cross-classified variable income with variable post-hyacinth infestation meat consumption. Table 17 shows results of the cross-tabulation.

TABLE 17: POST-HYACINTH MEAT CONSUMPTION AND POST-HYACINTH MONTHLY INCOME (Ksh)

POST-HYACINTH MEAT CONSUMPTION

INCOME	*Large extent*	*Small extent*	*Other*	*Total*
Below 999	2.4%(4)	5.9%(10)	12.3%(21)	20.6%(35)
1000-1999	3.5%(6)	4.7%(8)	9.4%(16)	17.6%(30)
2000-2999	1.8%(3)	2.4%(4)	11.2%(19)	15.4%(26)
3000-3999	2.4%(4)	2.9%(5)	7.1%(12)	12.4%(21)
4000-4999	3.5%(6)	1.2%(2)	10.0%(17)	14.7%(25)
5000+	7.6%(13)	6.4%(11)	5.3%(9)	19.3%(33)
Total	21.2%(36)	23.5%(40)	55.3%(94)	100%(170)

Chi-square (x^2) = 14.553 Degrees of freedom (df) = 10

Significance = .142 Contingency coefficient (c) = .281

In terms of cell frequencies there is no pattern or patterns in the distribution of observations column-wise. However, the cross tabulation of the variables in question yielded a chi-square of 14.553. With 10 degrees of freedom this chi-square value reaches a significance of .142 which is greater than the .01 probability level. Thus, there is an association between income and post-hyacinth infestation consumption of meat. The degree of he association is indicated by the contingency coefficient of .281. The most plausible explanation of this association is that the water hyacinth infestation of Lake Victoria depressed income, which, in turn, led to cutting down meat consumption. In this connection, it is undoubtedly the case that fish harvesters are highly unlikely to buy the fish they consume – they just consume part of harvest – but they have to buy the meat that they consume. After the water hyacinth infestation of the fishing waters, meat consumption came to be significantly perceived as a luxury in the face of diminished income compared to more pressing demands in terms of cash expenditure such as school fees, sickness and the like. That is why according to the data of table 17 there is a statistically significant relationship between income and post-hyacinth infestation meat consumption. The quantitative values of tables 16 and 17 uphold the second hypothesis of this study. To put it differently, the water hyacinth infestation of the fishing waters and its reduction in the quantity of fish harvested has negatively affected the consumption of meat in the sense that post-hyacinth consumption of meat is much less than pre-hyacinth consumption. This is courtesy of the data of tables 16 and 17.

Vegetables constitute a considerable amount of the diet of the population from which the research subjects of this study were selected. Obviously, vegetables are cheaper than meat and fish. But the consumption of vegetables, like that of meat and fish, varies as a function of education, occupation, income, taste and folkways. Data on the consumption of vegetables before and after the water hyacinth infested Lake Victoria are presented in table 18.

TABLE 18:SIMPLE FREQUENCIES OF PRE-HYACINTH AND POST-HYACINTH CONSUMPTION OF VEGETABLES.

Extent of veg. consumption	*Pre-hyacinth*	*Post-hyacinth*	*Relative change*
Large	34.1%(58)	47.6%(86)	48.3%(28)
Small	23.5%(40)	6.5%(11)	-72.5%(-29)
Other	42.4%(72)	43.0%(73)	8.3%(6)
Total	100%(170)	100%(170)	

In table 18 the third response category column-wise (other) represents respondents whose consumption of vegetables was by and large unaffected by the hyacinth infestation of Lake Victoria. In terms of socioeconomic status these respondents belong to the high income categories. This aside, there is marked difference between pre-hyacinth infestation consumption of vegetables and post-hyacinth infestation consumption of the same. For large extent consumption there is a relative increase of 48.3% in post-hyacinth consumption whereas for small extent consumption there is a relative decrease of 72.5% in post-hyacinth consumption. There is an obvious diagonal relationship between these figures (48.3% and 72.5%), namely most of the pre-hyacinth infestation small extent consumers of vegetables became large extent consumers after the hyacinth infestation of the fishing waters. The data of table 18 clearly show that after the hyacinth infestation of Lake Victoria, large extent consumption of vegetables increased greatly in relative terms. To make sense of this increase, variable income with variable post-hyacinth infestation vegetable consumption were cross-classified. Results of the cross-tabulation are presented in table 19 below.

TABLE 19: POST-HYACINTH VEGETABLE CONSUMPTION BY POST-HYACINTH MONTHLY INCOME (Ksh)

VEGETABLE CONSUMPTION

INCOME	*Large extent*	*Small extent*	*Other*	*Total*
999 and below	11.2%(19)	2.4%(4)	8.2%(14)	21.8%(37)
1000-1999	9.4%(16)	1.7%(3)	5.3%(9)	16.4%(28)
2000-2999	6.5%(11)	2.4%(4)	3.5%(6)	12.4%(21)
3000-3999	5.8%(10)	2.9%(5)	7.7%(13)	16.4%(28)
4000-4999	8.9%(15)	1.2%(2)	7.1%(12)	17.2%(29)
5000+	7.6%(13)	3.5%(6)	4.7%(8)	15.8%(27)
Total	49.4%(84)	14.1%(24)	36.5%(62)	100%(170)

Chi-square (x^2) = 21.196 Degrees of freedom (df) = 10

Significance = .529 Contingency coefficient (c) = .333

Table 19 is a two-way table but it is similar to table 18 in that low income respondents (that is, the first three response categories column-wise) have higher probabilities of consuming vegetables to a large extent than high income respondents (that is, the last three response categories column-wise). And again, as in table 18, the proportion of respondents who said that they consume vegetables to a large extent is about four times the proportion of those who said that they consume vegetables to a small extent. Besides, in table 19 all cell frequencies of small extent consumption of vegetables are less than those of corresponding large extent consumption. The table's chi-square of 21.196 is quite large. With 10 degrees of freedom this chi-square value reaches a significance of .529, which is far, more than the .01 probability level. These statistical values (.01 and .529) mean that the post-hyacinth monthly income and the post-hyacinth consumption of vegetables are not independent events; they are associated and the degree of their association is indicated by the contingency coefficient of .333 which can be considered as being marked if for no reason other than this particular measure of association never reaches unity even when the cross-tabulated variables are perfectly related. The quantitative values of table 19 unprobematically support the hypothesis that reduced fish harvest negatively affects the food habits of the people living in Dunga. It is important to reiterate that before the water hyacinth infested Lake Victoria, income was hardly a differentiating factor of the extent to which vegetables were consumed. After hyacinth infestation of the lake, many respondents who had high income before the infestation regressed to being low -income people and, in this way, the number of respondents with low income increased. These respondents in the low income categories resorted to more consumption of vegetables because of their relative cheapness in order to save some of their cash earnings for other requirements or needs. These respondents increased their rate of vegetable consumption not because of reasons of taste preferences but because it was a viable adjustment to decreased cash earnings brought about by the water hyacinth infestation of Lake Victoria. Many respondents when probed in connection with food indicated that they did not particularly like their rate of consuming vegetables but they had no worthwhile alternatives then or in the immediate future.

