VEGETATION COMPOSITION AND CONSERVATION STATUS OF BATURIYA WETLAND, JIGAWA STATE, NIGERIA

BY

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DECLARATION

I declare that the work in this thesis entitled "Vegetation composition and conservation status of Baturiya wetland. Jigawa state, Nigeria" was performed by me in the Department of Biological Sciences under supervision of Prof. M. L. Balarabe and Prof. S. O. Alonge. The information derived from the literature has been duly acknowledged in the text and a list of references provided. No part of this work has been presented for another degree at any institution.

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Signature Date

CERTIFICATION

This thesis entitled 'VEGETATION COMPOSITION AND CONSERVATION STATUS OF BATURIYA WETLAND. JIGAWA STATE' meets the regulations governing the award of the degree of Master of Science of Ahmadu Bello University, and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

I dedicate this piece of work to my parents Haj Maimuna and Alh Daudu Saleh (Sarkin Fulanin Hadejia), loving children Sadiq, Shahid, Aisha, Yusra, Muhammad, and Yasmin and also to my caring husband Mahmud Muhammad.

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ABSTRACT

An assessment of vegetative composition and conservation status in Baturiya wetland in Jigawa state was carried out during the dry and rainy seasons of 2013/2014. Ecological variables such as soil bulk density, canopy cover and regeneration potential in different segments of the wetland were studied. Tree sample plots of 100 x 100m were located using a stratified sampling method, within each plot, three sub plots 0f 50m x 50m were randomly selected for identification and enumeration of species. Species diversity and equitability were worked out using the Shanon- Weiner diversity and equitability index. Human exploitation in the wetland was also evaluated. A total of 98 plant species were recorded which were distributed among 42 families. Family Fabaceae had the highest representation of 12.1% relative frequency and family Moringaceae being the least represented with 0.32% relative frequency. *Azadirachta indica* was the most dominant species followed by *Hyphene thebaica*, the least represented species were 16 among them were *Mimosa Pigra, Mucuna prurient* and *Saba florida*. There was generally high species diversity, sample plot 2 being the highest with 3.767 diversity index and evenness range of 0.664. Plot I had more herbs, plot II had more trees while plot III had only trees and shrubs. The level of association between the 3 sample plots was also high. The regeneration potential of the diversified species was generally poor. There was also low level of canopy cover above the species beneath. The soil bulk density was high which has a great implication for the regeneration and conservation of the various species encountered. Correlation matrix revealed a positive relationship between the regeneration potential and the canopy area, but there was a negative significant relationship between the regeneration potential and soil bulk density. The vegetation of the wetland is not uniform and is rich in species composition but there is high level of human

exploitation. Deliberate strategies like awareness campaign, staff training, right legislation policy and provision of alternative source of energy need to be employed.

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CHAPTER ONE

1.0 INTRODUCTION

The world and Africa in particular are facing serious challenges in the area of environmental degradation. The most important and prominent challenge in Africa today is desertification and climate change. The rate at which forest is being depleted today due to population growth, indiscriminate logging, construction purposes and farming is alarming (Adewale *et al*., 2002). Nigeria as a geographic entity has been blessed with a rich and unique array of ecosystem and great variety of natural resources. Its broad climatic variation have resulted in a distinct North-South gradation of ecological formation which in turn has a direct bearing on the diversity of flora and fauna supporting more than 1340 species of animals and about 4600 species of plants (Marguba,1996).

Wetlands are essential for hydrological and ecological process and they support a rich fauna and flora, they have different habitats and are places where different species of flora and fauna live. Wetlands act as a water filter, nutrients and sediments are abundant and that makes it possible for many species to live (HNWCP, 1999).

1.1 Definitions of Wetland

A Wetland is an area of land where the soil is saturated with moisture either permanently or seasonally such areas may also be covered partially or completely by shallow pools of water. Wetlands are also defined as transitional land between terrestrial and aquatic system that are characterized by certain water regimes, plant species and soil characteristics (Winter, 2013).

Convention on wetlands of international importance (RAMSAR) defined wetland as areas of marsh, fen, peat land or water, whether natural or artificial, permanent or temporary with water that is static or flowing, fresh, brackish or salty including areas of marine water the depth of which at low tide does not exceeds six meters (6m).

Douglas (2009) defined wetland as geographic area with characteristics of both dry land and bodies of water. Wetland typically occur in low lying areas that receive fresh water at edges of lakes ponds streams, rivers or salt water from tides in coastal areas protected from waves. In wetlands water level called the water table is usually at above or just below the soil surface for enough time to restrict the growth of plant to those that are adapted to wet condition and promote the development of soil characteristic of wet environment (HNWCP, 1999).Wetlands are important to both human and wildlife, because they deliver a variety of beneficial ecosystems services such as supply of food, control of flood, cycling nutrients, filtering of water, removal of pollution and provision of habitats.

1.2 Distribution of Wet Lands

Wetlands are found on every continent (except Antarctica) and in climates ranging from tropic to the tundra. They occupy about six percent (6%) of the land surface of the world or approximately 890 million hectares (Douglas, 2009), they vary in location and size. Some wetlands cover a few million hectares while others are only a few thousand square meters (IUCN, 1980).

They are found in many countries such as the United Kingdom, Iraq, South Africa and the United states. Wetlands are the subject of conservation efforts and biodiversity action plan (NCF, 2010). Notable African wetlands indicated on the map of Africa

are Logon flood plain in Cameroon, Amsuri Wetland of Ghana, Baobalon wetland in Gambia, Seri wetland in Mali and Hadejia- Nguru Wetlands of Nigeria.

Nigeria is uniquely bestowed with fresh water wetlands and the coasted saline wetlands. The fresh water wetland comprises the Imo River, Lake Chad, River, Niger Delta, Cross River, Niger River and Benue River, while the coastal saline wetlands consist of the Cross river estuary, Imo River, and the Niger River (Zaccheaus, 2012). Wetlands are among the world most productive environment. They produce numerous products for man and wildlife. They provide economic and good opportunities to observe wildlife and also educate people during field and school practical on Ecology. Indeed wetlands are considered as the most biologically diverse of all ecosystems (HNWCP, 1999).

Nigerian wetland resources are currently being threatened by certain anthropogenic and bio-geophysical factors. Notable among such factors are population pressure, overgrazing, logging, unprecedented land reclamation, construction of dams, transportation routes and other infrastructures (Anonymous, 2006). Conservation of habitat does not always mean that people are not allowed to live, work and make use of specific environment, it aims at making sure that people do not over-exploit the environment so that the environment can keep on self renewal and regenerating for present and future use. It is quite unfortunate that despite the importance of this resource and the consequences of its deterioration effort on its conservation has not been yielding positive result. This largely may be due to lack of up to date information on the extent, rate and nature of depletion (Akinyemi *et al.*, 2001). Nigeria is a country richly endowed with both coastal and inland wetlands, which

altogether cover about 3% of the country's land surface. These wetlands are of ecological, economic, social cultural, scientific and recreational significance.

Baturiya wetland is a part of Hadejia – Nguru wetlands which are located in the North eastern zone of Nigeria with an estimated area of 3500 square kilometers (HNWCP, 1999).The wetland currently support a population of about 1.5 million people engaged in various forms of livelihood such as fishing, farming and grazing. The area supports rich fisheries of which about 40 million Naira worth of fish is produced annually, according to 1989-90 estimate (Hollis *et al*., 1993).

In 1965, a Lion by name' Danjuma' was discovered in the wetland which was taken to the Emir of Hadejia and later in 1972 taken to Kano state zoological garden (Kabir, 2006).

1.3 Importance of Wetlands

An economically important plant locally called (Kabba' or Doum palm) Hyphaene thebaica yields over 40 million Naira from its products annually. The products are used for making ropes, mats, baskets and hats .They also provides employment for a good number of people within and outside the wetland (Becker, 1994).

The people produce large quantities of rice, wheat, cowpea and vegetables which are marketed to other parts of the country. The wetlands also support over 250,000 herds of cattle which encourage cattle traders, with an annual turnover of 416 million naira (HNWCP, 1999). Ecologically the wetlands serve as a natural barrier to the process of desertification and play a major role in the recharge of groundwater in the basin. It also harbours large numbers of diverse species of wildlife, particularly Pale arctic and afro tropical migrant water birds (Hollis *et al*., 1993, HNWCP, 1999).

Baturiya wetland reserve focuses on protecting the forest and conserving its natural resources in their domain. It also serves as a centre for recreational services, tourism excursion and scientific researches (Kabir, 2006). In theory, all grazing, fishing, woodcutting and farming are banned in the area, there is clear evidence that most of these activities are continuing in the area. There is a new feeder road to Baturiya village cutting a broad swath through the reserve, and wood cutting takes place along it and bodies of water in the early dry season are intensively fished.

1.4 Statement of the Problem

Hadejia-Nguru wetland has a high economic values and support farmers, herdsmen and fishermen. In recent years, the water has been severely reduced and the wetland is showing a signs of distress and the cover of shrub and grasses has been sparse in many years (Adams, 1993).The wetland has suffered from increasing severe drought since 1980s, the use of gasoline powered irrigation pumps has increased the number of lands that can be used for farming in the wetland (Hollis *et al*., 1993). There are increasing human activities which exert prevailing pressure and exploitation of the wetland. There is need for baseline information on the wetland.

1.5 Justification of the Study

Hadejia Ngruru wetland support about 1.5 million farmers, herdsmen and fishermen, the wetland support wet season rice farming, flood recession agriculture and dry season farming using irrigation water source. The wetland also support herders men who often also farm and provide fuel wood and leaves for making mats and ropes, the lands are also grazed by Fulani cattle. The wetland is situated within an Sudan-Sahel ecological zone, characterized by desert encroachment, surrounded by large communities that utilize the diverse biological resources which calls for the need to

preserve the wetland's rich biodiversity through sustainable exploitation. This is because the biological resources are potentially renewable and can strategically be conserved.

The vegetation survey and analysis along with floral checklist will highlight the basic information of Baturiya wetland and possibly provide the major strategic tool for its sustainable use and management strategy. One of the National conservation foundation (NCF) objectives are, increasing the number of researchers and academic community's effort around the wetland that will further enhance conservation action around the wetland. So far this has not been reported for Baturiya wetland at my current stage of knowledge, hence the necessity for this study.

