CONSERVATION OF FISHERIES RESOURCES IN KAINJI LAKE NIGER STATE

BY

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PGD/GEO/2005/2006/335

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BEING A THESIS SUBMITTED TO THE POSTGRADUATE SCHOOL, FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF POSTGRADUATE DIPLOMA IN ENVIRONMENTAL MANAGEMENT.

DECLARATION

I hereby declare that this research work titled "Conservation of Fisheries Resources in Kainji Lake Niger State" is purely a record of my own research work. All informations used in this work were obtained from personal research while due acknowledgement are given to those materials used in this work through appropriate referencing.

Sign: ________________________________

Name: ________________________________

Date: ________________________________

CERTIFICATION

This thesis titled: Conservation of Fishery Resources in Kainji Lake' by David Terfa Amu (PGD/GEO/2005/335) meets the regulations governing the award of Post – Graduate Diploma (PGD) of the Federal University of Technology, Minna and is approved for its contributions to scientific knowledge and literal presentation.

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Dean, Postgraduate School

DEDICATION

This Project work is dedicated to the loving memory of my father Late Mr.Ato Amu, you left too soon. I miss you dearly.

ACKNOWLEGDEMENT

My gratitude to the Almighty God for saying it and making it happen.

My sincere appreciation goes to my project supervisor Prof. G.N. Nsofor for graciously supervising this work with the critical eye of an eagle and insisting on high standards. Also to all the lecturers in Geography department.

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ABSTRACT

The value of fish can not be over emphasized; they form an important element of the aquatic ecosystem and contribute to the natural self purification. The state of these resources indicates the quality of the aquatic environment. Conservation is the sustainable use and protection of natural resources, although the resource under study is renewable it can still be depleted if the rate of catch is higher than the repletion rate.

The challenge of conservation is to understand the complex connections

among natural resources and balancing the resource use and preservation to ensure an adequate supply for future generations.

This project therefore aimed at verifying how and the extent, human activities such as over exploitation, destruction of aquatic habitat, pollution the introduction of aliens species and the construction of dams among others, have affected these fisheries resource. Also to analyze the best conservation methods most suitable for the study area, to curtail these threats.

This was achieved by reviewing the map of the lake indicating the fishing localities found along it, reviewing the number of fishing villages and fisher men ,reviewing the Fishing canoes and Engines, reviewing the

different types of fishing gears used in the study area and also the rate in which they are used. Also reviewing the available statistics on the total fish yield in the lake.

The data collected included the total number of the fishing villages, fishing forks, the number of fishing boats, and the monthly landings of the study period. These were plotted into graphs to enable us see the rate of change.

TABLE OF CONTENTS

CHAPTER TWO

CHAPTER THREE

CHAPTER FOUR

CHAPTER FIVE

LIST OF TABLES

LIST OF FIGURES

CHAPTER ONE

1.0 BACKGROUND OF STUDY

With most countries having signed the convention on Biodiversity in Rio de Janeiro in 1992, the conservation of species and natural environments is being looked at in a new way. As a result, the biological diversity of tropical forest and terrestrial ecosystems has been hotly debated, as have been the often negative effects of anthropogenic activities on the evolution of these environments. At the same time, however, the situation of inland waters and their resources has received little attention, although it is highly topical. It is against this background that we must place the adoption in 1996 by the Ramsar Convention on wetlands of international importance .The new criterion now provides with a strong tool to advocate for the conservation needs of fish. There are two main reasons for this new interest in fish around the world.

Firstly, fish are valuable and interesting at various levels. They form part of a regional ecological heritage to be preserved (like any other historical monument or archaeological or scientific site) both for its own sake and for the benefit of future generations (ethical, aesthetic and scientific values). Fish are structure elements of aquatic ecosystem and contribute to natural self purification (functional and ecological values). The presence and health of fish are ruthless biological indicators of water quality and more generally, of the quality of the aquatic environment, from the view point of its physical, chemical and biological contents (methodological value). Furthermore fish are a natural renewable resource exploited through fishing (social, cultural and economic values).

Secondly, although the conservation status of fish is not well known, scientists and naturalists often devote more attention to other vertebrates, especially terrestrial species. I have to say that this is particularly true for the situation in West Africa. Fish is the vertebrate most closely associated with the diversity of lakes and other water bodies. Of the approximately 10,500 freshwater species found around the world, the ichthyological fauna of Africa is made up of 3,000 species belonging to 88 families. West African waters host 50 freshwater fish families (61 of euryhaline species are included) comprising 528 species (558) in 163 genera (180) (Paugy et al.,1994). In Africa, fish products play a crucial socio-economic role since thousands of men and women of all ages are involved in fish production, and in most cases fish provide more than 50% of animal proteins in countries with a low level of animal protein intake. Over the years, local communities have developed techniques, ranging from the simplest to the most sophisticated, in order to exploit the resources of their environment as intensively as possible.

There is no general agreement amongst scientists, development experts and even fishermen that West African inland resources are being fully exploited, over-exploited or depleted, or are waiting for regeneration. Apart from over-fishing there are many other threats facing West African fish including man-made disturbances to hydrological system and de facto, to aquatic resources when dams are constructed, when a river basin is degraded, a riverbed is dug out or a wetland is reclaimed for agricultural purposes. If we are to protect the natural heritage for present and future generations in West African inland waters, we should make it a top priority to put in place a management and conservative plan for aquatic resources in general, and fish in particular.

This is the rationale behind this project, to analyze the management and conservation of renewable resources in Kainji Lake. One of the merits of this project is that it will tackle all pertinent issues and better still, it will represent the opinion of a number of resource persons and some governmental and non governmental organizations. It will study the problems relating to the conservation of fishery resources in Kainji Lake and provide a list of useful recommendations that can be seen as action plans that can be implemented in short, medium and long term for each of the problems identified.

1.1 STATEMENT OF PROBLEMS

Over 500 Species of living organisms are known to live in the Kainji Lake alone. The large majority of these species are concentrated along the edges of the lake where vegetable matter are mostly to be found. It must be pointed out that there is a great degree of biological diversity in the lake. The relationship that exists among the species in the lake is intricate. Larger fish feed on smaller ones which feed on plankton. These in turn depend on the mineral nutrients washed into the lake from land based sources. The threats to fishery resources in kainji lake are principally viz:

1.1.1 **Over-exploitation**: Over fishing may perhaps not lead to extinction but may cause an imbalance in the ecosystem. For example an over fished species may not recover its former place in the ecosystem and may in fact be replaced by another species.

1.1.2 **Habitat destruction**: This includes dredging, trawling, filling or silting and construction activities in species rich aquatic habitants. It is obvious, fish or fish like creatures that live on the bottom will be destroyed and food chain destabilized

1.1.3 **Pollution**: The more insidious threats are land based pollution as a result of dumping of toxic substances such as pesticides, heavy metals and polychlorinated biphenyls (PCB), which are introduced into the water bodies by run off. Pollution by speed boats, ships and oil mining activities are some other sources of pollution.

1.1.4 **Introduction of alien species :** Exotic species tend to compete ith native species for space and food. Sometimes they are also predatory in ature.

1.5 **Hydropower Effects on Fishery resource**: Although hydropower is cleaner than fossil fuel and nuclear power, it is not free from adverse environmental effects, and can have significant impacts on anadromous fish and their habitats. Pacific and Atlantic salmon, shortnose sturgeon, American shad, and many other fish species depend on access to upriver habitat to complete their lifecycles. Habitat alteration, impeded fish passage, degraded water quality, and compromised flows are significant adverse effects of dams on river systems.

Many dams were constructed before their effects on river systems were fully understood, and before key environmental laws were in place. Many lack adequate fish passage and other environmental protection measures, and will have to come into compliance with current environmental laws and mandates upon relicensing.

Fortunately, these impacts can be greatly reduced by including state-of-the-art fish passage facilities and other measures to ensure adequate resource protection. Given the large number of license expirations in the next decade, there is an unparalleled opportunity to modernize projects and provide fish and habitat protection measures.

.2 AIMS AND OBJECTIVES

This project work is aimed at verifying how human activities affect/threaten the fishery resources of Kainji lake and the extent of this threat and also to analyze the conservation methods that can be best used to curtail these effects/threats. These will be achieved by the following objectives;

a) Reviewing the map of the lake indicating the fishing localities found along it.
b) Reviewing the number of fishing villages and fisher men
c) Reviewing the Fishing canoes and Engines
d) Reviewing the different types of fishing gears used in the study area and also the rate in which they are used.
e) Reviewing the available statistics on the total fish yield in the lake.

1.3 SCOPE AND LIMITATION OF STUDY

This study will be limited to the threats on fishery resources in kainji lake in Niger State, it will also look into the available conservation policies in place, their short comings and suggest a frame work plan that will help mitigate these threats on the fishery resources.

Limitations encountered during this project work include the following;

1. High financial cost of traveling to the study area
2. Lake of adequate and up to date data at the National Institute for Freshwater Fisheries Research New Bussa.

3. Difficulties in communication with the villagers as most of them did not understand English language.
4. Lack of co-operation by the fisher men for fear that we were Government officials sent to prevent them from fishing.

1.4 JUSTIFICATION OF STUDY

In Africa fish is an important source of animal protein, consisting 21% of human daily animal protein intake. In this respect, Africa ranks second after the far East. Most wetlands in Africa play an important role in the production of fish for food and income. Fish resources have a well defined economic value on which many people depend both directly (fishing and home consumption) and indirectly (fish processing, trade, transport, etc.)

Although the function of fish in wetland ecosystems has long been recognized, fish have received little attention in nature conservation activities. It must be stressed that the conservation of fish should go hand in hand with sound fisheries management. It is obvious that in a situation in which fish play such an important role in the livelihood of so many people, as in Africa, conservation objectives should not deprive local communities of their resources. Rather, guided by ' wise use principles', conservation objectives should support local fishing communities and aim at the sustainable utilization of the fishery resources.

This project therefore intends to provide a technical overview of the situation with regard to fishery resource conservation in kainji lake and it is hoped to guide governments and stakeholders in setting priorities for action towards the conservation of fishery resources.

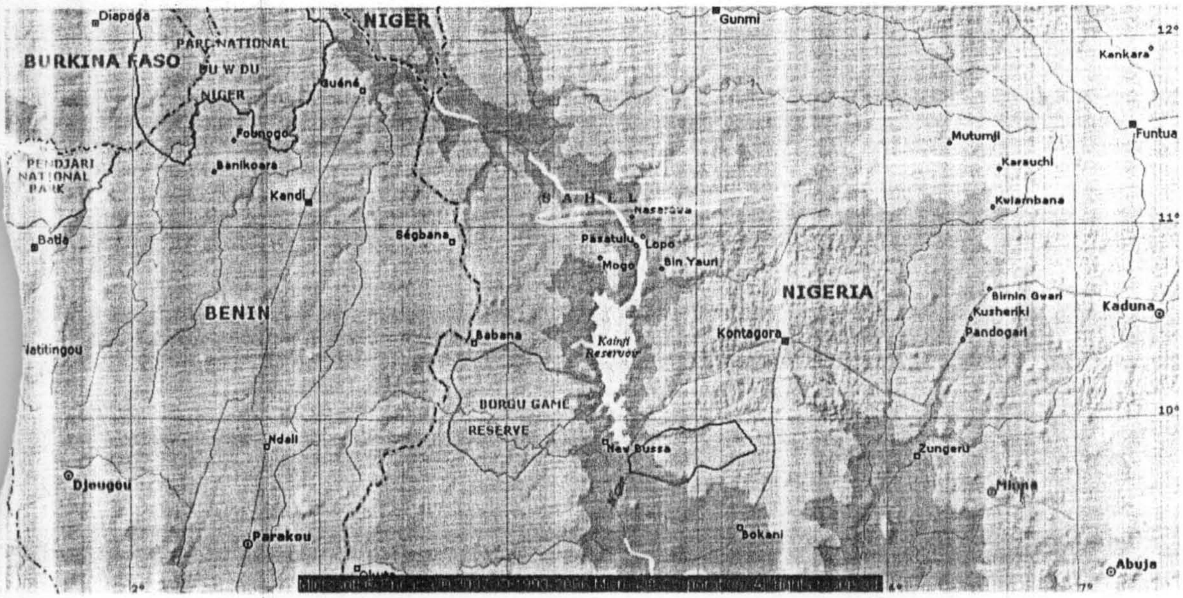
1.5 BRIEF DESCRIPTION OF STUDY AREA

Kainji Lake, is a reservoir on the Niger River in Niger State Western Nigeria. It is formed by Kainji Dam, a hydroelectric facility that was built from 1964 to 1968. Kainji Lake is about 135 km (about 84 mi) long and 30 km (20 mi) across at its widest point.