Fish and meat as well as vegetables are usually eaten with other foods prepared from grains. Grain food, unlike the other foods already discussed above, is consumed invariably every day. There are different types of grain food, and each type's consumption is related to the socioeconomic variables specified already in the discussion of vegetable consumption. Again, it is important to look at data pertaining to pre-hyacinth and post-hyacinth consumption of vegetables before proceeding to consideration of post-hyacinth infestation vegetable consumption and post-hyacinth infestation income. Table 20 presents the data.

TABLE 20: SIMPLE FREQUENCIES OF PRE-HYACINTH AND POST-HYACINTH INFESTATION GRAIN CONSUMPTION.

Extent of grain consumption	*Pre-hyacinth*	*Post-hyacinth*	*Relative change*
Large	70.0%(119)	51.2%(87)	-26.9%(-32)
Small	4.1%(7)	11.8%(20)	185.7%(13)
Other	25.9%(44)	37.0%(63)	43.2%(19)
Total	100%(170)	100%(170)	

To begin with the response category " other" in table 20 encompasses research subjects whose post-hyacinth infestation consumption of grain foods could not be very sensibly described as large extent or small extent relative to pre-hyacinth infestation consumption. The data of this research, not presented here in a tabular form, evidenced that members of this response category have high income earnings (that is, 3000-3999, 4000-4999, 5000 and above). The table shows that after hyacinth infestation of Lake Victoria grain consumption dropped from 70% (pre-hyacinth infestation) to 51.2% (post-hyacinth infestation) – a relative downward change of –26.9%. One plausible explanation of this decrease in grain consumption is that the water hyacinth infestation of Lake Victoria disrupted the network of water transportation thereby partly affecting the supply of grains to the population of this study. The high-income respondents among the 70% large extent consumers of grain foods became small extent consumers while some of the high income respondents (category "other") increased their consumption of such foods for reasons other than the water hyacinth disruption of the water transportation network. Be that as it may, it is obvious in table 20 that the pattern of pre-hyacinth infestation frequency distributions is markedly different from the pattern of post-hyacinth infestation distribution. To account for this observed difference, variable post-hyacinth infestation grain consumption with variable post-hyacinth income were cross-classified. The cross-tabulation of these two variables yielded the quantitative values of table 21.

TABLE 21: POST-HYACINTH GRAIN CONSUMPTION BY POST HYACINTH MONTHLY INCOME (Ksh)

GRAIN CONSUMPTION

INCOME	*Large extent*	*Small extent*	*Other*	*Total*
999 and below	10.6%(18)	2.9%(5)	1.8%(3)	15.3%(26)
1000-1999	12.3%(21)	1.8%(3)	3.5%(6)	17.6%(30)
2000-2999	16.5%(28)	3.5%(6)	5.9%(10)	25.9%(44)
3000-3999	5.9%(10)	7.1%(12)	2.3%(4)	15.3%(26)
4000-4999	7.6%(13)	4.7%(8)	4.1%(7)	16.5%(28)
5000+	4.7%(8)	4.1%(7)	.6%(1)	9.4%(16)
Total	57.6%(98)	24.1%(41)	18.2%(31)	100%(170)

Chi-square (x^2) = 15.436 Degrees of freedom (df) = 10

Significance = .165 Contingency coefficient (c) = .289

Only 22% of the cells in table 21 have observations of less than 5 frequencies per cell. Thus, it is a good contingency table in terms of generalizing about the population from which the sample was drawn. However, in terms of cell frequencies as a whole there is no pattern column-wise or row-wise on the basis of which to make a general statement about the table. That aside, it can be seen from the table that most respondents (57.6% of the sample) said that they consumed grain foods to a large extent, and most of these consumers (that is, 68.4%) belong to low income categories. And it is notable, in this connection, that response category "other" takes 37% of the sample for post-hyacinth infestation consumption of grains in table 20 but in table 21 this response category goes down, in partial sense, to 18.2% of the sample which is sensibly construable as representing research subjects whose consumption of grain foods was not affected by the hyacinth infestation of Lake Victoria. Table 21 has a chi-square of 15.436, which, with 10 degrees of freedom, reaches a significance of .165. This significance value is greater than the .01 probability level. It follows, therefore, that after the water hyacinth infestation of Lake Victoria respondents' consumption of grain foods came to be significantly contingent upon income. In other words, according to the table there is a greater than chance association, at .01 probability, between post-hyacinth infestation income and post-hyacinth infestation consumption of grain foods. The statistical values of table 21 are in line with the hypothesis that reduced fish harvest negatively affects the food habits of the people living in Kisumu Municipality.

4.3: SOCIAL INTERACTION AND INFESTATION OF LAKE VICTORIA WITH THE WATER HYACINTH.

In this study, three hypotheses were advanced and the researcher went out in the field to collect data pertinent to them. Thus far, data bearing on the first two hypotheses have been presented and discussed. The third hypothesis states that the social interaction of the people of Kisumu Municipality has been adversely affected by the infestation of Lake Victoria with the water hyacinth. The rest of this chapter presents and discusses data bearing on the third hypothesis. The domain assumption for this hypothesis is that Lake Victoria significantly gives order and organization to the life experiences of the people who live in its environs, and that therefore, what happens to its water in a noticeable manner is likely to have consequences (functional or dysfunctional) for these people. The third hypothesis has been posited in such a way as to accent the dysfunctional consequences without thereby implying denial of functional consequences. The existence of a sense in which empirical evidence could be adduced for the notion that the infestation by the water hyacinth of Lake Victoria has functional consequences was recognized; but this notion was counter to the conceptual and concrete thrust of my research, and so, it was excluded from the purview and parameters of data collection.

In this third hypothesis what is to be described and explained by multiple indicators of the infestation of Lake Victoria by the water hyacinth is social interaction. Social interaction is the object of explication. Since the term social interaction is widely used in both lay and technical (scientific) ways, it is important to specify the sense in which this term is used here before bringing indicators, direct and indirect, of infestation of lake Victoria with the water hyacinth to bear on it. Interaction is the basis of group existence regardless of group structure. That is, all forms of social organization, formal and informal, are necessarily based on interaction. Strictly speaking, social interaction includes every human act that somehow influences an individual. But it is not the case that all sorts of interaction lead to the formation of groups. This is a critically important point to bear in mind precisely because fish harvesting and selling together with buying objectify formal and informal aspects of social behaviour. A great deal of behaviour that has to do with fish, directly or indirectly, explicitly or implicitly, is characteristically transitory. Transitory interaction typifies the behaviour of human beings whose members interact only briefly, although often with great intensity, and then go their separate ways. Transitory interaction is non-recurrent only in the sense that the same individuals do not interact on a repeated basis. The situation that makes for the interaction is the repetitive participants change. This is, for instance, what obtains at places like the Kisumu municipal market where fish selling and buying interaction takes place. But even so, that is only one dimension, namely co-ordinated recurrent interaction which is formal because it is governed by a body of explicit rules that specify in some detail the behaviour each party will tolerate and expect of the other. This interaction is largely observable, for instance, among fish harvesters as a formally structured interest group. From what I have said above in this paragraph about interaction it is obvious that the social relationships generated by fish harvesting and selling along with buying and even consumption have formal and informal elements of social interaction. That is the sense in which social interaction as an effect variable of the third hypothesis of this study is construed. Presentation and discussion of tabular data pertaining to the hypothesis now follow.