1.6 Aim and Objectives

The aim of the study is to provide data and information on vegetation and conservation status of Baturiya wetland with the following objectives:

1. To determine the vegetation composition of plant species in the study area
2. To determine the regeneration potential of the trees in the study area.
3. To determine the soil bulk density of the study area as possible determinant of regeneration potentials.
4. To determine the canopy cover of trees as determinants of survival of the seedlings.
5. To evaluate the level of anthropogenic impact on the wetland.

1.7 Research Hypotheses

1. There is no vegetation similarity among the sampled plots.
2. There is no significant regeneration potential of trees in the study area.

3. There is no correlation between soil bulk density and natural regeneration of seedlings.
4. There is no correlation between canopy ground cover and seedlings regeneration.
5. There is no anthropogenic impact on the study area.

CHAPTER TWO

2.0 LITERATURE REVIEW

The high demand for energy and other human needs have made people go beyond the limit of reasonable exploitation of forest resources. This consequently expose the environment to agent of denudation like strong winds and running water which further degrade the environment and increases the chances for desertification (Danladi, 2008).

In the last two decades, there has been a growing concern on the ecological, socio-economic, and climatological impact on wetlands. Consequently, the imperative to conserve and utilize wetlands especially in developing countries whose economy depend heavily on the wise use of resources such as those provided by wetlands (Hollis *et al.,* 1993).

Wetlands exist in many parts of the world, in and around cities, uninhabited areas and wild lands. They serve as local resources whose presence and values are appreciated at local levels (Cowles *et al*., 1991).

In south Florida, wetlands are critical resources. The fresh water wetland filter and purify the surface and ground waters, preserve wildlife habitat, provides temporary storage of water during storms, and recharge the sole aquifer serving as the sole source of drinking water for the state (Cowles *et al*., 1991).

In Nigeria, in spite of the dramatic increase in the appreciation of the values of wetlands, it stills remain one of the most threatened and critical ecosystem (Moses, 2008; Oguntola, 1981). In view of this, the IUCN/ Hadejia – Nguru Wetland Conservation Project, as a major aspect of its efforts towards the conservation and

wise use of the Hadejia – Nguru wetlands, decided to develop standard guidelines for the sustainable use of natural resources of the wetland.

Hadejia –Nguru wetland constitute important feeding ground for different migratory bird species like quelia species. The area support farmers herdsmen and fishermen who depend on the wetland for their livelihoods (NCF, 2003). The water in the wider basin is most important for drinking and other agricultural purpose. Based on the natural annual flooding, the wetland performs a number of economic and ecological functions which are of critical local, national, and international significance (NCF, 2003). Unfortunately, there is generally poor appreciation of the environmental values in our society due to poor management and ignorance. Baturiya wetland reserve is aimed at protecting the forest and conserving its natural resources in their domain. It also serves as a centre for recreational services, tourism, excursion, and scientific research (Kabir, 2006). The wetlands of Jigawa state are very critical for the direct livelihood of the people in the area. About 50% of the rural communities depend on the wetlands for their livelihood; this is evident by the proximity of the communities to the wetland. The project supports various forms of agricultural production, fishing, grazing and the sustainability of wild resources, (HNWCP, 1999).

Natural diversity in the ecosystem provides essential economic benefit and serves the society with food, clothing, shelter, fuel and medicine as well as ecological, recreational, cultural and aesthetic values and these play important roles in sustainable development. Biodiversity is under threat in many areas of the world and concern about global biodiversity loss has emerged as a prominent and widespread public issue (Anonymous, 2012).

Muller and Bridgeswater (2006) observes that wetlands offer a wide range of services to farmers and people in general, yet human population can be considered as the source of the causes leading to the loss and degradation of these fragile ecosystem. Pollution, poor drainage, over exploitation of species, inadequate flood control scheme and reclamation are threats to the wetland (NCF 2003). Wetland performs two important functions in relation to climate change. They have mitigation effect through their ability to sink carbon and adaptation effect through their ability to store and regulate water.

2.1 Wetland and Conservation.

The most serious environmental problem facing human race today is the irretrievable loss of biodiversity leading to extinction of plant and animal species and erosion of genetic resources (Ehrlich and Ehrlich, 1981).

The rate of loss and degradation of wetlands is accelerating in all regions of the world, the pressure on wetlands is likely to intensify in the coming decades due to increase global demand for land and water resources as well as climate change (Anonymous, 2010).

Conservation is a protective measure to prevent the loss of genetic diversity of all species, to save species from extinction and ultimately to protect all the ecosystems from damage so as to promote their sustainable utilization (Marguba, 1996).

Conservation of wetland ecosystem is essential not only for sustainable fresh water supply but also for preserving and ensuring other ecological services necessary to health and well being of people around the world (Muller and Bridgeswater, 2006).

Muller and Bridgeswater (2006) pointed out that wetland needs conservation and wise management because they are significant in water supply for food resources. They are

also useful in areas such as fishing, hunting, irrigation, energy production and recreation among other uses.

One of the main objectives of conservation is to protect biological diversity from being threatened or getting extinct. In undertaking a biodiversity survey threatened species are usually listed for the purpose of conserving them as biological resources. In the United States for instance the endangered species Act was enacted in 1973. (Becker, 1994). Unfortunately, there is generally poor appreciation of the environmental values in our society, This general poor societal attitude to preserving and protecting environmental values could be due to lack of awareness and poor environmental framework at various levels of government.

Biodiversity conservation is necessary not only for the protection of threatened species, but also for the benefit we gain by having a diverse ecosystem. It has been revealed through ecotron studies that, the more species there are in ecosystems the more efficiently organism can harness energy from sunlight. The more diverse ecosystems are the more productive they become. To be precise, species rich systems are more productive, stable and less affected by outside stress hence the need to conserve biodiversity (Becker, 1994).

2.2 The Hadejia-Nguru Wetlands Conservation Project

The Hadejia – Nguru wetland conservation project started as a partnership between the government of Borno, Bauchi, and Kano state, the Nigeria conservation foundation (NCF) and Royal society for the protection of Birds. (Hollis *et al*., 1993, HNWCP/IUCN, 1999). The project was established in 1987 with the following objectives;

i. To explore appropriate land use options for the water resources of the Hadejia-Nguru wetlands for the benefit of wild life and human activities.

ii. To monitor wildlife resources throughout the project, especially migrants' water birds whose movement depend on the seasonal variations in water cover.

iii. To develop conservation education and public awareness programs for communities in the area.

iv. To assist state Wildlife Departments by training both staff in the Hadejia-Nguru wetland and the overseers.

This was due to the area's outstanding importance for the national economy and its significance as a habitat for the palaeartic and afro-tropical migrant water birds such as quelia species to which attention was initially focused. (HNWCP/IUCN, 1999). The project aims to protect migratory bird species which are threatened by habitat destruction pollution and hunting.

The project has been under the management of the world conservation union (IUCN) Since 1990, and has increasingly been concerned with the maintenance of the economic and ecological function of the wetland in particular and the promotion of sustainable development in the Komadugu-Yobe basin in general,(Becker, 1994). Many parts of the area covered by Hadejia-Nguru wetland conservation project are suffering from land degradation .Large areas exist with only two or three trees per hectares and supplying needs for fuel wood is a serious problem in many villages.

2.3 Threat to Sustainability

One of the main objectives of conservation is to protect biological diversity from being threatened or getting extinct. In undertaking a biodiversity survey threatened

species are usually listed for the purpose of conserving them as biological resources (Becker, 1994).

The continued availability of the above function and resources depend on the continued function of the wetlands as stable ecosystems. Population pressure, estimated to be growing at the rate of 33% per annum as a result of immigration.

The Hadejia-Nguru wetlands have long been known as a centre of fish production, but upstream hydrological development induced by irrigation projects threaten to degrade this important resource. The dams are likely to bring changes in water flow, loss of habitat, plankton abundance and temperance which are likely to affect fish communities, (FAO, 2013).

There are natural changes on the wetland, for example the impact of drought that have serious implication for the future of the wetland and the sustainability of its production systems (FAO, 1992).

The wetland has also been affected by development elsewhere in the river basin. The construction of Tiga Dam on a Tributary of the Hadejia River in the early years of 1970 has exacerbated the effect of the low rainfall in the last two decades. The result has been a reduction in the extant of flooding in the wetland (FAO, 1992).

2.4 Exploitation of Wetlands

Wetlands are one of the world's most important environmental assets containing a disproportionately high number of plant and animal species compared to other areas of the world, they are vulnerable to exploitation due to abundance of energy source, food and water resources.

Commercial exploitation of plants for medicinal and other uses has important implication for their conservation. The surge in public interest in the use of plant as medicines has been based on the assumption that the plants will be available on continuous basis, (Wambebe,1997).Human activities on the environment need to be controlled or minimized in order for biodiversity to be protected and conserved for sustainable use (Becker, 1994).

Fuel wood is transported out of the wetland by porters and camels, donkeys, carts and trucks at least two truckloads daily. The large quantity of fuel wood taken from these villages is transported to the cities of Kano and Maiduguri (Jimoh, 1989).

Conservation involves protection and establishment of plants in location of their natural occurrence. This method is feasible when pressure on natural forest is light and endangered species of climax vegetation do not regenerate naturally and cannot be cultivated with present knowledge (Roche, 1975). Akinyemi *et al*., 2001 concluded that, "The most important aspects of managing natural regeneration are protection from herdsmen, application of controlled bush burning and effective weed control. Apart from wood product derived from the community the local dwellers within and around the reserve depend so much on medicinal plants for treatment of their common ailments such as malaria, animal diseases, headaches and weakness of the body (Akinyemi *et al*., 2001). At least sixty seven (67) plant species from thirty eight (38) families are used by people living inside and within support zone of the Cross River National park. The plants are utilized both in traditional medicine practice. (Anwana and Obot, 2003).

Adekunle *et al* (2002) in their study on exploitation of Omo forest found out that the habitat has been disturbed by man. The richness of the forest in terms of species diversity has been greatly depleted.