The creation of the reservoir forced about 44,000 people to be resettled. New villages were constructed of sandcrete, a material resembling cinder block. The designs were based on the adobe villages of the Gungawa, Hausa, and Kamberi peoples. The towns of Bussa, Wara, and Yelwa were moved and rebuilt in this manner. New Bussa was the construction center for the dam and grew rapidly after its completion.

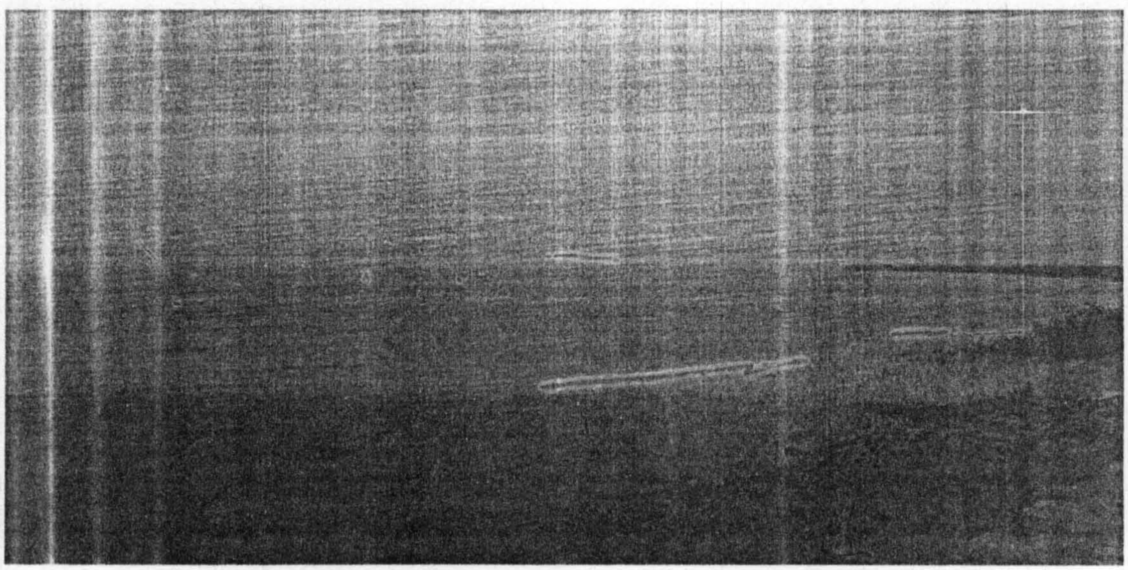
Farmers near Kainji Lake irrigate their crops with water from the reservoir. Fishing takes place from plank boats, and fish taken from the reservoir and then smoked is traded throughout Nigeria. Two sections of Kainji Lake National Park border the reservoir. Antelopes, Buffalos, Hippopotamus, Lions, and a variety of primates are the major attractions of the park, which draws about 5000 visitors yearly.

Figure 1.1: Map showing Kainji Lake



Source; Microsoft Encarta 2007.

Figure 1.2: Picture showing Kainji Lake



Source; authors field work

Geology: Niger State, like other states on the same latitude, is covered by two major rock formations the sedimentary and basement complex rocks. The sedimentary rocks to the south are characterised of sandstones and alluvial deposits, particularly along the Niger valley and in most parts of Borgu, Bida, Agaie, Lapai, Mokwa, Lavun, Gbako and Wushishi LGAs.

This subarea also contains the extensive flood plains of the River Niger and this has made the state to be one of the largest and most fertile agricultural lands in the country. It also provides the best area for rice growing in Nigeria. Perhaps this may account for the location of the National Cereals Research Institute at Badeggi in the State.

To the north is the basement complex, characterized by granitic outcrops or inselbergs which can be found in the vast topography of rolling landscape. Such inselbergs dominate the landscape in Rati, Shiroro, Minna, Mariga and Gurara

Climate: The State experiences two distinct seasons the dry and wet seasons. The annual rainfall varies from about 1,600mm in the south to 1,200mm in the north. The duration of the rainy season ranges from 150 210 days or more from the north to the south.

Mean maximum temperature remains high throughout the year, hovering about 32°F, particularly in March and June. However, the lowest minimum temperatures occur usually between December and January when most parts of the state come under the influence of the tropical continental air mass which blows from the north. Dry season in Niger State commences in October.

Soils and Vegetation: Three major soils types can be found in the State. These include the ferruginous tropical soils, hydromorphic soils and fer rosols. The most predominant soil type is the fer ruginous tropical soils which are basically derived from the Basement Complex rocks, as well as from old sedimentary rocks. Such ferruginous tropical soils are ideal for the cultivation of guinea corn, maize, millet and groundnut.

Hydromorphic or waterlogged soils are largely found in the extensive flood plain of the Niger River. The soils arepoorly drained and are generally greyish or some times whitish in colour due to the high content of silt. Ferosols which developed on sandstone for mations can be found within the Niger trough.

Their characteristic red colour enriched with a clay sub soil is noticeable in the landscape. Termite hills dot the landscape, particularly between Mokwa, Bida and Kontagora. These can be seen along the major highways in the state. The Southern Guinea Savannah vegetation covers the entire landscape of the state. Like in other states of similar vegetation, it is characterized by woodlands and tall grasses interspersed with tall dense species. However, within the Niger trough and flood plains occur taller trees and a few oil palm trees. In some areas, traces of rain forest species can be seen.

Ecological Problems: The major ecological problem in the state is flooding, particularly when the Niger River overflows its banks. During such incidents, as happened recently (1999), several villages were nearly submerged, thousands of people displaced and property worth millions of naira destroyed. Uncontrolled bush burning is another ecological problem in the State.

Ethnic Composition, Languages, Culture and the Arts: Several ethnic groups are found in the State. These include the Nupes who are largely though not exclusively found in Bida, Gbako, Lavun, Mokwa, Lapai and Borgu Local government areas; the Gbahyis (Gwari) who dominate Minna, Suleja, Gurara, Bosso, Maikunkele and Shiroro LGAs; the Hausas are predominant in Kontagora, Suleja, Mariga, Chanchaga and Magama LGAs.

Other ethnic groups include the Kadara, Koro, Baruba, Fulani, Ganagana, Dibo, Kambari, Kamuku, Pangu, Dukkawa, Gade and Ingwai. Islam and Christianity are the major religions in the State. Niger State is popular for its brass works, particularly at Bida, and also for pottery, weaving and several cottage industries which can be found throughout the length and breadth of the state.

Population Structure and Distribution: Niger State had a total population of 2,482,367 people in 1991. Out of this, about 1,290,720 or 52 per cent were males; while 1,191,647 or 48 per cent were females. Thus, the population is slightly skewed towards males. With a total land area of 74,244 sq. km, this gives the State a population density of about 33 per sq km; the lowest in the country. It should be noted, however, that this low population density conceals local variations, particularly in some of the largest local government areas such as Wushishi, Borgu, Mariga and Shiroro where population density is below the state aver age. The implication of such low density of population is that large expanses of land exist which are currently undeveloped or uncultivated.

Urban and Rural Development and Pattern of Human settlement: The majority of the people of the State reside in rural areas (about 90 per cent). Thus, only 10 per cent reside in urban centres . There are four urban centres that might qualify as urban Minna, the state capital, Bida, Suleja and Kontagora. Thus, most of the LGA headquar ters are rural even though there is the tendency to regard them as urban through an administration definition .

These four urban centres form the higher order central places which provide goods and services to lower order central places made up of rural settlements. Given the proximity of Suleja to the Federal Capital of Abuja, it is fast becoming an important centre. Indeed, it is now serving as a satellite town to Abuja.

Problem of Urban Primacy: There is no problem of urban primacy as far as the State is concerned. However, Minna, the state capital is the leading urban centre. This is closely followed by Suleja, Bida and Kontagora. Perhaps, Niger State can claim to be one of those states which, in spite of the predominance of rural settlements, does not experience the problem of urban primacy since similar facilities are located in the four major urban centres in the State. This notwithstanding and by virtue of its status as a state capital, most of the Federal and State parastatals are located in Minna .

1.6 ORGANISATION OF THE THESIS

This thesis is organized in chapters. Chapter one covers the introduction, statement of problems, aims and objectives, scope, limitations and justification of the study and also a brief review of the study area. Chapter two contains the concepts used in the study and literature review of works related to the study. Chapter three and four cover the methodology and analysis while chapter five summarizes the findings, solutions and recommendations.

CHAPTER TWO

2.1 CONCEPTS

.1.1 CONSERVATION

Conservation is the sustainable use and protection of natural ources including plants, animals, mineral deposits, soils, clean water, ean air, and fossil fuels such as coal, petroleum, and natural gas. latural resources are grouped into two categories, renewable and non-renewable. A *renewable* resource is one that may be replaced over time by natural processes, such as fish populations or natural vegetation, or is inexhaustible, such as solar energy. The goal of renewable resource conservation is to ensure that such resources are not consumed faster than they are replaced. *Non-renewable* resources are those in limited supply that cannot be replaced or can be replaced only over extremely long periods of time. Non-renewable resources include fossil fuels and mineral deposits, such as iron ore and gold ore. Conservation activities for non-renewable resources focus on maintaining an adequate supply of these resources well into the future.

Natural resources are conserved for their biological, economic, and recreational values, as well as their natural beauty and importance to local cultures. For example, tropical rain forests are protected for their important role in both global ecology and the economic livelihood of the local culture; a coral reef may be protected for its recreational value for scuba divers; and a scenic river may be protected for its natural beauty.

Conservation conflicts arise when natural-resource shortages evelop in the face of steadily increasing demands from a growing human oulation. Controversy frequently surrounds how a resource should be d, or allocated, and for whom. For example, a river may supply water r agricultural irrigation, habitat for fish, and water-generated electricity or a factory. Farmers, fishers, and industry leaders vie for unrestricted access to this river, but such freedom could destroy the resource, and conservation methods are necessary to protect the river for future use.

Conflicts worsen when a natural resource crosses political boundaries. For example, the headwaters, or source, of a major river may be located in a different country than the country through which the river flows. There is no guarantee that the river source will be protected to accommodate resource needs downstream. In addition, the way in which one natural resource is managed has a direct effect upon other natural resources. Cutting down a forest near a river, for instance, increases erosion, the wearing away of topsoil, and can lead to flooding. Eroded soil and silt cloud the river and adversely affect many organisms such as fish and important aquatic plants that require clean, clear freshwater for survival.