On a purely logical plane the hypothesis does not deny that prior to the water hyacinth infestation of Lake Victoria social interaction was encumbered by negative effects of factors other than the hyacinth infestation of the lake. And on an empirical plane it is not improbable that such effects not only preceded hyacinth infestation but also do exist after hyacinth infestation. Thus, in this vein, the water hyacinth infestation may sensibly be said to have increased the extent of the effects rather than exclusively produced and reproduced them. The analytical task here is not to isolate the unique adverse contribution of hyacinth infestation to post-hyacinth social interaction while disregarding, because of lack of relevant data, the contribution of the other factors to the effects. Now, knowing that Lake

Victoria is infested with the water hyacinth does not necessarily mean that social interaction is adversely affected, but knowing that social interaction is adversely affected by the water hyacinth necessarily implies that Lake Victoria is infested with the hyacinth – granted that the lake constitutes a core factor in terms of influencing various aspects of the life experiences of the people living in Kisumu Municipality and elsewhere within the immediate environs of the lake. Most of the research subjects (80.6%) said that the extent of hyacinth infestation of Lake Victoria was large and the rest (19.4%) said that the extent of the infestation was small. The respondents indicated, furthermore, that the infestation had undesirable consequences in terms of interpersonal relationships. Marriage and family dynamics tend to be influenced by what happens in the economic sphere of a social system. Given that the effects of the water hyacinth infestation of Lake Victoria are perceived as being mostly economic, it was considered reasonable to look at marital status in the face of post-hyacinth infestation of Lake Victoria. Table 22 below is a cross-tabulation of these variables.

TABLE 22: POST-HYACINTH INFESTATION BY MARITAL STATUS.

POST-HYACINTH INFESTATION

MARITAL STATUS	*Large extent*	*Small extent*	Total
Married	46.5%(79)	15.3%(26)	61.8%(105)
Single	3.5%(6)	10.0%(17)	13.5%(23)
Widowed	11.2%(19)	2.3(4)	13.5%(23)

Divorced	5.3%(9)	.6%(1)	5.9%(10)
Separated	3.5%(6)	1.8%(3)	5.3%(9)
Total	70%(119)	30%(51)	100%(170)

Chi-square (x^2) = 9.137 Degrees of freedom (df) = 4

Significance = .118 Contingency coefficient (c) = .226)

In table 22 the column variable has to do with respondents' judgement about the spread of the hyacinth on Lake Victoria. The question about the spread was preceded with one about knowledge of the water hyacinth. All respondents knew about the water hyacinth – the vast majority (98.8%) came to have this knowledge by seeing the weed in the lake. Reading the table column-wise shows that the greatest difference between large extent and small extent hyacinth infestation is obtained among married respondents. Thus 45.6% of the sample all comprising of married respondents described hyacinth infestation as large scale. Although married people constitute the largest proportion of the sample; the 45.6% above cannot simply be attributed to this fact. In other words, 45.6% is not an artifact of the large size in the sample of married research subjects. Rather this percentage points to marriage existence as being more likely to call for engaging in fish-related business activities than any other category of marital status. Death of a spouse tends to have adverse consequences for the bereaved. That is why most widowed respondents (11.2% of the sample) said that the fishing waters of Lake

Victoria are infested with the water hyacinth to a large extent. The two percentages (45.6% and 11.2%) point towards existence of a causal connection between marital status and post-hyacinth infestation of Lake Victoria with the water hyacinth. The chi-square resulting from cross-tabulation of these variables is 9.137. With 4 degrees of freedom the statistic reaches a significance of .118 which is greater than the .01 probability level. This means that the variables of table 22 are associated, and the degree to which there is association between them is indicated by the contingency coefficient of .226. Ecological theory, which informs discussion of the chapter, has to do with physical environment. The column variable of table 22 (that is, post-hyacinth infestation of Lake Victoria) pertains to the physical environment. The quantitative values of the table uphold the hypothesis that the social interaction of the people of Kisumu Municipality has been adversely affected by the infestation of Lake Victoria with the water hyacinth. This conclusion accords with the assumption and logic of ecological theory.

Fishing activities constitute a mainstay occupation of most of this study's research subjects. But these activities are insufficient to cater for all their needs, and so the respondents resort to complementing activities. Table 23 gives data on pre-hyacinth infestation and post-hyacinth occupational activities. This is done to provide a legitimating basis for determining whether or not changes in hyacinth infestation mediated by occupation have impacted upon interpersonal coping.

TABLE 23: SIMPLE FREQUENCIES OF PRE-HYACINTH INFESTATION AND POST-HYACINTH INFESTATION COMPLEMENTARY OCCUPATIONS.

OCCUPATION	*Pre-hyacinth*	Post-hyacinth
Fishing	43.0%(73)	30.0%(51)
Farming	17.0%(29)	19.4%(33)
Trading	22.3%(38)	23.5%(40)
Transporting	16.5%(28)	9.4%(16)
Others	1.2%(2)	17.7%(30)
Total	100%(170)	100%(170)

The manner in which post-hyacinth frequencies are distributed in the above table is obviously different from that of pre-hyacinth distributions. Before hyacinth infestation, 43% of the respondents did not complement fishing by activities pertaining to farming, transporting, trading (in non-fish goods), and a host of other activities; but after hyacinth infestation only 30% of the sample did so. This represents a relative downward change of –30.1%. Thus, after hyacinth infestation the percentage of respondents who did not complement fishing by other occupational activities went down. They were compelled to get involved in auxiliary activities. Research subjects indicated that social interaction in these auxiliary activities was problematic and, hence, generative of anxiety and frustration because it called for considerable adjustment in terms of attitudinal and perceptual orientation. Also, in the table it can be seen that the last variable label (that is, other) shot up dramatically from 1.2% before the hyacinth infestation to 17.7% after infestation – a relative upward change of 1400%. This tremendous increase is accounted for by the decrease in the percentages for fishing and transporting activities after the hyacinth infestation of Lake Victoria. In order to see this change in the light of the hypothesis, I cross-classified variable changes in hyacinth infestation with occupational interpersonal coping. The cross-tabulation yielded the quantitative values of table 24.

TABLE 24: CHANGES IN HYACINTH INFESTATION BY OCCUPATON INTERPERSONAL COPING.