2.5 Floral Diversity

Diversity is a concept which refers to the range of variation or differences among some set of entities (Becker, 1994). Biological diversity is a term commonly used to describe the number, variety and variability of living organisms (WCMC, 1992). Biodiversity is defined as the variety of life, typically expressed in terms of species richness, but also may be applied to genes and ecosystems (Mayr, 1997).

Floral diversity refers to the variety of plants occurring in a particular region or time. It generally refers to the diversity of naturally occurring indigenous or natural plant (Anonymous, 2013). Globally it has been affected by man through a series of activities which may broadly be categorized into two. Those that produce direct effects such as hunting, fishing, and over grazing and those that produce indirect effects through destruction (bush burning, road construction) and modification of the environment (WCMC ,1992).

Flinn *et al*. (2008) In their studies of ‘ Plant species diversity and composition of wetlands within and upland forest found out that the wetlands of an upland forest of Canada contain two hundred and eighty (280) species of vascular plants. The dominant plant species were *Osmunda regalis*, *Glyceria striata*, *Osmunda cinnamomea*, *Deparia archrostichoides* and *Mettuga Struthioptetis*. Both local species richness and composition differed among the wetlands. Adhikari and Babu (2008) in their research on ‘Floral diversity of Baaganga wetland, India concluded that a total of

178 species were recorded and a total of 117 species comprising of *Phragmate karka*, *Polygonum barbtum*, *Ipomea kabba* and *Typha elephantia* were the dominant species.

Prasad (2005) in his work on floral diversity in piper peasant sanctuary, Nepal, found out that the major species available at the ground level dominated by *Potentilia fulgens* in the highest presentation followed by *Carex chiciate*, *Phragaria_rodendron* and *Primula glomerolia*.

Olubode *et al.* (2002) in their study on floral diversity of wetlands of Apete and Aleye River of Ibadan, Nigeria indicated that 'A total of thirty eight (38) plant species belonging nineteen (19) families were enumerated. Continued perturbation of the wetlands encouraged proliferation and dominance of some invasive species at the expense of native species populations, leading to subtle biodiversity erosion. Similarly a total of five hundred and fifty nine (559) trees comprising of thirty one (31) families were in Gashaka Gumti National park. (Akinsoji *et al*., 2003).

Etukudo (2002) also discussed that 'Although there are usually several species in the tropic rain forest ecosystem. Some may have only one representation per hectare. Similarly, Ojo *et al.* (1999) noted that in a typical rain forest, the smaller sized classes dominate while the larger sized classes are few in number. Prescott (1969) showed that aquatic plants are more widely distributed than the terrestrial, this is because factors or conditions to which aquatic plant species adjust in general are more uniform than terrestrial habitat.

2.6 Canopy Cover

The ability of plants to compete with other vegetation depends on the nature of the competing plants, the site, size and the species of the seedlings (Akinyemi *et al*.,

2001). For a successful establishment of the seedling, effective control of weeds, removal of dense cover to allow light penetration, total discouragement of herdsmen from grazing and elimination of annual bush burning in all ramifications will have to be adopted as form of sericulture management, (Akinyemi *et al*., 2001) .During the last two decades there have been increasing interest in the studies of forest canopies (Van and Franklin, 2000).

Most of the common tree species of savanna have the potential to regenerate by seedling (Akinyemi *et al*., 2001). The term canopy is used to refer to the extent of the outer layer of leaves of an individual trees or group of trees. Shade trees normally have dense canopy that blocks light from lower growing plants. Batcher (2007) defined tree canopy as the area of ground covered by the extension of plant foliage. Tree canopies grow in a range of sizes, forms, and widths, from wide spreading, umbrella shapes to narrow, and tall columnar forms. Low canopies can also create shade underneath and block rainfall which can create a difficult condition for plant growing underneath. Determination of canopy cover in a forest helps to determine the amount of photosynthesis from trees within the forest, which is critical to climate change and global warming policies (Batcher, 2007). Areola (1991) recognized that many emergence species in the forest grow slowly and require fair amount of overhead shade in their early life in order of survive and thrive.

Pham and Mitholner (2011) in their studies on "National regeneration patterns shows that abundance of Seedlings were strongly influenced by height of tree canopies, Canopy area and tree density. Dense forest allows little light reach the ground level where as some forest with a lot of cover can still allow a bit of light to reach the surface (Cook, 2006).

Akinyemi *et al* (2001) in their study on dynamics of natural Regeneration of savannah trees species in *Ribako* wetland reserve, showed that for a successful survival and establishment of seedlings, there should be effective control of weeds around them removal of dense canopy cover will have to be adopted.

Vanderwalk (2006) revealed that the plant canopies alter light regimes, water temperatures oxygen variations, soil chemistry ,while the direct and indirect effect of plant canopies have direct and indirect effect on the distribution of plant species. Major regeneration of forest diversity depends on their bone and biotic characteristics (Mc Donald, 1977). Akinyemi *et al.* (2001) in their study of regeneration potential of savanna tree species in *Ribako* woodland reserve, found out that species with the highest regeneration potential index is *Hymenocardia auda* with 0.23 probability of regeneration. Similarly Oduwaiye *et al.* (2002) in his study also indicated that the regeneration potential of Okomu forest was poor and most of the economically important plants of the forest have zero regeneration potential.

2.7 Regeneration Potential

Knowledge of forest regeneration may provide important insight for biodiversity conservation, after all it is the flora that establishes the environment in which the fauna will survive (White and Edward, 2000). Lack of adequate forest regeneration is an issue recognized by both foresters and ecologist. Forest resources are renewable because they have regeneration potential, (Tripathy and Khan, 2007) but now the repeatedly looped and affected forest regeneration is most common world wild problem for the economically important plant. Invasive species changed forest composition of northern India.

By determining which trees species return often in an area biologist will be able to understand better the dynamics of secondary forest ecology and those species that are favored by such forest (Murphy, 2006). Margadu community which is the north, west, part of the wetland (South of Hadejia to Nguru road) is one of the area worst affected by deforestation. In one of the demonstration on natural regeneration farms, Acacia nilotica survived well and grew quickly except where it was flooded and drowned. *Calotropis procera* and *Hyphaene thabeica* regenerates easily (Abubakar and Thomas, 1992, Pananjay and Tiwari, 2012).

Natural regeneration is generally easier on sites with poor soil which are fertile and freely drained where growth of competitive weeds is restricted. Akinyemi *et al.* (2001) found out that most trees have potential for natural regeneration by seed in Ribako woodland reserve but the abundance of seedlings vary greatly among species. The abundance of seedlings probably reflects a number of factors such as soil type, environment, browsing intensity and abundance of the parent trees (Hammer *et al*., 1994).

Akinyemi *et al*. (2001) in their studies on 'The dynamics of natural regeneration concluded that "Most of the species were represented in all the sites observed, but the overall representation is inadequate, mathematically it is proved that nearly all the savannah species are having low regeneration potential index.

2.8 Soil Bulk Density

Bulk density is a measure of soils mass per unit volume of soil. It is used as a measure of soil wetness, volumetric water content and porosity. (Hauston *et al*., 2001). There is an attractive, complementary relation between the soil that supports the plant

community and affects its characteristic and the plant community that develops and influences the character of the soil (Whittaker, 1975).

A soil that has a well-developed structure will become less dense as porosity increases; therefore the bulk density of the soil will decrease. Soils which show massive structures and less porosity will show higher bulk densities ranging from 1.6 to 1.7gcm^{-3}, water movement down the profile will be hindered at this point , (Hauston *et al*., 2007). A loose soil has a higher porosity and lesser bulk density, soil and bulk density and porosity can be affected by climate, biological activities and soil management practice (Hauston *et al*., 2007). Woody encroachment cause strong spatial pattern in bulk density that may contribute to high uncertainty in soil organic carbon responses to encroachment (Throop *et al*., 2012). (Arshad *et al*., 1996) stated that: high bulk density is an indicator of low soil porosity.

Numerous experiments that included measurement of physical effect on soils have shown that grazing increases bulk density or decreases porosity of soil. Durvall and Linnartz (1967) have reported an increase in bulk density of the soil in long leaf, pine-blue stream range of the southern United States as a result of over grazing. Reynolds and Pacer (1963) reported that grazing lower PH can change carbon content of soils, but has little effect on moisten tension, and bulk density Natural regeneration is generally easier on sites with poor soils which are infertile and freely drained where the growth of competitive weeds is restricted. In contrast wet, heavily fertile clays which support vigours weed growth are typically difficult to restock by natural regeneration (Hammer *et al*., 1994). Arshad *et al*., (1996) also discussed that high bulk density is an indicator of low soil porosity and soil compaction, it may cause

restriction to the root growth and poor movement of water and air through the soil, compaction can result in shallow plant rooting and poor plant growth.

2.9 Human Exploitation

The most important aspects of managing natural regeneration are protection from herdsmen, application of controlled bush burning and effective weed control.. Apart from wood product derived from the community' the local dwellers within and around the reserve depend so much on medicinal plants for treatment of their common ailments such as malaria, animal diseases, headaches and weakness of the body (Akinyemi *et al*,. 2001). At least sixty seven (67) plant species from thirty eight (38) families are used by people living inside and within support zone of the Cross River National park. The plants are utilized both in folk and traditional medicine practice. (Anwana and Obot, 2003).

Animals exert physical impact on plant species by pulling and discarding plants and bark of trees or shrubs, covering vegetation with soil and dung. Grazing by animals present two interrelated and mutually interfering problems, it can result in the loss of soil fertility and soil exposure to erosion, The ground which they pass and trample combine to bring disappearance of vegetation and deterioration of soils (Whittet, 1963) The physical damage to plants by trampling changes with plant moisture content, elevation of growing points, physical strength of leaves and flexibility of plant parts (Edmond, 1966).