2.1.2 **Methods of Conservation**

The challenge of conservation is to understand the complex connections among natural resources and balance resource use with rotection to ensure an adequate supply for future generations. In order accomplish this goal, a variety of conservation methods are used. ese include reducing consumption of resources; protecting them from ntamination or pollution; re-using or recycling resources when ossible; and fully protecting, or preserving, resources.

Consumption of natural resources rises dramatically every year as the human population increases and standards of living rise. From 1950 to 2000 the world population more than doubled to 6 billion people, with nearly 80 percent living in developing, or poorer, nations. The large, developed nations, however, are responsible for the greatest consumption of natural resources because of their high standards of living. For instance, the average American consumes as much energy as 27 Filipinos or 370 Ethiopians. Conservation education and the thoughtful use of resources are necessary in the developed countries to reduce natural-resource consumption. For example, reducing the high demand for tropical hardwoods such as teak and mahogany in the United States and Japan would slow the rate of tropical forest destruction.

To protect natural resources from pollution, individuals, industries, and governments have many obligations. These include prohibiting or limiting the use of pesticides and other toxic chemicals, limiting wastewater and airborne pollutants, preventing the production of radioactive materials, and regulating drilling and transportation of petroleum products. Failure to do so, results in contaminated air, soil, vers, plants, and animals. For example, if governments required that all tankers be fitted with double-layered hulls, the damages to fisheries id wildlife from the many oil spills of the 20th century, such as the 967 *Torrey Canyon* oil spill in the English Channel, may have been reduced.

In many cases it is possible to re-use or recycle resources to reduce waste and resource consumption and conserve the energy needed to produce consumer products. For example, paper, glass, *freon* (a refrigerant gas), aluminum, metal scrap, and motor oil can all be recycled. A preventative measure called *precycling,* a general term for designing more durable, recyclable products such as re-usable packaging, encourages re-use. Many states in the United States have established mandatory recycling laws in an attempt to reduce waste and consumption.

Some resources are so unique or valuable that they are protected from activities that would destroy or degrade them. For example, national parks and wilderness areas are protected from logging or mining in the United States because such activities would reduce the economic, recreational, and aesthetic values of the resource. Forests and wetlands (areas with high soil moisture or surface water) may be protected from development because they enhance air and water quality and provide habitat for a wide variety of plants and animals. Unfortunately, these as are often threatened with development because it is difficult to sure the economic benefits of cleaner air, cleaner water, and the ny other environmental benefits of these ecosystems (the plants and imals of a natural community and their physical environment)

2.1.3 **Conservation Principles**

In the development and conservation of renewable aquatic resources, there three principles in conservation policies that are relevant (Adeyemo 1987). The first principle is that of prevention. The basic thought behind the principle of prevention is that it is cheaper to avoid damage to the resource from the start than to find solution to the problem after it occurs.

The second principle is that of co-operation. To realize the objective of this principle, there must be co-operation among agencies and social groups, environmental organizations, trade unions non-governmental organizations and industries.

The third and the last principle is that of responsibility. This principle stipulates that individual or groups are responsible for protecting natural resources.

1.4 History of Conservation

Until the advent and spread of Christianity and Islam in the 4th and 5th centuries, there were many religions based on animism, the belief that all objects have a spiritual being. This belief led to careful stewardship, or protection, of natural resources out of fear or respect for these spiritual beings. Moreover, early agricultural lifestyles, dependent on nature to provide good crops and growing conditions, also encouraged sound land-use practices. Ancient Phoenicians, Greeks, and Romans developed irrigation, crop rotation, and terraced hillsides as early methods of water, nutrient, and soil conservation.

In Europe, the relationship between humanity and nature became strained with the beginning of the Industrial Revolution in the 19th and early 20th centuries. Industrialization stifled traditional agricultural lifestyles and encouraged urbanization and the marriage of science and technology to control nature and extract resources. The Industrial Revolution led to environmental damage on a grand scale as European technology spread around the globe. Coal-burning and iron-smelting produced waste that contaminated air and water, the concentrated populations in urban areas produced huge amounts of unconfined raw sewage that contaminated drinking water, and vast forests and plains were cleared for agriculture.

The modern conservation movement of the United States began in the mid-19th century when resource depletion and pollution were first becoming serious problems. Westward expansion was encouraged by the government—the Homestead Act of 1862 provided free land to settlers willing to clear it. Because land ownership required land-clearing, the rapid migration often resulted in barren landscapes. The extensive land-clearing and the rapid depletion of wildlife resources such as Buffalo and Beaver heralded a public outcry. This concern was reflected in the writings of public figures such as American essayist Ralph Waldo Emerson and naturalist author Henry David Thoreau.

As conservation ideas gained support, a wave of conservation activity swept the country. The world's first national park, Yellowstone National Park, was established in Wyoming in 1872 to protect an area of incredible natural beauty. In 1873, the American Association for the Advancement of Science petitioned Congress to halt unwise use of natural resources, the Forest Reserve Act of 1891 authorized what would become known as National Forests, and the Lacey Act of 1900 established the first wildlife protection measures by restricting commercial hunting and the trade of illegally killed animals.

The administration of President Theodore Roosevelt (1901-1909) was noted for its conservation achievements. Roosevelt set aside a total of almost 94 million hectares (235 million acres) of public lands to protect them from exploitation by private interests. He installed forestry expert Gifford Pinchot as the head of the new U.S. Forest Service in 1905 and adopted Pinchot's principle of *multiple use,* the nation's first formal natural-resource policy. The multiple-use policy advocated scientific management of public lands for a variety of uses, including commercial development.

This conservation policy was not popular among many Americans who backed full preservation of natural areas. Naturalist and author John Muir believed that any commercial development of natural areas was inappropriate. A powerful rift soon developed between multiple-use advocates and preservationists. This rift came to a climax during the 12-year battle over a plan to dam the Tuolumne River in Hetch Hetchy Valley in California, and the controversy still exists today.

A renewed surge of public conservation activity occurred during the Great Depression of the 1930s. In an attempt to encourage conservation and stimulate the economy, President Franklin D. Roosevelt established the Civilian Conservation Corp in 1933, which provided two million jobs planting trees, building dams and irrigation systems, and establishing soil conservation and wildlife protection programs.

The conservation movement rose into the spotlight again in the 1960s as publications such as *Silent Spring* (1962) by American biologist Rachel Carson raised public concerns about the health and environmental hazards of pesticides and other toxic chemicals used by industry. Several catastrophic events in 1969, including the toxic waste fires on the Cuyahoga River in Cleveland, Ohio and a coastal oil spill in Santa Barbara, California focused media attention on the need for environmental conservation. The estimated 20 million people across the United States who attended the first national Earth Day, a day for recognizing environmental concerns, on April 22, 1970, demonstrated massive public support for conservation issues. Conservation legislation passed in the 1970s included the Endangered Species Act, the Marine Mammal Protection Act, the Clean Air Act, the Clean Water Act, and the Toxic Substance Control Act.

The 1980s experienced a slowdown of the conservation momentum of the 1970s. Resource conservation concerns remained in the public mind, however, due to continued scientific discoveries concerning global warming, acid rain (a harmful mix of precipitation and damaging pollutants), and depletion of the ozone layer (a gaseous layer in the atmosphere that protects Earth from the sun's harmful ultraviolet rays). Ecological disasters such as the nuclear reactor explosion near the Ukrainian town of Chernobyl' in 1986 (Chernobyl' Accident) and the tanker Exxon Valdez oil spill in Prince William Sound, Alaska in 1989, served as catastrophic reminders of the effects of human carelessness.

The European conservation movement began to grow as the effects of industrialization worsened in the mid-20th century. Clean air legislation was enacted in the United Kingdom in 1956 in reaction to London's industrial smog, which killed more than 2,000 people in early December 1952. Political parties with environmental or conservation agendas sprang up in New Zealand, Australia, and Europe by the 1970s, and became known as Green Parties in the 1980s. In the 1970s and 1980s, courageous grassroots organizations such as the Chipko movement in India (a coalition of villagers, mostly women) and the Brazilian rubber tappers (workers who extract chicle, the tree sap used to make rubber) fought for preservation of the forests that provided their livelihood.

In 1972 the United Nations Environment Program was formed to encourage international co-operation in conservation and development strategies. Collaboration on environmental conservation issues included the 1987 Montreal Protocol to protect the ozone layer, the 1992 United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro, Brazil, and the 1994 United Nations Conference on Population and Development in Cairo, Egypt. The participation of the United States in this international movement was weak, while Canadian and European support and participation were strong.

The 1992 UNCED Conference, commonly referred to as the Earth Summit, was the largest international meeting ever held with 178 nations participating. Its proceedings noted the economic and environmental gulf between the northern and southern hemispheres and emphasized a sustainable growth, utilitarian approach to conservation. In the same year an appeal entitled *World Scientists' Warning to Humanity* was released. This paper was signed by 1,700 of the world's leading scientists (including 104 Nobel laureate scientists), 19 national academies of science, and the director general of the United Nations Educational, Scientific, and Cultural Organization (UNESCO). It stated that at the current rate of consumption, the Earth's resources may soon be reduced to the point at which the living world would be "unable to sustain life in the manner that we know." In several publications, ecologists and economists agree that despite the immediate benefits of economic growth, infinite growth in material and energy consumption is not compatible with the finite resources of the Earth and will undermine the well-being of both economic and ecological systems. For these reasons, natural resource conservation has become one of the most important challenges to face the human race.

2.1.5 **Renewable Resource**

A *renewable* resource is one that may be replaced over time by natural processes, such as fish populations or natural vegetation, or is inexhaustible, such as solar energy. The goal of renewable resource conservation is to ensure that such resources are not consumed faster than they are replaced.

2.1.6 **Fish**

Fish, a diverse group of animals, that live and breathe in water. All fishes are vertebrates (animals with backbones) with gills for breathing. Most fish have fins for swimming, scales for protection, and a streamlined body for moving easily through the water.

Fishes live in nearly every underwater habitat, from near-freezing Arctic waters to hot desert springs; from mud in dried-up tropical ponds to the deepest ocean abyss. Special anti-freeze chemicals in the blood of Antarctic icefish enable them to survive in water below 0° C (32° F). Desert pupfish found in hot springs of western North America live in temperatures higher than 40° C (100° F). Killifish release their eggs, or spawn, as the dry season begins in the tropics of South America and Africa, leaving their eggs to dry in the ground until the rains return six months later. In the deep ocean, where sunlight never reaches, many fishes cooperate with glowing bacteria to create their own light for communication and to attract mates and prey (*see* Bioluminescence).

With approximately 25,000 recognized species, fishes make up the most diverse vertebrate group, comprising about half of all known vertebrate species. New fishes continue to be discovered and named at the rate of 200 to 300 species per year. With this vast number of different fishes comes a diversity of sizes and shapes, from huge whale sharks that reach 12 m (40 ft) in length to the smallest vertebrate, the stout infant-fish (*Schindleria brevipinguis*), measuring only about 7 mm (0.3 in) long.

Fishes are generally streamlined with a pointed snout and pointed posterior and a broad propulsive tail. Unlike the shape of a human body, a fish's body shape is ideal for speeding through the water without creating excess resistance. This torpedo-shaped body is typical of the fastest-swimming fishes, the billfish and the tunas. One billfish, the sailfish, can swim in bursts of over 110 km/h (70 mph). Tunas are built for long-distance endurance as well as speed, swimming as fast as 50 km/h (30 mph) and migrating as far as 12,500 km (7700 mi) in only four months. Other fishes come in a wide variety of shapes. The snakelike eels, flat halibuts, and boxy puffers are all slower swimmers that have evolved distinctive bodies best adapted to their specific habitats. Unlike fishes that swim through the open water, these fishes have adapted to life in caves, on the ocean floor, and among coral reefs where speed is less important than camouflage or maneuverability.

