LINKING PERCEPTIONS OF DIVERSITY AND IMPORTANCE TO OCCURRENCE OF AVIFAUNA IN RURAL COMMUNITIES AND THE IMPLICATIONS FOR CONSERVARTION. A CASE STUDY OF MUPARI COMMUNAL AREA, SHURUGWI, ZIMBABWE.

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A thesis submitted in partial fulfilment of the requirements of the award of the degree of Master of Science in Ecological Resources Management.

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APPROVAL FORM

The undersigned certify that they have read and recommended to the Midlands State University for acceptance, a dissertation entitled; ***"Linking perceptions of diversity and importance to occurrence of avifauna in rural communities and the implications for conservation. A case study of Mupari communal area, Shurugwi, Zimbabwe."*** submitted by Kangamwiro Mwadzingeni Registration number ***R11172Q*** in partial fulfilment of the requirements for the Master of Ecological Resources Management Degree.

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Abstract

Birds constitute an important part of the earths' vertebrate organisms and are among the most diverse, conspicuous and fascinating forms of life. There are over ten thousand species of birds in the world. Besides their great ecological role in seed dispersal, pollination, importance in food weds / chains, they have also been crucial to man for meat, communication, recreation, decoration and as a source of inspiration. Unfortunately about 1,012 species of birds are being threatened by extinction due to anthropogenic induced factors, (Tabur, 2006). A perception survey was done by carrying out a questionnaire interview of villagers to determine their appreciations of avifauna diversity, importance and conservation with an objective to determine conservation principles for birds in communal areas. Avifauna diversity perceived by the community was confirmed by a scientific bird survey carried by the researcher. The bird listing technique was used to determine avifauna diversity and abundance. SSPS, excel, Sutrop salient index packages and ecological indices were applied to analyse the data obtained from the research. High appreciation of avifauna diversity and importance was revealed by the study among the communal people of Mupari. The use of Sutrop indicated that edible birds and those that pose little problems to crops and domesticated animals scored higher salience. Birds that had higher Sutrop salience value also form one cluster when analysed by the Principal Component and Hierarchical Cluster analysis. The research revealed little access to information on birds from respective monitoring and enforcement institutions. Great avifauna diversity exists in this communal area and bird conservation institutes need to work with such communal areas locally and across the globe to preserve this genus in light of their great mobile characteristic.

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Abbreviations and acronyms

CAMPFIRE - Communal Areas Management Programme for Indigenous Resources

CBD - Convention on Biological Diversity

CITES - Convention on International Trade in Endangered species

DNA – Deoxy-ribonucleic acid

EMA – Environmental Management Agency

IBAs – Important bird areas

HCA – Hierarchical Cluster Analysis

LNP - Lamington National Park

NGO – Non-Governmental Organisation

PCA – Principal Component Analysis

UNEP – United Nations Environmental Protection

US EPA – United States Environmental Protection Agency

ZIMASCO - Zimbabwe Mining and Steel Company

CHAPTER 1: GENERAL INTRODUCTION

1.1 BACKGROUND

Birds constitute an important part of the earths' vertebrate organisms and are among the most diverse, conspicuous and fascinating forms of life. They are found in almost all geographical environments and as remarked by Cottrell (1982) "birds are among the most accessible life form due to their presence in forests, farming, rural and urban areas. There are about ten thousand species of birds in the world that have been extensively studied due to their importance in human diet, communication, plant pollination, decoration of homes and ecological value (Tabur, 2006). Many people derive great pleasure, fulfilment and inspiration from watching and listening to birds (European Commission, 2004). Birds are also important for their ecological function, especially in food chains, as a means of biological control and their importance in studies that help us to understand nature. For the last three centuries, industrial developments and anthropological effects have degraded habitats and caused the natural balance to deteriorate. About 1,012 species of birds are being threatened by habitat loss, human persecution and introduced predators (Tabur, 2006).

Conservation efforts and programmes for birds have been mainly done at global scale by institutes and organisations that have international, regional or national representatives across the world. These institutes and organisations include BirdLife International, the World Wildlife Fund (USA), the World Conservation Union and the World Wide Fund for Nature, Conservation International, and the World Resources Institute (Burgess *et al*, 2002). Databases documenting the distribution of birds and other vertebrates provide an opportunity to quantify how many of them are potentially catered for by recent large-scale conservation proposals. According to Burgess *et al* (2002) gaps were found in all large-scale conservation programmes as most of these proposals perform better on species in large and protected areas of intact habitats as compared to randomly selected similar sized unprotected areas (Burgess *et al*, 2002)

The Important Bird Areas (IBA) Programme of BirdLife International is a worldwide project launched in 1989 aimed at identifying, monitoring and protecting critical sites for the world's birds. The IBA Programme is global in scale, and it is anticipated that up to 15,000 IBAs will be identified worldwide through this project to protect birds. IBAs are sites of global importance for biodiversity identified at a national level, using internationally agreed, objectives, quantitative and scientifically defensible criteria. IBAs are also selected because they hold bird species that are threatened with extinction, have highly restricted distributions, or are characteristic of particular biomes. Sites holding exceptionally large numbers of congregatory birds also qualify. The IBAs can be considered as having a minimum set of sites criterion for the long-term viability of wild bird population management (Arinaitwe, 2001).

One distinctive feature of birds is their ability to migrate from one place to another, migration diversity ranges from the spectacular mass migration of large soaring species such as storks to the almost invisible movements of some small passerines travelling silently and alone during the night hours (Pulido, 2007). This has made conservation strategies for birds complex as birds conserved in one habitat will be endangered after migrating to other areas that are poorly managed (Tabur, 2006). Populations of migratory birds differ to some extent from their propensity to migrate, migration timing, migration route, or how the migratory journey is done. Migration is an adaptive response to seasonal environments, which allows animals to take advantage of spatial variation in the seasonal fluctuation of resources. By using different areas during different times of the year many bird species have been able to successfully colonize areas offering favourable conditions only during a short period (Pulido, 2007). For instance, migratory birds breeding at high latitudes can take advantage of the extraordinary abundance of food during a few weeks in early summer and profit from long days which allow them to extend foraging time (Pulido, 2007).

Claus *et al* (2010) postulated that indigenous and local people have practiced conservation for hundreds of thousands of years. Conservation is a human activity that arises out of human actions; therefore human perceptions on conservation of biodiversity greatly influence the conservation trajectory. Appropriate perception on conservation is defined in the sense of conservation biology, the science of understanding earth's biological diversity for the sake of its protection. Indigenous knowledge is a body of knowledge built by a group of people through generations of living in close contact with nature. Indigenous groups offer alternative knowledge and perspectives based on their own locally developed practices of resource use. Local knowledge is increasingly being sought by academics, scientists, and policymakers as a potential source of ideas for emerging models of ecosystem management, conservation biology, and ecological restoration (Gandiwa, 2012).

According to a report by Thomas (2011), communal and local people can provide successful strategies in bird conservation. He pointed out that the relationship that people have with their environment is complex and locally specific in such a way that the environment and development programmes may need to be dealt with at the local scale so that remedies can be designed in ways that are culturally, socio-politically and environmentally suited to each local context. Thomas (2011) stressed that conservation programmes which local people are part, as decision makers and facilitators, are usually successful since it will be easy to find solution on the complications on environmental conservation. Locally-driven solutions are likely to be more relevant, and more effective, than policies or programmes originated and driven by national governments, international donors, or international NGOs. Addressing conservation by empowering local organisations can thereby help ensure relevance to local people, avoiding the perception of conservation as a marginal issue, resentment and opposition that can follow when conservation priorities, research agendas and strategies are set by international organisations without local input (Thomas, 2011).

In Zimbabwe's communally owned lands, an innovative plan called CAMPFIRE (Communal Areas Management Programme for Indigenous Resources) was established in the 1980s. 28 districts were authorised by the National Parks and Wildlife Authority to conserve and utilise wildlife in their districts. Unfortunately the key animal rescued under this programme was the elephant *Loxodonta africana*, and much of the success of CAMPFIRE projects depends on the use of this species (Childes and Mundy, 2002). By encouraging the sustainable utilization of wildlife, the resource is now protected and effectively thousands more square kilometres have been added to the existing system of protected areas (Childes and Mundy, 2002). The CAMPFIRE programme had little focus on bird conservation despite being very effective in adding thousands of square kilometres of land under the protected areas system.

It can be noted from the available literature that research and conservation efforts on birds have mainly been focussed on protected areas and important bird areas. This have ignored and excluded the great conservation potential of communal and local people. High mobility and migratory ability has left birds susceptible to attack when they land in areas with poor wildlife importance and poor conservation. The research aims at exploring the perceptions of people in the communal areas on importance and conservation of birds. Shurugwi is one of the most scenic places in Zimbabwe which has a diverse and dense flora (Gandiwa, 2012). It is therefore capable of being a great habitat for birds although it is not categorised as an important bird area. The exploration of conservation perceptions in communal areas seeks to identify biodiversity threats and conservation principles options for birds habituating or migrating into communal areas hence ensure the security of birds both in protected areas and communal areas.

1.2 PROBLEM STATEMENT

Avifauna constitutes an important part of the ecosystem. However they have been seriously threatened by extinction in the face of increased habitat loss caused by human activities. Most conservation efforts for avifauna have been concentrated in protected areas or important bird areas by Non Governmental Organisations (NGOs) and intergovernmental Organisations. This has left many birds susceptible to destruction outside these areas especially given the avifauna migratory capability. The exploration of the perceptions of indigenous people's knowledge on the importance and conservation of avifauna diversity would provide important information for the conservation of avifauna diversity. Shurugwi is well known for its highly scenic and dense vegetation which are a habitat of numerous avifauna species. However the forests and vegetation are continuously being threatened by agriculture, panning, small and large scale mining, expansion of urban settlement as well as expansion of farming lands. Though birds are being protected in IBAs and other protected areas, a need exists to protect birds in communal areas given their highly migration nature. Previous studies and practises haven't given any priority on birds in communal and non-important bird areas hence a requirement to assess significance of an initiative to conserve birds in such areas.

1.3 JUSTICATION

Avifauna is one of the most seriously threatened organisms. Birds are sensitive to environmental changes especially the ongoing habitat modification and destruction by human actions. Conservation efforts in place for avifauna have been concentrated to protected areas and important bird areas, instituted governments, NGOs or Intergovernmental organisations (Burgess *et al*, 2002). This has ignored the important contribution of rural communities in conservation and protection of wildlife. Rural communities constituting large pieces of land

and in addition, local people possess valuable indigenous knowledge important in the conservation of avifauna diversity (Thomas, 2011; Claus *et al*, 2010; Gandiwa, 2012).

Shurugwi has been selected as the study area because it is one of the most scenic places in Zimbabwe with dense and diverse vegetation capable of becoming a great habitat for birds. Moreover Shurugwi has been involved in a lot of economic activities and developments to include mining, housing and other infrastructural development. Major mines in the area include Unki Platinum mine, Falcon mine, Todal Mining and Zimasco Mine. Several small scale gold mines are also dotted across the whole district. The Unki Mine Impali Housing project had also expanded into neighbouring communal area of Mupari. The housing project has also come with infrastructural developments to include water, electricity, roads and telephone infrastructure.

The fast track land redistribution programme has also resulted in destruction of vegetation in the district, a development that has reduced habitats for birds. The dense and thick forest of Shurugwi has been turned into villages, farming and grazing land. This has further been accelerated by rampant gold panning in the area. Several small scale gold mills and gold mines have sprouted around Shurugwi. This has had an effect on the availability of birds.

1.4 MAIN OBJECTIVES

- To link rural communities knowledge and perceptions on avifauna diversity, importance and conservation to avifauna diversity and abundance as a way of exploring indigenous strategies in avifauna conservation.

1.4 .1 SPECIFIC OBJECTIVES

- To determine the appreciation of avifauna diversity and abundance by rural people.
- To determine the diversity and abundance of birds in Mupari communal area.
- To establish threats to avifauna diversity in Mupari communal area.
- To determine indigenous methods of avifauna conservation in Mupari communal area and how they can be applied at a global scale.

1.5 RESEARCH QUESTIONS

i. Do communal people appreciate the value and importance of birds in their area?
ii. What conservation threats are birds in communal areas exposed to?
iii. Can birds co-exist with humans and their activities in the communal areas?
iv. What conservation measures are available to avifauna found in the communal areas?
v. Which bird species are in the Mupari communal area of Shurugwi and how many are they?

1.6 HYPOTHESIS

H_O: There is no relationship between knowledge on avifauna importance, diversity and conservation and avifauna diversity.

H_a: There is a relationship between knowledge on avifauna importance, diversity and conservation and avifauna diversity.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

Avifauna is one of the most diverse groups of vertebrate organisms whose bright colours, distinct songs and showy displays add enjoyment to our lives (Dutson *et al*, 2005). Birds have been cherished by humans from different societies of the world for centuries as they have inspired cultural developments, poetry, music, fables and are often touted as symbols of freedom, strength and agility (Kushlan and Steinkamp, 2002). Birds are beautiful, very visible, common and offer an easy opportunity to observe their diverse plumage and behaviours (Tisdell and Wilson, 2004).

The Convention on Biological Diversity of 2002 raised concerns on the continuous decline in biodiversity and natural habitats which is resulting in the ongoing species extinction. The global targets to reduce the rate of biodiversity loss significantly by 2010 have not been met and the rate of biodiversity loss does not appear to be slowing down (Zedan, 2004). At the same time, targets to reduce human poverty worldwide have been reported to be off track given the close relationship between natural resources and development (David, 2011). This dual challenge has led to the search for effective mechanisms and entry points through which conservation and development objectives can be addressed together. Animals and plants that surround people in most local contexts, form an essential part of their livelihood, providing food, fuel, medicines, recreation, shelter and contributing to local culture (David, 2011).

Avifauna species diversity in Zimbabwe has been reported by Childes and Mundy, (2002) who indicated that the 1995 checklist of the Ornithological Association of Zimbabwe has 674 bird species including the *Agapornis nigrigenis* which is reported extinct and the rare *Milvus migrans* and *parasitus* species. This leaves Zimbabwe with 672 species, of which about 80 species are known to be vagrants. This list has however been reported to be increasing at a rate of about one bird species per year basing on Irwin's list of 1981.

Humans worldwide have rapidly degraded ecosystems due to their notable population explosion coupled with the rise in demand for settlements, agricultural land and wood products. This has altered important wildlife habitats, avian diversity and massive reduction in biodiversity (Pullin, 2002). The use and cover of grassland natural habitats have been unprecedentedly altered and unfortunately the impacts of these changes on bird community composition, structure and diversity are yet to be fully understood (Ntongani and Andrew, 2013). The accelerating extinction of avian species has been described as a tip of the iceberg in global wildlife decline that threatens disruption of vital ecosystem processes and services with currently 12 percent of the birds prone to extinction (Baillie *et al*, 2004). Lessons have also been learnt from the passenger pigeon where in the 1860s, one flock of birds was estimated at about one billion-birds taking about 14 hours to pass in the sky. On September 1, 1914, the very last Passenger Pigeon a captive bird that keepers at the Cincinnati Zoo called Martha died meaning a population loss from billions of birds to none in just 50 years (State of the Birds, 2014). Reduction in the number of individuals and species of organisms is not good since loss of some important functional groups negatively affects some ecosystem processes and services for instance decomposition, pest control, pollination, seed dispersal, control of spreading of diseases and agricultural pests (del Hoyo *et al*, 2008).

There have been diverse views on how conservation has to be met incorporating developmental objectives. This has led to a search for effective mechanisms, programmes and policies that concurrently address the two aspects. Both conservation and development, within their own sphere of interest, have advocated the importance of local participation and also of partnership between conservation agencies and local people (Tisdell and Wilson, 2004). The Millennium Ecosystem Assessment report in David, (2011) outlines that the measures to conserve natural resources are more likely to succeed if local communities are given ownership of them, share the benefits and are involved in decisions. He also established that a number of community based resource management programs have slowed the loss of biodiversity while contributing benefits to the people. It is therefore crucial to understand how these local community people appreciations and perceive the importance of biodiversity in their lives and their level of knowledge on the principles of conservation.

2.2 Ecological value of biodiversity

Life has existed on Earth for about four billion years and has constantly been evolving to form the spectacular richness of our current living world (Pullin, 2002). de Vere, (2008) defined biodiversity as the variety and variability of life on earth that includes variation at all levels of biological organisation from genes, species to ecosystems. The US Wildlife Society (1993) defines biodiversity as the richness, abundance, and variability of plant and animal species and communities and the ecological processes that link them with one another and with soil, air and water (Hunter and Gibbs, 2007). Life on earth is extraordinarily diverse and complex extending in all forms and at all levels of biological organization. Organisms differ in self-replicating pieces of DNA that shape the form and function of each individual organism to give gene diversity. It is not the genes themselves that conservation biologists value, but the diversity that they impart to organisms that is so essential (Global Biodiversity Outlook 3, 2010). The diversity of life begins with genetic differences among individuals and the processes of evolution that lead to differences among populations, species, and ultimately the higher taxonomic levels i.e. the genera, families, orders, and so on (Hunter and Gibbs, 2007). Unlike genes, ecosystems are large and conspicuous, thus anyone with a little understanding of ecology appreciates the difference in structure and value of lakes, forests, wetlands and grasslands (Pullin, 2002).

The diversity of organisms and their ecological functions is enormous and results in each of the earth's millions of species interacting with each other (Begon *et al*, 2006). Species interact in various ways directly or indirectly for instance through ecological processes such as competition, predation, parasitism, mutualism and others. Secondly, every species interacts with its physical environment through processes that exchange energy and elements between the living and non-living worlds, such as photosynthesis, biogeochemical cycling and respiration, these functional interactions sum up to billions (Molles, 2008). The diversity of evolutionary functions is even more complex and includes all the various ecological processes that constitute key elements of natural selection, in addition to processes such as genetic mutation that shape each species' physiological appearance (Hunter and Gibbs, 2007). Functional biodiversity is also important for instance, a management plan designed to keep a species from becoming extinct will almost certainly fail in the long run unless the processes of evolution, especially natural selection, continue to allow the species to adapt to environmental changes (Hunter and Gibbs, 2007: Molles, 2008). Nevertheless, conservation biologists usually focus on maintaining structural biodiversity rather than functional biodiversity mainly because maintaining structural biodiversity is usually more straightforward. In particular, it is easier to inventory species than their interactions with one another. Second, if structural diversity is successfully maintained, functional biodiversity will probably fall in place (Hunter and Gibbs, 2007).

In an illustration Hunter and Gibbs, (2007) indicated that maintaining a species of orchid and its primary insect pollinator together in the same ecosystem results in a pollination interaction between the two. Similarly, if we can maintain the orchid's genetic diversity, we will probably have orchid evolution. Natural selection for instance, may not have the opportunity to operate on the genetic diversity represented in the seeds that plant breeders store in a freezer to maintain the structural diversity of a crop plant species. On the other hand, it is much easier to think of circumstances where some major ecological processes are maintained, but structural diversity is severely degraded; for example, a plantation of exotic trees that maintain normal rates of photosynthesis and biogeochemical cycling. In short, both the structural and functional aspects of biodiversity are important; however, if genetic, species and ecosystem diversity are successfully maintained, then ecological and evolutionary processes will probably be maintained as well (Hunter and Gibbs, 2007).

2.3 Importance of avifauna diversity

Avifauna just like any other organism, plays a critical role in the ecosystem and in people's lives. Biodiversity contributes significantly in many aspects of people's livelihoods and well-being by providing products such as food, clothes, shelter, oxygen and fibres whose values are widely utilised (Leveque and Mounolou, 2003). Humans cannot exist without biodiversity as we use it directly and indirectly in a number of ways often without realizing it. Some direct uses include things like medicines and biological control, whilst indirect uses include ecosystem services such as atmospheric regulation, nutrient cycling and pollination. In reality, biodiversity underpins a much wider range of services, many of which are currently undervalued. Birds droppings serve as manure, raptors tearing up animal carcasses, birds pollinates crops and flowers, coral reefs and mangroves that protect coastlines, and the biologically rich landscapes and seascapes that provide enjoyment are only a few (de Vere, 2008). There are also non-use values of birds, such as the value in future use or non-use, bequest value which deals with passing on of a resource to future generations, existence value in the ecosystem irrespective of use or non-use and intrinsic value which is the inherent worthiness independent of that placed upon it by humans (Millennium Ecosystem Assessment, 2005).

