INFLUENCE OF DIFFERENT LAND USE TYPES ON BIRD AND TREE SPECIES DIVERSITY AROUND LAKE VICTORIA BASIN IN BUKOBA MUNICIPALITY, TANZANIA

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ABSTRACT

Following a notable loss of biodiversity around Lake Victoria Basin in Tanzania, caused by fast population growth and unsustainable land uses, a study aiming at understanding the influence of different land use types on bird and tree species richness, abundance and diversity in Bukoba Municipality was initiated. The choice of the two biota was made based on the fact that avian and tree communities are good indicators of overall biodiversity and environmental decline or recovery. In identifying the types of land uses, two methods were used, which were direct observation and focus group discussion. The types of land use identified were home garden, fishing zone, open grassland, forest reserve and settlement. Bird and tree data collection in all land uses involved two methods, which were transects walk and direct observations. The data collected were about types and number of bird and tree species in each land use type. The data were analyzed by Microsoft excel, PRIMER 6 and Diversity programme 2007. The results showed that the Shannon-Weaver indices of bird diversity for homegarden, fishing zone, open grassland, forest reserve and settlement were 2.855, 2.793, 2.5, 1.791 and 2.054 respectively. The Shannon-Weaver indices of tree diversity for homegarden, fishing zone, open grassland, forest reserve and settlement were found to be 1.973, 0.7857, 1.726, 2.087 and 1.877 respectively. The results further showed that fishing zone land use had high bird diversity, while the highest diversity in tree species was noted in forest reserve land use. Therefore, the study concludes that there is greater variation in species richness between land uses, showing how each land use has an influence on species abundance, richness and diversity in the area. Again, increase in human population was seen as the problem in the maintenance of different land uses. It is recommended that deliberate, steps should be taken to maintain these land uses to their natural state, despite of the increase in human population, so as to maintain the habit of both bird and tree species.

DECLARATION

I, REGINA MUTALEMWA, do hereby declare to the Senate of Sokoine University of Agriculture that this dissertation is my own original work done within the period of registration and that it has neither been submitted nor being concurrently submitted to any institution.

_____ _____

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Prof.Patrick P.L.Mwang'ingo Date

(Supervisor)

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DEDICATION

This work is dedicated to my lovely parents Mr. and Mrs. Method Mutagahywa Mutalemwa

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LIST OF ABBREVIATIONS AND SYMBOLS

ANOVA	Analysis of Variance
BMC	Bukoba Municipal Council
EAC	East African Community
FAO	Food Agriculture Organization of the United Nations
FGD	Focus Group Discussion
ha	Hectare
i.e	that is
m	metre
MEA	Millennium Ecosystem Assessment
N	Number of species
SNAL	Sokoine National Agriculture Library
SNR	School of Natural Resources
UNEP	United Nations Environment Programme
UNU-NWEH	United Nations University – Institute for Water, Environment and Health

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

Lake Victoria basin is endowed with abundant natural resources, which provide livelihoods for rural people in three countries (Kenya, Uganda and Tanzania). These resources contribute significantly to the respective countries national economies either through direct sales of the resources (like fish) or by playing a role in food security. In addition to fish, the basin plays a big role in agricultural production through cultivation of various subsistence and cash crops (Maitima *et al.,* 2010). Agriculture and other related activities in the basin have created a number of changes in land use and impact on land degradation. Usually land degradation associated with such changes in land use occur so creepily, making land managers hardly contemplate initiating ameliorative or counterbalance measures (Maitima *et al.,* 2010). Basically, poor land management has degraded vast amounts of land, reduced our ability to produce enough food, and is a major threat to rural livelihoods in many developing countries. Land use in the basin of lake Victoria like other parts of East Africa are changing fast (Maitima *et al.,* 2010).

Land use involves the management and modification of land as natural environment or wilderness into built environment such as settlements and semi natural habitats such as arable fields, pastures, and managed woods (UNEP, 1999). It describes the economic use of land and surface features (Campbell, 2007). Land use and its management have a major impact on natural resources including water, soil, nutrients, plants and animals and tend to vary from one country to another (Wood *et al*., 2000). Land use could result into complete transformation, such as transforming a forest land to the settlement land or it could involve partial transformation through retaining the primary status of the land such as vegetation covers (Christopher, 2003).

The various uses of land for economic purposes have greatly transformed land cover at a local and global scale (Turner *et al*., 1994). In using land to yield goods and services, humans alter ecosystems and their interactions with the atmosphere, aquatic systems, and surrounding land (Vitousek *et al*., 1997). Land scarcity and population pressure, weak governance and lack of alternatives force people to cultivate and inhabit marginal lands including lake, river banks, wetlands, forests and steep slopes, all of these lead to destruction of habitats for living organisms (Drakenberg, 2007). Land uses changes are known to be key drivers of biodiversity loss where by indigenous trees decrease leading into increase in exotic plant species. It also leads into disappearance of many bird species (Misana *et al.*, 2003 and Soini, 2006).

It is known that tree and bird species are most sensitive to change and hence the most critical indicators of the biodiversity impact of land use conversion (Bolwig *et al.,* 2006). Lake Victoria basin is among the areas that are in severe land transformation due to various human economic activities. These have resulted to intensive degradation that has transformed most of the natural environment, which in turn influence rate of biodiversity loss (Drakenberg, 2007).

1.2 Problem Statement and Justification

The biodiversity especially birds and tree species around Lake Victoria basin are under pressure due to fast population growth, agricultural expansion, persistence in land degradation and unsustainable land uses (FAO, 2013). Land uses impacts on the biodiversity also affects the livelihoods of the local population since they largely depend upon natural resources for their living (FAO, 2013). Increase in human population and per capita consumption are likely to lead to the great increase in agricultural demand (Godfray *et al.,* 2010) which could lead to further habitat destruction, loss of ecosystem services, ecosystem simplification and species loss (Tilman *et al.,* 2000).

Various studies on birds and tree species diversity such as, Naidoo (2004), Soini (2006) and EAC (2007), have been conducted in different parts of Tanzania including Lake Victoria Basin. Most of these studies do not provide information on bird and tree species abundance, richness and diversity in relation to land uses. This study aimed at understanding the influence of different land uses to bird and tree species richness, abundance and diversity by comparing bird and tree species diversity in the main land uses categories of the study area. Avian communities and tree species have been found to function as indicators of overall biodiversity and environmental decline or recovery (Canterbury *et al*., 2000; Chase *et al*., 2000), and thus their distribution should give an indication of the general biodiversity levels of the main land use categories of the study area.

Generally, the information derived in this study is intended to gives the indication on the conservation condition of the study area. It give the status of birds and tree inhabiting the area in terms of abundance and diversity, as well as to provide useful information to different stakeholders including conservation organizations, local government authorities, local communities, regional Natural Resource Managers and academicians in managing the area. It provides information that facilitates the planning and development of effective conservation measures concerning the trees and birds species richness and diversity.

1.3 Objectives

1.3.1 Overall objective

The overall objective of this study was to assess the influence of different land uses on bird and trees species abundance, richness and diversity around Lake Victoria basin in Bukoba Municipality.

1.3.2 Specific objectives

The specific objectives of this study were:

i. To document the land use types in the study area so as to understand the land use categories existing in the area.
ii. To assess bird species abundance, richness and diversity in different land use types so as to understand the status of bird species existing in the area.
iii. To assess tree species abundance, richness and diversity in different land use types so as to understand the status of bird species existing in the area.

1.3.3 Hypothesis

1. Ho: Different land use types does not influence bird species abundance, richness and diversity
2. Ho: Different land use types does not influence tree species abundance, richness and diversity

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Land use and its Varieties

Land use in the basin of the African Great Lakes is mainly subsistence farming, with more than 80 % of the population being engaged in agricultural production (Odada *et al.,* 2004). Although land use practices have largely been influenced by culture and seasonality of water, emerging trends reflect the influence of the introduced technologies. This has led to threats to the recovery mechanisms of the ecosystems (resilience), and subsequently species diversity and abundance (UNU-INWEH, 2011).

A study conducted in the Lake Tahoe Basin by Forney *et al*. (2001) documented urban, forest, agriculture, rangeland, wetlands, water, and barren lands as of major land use types. Other minor land use types include residential, commercial, industrial, and so on. Another study conducted in Musoma around the lake basin by Musamba *et al*. (2011) indicate that, the main land use types were fish landing areas, farms, commercial areas, industrial areas, infrastructures, settlements, area for recreation and spiritual activities. Also a study conducted by Nindi (2007) in the basin of Lake Nyasa identified two types of land uses, which were agricultural and fishing activities.