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Study Area

The Baturiya wetland was gazetted in 1985 after ten years of planning and negotiation (Adams, 1993). The wetland acquires its name after a European lady which at one time paid a visit to the area. It is located 20 km south east of Hadejia Jigawa state (Kabir, 2006). The area of the wetland covers approximately 320 square kilometers and falls within Kiri kasamma local government area of Jigawa state (Figure 3.1). Baturiya wetland reserve is part of the Hadejia – Nguru wetland complex which covers approximately 4125 sq km it lies on longitude 10'10" and $10'35^0$ N and latitude $12'35^0$ and 12'57°E (Terpstra, 2003). There are two seasons in a year, the rainy season starts from May to September which may extend to October and the dry season from September to April (Terpstra, 2003).

The Hadejia- Nguru wetlands are on the list of Ramsar wetlands of international importance, parts of the wetlands are protected by five forest reserve, a wildlife sanctuary and a Ramsar site.

3.2 Sampling Procedure

This involved a reconnaissance survey in the month of April, before the onset of rainfall with the view of assessing the general features o the wetland, so as to justify the sampling criteria and sampling point. Different sites were identified for selection as sample plots. The map of the study area was obtained in order to determine the dimension and size of the area. Three sample plots were selected using a stratified sampling method to serve as representative of the larger study area.

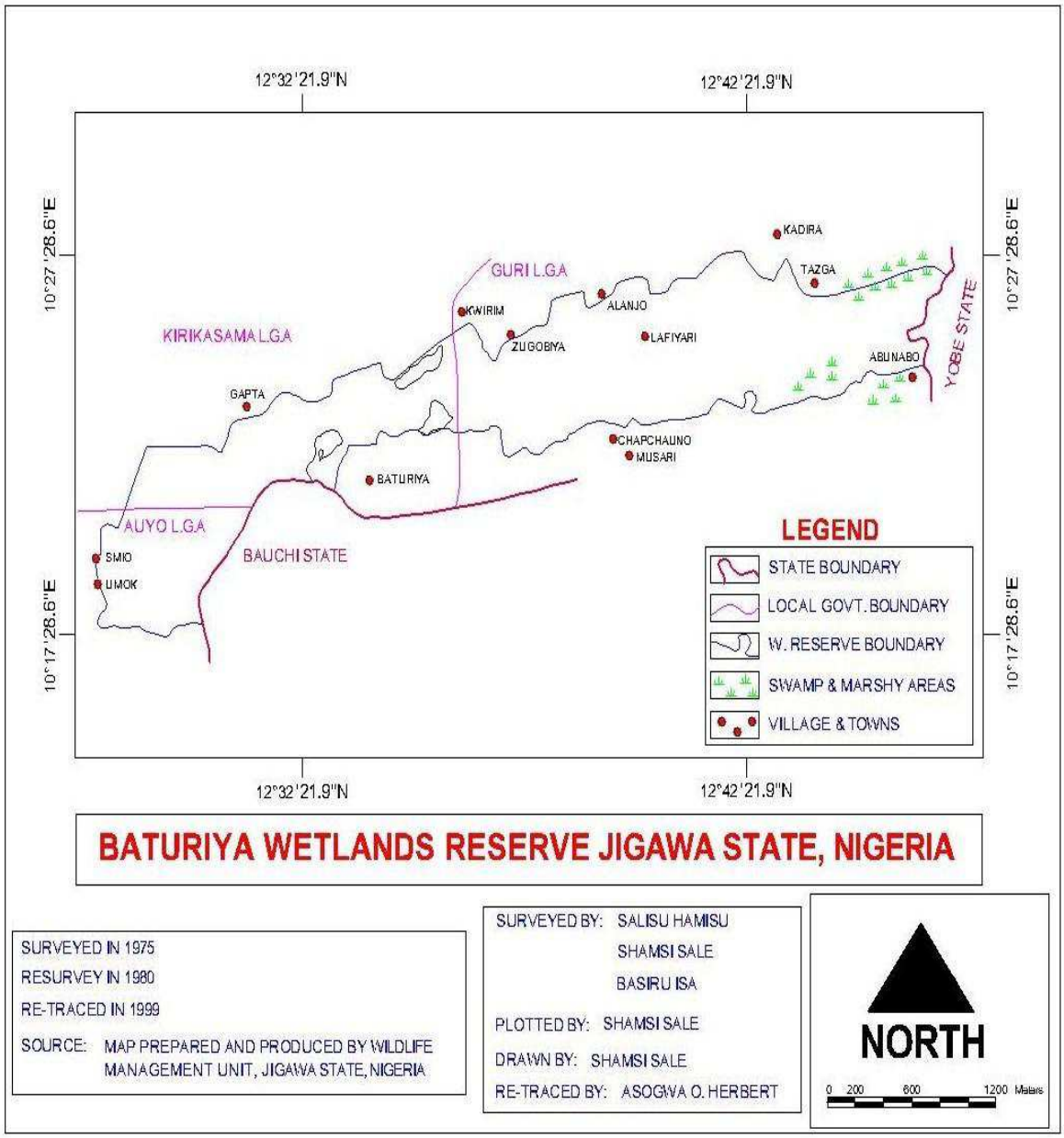

Figure 3.1: Map of Baturiya wetland
Source: Wildlife Management, Jigawa State.

The study area was divided into three sections, and then three plots of 100m x 100m were demarcated at the corner of each section. . Within each plot three clusters (or sub-plots) of 50m x 50m were randomly demarcated for consistent monitoring of species composition and regeneration studies.

3.3 Quadrat Sampling

A wooden frame quadrat of 5m x 5m was constructed and used for marking out the area to be investigated for enumeration of seedlings and herbaceous species. Within each plot the frame was thrown to fall at random three times at different areas in each 50m x50m sub-plot.

3.4 Species Identification and Categorization

All the species were enumerated by direct counting (see appendix 2, Plate 4) consolidated list of all the plant species in the sample plots were made. Plant entries include common names, trade or vernacular names of every living plant species encountered on the sub-plot (Bennet and Humphrey, 1974).The list of vernacular names and herbarium specimens were made for unidentified species for further identification. Species with basal circumference greater than 20cm were considered as trees and those less than 20cm as shrubs. Species of (2-3) meters height with fleshy stem and simple leaves were recorded as herbs (Akobundu, 1998).

3.5 Regeneration Studies

A survey was conducted to ascertain the possibility of self regeneration by the parent trees. Regeneration potential was determined by enumerating the trees stands in each sub-plot within the three main plots. The diameter at breast height (dbh) was measured using a tape. All the trees with dbh $\geq$ 15cm were enumerated as parent trees. The enumeration was made before the onset of rainfall in the first week of May.

The seedlings were enumerated in the month of September. Species with dbh= or ≤ 5cm are considered as seedlings (Akinyemi *et al*., 2001).

Regeneration potential index (RP) was calculated using Curlis and Inrosh method (1950) as follows:

$$RP = \frac{\text{Number of seedling of species/ha}}{\text{Number of parent trees/ha}}$$

Where RP= Regeneration potential.

3.6 Canopy Area Measurement

The canopy area was determined by using the crown diameter method. A tape was laid down from one end of the crown perimeter of each tree to the other end of the crown perimeter, this is the diameter of the crown (D1). Another crown diameter was measured approximately perpendicular to the axis of the first measurement (D2) (Appendix 2, Plate 4)

3.7 Soil Bulk Density Determination

The soil bulk density was determined using a core sampler, a helper and hammer (Grossman *et al*., 2002). The soil surface was cleared and then the metal core sampler was knocked into the ground, to obtain the wet soil from each sub-plot, the soil core with the wet sample was placed in a bag (Meguga) and sealed to preserve for laboratory analysis. The soil core was bagged so that soil does not dry out and loss moisture. In total, nine (9) core samples were taken (Three samples per plot, one sample per sub-plot). Laboratory analysis of soil core starts with the soil sample being weighed immediately after sampling. The samples were oven dried at 105°C for two hours to get the oven dried weight (OD). The water content was calculated by mass of

oven dried soil (gcm2) divided by the total volume of soil (cm) (Grossman *et al.*, 2002).

3.8 Questionnaire

The questionnaire was designed according to the objectives of the study (Appendix 1). It consists of nine (9) fixed responsive questions which were grouped into four sections: A- D

Section A: Socio-economic characteristics

Section B: Exploitation of wetland

Section C: Opinion on exploitation

Section D: Suggestion on control

The questionnaire was administered in four communities close to the wetland, the communities were selected by systematic sampling. It was assumed that different socio- cultural background within each community will influence their general view on the exploitation of the wetland.

3.9 Data Analysis

Shannon – Weinner (1949) diversity index was employed to determine the diversity of plant species in the sample plots,

$$H' = - \sum pi \ln pi$$

Where;

Pi =proportion of each species = ni/N

ni= number of individual of each species

N = Total number of individuals in the plot.

Equitability of plant species was calculated as

$$J = H'/Hmax = - \sum piln pi /ln N$$

- Association between the sample plots was evaluated using the Jaccard's similarity (1948) index as follows:

$$ISs = 2A/A + B \times 100$$

- Where C = number of species common to both plots

A = Total number of species in the first plot

B = Total number of species in the other plot

Determination of Regeneration Potential Index

Regeneration potential was calculated using Curtis and Intosh (1950)

$$Rp = \frac{Number\ of\ seedling\ species\ per\ hectare}{Number\ of\ parent\ trees\ per\ hectare}$$

Determination of Soil Bulk Density

Bulk density in $\left(\right) = \frac{Mass\ of\ oven\ dried\ soil}{Total\ volume\ of\ the\ soil}$

Mass of oven dried soil (g) = $W_2 - W_1$

Where;

W2 = Weight of the dry soil + weight of the core sampler

W1 = Weight of the core sampler

Total volume of the soil = volume of the core sampler

Volume of core sampler = $\pi r^2 h$

Where;

h = height of the core sampler in cm to the nearest mm

r = half of the value of diameter of the core sampler

π = 3.14 (constant)

Determination of Canopy Area

Canopy area was calculated using the formula:

$$CC = \pi\left(\frac{D1 + D2}{4}\right)2$$

Where: D1 = Diameter 1,

D2 = Diameter 2 and

π = 3.14 (Constant)

CHAPTER FOUR

4.0 RESULTS

4.1 Floristic Distribution

Ninety eight (98) different plant species were enumerated in the study area. The distribution and diversity of plant species of sample plot 1 is presented in Table 4.1. A total of thirty nine (39) species were enumerated in sample plot 1, the diversity was 2.059 with an equitability (evenness of distribution) measured by J value as 0.359. *Azadirachta indica* was found to be the most abundant with a total of 114 stands per plot followed by *Hyphaene thebaica* and *Acacia ataxacantha* with a total of 50 and 17 stands respectively. A total of 16 species were having the least representation per plot, they are *Piliostigma reticulatum, Mimosa pigra, Ziziphus abyssinica, Mollugo nudicaulis, Tamarindus indica, Saba florida, Mucuna pruriens, Indigofera arrecta , Leucas matinicensis, Ipomoea carnea, Phyllanthus nuriri, Vicoa leptoclada, Desmodium scorpiurus, Desmodium scorpiurus, Senna occidentalis,* and *Piliostigma thonningii.* This shows that, the plot is showing more presence than abundance. Sample plot 2 is presented in Table 4.2. Fifty four (54) different plant species were enumerated, the calculated diversity was of 3.769 with an equitability (evenness of distribution) measured by J value as 0.664. *Hyphaene thebaica* was the most abundant with a total of fifty nine (59) stands per plot followed by B*auhinia monandra* and *Ochna afzelia* with 30 and 17 species respectively. However the least represented species were twenty six (26) in number with only one representation per plot they are *Acacia nilotica, Acacia Senegal.*

Table 4.1: Species Composition, Family and Diversity of Sample Plot 1 in Baturiya Wetland.