People from all walks of life derive a lot of aspiration, pleasure and knowledge from birds. Many of these values and uses of avifauna diversity and biodiversity in general are not incorporated in economic accounts and this leads humans to under-value biodiversity (Kushlan and Steinkamp, 2002). Ecosystem services and resources such as soil nutrients, seed dispersal, pollination and fossil fuels are important assets and functions but traditional national accounts do not include measures of the depletion of these resources. This means a country could cut its forests and deplete its fisheries, birds and this would show only as a positive gain in gross national product without registering the corresponding decline in assets (de Vere, 2008).

The poor communities tend to be the most directly affected by the deterioration or loss of ecosystem services, as they are the major dependent on local ecosystems and often live in places most vulnerable to ecosystem change since it provides direct livelihood and security to them. It is particularly important for the livelihoods of the rural poor and for regulating local environmental conditions. Poor communal people across the globe have constantly hunted birds for meat and eggs that had constituted a significant source of protein in their diets. Birds have also been raised for recreation and some raised for commercial gains for instance the ostrich, as remarked by Copper and Horbanczuk (2004), the ostrich is an important animal in many livestock industries and, in the developing world, the export of meat and skins is a valuable source of foreign currency.

Agriculture throughout the world is on sector most dependent on ecosystem services and biodiversity for genetic resource materials. Agriculture is also the largest driver of genetic erosion, species loss and conversion of natural habitats. Avifauna has not been an exception in the domestication and farming as a lot of species have been successfully domesticated and these include the ostrich, guinea fowl, quails, pigeons and domestic chicken (*gallus gallus*). Sustaining the increasing global food needs will require intensification and extensification approaches in agriculture. Intensification is based on higher or more efficient use of inputs, such as more efficient breeds, agrochemicals, energy and water. Extensification requires converting increasing additional areas of land to cultivation. Both approaches have the potential to dramatically and negatively affect biodiversity. In addition, the loss of diversity in agricultural ecosystems may undermine the ecosystem services necessary to sustain agriculture, such as pollination, seed dispersion and soil nutrient cycling in which avifauna is an important player (Hyde and Campbell, 2012).

Birds have played an important role in human life as a means of pest control. Şekercioğlu *et al*, (2014) describes a good pest control agent as one that does not only consume the pest species but must also be able to affect the population of the pest species sufficiently to the extend where a positive development is realised on the resource attacked by the pest. The effectiveness of the pest control should be noted by improved yield or fitness of resource being protected. Bird-crop interactions have been on study since the 19th century as economic ornithology. The study had looked at birds and agriculture interaction, investigation of the food, habits, and migrations of birds in relation to both insects and plants. Early efforts focused on food habits of species presumed to be either beneficial or detrimental to agriculture, including granivorous and insectivorous birds as well as birds of prey. Interest in the role of birds as pest control agents fall when agriculture became intensive and became dependent pesticides. Current interest in the functional roles of birds arose from factors, such as food competition, predation and structuring mechanisms of ecological communities Şekercioğlu *et al*, (2014).

In ancient days people believed that birds of prey were detrimental to agriculture through predation of poultry or game birds. However early ornithology reports in the United States showed hawks and owls were far more helpful than injurious to the farmer. Rodents, rabbits, hares, snakes, and insects were vastly more important prey items than chickens or game. Given the preponderance of rodents in the diets of many raptors, it seems reasonable to assume that these birds benefit agriculture. Moreover, several raptor species readily occur in agricultural landscapes (Williams *et al*. 2000) in Şekercioğlu *et al*, (2014). Kay *et al*. (1994) in Jorgensen (2009) also reported that few studies have directly assessed effects of birds of prey as agricultural rodent control agents and that, results are somewhat ambiguous. Evidence is reported inconsistent and the effect of raptors sufficient to benefit agricultural production remains unknown and further investigation required.

Birds of prey have been important in the ecosystem as scavenger. Animals that die in the ecosystems get their carcasses torn up and get subjected to further decomposition by micro-organisms. Vultures and ravens are important birds for this critical function. Birds have also been important in the killing of some prey. Other carcasses scavenged are from natural death to include old age, mal-nutrition, disease, parasites, accidents, exposure, and catastrophic events like storms and wildfires. The broken down carcasses contribute the addition of organic matter content in soil through the decomposition of their bodies.

A number of bird species modify the environment by activities like nest construction hence, act as ecosystem engineers (Jones et. al., 1994) in Jorgensen, (2009). Such actions end up providing and supporting other functions and organisms in the ecosystem. There is a great range of complexity and size of nests. Most nests fall into excavated cavities, burrows, cup nests and dome shapes. When nests are abandoned, they offer various usefulness to other organisms in the ecosystem. Woodpeckers (*Picidae*) are the most familiar group of cavity excavating birds and are found in almost all continents except Antarctica. There are about 180 species that range in size from about 30g to over 500g. Cavity sizes thus vary with the size of the species. Cavities are very important and offer various uses to other organisms to include other birds, reptiles, amphibians and arthropods after their abandonment. Thus excavator birds are key species that influence and help maintain diversity (Şekercioğlu *et al*, 2014).

Another ecosystem function of birds reported by Stern *et al*, (2008) is their importance in alter and improvement of the soil through their activities including barrowing. These birds include penguins (*Sphenisciformes*), some seabirds (*Procellariiformes, Charadri-iformes*), parrots (*Psittaciformes*), owls (*Strigiformes*), kingfishers (*Coraciiformes*) and songbirds (*Passeriformes*), (Jorgensen, 2009). The process of barrowing has an effect to soil properties an important ecological aspect. Moreover holes created become homes for other organisms. Birds, snakes, mammals and amphibian alike shelter themselves in barrows left by birds. Open cup and domed nests are the most common nest types. These nests are constructed of a wide variety of materials, including plants, lichens, and spider webs. Most nests become ideal for sheltering larvae due to conducive temperatures, which increases survival and food exploitation (Şekercioğlu *et al*, 2014). Most nests are usually taken over by small organisms after the original occupants finish nesting and abandon them. Remsen (2003) in Jorgensen, (2009) reports that many animals to include insects, beetles, ants, wasps, rodents, lizards, snakes, frogs and even other bird species use abandoned nests. This in a way is an important product driven ecological service of avifauna.

Birds play a significant role in pant pollination, browsing and seed dispersion. A study was carried by Clout and Hay, (1989) on the interaction of birds and plants in New Zealand. The study was inspired by the extinction of the moas *(Dinornithidae)* that were forest-dwelling browsers and frugivores. Speculation about the importance of browsing by birds has concentrated almost exclusively on the possible impact of moas on the forest. According to Clout and Hay, (1989), the possible impact of other browsing birds, especially flying species capable of feeding at all levels in the forest, has been virtually ignored. About five species of the forest birds were noted to be consuming huge quantities of foliage including the leaves of several species known to have been browsed by moas. Observed among these forest browsers are the kereru, or New Zealand pigeon *(Hemiphaga novaeseelandiae),* and the kokako *(Callaeas cinerea),* both of which feed at all levels in the forest and are capable of significantly defoliating their favoured food plants. Kereru have been observed eating the leaves of 41 species of native plants and over 20 introduced species. This is a very important ecological function and interaction where birds are actively involved. According to Clout and Hay, (1989) further studies are required to explore the extend of benefits on both organisms

Flower visitation by avifauna has already been confirmed by many researchers and in a similar way, the importance of frugivory in seed dispersal by birds has been given high regard in studies by ecologists. Insects and birds are by far the most common flower visitors and there are several plant species whose flowers are visited specifically by birds especially the nectar-feeding birds such as bellbird *(Anthornis melanura)* and tui *(Prosthemadera novaezelandiae).* Birds which visit and potentially pollinate the flowers of forest trees include the bellbird, tui, stitchbird *(Notiomystis cincta),* kaka *(Nestor meridionalis),* red-crowned parakeet *(Cyanoramphus novaezelandiae),* yellow-crowned parakeet *(C. auriceps),* saddleback *(Philesturnus carunculatus)* and silvereye *(Zosterops lateralis)* (del Hoyo *et al*, 2008). Flowers, fruits and seeds provide significant ecological interactive points between plants and birds. The design and colours of most flowers help to attract animals including birds that transfer pollen between flowers. Adaptations of fruits and seeds for dispersal by animals, mainly birds are so diverse and include attractive colours, scents, and oils, laxatives to speed the passage of seeds through the animal gut and adhesive structures that attach to fur or feathers. Birds and other animals act as disseminating agents of seeds for many plants. Some birds may carry seeds for great distances in mud that adheres to their feet. Other birds and mammals eat fruits whose seeds pass unharmed through their digestive tracts which may be different with other animals like the Archipelago tortoise that may keep seeds in its gut for about 2 weeks and destroy their ability to geminate. In some birds like the blackbirds, disseminated fruits contain laxatives that speed their passage through the birds' digestive tracts where the seeds may take as little as 15 minutes in the birds' digestive system (Stern *et* *al*, 2008; del Hoyo *et al*, 2008). The fruits of many shrubs and lower canopy trees are fleshy and attractive to birds and the seed coats resist digestion in the gut. The seeds are dispersed by birds in a somewhat less certain fashion, depending on the defecating behaviour of the bird. The association between birds and plants is mainly mutuality as the seed is dispersed in a more or less unpredictable way and the disperser benefits by consuming the fleshy proportion of the seeds (Begon *et al*, 2006).

Avifauna suits appropriately in use as indicators in monitoring biodiversity and in developing meaningful indicators for wildlife abundance. Catalysed by the Rio de Janeiro Earth Summit in 1992, which reinforced the importance of biodiversity monitoring, a range of organisations have been involved in the development of indicators (Gregory *et al*, 2003). Key attributes to effective bio-indicators include ability to be quantitative, simple, user driven, policy relevant, scientifically credible, responsive to changes, easily understood, realistic to collect and susceptible to analysis. Avifauna perfectly meets these specifications given that they are found in most ecological environments and sensitive to environmental changes. Species loss or gain could then be used to gauge then trends in biodiversity. A problem with this method is that abundance and range could be modified without a net change in species number. There is also the problem that species of conservation concern may be supplanted by less desirable species, but in the process no overall change occurs in species diversity (Gregory *et al*, 2003). Birds become good indicators of watershed health monitoring because of their good responsiveness to basic changes in landscape and habitat conditions. Birds live in a wide range of habitats and they can be affected by many different impacts including land use changes, invasive species and pollution. They can integrate and accumulate environmental stresses and can indicate when some aspects of watershed health are being compromised (US EPA, 1993). Ntongani and Andrew, (2013) also acknowledged that birds serve as good ecosystems health indicators worldwide and could facilitate understanding and prediction of consequences of human disturbances to an ecosystem's biodiversity. However, studies looking at how bird species composition, abundance, richness and diversity vary between ecosystems for instance grasslands, wetland and forest have different disturbance histories between ecosystems and within the same ecosystem over time especially in semi-protected areas (Ntongani and Andrew, 2013).

Birds particularly water birds are good bio-indicators for heavy metal poisoning, as it easy accumulate and affect eggs and reproduction, internal organs and feathers (Burger and Gochfeld, 1997). Some heavy metals like mercury are also believed to cause thinning of the eggshells with the potential reduce breeding success and ultimately causing population decline (UNEP, 2014). Most studies on internal organs are done on dead birds since killing birds is inconvenient and undesirable. The affinity of heavy metals to sulfhydral group of protein accounts for high concentration of these pollutants in growing feathers which comprises mainly sulphydral protein. Burger (1993) in (Burger and Gochfeld, 1997) provided a global overview of mercury in feather and showed that 80% of body burdened with mercury is in feather.

Bio indictor studies comparing heavy metals in bird feathers of museum specimen and live birds indicated that the increase in the concentration of heavy metals in wildlife during the 20^{th} century was mostly driven by anthropogenic activities discharge these toxins rather than natural sources (Sams, 2007). Feather sampling in bio-monitoring has an advantage that it is non-destructive and requires no special field preservation like freezing and it allows comparison of current and ancient (museum) specimen (Burger *et al.*, 2007). According to UNEP (2014) publication, birds like humans are on the top of the food webs and provide important early warning for toxic metal and other pollutants. Birds are also used in experimental studies for instance Burger *et al.*, (2007) reported an experimental study on feeding methyl mercury contaminated chicks to a captive Red tailed hawk. Diet containing 10µg/g resulted in death after one month from neurotoxicity. Similarly in a study where Goshawk was feed from chicken with 13 µg/g mercury, it died after 30-40 days.

Besides birds being useful in bio-monitoring, they are also instrumental in studies that give much insight and knowledge about nature for instance bird ringing is a research method based on the individual marking of birds, EURING (2007). The technique is one of the most effective methods to study the biology, ecology, behaviour, movement, breeding productivity and population demography of birds. Tracking back the journeys of ringed birds allows us to define their migratory routes and staging areas, thus provides crucial information for planning of integrated systems of protected areas for our birds. Other information derived from recoveries and recaptures include population parameters e.g. survival estimates, lifespan, reproductive success, which are essential to determine the causes of changes in population sizes, EURING (2007).

According to US EPA (1993) publication approximately 63 million Americans watch birds and spend over $20 billion on bird-related activities and material every year which makes birds a significant source of income for the government, institutions and individuals. Conservation of birds provide an exciting career opportunities for a lot of people and in 1991, there were more than 190,000 people employed in bird-related jobs in United States (US EPA, 1993). Lamington National Park (LNP) in Queensland, Australia is noted for its rainforest and is part of the World Heritage listed property with a significant diversity of birds. Though no systematic study has been done on the importance of birds to its visitors their importance cannot be underestimated. Increasing appreciation of visitors remarking that birds are an important attraction, with attributes including singing birds, birds diversity, watching numerous birds, presence of rare birds, presence of brightly coloured birds and physical contact with birds (Tisdell and Wilson, 2004). LNP is well known for its birdlife and some threatened species such as the Albert's Lyrebird *Menura alberti,* Rufus Scrub-bird *Atrichornis rufescens,* Eastern Bristlebird *Dasyornis brachypterus* and the Coxen's Fig Parrot *Cyclopsitta coxeni* are found in the park. Furthermore, a variety of bird meat is served at the guesthouses and neighbouring communities. The park caters generalist visitors who like physical contact and the bright colours of the birds as well as the specialist birdwatchers (Tisdell and Wilson, 2004). LNP is one example of several bird sanctuaries across the globe that illustrates enjoyment offered by avifauna to visitors, researchers, ecologists and ordinary bird enthusiasts.

According to surveys carried by Hartley and Mundy (1991), game birds have been a very important and renewable resource to the rural communities in North America and Europe where they have been useful in contributing to a lot of developments. In the United Kingdom game birds hunting earns the country an amount of up to hundreds of millions of pounds sterling per year. Similarly in1991 in the United States, about US$1, 5 billion was spent in activities involving small game hunting with birds constituting a larger percentage. The gross revenue from the francolin hunting activities South Africa's Stormberg region amounts to over R4 million every year. In Zimbabwe, birds are a feature of wilderness areas and most of the farming environments. They are indeed compatible with agricultural activities though there are incidents where they can be destructive to crops and poultry. In Zimbabwe current rates of between US$150-200 per day are charged for rough shooting, possibly more for a top class hunt with all of the amenities. Dove hunting have been offered for US$100 per day and with a good shooting hunt of ground fowl earning up to US$500,00 per day (Hartley and Mundy, 1991). All this indicates the benefits and importance of birds as a biological resource and a component of the ecosystem together with uses in humans' lives which by far out way the damages hence the need to conserve these animals.

2.4 Threats to avifauna diversity

Biodiversity is currently being lost at an unprecedented rate mainly due to human induced factors coupled by natural factors with 12 % of avifauna threatened by extinction (Baillie *et al*, 2004). A number of factors have contributed to the continuous decline and loss to the populations and diversity of avifauna and these include habitat loss or alteration of ecosystems, introduction of invasive species, pollution, use of pesticides, birds hunting, climate changes and diseases (Skagen *et al*, 2005).

Dutson *et al*, (2005) noted Australia as one of the most important countries in the world in terms of birds diversity with 803 bird species, of which 312 are endemic and is also globally important for many species of water birds, shorebirds and seabirds that are shared with neighbouring countries and regions. Australia however is ranked among the top countries in the world for the number of globally threatened bird species with some close to extinction.

One greatest threat to avifauna biodiversity is habitat loss resulting from among other factors land use changes. Land use changes has caused conversion of natural ecosystems to include rivers, wetlands, grasslands and forest into mining centres, timber harvest zones, agricultural lands and expansion of communal and urban settlements. These impacts can cause chemical, physical, and biological changes to the environment (Zedan, 2004). Mining activities are associated with destruction of forests, accumulation of slime and discharge of chemicals into the environment. Noise and dusts are also mining impacts that threaten avifauna diversity. Similarly agricultural activities for instance cause considerable destruction to natural habitats by reducing vegetative cover, increasing sedimentation to rivers, increase nutrient runoff and addition of chemical pollutants to aquatic systems which has consequently affected avifauna by introduction of some toxins into their ecological pathways like the food webs.

Riparian forests and wetlands have long been considered important habitats for breeding of birds and growing evidence reinforces their importance during the migratory period as well. Riparian habitats of Western North America for instance covers less than 1 percent of the landscape yet they support a disproportionately large number of bird species and greater densities of birds than other forested habitats (Skagen *et al*, 2005). Extensive modification of natural flow regimes, grazing, and forest clearing along many rivers have led to loss and simplification of native riparian forests and to declines and endangerment of riparian-dependent birds species.

Watersheds have also been important habitats for birds but have been affected by human and natural factors that altered their ecological states and capacity. Natural factors driving changes in watershed include natural disturbances such as floods and fire. However, human activities have exacerbated the changes resulting in impacts that are more severe in frequency and magnitude as compared to natural agents working alone (US EPA, 1993). A variety of human induced impacts have impaired or destroyed the beneficial natural functions of several watersheds ecosystems to their avifauna species. Several types of human caused impacts are most likely to affect birds.

Wetlands are important ecosystems appreciated for providing quality and abundant habitats for avifauna populations throughout the year and thus a considerable number of wetlands are declared as important bird areas (BirdLife International, 2001). Nevertheless, wetlands are among the most threatened ecosystems as the size, quality and structure of their habitats have been altered by anthropogenic disturbances such as intensive agriculture and livestock overgrazing. Moreover, climate change may exacerbate further wetlands natural resources degradations, consequently affecting negatively the abundance, diversity and community composition of especially threatened bird species (BirdLife International, 2001).

All ecosystems and regions, evidence from many empirical studies suggest that disturbed and modified habitats sustains less avifauna diversity as compared to natural habitats because the later provides more resources (del Hoyo *et al*, 2008). Thus, effective management strategies should aim to restore these degraded habitats and simplified landscapes especially in the tropics where there is a dearth of information on birds' population dynamics in relation to anthropogenic disturbances. According to a study done by Ntongani and Andrew, (2013) the Kilombero wetland in Tanzania provides abundant and diverse habitats for variety of bird species, and is recognized internationally as an Important Bird Area (IBA) and a Ramsar site. The Ramsar Convention on wetland has devised the wise use principle, where all site qualifying to Ramsar sites criteria can be used as long as the use is compatible with their ecological characters, and all the uses meets the sustainable development objective (Culture and Wetlands, 2008). Contrary to the wise use principle, unregulated anthropogenic activities such as unplanned settlement development, intensive agriculture and overgrazing by livestock are on the rise at Kilombero (Ntongani and Andrew, 2013).