According to Imo *et al*. (2001) home garden is among the land use found around lakes basin. It's an agroforestry farming system in which coffee (*Coffea arabica*) and banana (*Musa spp*.) are the main crops. Many other food crops are grown and plenty of trees are integrated in the system. The most conspicuous trees and/or useful species for the farmers include *Albizia spp*., *Cordia holstii*, *Croton macrostachys*, *Grevillea robusta* and *Rauvolfia caffra* (Soini, 2005). Sometimes flowers are grown for decoration close to the

house. The haya homegarden has a lot of open space covered by scattered trees of many species, both indigenous and exotic, flowerbeds, and a hedge partly around. The number of trees decreases as more land is needed for houses, yards and vegetable gardens (Soini, 2006).

Homegardens are considered to be the richest in species diversity per unit area. Several landraces and cultivars, and rare and endangered species have been preserved in the home gardens (Watson and Eyzaguirre, 2002; Kumar and Nair, 2004). However, species richness in home gardens within region is influenced by homestead size, structure, climatic conditions, and market and socio cultural forces.

Forests as one of the land use in Lake Basins have been relied upon as a source of livelihood to provide both wood and non-wood forest products, yet their value is gradually declining due to changes in the land cover (Nampindo *et al.,* 2005). The changes are largely caused by the people living in and around the forests due to the increase in population. The demand of land for settlement increases, which force people to establish new settlement around the forests (Winterbottom and Eilu, 2006). This disturbs the forests ecosystem and ecosystem services (Shvidenko *et al.,* 2005). Due to their direct use and market value, forest goods, in particular wood, have been the object of more demand than other benefits provided by forests, such as soil stabilization (Liu and Diamond, 2005), climate regulation (Malhi *et al.,* 2008) or biodiversity (Barlow *et al.,* 2007). Production targets instead of conservation targets have often shaped these new forests (Koch and Skovsgaard,1999), which are frequently monocultures often composed of introduced species, a design that generally does not promote biodiversity (Hartley, 2002), because biodiversity has a key role in sustaining ecosystem services and promoting ecosystem resilience (MEA, 2005). As a result, production forests with low biodiversity tend to be

more vulnerable to disturbance and environmental change than natural forests (Bassi *et al.,* 2008).

A study conducted by Musamba *et al*. (2001) identified fishing zone as the main land use along Lake Basins. Fishing zones are characterized with many landscapes and are increasingly recognized as key areas for biodiversity conservation (Palmer and Bennett, 2006). A combination of aquatic and terrestrial fauna and flora in fishing area ecosystems contributes towards its complexity and heterogeneity. Due to human population growth, intensified developments, and increased anthropogenic activities, there is an inevitable expansion of urbanization which leads to the decrease in the size of fishing zone.

Urbanization is characterized by dramatic land use transformation and leads to the conversion of land cover from a natural to an urban environment (Walker *et al*., 2008). Urbanization is a dominant process, which affects ecological community structures and population dynamics, and generates unique assemblages of organisms (Hostetler, 1999). For this reason, urbanization is regarded to have some of the most severe impacts on the environment.

2.1 Birds Diversity in Relation to Land Uses

The studies of birds such as their ecology, habitat requirements and how they are affected with altering the world biomes are important for conservation strategies of the species and biodiversity in general (Ngongoloand Mtoka, 2013a). Birds have been used as source of income (Ngongoloand Mtoka, 2013b) and key model for measuring the quality of the altered biodiversity where diversity of bird is influenced by habitat stability. In bird community different land use system indicates, the changes in vegetation structure had strong influence in bird community structure (Beletsky, 2006). Altitude is also among the

factors for variation in birds' species diversity (Benton *et al*., 2003). Many researches on bird diversity emphasize the general negative effects of forest conversion to human dominated habitats (Castelletta *et al*., 2000). However, human dominated habitat and agricultural habitats vary a lot and therefore the effect on birds can be very different. According to Tworek (2002) responses of birds to habitat changes differ depending on their strategies.

Some bird species depend on the disturbed habitat for food and shelter such as homegarden. Reduction in their habitats therefore forces the species to migrate to other areas permanently. The composition of species in a home garden is governed by many factors that make home garden a dynamic system. The ecology and local food culture are the one which influence the diversity of bird in home garden (Hodel *et al.,* 1999).

Replacement of forests by agriculture and residential–urban development reduces, subdivides and isolates breeding habitat required by forest interior birds. Species requiring contiguous forest tracts above some minimum size therefore tend to disappear from highly fragmented landscapes (Robbins *et al.,* 1989). Naidoo (2004) studied bird diversity across different stages of forests in Mabira forest in Uganda and found that tree density is the only vegetation variable that is a significant predictor of the number of bird species. Another reason that may also explain differences in the richness of birds, in particular forest birds, between forest types is the availability of food, a factor that can also be related with forest structure (Proença, 2010).

Grassland natural habitats have been unprecedentedly altered (Toogood *et al.,* 2008) and unfortunately the impacts of these changes on bird community composition; structure and diversity are yet to be fully understood (Ntongani and Andrew, 2013). It should however

be remembered that the failure to understand the consequence of changes in these natural habitats is likely to increase the human pressure on open grassland natural resources including birds (Bibby *et al.,* 2000). The declines of grassland bird populations have been a topic of concern for at least two decades. As these declines persist, managers and researchers continue to investigate ways to create and improve grassland habitat (Sauer *et al.,* 2011). Also the grassland bird community relies on heterogeneity in nesting substrates. Grassland obligate species (Vickery and Herkert, 1999) often place nests directly on the ground in forbs, grasses or litter.

At fine scales, bird diversity in open grassland appears to be influenced by factors including cover of plant functional groups and litter, and the density and height of vegetation (Fisher and Davis, 2010). Specifically, it is often assumed that native warm-season grasses should attract greater abundances of birds than non-native cool-season grasses. At the landscape scale, land cover and landscape configuration appear to influence habitat selection of grassland birds (Winter *et al.,* 2006; Davis *et al.,* 2013). Many species of grassland birds avoid small grassland patches (Ribic *et al.,* 2009), because they often avoid sites surrounded by cropland or forested habitat (Cunningham and Johnson, 2006). At finer scales, nest-site selection is an important fact of habitat selection during the breeding season (Lima, 2009).

Fishing zone ecosystems are often more dynamic, diverse, and complex than the surrounding landscapes and encompass sharp environmental gradients in ecological processes and communities (Naiman *et al*., 1993). These ecosystems are often surrounded either by natural, urban, industrial, or agricultural landscapes. These surrounding landscapes influence avian diversity, populations and communities. Birds and other fauna make use of fishing area ecosystems, both as corridors and habitats. A corridor is a linear

landscape element that provides a passageway for animals between habitats patches (Rosenberg *et al*., 1997). Birds use corridors for movement between habitats where they live and reproduce, but the corridors themselves are not necessarily used for reproduction (Rosenberg *et al*., 1997). Therefore, not all requirements for residency and breeding may be met in a corridor, whereas all survivor requirements must be present in a habitat (Rosenberg *et al.,* 1997).

Corridors are critically important within urban environments due the fragmented nature of the surrounding landscapes, as many species need to move within these corridors to locate less fragmented habitat patches where they can breed. Fishing zone ecosystems consist of a variety of different habitat type's favorite to many birds' species. The formation and stability of these habitats are greatly influenced by the ecosystem itself (Naiman *et al.,* 1993).

Human dominated lands can have conservation value (Rosenzweig, 2003). In residential ecosystems, people have the collective potential to strongly influence bird population dynamics, directly or indirectly, intentionally or unintentionally, through landscaping and bird feeding practices (Lepczyk *et al.,* 2004; Cooper and *et al.,* 2007; Lerman and Warren, 2011). In settlement, the major human factors that negatively affect bird species are habitat alteration (removing, fracturing, and changing vegetation) and introduced species predators, including domestic pets, and competitors (Chace and Walsh, 2006). These factors, however, are mostly indirect i.e., the human actions are not aimed at the birds themselves. Humans can also have direct negative effects on birds, such as physical disturbance e.g., approaching and hunting (Campbell, 2006; Moller, 2008; Casas *et al.,* 2009). Humans also can have a positive effect on birds for example, humans provide

supplementary resources in urban areas through direct (bird feeders) and indirect e.g. garbage supplementary feeding.