S/N	Species	Family	Total Number(n)	Pi	PilnPi
1	*Acacia nilotitca*	Fabaceae	3	0.01	-0.046
2	*Acacia albida*	Fabaceae	5	0.016	-0.066
3	*Acacia ataxacantha*	Fabaceae	17	0.056	-0.161
4	*Acacia sieberitana*	Fabaceae	10	0.033	-0.113
5	*Azadirachta intdica*	Meliaceae	114	0.373	-0.368
6	*Bambusa vulgartis*	Poaceae	10	0.033	-0.113
7	*Bauhinia rufestcens*	Fabaceae	6	0.02	-0.078
8	*Capparis polymtorpha*	Capparidaceae	2	0.007	-0.035
9	*Centella astiatica*	Apiaceae	2	0.007	-0.035
10	*Chaemacrista rotundifolia*	Fabaceae	3	0.01	-0.046
11	*Chrozophora setnegalensis*	Suphorbiaceae	3	0.098	-0.228
12	*Desmodium scortpiurus*	Fabaceae	1	0.003	-0.017
13	*Detarium microcarpum*	Fabaceae	1	0.007	-0.035
14	*Dichrostachys tcinerea*	Fabaceae	2	0.007	-0.035
15	*Eclipta prostrtara*	Asteraceae	1	0.003	-0.017
16	*Feretia apodentthera*	Rubiaceae	2	0.007	-0.035
17	*Hyphaene thebatica*	Palmae	50	0.163	-0.296
18	*Indigofera arrtecta*	Fabaceae	1	0.003	-0.017
19	*Ipomoea carneat*	Convolvulaceae	1	0.003	-0.017
20	*Jussiea ervicotsa*	Onagraceae	7	0.023	-0.087
21	*Leucas martinitcensis*	Lamiaceae	1	0.003	-0.017
22	*Mimosa pigra*	Fabaceae	1	0.003	-0.017
23	*Mitragyna inertmis*	Rubiaceae	2	0.007	-0.035
24	*Mollugo nudicatulis*	Molluginaceae	1	0.003	-0.017
25	*Mucuna prurients*	Fabaceae	1	0.003	-0.017
26	*Onchoba spinosta*	Flacourtiaceae	2	0.007	-0.035
27	*Pennisetum purtpureum*	Poaceae	2	0.007	-0.035
28	*Phyllanthus nitruri*	Phyllanthaceae	1	0.003	-0.017
29	*Piliostigma retticulatum*	Fabaceae	1	0.003	-0.017
30	*Piliostigma thonningii*	Fabaceae	1	0.003	-0.017
31	*Saba florida*	Apocynaceae	1	0.003	-0.017
32	*Senna sinquteana*	Fabaceae	9	0.029	-0.103
33	*Senna occidenttalis*	Fabaceae	1	0.003	-0.017
34	*Striga hermontthica*	Scrophulariaceae	3	0.01	-0.046
35	*Tamarindus indtica*	Fabaceae	1	0.003	-0.017
36	*Urena lobata*	Malvaceae	2	0.007	-0.035
37	*Uzoroa insignits*	Euphorbiaceae	3	0.01	-0.046
38	*Vicoa leptoclatda*	Asteraceae	1	0.003	-0.017
39	*Ziziphus abysstinica*	Rhamnaceae	1	0.003	-0.017
	Total		306		
H = -∑ pi lin pi				3.767	
J = H/Hax				0.664	

Table 4.2: Species Composition, Family and Diversity of Sample Plot 2 in Baturiya Wetland.

S/N	Species	Family	Total Number (n)	Pi	Pi ln Pi
1	*Acacia ataxacantha*	Fabaceae	8	0.027	-0.098
2	*Acacia nilotica*	Fabaceae	1	0.003	-0.017
3	*Acacia senegal*	Fabaceae	1	0.003	-0.017
4	*Acacia sieberiana*	Fabaceae	7	0.024	-0.09
5	*Alternanthera nodiflora*	Amaranthaceae	2	0.007	-0.035
6	*Hyphaene thebaica*	Palmeae	59	0.203	-0.324
7	*Annona senegalensis*	Annonaceae	1	0.003	-0.017
8	*Anogeissus leiocarpus*	Combretaceae	1	0.003	-0.017
9	*Azadirachta indica*	Meliaceae	12	0.041	-0.131
10	*Bauhinia monandra*	Fabaceae	30	0.103	-0.234
11	*Blighia sapida*	Sapindaceae	2	0.007	-0.035
12	*Bridelia ferruginea*	Euphorbiaceae	5	0.017	-0.069
13	*Strychnos spinosa*	Loganiaceae	1	0.003	-0.017
14	*Calliandra portoricensis*	Fabaceae	2	0.007	-0.035
15	*Carissa edulis*	Apocynaceae	8	0.027	-0.098
16	*Mitragyna inermis*	Rubiaceae	15	0.052	-0.154
17	*Dichrostachys glomerata*	Fabaceae	1	0.003	-0.017
18	*Cyperus difformis*	Cyperaceae	1	0.003	-0.017
19	*Cyathula prostrate*	Amaranthaceae	1	0.003	-0.017
20	*Dysphania anthelminthica*	phenocleaceae	2	0.007	-0.035
21	*Desmodium barbatum*	Fabaceae	1	0.003	-0.017
22	*Desmodium tortosum*	Fabaceae	3	0.01	-0.046
23	*Diospyros mespilliformis*	Ebenaceae	8	0.027	-0.098
24	*Erythrina senegalensis*	Fabaceae	1	0.003	-0.017
25	*Erythropleum suaveolens*	Fabaceae	1	0.003	-0.017
26	*Feretia apodanthera*	Rubiaceae	1	0.003	-0.017
27	*Gardenia aqualla*	Rubiaceae	1	0.003	-0.017
28	*Ziziphus spinachristi*	Rhamnaceae	16	0.055	-0.16
29	*Guiera senegalensis*	Combretaceae	1	0.003	-0.017
30	*Grewia mollis*	Combretaceae	6	0.021	-0.061
31	*Hibiscus linearifolia*	Malvaceae	1	0.003	-0.017
32	*Ipomea involucrata*	Convulaceae	1	0.003	-0.017
33	*Mimosa pigra*	Rubiaceae	1	0.003	-0.017
34	*Ochna afzelia*	Ochnaceae	17	0.052	-0.165
35	*Lemna trisulca*	Lemnaceae	5	0.017	-0.069
36	*Maerua angolensis*	Capparidaceae	1	0.003	-0.017
37	*Moringa oleifera*	Moringaceae	1	0.003	-0.017
38	*Newbouldia laevis*	Bignoniaceae	14	0.048	-0.146
39	*Onhcoba spinosa*	Flacourtiaceae	1	0.003	-0.017
40	*Parkia biglobosa*	Fabaceae	2	0.007	-0.035

41	*Pavetta corymbosa*	Rubiaceae	2	0.007	-0.035
42	*Phyllanthus muellerianus*	Phyllanthaceae	10	0.034	-0.113
43	*Phyllanthus niruri*	Phyllanthaceae	3	0.01	-0.046
44	*Piliostigma thoningii*	Fabaceae	5	0.017	-0.069
45	*Plumeria rubra*	Apocynaceae	1	0.003	-0.017
46	*Pseudocedrela kotschyi*	Meliaceae	1	0.003	-0.017
47	*Psidium guajava*	Myrtaceae	5	0.017	-0.069
48	*Rauvolfia caffra*	Apoynaceae	1	0.003	-0.017
49	*Saba florida*	Apoynaceae	1	0.003	-0.017
50	*Senna sieberiana*	Fabaceae	13	0.045	-0.135
51	*Stereospermum kunthianum*	Bignoniaceae	2	0.007	-0.035
52	*Strophanthus gratus*	Apocynaceae	1	0.003	-0.017
53	*Tamarindus indica*	Fabaceae	1	0.003	-0.017
54	*Senna occidentalis*	Fabaceace	2	0.007	-0.035
	Total		291		

H = $-\sum$ pi lin pi	3.767
J = H/Hax	0.664

Anona senegalensis, Anogeissus leiorpus, Calliandra haematocephala, Dichrostachys glomeata, Cyperus difformis, Cythula prostrate, Desmdium barbatum, occidentals, Erythrina senegalensis, Eryhropleum suaveolens, Feretia apodanthera, Gardenia aqualla, Phyllanthus niruri, Vicoa leptoclada, Eclipta alba, Desmodium scorpiurus, Senna occidentalis, Plumeria rubra, Pseudocedrela kotschyi, Rauvolfia caffra, Saba florida, Strophatus gratus and Tamarindus indica.