Urbanisation is one of the major threats to both aquatic and terrestrial avian diversity. Destruction of forests and land for establishment of settlements damages wildlife habitats. Moreover urbanisation comes with generation of pollution which threatens life (Fegus *et al*, 2011). Urbanization also affects the quality of aquatic habitats by increasing pollution levels, sediments, heavy metal and nutrient loads to water. There will also be changes in the rate and amount of runoff reaching rivers. Such impacts to watershed habitats cause a decrease in the numbers of waterfowl. Wetlands are lost during the process which will result in reduction of migratory songbirds due to habitat fragmentation. All this consequently cause loss of avian diversity dependent on healthy aquatic and terrestrial habitats (Fegus *et al*, 2011).

Klem 1990 & Dunn 1993, both in Şekercioğlu *et al*, (2014) state that one hundred million to one billion birds are conservatively estimated to die annually within the United States from collisions with glass alone. Today we can add collisions with human-built structures like buildings, especially glass; power lines and transmission towers as well as collisions with automobiles as possible avian diversity threats.

Another major factor reducing the quality of endemic bird habitats is the introduction of invasive and non-native plant and animal species. People have brought thousands of species from other parts of the world and we continue to do so at an increasing rate. Some of these species become severe stressors in existing ecosystems and some particularly affect birds. The Fish and Wildlife Service of USA estimates that non-native, invasive species destroy approximately 4600 acres of indigenous habitat per day and researchers estimate that non-native species cause over $136 billion of damage every year. A particularly destructive non-native predator of birds is the domestic cat, particularly those that become wild in natural areas. There are over 100 million feral and domestic cats in the U.S. A study of cat predation on birds in the United States showed that, in that state alone, cats were estimated to kill about 39 million birds per year (Kushlan and Steinkamp, 2002).

Pollution and pesticides remain significant stressors on some bird populations. Pollutants from agriculture, logging activities, urban uses, industrial activities, mining and other human activities can significantly degrade watershed habitats. The quality of water have also been seriously affected and birds especially piscivirous birds have been affected. Legislation and control systems have been implemented across the globe but the effectiveness in controlling some of the point sources pollution is still a challenge across the globe. Non-point source pollution from overland runoff and air deposition is also still a significant contributor to the degradation of soil and water quality consequently affecting avifauna and other organisms. Use of pesticides and other toxins has also directly and indirectly affect bird species (Pullin, 2002).

Mining developments creates open pits, mine dumps, habitat fragmentation, toxic waste holding ponds, air and water pollution, infrastructures like refineries and pipelines. Some support service structures like shops, clinics, roads and schools spreading far beyond the mine site (Sodhi and Elrlich, 2010). These developments destroy habitats for avifauna endemic, the vagrant and migratory birds. In the case of the tar sand mining in the United States, in the Boreal forest, each year between 22 million and 170 million birds breed in the Boreal forest that could eventually be developed for tar sands mining (Wells, 2008). Tar sands mining development, do not just move migrating birds elsewhere, since they depend on a certain type of habitat, this can seriously affect them with some adult birds dying when faced with lost and fragmented habitat together with the noxious mining wastes. Birds will accumulate toxins in their bodies increasing chances of future generations losing their chance of existence as toxins weakens their adaptive ability (Wells, 2008). The Boreal forest tar sands area is incredibly important for birds as a breeding habitat and as a globally important flyway for a great abundance and diversity of wet land dependent birds. Unfortunately the rapidly expanding industrial tar sands extraction operations increasingly place these birds at risk. Virtually every facet of tar sands mining developments has the potential to harm Boreal birds many of which are migratory birds that are protected by treaty and national law (Wells, 2008). The combined cumulative loss of birds from mining and in situ operations, can be projected over the next 30 to 50 years ranging from 6 million birds to as high as 166 million birds lost. Beyond the direct habitat effects, there are many other impacts to birds that, while harder to quantify, are known or expected to cause significant problems for birds and other wildlife. The projected strip-mining of 740,000 acres of forests and wetlands in the Boreal tar sands mining will result in the loss of breeding habitat for between 480,000 and 3.6 million adult birds. The corresponding impact on breeding will mean a loss of 4.8 million to 36 million young birds over a 20-year period (Wells, 2008).

Changes in the global climatic conditions are also a factor placing the diversity of avifauna at risk. It has been estimated by Intergovernmental Panel for Climate Change (2007) that around 35% of bird species and 60% of plant species in the Tropical Andes forest would become extinct or critically endangered by 2080 (Herzog *et al*, 2011). The vulnerability of tropical forest ecosystems relates to their dependence on the level of vegetative cover, which is predicted to shift with climate change. Reduction in horizontal precipitation and ever rising temperatures could lead to decreased moisture, with consequences for diverse epiphytes and the animal communities they support. Many species in tropical forests are adapted to narrow elevation ranges on steep slopes. Spatial heterogeneity of climate change could lead to collapse of populations or increased vulnerability to extinction. Warming temperatures may cause increased evaporation in lakes and wetlands, with concomitant reduction of habitat and potential changes in water quality i.e. temperature and salinity especially where precipitation declines are predicted. (Herzog *et al*, 2011). Large-scale human impacts such as landscape transformation and contribution to climate change are not only a threat to the diversity and uniqueness of the region’s avifauna, but also radiation and speciation, evolutionary processes that have generated and maintain diversity (Herzog *et al*, 2011).

Zocchi (2004) reported that the main threats directly or indirectly affecting the Pond heron include habitat destruction and degradation; human disturbance at nesting sites; reduced nesting sites leading to competition for nesting, feeding and roosting sites; and collection of eggs and young birds. Birds in Zimbabwe’s rural areas just like in many parts of the world are threatened by the communal people as they are considered as a source of bush meat. Various ways have been utilised to catch birds to include use of poison, traps, snares, wax and guns. Eggs and chicks are also collected for food especially the bigger fowls like the guinea fowl, ostrich and goose. Breeding areas, nests and eggs for birds are also aimlessly destroyed by people in many parts of the country which can be attributed mainly to lack of knowledge and lack legal protection (Gandiwa *et al*, 2013). Zimbabwean wildlife policy promotes the utilization of wild animals to include birds. This has been considerably successful with other animals but relatively less utilization has happened with game birds. This applies in most communal lands, where population pressure, habitat change and degradation, hunting with dogs, snares and even poisons have probably diminished the numbers of gamebirds especially the francolins and guineafowl. Notwithstanding, these factors it is apparent that certain zones in some communal lands of Zimbabwe have significant numbers and diversity of gamebirds in areas where there is suitable habitat (Hartley and Mundy 1991)

Gandiwa *et al*, (2013) indicated that the vegetation changes in savanna landscapes can affect both ecosystem productivity and conservation value of Important Bird Areas that habitat many bird species in the Southern part of Zimbabwe. These factors affecting viability of vegetation in the region include fires, herbivory, rainfall levels, soil nutrients, soil type and anthropogenic activities. Studies have reported that bird species composition, habitat selection and foraging efficiency are influenced by habitat integrity, woody vegetation structure and composition. For instance, an increase in avifauna diversity has been associated with increased vegetation structural diversity. An understanding of the structure and composition of woody plants in IBAs is valuable for avian conservation since they are important for a diversity of bird species as they provide food, cover, sites for nesting, roosting, perching and observation posts for raptorial birds. Moreover, plants that produce fruit consumed by birds have been reported as being particularly important since they may attract a high number of bird species with the bird species also assisting in seed dispersal (Gandiwa *et al*, 2013)

2.5 Important avifauna behaviours in conservation

Knowledge on bird's adaptive and life behaviours is important to a conservationist if one has to understand and interpret the reasons for some of the changes in their population and density. One has to understand whether changes had been induced by migration or mortality. A conservationist need to be aware of behaviours and life skills of the birds like feeding process, reproduction process, nesting, roosting and care for young one. Below is a discussion of some important avifauna behaviours in conservation.

Avifauna migration is one distinctive behavioural action which is very important for continuity of their existence and it is ubiquitous in form. Avian migration is an adaptive response to seasonal environmental changes, which allows animals to take advantage of spatial variation in the seasonal fluctuation of resources (Skagen *et al*, 2005). By using different areas during different times of the year, many bird species have been able to successfully colonize areas offering favourable conditions only during a short period. Other ultimate factors favouring the evolution of migration include escape from inter- and intra-specific competition in saturated habitats and avoidance of predators and parasites (Meyburg *et al*, 2012). Avian migration is highly diverse, ranging from the spectacular mass migration of large soaring species such as storks to the almost invisible movements of some small passerines travelling silently and alone during the night to serious migratory species that travel thousands and thousands of kilometres (Pulido, 2007). Birds migration is probably one biological phenomenon that has fascinated and attracted many people, scientists and non-scientists alike. Some general features are common in all migratory birds for example, the suppression of maintenance activities or the deposition of energy reserves (Pulido, 2007). These features help to define migration and identify migratory individuals. The selective advantages leading to the evolution of migratory movements have long been acknowledged.

One of the characteristics of avian migration is its variability within and among species. One reason behind the high potential for evolution of migratory behaviour in sedentary populations seems to be the ubiquity of genetic variation for migratory traits in non-migratory individuals. In resident lineages, a high degree of hidden genetic variation for migratory traits can be maintained because a migratory threshold determines whether migratory behaviour is expressed. Genetic correlations among migratory traits and with other traits of the annual cycle are likely to play a major role in determining the rate and direction of evolutionary change. Variation in migratory behaviour, physiological and morphological adaptations to migration, is to a large extent due to genetic differences. Studies suggest that migratory behaviour has rapidly and independently evolved in different lineages (Pulido, 2007).

According to Dodman and Diagana, (2006) water birds across the globe have developed adaptive strategies to discover and exploit wetland resources. Most of these species are mainly sedentary, especially those in regions with relatively static tropical climatic conditions. However, most bird demonstrates movements in response to changing seasons and environmental conditions. The onset of rain is an important trigger for migration of most migratory water birds across the world. Some water birds are harbingers of the rainy season, whilst others follow in the wake of rain. However, levels and timing of rain can be unpredictable, and rain may not fall at all in some years. When rain falls in arid and semi-arid areas, productive temporary wetlands can appear overnight, and attract large numbers of water birds, many of which display some nomadic tendencies. This unpredictability presents difficult management scenarios. Some birds have been reported to be often blown off course by unusual winds that would leave them in totally new places.

Slobodkin (2003) reported that small birds, nests and breeds in the spring and most of these birds will die after they have left their nests independent of age. This has been high in most species of small birds that an average bird lives only a few months. Some large seabirds, such as the albatross, may live for decades but produce only one or two young every other year. There has been always a high death rate in new borns for most of the mammals and birds.

The outer covering of birds is made of feather, skin and scales that serve as a means of physical protection against injuries, germs and weather changes. In most cases the covering has specific markings that attract mates, defend its territory or serve as camouflage. Birds are warm blooded and feathers are helpful in regulation of temperatures and keeping the bird dry and insulated. The light weight and specific shape of the feathers allow birds to fly (Smith *et al*, 2009). Birds have got a seasonal life especially for individuals that spend most of their times further the equator. Breeding times often coincides with peak food availability and maximum foraging period. The closer that a Northern Temperate Zone bird lives to the polar region the more seasonal life becomes and the bigger the migration challenge it faces if it is to take advantage of local pulses in food production. This was supported by (Begon *et al*, 2006) when he remarked many of the birds of temperate forests are migrants that return in spring but spend the remainder of the year in warmer biomes. A seasonal abundance of seeds and insects supports large populations of migrating birds, but only a few species can find sufficiently reliable resources to be resident all year round.

Birds differ in roosting with some gathering together but others roost alone. Birds become more spherical reducing their volumes, tuck their heads and necks to reduce heat loss in cold environments. Arinaitwe, (2005) reported that migratory birds use more energy and oxygen to fly hence minimise unnecessary flying. Birds have more options than plants when it comes to defending themselves. In most birds territoriality if displayed both on nesting and feeding sites. Territoriality in birds like in many animals results in expenditure of a lot of energy in patrolling and advertising their territories, and these energetic costs must be exceeded by any benefits if territoriality is favoured by natural selection (Begon *et al*, 2006). One important adaptive and natural selection skill in birds is their natural ability to select nesting places and positions that are not easily accessible to predators and enemies (Begon *et al*, 2006).

Ornithologists are well aware that closely related species of birds often co-exist in the same habitat utilising different ecological sites. For example, five *Parus* species occur together in the European broad-leaved woodlands: the blue tit (*P. caeruleus*), the great tit (*P. major*), the marsh tit (*P. palustris*), the willow tit (*P. montanus*) and the coal tit (*P. ater*) (Begon *et al*, 2006). All have short beaks and hunt for food chiefly on leaves and twigs, but at times on the ground; all eat insects throughout the year, and also seeds in winter; and all nest in holes, normally in trees. However, a closer look at the details of the ecology of such co-existing species, the more observations done on ecological differences. Despite their similarities in structure, food and ecological requirements, one may be tempted to conclude that the tit species compete but co-exist. However reality is that they survive by eating slightly different resources. In a scientific study of the two species by Martin and Martin (2001) in Begon *et al*, (2006) the orange crowned warbler (*Vermivora celata*) and virginia's warbler (*V. virginiae*) whose breeding territories were similar, one of the two species was removed, the remaining orange crowned warblers fledged between 78 and 129% more young per nest. The improved performance was due to improved access to preferred nest sites and consequent decreased losses of nestlings to predators. (Begon *et al*, 2006). This concept had also been earlier proved by McAuthur in his 1955 experiments with five species of warblers that were living together in the spruce forests of North America. The theory predicted that two species with identical ecological requirements would compete with each other consequently they would not live in the same environment indefinitely. In McAuthur's experiments he wanted to find out how different species of warbler would co-exist and compete as they feed on insects in different zones within the same tree (Molles, 2008)

2.6 Land use and avifauna diversity in Shurugwi

Shurugwi is located in the Midlands Province of Zimbabwe approximately 30km south of the provincial capital, Gweru and its communal lands form the central part of the country. It lies in agro-ecological region III where the average annual rainfall is moderate and ranges from 650-800mm usually received from the month of November to April (Madebwe and Madebwe, 2005). Since granite is the dominant parent rock type the resultant soils ranges from sandy to loamy soil textures. Soil degradation through erosion varies from area to area due to vegetation types / cover variations and existing economic activities. The major rivers, draining through this region includes Tugwi, Nyamakupfu, Gurudze and Muteveki draining mainly from the North West to the south (Madebwe and Madebwe, 2005). Shurugwi lies south of the central Plateau and watershed, in the upper reaches of the Runde catchment. Associated with the diverse geology and topography, Shurugwi is a meeting point for three main vegetation types: *Brachystegia spiciformis – Julbernardia globiflora* (miombo) woodland, Acacia tree savanna and *Terminalia sericea* tree savanna (Wild and Barbosa, 1967).

Vegetation for much of the study site is open mixed miombo woodland of 4-5m height. Coppice re-growth forming stands of short, multi-stemmed trees also exist on some abandoned farm lands. On the gravely reddish brown soils, the predominant species *is J. globiflora* with occasional *B. spiciformis*. Where the soils are more shallow and quartzitic, Uapaca kirkiana becomes dominant. Some areas of woodland have been recently cleared for cultivation. The grasses are generally sparse annuals*: Loudetia simplex, Eragrostis sp*. with some of the perennial, *Themeda triandra*. Moving down the catena the deeper soils support taller trees and the grasses are taller and denser perennials: *Hyparrhenia rufa, Hyperthelia sp*. None of the vegetation types or plant species are considered rare or endangered (Wild and Barbosa, 1967). The area have mainly got bush savannah grassland with *hyperrania, hypothelia* and *digitaria* as the major grass vegetation type and scattered *brachystegia, terminalia* and *julbernadia* tree species.

There was some evidence of Common Duiker, Scrub Hare, baboons and Vervet Monkey are common animal in the area. Whilst in the past, the area would have supported a variety of wildlife, it is unlikely that much remains now. Since the miombo woodlands are widespread, the avian fauna associated with this habitat is also widely distributed (Wild and Barbosa, 1967). Specific plans were for a hotel, game conservancy, bird watching and exploitation of scenic views. Plans of the Gwenoro Wildlife Conservancy we also proposed on the south west of Shurugwi town. Land use on the surrounding farms was largely game and cattle ranching, but this has diminished considerably in recent years.

The Great Dyke is the main topographic and geological feature of the area. A section of the Dyke, known as the Chironde Hills, rises to 1537m above the lower, flatter surrounding land (1300m). The study site lies to the north west of the main Dyke and has a fairly flat topography, sloping from a flat ridge down into the Impali river valley. There are a series of granite hills rising to 1420m approximately 1 km to the south west of the site. The Dyke is an intrusion of mafic and ultramafic rocks from the Pre-Cambrian age. It is a younger geological feature than the surrounding rocks and separates the older western phyllitic schists and banded ironstones, from the eastern granites. The granites contain quartz and serpentine intrusions (Wilson, 2001). There are several gold mining claims and active small scale mine workings in the north east of the site. The complex geology is reflected in the soils which are classified as fersiallitic, meaning they are high in iron and silica. Moderately deep reddish brown granular clays formed on mafic rocks. Moderately shallow to moderately deep, reddish brown to greyish brown, relatively silty sandy clay loams over yellowish brown clay loams which are frequently mottled. Formed on argillaceous metasediments and some volcanics and metavolcanics. Moderately shallow to deep grayish brown, coarse grained sands over sandy clay loams; formed on granite rocks The soils in the study site fall into the second category. On the central ridge at the top of the catena the reddish brown soil is shallow and gravelly, becoming deeper and more loamy further down the slope. The bottom of the catena contains dark brown - grey clay.

Shurugwi experiences three main climatic seasons: hot, wet from November to March; cool dry from April to July; hot, dry from August to October. As with most of Zimbabwe, the rainfall is strongly influenced by the Inter Tropical Convergence Zone, but an additional factor is the steep sided hills in the area. These rise about 200m above the flatter surrounding land and intercept the moist winds blowing up from the Mozambique plain, resulting in orographic rainfall. Mists and “guti” are common. Much of the rain falls in short, heavy showers which results in high runoff intensities and therefore high erosion (Wilson, 2001). For the period 1971-1992, Shurugwi received a mean annual rainfall of 995mm. This is higher than the annual rainfall in the surrounding area and Shurugwi is an important source of above and below ground water recharge for the Runde catchment area. Because of the hilly topography the area is relatively cool, with a mean minimum temperature of 4.5 ºC in July and a mean maximum of 28.3 ºC in October. The prevailing wind direction is generally from the south east, changing to north east just before the start of the rains (Wilson, 2001).

Major economic activities in the communual areas is substance animal rearing and crop farming mainly maize and groundnuts (Madebwe and Madebwe, 2005). According to Matsa and Muringaniza (2011), Shurugwi like many other parts of Zimbabwe has been hit by the fast track land redistribution programme that has resulted in considerable land cover / land use changes. Matsa and Muringaniza (2011), indicated that the effects of this land redistribution programmes are still uncaptured, unstudied and undocumented and such an exercise will be very crucial in Shurugwi to establish baseline data. This will be very important for planning for conservation of birds and other wildlife in the area. It was further revealed that before the fast track land redistribution programme land cover has not been disturbed in the region with most of the land owned and protected by the white minority Matsa and Muringaniza (2011). In this study Matsa and Muringaniza 2011) established that 53 percent of land was cultivated or bare and 20 percent of the land with undisturbed vegetation and 2 percent covered with water. A similar study carried by Madebwe and Madebwe (2005) explored the impacts of socio-economic and environmental factors on wetlands in Shurugwi, where vegetation cover was used to determine wetland shrinkage a big adverse relationship was established between the economic activities and wetland status. It is reported by Madebwe and Madebwe (2005) that in 1980 wetlands occupied 220 hectares and significantly declined by 43 percent by the year 2003.