2.3 Tree Diversity in Different Land Uses

All forms of land use involve the utilization of land resources for human benefit. Trees are one of the land resources that are more often the target for human utilization. Land use may therefore have direct effects on trees, especially when the land use involves the harvesting or modifying the land cover (Olson *et al*., 2004). From a world perspective, agricultural expansion and infrastructural development highly influence the loss of tree species. Frequent burning for the regeneration of pastures is also favoring certain undesirable species and loss of some other tree species (Robe *et al.*, 2013).

In addition, diversity of trees and shrubs in home garden systems contributes to provision of wood and non-wood products, and protects the environment, thereby, enhancing socioeconomic and ecological sustainability of the systems (Abebe, 2005). The abundance, diversity and richness of trees are influenced by physical and socioeconomic factors. The major physical factors are geographical distance between sites and differences in altitude of farms. The most important socioeconomic factors are farm size and access to roads which facilitate market opportunities to tree products. Native trees are largely been replaced with new cash and fast growing exotic tree species which endanger the integrity and complexity of the system responsible for its sustenance which often cause many home garden farms to decrease in the diversity of native tree species (Abebe, 2005).

Habitat loss, fragmentation, and degradation are currently the most important threats to biodiversity conservation worldwide (Cannon *et al.,* 1998). Human activities have been widely reported to contribute more to this problem compared to natural factors (Putz,

2002). Tropical forests especially those located in developing countries are more vulnerable following the fact that the majority of communities adjacent to the forest are poor and depend directly on the forest resources to sustain their livelihood (Shackleton and Shackleton, 2004). Unsustainable use of forest resources, for example, logging and shifting cultivation, has potential impact on its ecological function due to sudden changes on their structure and composition (Denslow, 1995). The emergence of invasive species and loss of ecosystem services resulting from the occurrence of many woody pioneers and herbaceous species have been observed in several disturbed forest ecosystems (Eichhorn, 2006). Opening of forest canopies in the logged or burnt forests increases light levels which in some cases positively influences diversity of trees (Pinard *et al.,* 2000). Understanding the factors related to human disturbance that affect the tree biodiversity and forest vegetation structure can help conservation managers to suggest best forest management practices in ways that can best protect these values (Pickett, 1998).

Due to the increase in population growth in most areas around the world, utilization pattern of open grassland resource has been transformed; the grassland itself still serves multiple functions. Grassland is the key component to the most of the farming system, since it has always played an essential role in the subsistence economy and culture. Open grassland provides cattle with feeding grass, which at last benefits the farmer in the form of manure. It also provides mulch which is recently more applied to farms with less available manure (Stone, 1996).

Moreover, indigenous farming systems with intensive land use have developed in densely populated communities. In such cases, settlement pattern becomes less fluid as land resource is limited. In central Nigeria, the Kofyar have intensified farming due to population increase during the last century (Netting, 1993; Netting *et al.,* 1993).

Man has altered fishing zone of lakes at rapid rates across a large portion of the landscape, first by logging and more recently by lakeshore development. In the upper mid-western United States, forest stands have recovered, more or less, in previously logged areas and now sustain second growth forests. As a result, trees again recruit to lakes by a variety of natural processes and anthropogenic events. In contrast, along developed shorelines of lakes, many riparian landowners have removed some or all trees from both land and water. In so doing, the act has eliminated the beneficial uses provided in natural systems, as it is to other perturbations which cause the tree species to decrease in these areas.

Most of the trees planted in settlement land use are exotic trees and their flowers are used for providing shades and decorating the house. Trees in settlement land use are usually small due to small land sizes (Stoffberg *et al.,* 2010). The reduction in numbers of trees in towns and around towns is a common phenomenon (SNR, 2005), due to development and high collection of fuel wood for energy (Kalaba *et al.*, 2009). As more people migrate into urban areas, the demand for tree products is expected to increase (UNEP, 2002; Malimbwi *et al*., 2010), potentially resulting in overexploitation and depletion of tree resources (Malimbwi *et al*., 2010). Therefore, given the higher number of people moving into urban areas, more land is converted into residential areas (Openshaw, 2010) and many trees are cut down to build houses (Padoch *et al.*, 2008).

However, various studies on birds and tree species diversity such as, Naidoo (2004), Soini (2006) and EAC (2007), have been conducted in different parts of the world including Tanzania around Lake Victoria Basin. There are is a missing data on bird and tree species abundance, richness and diversity in relation to land uses. Hence, this study aimed at exploring the influence of different land uses to bird and tree species richness, abundance and diversity in the main land uses categories of the study area.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Description of the Study Area

3.1.1 Location

The study was conducted in Bukoba Municipality which lies between $1^{o}6'0"$ to $1^{o}8'42"$ S and $31^{o}16'12"$ to $31^{o}18'54"$ E at an altitude of 1150 m above the sea level. The Municipal has a total area of 80 square kilometers of which 22 km^2 is covered by water and the remaining 58 km^2 is a dry land. Much of the town structure is at the basin surrounded by escarpment invariably decorated by coffee and banana plantations, trees and rocks. According to the 2012 National census, the Municipality had a total population of 128,796 people (URT, 2013).

3.1.2 Climate

The area receives bimodal pattern of rainfall with an average of 2000 mm per annum. There are also spills of rain which account for the secret of Bukoba being evergreen the whole year. Temperature range from 22 to $27^{o}C$ in the month of October to March, but in some period the temperature rises up to $35^{o}C$. During June to September temperature could fall up to $20^{o}C$ (BMC, 2011).

3.1.3 Vegetation

Much of the region is hilly terrain with thick tropical vegetation including forests and wide-open grasslands. The vegetation of the town consists of both indigenous and exotic tree species. Indigenous species include *Maesopsis* (*Mihumula*) and *Markhamia spp*

(Mishambya), while exotic tree species which prove successful in the area are *Grevellea Robusta, Pinus species, Senna apectabilis* and *Senna Siamea* (BMC, 2011).

3.1.4 Major economic activities

A substantial area of Bukoba Municipality is fully utilized for subsistence farming to enable the inhabitants to earn their living. Tea and coffee are the major cash crops grown in the area. Banana, maize, sweet potatoes, cassava and yams are the main food crops especially for the majority of the people in greenbelt. They are also keeping livestock and conducting fishing activities. Others are engaged in business activities or employed in formal sectors such as education and health (BMC, 2011).

3.2 Sampling Procedure and Data Collection

3.2.1 Study site sampling

All three wards located around Lake Victoria basin in Bukoba Municipality which includes Bakoba, Miembeni and Kahororo were selected. From each ward purposive sampling was used to select one street, basing on the fact that it was located close to the lake basin. Purposive sampling method was used to select the dominant land uses in each street through voting for the dominant land use types. This was done during group discussion.

3.2.2 Documentation of land use types

In documentation, the types of land use in each street, two methods were used which were direct observation and focus group discussion. This was done during the reconnaissance of the study area to identify the types of land use available in the study area. Focus Group Discussions (FGD) involved selected street elders, street leaders and ward leader. The selection was based on the position, knowledge and opinions and views of the individuals on land use of the study area and other important required information. Eight people were

selected in each ward. These people were combined during the discussion so as to allow triangulation of views and opinions. Focus group discussion guide was prepared in advance to facilitate the discussions which consisted of ten questions (Appendix 1). It contained themes and guiding questions covering specific objectives of the study. The discussions were held in a place and time that was suggested by participants. Review of different document from the internets, SNAL and Bukoba Municipal office, which consisted information on the land uses types. The document reviewed from Bukoba Municipality was the land use plan for Bukoba Municipality in 2007.

3.2.3 Birds sampling and data collection

3.2.3.1 Bird species sampling

Line transect sampling was used whereby three transect line were established in each land use type with the exception of settlement land use type where two transects were established due to the small size of the area. Homegarden area was sampled with three routes; the first route was in the upper part of the homegarden with approximately distance of 2000 m. The second route was in the lower land with 1500 m, while the third route was established in middle part of the home garden with 600 m.

Fishing zone was sampled with three transect, the first transect was located in Makongo and had a distance of 1600 m, while the second transect was located in Kafuti and had a distance of 2500 m. The third transect was located in Miembeni and had 600 m.

Three routes were established in open grassland where by the first transect had a distance of 720 m. The second transect had 740 m, while the third had 600 m. In forest reserve, the first transect had 400 m, the second 600 m, while the third transect had 1000 m. In the

settlement only two transects were established because the area was small. The first transect had 600 m and the second transect had 700 m.