CHANGES IN HYACINTH INFESTATION

OCC. INTERPERSONAL COPING	*Yes*	*No*	**Total**
Fishing	25.9%(44)	4.1%(7)	30.0%(51)
Farming	3.5%(6)	15.9%(27)	19.4%(33)
Trading	12.4%(21)	11.2%(19)	23.5%(40)
Transporting	7.6%(13)	1.8%(3)	9.4%(16)
Others	14.7%(25)	2.9%(5)	17.7%(30)
Total	64.1%(109)	35.9%(61)	100%(170)

Chi-square (x^2) =12.472 Degrees of freedom (df) =4

Significance = .016 Contingency coefficient (c) = .261

The column variable of table 24 is subject to two ecological phenomena in Lake Victoria. That is to say, infestation of fishing waters with the hyacinth weed is a variable in the sense that a given part of the lake's water that was free from the weed can get blanketed by it or the weed can be swept away, by wind from an area it hitherto covered. That is the operational meaning of variable changes in water hyacinth. The table's row variable (that is, occupational interpersonal coping) refers to respondents' ability to adjust and effectively perform various role activities in the occupational domains of farming, trading, transporting and such other complementary activities. One general statement about table 24 is that apart from activities that have to do with farming domain – for which the percentage of negative responses (15.9%) greatly exceeds that of positive responses (3.5%) – all other domains were affected by changes in hyacinth infestation. That is to say, effective role performance in these domains was lessened, more or less, by adjustment demands on the part of respondents, thereby compromising social interaction. The variable cross-tabulated in table 24 produced a chi-square of 12.472. With 4 degrees of freedom this chi-square value reaches a significance of .016 which is greater than the .01 probability level. It follows, therefore, that at one percent probability level there is a significant relationship between changes in hyacinth infestation and occupational interpersonal coping; and the degree of the relationship is indicated by the contingency coefficient of .261. These statistics lend validity to the hypothesis that the social interaction of the people of Kisumu Municipality has been adversely affected by the infestation of Lake Victoria with the water hyacinth.

Food consumption plays a central role in the social interaction among the people that were sampled for this study. Giving a visitor – in a broad sense – "something to eat or drink" is not only a cultural norm but tends to influence the outcome of interaction in a positive direction. In line with this socio-cultural state of affairs, It was considered justified to compare pre-hyacinth infestation consumption food sharing with post-hyacinth infestation consumption food sharing as a prerequisite to determining whether or not hyacinth infestation of Lake Victoria has attenuated consumption food sharing, thereby making for adverse social interaction. Table 25 presents data on pre-hyacinth infestation and post-hyacinth infestation consumption food sharing.

TABLE 25: SIMPLE FREQUENCIES OF PRE-HYACINTH FOOD CONSUMPTION SHARING AND POST-HYACINTH FOOD CONSUMPTION SHARING.

CONSUMPTION SHARING	*Pre-hyacinth*	Post-hyacinth
Nuclear family	18.8%(32)	46.5%(79)

Extended family	7.6%(13)	5.3%(9)
Friends/neighbours	5.3%(9)	2.4%(4)
Business transaction	23.5%(40)	18.8%(32)
All the above	44.7%(76)	27.0%(46)
Total	100%(170)	100%(170)

The table's fourth variable label (business transaction) has to do with potential customers. Table 25 shows that the percentage of food sharing within the nuclear family dramatically increased after hyacinth infestation of Lake Victoria. When seen in the light of diminished cash earnings from fish, this increase implies heightened social interaction among family members with social stress a likely consequence. All other variable labels or response categories have lower percentages for post-hyacinth infestation than pre-hyacinth infestation. Be that as it may, it is clear from the table that the pre-hyacinth frequency distributions are markedly different from the post-hyacinth frequency distributions for all categories of the variable. This marked difference led me to cross-classify post-hyacinth infestation of Lake Victoria with post-hyacinth consumption food sharing. Table 26 displays statistical values of the cross-tabulation.

TABLE 26: POST-HYACINTH INFESTATION BY POST-HYACINTH CONSUMPTION FOOD SHARING.

CONSUMPTION FOOD SHARING	*Large extent*	*Small extent*	**Total**
Nuclear family	37.6%(64)	8.8%(15)	46.5%(79)
Extended family	1.2%(2)	4.1%(7)	5.3%(9)
Friends/neighbours	.6%(1)	1.8%(3)	2.4%(4)
Market exchange	5.9%(10)	12.9%(22)	18.8%(32)
All the above	7.1%(12)	20.0%(34)	27.0%(46)
Total	52.4%(89)	47.6%(81)	100%(170)

Chi-square (x^2) = 10.677 Degrees of freedom (df) = 4

Significance = .041 Contingency coefficient (c) = .243

Table 26 has no definite pattern row-wise and column-wise in terms of cell distribution of observations. As such, the table hardly lends itself to generalization about cell distribution of observed values. Column-wise the difference between large extent marginal (52.4%) and small extent marginal (47.6%) is not much. But row-wise the marginal for category nuclear family comes close to taking about one half of the sample (46.5%). Thus, it is not surprising that 37.6% of the respondents are bunched in the top right hand cell of the contingency table – the intersection of categories large extent and nuclear family. In terms of observed values table 26 is basically good because 70% of its cells have frequencies that are greater than 5. The table has a chi-square of 10.677. With 4 degrees of freedom this statistic reaches a significance of .041 which is well above the .01 probability level. It follows, therefore, that post-hyacinth infestation of the waters of Lake Victoria and post-hyacinth infestation consumption food sharing are not independent events – they are associated. And the strength of their association is indicated by the contingency coefficient of .243. This finding stands in support of the posited relationship between the variables of the third hypothesis.

Other things being equal, people who live in the same house, nuclear family members for example, necessarily interact. Beyond this fact, social interaction takes place by virtue of people visiting one another, among other things; or going to various places for a variety of reasons. Again, it is important to present data on pre-hyacinth infestation visit and post-hyacinth infestation visit in order to facilitate telling whether or not the water hyacinth infestation of the waters of Lake Victoria disrupted visiting and consequent social interaction. Data on pre-hyacinth infestation are given in table 27. Without evidential data of table 27 it would be impossible to tell whether or not the water hyacinth infestation of Lake Victoria has had effect on post-hyacinth visit.

TABLE 27: SIMPLE FREQUENCIES OF PRE-HYACINTH INFESTATION VISIT AND POST-HYACINTH INFESTATION VISIT.

VISIT	*Pre-hyacinth*	*Post-hyacinth*
Frequent	92.4%(157)	55.3%(94)
Rare	7.6%(13)	44.7%(76)
Total	100%(170)	100%(170)

The frequency distributions of the table show that before hyacinth infestation of Lake Victoria frequent visiting was typical of 92.4% of the sample while rare visiting was characteristic of only 7.6% of the sample – a really great difference between frequent and rare visiting. After the water hyacinth infestation of Lake Victoria frequent visit dropped to 55.3% of the sample while rare visit shot up to 44.7% of the sample. But the difference between post-hyacinth infestation frequent visit and post-hyacinth infestation rare visit is very small compared to pre-hyacinth infestation difference between the same categories. It is apparently plausible that many pre-hyacinth infestation frequent visit makers became post-hyacinth infestation rare visit makers. It was deduced, on the basis of ecological theory, that post-hyacinth infestation frequency distributions are considerably attributed to post-hyacinth infestation of Lake Victoria; and subsequently cross-classified the two variables (that is, post-hyacinth infestation of Lake Victoria and post-hyacinth infestation visit) so as to determine whether or not the deduction accords with empirical reality. The variables are cross-classified in table 28 below.