Species distribution and diversity of sample plot 2 is presented in Table 4.3. Thirty six (36) different species were enumerated, the calculated diversity was 2.628 with an equitability (evenness of distribution) measured by J value as 0.459. *Albizia lebbeck* was the most abundant with 99 per plot stands followed by *Bauhinia rufescene* and *Nymphea lotus* with 30 and 19 stands respectively. However, the least represented species were 14 in number. They are as follows *Luffa aegyptiaca*, *Cissus quadrangularis, Combretum lamprocapum, Dischrostachys glomerata, Feretia apodanthera, Acacia nilotica, Cyperus rotundus, Lantana camara, Mytragyna inermis, Acacia albida, Psidium guajava, Rauvolfia caffra, and Taccazzea apiculata.* Association between the three sample plots is presented in Table 4.4. It showed that sample plot (2 and 3) has the highest association of 39 % followed by (1 and 3) and (1 and 2) with 38% and 36% respectively.

The distribution of plant families in Baturiya wetland is presented in Table 4.5 and Table 4.6. The total of ninety eight (98) species enumerated were distributed in 42 families. It shows that family *Fabaceae* has the highest representation of 12.1% followed by the family *Apocynaceae* with 2.54 % then families *Poaceae* and *Rubiaceae* with 1.69 % each.

TABLE 4.3: Species Composition, Family and Diversity of Sample Plot 3 in Baturiya Wetland.

S/N	Species	Family	Total number (n)	Pi	PilnPi
1	*Acacia ataxacantha*	*Fabaceae*	6	0.02	-0.078
2	*Acacia sieberiana*	*Fabaceae*	15	0.049	-0.148
3	*Melochia corchrufolia*	*Tiliaceae*	2	0.007	-0.035
4	*Albizia lebbeck*	*Fabaceae*	99	0.324	-0.365
5	*Azadirachta indica*	*Meliaceae*	17	0.056	-0.161
6	*Bauhinia rufescens*	*Fabaceae*	30	0.098	-0.228
7	*Carissa edulis*	*Apocyanaceae*	6	0.03	-0.078
8	*Luffa-aegyptica*	*Cucurbitaceae*	1	0.003	-0.017
9	*Cissus quadrangularis*	*Vitaceae*	1	0.003	-0.017
10	*Combretum lamprocapum*	*Combretaceae*	1	0.003	-0.017
11	*Cycas circinalis*	*Cycadaceae*	1	0.003	-0.017
12	*Digitaria debilis*	*Poaceae*	2	0.007	-0.035
13	*Desmodium tortusum*	*Fabaceae*	14	0.046	-0.142
14	*Dischrostachys glomerata*	*Fabaceae*	1	0.003	-0.017
15	*Diospyros mespiliformis*	*Euphorbiaceae*	11	0.036	-0.12
16	*Feritia apondanthera*	*Euphorbiaceae*	1	0.003	-0.017
17	*Gmelina arborea*	*Verbenaceae*	13	0.042	-0.133
18	*Acacia nilotica*	*Fabaceae*	1	0.003	-0.017
19	*Cyperus rotundus*	*Cyperacea*	1	0.003	-0.017
20	*Nymphea lotus*	*Nymphaceae*	19	0.062	-0.172
21	*Lantana camara*	*Verbenaceae*	1	0.003	-0.017
22	*Mytragyna inermis*	*Rubiaceae*	1	0.003	-0.017
23	*Mangifera indica*	*Anacardiaceae*	14	0.046	-0.142
24	*Newbouldia laevis*	*Bignoniaceae*	12	0.039	-0.127
25	*Acacia albida*	*Fabaceae*	1	0.003	-0.017
26	*Parkia biglobosa*	*Fabaceae*	2	0.007	-0.035
27	*Senna obtusifolia*	*Fabaceae*	12	0.039	-0.127
28	*Phyllanthus niruri*	*Phyllanthaceae*	3	0.01	-0.046
29	*Pseudocedrella kotschyii*	*Meliaceae*	2	0.007	-0.035
30	*Psidium guajava*	*Myrtaceae*	1	0.003	-0.017
31	*Rauvolfia caffra*	*Apocyanaceae*	1	0.003	-0.017
32	*Senna sieberiana*	*Fabaceae*	3	0.01	-0.046
33	*Tacscazzea apiculata*	*Periploceae*	1	0.003	-0.017
34	*Sporobulus pyramidalis*	*Poaceae*	5	0.016	-0.066
35	*Ziziphus abysinica*	*Rhamnaceae*	3	0.01	-0.046
36	*Vitex doniana*	*Verbenaceae*	2	0.007	-0.035
	Total		306		
	$H = \sum PilnPi$		2.628		
	$J = H/Hmax$		0.459		

Table 4.4: Jaccard's Similarity Index of Interaction between the Three Sample Plots of Baturiya Wetland

Plots	Jaccard's Similarity Index (%)		
	Plot 1	**Plot 2**	**Plot 3**
Plot 1	-	36	38
Plot 2	3	-	39
Plot 3	38	39	-

Table 4.5: Distribution of Families of Plant Species in Baturiya Wetland.

S/N	FAMILY	RELATIVE FREQUENCY %
1	Fabaceae	12.10
2	Amaranthaceae	0.84
3	Palmae	0.42
4	Annonaceae	0.42
5	Combretaceae	1.26
6	Milliaceae	0.84
7	Phyllanthaceae	1.26
8	Sapindaceae	0.42
9	Euphorbiaceae	2.10
10	Baraginaceae	0.42
11	Apocynaceae	2.54
12	Rubiaceae	1.68
13	Cypraceae	0.84
14	Spenocleaceae	0.42
15	Balanitaceae	0.42
16	Rhamnaceae	0.84
17	Tiliaceae	0.84
18	Malvaceae	0.84
19	Convulvaceae	0.42
20	Verbanaceae	1.26
21	Lemnaceae	0.42
21	Capparidaceae	0.84
23	Moringaceae	0.32
24	Bignoniaceae	0.84
25	Flacourtiaceae	0.42
26	Myrtaceae	0.42
27	Molluginaceae	0.42
28	Lamiaceae	0.42
29	Scrophulariaceae	0.42
30	Apiaceae	0.42
31	Poaceae	1.68
32	Asteraceae	0.42
33	Onagraceae	0.42
34	Cucurbitaceae	0.42
35	Vitaceae	0.42
36	Cycadeaceae	0.42
37	Loganiaceae	0.42
38	Urtaceae	0.84
39	Nymphaceae	0.42
40	Anacardiaceae	0.42
41	Periploceae	0.42
42	Araceae	0.42

Table 4.6: Distribution of Trees, Shrubs and Herbs in Baturiya wetland

Plot	Number/Plot			Total
	Trees	Shrubs	Herbs	
I	10	14	23	47
II	16	10	7	33
III	8	10	0	18
Total	**34**	**34**	**30**	**98**

4.2 Regeneration Potential

The calculated regeneration potential index of the three sample plots of Baturiya Wetland is presented in Table 4.7, it shows that *Cassia singuena and Chrozophora senegalensis* has the highest potentiality to regenerate with mean regeneration potential index of 3.33 followed by *Azadirachta indica* with 2.01 then *Mitragyna inermis* with 1.79 respectively. The mean total of regeneration potentials of the sample was plot found to be 0.96 which is very poor. This may be due to the fact that every species in the sample plot is required different conditions for germination and seedling growth.

Moreso some of the species may have their seedling being exploited by the community around and their grazing animals. However, the overall regeneration potential index is found to be 1.52 which is very low.

4.3 Soil Bulk Density

The result obtained from the soil bulk density estimate is presented in Table 4.8. The highest bulk density is 1.87g/cm^2 in plot 2 and all the remaining were 1.75g/cm^2 respectively. This implies that the soil bulk density of the wetland is almost uniform and constant.

4.4 Canopy Cover

The result of canopy area measurement is also presented in Table 4.8. It shows that, the highest canopy cover is 23.7 m^2 in plot 1, followed by 6.13 in plot 2 then 5.71 in plots 3. The plot with least canopy cover is plot 2 with 0.05m^2 however the general canopy cover of the wetland is found to below.

Table 4.7: Regeneration Potential Index of Plant Species in Baturiya Wetland

S/N	Species	Regeneration Potential Index			Total	Mean
		Plot 1	Plot 2	Plot 3		
1	*Acacia albida*	0.42	0.09	0.03	0.54	0.18
2	*Acacia nilotica*	0.01	0.60	0.03	0.64	0.21
3	*Acacia senegal*	0.03	0.21	0.18	0.42	0.14
4	*Acacia siebrena*	0.03	0.03	0.01	0.07	0.02
5	*Azadirachta indica*	6.00	0.00	0.03	6.03	2.01
6	*Balanites egyptica*	0.00	0.00	0.00	0.00	0.00
7	*Bauhinia rufescens*	0.00	4.00	0.02	4.02	1.34
8	*Cassia singuena*	0.01	0.00	0.00	0.01	3.33
9	*Dichrostachys cinerea*	0.03	0.00	0.00	0.03	0.01
10	*Diospyros mesiliformis*	0.30	0.00	0.00	0.30	0.10
11	*Hyphaene thebaica*	2.40	2.00	0.00	4.40	1.46
12	*Mitragyna inermis*	0.03	2.03	3.33	5.39	1.79
13	*Moringa oleifera*	0.00	0.00	0.00	0.00	0.00
14	*Piliostigma reticaulatum*	0.00	0.00	0.00	0.00	0.00
15	*Vitex doniana*	0.00	0.00	0.00	0.00	0.00
16	*Albizia lebek*	0.00	0.03	0.01	0.04	0.01
17	*Senna siebriana*	0.12	0.06	0.04	0.22	0.07
18	*Tamarindus indica*	0.00	0.57	0.04	0.61	0.20
19	*Annona senegalensis*	0.06	0.18	0.03	0.27	0.09
20	*Gueira senegalensis*	0.00	0.18	0.00	0.18	0.06
21	*Anogeissus leocarpa*	0.00	0.18	0.00	0.18	0.06
22	*Dichrostachys glomerata*	0.00	0.00	0.18	0.18	0.06
23	*Parkia biglobosa*	0.00	0.00	0.00	0.00	0.00
24	*Chrozopora senegalensis*	0.01	0.00	0.00	0.01	3.33
25	*Psidium guajawa*	0.15	0.09	0.45	0.69	0.23
	Total				**24.23**	**0.96**