3.2.3.2 Data collection on bird species

The data were collected along the transect lines where direct observations of birds was done. For each transect, an observer recorded any bird species and numbers in the area with the aid of binoculars. Timed walks were used, four to five hours in the morning starting from (6:00 am to 10:00 am) when the activities of birds were most prominent (Hill *et al.,* 2005). The birds at a distance of 30m in all directions along the transect line were counted and recorded. Binocular was used to observe birds falling within 30m from the transect line. Field guide books by (Williams and Arlottin, 1982) and (Hosking and Withers, 2006), and bird identifier were used to identify names of birds. The birds were counted and recorded in the data sheets by their common names and scientific names. For those species which were difficult to make quick identification, photograph and/or note taking on colour and shape of various parts of the bird body were done for later identification. The data were collected in four days per week in each street.

3.2.4 Tree species sampling and data collection

3.2.4.1 Tree species sampling

Line transect sampling was used according to Safranyik and Linton (2002). Line transect is potentially useful method for estimating the abundance of a wide range of objects, including immobile objects such as trees in the forest. Three transect line were established in each land use type with the exception of settlement land use type, where only two transects were established due to the small size of the area. In homegarden land use the first route was established in the upper part of the homegarden with a total length of 2000m. The second route was in the lower land with a distance of 1500 m, while the third

route was established in middle part of the homegarden and had a total of 600 m. In fishing zone land use the first transect was located in Makongo with a total distance of 1600 m, the second transect was located in Kafuti and had a length of 2500 m, while the third transect was located in Miembeni with 600 m. In open grassland land use the first transect had a total length of 720 m, the second transect had a length of 740 m and the third had 600 m length. In the forest reserve, the first transect had 400 m length, the second 600 m length and the third transect had a total length of 1000 m. In the settlement only, two transects were established because the area was small. The first transect had 600 m length and the second transect had 700 m length.

3.2.4.2 Data collection on tree species

For each transect, an observer recorded all tree species and numbers in the area which falls within a distance of 30m in both directions along transects. The data collected were types of tree species available and the number of trees and frequency per transect in each land use type. A key informant (botanist and local botanists) was used to identify the trees with their local name, and field guide book by Kanywa (1986) which consisted of the name of trees in local names and botanical name was used to identify the botanical names of tree species.

3.3 Data Analysis

3.3.1 Data analysis for bird species

The birds' species were identified and their abundance, richness and diversity were determined. The data were entered and summarized in Microsoft excel spread sheet and then exported to PRIMER 6 and Diversity programme 2007 computer software for analysis. Tables and figures were used to present the results. One way ANOVA was used to determine whether there was a significant difference at ($p<0.05$) between land uses in

term of abundance. Richness, similarity and diversity index were computed by the following formulas:

Species diversity

The species diversity for both birds and trees were analyzed by using Shannon Wiener index (H′) by using the following formula

$$H' = -\sum_{i-1}^{s} P_i \ln P_i$$

…… (1)

Where: H′= Shannon's diversity index, pi = proportion of species, i = from the total sample, ln= natural logarithm and S = number of species (Beals*et al.,* 2000; Rojas, 2003).

Species richness

Species richness was obtained by counting the total number of bird and tree species available within the area.

Species similarity

Sorensen similarity index was used to compare the similarity of bird and tree species between land use categories. It measures similarity in species composition (Magurran, 2004) for two sites, A and B, by the Equation:

$$C_{s=} \frac{2ab}{a+b}$$ …… (2)

Where, a is the number of species found in site A; b is the number of species in site B and ab is the number of species shared by the two sites.

3.3.2 Data analysis of tree species

The trees' species were identified and their abundance, richness and diversity determined. The data were entered and summarized in Microsoft excel spread sheet and then exported to PRIMER 6 and Diversity programme 2007 computer software for analysis. Tables and figures were used to present the results. One way ANOVA was used to determine whether there was a significant difference at ($p<0.05$) between land uses. The status of species diversity, richness and similarity data was analyzed by the use of Shannon diversity index and Sørensen similarity index as summarized in the above formula

3.4 Assumptions of Study

- The counter considered the birds observed within a distance of 30m in both direction along a transect line
- During the study the distance was estimated accurately
- Birds were 100% detected from observer location
- Birds didn't move from their snapshot location before detected and identified

3.5 Limitation of Study

- Poor visibility due to dense vegetation which was hindering the collection of data, and failure to walk in a straight line due to the terrain and obstructions these caused the Researcher to opt collecting the data by standing at a certain angle in order to capture the missed data.

CHAPTER FOUR

4.0 RESULTS

4.1 General Overview

This section presents the results of land use types documented in the study area, with the abundance, richness diversity and types of birds and native tree species in each land use type documented. Here a land use type is defined as not only the actual cover of land with vegetation, but the functional use of land and the social values attached to the different land use types.

4.2 Documentation of Different Land Uses and their Varieties

A total of five land use types were documented in the study area; they included home garden land use which consisted of houses surrounded by trees/shrubs in intimate interaction with agricultural crops, food crops such as banana, cassava, yam and cocoyam and/or animals. Settlement land use consisted of houses in proximity with native trees and exotic trees. Fishing zone land use consisted of wetlands surrounded by native trees and exotic trees all together running across the lake shores. Forest reserve land use consisted of exotic trees and native trees with some few shrubs, while open grassland consists of native trees, exotic trees, shrubs, cultivation and grazing lands.

Table 1: Land use type around Lake Victoria basin

	Ward		
Land use types	Kahororo	Miembeni	Bakoba
Homegarden land use	✓		✓
Fishing zone land use	✓	✓	✓
Settlement land use		✓	
Open grassland land use	✓		
Forest reserve land use			✓

4.3 Bird Species

4.3.1 Bird's abundance in different land uses

A total of 1970 individuals' birds were seen in all land uses (detail in appendix 2). Bird abundance varied between the five land uses. The highest in fishing zone was 83 per hectare and lowest in settlement land use was 18 per hectare. One way ANOVA was used to detect the significant different in abundance of birds between land uses based on the hypothesis that land use does not influence the abundance of birds. The difference between five land use categories was significant at 5% level of significance (F=3.556, P=0.007631). Fig. 1 shows the abundance of birds of all five land use categories. Though fishing zone had a very high abundance, it was dominated by two species of birds (pied kingfischer and little egret) which were seen in high abundance compare to the others species.

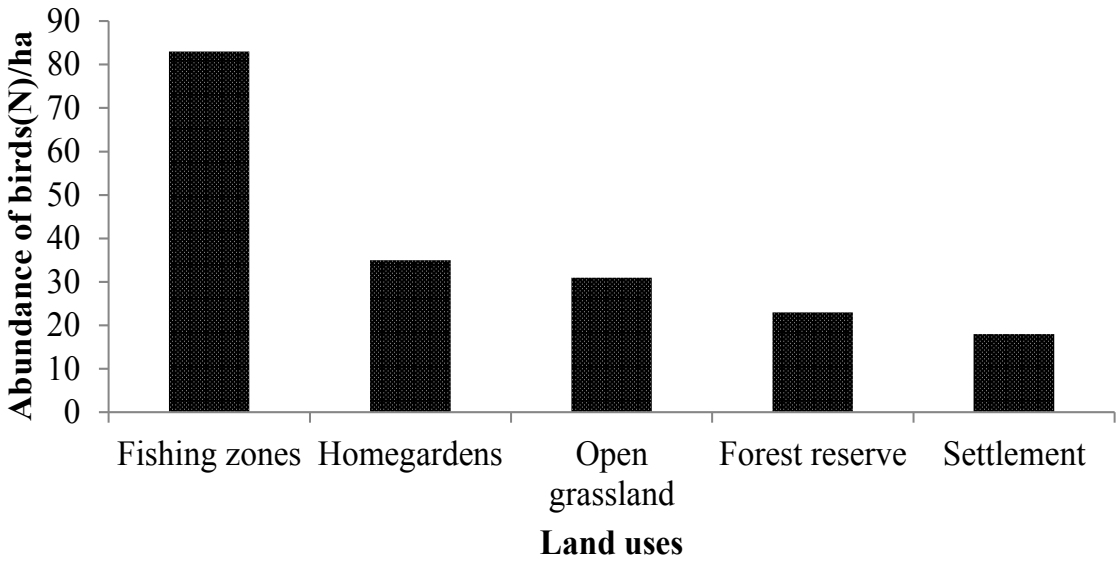

Figure 1: Abundance of bird between different land use types, around Lake Victoria basin.

4.3.2 Bird's species richness in different land use

A total of 109 bird species were seen and they belonged to 43 families. From the result, it was observed that fishing zone had the highest species richness compare to the other land uses, and the forest had the lowest species richness. The homegarden had low birds abundances but it had higher species richness than it was expected for the fishing zone land use to have higher species richness due to its higher abundance. Therefore as the specie abundance increases then the specie number is expected to be high also.