Fishes are an important source of protein for millions of people worldwide. Since the early 1970s, 70 to 100 million metric tons of fish are caught each year for food. People consume about 70 percent of fish caught, and nearly 30 percent are used as animal feed that helps produce other forms of protein. Fish protein represents about 25 percent of the total animal protein consumed by the world's population, second only to beef.

2.1.7 **Types of Fishes**

Fishes may be divided into two distinct groups, jawless fish and jawed fish. The jawless fish are represented by two families of distantly related eel-like fish, the hagfish and the lampreys. Both fishes have tongues equipped with numerous small teeth and lack paired fins and a bony skeleton. Although these two families include only a handful of living species, the fossil record shows they were once a highly diverse group that also included fish whose head and trunk were covered with a hard bony shell. Hagfish are the vultures of the abyss, feeding on carcasses of dead fish and other animals. Lampreys, in contrast, feed on live fish by attaching their sucking disk to their host and rasping away tissue with their toothed tongue.

The jawed fish may also be separated into two major groups: *bony fish,* which have skeletons made of rigid bone, and *cartilaginous fish,* which have skeletons made of elastic cartilage. There are nearly 1000 species of cartilaginous fish, including sharks, rays, and chimaeras, or ratfish. Sharks and rays live in relatively shallow ocean waters and occasionally freshwater, while chimaeras are found only in the ocean, mostly in deep water. Sharks have an age-old reputation for savagery, but only a few of the approximately 370 species deserve this reputation. Most sharks, like the spiny dogfish, are predators of small fish and invertebrates, while the largest, such as megamouths, whale sharks, and basking sharks, feed by filtering tiny invertebrates from the water. The nearly 200 species of rays are essentially sharks flattened like a pancake that have adapted to life on the ocean floor.

The bony fishes encompass by far the largest diversity of fish, with about 24,000 species inhabiting nearly every body of water on the earth. They are divided into two groups—the lobe-finned fish and the ray-finned fish. Lobe-finned fishes include the lungfish, a small group of primitive air-breathing fish, and the coelacanth, the single living species of a group long thought to be extinct.

2.1.8 **Classification of Fishes**

The ray-finned fishes are divided into two major groups, the primitive sturgeons and paddlefish, and the more evolved new-finned fishes. Most of the common and well-known fish species are new-finned fish, including the herrings, which support one of the largest fisheries in the world, and the eels, which are found in nearly all marine habitats. Other new-finned fishes include the ostariophysans—minnows, characins, and catfish—which inhabit the freshwaters of the tropics and surrounding areas. Salmon have adapted to the coasts of northern oceans by living part of their lives in freshwater and part in the ocean. There are over 9000 species of perch, including tunas, jacks, billfishes, sunfishes, and darters, making it the largest vertebrate order. Perches and their relatives are the dominant fishes in tropical marine waters. Closely related to the perches are the flatfish, which look and swim like normal fish when young, only to lay on one side of their body as adults after one eye migrates to the "top" side.

2.1.9 **Habitats of Fishes**

Fishes may be classified as either freshwater or saltwater species. Although freshwater lakes and rivers comprise less than 0.001 percent of the volume of water on earth, 40 percent of fish species are found there. Most of the rest are found in the salty oceans, while only 2 to 3 percent are found in somewhat salty, or brackish waters. Similarly, most marine fishes are found associated with the seafloor or with other natural or artificial features, such as reefs or docks. These structures offer them protection from predators or serve as focal points for feeding and social interactions. The variety of seafloor habitat has enabled fish to diversify while the relatively uniform habitat of open waters has not. Only 13 percent of fish species live primarily in the open ocean.

Fish are not randomly distributed in the world's waters. For example, the continental shelves, shallow areas of the ocean typically 200 m (650 ft) deep or less, with abundant light from the sun and nutrients from the continents, contain most of the ocean's fishes. This habitat promotes large populations of tiny invertebrate animals that are in turn eaten by fishes. Similarly, the upper 200 m (650 ft) of the ocean holds 78 percent of marine fish species. The warm, well-lit waters near coral reefs also promote a rich diversity of fish species. In freshwaters, the greatest diversity of fish species occurs in the warm tropics of South America, Africa, and south-east Asia. There are many species of tropical minnows, characins, and cichlids that are yet to be identified.

2.1.10 **Fish Reproduction**

Fish exhibit a wide array of reproductive strategies. Sharks, for example, produce only a few eggs at a time while cods may produce several million. Some species simply release their eggs into the open water while others carefully place individual eggs on a surface and care for them for days. Typically, a male will fertilize the eggs by moving alongside a female and releasing sperm as the female releases her eggs. In some species, such as guppies, rockfish, and sharks, females retain the eggs in their bodies and accept sperm from males. The young hatch within the mother's body and are then released into the water. In pipefish and sea horses, females, transfer their eggs to the male, who then carries and incubates them. Once fertilized, fish eggs can take anywhere from one day to hatch in some warm water species, to several months in some cold water species.

To signal readiness and prepare their surroundings for spawning, fishes have evolved an amazing diversity of behaviors. In nest builders, males build a nest and advertise to females their interest in mating by dancing in front of the nest. Three-spine sticklebacks build nests of vegetation glued together by cement secreted by their kidneys, and gouramis build bubble nests held together by mouth secretions. The splash tetra of South America lays and fertilizes its eggs by leaping out of the water and attaching eggs and sperm onto leaves above the water surface. The eggs are kept moist by the male who splashes them with his tail until the young hatch.

Deep-sea fishes use light to attract mates as well as prey. Lantern-fish likely use the specific patterns of light organs along the sides of their bodies to signal other members of their own species. The bright colors in some non schooling fishes are specific to individual species and may serve to attract appropriate mates.

2.1.11 **Fish and Humans**

It is impossible to overstate the importance of fish to human populations around the world. Throughout history, humans have used fish protein as a food source, with wild caught fish providing the bulk of fish protein. Fish have also been farmed in large quantities for more than 2000 years in China. Recent advances in fish farming (Aquaculture), especially with some African cichlids (Tilapia), have alleviated hunger in many parts of the world. In industrialized countries, farm-raised fish provide relief for over fished stocks of wild fish. Fish also have served as a source of recreational pleasure for many people. The catches from sports fisheries are far larger than commercial catches from most freshwaters and in marine waters close to large population centers. Aquariums provide an intimate acquaintance with the aquatic world. More than 20 million home aquariums are kept in the United States alone. Among the many fish kept in aquariums, the most common are minnows, characins, and cichlids.

Some fishes may be dangerous to humans, although in most cases the danger is easily avoided. The stonefish is one of the most venomous vertebrates known, with enough toxin in the sharp dorsal spines to kill an adult human that steps on one (Rockfish). The toxin of the pufferfish, or fugu, is deadly when eaten. Sharks have perhaps the worst but least deserved reputation for aggressiveness, for only a few of the species have been known to attack humans. Many larger fish when provoked are capable of inflicting wounds on humans. For example, moray eels, as sinister as they appear, do not go out of their way to attack humans, but will bite if provoked.

2.1.12 **Lakes**

Lake, large inland body of fresh or salty standing water. Lakes are distinguished from bodies of water such as bays and gulfs, and some seas, that have an interchange with the ocean and are subject to tides. Lake basins are formed by many geologic processes, such as buckling of stratified rock into large folds, displacement of large masses of rock by faults (Fault), and blocking of valleys by landslides. Lakes also form by glaciation. Glaciers carve out large basins by scooping up bedrock and redistributing loose material. Many of the lakes of North America formed this way, including the Great Lakes and New York's Finger Lakes. The source of lake water is atmospheric precipitation that reaches the lake directly and by means of springs, brooks, and rivers. Lakes form and disappear over the course of varying lengths of geologic time. They may evaporate, as the climate becomes more arid, or they may fill up with sediment, leaving a bog or swamp in their place. In arid regions where precipitation is slight and evaporation great, lake levels rise and fall with the seasons and sometimes dry up for long periods. In lakes where evaporation prevents the water from overflowing the basin rims, substances dissolved in the water become concentrated. The dissolved matter, brought by tributary streams, varies in composition with the nature of the rocks in the local drainage system. The primary mineral constituent of salt lakes is common salt; bitter lakes contain sulfates; alkali lakes contain carbonates; borax lakes contain borates; and some lakes contain combinations of these substances.

Lakes form at all altitudes and are distributed throughout the world. Almost one-half of the world's lakes are in Canada. Lakes are abundant in high latitudes, particularly in mountain regions subjected to glacial action. Many lakes are important commercially as sources of minerals and fish, as shipping arteries, and as vacation resorts.

The largest lakes in the world include the Caspian Sea, Lake Superior, and Lake Victoria. The Dead Sea is the world's lowest lake, 408 m (1,340 ft) below sea level. The Caspian, the world's largest lake, covers an area of 370,998 sq km (143,243 sq mi). Lake Baikal is the deepest freshwater lake in the world, with a maximum depth of 1637 m (5371 ft).

2.1.13 **Why Conserve?**

Conservation conflicts arise when natural-resource shortages develop in the face of steadily increasing demands from a growing human population. Controversy frequently surrounds how a resource should be used, or allocated, and for whom. For example, a river may supply water for agricultural irrigation, habitat for fish, and water-generated electricity for a factory. Farmers, fishers, and industry leaders vie for unrestricted access to this river, but such freedom could destroy the resource, and conservation methods are necessary to protect the river for future use.

2.2 LITERATURE REVIEW

Angelo Antonio Agostinho and Luiz Carlos Gomes in their work biodiversity and fisheries management in the paraná river basin address fishery resources and management in the upper Paraná River. Collection of data relating to landings and social-economic aspects of the fishery was begun in 1986.

Surveys conducted since 1983 have registered more than a hundred species, 83 of which were found in the lentic portion of the reservoir. A strong spatial gradient of the fish fauna composition and abundance was verified by Agostinho et al. (1999a). This gradient, which causes strong zones of primary and secondary production, has resulted from a sedimentation process and is related to other physical and chemical variables (Pagioro 1999, Okada 2001).

The riverine zone of the Itaipu Reservoir includes all the species that occur in the transitional and lacustrine zones (Thornton 1990), plus species that are typical to the lotic stretches upstream, such as large migratory fishes (Agostinho et al. 1994a). Higher diversity in this zone is likely due to the retention of characteristics of the original lotic environment.

The number of individuals caught per 1,000 m2 of net, in a 24-hour period, were 388 in the littoral zone, 22 in the epipelagic zone and 20 in the bathypelagic zone (Agostinho et al. 1999a). These gradients are reflected in the use of different fishery strategies. The dominant species in the experimental fisheries are Hypophthalmus edentatus, Auchenipterus nuchalis, and Plagioscion squamosissimus (Agostinho & Julio Jr. 1999).

The Itaipu Reservoir was opened to fishing 28 months (March 1985) after the dam was closed. Over 60 species, out of the more than 100 species that have been identified, are exploited in the fishery, with an average landing of 1,560 tons/year (Agostinho et al. 1999c).

Gillnets, not important in this zone, are used to catch Prochilodus lineatus. Species exploited in this region utilize the lotic stretch of the Paraná River upstream (230km) as spawning and nursery areas. In the inner part of the reservoir the fisheries is based on Hypophthalmus edentatus, a filtering zooplanktivore species, and Plagioscion squamosissimus, a piscivore introduced in the basin before the dam closure. Both species spend their entire life cycle inside the reservoir (including arms). Fishing in the inner zone of the reservoir is performed with gillnets. These findings reveal a need for management to realize the complex nature of the reservoir and to consider the peculiarities of each zone.