TABLE 28: POST-HYACINTH INFESTATION BY POST-HYACINTH INFESTATION VISIT.

POST-HYACINTH VISIT	*Large extent*	*Small extent*	*Total*
Frequent	17.1%(29)	38.2%(65)	55.3%(94)
Rare	28.8%(49)	15.9%(27)	44.7%(76)
Total	45.9%(78)	54.1%(92)	100%(170)

Chi-square (x^2) =10.911 Degrees of freedom (df) = 1

Significance = .003 Contingency coefficient (c) = .245

Post-hyacinth infestation frequent visit is disproportionately split between large extent and small extent post-hyacinth infestation, with the latter taking only 17.1% of the sample. But this pattern of observed values is reversed with respect to rare visit. That is to say, large extent post-hyacinth infestation takes 28.8% of the sample, and small extent post-hyacinth infestation takes 15.9% of the sample. The difference between row marginals exceeds the difference between column marginals by 2.4%, which is not much. Table 28 has a chi-square of 10.911, which, with 1 degree of freedom, reaches a significance of .001. This significance is less than the .01 probability level. Therefore at this probability level post-hyacinth infestation of Lake Victoria and post-hyacinth infestation visit are independent phenomena. In the circumstance, no meaningful interpretation can be given to the table's contingent coefficient of .245 other than saying that it is a chance occurrence. The statistical values of table 28 do not lend support to the hypothesis that the social interaction of the people of Kisumu Municipality has been adversely affected by the water hyacinth infestation of Lake Victoria.

Thus far, data bearing on the third hypothesis in terms of contingency tables has been presented and discussed. Data on all the various categorical measures of this hypothesis' variables could not be presented here in the form of contingency tables because the tables were not good cross-tabulations – most of their cells had observed values of less than 5 cases. Consequently, in order to enhance the rigour of testing this hypothesis, I transformed the categorical measures into dummy variables and got Pearson correlation coefficients computed on them. The Pearson correlations that are better measures of association than chi-squares and contingency coefficients, are given in table 29.

TABLE 29: SQUARE MATRIX OF CORRELATES OF SOCIAL INTERACTION AND INFESTATION OF LAKE VICTORIA WITH THE WATER HYACINTH.

	V1	*V2*	*V3*	*V4*	*V5*	*V6*	*V7*	*V8*
V1	1.000	.778	-.037	.680	-.142	-.487	-.339	-.419
V2	.778	1.000	.016	.253	.009	-.268	-.242	.013
V3	-.037	.016	1.000	.789	.005	.012	.156	.233
V4	.680	.253	.789	1.000	-.148	-.316	.110	-.236
V5	-.142	.009	.005	-.148	1.000	.752	.008	-.151
V6	-.487	-.268	.012	-.316	.752	1.000	-.117	.129
V7	-.339	-.242	.156	.110	.008	-.117	1.000	.228
V8	-.419	.013	.233	-.236	-.151	.129	.228	1.000

V1. Extent of hyacinth infestation

V2. Change in hyacinth infestation

V3. Pre-hyacinth infestation residence

V4. Post-hyacinth infestation residence

V5. Pre-hyacinth infestation dependants

V6. Post-hyacinth infestation dependants

V7. Fishing knowledge

V8. Spouses

In the above table the first and second variables pertain to hyacinth infestation of lake Victoria while the third through the eighth variables pertain to social interaction. It is clear from table 29 that most of the intercorrelations of social interaction variables wit post-hyacinth infestation variables are negative and, hence, consistent with the hypothesis that the people of Kisumu Municipality have been adversely affected, in terms of social interaction, by the infestation of Lake Victoria with the water hyacinth. The above matrix of Pearson correlation coefficients constitutes very strong and unproblematic evidence for the third hypothesis of this study.

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS.

5.1: CONLUSIONS

In an attempt to determine the effects of the water hyacinth infestation of Lake Victoria on the fisheries industry in Kisumu Municipality, certain conclusions have been made In regard to the findings that were derived from a variety of data analytic techniques in the preceding chapter. This chapter presents the conclusions about the major findings of this study.

However, it would be appropriate to recap the discussion of the problem of this study, the objectives of the study, the hypotheses, methodology used in data collection and the data – analytical techniques used to arrive at the findings in chapter four. The water hyacinth, due to its extremely high growth rate and vegetative propagation, is known to clog drainage, waterways and canals. In addition, its presence does not only make fishing difficult, but also prevents fish from hatching and spawning. Water transport is also largely affected because ships and boats cannot easily sail through the thick mats of the water hyacinth completely covering the water surface and spread across the lake. Also, as a result of the weed completely covering the water surface, turbulence of the water is lowered and consequently, the amount of oxygen circulating in the water is also lowered. This generally affects the ecosystem and particularly, for this study, the people who live near Lake Victoria and who wholly or partially depend on the lake for a livelihood. In view of the fact that these people are mainly fishermen/women or that they depend on the fisheries industry in one way or the other, directly or indirectly, the study was therefore focused on the impact of the water hyacinth infestation of Lake Victoria on the fisheries industry among the people of Kisumu Municipality.

Generally, the objective of the study was to find out how the water hyacinth infestation of Lake Victoria affects the lives of the people of Kisumu Municipality. The study specifically aimed at determining the consequences of the water hyacinth for the economic activities of the people of Kisumu Municipality, establishing how reduced fish production or harvest affects their food habits and establishing the impact of the infestation by the water hyacinth of Lake Victoria on their social interaction.

This study adopted the theory of cultural ecology to explain the impact of the water hyacinth on the fisheries industry in Kisumu Municipality. The theory seeks to explain the concept of ecology in relation to human beings so as to make clear the understanding of the effect of the environment upon a people's way of life. Within this framework, it was expected that people have changed their way of life to adopt to the changing environment in Lake Victoria as a result of the water hyacinth infestation of its waters. This is specifically so because Lake Victoria is a major component to these people's environment.

Three hypotheses derived from the objectives of the study were formulated. The first hypothesis posited an inverse relationship between the infestation by the water hyacinth of Lake Victoria and fish-based economic activities of the people of Kisumu Municipality. Secondly, it was hypothesized that reduced fish production or harvest negatively affects the food habits of the people of Kisumu Municipality. The third hypothesis stated that the social interaction of the people of Kisumu Municipality has been adversely affected by the infestation of Lake Victoria with the water hyacinth.

A total of 170 respondents were interviewed. The data obtained from these people can be regarded to be as representative as data that could have been collected from the entire population because they (respondents) accurately define and characterize the population of my research interest. The representative sample was obtained mainly from a sampling frame provided by Dunga Co-operative Fishing Society register. Sampling was done randomly. The main method of data collection was the questionnaire interview. Other techniques of data collection included observation, key informant interviews and documentary sources of data.