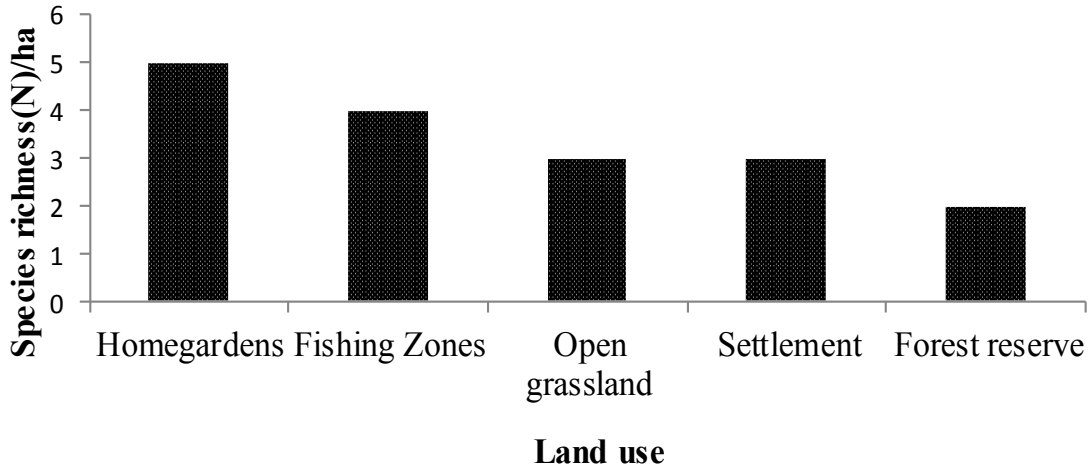

Figure 2: Richness of birds' species between land use types, around Lake Victoria basin.

The similarity in bird species composition between land use types, varied as is shown in Table 2. Fishing zone and settlement land use had the highest similarity. The settlement and forest reserve have the least similarity index among all land use categories. All land use categories had a considerable number of species that were not seen in another land use categories, 42 species in fishing zone, 10 species in open grassland, 18 species in home garden, 1 specie in forest reserve and 3 species in settlement. No bird specie was seen in all land use categories.

Table 2: Sorensen's similarity indices for the five land uses based on their bird species composition around Lake Victoria basin

	Homegardens	Fishing Zones	Open Grasslands	Forest Reserves	Settlements
Homegardens	-				
Fishing Zones	0.2385	-			
Open Grasslands	0.5688	0.3394	-		
Forest Reserves	0.6605	0.3944	0.7247	-	
Settlements	0.5963	0.4220	0.6788	0.8073	-

4.3.3 Bird's species diversity in different land use

There were variations in species diversity between land use types (Fig. 3). Home garden has the highest diversity index, followed by fishing zone, then open grassland, settlement and lastly forest reserve. Although fishing zone had the highest abundance and number of species richness it had a relative low value of diversity. This was caused by the high abundance of two species pied kingfischer which accounted for a total of 290 individual and little egret which accounted for 269 individuals which caused the diversity in fishing zone to decrease. Home garden represent a land use category with the lowest number of individuals, but a more even distribution.

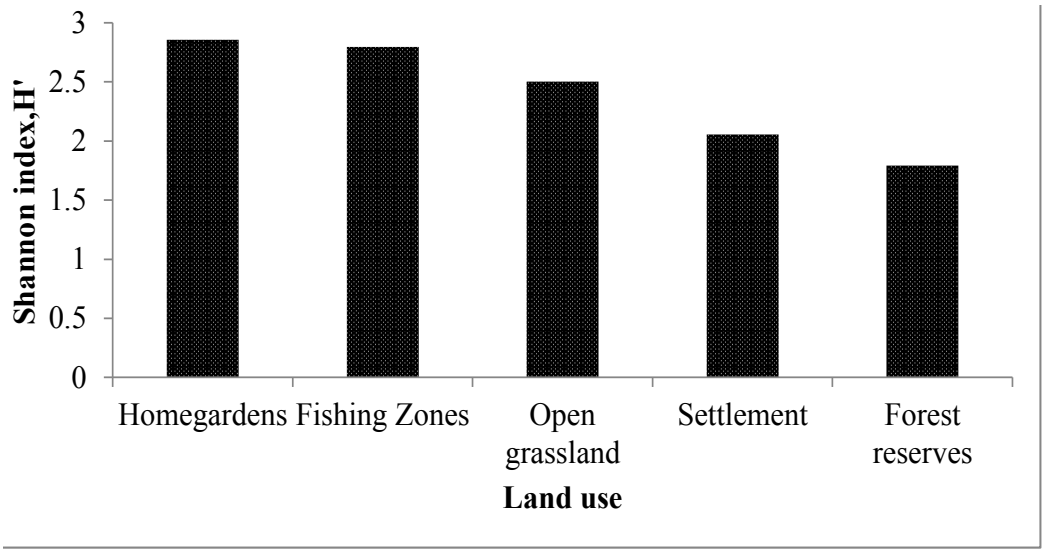

Figure 3: The diversity of bird species between land use types, around Lake Victoria basin

4.4 Tree Species

4.4.1 Tree abundance in different land use

A total of 2224 individual tree were seen in all land uses (details in appendix 3). The abundance varied between the five land use, being highest in forest reserve land use and lowest in fishing zone land use (Fig. 4). The forest reserve had the highest tree species

abundance as it was expected compare to other land uses due to its status as a forest reserve. One way ANOVA was used to detect the significant different in abundance of tree species between land uses based on the hypothesis that land use does not influence the abundance of tree species. The test showed that there was a significant difference in abundance of tree species between the five land use categories at 5% level of significant (F=2.1067, P=0.00425).

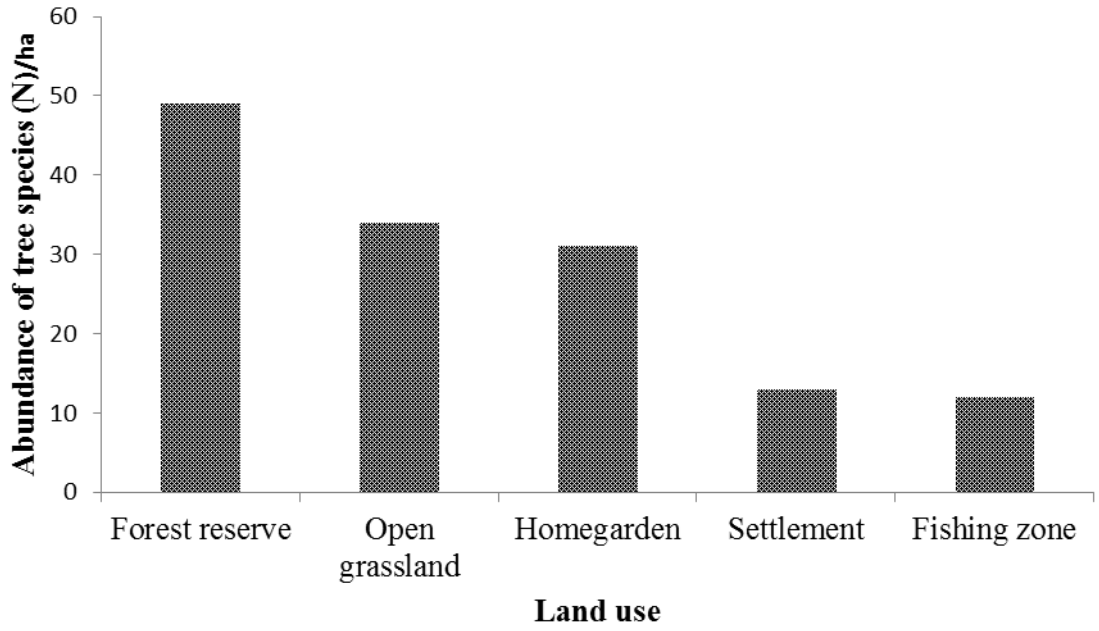

Figure 4: Abundance of tree species between land use types, around Lake Victoria basin

4.4.2 Tree species richness in different land uses

From this study a total of 47 tree species was observed in both land use type (Fig. 5). The homegarden was seen to have the highest specie richness than other land uses followed by forest reserve then fishing zone, open grassland and settlement.