Shurugwi is located in the path of the Great Dyke which is the seam of ore bearing rock that stretches from the north to the south of Zimbabwe. Since the early 1900's Shurugwi Town developed as a result of the gold and chrome mining activities that have taken place along this section of the southern Great Dyke. It spans for about 550 kilometres with a width of about 11 kilometres. It is rich in minerals like platinum, chrome, gold, nickel, copper together with several other precious metals. This makes Shurugwi one of the main mining centre in the country with major mines like Zimbabwe Mining and Steel Company (ZIMASCO Shurugwi), Unki Mine, Todal Platinum Mine and Falcon Gold Mine (Makore and Zano, 2012). In addition to these large scale mines there are thousand small scale chrome and gold mines in the region. The place also has several illegal artisanal gold miners operating it the forests around Shurugwi. Given the massive impacts of mines to environmental, the ecological effects of this human activity to the ecosystem cannot be underestimated. Mining causes various environmental impacts to include destruction of vegetation, noise pollution, air pollution, water pollution and mine dumps. Consequently birds population and diversity are placed at high risk given their great sensitivity to changes in the environmental and habitat condition.

2.7 Strategies in avifauna conservation

Conservation in the sense of conservation biology is the science of understanding Earth's biological diversity for the sake of its protection (Hunter and Gibbs, 2007). The earth is currently undergoing through the sixth mass extinction episode and unfortunately as opposed to the first five mass extinction episodes that were basically natural driven the current episode is mainly as a result of anthropogenic causes. It has been reported that more than 99 percent of species ever to be on earth had gone (Hunter and Gibbs, 2007; Pullin, 2002). Arguments have been posed if it's then necessary to protect the existing biodiversity from extinction when extinction itself is natural. This thinking has not been very reasonable since conservation efforts done now can take the available resources much longer into the future. World leaders in their Convention for Conservation of Biodiversity, agreed the year 2010 as a target to significantly reduce the current rate of biodiversity loss at the global, regional and national levels. Locally based, participatory approaches have shown promises in overcoming this problem, but may not contribute effectively to monitoring at larger scales. BirdLife International is a framework for monitoring Important Bird Areas (IBAs) across the globe and is designed to be a simple, robust and locally oriented measure to produce scaleable results that can be compiled into national or regional indices for avifauna (Arinaitwe, 2005).

Conservation is not a new discipline but have its roots lost in prehistory, no wonder why humans had plans in place to preserve food stuffs for consumption on some future periods, decisions to leave some tubers to grow so that there will be more in future when they pass through the place and take this calf home so that they can raise it for meat in the next winter when its bigger since time immemorial (Hunter and Gibbs, 2007). Certainly, such practices were common sense and simple issues evident also in animal behaviours like food hoarding exhibited by many animals. The roots of conservation are quite ancient dating back to the development of spirituality when some species were given special status as gods or totems that protected them from exploitation. Sometimes, large areas such as sacred mountains were decreed not accessible or visited only spiritually gifted people. Many conservationists have proposed the protection of ecosystems as independent biological entities rather than as loose assemblage of wildlife species. The protection of ecosystems has been viewed as a better way of protecting the species that make up ecosystem (Hunter and Gibbs, 2007).

Wildlife conservation is a human function and the need for conservation arises out of human actions. Therefore understanding human activities and their effects in conservation is fundamental to effective conservation (Sodhi and Ehrlich, 2010). Human beings have modified and adapt to inhabit virtually any terrestrial environment from high altitudes to high latitudes. Just as co-evolution and co-adaptation occur among plants and animals in ecosystems, so too do they occur between humans and other components of ecosystems around the world. Indigenous and local people have practiced conservation for hundreds of thousands of years. The Western conservation movement, however, arise in the past 150 years. In 1864, George Perkins Marsh published a remarkable book, Man and Nature, based in part on his observations of the destruction of the environment in his home area in America. In the book Marsh highlighted the consequence of stream bank cultivations, impacts of trees removal in the river banks that was causing flooding (Sodhi and Ehrlich, 2010).

Human beings' relationship with their environment is complex and locally specific, consequently environment and development problems are related and need to be dealt with at the local scale so as to design solutions that are culturally, socio-politically and environmentally suitable to each local context. Conservation programmes that engage indigenous people as part, decision makers and participants are most likely successful as the people understands the complexity involved and solutions required in environmental conservation. David, (2011) indicated that conservation programmes that are driven by indigenous intervention are likely to be more relevant and more effective, than policies or programmes devised at global and general scale by governments, international donors, or nongovernmental organisations.

BirdLife International is an encouraging initiative on the protection of aviafauna species. The institute is a global network in many countries that have partner organisations in each and every country with its respective coordinating Secretariats decentralised in all the continents (Gandiwa *et al*, 2013). The Important Bird Areas (IBAs) programme is a brain child of

BirdLife International that have a long term objective of identifying, monitoring and conserving bird species abundance and diversity across the globe by creating global linkages of ecosystems from all geographic regions worth recognising for birds at local scale (Arinaitwe, 2005). The qualifying criteria for a site to be an IBA requires the ecosystem to meet some internationally agreed characteristics that include presence of globally threatened species, species of restricted range, biome restricted species assemblages and bird numbers. The national partners of BirdLife are available 116 nations across the globe. More than 11,000 sites have been identified as IBAs by BirdLife Partners in the member countries David, (2011). BirdLife Africa was originated in 1993 and has identified and documented over 1200 IBAs sites across the continent. According to Gandiwa *et al*, (2013) IBAs are unfortunately being threatened by habitat loss and lack of legal protection despite their significant bird stock and biodiversity value.

National BirdLife Partners have incorporated the local organisations and people in the respective IBA sites. For many countries and places important for birds diversity, there are existing institutes or organisations whose mission and objectives similar with those of the BirdLife Partnership. In the absence of such organisations BirdLife had placed efforts to support the emergence of a new local organisation with their functions and objectives David, (2011). In developing countries the challenges of conservation and poverty reduction have to be addressed together considering the dependency of these societies to the environmental resources. People’s livelihood and industrial developments are naturally resource based for instance fishers, tour-guides and beekeepers are people whose incomes are most directly linked to the health of the environment. National BirdLife Partners work with such locally based groups and communities to identify, negotiate and make decisions around a shared agenda and work in partnership towards an agreed set of objectives. Community empowerment is obviously a key aspect of the Birdlife collaboration. In most continents to include Africa, America and Australia, BirdLife Partners have also worked with local people in economic related linkages to include international tourism, sustainable use of natural resources and regional services for recreation David, (2011).

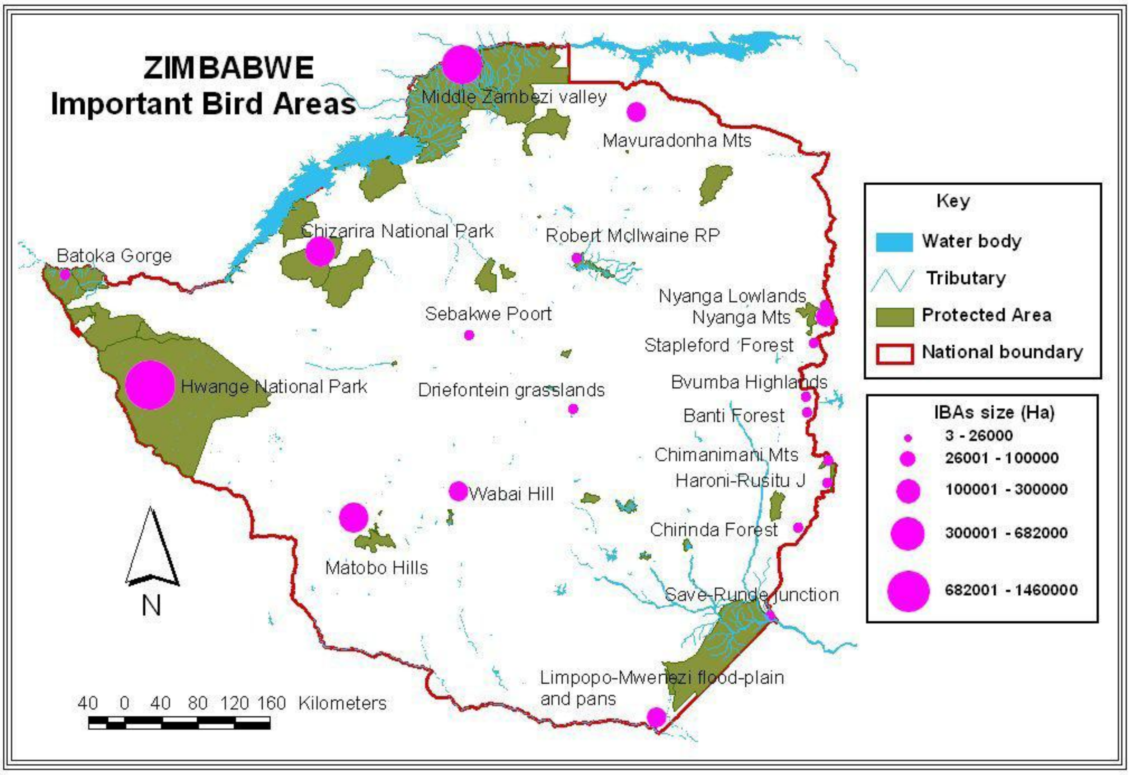

Figure 2.1: Important Bird Areas Zimbabwe Source: Mukwashi and Matsvimbo (2008)

Gandiwa *et al*, (2013) in his research on importance of woody vegetation to birds recommended that species richness and diversity of woody forests should be maintained and invasive plant species controlled for the conservation of endemic and migratory avifauna. Conservation of terrestrial birds depends on a clear understanding of their habitat requirements and the physical and biotic processes that create and maintain those habitats as a health bird community depend on the quality and quantity of their habitat. Riparian forests are typically more productive and biologically diverse than surrounding uplands and are structured by the distinctive fluvial geomorphic processes and hydrologic conditions found on bottomlands (Skagen *et al*, 2005). Most bird species of game birds, waterfowl, raptors, songbirds and shorebirds require grassland habitats during the breeding season for courtship, nesting, foraging, rearing young, and roosting. In North American, grassland birds, as a group, have suffered a severe population declines than any other birds due to the enormous loss and fragmentation of their required habitat. The present managed hayfields, pasturelands and old fields comprise a significant portion of grassland bird habitat. Unfortunately, several factors result in the decrease of suitable nesting habitat or in the killing of birds and loss of nests. Patches of uncultivated land act as refuges that provides cover for birds, allow nesting to occur and ensure that some standing grasses will be available for cover during the spring. When chosen strategically, they can also prevent soil erosion and filter storm water runoff. A grassland refuge surrounded by a mix of pastures, old fields and small grains e.g. wheat, barley, oats, rye and canola has greater habitat value than a grassland of similar size surrounded by row crops e.g. corn and soybeans, woodlots and residential areas (Hyde and Campbell, 2012).

Hyde and Campbell, (2012) reported that larger grassland areas that are not fragmented by woodlots, farmlands and woody fence lines are beneficial for many grassland birds. They contain a diversity of conditions that can provide habitat for a greater number of bird species, reduce predator efficiency and decrease nest parasitism. Large square or rounded grasslands are usually better than long, narrow and rectangular plots for grassland birds. Woodlots and fence rows with irregular shrubby edges are preferred over abrupt linear edges. Narrow hedgerows can create travel lanes for predators while wide and irregular field borders can provide habitat for grassland birds that require some woody vegetation

People have constructed meanings on conservation based on perceptions arising through their daily life experiences. Perceptions however have arisen from and concurrently shape, our worldviews and often, institutions direct or mediate those worldviews. Since human beings have a broad range of experiences, perception is also highly variable, and it is based on these perceptions that people act. Similarly, conservationists have based resource management strategies on their perceptions of local resource use. These misperceptions can also be enhanced by unequal relations of power within and between international organizations and local people. One important fact about environmental management is that its success dependent on its relationship to the political process. A recurring issue, in practice and in the literature, is the value and role of traditional institutions and systems in natural resource management (Katerere, 2001). Conservationists have been defined as people who identify themselves as practitioners or advocates of wild living resource conservation, but this task is influenced by several external factors to include political and economic environments. Cultural, political and economic institutions are powerful social forces that dynamically impact the environment, as co-evolution of social institutions and ecological systems occurs in interesting and often unpredictable ways (Sodhi and Ehrlich, 2010).

Legislation at international, regional, national and local level has been an important conservation measure in natural resources management and protection of biodiversity. The United States for example has recognized the critical importance of this shared resource by ratifying international, bilateral conventions for the conservation of migratory birds. Such conventions include the Convention for the Protection of Migratory Birds with Great Britain on behalf of Canada 1916, the Convention for the Protection of Migratory Birds and Game Mammals- Mexico 1936, the Convention for the Protection of Birds and Their Environment-Japan 1972, and the Convention for the Conservation of Migratory Birds and Their Environment-Union of Soviet Socialist Republics 1978, (US Executive Order, 2001). Zimbabwe apart from its important act of parliament which includes the Parks and Wildlife Act and the Environmental Management Act has also ratified to regional and international treaties to ensure its commitment to the conservation of wildlife to include avifauna and these include Convention on Biological Diversity (CBD), Ramsar Convention on Wetlands of International Importance, Convention on International Trade in Endangered species (CITES), Bonn Convention-Convention on the Conservation of Migratory Species of Wild Animals and the World Heritage Convention-Convention concerning the protection of the world cultural and natural heritage of 1972 adopted 1980.

An important lesson was leant from the population crash of the Passenger Pigeon that occur right in the sight of human eyes. The Passenger Pigeon in American in the late 19th century could be seen as a massive flock nobody could image going extinct in just 50 years. But without a mechanism for population monitoring, there was no widespread recognition that the population was in a serious trouble. Conservation scientists at the moment have gathered significant amount of data sets for assessing the health of bird populations (The State of the Birds 2014). Analogous to business principles of stock taking on assets, monitoring of the inventory bird populations allows scientists to rescue some avifauna species from extinction. Continues monitoring and analysis of data over time makes it possible for conservationists to track dangerous population changes for management. Upon detection of changes in trends causes must be diagnosed. The American Bird Conservation Initiative through its State of Birds reporting system have managed to develop long term, consistent monitoring plans such as the Breeding Bird Survey, Christmas Bird Count, and e-Bird. The initiative has resulted in the production of important information which has been availed to both the public and scientists through the Avian Knowledge Network.

Wetlands are important habitats for avian populations and diversity throughout the world. Unfortunately the increase of human population, rise in demand for settlements and agricultural land have degraded these wetland habitats in the tropical region. To effectively restore these natural wetland habitats and conserve avifaunal biodiversity, an understanding of the relationships between habitat conditions and bird community structure are central. Ntongani and Andrew, (2013) surveyed two habitats to examine variation in the abundance, richness, diversity and composition of birds at Kilombero Wetland Tanzania. In total, 3049 individuals, 126 species, 88 genera and 45 families were recorded from Kilombero wetland. Wetland habitat with low human disturbance had more numbers of bird species, genera, families and diversity than the most disturbed areas. However, the abundance and evenness of birds were not different between low and highly disturbed habitats suggesting that other factors including variety of foraging sites are important. Wetlands of Kilombero like any other wetland in the world have proved to be important for conservation of birds including rare and endemic species. It is recommended that anthropogenic disturbances should be minimized including control of fire, regulation of agricultural activities and population of cattle within the wetland system to restore and conserve biodiversity (Ntongani and Andrew, 2013). Madebwe and Madebwe (2005) also confirmed that wetlands should be effectively protected and that sound environmental policies supported by adequate financing in social services in order to raise the threshold of wetland protection effort.

2.8 Birds survey using transect technique

Listing is a survey technique used to provide rapid inventories of the species in a particular area to yield information only on the relative abundance of species. The technique is simple and efficient but however differs the majority of the other methods yield estimates of absolute abundance (Sutherland, 2006). Birds are much easier to see or hear hence census methods that involve catching birds are less desirable, moreover catching birds involves extra investment in equipment and expertise. Listing methods are applicable to a wide range of species and habitats, but most widely used in tropical habitats. They are suitable for rapid assessments of poorly known areas and are crucial in population monitoring. Roberts *et al*. (2004) in Sutherland, (2006) show that changes in the frequency of occurrence on lists are a reasonable measure of changes in abundance over decadal time periods obtained from much more intensive territory-mapping and capture techniques.

Lists of birds are recorded for a particular geographical area. Common species will occur on many lists, rare species on only a few. The frequency of occurrence of species on list gives a crude measure of relative abundance. The more effort put into generating each list, the longer that list is likely to be, making comparisons between areas with different levels of effort problematic. To overcome this, lists should ideally be produced for specific time periods, such as an hour or a day. Lists can also be constrained to a more precise geographical area. Hewish & Loyn (1989) in Sutherland (2006), found that producing species lists for 2-ha plots during 20 minutes periods appealed to observers because they felt that they were able to record all species present within the time period. The more lists that are produced, the more precise the reporting rates will be, so a reasonable number of lists, perhaps 15 or more is required (Sutherland, 2006).

McKinnon lists are a specific form of listing that records species on fixed length lists rather than within fixed periods. To produce a McKinnon list, walk slowly around the study area listing the first *n* species encountered, where *n* could be, for example, 10, 15 or 20. List the names of all new species encountered and when *n* have been listed, start a new list and continue surveying until, again, *n* species have been encountered. Repeat this process until a reasonable number usually 15 or more lists has been produced (Sutherland, 2006). To obtain an idea of what proportion of species are present in a study area one has to plot out the cumulative number of species recorded across the lists. This species-accumulation curve will begin to plateau when you have recorded a high proportion of the species present. As for other listing approaches, the relative abundance of each species is the proportion of lists on which it was recorded.

Listing technique does not require counting of individuals as a result this allows more time on bird identification, which is particularly valuable for inexperienced observers and for areas that have not been studied but with rich bird habitats. However, the index produced will be most useful for moderately abundant species (Sutherland, 2006). Very common species will be recorded on all lists and thus true variation in abundance of these species will be masked and trends dampened. Very rare species will be recorded few lists giving little variation in abundance between species and sites, often no better than recording their presence or absence. An advantage of the McKinnon lists over time-limited lists is that, because observers are not restricted to particular time periods less skilled observers who take longer to find and identify species can still produce lists that will be comparable with those of more experienced observers. The more skilled observers will simply collect more lists. Data from such lists can be used to produce maps of distribution and geographical patterns of relative abundance. However, this approach has the considerable weakness that the index of abundance it produces is relative to that of other species (Sutherland, 2006).

One advantage of line-transect method over point transect is that with line transects double counting of individuals is minimal especially when the observer is travelling faster (Cavarzere *et al*, 2012). With line transects distance sampling or counting is possible where any bird within 20 m of another is defined as part of the same group. This allows the separation of one large flock at one place along a route section from many scattered individuals. When travelling through a contiguous biotope for instance along a forest track, the observer records data in 20 minutes intervals. Otherwise, routes are split by obvious landmarks like road intersections that separating areas of broadly different biotope. The lengths of these sections vary markedly from hundreds of metres to a few kilometres as their creation is been primarily determined by convenience, repeatability and the speed at which the observer is moving (Cavarzere *et al*, 2012). Sullivan, (2012) gives a research where the mobile method has been employed in March 2003 to count pre-human native birds, birds of the size of starlings or larger and road-kill, along a 17 km cycling route from Christchurch to Lincoln in the United States. The method has also been applied to a standard run route in July 2008 initially just to pre-human forest bird species and later to the same suite of birds as recorded on the cycle route. The eastern and western halves of this 25.4-km route are alternated weekly; the route was created to compare areas of housing and open parkland with areas of native planting. Line transects work particularly well for counting conspicuous, low density species in open habitats Gregory *et al*. (2004) in Sullivan (2012). This matches the counts of large birds through the open pastoral farmland between Christchurch and Lincoln. The detection probability for non-vocalising, non-flying individuals undoubtedly decreases markedly in areas of housing and forest cover, underscoring the importance of choosing route sections that separate areas of dissimilar visibility and revisiting those routes with high frequency (Sullivan, 2012).