Table 4.8: A comparison of Soil Bulk Density, Canopy Cover Estimate and Regeneration Potential in different Plots and Quadrats in Baturiya Wetland

Plot	Sub-plot	Bulk Density (g/cm^2)	Canopy Area (m^2)	Regeneration Potential Index
Plot I	Q1	1.75	23.7	0.40
	Q2	1.75	6.13	0.15
	Q3	1.87	4.83	0.03
Plot II	Q1	1.75	0.10	0.05
	Q2	1.75	0.14	0.50
	Q3	1.75	0.05	0.05
Plot III	Q1	1.75	4.54	0.02
	Q2	1.75	2.46	0.09
	Q3	1.75	1.02	0.00

4.5 Relationship between Soil Bulk Densities, Canopy Area Regeneration Potential

The relationship between the regeneration potential canopy cover and bulk density was analyzed using correlation matrix. The result is presented in Table 4.9. It shows that there was no significant association between the regeneration potential and canopy area, but there is a significant relationships between regeneration potential and soil bulk density

4.6 Human Exploitation

The result indicated that there was no significant association between the regeneration potential index and canopy cover. But there was a significant relationship between the regeneration potential and soil bulk density. Table 4.10 indicated that, most of the respondents were between the ages of 21-39 years, or between 40-49 years of age. While only 10% of the respondents were less than 20 years of age. Similarly Table 4.11 below showed that 65% of the respondents were males while 35% of them were females.

However, Figure 4.1 (a pie chart) indicated that almost 92.52% of the respondents were aware of the massive exploitation taking place in the Baturiya wetland. While only 7% of the respondents were not aware of the exploitation on the wetland. The respondent can be aware but may not know the implication of doing so. Figure 4.2 below showed that, the exploitation of the wetland occurs mostly due to the massive need for energy through firewood. However, the exploitation of the wetland can also be attributed to the recurrent needs for medicinal aspects of plants. Other reasons behind the exploitation are the need for constructional materials used for building houses and income generation through the sale of firewood, fruits collection or food.

Table 4.9: Correlation matrix comparing the relationship between regeneration potential, canopy area and soil bulk density.

	Regeneration Potential Index (RPI)	**Bulk Density (BD) (g/cm^2)**	**Canopy Area (CA) (m^2)**
RPI	1		
SBD	0.626*	1	
CAE	0.346	0.607*	1

Key; * Significant

Table 4.10: Age Range of the Respondents.

S/N	Age Range (Years)	Frequency	Percentage (%)
1	≤20	20	10
2	21 – 39	85	42.5
3	40 – 49	65	32.5
4	50 above	30	15
Total		**200**	**100**

Table 4.11: Gender distribution of the respondent in Baturiya wetland.

S/N	Gender	Frequency	Percentage (%)
1	Male	130	65
2	Female	70	35
Total		**200**	**100**

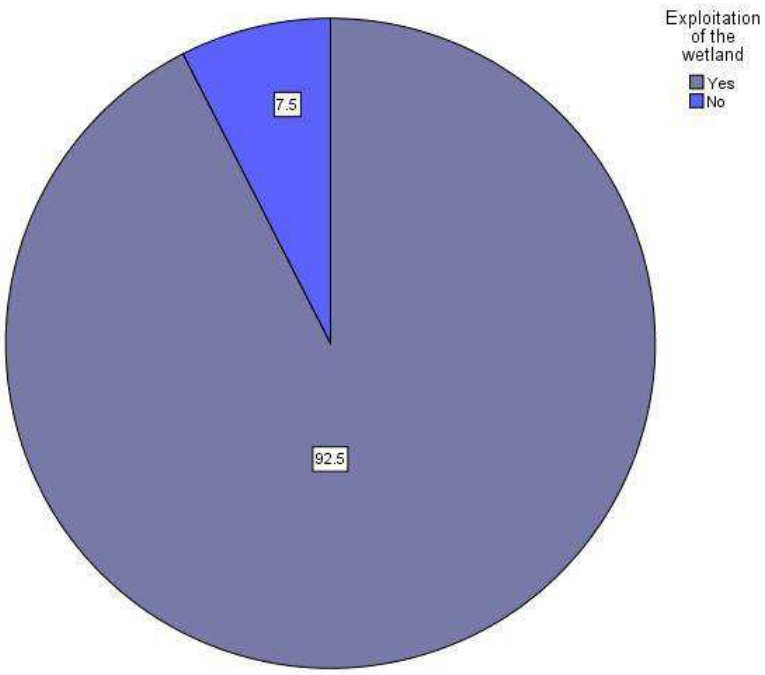

Figure 4.1: Degree of Awareness of the Extent of Wetland Exploitation

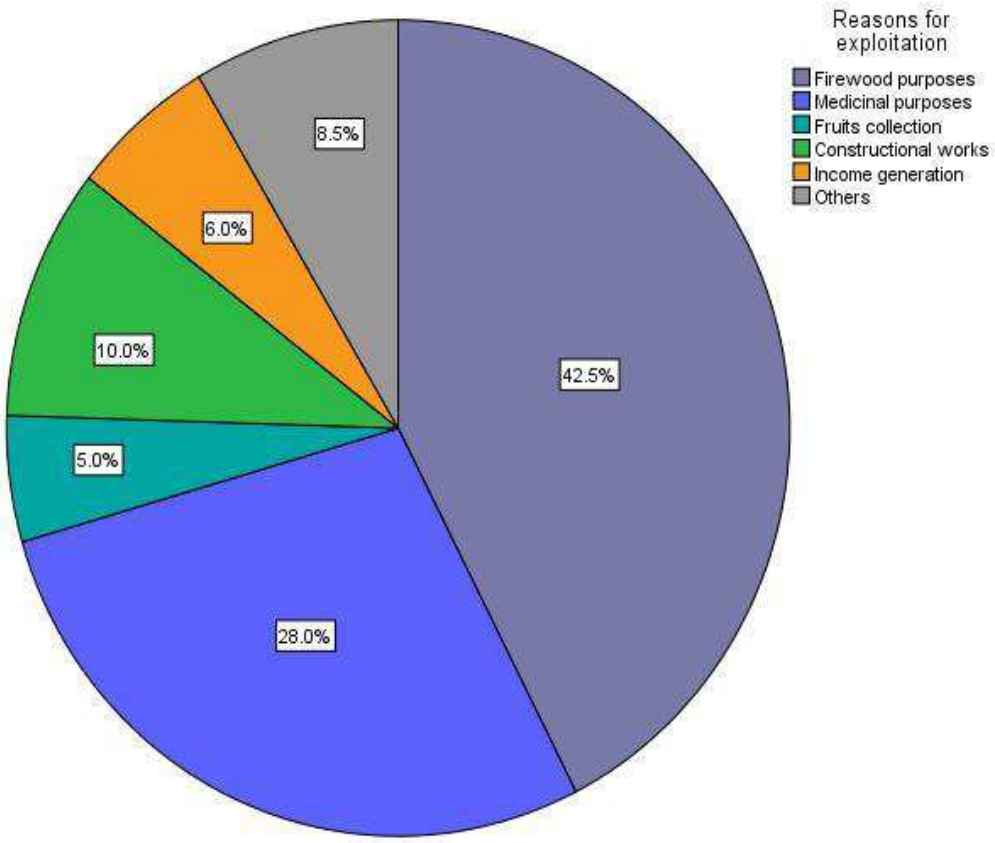

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Figure 4.2: Reasons for Exploitation of Baturiya Wetland

The reason for exploitation shows that exploitation for firewood purpose is the highest this may be due to increasing need for energy as well as income generation, followed by medicinal purposes.

Figure 4.3: below presented the possible outcome for the exploitation of Baturiya wetland. The data showed that the exploitation of the wetland causes the destruction of animal's breeding places (especially migratory birds) and extinction of some important plants (that possess medicinal and environmental protection value). More so, the exploitation would lead to changes in the period of bird's migration and later desertification. (Appendix 2, Plate I)

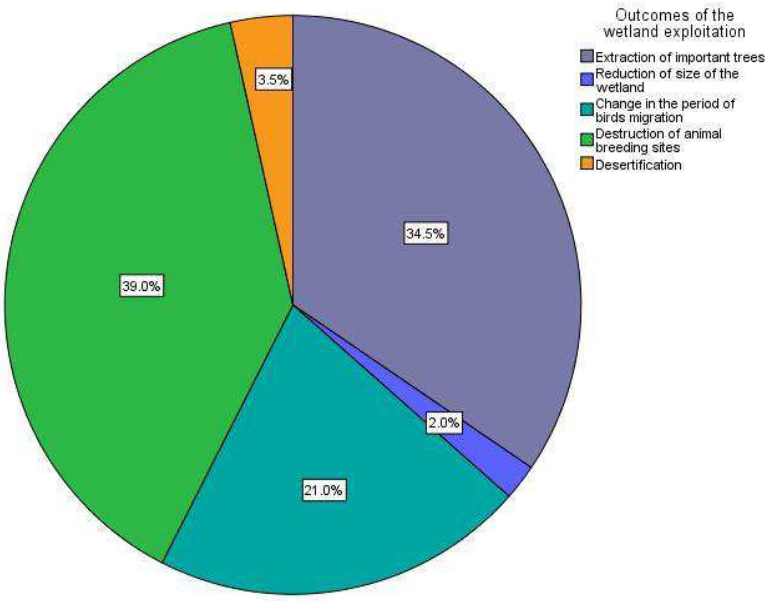

Figure 4.3: Outcome of Baturiya Wetland's Exploitation

CHAPTER FIVE

5.0 DISCUSSION

5.1 Floristic Composition and Taxonomic Distribution

The floristic composition of Baturiya wetland shows that a total of 98 species were recorded which are distributed among 42 families. The highly represented family is Fabaceae with relative frequency of 12.1% followed by Apocynaceae with 6.19%, then Poaceae and Rubiaceae with 4.12 each. The least represented family is Moringaceae with 0.32 % relative frequency. This may be due to hard seed coat or exploitation. This result can be due to the fact that the seedlings of the poorly represented species are facing inadequate conditions for growth or are being exploited by man. Plot I had more herbs, plot II had more tress, plot III had only trees and Shrubs. This may be due to fact that family Fabaceae are the most common family found in the tropics and can be found in all habitats. This finding is similar to that of (Adikhari and Babu, 2008) where a total of 178 species were recorded in Baganga wetland of India and a total of 117 species comprises of *Phragmate karka*, *Polygunum barbatum*, *Ipomoea carpa* and *Typha elephantia* were the dominant species. Similarly Prasad (2009) in his work of floral diversity in Piper Pheasant Sanctuary, Nepal, found out that the major species available at the ground level are dominated by *Potentilia fulgens,* followed by *Carex cruciate*, *Fragaria rhodendron* seedling, *Primula glomerata.* The study of plant species diversity of the upland wetland forest of Canada also indicated that, the wetland contain a total of species 280 which were sorted into five types. The strongest species were *Osmunda cinnamomea, Glyceria striata, Osmunda* regalis, *Deparia achrostichoides* and *Matteuga struthioptheris*. Compared to these: Indian (178 spp) and Canadan (280 spp) wetlands, Baturiya wetland is low in plant diversity.