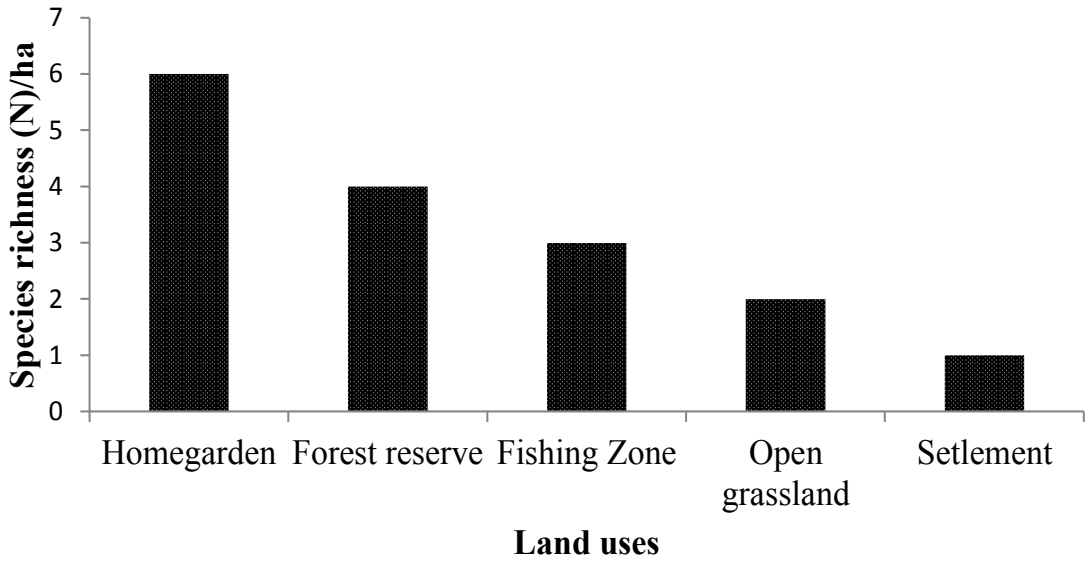

Figure 5: Richness of tree species between land use types, around Lake Victoria basin

Home garden and fishing zone, and home garden and settlement where seen to have the highest similarity index, while forest and fishing zone had a least similarity index (Table 3). All land use categories had a considerable number of species that were not seen in another land use category, 2 species in fishing zone, 5 species in open grassland, 10 species in home garden, 2 species in forest reserve and 2 species in settlement. Only 2 species were seen in all land use categories.

Table 3: Sorensen's similarity indices for the five land uses based on their tree species composition around Lake Victoria basin

	Homegarden	Fishing Zones	Open Grassland	Forest Reserve	Settlements
Homegardens	-				
Fishing Zones	0.3958	-			
Open Grasslands	0.3333	0.5208	-		
Forest Reserves	0.5833	0.6875	0.5416	-	
Settlements	0.3958	0.6666	0.5208	0.6041	-

4.4.3 Tree species diversity in different land uses

Forest reserve had the highest diversity index while the fishing zone had the least (Fig. 6). These results on the species diversity confirm that there is variation in status of tree species between the five land use categories. It was noted that there are less tree species diversity in fishing zone land use compared to the other land uses.

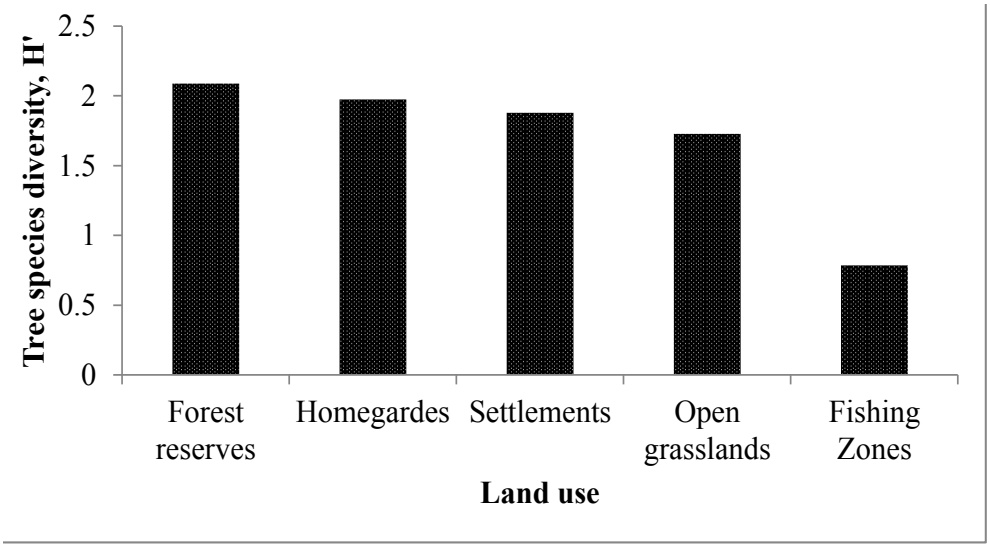

Figure 6: The diversity of tree species between land use types, around Lake Victoria basin

CHAPTER FIVE

5.0 DISCUSSIONS

5.1 Land Uses and their Varieties

From the study, five types of land uses were documented which was home garden, forest reserve, fishing zone, open grassland and settlement. These results are in line with those obtained by Musamba *et al*. (2011) a study conducted in Musoma around the Lake Victoria Basin and those obtained in the Lake Tahoe Basin by Forney *et al*. (2001). It was found that fishing zone were the dominant land uses due to most of the activities in this area depend on fishing activities. This result correlates with those of Musamba *et al*. (2001) which reported that fishing zone was the dominant land use in Musoma lake basin.

5.2 Birds' Species Abundance, Diversity and Richness

The species abundance in this study differed between land uses. The higher abundance was noted in fishing zone land use due to the food resource availability in this land use type. A number of activities conducted in the fishing zone influence the availability of food for birds from dried small fishes left over from fishers. Moreover, the area has a lot of frogs, earthworms and other bird food species. The study conducted by Chouteau (2006) showed similar results, that fishing zone land use have the highest abundance of avian species, influenced by space, food availability, feeding and nesting sites, water availability and the presence of other bird food species. Also, fishing zone was highly diverse in bird due to the presence of different strata of wetland, similar observation was reported by Soka *et al*. (2013) by a study conducted in Hombolo wetland that wetlands are highly in bird species abundance and richness because they are a source of food to birds and they support bird nesting, good birds hiding place, and they provide variety of

placements for nests, protection against predation, supply of food and conducive microclimate for this species.

Similarly, fishing zone land use consists of a relatively low species richness despite of it high disturbance. The richness of bird species is contributed by high encounter rates and the presence of favorable habitats around the Lake. The availability of food makes some birds with the same feeding guild to dominate the area (Soka *et al.,* 2013). Also, it was found that, wet season might influence the presence of some bird especially migratory bird species that tend to shift their feeding habit between seasons. Again, the diversity of fishing area was low despite of its high abundance and richness because it was dominated by two species which appeared in high abundance.

Usually, homegarden has varieties of food crops such as banana, cassava, yam, cocoyam and fruit trees which provide food and shelter for birds. Some birds like weaver birds build their nest in banana leaves. However, despite homegarden had the highest species richness the abundance of bird (Fig. 1) was seen to be relatively low in homegarden. This is due to the agricultural system and constant mulching of the ground strata, which cause variety of food available in the coffee-banana system for birds to be low. The abundance of birds in home garden decreases because people are chasing them away by killing them because they destroy their bananas and other food crops.

From the result, it was found that diversity of bird species in home garden land use was the highest (Fig. 3). This is due to the presence of varieties of microhabitats which provide niche for different species of birds. The higher diversity in home garden land use was due to high numbers of individuals in some bird species and diverse vegetation types as microhabitats which favoured varieties of bird species. Vegetation cover has been reported

to have a strong influence on avifauna diversity (Radford *et al.,* 2005). Also vegetation is among the factors which bird diversity in tropical Africa depends on (Soka, 2013).

Human disturbance to birds is frequent in the settlement land use which lowers the abundance (Fig. 1) and diversity (Fig. 3) of bird species. The farms are just small gardens and houses with a very dense network of busy footpaths which in some cases disturbs the birds hence lower their abundance. This finding is in line with those of Campbell (2006) who found that settlement land uses negatively affect birds' abundance simply by human walking near a feeding or nesting area. According to McKinney (2002), the concentration of human presence in residential areas and their associated effects is currently a worldwide concern to biodiversity conservation. The continued expansion and growth of cities in the near future could bring about the conversion of large swaths of natural habitats to urban areas (Marzluff *et al.,* 2001) which results to the general bird species richness and diversity decrease.