The various data-analytic techniques used for analysis for the first hypothesis, which posits an inverse relationship between infestation by the water hyacinth of Lake Victoria and fish-based economic activities of the people of Kisumu Municipality, indicate that indeed there is an inverse relationship between the two variables. It would be in place to point out that fish-based economic activities in this study were mainly rooted in harvesting fish and that different people use different methods/techniques of fishing to accomplish this. In the findings it is clear that all the fishing methods were affected by the water hyacinth infestation of Lake Victoria and the effect is overwhelmingly negative. The majority representing negative effects of the water hyacinth on fishing methods implies diminished economic activities on the part of the respondents.

Nets constitute the technique of fishing that is most affected by the infestation of the fishing waters by the water hyacinth. The use of multiple techniques, like the use of nets, decreased because it was not economically viable. The users of these two types of techniques (nets and multiple techniques) reverted to using hooks, which in turn recorded an increase. This is because hooks can be used in situations where nets cannot be used and also, they are economically viable.

The scale of fish-based economic activities is determined by the quantity of fish harvested. Data collected on pre-hyacinth and post-hyacinth infestation quantities of fish harvested show that there is a drastic fall in the quantities if fish harvested in the post-hyacinth infestation period. This change is not merely a chance occurrence but a clear indication that it is as a result of the water hyacinth infestation of the fishing waters. This upholds the posited hypothesis that there is an inverse relationship between the water hyacinth infestation of Lake Victoria and fish-based economic activities.

In recognition of the high dependence on fish as a food item for the people of Kisumu Municipality, it was hypothesized that reduced fish harvest negatively affects their food habits. After the water hyacinth infested Lake Victoria, some foods (non-fish) were either abandoned or the frequency of eating them dropped considerably. People eat less meat in the post-hyacinth infestation period compared to consumption during the pre-hyacinth period. The reduction in fish production and consequent reduction in income has caused these people to perceive meat as a luxury, since they have to buy it. Vegetable consumption increased in general but more particularly among the low- income groups. The low- income groups constitute the larger percentage of the respondents in the post-hyacinth infestation period since most of those who were placed in the high-income groups regressed to being low-income people after the water hyacinth blanketed the fishing waters. These respondents do not particularly like their rate of vegetable consumption but they have no worthwhile alternatives considering the prices of other foods. The consumption of grains dropped, despite their being the main component of almost all of these people's meals. This can be explained by saying that the source of grain food among the people of Kisumu Municipality is through purchase and therefore contingent upon income. The infestation of the fishing waters by the water hyacinth caused a decrease in income for these people, who economically depend on the lake, and therefore, their purchasing power for non-fish food dropped.

The sources of other non-fish foods was affected by the infestation of Lake Victoria by the water hyacinth. During pre-hyacinth infestation period, the main source of food was through purchase. The other sources were by farming and borrowing. After the infestation of the lake with the water hyacinth, there occurred a reduction in number of people who obtain food through purchase and an increase in the number of those who obtain food through a combination of multiple food sources (mainly purchase, farm and borrowing). The drop in foods obtained through purchase and the increase in foods obtained through a combination of purchase, farming and borrowing can be attributed to diminished cash earnings from fish-based economic activities, a consequence of the water hyacinth infesting Lake Victoria.

The changes observed in the sorts of foods consumed before and after the water hyacinth infestation of Lake Victoria and the sources of the same foods before and after the water hyacinth infestation of the lake uphold the hypothesis that reduced fish production affects the food habits of the people of Kisumu Municipality. However, it was out of the scope of this study to cover the aspect of nutrition in relation to the infestation by the water hyacinth of the lake and therefore further studies should be done to arrive at more conclusive results.

The third hypothesis posited that the infestation of Lake Victoria by the water hyacinth affects the social interaction of the people living in Kisumu Municipality. The vast majority of the respondents knew about the water hyacinth in the lake and most of them came to have this knowledge by seeing the weed in the lake. Most of the respondents say that the extent of the weed's infestation of the lake is large. Since fishing activities constitute a mainstay occupation of most of the respondents, the large extent to which the water hyacinth has infested Lake Victoria has caused the respondents to resort to complimentary occupational activities pertaining to farming, transporting, trading (in non-fish goods) and many other activities. For most respondents, adjusting to these auxiliary activities proved frustrating for it called for change in their attitudes and perceptions. This in turn led to lessened effective role performance in these activities, thereby compromising social interaction. This finding, therefore lends validity to the hypothesis that the social interaction of the people of Kisumu Municipality has been adversely affected by the infestation of Lake Victoria with the water hyacinth.

Food consumption plays a central role in social interaction among the people that were sampled for this study. It was found that the percentage of food sharing within the nuclear family dramatically increased after the water hyacinth infestation of Lake Victoria. This increase implies heightened social interaction among family members (especially the nuclear family) but lesser social interaction beyond the family sphere. This finding stands in support of the posited hypothesis that the infestation by the water hyacinth has an adverse effect on the social interaction of the people of Kisumu Municipality.

People who live in the same house necessarily interact. Beyond this fact, social interaction takes place by virtue of people visiting one another or going to various places for a variety of reasons. Before the water hyacinth infestation of Lake Victoria, frequent visiting was typical of the people of Kisumu Municipality. These visits constituted visits to relatives' and friends' homes within and without Kisumu Municipality. Also visits to Kisumu Municipal Market and other markets within the municipality, for business transactions or merely social calls, were of special interest. After the water hyacinth infested Lake Victoria, visits to all sorts of places, for whatever reasons, became rare among the research subjects. This could be attributed to the poor means of transport as a result of the water hyacinth blanketing the lake, for those who visit by this means. Also, low income earnings as a result of the water hyacinth infestation of the lake, does not allow for these people to spare extra money to pay for visits in terms of fares and gifts to be presented to the people being visited. Therefore, in terms of visitation, the findings support the posited hypothesis that the water hyacinth infestation of Lake Victoria adversely affects the social interaction of the people living in Kisumu Municipality.

All in all, on the basis of the findings presented in chapter four, it can be concluded that the three hypotheses posited for the study are upheld. The findings concretely determine the consequences of the water hyacinth for the economic activities of the people of Kisumu Municipality, establish how reduced fish harvest affects their food habits and establish the impact of the infestation by the water hyacinth of Lake Victoria on their social interaction.

5.2: RECOMMENDATIONS

The findings of this study are directed to researchers, policy makers, planners and other groups interested in improving the general welfare of the people living around Lake Victoria in the face of the water hyacinth infesting the fishing waters.

5.2.1: RECOMMENDATIONS FOR FURTHER RESEARCH.

1. It is recommended that more studies be carried out in the same community or anywhere else along the shores of Lake Victoria for purposes of comparison and/or replication and to beef up the little existing literature on this subject in the Kenyan context. A wider range of social, economic and cultural studies would expose more of the effects of the water hyacinth infestation of Lake Victoria not only on the fisheries industry but also on the general welfare of the people living near the lake.