The most important of the species captured in the reservoir are Hypophthalmus edentatus, Plagioscion squamosissimus, Prochilodus lineatus and Pterodoras granulosus. H. edentatus, a middle-sized catfish, was very abundant after the formation of the reservoir (Okada et al. 1996), but recently, its contribution to landed fish has decreased sharply (Ambrósio 2000). In the Itaipu Reservoir, six out of the ten principal species in the artisanal fishery use the upstream floodplain for spawning and nurturing (Agostinho et al. 1994a). Annual failures in recruitment, caused by the absence of floods (upstream impoundment regulations are, in general, based on previous drought years), are related to stock depletion of this group of species (Agostinho et al. 1999a,c). This relation is particularly clear for P. lineatus, which saw a sharp decrease from 500 tons in 1987 to 220 tons in 1988, due to an absence of flood (failing recruitment) (Gomes & Agostinho, 1997).

The fishery in the Itaipu Reservoir can be characterized by its low profitability and over exploitation. The CPUE reduced from 21.7 kg/fishers-day in 1987 to 15.5 kg/fishers-day in 1992 and 11.5 kg/fishers-day in 1998 (Okada, 2001). Growth overfishing was identified for P. granulosus, Paulicea luetkeni and Pseudoplatystoma corruscans (fished mainly with longlines). Stocks exploited in the inner part of the reservoir (H. edentatus) are probably affected by recruitment overfishing. Both recruitment and growth overfishing were identified for the stocks of Rhinelepis aspera (armored catfish fished with cast nets), whose catches declined by 70% (Okada et al. 1996, Miranda et al. 2000) causing the recent collapsed of its fishery (Okada, 2001). In addition, the landings of the introduced piscivore P. squamosissimus are composed essentially of juveniles.

The first management action taken in the Itaipu Reservoir, mandatory by law, was the construction of a hatchery on the Paraguayan side of the reservoir. Initially, the main goal of the hatchery was to produce fry of native species for stocking purposes. Some of their attempts, mainly with Piaractus mesopotamicus, were not successful. Currently the hatchery is devoted to developing technologies for artificial reproduction of native species and to producing fry (Ed Note: native or non-native?), to be raised in ponds by local farmers.

Additional management actions, taken to directly control the fishery, include licensing, mesh size restrictions and season restrictions. Unfortunately, many of the management actions taken in the Itaipu Reservoir have not had the desired results. For example, attempts to increase yield by decreasing minimum mesh size to exploit a new stock (Hypophthalmus edentatus) were problematic and taught fisheries management of the need to consider the human dimensions when making management decisions. Today, in order to minimize possible weak points in management plans, all stakeholders are consulted before any actions are taken related to the management of the reservoir.

Management actions related to the maintenance of the biodiversity have been, on the other hand, very successful. Fish life history studies have indicated that protection of critical habitats is the most important management consideration. As of yet, only the first step toward this goal has been taken - the legal creation of three conservation units:

-The Area of Environmental Protection (APA) of the Islands and Várzeas of the Paraná River (10,031 km2), extending from the mouth of Paranapanema River to the Itaipu reservoir,

-The Ilha Grande National Park (788 km2), including the lower stretch of the former Area of Environmental Protection, and

-The State Park of Ivinheima River (700 km2), which includes the floodplain of the lower stretch of the Ivinheima River.

The effective conservation of the upper Paraná River floodplain and its biological diversity will therefore depend on the prompt and effective management of these conservation areas. The integrity and functionality of this stretch will also depend on the maintenance of the hydrological regime of the Paraná River (affected by the operation of upstream reservoirs) as close as possible to its natural state.

An additional measure, possibly related to the conservation of biodiversity, is the fish ladder, currently under construction in a lateral tributary near the Itaipu Dam. The purpose of this facility is to improve the genetic quality of the natural populations in the reservoir and upstream stretch.

The following guidelines have been consolidated according to the results obtained from life history studies and surveys and fisheries-system monitoring programs conducted in the Itaipu Reservoir, which collected data on environmental, landing and socioeconomic aspects.

-Fishery management in reservoirs needs to consider, with equal emphasis, both fish production (social reasons) and the maintenance of biodiversity (ethical reasons).

-The focus of management actions must be the integrity of the critical areas upstream the reservoir (spawning and nursery areas), including the flood regime.

-Fishery control and its legal regulation need to be defined with the participation of the fisher community.

V. Vijayan, L. Edwin and K. Ravindran in their work conservation and management of marine fishery resources of kerala state, india made some suggestions for monitoring and conservation of the fisheries in Kerala because the highly productive fisheries of Kerala, India, are suffering from overexploitation. Use of unsuitable fishing gears that result in a high level of wasteful bycatch and destruction of egg bearing and juvenile fish should be controlled. (V. Vijayan, L. Edwin and K. Ravindran ,1984).

Marine fish production of Kerala State, India increased from 0.13 million in 1951-55 to 0.58 million in 1994. In 1976-80, the fish production of the State was 0.41 million .It was 0.27 million t in 1981 and increased to 0.39 million t in 1984.The landings dropped to 0.30 million tin 1987 and peaked at a maximum of 0.56 million t in 1994.The production of prawns was 74,000 t during 1973-75. During 1976-78 and 1978-80, it fluctuated between 38,000 t and 43,000 t and reached about 72,000 t in 1994. Thus, marine fish landings in Kerala showed wide fluctuations over the years, especially during the post-mechanization period. Massive changes in the species composition of the catch and the disappearance of previously important species with an increase in unmarketable or small-sized species are signs of overfishing.

Kerala accounts for 12,570 sq. km of coastal sea area, which has an estimated Maximum Sustainable Yield (MSY) of 400,000 t. This highly productive inshore area is being exploited intensively by more than 4,000 mechanized boats and nearly 26,000 traditional crafts, of which about 17,362 are motorized (Anon 1991). The fishing pressure exerted by the increasing number of crafts using innovative gears in the narrow nearshore regions has resulted in heavy competition leading to inter- and intra-sectoral conflicts. Active fishing with synthetic fibres, propulsion with outboard motors and modification of craft and gears, including indigenization of fishing techniques such as mini purse-seining and mini-trawling, have contributed to the overfishing. This has also coincided with an enormous increase in fishing by the mecha- nized sector, which has led to large scale destruction of egg bearing and juvenile fishes. As a preventive measure, the Kerala Marine Fishing Regulation Act (Anon 1981), the first of its kind in the country, was based on the 'draft bill' of the Majumdar Committee constituted by the government of India in 1976 for examining the question of delimiting the areas of fishing for different types of boats. This act provides for a regulation of fishing in the territorial sea along the coastline of the State through registration and licensing, mesh size regulation, prohibition of certain fishing methods, delimitation of fishing zones and declaration of closed seasons. The question of closed seasons was later studied by various groups of specialists on marine fishery resources appointed by the Government of Kerala, and a partial ban on trawling during the monsoon season was introduced in May 1981 (Kalawar et al.1985; Nair 1989).

The Babu Paul Committee (1982) recommended an area of 2-3 sq. miles as a fish sanctuary at important bar mouths, i.e., Neendakara, Cochin, Chawghat and Beypore. The Committee stressed that no fishing, especially stake net and Chinese dip net fishing, be permitted within this zone, that further licensing of these fishing implements should be stopped, and all unauthorized Chinese dip nets and stake nets should be removed. (Chinese dip net is a type of lift net operated along the backwaters of Kerala during high tide, and is supposed to have originated from China). Use of unsuitable fishing gears that result in a high level of wasteful by catch and destruction of egg bearing and juvenile fish should be controlled.

In the 1983 experimental survey to evaluate the current status of the Jebba lake fishery (Ita and Omorinkoba *et.al.*, 1984 and 1985) a total of 18 fish families and 50 species were recorded in the catch from 15 stations. The family Cichlidae was the most prominent with 27.9% of the total catch. Again, unlike Kainji Lake, Jebba Lake showed signs of becoming a tilapia lake barely 5 months after impoundment. A comparison of the relative composition of the fish families in Kainji Lake one and two years after impoundment (1969/70) with Jebba Lake 5 months and one year 5 months after impoundment shows that the families Schilbeidae, Citharinidae and Centropomidae dominated the catch in Kainji Lake soon after impoundment, while the Cichlidae maintained their leading position in Jebba Lake in 1984, followed by the Schilbeidae. The Characidae succeeded in dominating the catch in Kainji Lake two years after impoundment.

The habitat distribution of the fish in Jebba showed a shift in abundance from shore (47.9%) in 1983 to surface (42.2%) in 1984. This was possibly a reflection of the increase in the abundance of the family Schilbeidae, a major pelagic group in the surface of open water.

The relative catch by mesh size showed that 1 inch mesh nets had the highest catch by number both in 1983 and 1984 suggesting that the majority of fish caught were juveniles. There was a decreasing trend in abundance with increasing mesh size although three inch mesh caught the greatest weight of fish in 1983 showing that bigger fish were caught in that mesh. The average mean catch per 1,000 m^2 of gillnet fleet was 3.0 kg in 1983 and 3.2 kg in 1984. The difference, although slightly positive, is not significant.

A comparison of the relative composition of the catch in commercial landings showed that carnivores topped the list in 1983 with *Clarias* and *Lates* comprising about 26.5% by weight of the total fish landed. In 1984 there was a shift in dominance from carnivores to herbivores with *Labeo* and tilapias dominating both by number and weight. The mean weights of fish caught by fishermen during the two surveys were large which indicates that they were using mostly larger mesh gillnet.

The frame survey statistics for the two surveys revealed that the number of fishing villages and camps had increased from 17 in 1983 to 32 in 1984. Similarly, the number of boats on the lake had also increased from 266 (68 with engines) in 1983 to 369 (91 with engines) in 1984. A total of 551 professional fishermen was counted in 1983 but in 1984 the number had increased to about 1,025 fishermen. This lake, with its surface area of 303 km^2, could cater for about 300 boats and 600 fishermen. By 1984 the lake had already become overpopulated. The average catch per boat dropped slightly from 8.5 kg in 1983 to 7.6 kg in 1984. Like other newly impounded reservoirs, such as Tiga and Shiroro, Jebba Reservoir had the potential of being a highly productive lake in time if appropriate control measures were taken. Management recommendations prescribed for Kainji, Tiga and Shiroro, all of which are classified as larger reservoirs, also apply to Jebba Reservoir.

The statistics available from the 1983 survey revealed that the lake was not yet overpopulated with fishermen. It was timely then to license and register the appropriate number of fishermen expected to fish in the lake, prior to the influx from other lakes of excess fishermen in 1984. The lake is bordered by Niger State on the eastern shore and by Kwara

State on the west but with the transfer of Borgu Local Government to Niger State, both Kainji and Jebba Lakes (formerly shared by Kwara and Niger States) are now controlled by Niger State. At the time of the surveys, neither of these two States had any fishery edict and therefore the lake was open to exploitation by fishermen from different parts of the country, including fishermen previously operating on Kainji Lake.

An experimental survey with a graded fleet of gillnet, together with frame and catch assessment surveys of the commercial fishery were conducted in the Shiroro reserve Niger State. The results revealed that the family Cichlidae (tilapia) dominated the catch (Table 18), as earlier observed for Jebba Lake one year after impoundment (Ita and Omorinkoba *et.al.*, 1984) showing that in spite of its relatively deep mean depth (22.4 m) compared with Jebba (11.0 m) the lake was likely to become a tilapia lake. However, with *Lates niloticus* (family Centropomidae) ranking third in terms of abundance (16.1%) in experimental samples and fourth (5.8%) in commercial landings (Tables 18 & 19) it was obvious that the reservoir, with its rocky landscape, was likely to provide ideal habitats for the breeding of *Lates*.