There is little to choose between line and point transects because they are so adaptable to species and habitats, but each is better suited to particular situations (Sullivan, 2012). The strengths and weaknesses of the methods need to be matched against your survey objectives. Both methods require a relatively high level of observer skill and experience because a large proportion of contacts and identifications will be by song or call.

According to Cavarzere *et al*, (2012), point counts have been tested in Neotropical systems and some authors concluded that 5 to 10 minutes counts are ideal for detecting a significant number of species, including endemic and threatened species. In addition, Herzog *et al.* (2002) in Cavarzere *et al*, (2012), suggested the use of 10 species lists in tropical regions as more ideal as compared to 5 or 20 species list. He further suggested that species lists are better than any other method for surveying birds, though no reasons were given for this suggestion. The list method of avifaunal assessment has been increasingly adopted for tropical bird studies worldwide, from Indonesia (MacKinnon & Phillips, 1993; Trainor, 2002a,b), to mainland Africa (Fjeldså, 1999), Madagascar (O'dea *et al.* 2004), and South America (Poulsen *et al.,* 1997; O'dea *et al.*, 2004; Herzog & Kessler, 2006; Herzog, 2008) all cited in(Cavarzere *et al*, 2012). It has also been promoted as a potentially useful technique in a manual on bird census methods. A study has also been carried where forest birds were surveyed using 10 minutes point counts and 10 species lists in lowland Atlantic Forests in south eastern Brazil to test the hypothesis that both methods equally detect most bird species. 90% of the estimated species were detected with in short time frames indicating that the methods are quite suitable for rapid assessment programs.

CHAPTER 3: MATERIALS AND METHODS

3.1 Introduction

This chapter presents the methods used by the researcher to obtain information on the research. It gives the research philosophy, research design, the population of the study, sources of data, data collection techniques, research instruments, methods used to present and analyse data and the chapter summary.

Data collection was in two parts, with first part being a perception survey on communal populace of Mupari on avifauna importance, diversity and conservation. The second part was an application of a scientific method of bird listing technique to verify the diversity of avifauna in Mupari communal area as identified in the perception survey.

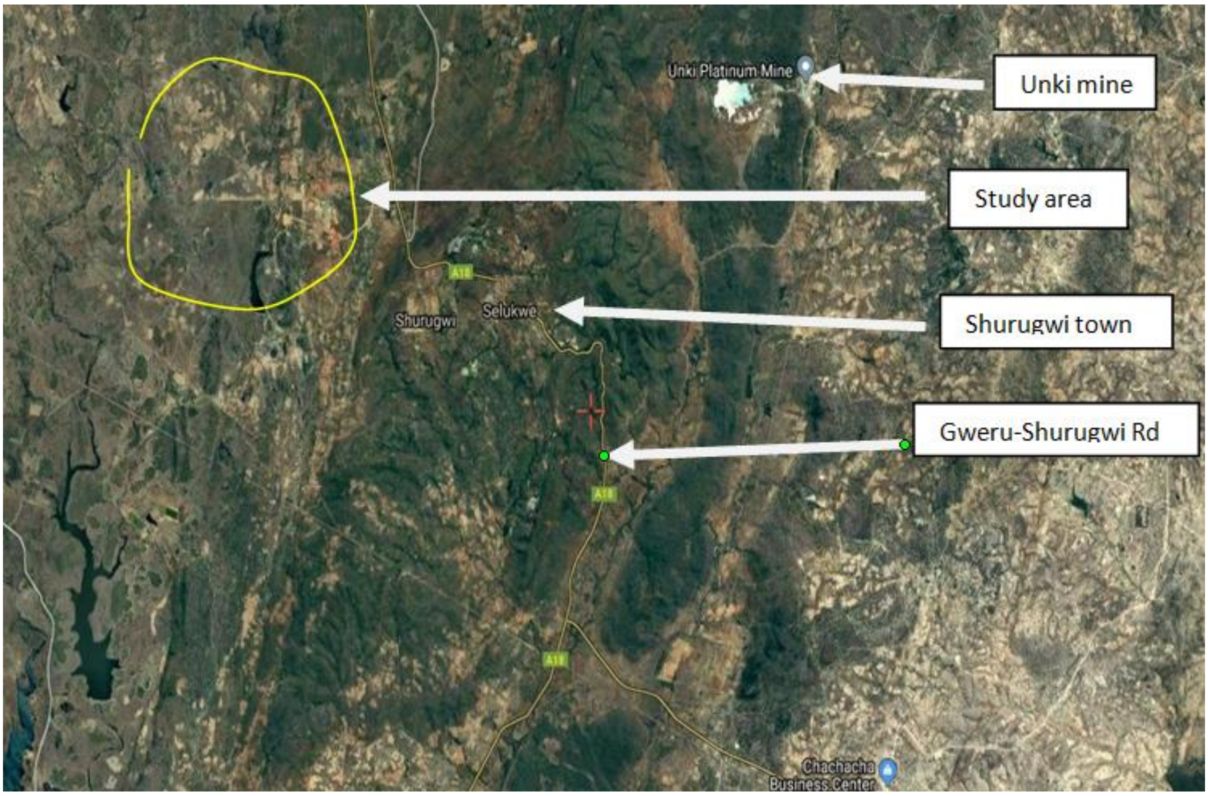

Figure 3.1: Satellite image of study area, Source: © Google map 22 June 2018

3.2 PERCEPTIONS SURVEY

The research was conducted in Mupari communal area located about 10km on the north western side of Shurugwi town. The researcher employed self administered questionnaire that were developed for the purpose of data collection for the study. The questions generated by the researcher were in standardised format comprising a mixture of both open-ended and closed-ended questions in order to assist the researcher make decision on findings. Closed ended questions were used to reduce the chances of impartiality as well as to be able to quantify responses and also to allow for comparison of respondent views. Open ended questions were adopted in order to capture some of the relevant aspects of the research that the researcher could have omitted as well as to capture non guided opinions and views of respondents. Open ended questions also gave the researcher insights into beliefs and avifauna conservation principles known by respondents. The questionnaire was completed by the researcher carrying out interviews in person to allow him explain to the respondents issues that require explanation. The researcher introduced himself to the interviewee and explained the purpose of the research. Information was recorded on each individual respondent's questionnaire. Appendix A shows the sample of questionnaire used.

A total area of 20km^2 was used as the study area. A sample of 140 people was requested to respond to a questionnaire with 12 questions. The questionnaire was responded by both men and women who were between 18 and 80 years of age. A total of 70 women and 70 men was used in the study. Household members in Mupari communal area were used as the sample population. The World birds – Birds of Zimbabwe encyclopaedia and Zimbabwe Bird Checklist with colourful bird pictures were used to help researcher identify and confirm birds referred by respondents to avoid incorrect bird identification.

3.3 LISTING BIRD SURVEY

Bird listing technique was employed to determine avifauna diversity in Mupari Communal area as a way of confirming avifauna species diversity identified in the perception survey. Line transects were used and bird listing used to identify birds along each transect. A binocular was used to view birds along transects. Flagging tapes were used to make starting and finishing points. Researcher walked slowly and calmly along pre-determined transects noting birds on both sides of the transect. Bird calls were noted by recording using a sound recorder which was replayed to identify the bird species. However researcher put effort to view calling birds to avoid incorrect identification. Time limited listing was employed by the researcher where, a total of 15-line transects were surveyed and a total of 20 minutes spent on each transect. Transects run from south to north and they were 200 metres apart. Bird surveys were done in the morning starting from 5:00 – 9:00 am when the birds were still more active. The World birds – Birds of Zimbabwe encyclopaedia and Zimbabwe Bird Checklist were used to help researcher identify birds observed during the research. Lists of birds identified were generated on an observation sheet to make a list for each transect. Information generated was recorded on Species list form Appendix B. Review of literature was done to verify findings.

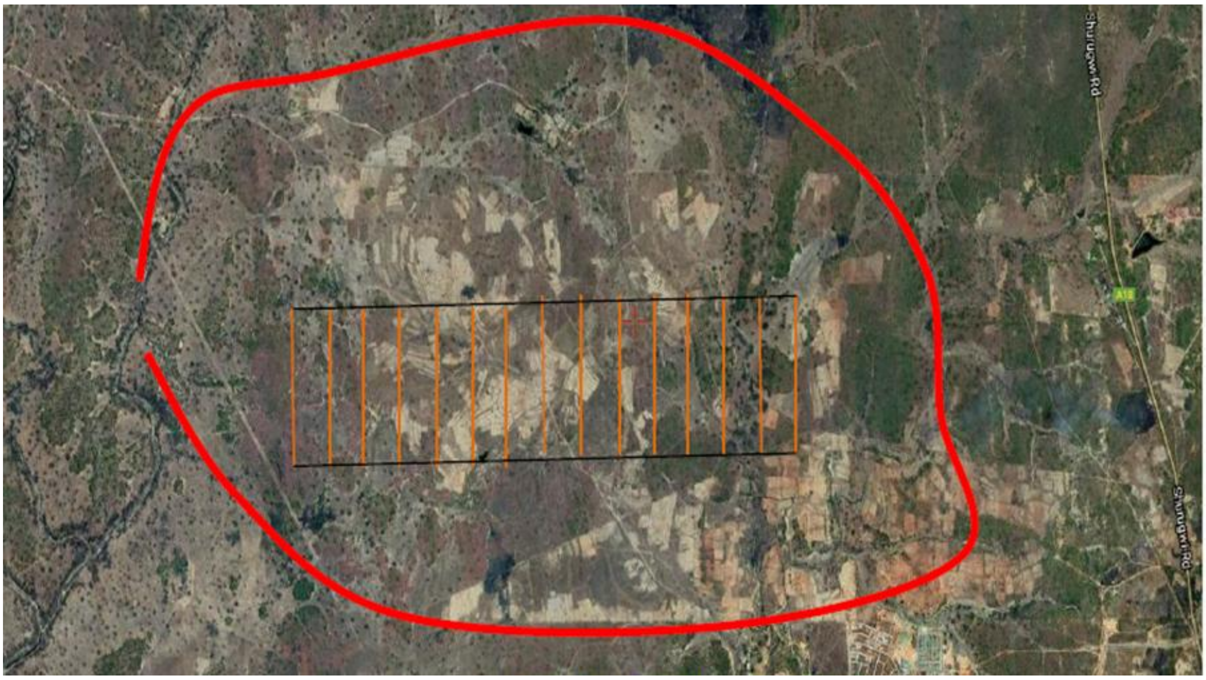

Figure 3.2: Satellite image showing transects, Source: © Google map 22 June 2018

3.4 Ethical Considerations

The researcher obtained permission to carry out research from the Shurugwi District Administrator. (Shurugwi District Administrator permission Appendix I) The researcher approached the village Headman and introduced himself and his assistant before explaining his intention. Permission was requested from all respondents approached. The Midlands State University undertaking was made by the researcher in acceptance of the Midlands State University Research Ethics Policy.

3.5 Data analysis

Data was analysed using excel, SPSS, PAST 3.2 statistical package, descriptive and graphical methods. Scientific and biodiversity models were also applied in data analysis. Models used include Sutrop index, Simpson, index and Shannon-Weiner indices. SPSS was used to find the relationship of age and number of bird mentioned by respondents in the perception survey. The PAST 3.2 package was used to calculate diversity indices where as Principal Component Analysis and Hierarchical Cluster Analysis were also employed in establishing relationships on identified birds. The Sutrop salient index was used to determine the importance which each individual bird species is given by the respondents. The Simpson and Shannon-Weiner indices were used to determine avifauna species diversity, relative abundance, evenness as well as to analyse the relationships between questionnaire surveys and field bird listing survey. Comparisons were made on Simpson and Shannon indices to check relationships of outcome from perception survey and field bird counts. Results from questionnaire survey on importance placed on birds by respondents were related to findings on birds diversity and abundance from the birds listing/ count survey to draw conclusion of the research. Data was presented in tabular and graphical forms.

CHAPTER 4: RESULTS

4.1 Introduction

A questionnaire survey with both open and closed questions was administered to establish the perceptions on bird diversity, importance and conservation in Mupari communal area of Shurugwi. Further, a bird field survey was carried out to determine bird species occurrence and composition to compare the findings with the perceptions survey.

4.2. Local perceptions of bird composition

A total of 140 respondents were interviewed and these included 70 women and 70 men of ages ranging from 18 to 80 years. Respondents were asked to list all bird species they knew in a free listing exercise. Bird checklists with colourful bird pictures were used to confirm bird species to avoid incorrect identifications. The respondents managed to name accumulative total of 30 bird species. Individually, the respondents who listed the least number of birds managed about eight species whereas those who listed the most reached about 18 species. Figure 4.1 below shows the relationship between the number of bird species mentioned by each respondent and their age.

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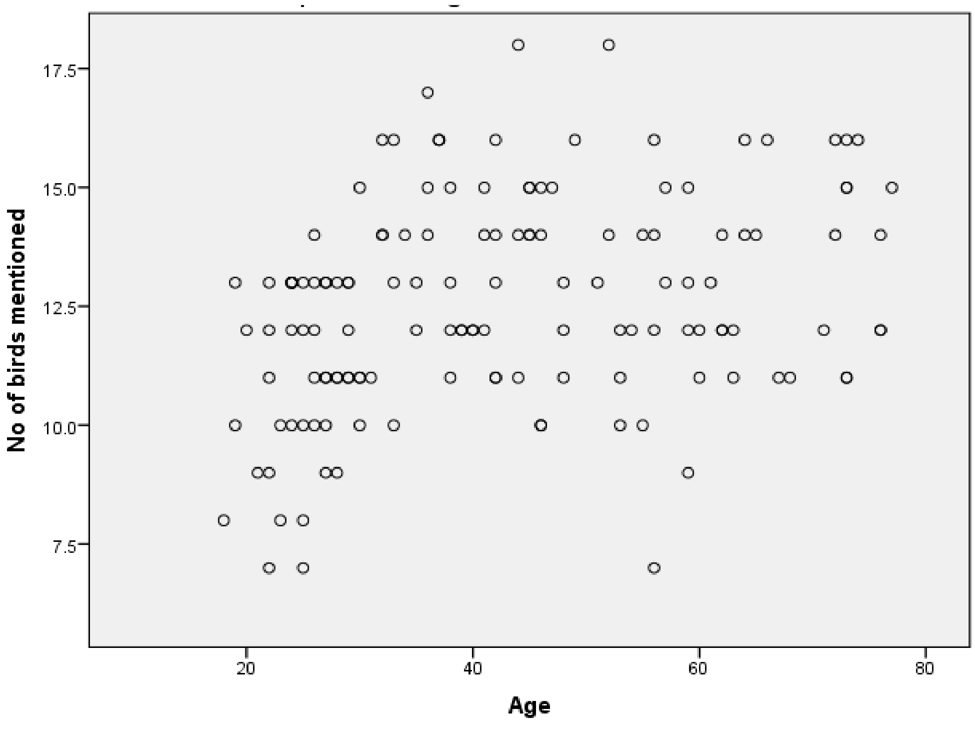

Figure 4.1 Scatter plot showing relationship of birds mentioned and respondent's age

Using Pearson Correlation coefficient it was determined that there is a linear relationship between age and number of bird species named as P value is 0.00 at 0.01 significant value. The correlation co-efficient is 0.32 indicated a weak relationship between age and number of bird species identified. Appendix C shows the correlation table. Table 4.1 below provides a list of birds listed by the respondents. They listed vernacular names which then translated to their scientific names.

Table 4.1 List of birds identified by respondents during bird free listing

Vernacular Name	Scientific Name	Frequency of occurrence
Njiva	*Streptopelia senegalensis*	92
Zizi	*Strix woodfordi*	87
Hanga	*Numida meleagris*	86
Gwenhure	*Pycnonotus barbatus*	85
Chitiitii	*Iduna natalensis*	83
Dendera	*Bucorvus leadbeateri*	82
Chititi	*Uraeginthus angolensis*	81
Gunguwo	*Corvus albicollis*	81
Gondo	*Micronisus gabar*	80
Hurekure	*Vanellus senegallus*	80
Hohodza	*Campethera abingoni*	79
Hoto	*Tockus nasutus*	77
Chivangu	*Accipiter tachiro*	70
Gukutiva	*Columba larvata*	63
Nhengure	*Dicrurus adsimilis*	63
Chapungu	*Milvus migrans*	61
Chidimba	*Cisticola lais*	61
Hwiriti	*Treron calvus*	55
Nzembe	*Turtu rafer*	52
Chihuta	*Coturnix delegorguei*	51
Chikwari	*Coturnix coturix*	46

Chinyenganyenga	*Hirundo rustica*	45
Dahwa	*Caprimulgus pectoralis*	45
Husvu	*Dicrurus ludwigii*	40
J'enyama	*Prionop splumatus*	37
Todzvo	*Nectarinia amethystina*	35
Chizizimbori	*Glaucidium perlatum*	35
Funye	*Lophaetus occipitalis*	23
Jichidza	*Bubo africanus*	23
Njerere	*Aquila nipalensis*	22

Common birds identified during the interview include; *Streptopelia senegalensis, Acrocephalus schoenobaenus, Pycnonotus barbatus, Corvusalbicollis, Aquila nipalensis, Micronisus gabar, Strix woodfordi, Dendroperdix sephaena, Numida meleagris* and *Uraeginthus angolensis* among other birds. From the birds listed above, the Sutrop Salience index was used to determine salience of bird species named. This was meant to establish the importance placed on each particular bird species by local populace. The Sutrop Index (S) is based on ranking species according to the order given by each respondent during free listing. It was calculated using the formula below:

S=F/(N*mP)

Where:

F is frequency of citation a given bird species during the respondent free listing

N - total number of citations and

mP - stands for mean of rankings for each bird species.

Table 4.2 Rankings of birds according to the Sutrop's salience index (S)

Rank	Vernacular Name	Scientific Name	Sutrop Index
1	Njiva	*Streptopelia senegalensis*	0.47
2	Zizi	*Strix woodfordi*	0.39
3	Hanga	*Numida meleagris*	0.38
4	Gwenhure	*Pycnonotus barbatus*	0.36
5	Chitiitii	*Iduna natalensis*	0.32
6	Dendera	*Bucorvus leadbeateri*	0.32
7	Chititi	*Uraeginthus angolensis*	0.31
8	Gunguwo	*Corvus albicollis*	0.26
9	Gondo	*Micronisus gabar*	0.22
10	Hurekure	*Vanellus senegallus*	0.21
11	Hohodza	*Campethera abingoni*	0.19
12	Hoto	*Tockusnasutus*	0.18
13	Chivangu	*Accipiter tachiro*	0.16
14	Gukutiva	*Columba larvata*	0.16
15	Nhengure	*Dicrurus adsimilis*	0.16
16	Chapungu	*Milvus migrans*	0.15
17	Chidimba	*Cisticola lais*	0.15
18	Hwiriti	*Treron calvus*	0.14
19	Nzembe	*Turtur afer*	0.14
20	Chihuta	*Coturnix delegorguei*	0.13
21	Chikwari	*Coturnix coturix*	0.12
22	Chinyenganyenga	*Hirundo rustica*	0.11
23	Dahwa	*Caprimulgus pectoralis*	0.08
24	Husvu	*Dicrurus ludwigii*	0.05
25	J'enyama	*Priono psplumatus*	0.05
26	Todzvo	*Nectarinia amethystina*	0.03
27	Chizizimbori	*Glaucidium perlatum*	0.01
28	Funye	*Lophaetus occipitalis*	0.01
29	Jichidza	*Bubo africanus*	0.01
30	Njerere	*Aquila nipalensis*	0.01

The greater the Sutrop Salience index indicates higher value / importance placed on bird species by the respondents. On the results generated the Sutrop value range from 0.47 to 0.01. Birds with high S value indicating higher importance to the society of Mupari. *Streptopelia senegalensis*, *Strix woodfordi*, *Numida meleagris*, *Pycnonotus barbatus*, *Iduna natalensis*, *Bucorvus leadbeateri* and *Uraeginthus angolensis* had higher salience indicating a greater value / importance given by the society. At the bottom of the list indicating little importance to the community includes *Prionops plumatus, Nectarinia amethystine, Glaucidium perlatum, Lophaetus occipitalis, Bubo africanus* and *Aquila nipalensis.*

4.3 Perceptions of Bird Diversity

Using data collected from the questionnaire surveys, such as bird species mentioned and the frequency, diversity indices were calculated. Table 4.3 below summarises the diversity indices calculated from the collected data.