The abundance of bird in open grassland was also found to be low due to the increasing human population growth coupled with the rise in demand for settlements, agricultural land and wood products all together altering important wildlife habitats, bird diversity patterns and overall biodiversity around the world. At Kahororo grasslands, it was found that some ecological factors including the availability of variety of foraging sites also determine the abundance of bird species. It appears that human-induced disturbances and possibly presence of variety of foraging sites contribute to the variation of abundance, richness and diversity of bird species in the area. Moreover, highly disturbed habitat supported less bird species richness and diversity than low and/or undisturbed habitat.

The abundance of birds in forest reserve was lower compare to other land uses which were due to the lack of food. It was found that bird use a forest reserve as their resting place. Also it was observed that some parts of the forests have been replaced by agriculture and residential–urban development due to population growth; this subdivides and isolates breeding habitat required by forest birds (Robbins *et al.*, 1989). The studied forest reserve consists of different trees varieties including exotic species like pine trees which do not favor the birds abundance as pines do not provide food to them. These results were in contrast with other studies that compare bird species and diversity between forested and different types of land use which showed that forested areas contain more bird species than other land use (Estrada *et al*., 1997 and Daily *et al*., 2001).

5.3 Tree Species Abundance, Richness and Diversity

Trees provide economic benefits to local people, such as fruits, medicines, fibre, timber, fuel wood, livestock feed, shade and wind-breaks for crops and livestock (Bolwig *et al.,* 2006). Trees and other forms of natural vegetation may also be a basis for local enterprise development (Baldascini, 2002). Further, trees help to maintain life conditions through soil stabilization, improved soil water availability, nutrient cycling (from deeper soil layers), microclimate effects, carbon sequestration and habitat for birds and other species (Kinzig *et al.,* 2001).

It was observed that home garden had low tree abundance because, homegarden nowadays have become increasingly fragmented due to subdivision of farms among sons. This was also reported in the study conducted in Kilimanjaro by Soini (2006). Also poverty forces people to sell some of their land. This was also reported by Soini (2006) as well as timber for income. These lead to decrease in number of trees as more land is needed for houses, yards and vegetable gardens. In terms of trees species richness home garden appears to be

richer due to environmental and edaphic influences of home gardens (Lulandala, 2013). The lower index of diversity in home garden despite of its higher species richness, it simplifies the imbalance in species distribution within land uses, as a result of the differential species preferences example most loggers prefer trees with large diameter and straight shape (Kimaro, 2013). Also it was observed that in settlement land use, trees were harvested for houses and other activities hence decreases tree abundance, this results was in line with those observed by Soini (2006).

From focus discussion, it was also observed that, most families have almost abandoned the tradition of distributing their land to children as inheritance. Now-days in many families, there is a very little land left any further for distribution to the coming generations (Ngailo *et al.,* 2001). This had caused people to opt to shift to new areas in response to continued land fragmentation, whereby they interrupt the open grassland and forest reserves, and establish new settlement which led to the destruction of biodiversity mostly trees for example Kahororo open grassland and Kalobela forest reserve.

From group discussion, it was observed that open grassland and forest reserve have been subjected to human disturbances such as logging and other encroachments in the past which leads to fewer tree species richness. According to Obiri (2002), high levels of extraction of live wood tend to affect forest composition and structure, leading to alteration in the forest ecosystem functions and imminent succession collapse. Forest reserve was relatively high in species abundance and diversity compare to other land uses. This is probably due to high species heterogeneity in the ecosystem.

The livelihood of communities around Lake Victoria basin in Bukoba Municipality depends on fishing. This cause the fishing zone land use to be the most visited than the

other land uses. In fishing zone land use, tree species abundance was found to be low due to high deforestation rate, trees have been harvested and being used for drying fish, brick making, firewood collection, timber and for charcoal burning. Areas owned by government are always much disturbed due to poor policies and laws enforcement. As population increases, people required trees and areas for building their settlements which lead to exploitation of fishing zone area through deforestation. A study conducted by (Ngailo *et al*., 2004) showed the same results of the effect on increase of population on tree species diversity.

From the focus group discussion and direct observation, it was found that fishing zone land use had lowest tree species abundance and diversity (Fig. 6). This is because trees have been replaced with fast growing exotic species, mainly pines and eucalypts. This was also reported by Lara *et al*. (2009) in a study conducted in south-central Chile streams that, in fishing land native forest have been replaced with pine and eucalyptus plantations which lowers the tree species abundance and diversity.

CHAPTER SIX

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

The study concludes that difference in uses of land has big influences on bird species diversity. The study revealed further that Lake Victoria basin is very important to the bird communities. Of the five dominant land uses, fishing zone had the highest abundance followed by home garden, open grassland, forest reserve and settlements. There was a greater variation in species richness between land use types, and fishing zone land use contributed much in terms of species richness compared to other land uses.

While fishing zone had the highest species richness, it had diversity, being attributed by high frequency of occurrences of two bird species, which were pied kingfischer and little egret. The lake basin could have more bird species if intentional measures were taken early to manage the area from anthropogenic activities that have threatened the life of avifauna for years. Habitat destruction due to the increase in land use imposed a net negative effect on the population of birds.

From the study on the abundance, richness, and diversity of tree species in relation to land use, it can be concluded that forest reserve land use has the highest diversity. Human disturbance had a significant effect on tree abundance and richness in different land use leading to lowered diversity of useful plants especially important timber trees. Tree harvesting was observed to be the central part of several disturbances being accelerated by expansion of land for cultivation, charcoaling, and bricks making.

6.2 Recommendations

i. In order to maintain the biodiversity of the area the study recommends designing urban areas that mimic the vegetative composition and configuration of the wild lands being replaced to help combat the loss of urban biodiversity. Land use planning that both protects the native tree species and emphasizes on bird friendly landscape design may enhance avian and tree species diversity within the area.

ii. Despite the fact that the municipal authorities still hold an important proportion of forest reserves, open grassland and fishing zone there is a need to prevent further human disturbances within the forest reserves, open grassland and fishing zone land uses so that they can sustain their ecological functioning.

iii. Strict law enforcement on exploitation of plant species in forest reserve, open grassland and fishing zone need to be there.

iv. Community education and promotion of alternative income generating activities should be encouraged. This should go hand in hand with restoration of the ecosystem through reforestation in most degraded areas.

v. There should be adjustments in national policies, reorientation of institutions and provision of public goods and services so that the abundant natural resources in Lake Victoria basin can provide a basis for pro-poor agricultural development.

vi. With increasing population growth in urban neighborhoods, it is becoming more important to plan for the kinds of wildlife values we wish to uphold at municipal, provincial or state, and national levels

vii. Further studies to cover dry-season and nocturnal birds to generate a comprehensive list of bird species diversity around the basin are vital.

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APPENDICES

Appendix 1: Checklist for key informants

VILLAGE LEADERS, WARD LEADERS, AND MUNICIPAL NATURAL RESOURCE STAFFS.

Village;_____

Ward;_____

1. What are the types of land uses in your area?
2. What are the causes of these land use?
3. Is the use of land, the same from the past or it as changed? And what is the reason for it to change? What was the previous land use?
4. What year the land was put under the current use?
5. What are the effects of these land use types in your area?
6. How does these land use affects tree and birds diversity in your area?
7. How do you project the land use in 10 years to come?
8. What are the types of birds and types of tree species found in your area currently?
9. What types of tree and bird species are not seen any more in the area, and what the reasons for those species to disappear.
10. What are the potential threats to birds and trees species diversity?

Appendix 2: Checklist of bird's species recorded around Lake Victoria basin in Bukoba municipality

A total number of 109 bird's species were identified and counted. They are belonging to 43 families. Naming according to (Williams and Arlottin 1982)and (Hosking and Withers in 2006).