The International Institute for Tropical Agriculture (IITA) at Ibadan, in Oyo State has a small irrigation and water supply reservoir with a surface area of about 78 hectares. It was first surveyed in May 1978 at the invitation of the IITA management, to determine its productivity (Ita, 1978b).

Old catch records held by the Ministry of Agriculture and Natural Resources (MANR), Ibadan, revealed that the yield from the reservoir had been sustained at about 7.6 mt (97.5 kg/ha)) with minor fluctuations for the previous 4 years. About 98% by number of the catch during those 4 years comprised mostly *Tilapia*. Predominantly 89 mm (3.5 inch) and 102 mm (4 inch) mesh gillnet had been used. Other species recorded in the catch between 1976 and 1977 (Moriarty, 1977) included *Hepsetus odoe* (3 specimens), *Clarias lazera* (13), *Pelmatochromis (Chromidotilapia) guentheri* (35) and *Hemichromis fasciatus* (13). Within the same period about 3,978 specimens of tilapia were captured.

From this record, it was obvious that the mesh sizes of the gillnet used exploited mostly the tilapias, to the exclusion of other species. It was therefore decided to conduct an intensive survey of short duration using diverse gear and multimesh gillnet fleets to update the available information. Other gears used included long line with hooks, wire traps, and a beach seinenet with the intention of establishing their relative effectiveness for the different fish specie.

After the 1978 survey, systematic harvesting continued throughout 1978 and 1979 with regular documentation of species and mesh size statistics. A repeat survey was conducted in August 1986 to evaluate the status of the commercial fisheries in the reservoir (Ita, 1987a) and to update the catch statistics. Information obtained from the IITA Management revealed that *Lates niloticus* had been introduced into the reservoir in 1980 to promote sport fishing.

The results of the 1986 survey revealed that tilapia, mostly *Sarotherodon galilaeus*, which dominated the catch in 1978, was still the dominant species in the reservoir. Five new species were added to the checklist of species in the lake while three of the species recorded in 1978, were not captured in 1986 namely *Clarias* spp. and *Parachanna* sp. possibly because no long-line was set and, as discussed earlier, suspended gillnet were not very effective at catching *Clarias* spp.

A drastic decline in the populations of *Chromidotilapia* (1.0%) and *Hepsetus* (0.3%) was observed compared with their relative composition in 1978 (25% and 19% by number respectively). The catch per unit effort had also decreased from 20.6 kg/1,000 m^2 of net fleet in 1978 to 12.6 kg/1,000 m^2 (in 1986) of the standard gillnet fleet used in the two surveys. The mean weight of *Sarotherodon* captured had however, increased from 407 g/fish in 1978 to 521 g/fish in 1986. Estimates of the efficiency of the gillnet mesh sizes in the fleet used for sampling the reservoir in 1986 revealed that the highest catches were recorded in 3.5, 4.0 and 5.0 inches.

Catch statistics were documented for 3 months in 1978, 12 months in 1979, 10 months in 1980 and 8 months in 1986. No record was obtained for 1981 – 1985. Estimates based on available records for a 25 days sampling schedule in the month showed that about 19.5 mt of fish could have been landed in 1978, 16.5 mt in 1979, 8.2 mt in 1980 and 13.8 mt in 1986. The estimated landings in 1978 and 1979 (19.5 mt and 16.5 mt respectively) appeared much closer to the predicted estimate of 22 mt than those of 1980 and 1986. This was attributed to the fact that fishing with a multimesh fleet combination as recommended earlier was effected in 1978 and 1979. Subsequently a change in mesh sizes was effected in favour of bigger fishes. Also, the introduction of *Lates* in 1980 possibly contributed to the elimination of the large populations of *Chromidotilapia* and *Hepsetus*.

The factors responsible for the high fish production in the IITA Reservoir were identified as the washing down of inorganic fertilizers from the surrounding farmlands into the lake, coupled with the recycling of sterilized sewage back to the reservoir. This model is worthy of emulation by other agricultural enterprises in Nigeria. The IITA reservoir appears to be the only protected reservoir in the country with regulated fishing and accurate catch statistics records.

Some interesting studies have been carried out in this area. Its potential for agricultural and fisheries development has been reported on by Mutter (1972b). Awachie (1976) also discussed the fishery potential of the Lake Ndakolowu area. Investigations into the fisheries of this lake were also conducted by the Kainji Lake Research Institute between 1977 and 1979. In 1971 the surface area of the lake was estimated at 9 km^2 and by 1977 it was reduced to 6 km^2. By 1979 the area was much less than 6 km^2 and after the completion of Jebba Dam in 1983 the open water area of the lake was completely obliterated and the lake was reduced to pockets of overgrown swamps.

In April 1988 the lake completely dried up, with terrestrial vegetation covering the entire area, leaving a few ponds here and there. Between April and June 1988 the embankment along the Niger was excavated down to the level of water in the river in order to permit inflow of water, along the 6km channel, into the lake during the flood. The experiment was successful and in September 1988 the lake was restored with increased fish landings.

Estimates of potential fish yield from the Cross River and its wetlands have been attempted by Moses (1981). Using Welcomme's (1975) formula for quick approximation of possible yields from rivers he arrived at estimates ranging between 7,790 and 17,140 mt per year with a mean of 12,405 tonnes. However, he accepted the lower limit of 7,790 tonnes as the approximate potential yield considering the low fish production of the river (about 10 kg/ha/y).

Moses (1987) also attempted to extrapolate the catch from the Cross River floodplains, based on the influence of the flood regime, and arrived at a mean annual catch of 4,791 tonnes over a period of twelve years (1972–1983).

Statistical frame and catch assessment surveys of the artisanal fisheries were conducted between 1985 and 1986 with the objective of substantiating these theoretical estimates and providing a working data base for the management and control of the fisheries and the population of fishermen. A total of 811 boats and 2,214 fishermen were counted along the eastern shore in 43 fishing camps, 29 fishing villages and one resettlement village (Table 7). Along the western shore a total of 929 boats were counted with 2,665 fishermen giving an average of two to three fishermen per boat for the river stretch.

The estimated total landings along the eastern and western shores of the Cross River during the flood season of June to August 1985, and a combined estimate for the eastern and western shores at the peak of the low water season prior to the onset of the flood in April 1986, is shown in Table 8. The mean of monthly landings for the flood season was about 153mt for the western shore and 216.3mt for the eastern shore giving an overall total for the flood season of 368.9mt. Thus the total landing for the flood season extending between May to October was about 2,213.4 mt, while that of the dry season was estimated at 2,534.4 mt giving a total annual fish landing of about 4,747.8 mt for the freshwater zone of the river.

The above estimates exclude landings along the brackish water areas extending from Calabar creeks on the eastern shore and Oron along the western shore to the confluence towns of Obioko and Effiong Oron on the eastern and western shores respectively. Estimated landings at Calcemco Beach (Calabar Town) in June 1985 gave average monthly landings of 31.2 mt for the flood season. These estimates confirm Moses' (1981) conclusion that the lower figure of 7,790 tonnes is preferable to his upper estimate of 17,140 tonnes. However, in view of the limited number of boats operating along the brackish water area the lower limit of 7,790 tonnes is a good approximation of the total fish landings along this whole river stretch.

Several studies have been commissioned within the project area among which are studies on the Hydrology and sustainable resource development (Adams and Hollis, 1987); Economic valuation of wetland benefits (Barbier *et.al.*, 1991); Studies on the fishery-related aspects of the protected area (Matthes, 1990) and several other studies.

Adams and Hollis (1987) have identified the impact of drought and dam construction on the Hadejia - Nguru wetlands. Their model reveals that between 1964 and 1971 over 200,000 ha of the project area were flooded every wet season. From 1972 to 1982 between 100,000 and

200,000 ha were flooded, but since 1983 flooding has covered less than 90,000 ha each year with 1984 having less than 30,000 ha of floods. Their model shows that evaporation from the inundated area and flooded soils represents about 64% of the volume of river inflow while the discharge at Gashua into the Yobe River represents about 24% of the river inflow.

A comprehensive fishery investigation has been conducted within the HADEJIA NGURU WETLANDS area (Matthes, 1990). A total of about 60 fish species were identified during the investigation of which 25 were found to reach weights exceeding 1 kg, while about 35 could reach about 100 g or more. Using the generalized estimates for other African floodplains ranging from 50 - 60 kg/ha/yr the author estimated that 100,000 ha of the floodplain could yeild a fish biomass of 5 - 6,000 mt annually. Assuming that about 10% of this biomass survives the dry season in permanent pools/rivers, it was assumed that about 90% of the production is fished out each year.

Frame survey results revealed that of the 25.855 households which make up the 30 villages, the majority have at least one person fishing all year round. In all, between 14,000 and 18,000 households fish most of the year. Based on the estimates from the 30 villages, out of a total of 150 (20%), it was estimated that there were about 40,000 to 70,000 fishermen in the project area. Given an estimated average number of

50,000 fishermen in the area, each catching about 100 kg/yr, it was estimated that annual production from the area was about 5,000 mt. This gives a total estimated fish production for the whole floodplain area from Hadejia to Lake Chad (624,000 ha) of about 31,200 mt/yr. Production for any particular year however, depends on the extent of flooding.

Fishing gear and methods used included foul-hook lines, fish baskets, clapnets, gillnet, seines, traps and pots adapted from Mali fishermen. Gaff hooks, clapnets and seines are usually used during communal fishing parties and festivals along water bodies in depressions (fadama) or residual pools in riverbeds. Castnets, long lines (baited) and gillnets are used in permanent water bodies by professional fishermen. Mesh sizes used are small, ranging from quarter inch for castnets and traps to 1 – 3 inches for gillnets

Sagua (1991) gives current fish production estimates for Lake Chad by extrapolation from the quantity of fish marketed in two major market places (Baga Kawa in Nigeria and Blangoua in the Cameroon) with estimated production equivalent to 25% and 75% of the total lake production. In 1986/87 the fresh weight equivalent of processed fish, estimated at four times the processed weight, was 19,380 mt at Baga Kawa. In 1988/89 fish marketed through Baga was 12,108 mt (fresh weight equivalent) while that passing through Blangoua was estimated at

43,270 mt The author recognizes that such statistics, derived from road traffic censuses of vehicles conveying fish, are by no means accurate and there is therefore a need for a more accurate study of catch statistics and a frame survey for the lake. It is however, possible to estimate the potential yield from the lake based on the observed mean yield from floodplains of about 60 kg/ha/yr for the observed area of 1,000,000 ha. This puts the potential yield for the lake at 60,000 mt and about the same figure for the floodplain area.

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 INTRODUCTION

Over 500 Species of living organisms are known to live in the Kainji Lake alone. The large majority of these species are concentrated along the edges of the lake where vegetable matter are mostly to be found. It must be pointed out that there is a great degree of biological diversity in the lake. The relationship that exists among the species in the lake is intricate, hence the need to protect it. They play a very important role in the aquatic food chain therefore the reduction or extinction of any aquatic species can and will lead to an off set of the eco-system. The threats to fishery resources in Kainji Lake are principally viz: Over-exploitation, Habitat destruction, Pollution, Introduction of alien species, Hydropower Effects on Fishery resources. The conservation of these resources is much needed so as to preserve these resources not just for the present but for future generation.

This project work is aimed at verifying how human activities affect/threaten the fishery resources of Kainji Lake and also the extent of these threats. Also the conservation methods that can be best used to curtail these effects/threats were also looked into. These were achieved by the following objectives viz;

A) Reviewing the map of the lake indicating the fishing localities found along it.