Table 4.3: A summary of diversity indices for the bird perceptions data

Index	Value
Species richness (S)	30
Dominance (D)	0.037
Simpson (1 – D)	0.963
Shannon-Wiener (H)	3.334
Evenness ($e^{H/S}$)	0.935
Total number of individuals	1820

The community managed to identify 30 bird species cumulatively. Little dominance (D) of bird species was observed as D recorded 0.0374 against a lower limit of 0.0370. This is because most respondents managed to name quite a number of birds. Simpson Diversity Index was high recording 0.9625 against a maximum possible value of 0.963. The Shannon index recorded a high diversity of 3.334 against a maximum possible value of 3.342. High evenness of 0.9349 was also recorded against a maximum possible value of 0.9422.

4.4 Field survey of bird composition

To complement the data collected from interviews with the locals, a field survey of birds was carried out as described in Chapter 3. A total of 46 bird species were identified from a total population of 318 birds counted. Table 4.4 below shows the list of bird species identified during the bird count survey and the total counts.

Table 4.4 List of birds identified in the field and their respective counts

English Name	Scientific Name	Total Counts
Laughing dove	*Streptopelia senegalensis*	21
Ring-necked dove	*Streptopelia capicola*	24
Sedge Warbler	*Acrocephalus schoenobaenus*	28
African yellow warbler	*Iduna natalensis*	14
Cape bunting	*Emberiza capensis*	5
Common Bulbul	*Pycnonotus barbatus*	32
Wailing cisticola	*Cisticola lais*	3
Amethyst sunbird	*Nectarinia amethystina*	2
Scarlet-chested Sunbird	*Chalcomitra senegalensis*	1
Golden-tailed Woodpecker	*Campethera abingoni*	2
Cardinal woodpecker	*Dendropicos fuscescens*	1
Blue-spotted wood dove	*Turtur afer*	3
Southern Ground Hornbill	*Bucorvus leadbeateri*	3
Yellow-bellied Greenbul	*Chlorocichla flaviventris*	3
African Grey Hornbill	*Tockus nasutus*	2
White-crested helmetshrike	*Prionops plumatus*	15
African Green Pigeon	*Treron calvus*	1
Fork-tailed Drongo	*Dicrurus adsimilis*	4
White-necked Raven	*Corvus albicollis*	8
Pied crow	*Corvus albus*	4
Long-tailed widowbird	*Euplectes progne*	1
Tawny Eagle	*Aquila nipalensis*	3
Gabar Goshawk	*Micronisus gabar*	3
Fiery-necked nightjar	*Caprimulgus pectoralis*	6
African Wood Owl	*Strix woodfordi*	3
Black Kite	*Milvus migrans*	4
African Harrier-Hawk	*Polyboroides typus*	6
Crested francolin	*Dendroperdix sephaena*	5
Helmeted Guineafowl	*Numida meleagris*	18
African wattled lapwing	*Vanellus senegallus*	4
Harlequin quail	*Coturnix delegorguei*	6
Stock - migratory	*Coraciiformes*	4
Shikra	*Accipiter badius*	2
Bradfield's Hornbill	*Tockus bradfieldi*	5
Barn Swallow	*Hirundo rustica*	1
Blue-spotted wood dove	*Turtur afer*	3
Square-tailed drongo	*Dicrurus ludwigii*	7
Common quail	*Coturnix coturix*	4
European Bee-eater	*Merops apiaster*	3
Blue Waxbill	*Uraeginthus angolensis*	30
Red-billed oxpecker	*Buphagus erythrorhynchus*	2
Eurasian Reed Warbler	*Acrocephalus scirpaceus*	6
Jameson's firefinch	*Lagonosticta rhodopareia*	4

Bronzy sunbird	*Nectarinia kilimensis*	3
Red-backed Shrike	*Lanius collurio*	4
Orange-breasted bushshrike	*Chlorophoneus sulfureopectus*	5
Total		**318**

Using data collected from the field counts diversity indices were calculated. Table 4.5, below summarises the diversity indices calculated from the collected data.

Table 4.5 A summary of diversity indices for field bird count data

Index	**Value**
Species richness (S)	46
Dominance (D)	0.050
Simpson (1 – D)	0.950
Shannon-Wiener (H)	3.356
Evenness ($e^{H/S}$)	0.623
Total number of individuals	318

A total of 46 species of birds were recorded and a total of 318 birds was counted by the researcher. There was significantly high level of dominance (D) of some bird species, as D recorded 0.0501 against a lower limit of 0.0442 and an upper limit of 0.05914. This was attributed by some bird species being found in large groups of up to 32 birds and a single bird being counted for some species. Simpson Diversity Index (D) was moderate and recorded 0.9499 against a lower limit of 0.9408 and an upper limit of 0.9557. The Shannon index (H) and evenness were significantly high as they were closer to upper limits recording 3.356 and 0.623 respectively.

4.5 Comparison of perceived and field counted bird diversity and composition

A total of 30 bird species were listed from the questionnaire interviews. However, bird counts carried out in the field yielded a total of 46 species. Table 4.6 below summarises the compositional differences between birds that were mentioned during interviews and those that were actually spotted in the field.

Table 4.6 Comparison of birds identified in the perception survey and in the field counts

Birds mentioned during interviews and also spotted in the field	Birds spotted in the field only
Streptopelia senegalensis	*Chalcomitra senegalensis*
Strix woodfordi	*Dendropicos fuscescens*
Numida meleagris	*Tockus nasutus*
Pycnonotus barbatus	*Accipiter badius*
Iduna natalensis	*Merops apiaster*
Bucorvus leadbeateri	*Lagonosticta rhodopareia*
Uraeginthus angolensis	*Lanius collurio*
Corvus albicollis	*Merops hirundineus*
Micronisus gabar	*Corvus albus*
Vanellus senegallus	*Chlorophoneus sulfureopectus*
Campethera abingoni	*Acrocephalus scirpaceus*
Tockus nasutus	*Emberiza capensis*
Accipiter tachiro	*Dendroperdix sephaena*
Columba larvata	*Acrocephalus schoenobaenus*
Dicrurus adsimilis	*Streptopelia capicola*
Milvus migrans	*Accipiter badius*
Cisticola lais	*Lophaetus occipitalis*
Treron calvus	
Turtur afer	
Coturnix delegorguei	
Coturnix coturix	
Hirundo rustica	
Caprimulgus pectoralis	
Dicrurus ludwigii	
Prionops plumatus	
Nectarinia amethystina	
Glaucidium perlatum	
Lophaetus occipitalis	
Bubo africanus	
Aquila nipalensis	

The diversity indices calculated from data collected in the field and that from the interviews were also compared. Table 4.7 below summarises the comparison of diversity indices.

Table 4.7 Comparison of perception and fields survey p-values

Index	**Perceptions Survey**	**Field Count**	**P-value(α = 0.05)**
Species richness	30	46	
Shannon (H)	3.334	3.556	0.696
Simpson (1-D)	0.963	0.95	0.002

For the Hutchesan t-test, P value is greater than 0.05 therefore we accepted the null hypothesis meaning there is no significant relationship between diversity of birds as appreciated or known by the respondents to the diversity noted during the field bird counts. However with the Simpson index we rejected the null hypothesis as p-value is 0.002 meaning there is a strong relationship in the diversity indices.

4.6 Functional groups of birds mentioned during interviews

Birds that were mentioned during the questionnaire interviews were analysed to see if any functional groups could be identified. Using a principal components analysis and a hierarchical cluster analysis we sought to find if there were any relationships between how respondents listed their birds.

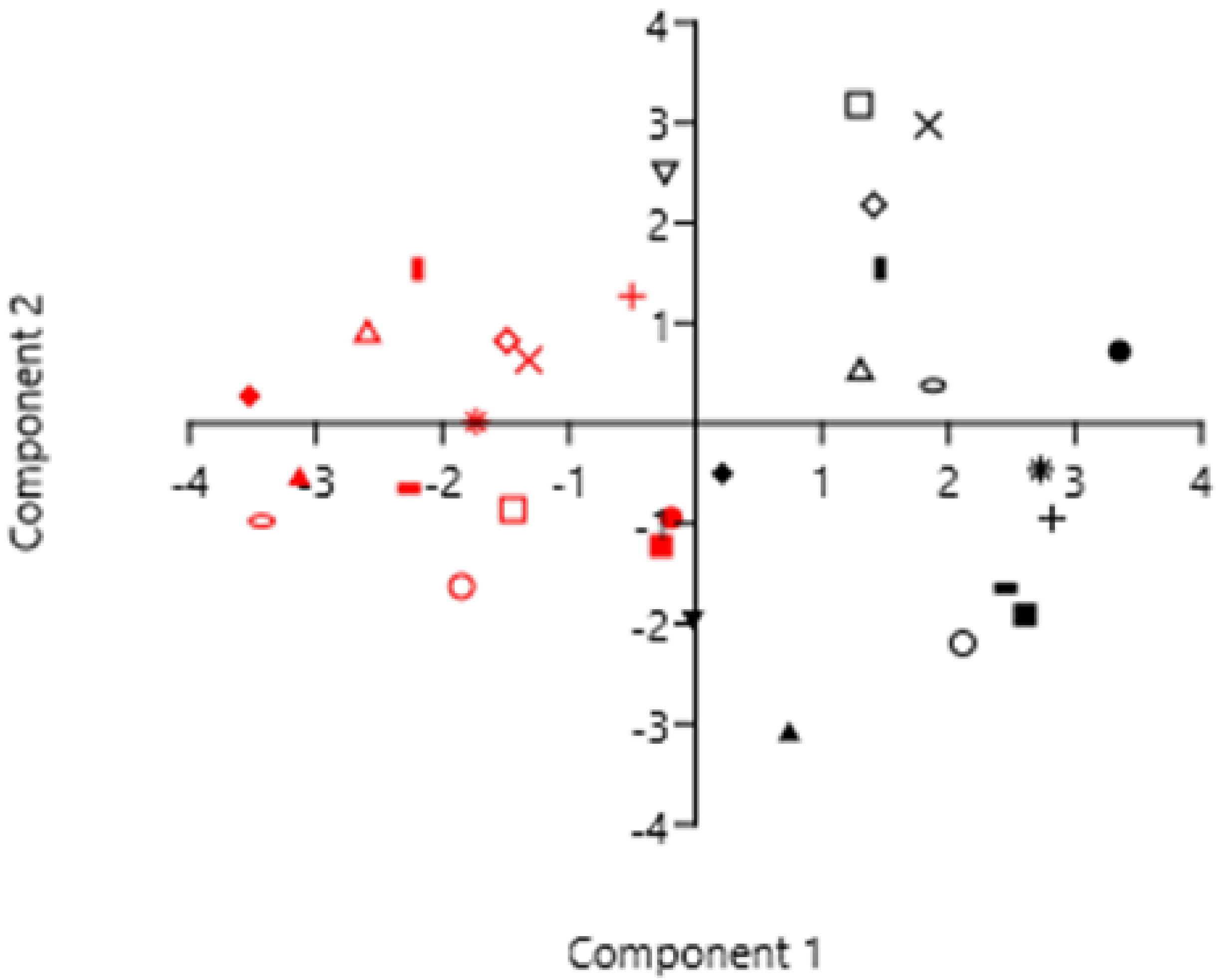

Figure 4.2 PCA plot showing cluster or relationships of birds identified by respondents

Figure 4.2 shows the PCA cluster plot and has four distinct clusters were observed mainly basing on the axes. The first upper right quartile consists of *Streptopelia senegalensis, Numida meleagris, Iduna natalensis, Uraeginthus angolensis, Campethera abingoni* and *Tockus nasutus.* These are very common birds with high salience value on the Sutrop Index. They are also edible and pose little or no problems to humans as far as destruction of crops and domesticated animals. The lower right quartile consists of *Bucorvus leadbeateri, Vanellus senegallus* and *Corvus albicollis* among other birds. This cluster had fairly common birds with a mixture of problematic and non problematic birds to humans. They are not considered as suitable for human consumption. The third upper left quartile consists of *Treron calvus, Coturnix coturix and Caprimulgus pectoralis* among others. This cluster had rare birds consisting of both edible and non-edible birds. Birds that are usually active at night were also in this group. These birds are mainly not problematic to humans. The last quartile consists of *Turtur afer, Lophaetus occipitalis, Nectarinia amethystine* among other birds. This group had rare to very rare birds and consists of both edible and non-edible birds. They pose no problem to crops and livestock.

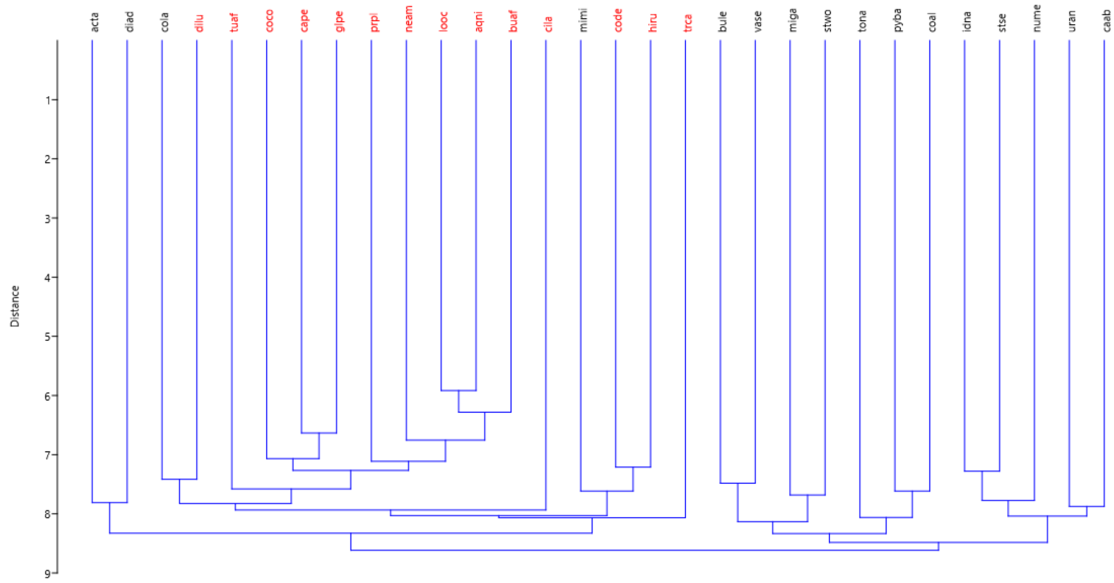

Figure 4.3 HCA plot from birds mentioned by respondents

From figure 4.3 two distinct hierarchies were observed mainly common and rare birds. On the common birds a hierarchy exists with *Streptopelia senegalensis, Numida meleagris, Iduna natalensis, Uraeginthus angolensis, Campethera abingoni* all of which were identified in the first quartile of the PCA analysis. Another cluster of fairly common birds identified by respondents includes *Pycnonotus barbatus, Corvus albicollis, Tockus nasutus, Strix woodfordi, Micronisus gabar, Vanellus senegallus* and *Bucorvus leadbeateri. Treron calvus, Hirundo rustica, Coturnix delegorguei, Cisticola lais* and *Milvus migrans* formed another cluster of some fairly rare birds. A cluster of some less frequently mentioned birds includes *Aquila nipalensis, Bubo africanus, Lophaetus occipitalis, Nectarinia amethystine* and *Coturnix coturix* among other species.

4.7 Perceptions on importance of birds

116 respondents of the total 140 (82.9 percent) testified birds have an importance or value in life. Importance of birds for meat and eggs was identified by the community despite being currently insignificant. Importance in birds in communication was also confirmed. People confirmed birds tells them danger especially presence of snakes and bad weather. Birds also served to inform people time in the morning and predicting rains. Owls are also perceived to be used in witchcraft activities and eagle species used by witchdoctors to foretell events. Ecological services of birds to include importance in seed dispersion and helping in pollination were acknowledged by the community. Among the respondents 90.7 % were quick to note that birds have a negative impact to their lives as they cited their destruction of their poultry and crops. The eagle species had been known to destroy chicks while the doves, quails and warblers are known for damaging crops during the planting and germination stage.

4.8 Perceptions on the future of birds in communal area

According to the perception survey 87% of the respondents had a view that birds population and species are decreasing while 8.5% feels there is no change. This was in light of the threats available to the conservation of birds and the absence of appropriate measures to protect avifauna. The remaining 4% feels there is an increase in bird population and diversity. Most of the responses that birds are increasing came from the 18-30 years age group as 5 out of 6 respondents fall in this age group. Only 2 out of the 94 respondents above the age of 30 years had a view that there is an increase in the population and diversity of birds. It thus can be deduced that there is really a reduction in bird diversity and population as the young respondents who suggested an increase might not have a precise knowledge of the past. It was also established certain birds are becoming fewer or rare as compared to the past i.e. about 15 or more years ago. The birds perceived as fewer or rare include *Tockus nasutus, Columba livia, Milvus migrans, Micronisus gabar, Meropspusillus, Glaucidium perlatum* and *Cisticola lais* among other birds cited by the respondents. The respondents confirmed that birds diversity and abundance are on a decrease and species sited disappearing or rare are shown in Appendix D.

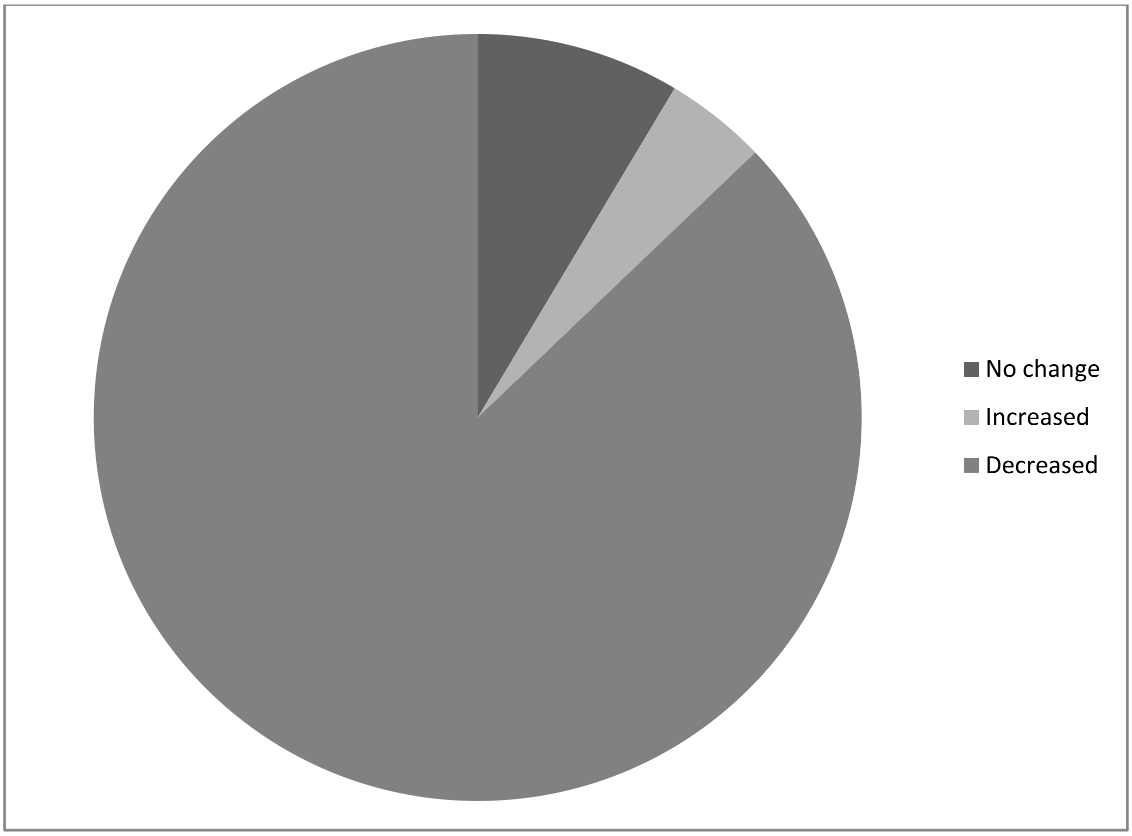

Figure 4.4: Pie chart on perceptions on future of avifauna diversity and abundance

4.9 Perceived cause of loss in bird diversity and abundance

According to the study a number of factors have been identified to be causing avifauna diversity loss as in figure 4.5. Habitat loss and hunting of birds were identified as the main causes of continuous decline of birds species and population. Forests are continuously being destroyed to create space for agricultural activities and settlement. Destruction of habitats consequently destroys food sources for birds. Loss of habitats has also been noted by some respondents to be caused by veld fires and persistent droughts. Birds migration has also been pointed out by some interviewees as a cause of bird loss. Below is a bar graph illustration of some cause of avifauna diversity and abundance loss identified by the community.