2. It is also recommended that similar studies should be done to off-set the limitations of the current study. This is mainly in the areas of the nutritional effects of the people' change in food habits, implications of low fish production/ harvest on industrial fish production and implications of the water hyacinth infestation of the lake on water transport. For this to be done, it is recommended that the multiple and more advanced methods of data collection

and analysis be used, over a longer period of time and on a larger sample. This way, findings will be more reliable and more valid.

3.2.2: RECOMMENDATIONS FOR POLICY MAKERS/PLANNERS

1. For policy makers, planners, NGO's and other interest groups that are charged with the responsibility of effecting change and development along the shores of Lake Victoria, it is recommended that eradication of the water hyacinth be prioritized. Removal of the weed from the lake will ensure removal of the problems that come with it.
2. It is also recommended that mechanical methods of removal be employed at first, so that the process is faster and "normal" activities resume for the people of Kisumu Municipality, and then later, biological methods can be employed for a long-term effect.
3. Still on eradication of the water hyacinth it is recommended that the local community be involved. This way, the people cultivate a sense of responsibility for the lake and they too can get their economic lives back on their feet from the earnings they make in the process.
4. It is also recommended that projects be set up along the shores of Lake Victoria to utilize the "harvested" weed by making fertilizers, mats, weed chairs, pulp, cardboard and all other innovative items that can be made from the weed. This way, the problem of weed disposal will be under control and there will be income generation for the weed "harvesters" and the utilizers, whose supply will be cheaply and readily available.

REFERENCES

Abila, R.O and E.G. Jansen, 1997.

From Local to Global markets:

The fish processing and exporting industry in the Kenyan part of Lake Victoria. Paper presented at the 3rd International Fisheries conference, Cape Town, April 9th-11th, 1997.

Alimi, T. and O.A. Akinyemiju, 1991.

Effects of Water Hyacinth on Water Transportation in Nigeria. Journal of Aquatic Plant Management, 29:109-112.

Babbic, E.R., 1973

Survey Research Methods. Belmont, California: Wadsworth.

Central Bureau of Statistics, 1990

Statistical Abstract. Nairobi: Government Printer.

Central Bureau of Statistics, 1997

Statistical Abstract. Nairobi: Government Printer.

Champion, D.J., 1970

Basic Statistics for Social Research. Scranton, Pa.: Chandler

Coe R.N., 1970

Sociology of Medicine. New York: McGraw Hill.

Crul, R.C.N., 1995

Limnology and Hydrology of Lake Victoria. Paris: UNESCO

Evans, E.C., 1963

The Grip of the Water Hyacinth; New Scientist 19:666-668

F.A.O, 1990

Socioeconomic Effects of the Evolution of Nile Perch Fisheries in Lake Victoria. Rome: F.A.O

F.A.O., 1995

Management of African Inland Fisheries for Sustainable Production. Paper Presented at the "First Pan African Fisheries Congress and Exhibition". UNEP, Nairobi.

Francis, E. and Hoddinott J., 1993

Migration and Differentiation in Western Kenya: A Tale of Two Sub-locations. Journal of development Studies 1:30.

Garg, S.P., 1968

Studies on Aquatic Weed Control. In U.P. Technical Memorandum No. 39

Gay, P.A. and L. Berry, 1959

The Water Hyacinth: A New Problem on the Nile. Geographical Journal 125:89-91

Geheb, K., 1996

THE Regulators and the Regulated: Fisheries Management.Options and Dynamics in Kenya's Lake Victoria

Fishery. Ph.D. Thesis, Department of Philosophy, University of Sussex.

Ghosh, S.R., T., Goswami, M.C.K.,Nambian, B.P.,Chaliha and J.N.,Barua, 1984

Investigation of Water Hyacinth for Making Cement Boards. In Proccedings of the International Conference on Water Hyacinth 461-488 G. Thyagarajan (Ed) Nairobi: UNEP.

Hearne, J.S., 1966

The Panama Canal's Aquatic Weed Problem. Hyacinth Control Journal 5: 1-5

Holm, L.G., L.W. Weldon and R.D Blackburn, 1969

The Water Hyacinth Science 166:699

Hooker, W.J., 1829

Pontederia Azurae- Large Flowered Pontederia Curtis. Botany Magazine 3: 18-29

Matthews, L.J and B.E. Manson, 1969

Those Weeds Mean Trouble. New Zealand Journal of Agriculture 118: 33-39

McVea, C., and C.E. Boyd, 1975

Effects of Water Hyacinth Cover on Water Chemistry, Phytoplankton and Fish in Ponds. Journal of Environmental Quality 4:375-378

Mendenhall, W., O. Lyman and R.L.,Scheaffer, 1971

Elementary Survey Sampling. Belmont, California: Wadsworth.

Oduor Noah, E., and A. Ligunya, 1995

A Lake Victoria Environmental Management Programme Consultant's Report. In Proceedings of the Promotion of Stake Holders Consultation and Community Participation: Kisumu, August, 1995.

Ogunja, J.C., 1994

Alternative utilization of Nile Perch of Lake Victoria. Proceedings of the KMFRI Seminar on "The Utilization of Nile Perch By-products". Kenya Marine and Fisheries Research Institute, Kisumu, 7th-10th June, 1994.

Ogutu, G.E.M., 1994

Empowering Small Scale Enterprise Groups for Effective Participation in the Fisheries of Lake Victoria, Kenya.

Paper presented at the Small Scale Fish Systems (Kenya) workshop. Kisumu, September 8th-10th 1994

O'Riordan, B., 1996

An Assessment of The Current Status Of Kenya's Lake Victoria Fisheries. Nairobi: Intermediate Technology Development Group (I.T.)

Pantulu, V.R., 1984

Water Resource Development and Aquatic Weed Management. In Proceedings of the International Conference on Water Hyacinth G. Thyagarajan (Ed) Nairobi: UNEP

Riedmiller, S., 1994

Lake Victoria Fisheries: The Kenyan Reality and Environmental Implications. Environmental Biology 39:329-338

Scott, R.A., 1968

Resume of the Corps of Nationwide Aquatic Plant Control Programme. In Proceedings of the 22nd N.E Weed Control Conference. 170-176 U.S.A

Steward, J.H., 1955

Theory of Culture Change. Illinois: University of Illinois Press.

Swartz, O., 1797

Flora Indiae Occidentalis

Jacobi Palmi: Erlangen.

Tabitha, A., and J.W. Woods, 1962

History of Hyacinth in Florida. Hyacinth Control Journal. 1: 19-22

Tackholm, V. and M. Drar, 1950

The Flora of Egypt. Cairo: University Press

Werimo, K.O., 1994

Handling and Processing of Nile Perch Skeletons at Artisanal Level. In Proceedings of the KMFRI Seminar on "The Utilization of Nile Perch By-products." Kenya Marine And Fisheries Institute Kisumu, June 7th-10th, 1994.