B) Reviewing the number of fishing villages and fisher men

C) Reviewing the Fishing canoes and Engines

D) Reviewing the different types of fishing gears used in the study area and also the rate at which they are used.

E) Reviewing the available statistics on the total fish yield in the lake.

This project intends to provide a technical overview of the situation with regard to fishery resource conservation in kainji lake and it is hoped to guide governments and stakeholders in setting priorities for action towards the conservation of fishery resources.

3.1.1 <u>DATA COLLECTED (MATERIALS) AND METHOD OF DATA ANALYSIS</u>

The data for this project were collected via the following sources: Literature materials (Internet) and Journals: Data about the fish species, their distribution, and the rate of catch etc

National Institute for freshwater fisheries conservation and management: Conservation policies, information about the fishing villages, fishing gears and statistics of the fish habitats were gotten from the library of the institution.

Ground truthing: To enable us have first hand information on the following issues; on the type of fishing gears being used, rate at which fingerlings were being caught, fishing practices e.g. the use of chemicals for fishing, pictures were also taken and also we interviewed the fisher men.

Data on conservation and management of fishery resources were gotten from The Federal Environmental Protection Agency Abuja

We visited and collected data in some few fishing villages, about the fisher folk, gears and crafts. Also we used the results of The National Institute of Freshwater Fisheries Research annual frame surveys which were used to implement a gear-based catch and effort sampling program from which monthly and annual estimates of fishing effort and gear type were derived. Activity data were derived from some fishermen in a few villages as being representative of the total gears present for that village. The number of gears recorded as having fished on each day is divided by the total for the village to give an estimate of activity by gear type. Catch per unit effort (CpUE) data were derived by recording any fisherman's catch landed at the fishing village. For each gear type the catch is seen and grouped with the numbers and size of fish in each being taken.

All the fisheries data generated were compiled and analyzed and put into graphs to enable us see the extent of change in the data collected.

3.3 PROBLEMS ENCOUNTERED IN DATA COLLECTION

During the process of data collection the following problems were encountered.

1. Lack of adequate and up to date data at the National Institute for Freshwater Fisheries Research New Bussa on kainji lake as most of the research works available were not current.
2. Difficulties in communication with the villagers as most of them did not understand English language.
3. Lack of co-operation by the fisher men for fear that we were Government officials sent to prevent them from fishing.
4. High financial cost of traveling to the study area
5. Most of the materials posted on the internet were not open sourced, as payments were to be made before having access to them.

CHAPTER FOUR

4.0 DATA ANALYSIS

The study area is known to have over 500 species of living organisms in it. The larger percentage of these species are concentrated along the edges of the lake were vegetable matter are mostly found.

The threats to the fishery resources in Kainji Lake are principally through these five ways:

-The overexploitation of the resources might not have led to extinction but has greatly reduced the population of some species thereby causing an imbalance in the ecosystem.

-The destruction of habitat through dredging, trawling, filling or silting and construction activities taking place in species rich aquatic habitats.

- The introduction of toxic substances into the water body either through direct way; where by toxic materials are used for fishing or indirectly; through run off from near by farms where fertilizer or herbicide is used.

-Also the introduction of alien species and the construction of dams along the study area.

As a result of these human activities the status of these resources have become an issue to be looked into. This study was therefore aimed at verifying how and how much these activities (human) have affected the fishery resources of the study area.

The data collected via the various sources mentioned in chapter III are therefore analyzed below to show the extent of the threat.

4.1 **Fishing villages**:

Two types of fishing localities were identified around Lake Kainji area. These included permanent fishing villages and temporary fishing camps. The number of permanent fishing villages rose from 228 in 1995 to 276 in 2001, an increase of 21% while the temporary fishing camps also increased by 46% from 26 in 1995 to 38 in 2001. In general, the number of fishing localities increased steadily from 273 in 1995 to 309 in 1999. However, in 2001, the number stabilized with a total of 314 fishing localities recorded. The highest number of fishing localities occurred at the eastern side of the lake, especially in the southern and northern basins where conditions are more congenial for settlement and farming and the area is the most productive of the lake for fishing (Du Feu and Abiodun, 1998).The various fishing villages located in the study area can be seen in figure 4.1, which shows how close they are located along the edge of the lake. From the map also it is seen that the northeast and southeast of this lake is highly populated by these villages.

4.2 Fisher folk:

A total of 4,973 fishermen with 12,218 fishing assistants were counted in 1995 (Compiled data). The number rose in 1995 and 1996 until it reached 5,817 fishermen and reduced to 7,126 fishing assistants in 1997. There existed a progressive decline from 5,564 fishermen and 6,140 fishing assistants in 1998 to 4,499 and 3,009 fishermen and fishing assistants respectively in 2000. There was a decrease by 17% in the number of fishermen and 79% fishing assistants over the seven-year sampling period, while the number in 2001 showed a further reduction since the peak in 1997. A total of 4,105 fishermen and 2,508 fishing assistants were recorded in the 2001.

This decline was partly due to the exodus of fishermen from fishery due to falling ownership of gears because of high cost of gear materials and the ban on fishing with beach seines (in 2000 about 6.4% of fishermen stopped fishing, whilst 7% migrated with other gears), as well as the introduction of a systematic licensing program.

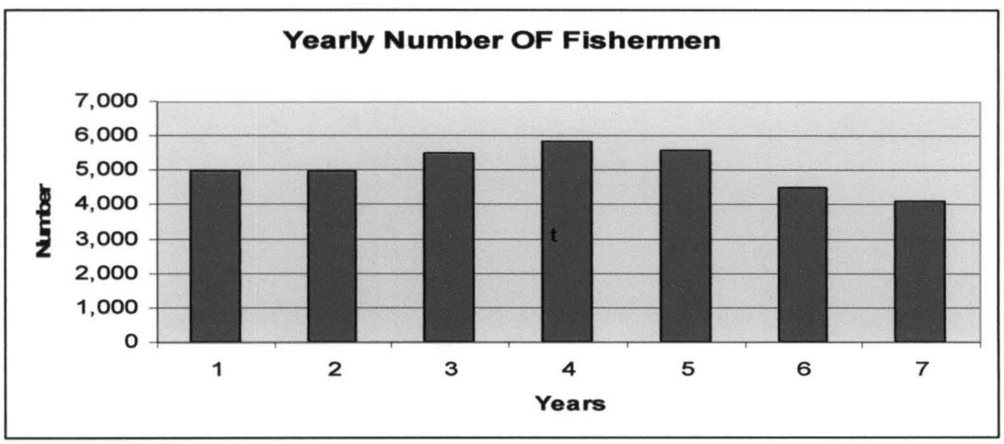
There has been a large reduction in the number of assistants due to the lower ownership of fishing gears (effectively making them redundant). For an optimum catch, 2 fishermen per kilometer square was recommended for Lake Kainji (Henderson and Welcome, 1974) and therefore only about 1,905 fishermen ought to have been engaged in full-time fishing activities if Kainji Lake is properly managed. Surpluses of over 2,200 fishermen were therefore still recorded as at the time of data collection in spite of the implementation of management measures of licensing and banning of beach seine. It is expected that with better conservation measures, this surplus will reduce if not phased out to the level recommended by Henderson and Welcome.

Table 4.1; yearly number of fishermen in the study area

Year	Total
1995	4,973
1996	4,973
1997	5,499
1998	5,817
1999	5,564
2000	4,499
2001	4,105

Source; Abiodun 2003

Figure 4.2; Yearly number of fishermen recorded in the study area



Source; authors work

4.4 **Fishing Canoes and Engines**:

From table 4.2 it is seen that the total number of fishing canoes decreased from 8,755 in 1995 to 4,820 in 2001. This showed a decrease of 44%. Like the localities and fishermen, the highest concentration occurred at the eastern side of the central lake basin. The average number of canoes per fisherman has consistently decreased from 1.9 % to 1.2 % during the past seven years and, like the fishing assistants, is as a result of the declining numbers of gears owned by fishermen.

There was a decrease in the number of transport canoes. The number of outboard engines also declined drastically to less than half the level recoded in 1995. This is evident from table4.2, which shows that only 7% of the canoes used for fishing were motorized. The decline in transport canoes and outboard engines could have been due to high cost of these materials and low income resulting from declined daily catch.

Table 4.2:Frame Data for Kainji Lake Fishery,1995-2001

Year	Ent	Asst	Can	Eng
1995	4,973	12,218	8,755	1,303
1996	4,973	12,449	9,278	1,292
1997	5,499	7,126	7,610	998
1998	5,817	6,140	7,127	585
1999	5,564	4,301	6,204	541
2000	4,499	3,009	5,407	402
2001	4,105	2,508	4,820	429

Note: Ent= Entrepreneur, Asst= Assistant, Can= Canoe, Eng= Engine,

Source; Abiodun 2003

4.5 Fishing Gears:

Analyzing the fishing gear rate recorded in the study area as seen in table 4.2, 1995 had a total of 17,680-gill nets, 1,576 drift nets, 5,760 cast nets, 7,762 long lines and 38,817 fishing traps were recorded. But in 2001 survey, a total of 6, 704 gill nets, 762 drift nets, 1,314 cast nets, 4,167 long lines and 16,848 traps were recorded (Table 4.1).

The percentage reductions in that order were: 62%, 51%, 77%, 46% and 56%. The consequences of the downward trend in the total number of gears recorded for all fishing methods from 1995 till date are among others, the following: One of such consequences is that each fisherman owns fewer gears than before. The reduction is critical when calculating yield estimates from the catch assessment survey, since lower gear ownership will result in lower yield estimates.

For sustainable exploitation, however, the reduction in the number of fishing gears and ultimately fishing effort is welcome given the present level of over fishing of some commercially important species.

The lower number in all the fishing gear types is due to decline in daily catch and the high price of fishing gears causing the fisher folk to purchase less of the fishing materials in spite of gain accruing from the higher fish price.

Gears such as gill nets and long lines are increasingly being stolen as claimed by fisher folk, when set on the lake and fishermen are discouraged from investing in them. The beach seine fishery is the most controversial of all the fishing methods on Lake Kainji and has an associated high by-catch of juvenile and undersized fish that comprised of 25% of the total seine yield.

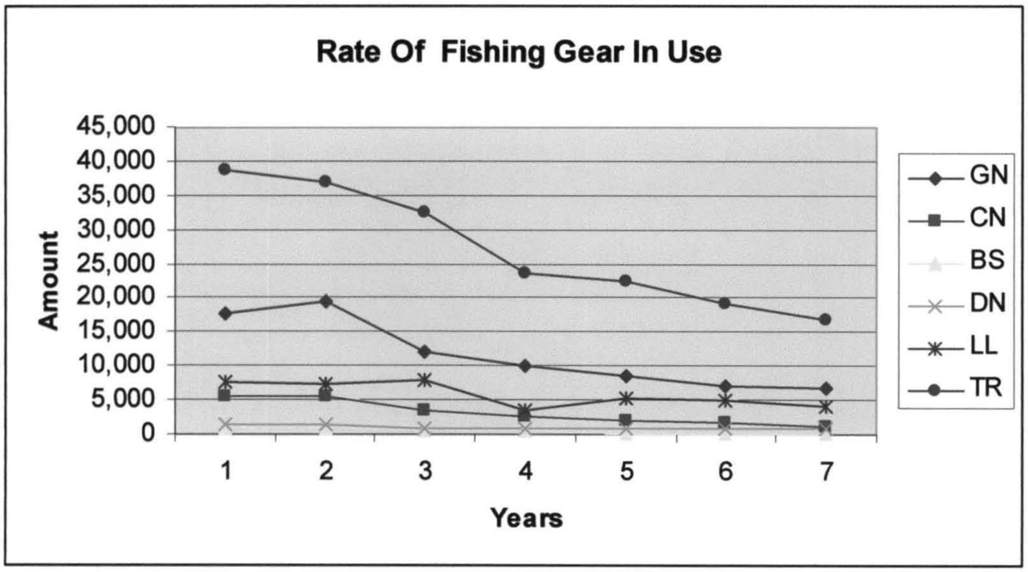
Table 4.3; showing the amount of the different fishing gears in use in the study area.