The calculated diversity index of sample plot 2 was the highest with 3.678 and evenness range of distribution of 0.664. However in plot 3 the lowest is having higher diversity of 2.628 and evenness range of distribution of 0.459 which is higher than that in plot1.Generally the species diversity of the three sample plots were similar and not uniform because their level of association between the plots was also high. This may be due to the fact that vegetation can have large number of species but many of them may have few numbers of stands. Nadunga (2008) reported that the unlogged site has the highest diversity in comparison with the other sites, the forest site has a higher diversity of 1.503 followed by logged and the unlogged site with 1.195 and 1.227 respectively. These results are also similar to the earlier finding of Richards (1952), Oguntola (1981) and Etukudo (2002) that although there are usually several species in the tropical rain forest ecosystem, some families may have only one representative per hectare. Ojo *et al.* (1999) noted that, in a typical rainforest the smaller sized classes dominate, while the larger the class sizes the fewer the number. Olubode *et al.* (2002) also found out that, "thirty eight plant (38) species from 19 families were enumerated in Eleyele and Apere wetlands Ibadan, Nigeria. The result generally shows that many families are represented in the wetland

5.2 Regeneration Potential

The result shows that the regeneration potential of the sample plots were poor. It therefore has a great implication on the regeneration and conservation of the various species encountered. *Azadirachta indica* has the highest probability of regeneration potential at 6.0 followed by *Bauhinia rufescens* with 4.0 then *Hyphaene thebaica* and *Mitragyna inermis* has 2.4 and 2.3 probability respectively. This agrees with the findings of Bajpai and Omesh, (2013) found out that, species with maximum

regeneration was (0.64). However economically important plant species *Madhuca langifolia*, *Terminalia elliptica* etc have been found in poor regeneration phage of 19% and 7% species respectively. Majorly, regeneration of forest diversity depends on their biotic and abiotic characteristics (McDonald, 1977). Akinyemi *et al.* (2001) in their study of regeneration potential of savanna tree species in *Ribako* Woodland Reserve, found out that the species with the highest regeneration potential index is *Hymenocardia acida* with 0.23 probability of regeneration. Similarly, Oduwaiye *et al* (2002) also indicated that the regeneration potential of Okomu forest was poor and most of the economically important plants have zero regeneration potential.

5.3 Canopy Area

The result indicated that there is high canopy area in plot I with 23.7 m^2 canopy cover, but the canopy cover was generally low The result supported the work of Vanderwalk, (2006) who reported that, the plants canopies alter light regimes, water temperatures, oxygen concentrations, water chemistry etc. The direct and indirect effects of plant canopies ultimately determine the spatial and temperature distribution of most organisms in wetland. Pham and Mitholner (2011) also stated that, abundance of seedlings was strongly influenced by the height of canopy trees, shrubs cover, shrub height, and canopy area and tree density. Akinyemi *et al.* (2001) reported that, for a successful reestablishment of seedlings, effective control of weeds, removal of dense canopy cover will have to be adopted as part of sericulture management.

5.4 Soil Bulk Density

The soil bulk density of all the sampled four plots were almost the same with highest soil bulk density of 1.87 in plot I and the lowest of 1.75 g/cm^2 in plot 1, 2 and 3. This indicated that, overall soil bulk density of the study area is high. Hauston *et al.* (2002)

stated that, the difference in bulk density between land uses is caused by the continuous cultivation of the soil which causes the soil structure to decline. It means that, the bulk density is generally high and the soil compaction is also high. This can bring negative impact on plant growing in the area.

5.5 Relationship between Regeneration Potential, Canopy Area and Soil bulk Density

The result shows that there was no significant relationship between the regeneration potential of trees and canopy area but there was a significant relationship between soil bulk density and regeneration potential. This may be due to the high soil bulk density which make the soil compacted and make it less porous for passage of air and water.

5.6 Human Exploitation

The result indicated that, most of the respondents were adult, and majority of them were men, economic activity within the wetland appears to be mainly in the hands of men. This may be due to the fact that, the prevailing culture of the area requires men to be the ones to cater for the family. It also indicates that adults were more interested in the wetland than children of the same communities; this may not be unconnected to the fact that children are less concern about income generation and most of the exploitation exercise is laborious.

About 93% of the respondents were aware about the exploitation of the wetland and the reasons for exploitation were mainly for fuel wood, medicinal purpose, constructional work and income generation.

Community interaction of the Baturiya wetland shows the respondent's age range between 21-39 years. This indicates that, people of this age are the ones taking part in active interaction of the wetland because it entails laborious work, similarly, low

involvement of respondent of ages 50 years and above is not unconnected with the fact that, people in this age class cannot function actively in the interaction with the wetland.

The reasons given for exploitation of the wetland revealed that, the respondents in the study area are in one way or the other engaged in cutting trees for firewood purpose, medicinal purpose, fruit collection, constructional work, income generation, firewood purpose has the highest number of respondents (42.5%) followed by medicinal purpose with (28%). The implication of this result is that exploitation for firewood and medicinal plant can lead to reduction of the exploited species.

Exploitation for medicinal purpose or firewood where parts of the roots are removed the risk of species exploitation become higher, since the plants are becoming over stressed and cannot regenerate easily. Similarly, the species whose stem or barks were extracted are not allowed to attain reproductive stage; they are usually subjected to inimical condition. Species of economic importance such as medicinal and aesthetic values can be kept in perpetuity in a well preserve forest (Oduwaiye *et al.,* 2002).

CHAPTER SIX

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

The vegetation of Baturiya wetland is not uniform with dissimilar diversity among the plots surveyed. Soil bulk density were high, soil compaction was also high. Regeneration potential was low and exploitation for economic purpose was high. Canopy areas of mother trees seem not to lend support to regeneration and soil bulk density seem not to support regeneration. The high biodiversity is threatened and the wetland is therefore at risk.

Proper management of Baturiya wetland is highly important because the wetland performs a number of economic and ecological functions which are of local, national and international significance. From the research it was observed that plant species were expose to a great threat to exploitation, conservation of the diverse species in which the area is rich is limited.

6.2 Recommendations

The socio economic activities of the communities living around the forest reserve should be given appropriate attention by creating buffer zones where they can easily utilize their forest reserve unhindered without harming it. Declaration of strict nature reserve and frequent vegetation survey during all season is also recommended. People attitude need to be changed through awareness campaign to the communities encouraging natural tree regeneration. The wetland reserve lacks the services of trained personnel, there is a strong need for the staff to be exposed to global best practice in the management of wetlands. There is also need for adequate funding by the government for proper management.

Multiple uses of concepts in forest management will provide a way of regenerating the forest to provide for the people on sustainable bases.

It is necessary to understand the phenology of the forest reserve as well as study whether seeds or fruits produced are under adequate physiological conditions to geminate and grow into seedlings for regeneration purpose.

The country's wetland resources need to be properly identified and mapped. Moreover, the right legislation and policy framework has to be put in place and enforced to safeguard the wetland from ongoing wanton destruction. The federal and state governments need to provide alternative source of energy like solar, kerosene, biogas e.t.c. to the rural communities

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APPENDICES
Appendix 1

QUESTIONNAIRE
DEPARTMENT OF BIOLOGICAL SCIENCES
AHMADU BELLO UNIVERSITY ZARIA

This is an MSc research on "floral diversity and conservation status of Baturiya Wetland". You can respond to each question with good heart as your response is to be treated confidentially. The research is not meant to humiliate anybody. Your kind response is highly needed by ticking appropriate answer.

Section A: Socioeconomic Characteristics of the Respondent

1. Age
2. Gender Male Female
3. Occupation

Section B: Exploitation of the Wetland

1. Are you aware that Baturiya Wetland is under exploitation
   Yes No
2. If your answer to the question one is "Yes" on what reason to your understanding the Wetland is being exploited?
   (You can choose as many options as appropriate)
   i. Fuel wood purpose
   ii. Medicinal purpose
   iii. Fruit
   iv. Constructional work
   v. Income generation
   vi. Others (specify) --------!

Section C: Respondent Option on Exploitation of the Wetland

1. What do you think is the direct outcome of the exploitation of the exploitation to the community around the wetland?
   a. Extinction of some important plants
   b. Reduction of the size of the wetland
   c. Change in the period of bird's migration
   d. Destruction of bird's and other animals' breeding step
   e. Desertification

Appendix 2

Plate I: Cutting of Doum Palm Leaves

Plate II: Collection of Doum Palm Leaves

Plate III: Exploitation for Fire Wood

Plate IV: Measuring Canopy Area

Plate V: Enumeration of Parent Trees

Plate VI: Side view of sample plot 1

Plate VII: Side view of sample plot 2

Plate VIII: Side view of sample plot 3

Plate IX: Cutting of Branches

Plate X: Canopy Cover