Families	Common name	Scientific name
Accipitridae	African fish eagle	*Haliaeetus vocifer*
	Augur buzzard	*Buteo rufofuscus*
	Black Kite	*Milvus migrans*
	Bateleur eagle	*Terathopius ecaudatus*
	African hawk eagle	*Hieraaetus spilogaster*
Alcedinidae	Giant kingfischer	*Ceryle maxima*
	Pied kingfischer	*Ceryle rudis*
	Woodland kingfischer	*Halcyon senegalensis*
	Malachite kingfisher	*Alcedo cristata*
Anatinidae	Yellow billed duck	*Anas undulata*
	Egyptian Goose	*Alopochen aegyptiacus*
	Spur wing goose	*Plectropterus gambensis*
Apodidae	Little Swift	*Apus affinis*
Ardeidae	Cattle egret	*Bubulcus ibis*
	Great white Erget	*Egretta alba*
	Grey heron	*Ardea cinerea*
	Little egret	*Egretta garzetta*
	Yellow billed Erget	*Egretta intermedia*
	Squacco Heron	*Ardeola ralloides*
	Goliath Heron	*Ardea goliath*
	Purple Heron	*Ardea purpurea*
Bucerotidae	Silvery checked horn bill	*Tockus flavirostris*
	Trumpeter horn bill	*Bycanister bucinator*
Burhinidae	Water thick knee	*Burninus vermiculatus*
Campephagidae	White breasted cuckoo shrike	*Coracina pectoralis*
	Black cuckoo shrike	*Campephaga sulphurata*

Capitonidae	Double toothed barbet	*Lybius bidentatus*
Charadriidae	Spur winged plover	*Venellus spinosus*
	Blacksmith plover	*Vanellus armatus*
	Three banded plover	*Charadrius tricollaris*
Ciconiidae	Black stork	*Ciconia nigra*
	Marabou stork	*Leptoptilos crumeniferus*
	Woolly necked stork	*Cinonia epscopus*
	Saddle Billed Stork	*Ephippiorhynchus senegalensis*
	Yellow Billed Stork	*Mycteria ibis*
	Open bill Stork	*Anastomus lamelligerus*
Coliidae	Speckled mouse bird	*Colius striatus*
Columbidae	African mourning doves	*Streptopelia decipiens*
	Red eyed dove	*Streptopelia Semitorquata*
	Ringed necked dove	*Streptopelia capicola*
	Speckled pigeon	*Columba guinea*
Corvidae	Pied crow	*Corvus albus*
	Fan Tailed raven	*Corvus rhipidurus*
	White necked raven	*Corvus albicollis*
Cuculidae	Red chested cuckoo	*Cuculus solitarius*
	White browed coucal	*Centropus supercilious*
Emberizidae	Red billed firefisch	*Lagonasticta senegala*
	Pin tailled whydah	*Vidua macroura*
Estrildidae	Jameson's Hylia - finch	*Parmoptila rubifrons*
Fringillidae	White bellied canary	*Serinus dorsostriatus*
Gruidae	crowned crane	*Balearica regulorum*
Hirundinidae	wired tailed swallow	*Hirundo smithii*
Jacanidae	African Jacana	*Actophilornis africanus*
Laniidae	Grey backed Fiscal shrike	*L. excubitorius*
	White crowned shrike	*Eurocephalus rupplli*
Laridae	Grey headed gull	*Larus cirrocephalus*
Leiothrichidae	Arrow marked babbler	*Turdoides jardinei*
Lybiidae	Red and yellow barbet	*Trachyphonus erythrocephalus*
Meropidae	Eurasian bee eater	*Merops apiaster*
	Little bee eater	*Merops pusillus*

	Cinnamon chested bee eater	*Merops oreobates*
Motacillidae	African pied waigtail	*Motacill aguimp*
	Golden pipit	*Tmetothylacus tenellus*
Muscicapidae	African grey flycatcher	*Bradornis microrhynchus*
	Black roughwing swallow	*Psalidoprocne holomelaina*
Musophagidae	Ross's turaco	*Musophaga rossae*
	White bellied Go away bird	*Corythaixoides Leucogaster*
	Bare faced go away bird	*Corythaixoides personata*
Nectariniidae	Beautiful sunbird	*Nectarinia pulchella*
	Bronze sunbird	*Nectarinia kilimensis*
	Hunter's sunbird	*Nectarinia hunteri*
	Variable sunbirds	*Netarinia venusta*
	Green throated sunbird	*Nectarinia rubescens*
Passeridae	Black caped social weaver	*Pseudonigrita cabanisi*
Pelecanidae	White pelican	*Pelecanus Onocrotalus*
	Pink backed Pelican	*Pelecanus rufescens*
Pesseridae	Grey headed sparrow	*Passer grisens*
Phalacrococidae	Great white cormorant	*Egretta alba*
	Long tailed cormorant	*Phalacrocorax africunus*
	White necked cormorant	*Phalacrocorax carbo*
Ploceidae	Golden palm weaver	*Ploceus bojeri*
	Golden weaver birds	*Ploceus subaureus*
	Little weaver	*Ploceus Luteolus*
	Masked weaver bird	*Ploceus intermedius*
	Norher masked weaver	*Ploceus teaniopterus*
	Slender billed weaver	*Ploceus pelzelni*
	Speke's weaver	*Plocus spekei*
	Vieillolet's black weaver	*Ploceus nigerrumus*
	Reichenow's weaver bird	*Ploceus baglafecht reichonowi*
Pycnonotidae	Common bulbul	*Pycnonotus barbatus*
	Dark caped bulbul	*Pycnonotus tricolor*
	Yellow vented bulbul	*Pyconotus barabatus*
	Fischer's green bulbul	*Phyllastrephus fischeri*
Rallidae	Black crake	*Limnocorax flavirostra*

Rynchopidae	African skimmer	*Rhynchops flavirostris*
Scolopacidae	Curlew sandpiper	*Calidris ferruginea*
	Green sandpiper	*Tringa ochropus*
Scopidae	Hamerkop	*Scopus umbretta*
Sturnidae	Ruppell's long- tailed starling	*Lamprotonis purpuropterus*
	Ashy starling	*Cosmopsarus unicolour*
	Red winged starling	*Onychognathus morio*
Threskiornithidae	Sacred Ibis	*Threskiornis aethiopicus*
	Hadada Ibis	*Hagedashia hagedash*
	Africa Spoonbill	*Platalea alba*
Turdidae	Blue shouldedrabin chat	*Cossypha cyanocampter*
	Cliff chat	*Thamnolea cinnamomeiventris*
	Northern Anteater chat	*Myrmecocichla aethiops*
	Snowy header robin chat	*Cossypha niveicapilla*
	White browed Robin chat	*Cossypha heuglini*

Appendix 3: Checklist of tree species recorded around Lake Victoria basin in Bukoba municipality

A total of 47 tree species were recorded. Naming according to Kanywa, 1986.

Local Name	Botanical name
Amatujo	*Acanthus pubescens*
Mjululuzi	*Alchornea angleri*
Mlinzi	*Erythrina abyssinica*
Mshangati	*Canthium vulgare*
Mshunshu	*Basili cummultiflorum*
Mubugu	*Ficus Mucosa*
Mugabaigana	*Anthocleista pulcherrima*
Mugiribwa	*Vanguelia Ogutoroba*
Muhumula	*Maesopsis eminii*
Muhunda	*Acacia albida/Vitexsp*
Mujugangoma	*Combretum paniculatum*
Mujuna	*Ricinus communis*
Mukuzanyana	*Haplocoelopsis*
Mulamura	*Dracaena usambarensis*
Munazi	*Parinari curatellifolia*
Munyabusindi	*Rauvolfia vomitoria*
Mushakwanyonyi	*Macaranga kilimandscharica*
Mushambya	*Markhamia lutea*
Mushasha	*Sapium ellipticum*
Musomolo	*Ficus exasperata*
Obuhuki	*Lantana camara*
Omkindo	*Phoenix reclinata*
Omubafu	*Canarium schweinfurthii*
Omubirizi	*Vernonia amygadina*
Omufulu	*Clasopharum Otizz*
Omugango	*Senecio muticorymbosa*
Omugege	*Syzygium cordatum*
Omugologolo	*Parnary schwenchfuthii*
Omuhuwe	*Trema orientalis*

Omujuju	*Antiaris toxicaria*
Omujumbo	*Harungana madagascariensis*
Omukungu	*Ficus sonderi*
Omumwanikibira	*Tricalysia nyassae*
Omunoba	*Pyenathus angolensis*
OmunyembeKibila	*Tabonamontana Usambarensis*
Omushamako	*Syzygium cuminii*
Omushambya	*Markhamia zanzibarica*
Omushekeyanda	*Arundinaria tolange*
Omushongolwa	*Phonex spp*
Omushunshu	*Iboza multiflora*
Omusomolo	*Ficus thonningii*
Omutangarara	*Macaranga schweinfurthii*
Omutoma	*Ficus natalensis*
Omuzambarau	*Syzygium jambolanum*
Omuzilanyama	*Maesa lanceolata*
Omuziru	*Pseyalospondiam icrocapa*
Omwasha	*Ugandensis tylostenom*