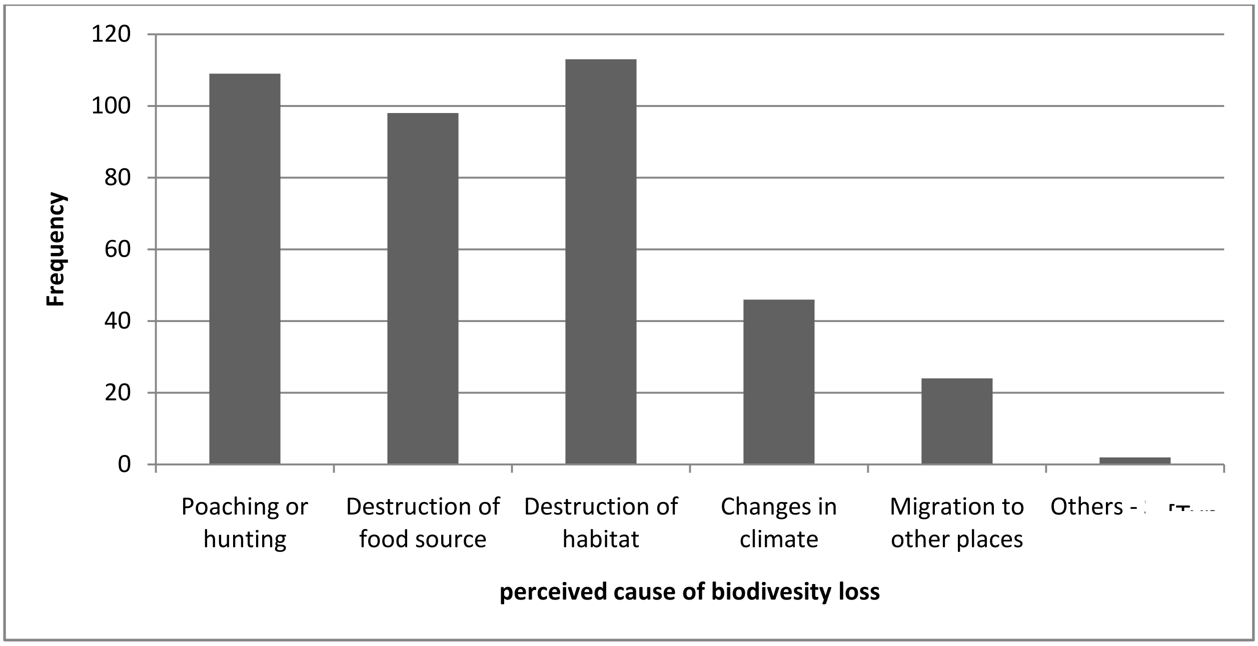

Figure 4.5: Bar graph on perceived causes of avifauna diversity and abundance loss

4.10 Conservation and protection of avifauna in Mupari Communal area

83.6% of the respondents indicated they do not have access to information on bird conservation. Quite a few of the homestead in Mupari have access to television sets but however most have some radios. The village access some of important information to include developmental issues through meetings organised by village head. The environmental Management Agency is the prominent conservation group that access the area, though it is reported that their main focus is protection of forests and environmental damage from illegal gold mining. It is from EMA where the community indicate killing of wildlife is an illegal act and that use of snares and traps for birds is not allowed. The Park and wildlife, Birdlife and Forest Commission are not known to the community. Respondents who showed knowledge on bird conservation indicate they know it from years back at school, through televisions and newspapers. It have also been established that indigenous knowledge plays an important role as some respondents cites folktales as their source of information in bird protection. Importance of bird on totems among the community was also determined.

Figure 4.6 shows that 97.1 % of the interviewees indicated people still hunt birds and their eggs for food. This comes in the absence of strong legal systems to protect avifauna and lack of education on bird protection. 98.5% indicated there is no punitive system that has been applied to those who have killed birds or destroyed their eggs. 60.7% of the respondents indicated there are some ways to protect birds in the area. They cited protection of eggs and chicks as one technique. There were also indications that catapults which are deadly weapons for birds had been banned by the police and that traps, wax and use of chemicals are also banned even with the traditional leaders and society norms.

Figure 4.6: Graph on perceived ways of avifauna conservation in percentage

The chapter reveals results from the perception survey and bird counting survey carried as analysed and presented above. Discussions and recommendation from the study are presented in chapter five.

CHAPTER 5: DISCUSSIONS

5.1 General Discussions

Conservation involves the understanding of the protection of wildlife species and their habitats. Consequently conservation of avifauna involves protection of birds, nests, their eggs, nestles as well as their habitats. It was noted during the research that respondents gave a lead of some important conservation practices indicating some appreciation on avifauna conservation principles. The study reveals high appreciation of avifauna diversity as Simpson result on perception of birds correlates counts survey done by researcher. The Shannon index however reveals no relationship between the perception survey and bird count this can be attributed by wide differences in total numbers of birds counted per species in the count survey. High appreciation of the community on birds is also shown by some high salience on the Sutrop index for instance 0.47 for *Streptopelia senegalensis.* It has also been revealed during the study that conservation of some habitats in the pretext of respected place to include forests, trees, mountains and rivers is still an important conservation strategy. It thus can be deducted from a conservation point of view that having some scared places means these habitats would not be destroyed thus they would be kept natural hence promote avifauna and wildlife conservation.

A relationship exists between importance of birds identified by the respondents during free listing and these found during the listing bird survey. The *Streptopelia senegalensis, Numida meleagris, Pycnonotus barbatus, Iduna natalensis, Bucorvus leadbeateri and Uraeginthus angolensis* species considered significant by the Sutrop index were confirmed abundant when ranking birds for abundance in the Simpson index. The Sutrop index also pointed out that birds important for food, predators and scared birds have higher significance. Birds that are active during the night like *Glaucidium perlatum* and less troublesome birds eg *Prionops plumatus* are not well known. The PCA and HCA also reveal higher abandancy to birds that do not cause problems to people for instance *Streptopelia senegalensis, Numida meleagris, Iduna natalensis, Uraeginthus angolensis, Campethera abingoni* and *Tockus nasutus* that for a common group in both clusters.

It was noted from the research that beliefs including associating some wildlife species with spirituality, respected values and totems play important local roles in conservation of biodiversity. During the study, the African Wood Owl and the Spotted Eagle Owl had been associated with witchcraft. The cry of the Spotted Eagle Owl has been used in the community to predict deaths of a person. This is also a possible reason on why *Strix woodfordi* species scored a high Sutrop value of 0.39 as it has been considered by the community to be used in witchcraft activities. Similarly the Ground Hornbill and Hirundo cry had been associated with prediction of rains and forecast of a good agricultural season. Such values in human lives gave the birds some special status and killing them become unacceptable to the society. It has also been noted from the study that people always leave behind some fruit trees even when clearing their farming lands. The *Ficus carica, Berchemia discolor, Strychnos, Vitez mombassae* and baobab trees have been observed and reported to be left behind even in the cultivated fields. From an ecological management perspective the trees provides food to man, birds and other animals.

It has been a known principle in the community that bird snares and traps are strictly prohibited by national laws and community norms. This is a great conservation strategy that helps in preservation of our biodiversity. It was however reported that the law has not been effective in prohibiting bird killing as nobody has been penalised killing birds or destroying their chicks and eggs. Most people acknowledge receiving knowledge on protection of birds from long back at school. The Environmental Management Agency is however a pronounced department known in the area for fostering prevention of cutting down of trees especially for firewood and fighting illegal gold panning a move that have a positive impact on bird conservation as protection of their habitats is encouraged in the process. Little is known on the Parks and Wildlife Authority in the area as a custodian of wildlife conservation.

In the survey birds have also been noted to have important values in the day to day life of people in the community. Crying birds have been reported to give warning of danger. Birds have been reported to cry when they see snakes or other predators. Some bird species or behaviours has also been used by the communities to predict bad or good luck for instance coming across one dove was associated with bad like while meeting two of them is good luck. Some scavenger birds hovering in the air have helped people in the communities identifying their dead animals or stray animals that would have given births. Some birds have also been reported to be important to agriculture as they destroy rodents and pests for the farmer.

The research reveals a great diversity of birds and diversity in Mupari Communal area. A total of 46 bird species observed during the listing survey over a 2-week period of one season. It can also be learnt from the research that people appreciate the importance of birds in life but there is however no or little enforcement that support conservation of birds in communal area. Information accessed by the community on bird conservation is more of by coincidence. Successful conservation strategies require an organised and well-structured approach if positive results are to be yield. There is great potential for bird conservation in the communal areas of Zimbabwe, given the ability of birds to co-exist with humans.

5.2 Conclusion

Conservation is crucial in preventing extinction of avifauna species. It includes putting in place measures that prevent killing birds, destruction of their eggs and their habitats. Common threats to avifauna density and abundance include habitat loss, alteration of ecosystems, introduction of invasive species, pollution, use of pesticides, birds hunting, climate changes and diseases. Local and indigenous people have got an influence, effect and impact on all these threats. Involvement of local and indigenous people is crucial as local solutions yields global results. Placing scared values on avifauna by indigenous people has been a very important technique in ensuring conservation. Human beings' relationship with their environment is complex and locally specific. Consequently, environment and development problems are related and need to be dealt with at local scale so as to design solutions that are culturally, socio-politically and environmentally suitable to each local context. The research strongly recommends conservation programmes that engage indigenous people as part of decision makers and participants as they are most likely to be successful since indigenous people understands the complexity and solutions required in conservation.

5.3 Recommendations

Given the encouraging results from the research project in establishing a number of bird species in the communal area over a short period in one season, a number of recommendations are suggested if avifauna resources in communal areas can be conserved.

i. Firstly, inventories need to be established in areas that have potential for many birds like Mupari Communal area of Shurugwi. Funds should also be availed so that a survey will be carried in the four seasons of the year to come up with a database of areas with potential for high bird diversity. A study covering the four seasons will cater for migratory bird migrations over the period of a year. It is important that the study is done to build a baseline for future monitoring of bird diversity and abundance.

ii. Shurugwi district should go ahead with the Gwenhoro Conservancy project and hotel construction as earlier proposed in their town plan. Shurugwi is a greatly scenic place coupled with good geographic features that include rivers, hills, good soils, good vegetation and weather condition. This makes Shurugwi a potentially great tourist destination once a conservancy has been established.

iii. The department of Park and Wildlife has to be more visible to all national corners to promote conservation of birds as birds have no boundaries. The presents of the department of Parks and Wildlife will help in creating harmony between humans and birds in their areas.

iv. The government should run programme and campaigns that encourage conservation of birds in communal areas. These programmes should include frequent broadcasting over radios and television information of bird importance and conservation.

v. Collaboration of the government, communities with institutes like Bird Life to reach out non-IBAs that have great bird diversity potential like Shurugwi, is recommended so that people appreciate birds and learn on conservation of natural habitats. BirdLife International over time have accumulated a lot of skills in management of birds, unfortunately they have confined their services to IBAs. Recommendations are for this institution to also honour birds in every part of the globe by raising awareness.

vi. Indigenous local people possess a considerable volume of knowledge of avifauna conservation that can be used by present and future conservationists to generate models in conservation. This knowledge includes scared avifauna species, scared places, beliefs and some indigenous values attached to avifauna. It will be helpful to compile a publication of these values for reference and future use by conservationists.

vii. Headmen and Chiefs have to be empowered with skills that view wildlife as one of the heritages under their management. Traditional leaders are respected and form a powerful local judicial system that can successfully manage local conservation issues like destruction of birds, their chicks, eggs and their nests. Abusive actions like use of traps, wax, chemicals and catapults can also be locally managed. The communal people appreciate destruction of birds is unlawful but killing of birds is still common due to poor enforcement.

viii. Further research is recommended on avifauna diversity and abundance in communal areas of Zimbabwe with potential for sustaining large numbers of bird species outside protected areas and IBAs. Baselines need to be established so that monitoring of changes in diversity and abundance of birds can be done. These studies will help to generate polices that help to protect birds in areas outside protected wildlife areas and IBAs.

REFERENCES

Arinaitwe J., (2005) *Strategy for the conservation and sustainable management of IBAs in Africa:* BirdLife Africa.

Baillie J. E. M., Taylor C. H., and Stuart S. N., (2004) A *Global Species Assessment: IUCN Red List of Threatened Species,* IUCN Publication, Cambridge, United Kingdom

Begon M., Townsend C. R. and Harpers J. L., (2006) *Ecology: From Individuals to Ecosystems*, 4TH Edition, Blackwell Publishing Ltd.

BirdLife International (2001), *Important Bird Areas and potential Ramsar Sites in Europe.* BirdLife International, Wageningen, The Netherlands.

Burger J. and Gochfeld M., (1997) *Risk, Mercury Levels, and Birds*: Relating Adverse Laboratory Effects to Field Bio-monitoring.

Burger J., Gochfeld M., Jeitner C., Snigaroff D., Snigaroff R., Stamm T. and Volz C., (2007) *Assessment of metals in down feathers of female common eiders and their eggs from the*

Aleutians: arsenic, cadmium, chromium, lead, manganese, mercury and selenium, Environment Monitor Assess.

Burgess N. D., Rahbek C., Larsen F. W., Williams P. and Balmford A., (2002) How much of the vertebrate diversity of sub-Saharan Africa is catered for by recent conservation proposals? *Biological Conservation* **Volume 107**, 327–339.

Cavarzere V, Vieira da Costa T, V., Silveira F., (2012) On *the use of 10-minute point counts and 10-species lists for surveying birds in lowland Atlantic Forests in southeastern Brazil,* Seção de Aves, Museu de Zoologia da Universidade de São Paulo. Avenida Nazaré, 481, CEP 04218-970, São Paulo, SP, Brasil, **Volume 52(28):**333.

Childes S. L. and Mundy P. J., (2002) *Zimbabwe: Important Bird Areas and Associated Islands* – Zimbabwe.

Claus A. C., Chan K. M. A. and Satterfield T., (2010) *The roles of people in conservation,* Oxford University Press.

Clout M. N. and Hay J. R., (1989) *The importance of birds as browsers, pollinators and dispersers in New Zealand forests,* New Zealand Journal of Ecology, **Volume 12,** New Zealand Ecological Society.

Cooper R.G. & Horbanczuk J.O., (2004) *Ostrich nutrition: a review from a Zimbabwean perspective,* Rev. sci. tech. Off. int. Epiz., **Volume 23 (3),** pp 1033-1042

Cottrell C. B., (1982) An *important milestone in Zimbabwean ornithology*, Essay Review, Zambezia, X (ii), University of Zimbabwe.

Culture and Wetlands, (2008), A *Ramsar Guidance document, Convention on Wetlands*. Ramsar.

David T., (2011) *Poverty, Biodiversity and Local Organisations:* Lessons from Bird-Life International, Gatekeeper Series, BirdLife International, Cambridge, UK.

Del Hoyo J. Elliott A. And Christie D., (2008) *Handbook of the Birds of the World* , **Volume 11,** Birdlife international, Lynx Edition, Stanford, USA.

de Vere N., (2008) *Biodiversity,* National Botanic Garden of Wales, Carmarthenshire, UK.

Dodman, T. & Diagana, C.H. (2006) Conservation dilemmas for intra-African migratory waterbirds. *Waterbirds around the world.* Eds. G.C. Boere, C.A. Galbraith & D.A. Stroud. The Stationery Office, Edinburgh, UK. pp. 218-223.

Dutson G., Garnett S. and Gole C., (2005) *Australia's Important Bird Areas, Key sites for bird conservation*, BirdLife Australia.

European Commission Publication, (2004) *Why do we need to take care of our birds?,* EU.

European Union for Bird Ringing, (EURING) (2007) *Birds Ring for Science and Conservation*.

Fergus, R., Kwak R. and Kooijmans, J., (2012) *Urban Bird Conservation: For Birds and People, report of workshop held at the Society for Conservation Biology*, 25th International Congress for Conservation Biology, Auckland, New Zealand.

Gandiwa E., (2012*) Local knowledge and perceptions of animal population abundances by communities adjacent to the northern Gonarezhou National Park, Zimbabwe*, Mongabay.com Open Access Journal - Tropical Conservation Science, **Volume 5 (3)**, pp 255-269.

Gandiwa P, Chinoitezvi E. and Gandiwa E., (2013) *Structure and composition of woody vegetation in the important bird areas in Southern Zimbabwe, The journal of animal and plant science.*

Global Biodiversity Outlook 3, (2010), *Secretariat of the Convention on Biological Diversity,* Montreal.

Gregory D., Noble, D., Field R. Marchant J., Raven M., and Gibbons D. W., (2003) *Using birds as indicators of biodiversity*, Ornis Hung.

Hartley R. R. and Mundy P., (1991) *Sustainable development and natural resources management in Southern Zimbabwe*, Bird Surveys, Biodiversity Foundation for Africa.

Herzog S. K., Martinez R., Jørgensen P. M. and Tiessen H., (2011) *Climate Change and Biodiversity in the Tropical Andes, Inter-American Institute for Global Change Research (IAI) and Scientific Committee on Problems of the Environment* (SCOPE).

Hunter M. L., and Gibbs J. P., (2007) *Fundamentals of Conservation Biology*, 3rd Edition, Blackwell Publishing Ltd.

Hyde D. and Campbell S., (2012) *Agricultural Practises that Conserves Grassland Birds*, Michigan State University Extension.

Jorgensen S. E., (2009) *Ecosystem Ecology*, Netherlands.

Katerere J. M., (2001) *Participatory Natural Resource Management in the Communal Lands of Zimbabwe: What Role for Customary Law?* African Studies Quarterly, **5**, Issue 3.

Kushlan J. and Steinkamp M., (2002) Waterbirds Conservation For The Americas, *North American Waterbird Conservation Plan,* U.S. Fish and Wildlife Service National Publications, USA.

Leveque C. and Mounolou J. C., (2003) *Biodiversity*, John Wiley & Sons, West Sussex, England.

Madebwe V. and Madebwe C.,(2005) *An Exploratory Analysis of the Social, Economic and Environmental Impacts on Wetlands: The Case of Shurugwi District, Midlands Province, Zimbabwe*, Journal of Applied Sciences Research **Volume 1(2)**: pp 228-233.

Makore G. and Zano V., (2012) *Mining within Zimbabwe's great dyke: extent , impacts and opportunities,* Zimbabwe Environmental Law Association (ZELA).