Wild, H., 1961

Harmful Aquatic Plants in Africa and Madagascar. Kirkia 2: 1-66

Williams, T.R., 1959

A Critique of the Assumptions of Survey Research. Public Opinion Quarterly 23:55-62

Yadurajan, N.T. and V.S. Mani, 1979

The Water Hyacinth. Science Today 13:51-54

Yongo, E.O., 1993

The Dilema of Resource Use in Lake Victoria Basin – The Socioeconomic implication. Paper presented at the FIRI/IDRC Workshop on "Environment, Fisheries and Socioeconomic Changes in the Lake Victoria Basin." Jinja, Uganda, November 15th-20th 1993.

Yongo, E.O., 1994

Socioeconomic aspects of Artisinal Nile Perch Processors. Paper presented at the FAO/KMFRI Seminar on the "Utilization of Nile Perch Products." Kisumu, Kenya .June 7th-10th,1994

APPENDIX

QUESTIONNAIRE

Good morning/afternoon/evening. I am a student from the University of Nairobi interested in knowing the feelings and views of the people of this area in relation to the water hyacinth. You have been selected as a source of those feelings and views. You are requested to express your feelings and give your views by answering the questions that I am going to ask you. There is no correct or incorrect answer to a question. But, please, answer each question as best as you can.

1. Name of respondent ______________________
2. Sex

M	
F	

3.Age

20-29	
30-39	
40-49	
50-59	
60+	

4. Marital Status

Married	
Single	
Widowed	
Divorced	
Separated	

5. Family Size

No. of husbands/wives	
No. of children	

6. Level of education

None	
Primary	
Secondary	
High School	
Above High School	

WATER HYACINTH

7. Do you know about the water hyacinth in Lake Victoria?

Yes	
No	

8. If yes, how did you know about it?

Newspaper	
Radio	
T.V	
Rumours	
Seen it	

9. When did you come to know about it?

Before 1980	
1981-1985	
1986-1990	
1991-1995	
1996-Present	

10.What part of the lake has it covered?

Large	
Small	

11.Is anything being done to control it?

Yes	
No	

12. If yes, who is controlling it?

Local people	
NGO'S	
Government	
Lake Basin Dev. Authority	
Other	

13. How is it being controlled?

Manually	
Biologically	
Chemically	
Utilization	
Other	

FISHING

14. If occupation is not fishing, do you know about fishing?

YES	
NO	

15. If yes, what were the methods of fishing before the infestation by water hyacinth of Lake Victoria?

Hooks	
Nets	
Baskets	
Other	

16. To what extent were these methods used?

Method	**Small**	**Larger**
Hooks		
Nets		
Baskets		
Other		

17. What quantities of fish wee produced, marketed and consumed?

Quantity produced (Kg/Month)	Quantity consumed (Kg/Month)	Quantity marketed (Kg/Month)

18. What were the other sources of food before the infestation by water hyacinth of L. Victoria?

Farm	
Purchase	
Borrowing	
Other	

19. What kinds of foods were they?

Grains	
Meat (not fish)	
Vegetables	
Other	

20. To what extent were these foods consumed?

Food	Large	Small
Grains		
Meat (not fish)		
Vegetables		
Other		

21. Presently, what are the methods of fishing used?

Hooks	
Nets	
Basket	
Other	

22. To what extent are these methods used?

Method	Small	Large
Hooks		
Nets		
Baskets		
Other		

23. What quantities of fish are produced, consumed and marketed?

Qty produced (Kg/month	Qty consumed (Kg/month)	Qty marketed (Kg/month)

24. What are the other sources of food?

Farm	
Purchase	
Borrowing	
Other	

25. What kinds of food are they?

Grains	
Meat (not fish)	
Vegetables	
Other	

26. To what extent are these foods consumed?

Food	Large	Small
Grains		
Meat (not fish)		
Vegetables		
Other		

ECONOMIC STATUS

27. What was your business/occupation before the infestastion by the water hyacinth of Lake Victoria?

Farmer	
Fisherman/woman	
Trader	
Transportation: specify	
Civil Servant	
Other: specify	

28. How many defendants did you have then?

None	
1-5	
6-10	
11-15	
15+	

29. In which ways did you support the above dependants?

Support	Estmated expenses (per month)
Financial	
Subsistence	
School fees	
Clothing	
Shelter	
Other	
Total	

30. Approximately how much income were you getting from your occupation/business per month?

-999	
1000-1999	
2000-2999	
3000-3999	
4000-4999	
5000+	

31. What is your business/occupation now?

Farmer	
Fisherman/woman	
Trader	
Transportation: specify	
Civil servant	
Other: specify	

32. If not the same business/occupation as before, has the water hyacinth infestation of l. Victoria contributed to your change in business/occupation?

Yes	
No	

33. How has the water hyacinth infestation of l. Victoria affected your business/occupation?

No effects	
Positively	
Negatively	

34. How much income do you get from your present business/occupation per month?

0-999	
1000-1999	
2000-2999	
3000-3999	
4000-4999	
5000+	

35. How many dependants do you have?

None	
1-5	
6-10	
11-15	
15+	

36. In what ways do you support the above dependants?

Support	Estimated expenses per month
Financial	
Subsistence	
School fees	
Clothing	
Shelter	
Other	
Total	

SOCIAL INTERACTION

37. Before the infestation by the water hyacinth of L. Victoria, who performed the following roles in the family/household?

Role	Husband	Wife	Male head of extended family	Other relative; specify
Head of family				
Overall decision making				
Purchase				
Purchase of clothing and other				

necessities				
Building houses				

38. Who performs the roles today?

Role	Husband	Wife	Male head of extended family	Other relative (specify)
Head of family				
Overall decision making				
Purchase of food				
Purchase of clothing and other necessities				

39. If there is a change in the pattern above, do you think it is connected with the water hyacinth in L. Victoria?

Yes	
No	

40. Give reasons--

41. How was the distribution and consumption of food and gifts before the water hyacinth infestation of L. Victoria?

Family members	
Extended family	
Age-sets, friends, neighbours	
Market exchange	

42. Where did these people (above) live?

Within the village	
Within the location	
Within the district	
Island in the lake	
Other: specify	

43. Did the distribution and consumption of food and gifts involve contact by visitation?

Yes	
No	

44. If yes, what means of transport do you use?

Boat	
Ship	
Foot	
Bicycle	
Matatu	

45. Currently, how is the consumption and distribution of food and gifts?

Family members	
Extended family	
Age-sets, friends, neighbours	
Market exchange	

46. Where do the people (above) live?

Within the village	
Within the location	
Within the district	
Island in the lake	
Other: specify	

47. Does the distribution and the consumption of food and gifts involve contact by visitation?

Yes	
No	

48. If yes, what means of transport do you use?

Boat	
Ship	
Foot	
Bicycle	
Matatu	

49. If there is a change in the pattern of distribution and consumption of food and gifts and the transport pattern, do you think it is connected with the water hyacinth infestation of L. Victoria?

Yes	
No	

50. Give reasons --------------------------------------