Year	GN	CN	BS	DN	LL	TR
1995	17,680	5,760	810	1,576	7,762	38,817
1996	19,655	5,548	753	1,560	7,390	36,979
1997	12,147	3,661	582	1,001	7,996	32,691
1998	10,163	2,740	486	967	3,450	23,628
1999	8,706	2,074	122	1,002	5,364	22,565
2000	6,977	1,638	N/A	909	5,003	19,106
2001	6,704	1,314	17	762	4,162	16,848

GN= Gill Net, CN= Cast Net, BS= Beach Seine, DN= Drift Net, LL= Longlines, TR= Traps

Source; Abiodun 2003

Figure 4.3; rate of the different fishing gears in use in the study area



Source: authors' work

4.6 Annual Fish Yield:

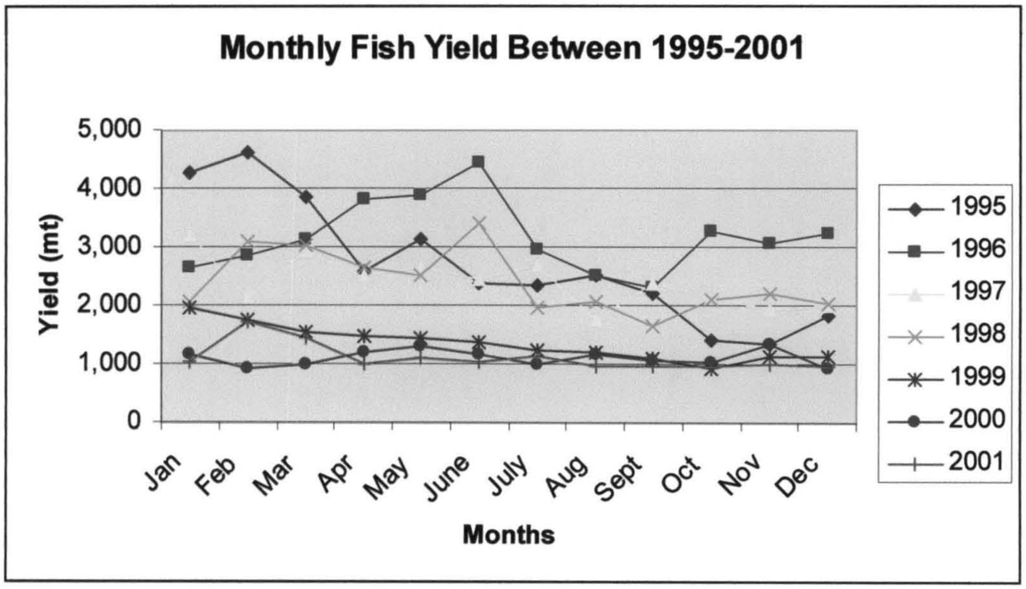
The estimated total yield as seen in table 4.3 for the lake fishery was 13,361 mt. during 2001. This showed no significant reduction from 13,375 mt. recorded in 2000 but showed a reduction of 65% since the peak in 1996. The total yield was more likely higher since the yields from the seine nets were not taken into consideration in 2001 because of the ban on it. The reason for this high decline from 1996 can be attributed mainly to the absence of the yield from beach seine fishery, which targets the small pelagic clupeids and contributed 53% to the 1996 yield (du Feu and Abiodun, 1998). There was a sharp decrease between 1996 and 1997. The peak was in 1996 and the decline has continued from then till date, this could be attributed to the decline in the rate of fishing gears and also might have been as a result of reduction in the population of this resource.

Table 4.4 : Monthly Fish Yield (t) for Kainji Lake, 1995-2001

Mth/yr	1995	1996	1997	1998	1999	2000	2001
Jan	4,267	2,659	3,209	2,066	1,976	1,173	1,049
Feb	4,618	2,867	2,144	3,093	1,769	927	1,714
Mar	3,876	3,151	2,924	3,026	1,544	1,012	1,432
Apr	2,586	3,830	2,515	2,669	1,468	1,207	1,003
May	3,127	3,894	2,643	2,524	1,447	1,309	1,110
June	2,387	4,446	2,435	3,402	1,379	1,178	1,049
July	2,330	2,979	2,684	1,978	1,255	1,002	1,144
Aug	2,519	2,502	1,747	2,062	1,200	1,182	971
Sept	2,193	2,317	2,384	1,655	1,099	1,065	965
Oct	1,427	3,288	2,140	2,119	946	1,050	979
Nov	1,333	3,072	1,934	2,209	1,126	1,355	983
Dec	1,811	3,241	1,994	2,048	1,144	915	962
Total	**32,474**	**38,246**	**28,753**	**28,851**	**16,351**	**13,375**	**13,361**

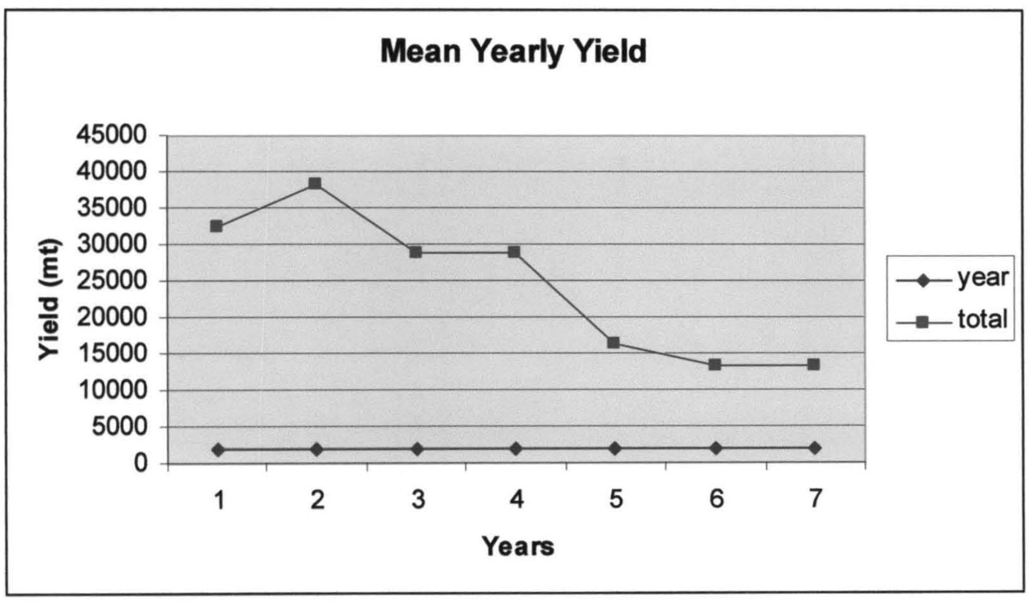
Source; Abiodun 2003

Fig 4.4; Monthly fish yield between 1995-2001



Source; author's work

Figure 4.5;Mean yearly yield of the study area between 1995-2001



Source; author's work

CHAPTER FIVE

5.0 Introduction

The value of fish can not be over emphasized; they form an important element of the aquatic ecosystem and contribute to the natural self purification. The state of these resources indicates the quality of the aquatic environment. Conservation is the sustainable use and protection of natural resources, although the resource under study is renewable it can still be depleted if the rate of catch is higher than the repletion rate.

The challenge of conservation is to understand the complex connections

among natural resources and balancing the resource use and preservation to ensure an adequate supply for future generations.

This project was therefore aimed at verifying how and the extent, human activities such as over exploitation, destruction of aquatic habitat, pollution the introduction of aliens species and the construction of dams among others, have affected these fishery resource. Also to analyze the best conservation methods most suitable for the study area, to curtail these threats.

This was achieved by reviewing the map of the lake indicating the fishing localities found along it, reviewing the number of fishing villages and fisher men ,reviewing the Fishing canoes and Engines, reviewing the different types of fishing gears used in the study area and also the rate in which they are used. Also reviewing the available statistics on the total fish yield in the lake.

The data collected included the total number of the fishing villages, fishing forks, the number of fishing boats, and the monthly landings of the study period. These were plotted into graphs to enable us see the rate of change.

The annual fish landing was established at 32, 474 metric tones in 1995. There was a downward trend in the total number of Fishermen, gear recorded for all fishing methods and annual fish yield between 1995 and 2001. The annual fish yield reached 32,474 metric tones in 1995 and declined to 13,361 metric tones in 2001. However, the results further revealed that a surplus of over 2,200 Fishermen were still recorded actively fishing in the study area as at the time the data were collected despite the interjected management measures of licensing and banning the use of beach seine on the Lake. This has led to a decline in daily catches of Fishermen, which invariably caused a reduction in the total annual fish yield by 58%.

5.2 Recommendations

Conservation must be started to arouse people to awareness that man is dependent on nature and that he is part of a bio-community. Though he is its dominant member, nature contains forces that man cannot override. The series of conservation methods that have to be employed include the following:

(i) **Gear Control**: This involves the control of fishing gear either by banning of certain types of fish methods and the restriction of mesh sizes in the mesh- selective gears. Despite the ban placed on the gear in 1999, the rate at which the gear came up till date on the lake was alarming. This probably meant not enough enforcement; policing and strict penalty was placed on the ban. Perhaps buyers of undersized fish caught by the gear should also be prosecuted. By so doing, the fisher folk would stop fishing undersized fish once they know there would be no market for it.

(ii) **Mesh Regulation**: This involves the control of mesh size in mesh-selective gear where the fishery is based on a certain number of finfish species of high economic importance.

(iii) **Season Control**: This regulation governs the seasons of fishing in traditional fishing communities in order to prevent fishing during spawning seasons, or when fish are congregated in much reduced water area during dry season when prespawning fish are especially vulnerable to certain fishing methods. Therefore the authorities should enforce strike ban on fishing during spawning seasons and also tough penalties on defaulters.

(iv) **Maintenance of Water Quality**: The quality of water deteriorates rapidly as urbanization and industrial development places increasingly heavy pollutants in the water. Legislation on water quality control for discharges from sewage treatment plants and industrial effluent would be based on an extensive knowledge of the tolerances of human or aquatic life to the major contaminants appearing in waters.

(v) **Monitoring of Fisher folks**: The continuous reduction in the of fisher folk and consequent reduction in total effort is an appropriate management measure if fish production and total biomass is to be sustained.

(vi) **Overall planning**: It is evident that fisheries can be developed and consumed in a river in close collaboration with all other users of the basins. it is necessary that decision makers should ensure with proper planning that fisheries be sustained along side other uses to provide good quality protein rich food.

During the course of the project it was seen that past implementation of fishing gear and mesh regulation has not been very effective, therefore we recommend that a lot of awareness should be carried informing the fishermen the long term benefit of conserving this resource and also the seasonal control should be implemented so as to protect these resource during their spawning season so as to ensure hat they breed and grow to an extent without the interference of human activity.

Also activities such as dredging trawling e.t.c. should be controlled and area with threatened habitat should not be encroached upon until the ecosystem has naturally stabilized.

5.3 Conclusion

Conservation of productive fish waters and a wise use of such resource are necessary to maintain the actual cropping yield at a sustained level. The harvest of fish populations in many freshwaters can be increased by decreasing the fishing pressure. On the other hand, increased fishing intensity can lead to the destruction of the fishery as observed in lake kainji.

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