Matsa, M. and Muringaniza, K., (2011) *An Assessment Of The Land Use And Land Cover Changes In Shurugwi District, Midlands Province, Zimbabwe*, Ethiopian Journal of Environmental Studies and Management **Volume 4 No.2.**

Meyburg B., Meyburg C. and Paillat P, (2012) *Steppe Eagle migration strategies – revealed by satellite telemetry, British Birds,* **Volume 105**, pp 506–519.

Millennium Ecosystem Assessment, (2005) *Ecosystems and human well-being : wetlands and water synthesis : a report of the Millennium Ecosystem Assessment*, World Resources Institute, Washington, DC.

Molles M. C., (2008) Ecology: *Concepts and Application,* Mc Graw-Hill Company, New York

Mukwashi K. and Matsvimbo F., (2008) *Zimbabwe's Important Bird Areas: National Status Report 2008,* European Commission, EuropeAid/ENV/2007/132-278

Ntongani W. A and Andrew S. M., (2013) *Bird species composition and diversity in habitats with different disturbance histories at Kilombero Wetland,* Open Journal of Ecology, **Volume 3, No.7**, pp 482-488.

Pulido F., (2007) *The Genetics and evolution of avian migration*, Journal of Biosciences, **Volume 57 No. 2**.

Pullin A. S., (2002), *Conservation Biology*, Cambridge University Press, United Kingdom

Sams E. C., (2007) *Methyl-mercury Contamination: Impacts on Aquatic Systems and Terrestrial Species, and Insights for Abatement,* U.S. Department of Agriculture, Forest Service.

Scott Wilson report, 2001, *Environmental Impact Assessment report*, Scott Wilson, Harare.

Şekercioğlu C, H., Wenny D. G., Whelan C. J. and Floyd C., (2014) Bird *Ecosystem Services Promote Biodiversity and Support Human Well- Being,* University of Chicago Press

Skagen S. K., Hazlewood R. and Scott M. L., (2005) *The Importance and Future Condition of Western Riparian Ecosystems as Migratory Bird Habitat*, USDA Forest Service General Technical Report, PSW-GTR-191.

Slobodkin L. *B.*, (2003) *A Citizen's Guide to Ecology*, Oxford University Press, New York.

Smith M. H., Meehan c. l., Ma J., Dasher H. S., Camarillo J. D., Alupay J., Allaband C. and Techanun J., (2009) *Fur, feathers, skin and scales,* Division of Agriculture and Natural Resources, University of Carlifonia.

Sodhi N. S. and Elrlich P. R., (2010) *Conservation Biology For All*, Oxford University Press, New York.

Stern K. R., Bidlack J. E. and Jansky S. H., (2008) *Introductory Plant Biology*, 11TH Edition, McGraw-Hill, New York.

Sullivan J. J., (2012) *Recording birds in real time: a convenient method for frequent bird recording*, Lincoln University, New Zealand.

Sutherland W. J., (2006) *Ecological Census Techniques, a handbook,* Second Edition, Cambridge University Press, New York.

Tabur M. A., and Ayvaz Y., (2006) *Ecological Importance of Birds,* Suleyman Demirel University, Isparta Turkey.

The state of the birds, (2014) *North American Bird Conservation Initiative*, United States of America.

Thomas D., (2011) *Poverty, Biodiversity and Local Organisations*: Lessons from Bird-Life International, Gatekeeper, Tara, UK

Tisdell C. and Wilson C., (2004) *Economics, ecology and the environment*: Birds in an Australian Rainforest, University of Queensland, Brisbane 4072, Australia.

UNEP, (2014), *Convention on the Conservation of Migratory Species of Wild Animals, Review Of The Ecological Effects Of Poisoning On Migratory Birds.*

U.S. Environmental Protection Agency, (1993) *Birds: Bellwethers of Watershed Health.*

US Executive Order 13186 of January 10, (2001) *Responsibilities of Federal Agencies To Protect Migratory Birds*, US Government.

Wells J. (2008) *Impact on Birds of Tar Sands Oil Development in Canada's Boreal Forest,* Natural Resources Defense Council, New York.

Wild H. And Barbosa G., (1967), *Vegetation map of the flora Zambesiaca Area*, M.O Collins Publication, Salisbury.

Zedan H., (2004), *Convention on Biological Diversity Guidelines*: The Ecosystem Approach, The Secretariat of the Convention on Biological Diversity, Montreal

Zocchi A., (2004) *Life for Birds*, European Commission, Luxembourg.

Appendix A

RESEARCH QUESTIONNAIRE

My name is Kangamwiro Mwadzingeni and I am a student with Midlands State University. I am carrying out a study in partial fulfilment of the Master of Ecological Resources Management. I am requesting assistance in completing this questionnaire to the best of your knowledge with honesty. Information obtained will be used for academic purpose only and shall remain confidential. Your cooperation is greatly valued.

Name of respondent (Optional): ______________________________ Questionnaire No: ☐

Sex: **M** ☐ **F** ☐

....

1. Age 18-30 yrs ☐ 30- 49yrs ☐ Above 49 yrs ☐
2. Which birds do you know and exist in your area? (Can use Shona or Ndebele names)
   ....
   ....
   ....
3. Do birds have any value / importance? **Yes** ☐ **No** ☐

If yes what are the values / importance?

i.	
ii.	
iii.	
iv.	
v.	

4. Do birds have any negative effects or damages? **Yes** ☐ **No** ☐

   If your answer is yes what are they?

5. Do we still have the same type of birds (species diversity) today, as we used to have in the past (more than 15 years ago). **No change** ☐ **Increased** ☐ **Decreased** ☐

If decreased what species of birds have disappeared (Can use Shona or Ndebele names)

____

____

____

6. If your response to question 5 is **decrease**, what do you think has been causing decrease in bird species and /or population. (Tick your response)

Poaching or hunting	
Destruction of food source	
Destruction of habitat	
Changes in climate	
Migration to other places	
Others **-** Specify	

7. Have you ever had some information or training on protection / conservation of birds?

Yes ☐ **No** ☐

If yes where / how?

At school	
Radio / newspaper	
Government department (specify)	
NGO	
Researchers	
Others (Specify)	

8. Have there been any ways of protecting birds in your area? **Yes** ☐ **No** ☐

If yes what are the ways?

9. What do you think can be done to protect birds in your area?

10. Do you or people in your area hunt or kill birds for meat or destroy birds nests, eggs or kill birds chicks?? **Yes** ☐ **No** ☐

    If yes what ways do people in your area use to catch birds?

    ____

    ____

    ____

11. Have people in your area been punished or charged for killing birds or destroying their nests and eggs? **Yes** ☐ ☐

12. Do you expect birds in your area to increase or decrease in the near future (about 15 – 20 years)? **Increase** ☐ **decrease** ☐

THE END

THANK YOU VERY MUCH FOR YOUR COOPERATION.

Appendix B

Avifauna diversity and abundance record form

Transect No: ___________________________

Date:________________________

Starting time:_________ Finishing time:_________

Bird species name observed (Include shona names to assist in bird identification)	Brief description to assist identification	Number of birds counted

Appendix C

Correlation table for number of birds against age of respondent

Correlations

		AGE	Bird_counts
AGE	Pearson Correlation	1	.320**
	Sig. (2-tailed)		.000
	N	140	140
Bird_counts	Pearson Correlation	.320**	1
	Sig. (2-tailed)	.000	
	N	140	140

**. Correlation is significant at the 0.01 level (2-tailed).

Appendix D

Birds perceived disappearing/ rare in Mupari Shurugwi

English name	Scientific name
Hooded Vulture	*Necrosyrtes monachus*
Gabar Goshawk	*Micronisus gabar*
Long-crested Eagle	*Lophaetus occipitalis*
African Black Duck	*Anas sparsa*
African Green Pigeon	*Treron calvus*
Rock Dove	*Columba livia*
Little bee-eater	*Merops pusillus*
Crested francolin	*Dendroperdix sephaena*
Jameson's firefinch	*Lagonosticta rhodopareia*
Brubru	*Nilaus afer*
Spotted Eagle-Owl	*Bubo africanus*
Pearl-spotted Owlet	*Glaucidium perlatum*

Appendix E

Simpson's index of diversity – Bird listing survey

Scientific Name	No. Of Birds	Rank	Relative Abandance	ni/N	(ni/N)^2
Pycnonotus barbatus	32	1	10.05176143	0.100628931	0.010126182
Uraeginthus angolensis	30	2	9.433962264	0.094339623	0.008899964
Acrocephalus schoenobaenus	28	3	8.805031447	0.088050314	0.007752858
Streptopelia capicola	24	4	7.547169811	0.075471698	0.005695977
Streptopelia senegalensis	21	5	6.603773585	0.066037736	0.004360983
Numida meleagris	18	6	5.660377358	0.056603774	0.003203987
Prionops plumatus	15	7	4.716981132	0.047169811	0.002224991
Iduna natalensis	14	8	4.402515723	0.044025157	0.001938214
Corvus albicollis	8	9	2.51572327	0.025157233	0.000632886
Dicrurus ludwigii	7	10	2.201257862	0.022012579	0.000484554
Caprimulgus pectoralis	6	11	1.886792453	0.018867925	0.000355999
Accipiter tachiro	6	12	1.886792453	0.018867925	0.000355999
Coturnix delegorguei	6	13	1.886792453	0.018867925	0.000355999
Acrocephalus scirpaceus	6	14	1.886792453	0.018867925	0.000355999
Emberiza capensis	5	15	1.572327044	0.01572327	0.000247221
Dendroperdix sephaena	5	16	1.572327044	0.01572327	0.000247221
Tockus bradfieldi	5	17	1.572327044	0.01572327	0.000247221
Chlorophoneus sulfureopectus	5	18	1.572327044	0.01572327	0.000247221
Dicrurus adsimilis	4	19	1.257861635	0.012578616	0.000158222
Corvus albus	4	20	1.257861635	0.012578616	0.000158222
Milvus migrans	4	21	1.257861635	0.012578616	0.000158222
Vanellus senegallus	4	22	1.257861635	0.012578616	0.000158222
Merops hirundineus	4	23	1.257861635	0.012578616	0.000158222
Coturnix coturix	4	24	1.257861635	0.012578616	0.000158222
Lagonosticta rhodopareia	4	25	1.257861635	0.012578616	0.000158222
Lanius collurio	4	26	1.257861635	0.012578616	0.000158222
Cisticola lais	3	27	0.943396226	0.009433962	8.89996E-05
Columba larvata	3	28	0.943396226	0.009433962	8.89996E-05
Bucorvus leadbeateri	3	29	0.943396226	0.009433962	8.89996E-05
Chlorocichla flaviventris	3	30	0.943396226	0.009433962	8.89996E-05
Aquila nipalensis	3	31	0.943396226	0.009433962	8.89996E-05
Micronisus gabar	3	32	0.943396226	0.009433962	8.89996E-05
Strix woodfordi	3	33	0.943396226	0.009433962	8.89996E-05
Turtur afer	3	34	0.943396226	0.009433962	8.89996E-05
Merops apiaster	3	35	0.943396226	0.009433962	8.89996E-05
Glaucidium perlatum	3	36	0.943396226	0.009433962	8.89996E-05

Nectarinia amethystina	2	37	0.628930818	0.006289308	3.95554E-05
Campethera abingoni	2	38	0.628930818	0.006289308	3.95554E-05
Tockus nasutus	2	39	0.628930818	0.006289308	3.95554E-05
Accipiter badius	2	40	0.628930818	0.006289308	3.95554E-05
Bubo africanus	2	41	0.628930818	0.006289308	3.95554E-05
Chalcomitra senegalensis	1	42	0.314465409	0.003144654	9.88885E-06
Dendropicos fuscescens	1	43	0.314465409	0.003144654	9.88885E-06
Treron calvus	1	44	0.314465409	0.003144654	9.88885E-06
Lophaetus occipitalis	1	45	0.314465409	0.003144654	9.88885E-06
Hirundo rustica	1	46	0.314465409	0.003144654	9.88885E-06
	318			**$\sum(ni/N)^2$**	**0.050136466**

Appendix F: Table of results diversity indices

Alpha diversity indices

Numbers | Plot

	A	Lower	Upper
Taxa_S	30	30	30
Individuals	1820	1820	1820
Dominance_D	0.03746	0.03703	0.03901
Simpson_1-D	0.9625	0.961	0.963
Shannon_H	3.334	3.309	3.342
Evenness_e^H/S	0.9349	0.9122	0.9422
Brillouin	3.288	3.264	3.296
Menhinick	0.7032	0.7032	0.7032
Margalef	3.863	3.863	3.863
Equitability_J	0.9802	0.973	0.9825
Fisher_alpha	5.102	5.102	5.102
Berger-Parker	0.05055	0.04945	0.06209
Chao-1	30	30	30

	B	Lower	Upper
Taxa_S	46	46	46
Individuals	318	318	318
Dominance_D	0.05012	0.04424	0.05914
Simpson_1-D	0.9499	0.9408	0.9557
Shannon_H	3.356	3.231	3.425
Evenness_e^H/S	0.6232	0.5504	0.6677
Brillouin	3.124	3.009	3.189
Menhinick	2.58	2.58	2.58
Margalef	7.81	7.81	7.81
Equitability_J	0.8765	0.844	0.8945
Fisher_alpha	14.77	14.77	14.77
Berger-Parker	0.1006	0.08805	0.1384
Chao-1	46.75	46.27	57

Appendix G- Results of Bird Count survey

English Name	Scientific Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	No of lists	No. Of Birds
Laughing dove	*Streptopelia senegalensis*	1	1		1		1			1			1				1	7	21
Ring-necked dove	*Streptopelia capicola*			1	1	1			1		1			1	1		1	8	24
Sedge Warbler	*Acrocephalus schoenobaenus*	1			1			1		1		1				1	1	7	28
African yellow warbler	*Iduna natalensis*	1			1			1		1			1		1			6	14
Cape bunting	*Emberiza capensis*			1			1							1				3	5
Common Bulbul	*Pycnonotus barbatus*		1		1			1	1			1		1		1	1	8	32
Wailing cisticola	*Cisticola lais*			1						1								2	3
Amethyst sunbird	*Nectarinia amethystina*											1					1	2	2
Scarlet-chested Sunbird	*Chalcomitra senegalensis*			1														1	1
Golden-tailed Woodpecker	*Campethera abingoni*					1						1						2	2
Cardinal woodpecker	*Dendropicos fuscescens*									1								1	1
Blue-spotted wood dove	*Turtur afer*			1													1	2	3
Southern Ground Hornbill	*Bucorvus leadbeateri*				1													1	3
Yellow-bellied Greenbul	*Chlorocichla flaviventris*			1							1							2	3
African Grey Hornbill	*Tockus nasutus*	1																1	2
White-crested helmetshrike	*Prionops plumatus*		1	1				1					1					4	15
African Green Pigeon	*Treron calvus*														1			1	1
Fork-tailed Drongo	*Dicrurus adsimilis*								1								1	2	4
White-necked Raven	*Corvus albicollis*		1			1				1				1				4	8
Pied crow	*Corvus albus*						1						1			1		3	4
Long-tailed widowbird	*Euplectes progne*										1							1	1
Tawny Eagle	*Aquila nipalensis*				1				1				1					3	3
Gabar Goshawk	*Micronisus gabar*					1				1							1	3	3
Fiery-necked nightjar	*Caprimulgus pectoralis*			1		1		1		1		1		1				6	6

African Wood Owl	*Strix woodfordi*		1					1				1						3	3
Black Kite	*Milvus migrans*	1				1					1						1	4	4
African Harrier-Hawk	*Polyboroides typus*					1		1		1		1		1				5	6
Crested francolin	*Dendroperdix sephaena*			1				1			1							3	5
Helmeted Guineafowl	*Numida meleagris*			1			1			1			1			1	1	6	18
African wattled lapwing	*Vanellus senegallus*	1								1								2	4
Harlequin quail	*Coturnix delegorguei*			1			1				1				1			4	6
Stock - migratory	*Coraciiformes*											1						1	4
Shikra	*Accipiter badius*								1					1				2	2
Bradfield's Hornbill	*Tockus bradfieldi*		1			1						1						3	5
Barn Swallow	*Hirundo rustica*							1										1	1
Blue-spotted wood dove	*Turtur afer*										1			1				2	3
Square-tailed drongo	*Dicrurus ludwigii*	1					1					1				1		4	7
Common quail	*Coturnix coturix*					1						1						2	4
European Bee-eater	*Merops apiaster*						1					1				1		3	3
Blue Waxbill	*Uraeginthus angolensis*	1	1	1				1					1	1		1		7	30
Red-billed oxpecker	*Buphagus erythrorhynchus*					1								1				2	2
Eurasian Reed Warbler	*Acrocephalus scirpaceus*		1	1					1					1				4	6
Jameson's firefinch	*Lagonosticta rhodopareia*	1				1				1					1			4	4
Bronzy sunbird	*Nectarinia kilimensis*								1				1					2	3
Red-backed Shrike	*Lanius collurio*				1	1					1				1			4	4
Orange-breasted bushshrike	*Chlorophoneus sulfureopectus*		1		1				1									3	5
Number of bird species observed per transect		9	9	13	9	12	7	10	8	12	8	12	8	11	6	7	10	46 species	Total birds 318

Appendix H: Analysis of Data from free listing of birds by respondents

Bird species	Streptopelia senegalensis	Strix woodfordi	Numida meleagris	Pycnonotus barbatus	Iduna natalensis	Bucorvus leadbeateri	Uraeginthus angolensis	Corvus albicollis	Micronisus gabar	Vanellus senegallus	Campethera abingoni	Tockus nasutus	Accipiter tachiro	Columba larvata	Dicrurus adsimilis
Total of respondents	92	87	86	85	83	82	81	81	80	80	79	77	70	63	63
p*i*	0.051	0.048	0.047	0.047	0.046	0.045	0.045	0.045	0.044	0.044	0.043	0.042	0.038	0.035	0.035
(ni/N)2	0.0026	0.0023	0.0022	0.0022	0.0021	0.0020	0.0020	0.0020	0.0019	0.0019	0.0019	0.0018	0.0015	0.0012	0.0012
In	5.97	6.08	6.10	6.13	6.18	6.20	6.22	6.22	6.25	6.25	6.27	6.33	6.52	6.73	6.73
Inp*i*	0.302	0.290	0.288	0.286	0.282	0.279	0.277	0.277	0.275	0.275	0.272	0.268	0.251	0.233	0.233
p*i*(Inp*i*)	0.0153	0.0139	0.0136	0.0134	0.0128	0.0126	0.0123	0.0123	0.0121	0.0121	0.0118	0.0113	0.0096	0.0081	0.0081

Table continued

Bird species	Milvus migrans	Cisticola lais	Treron calvus	Turtur afer	Coturnix delegorguei	Coturnix coturix	Hirundo rustica	Caprimulgus pectoralis	Dicrurus ludwigii	Prionops plumatus	Nectarinia amethystina	Glaucidium perlatum	Lophaetus occipitalis	Bubo africanus	Aquila nipalensis		
Total of respondents	61	61	55	52	51	46	45	45	40	37	35	35	23	23	22	1820	Total
p*i*	0.034	0.034	0.030	0.029	0.028	0.025	0.025	0.025	0.022	0.020	0.019	0.019	0.013	0.013	0.012		
(n*i*/N)2	0.0011	0.0011	0.0009	0.0008	0.0008	0.0006	0.0006	0.0006	0.0005	0.0004	0.0004	0.0004	0.0002	0.0002	0.0001	0.0375	Simpson index
In	6.79	6.79	7.00	7.11	7.15	7.36	7.40	7.40	7.64	7.79	7.90	7.90	8.74	8.74	8.83		
Inp*i*	0.228	0.228	0.212	0.203	0.200	0.186	0.183	0.183	0.168	0.158	0.152	0.152	0.110	0.110	0.107		
	0.0076	0.0076	0.0064	0.0058	0.0056	0.0047	0.0045	0.0045	0.0037	0.0032	0.0029	0.0029	0.0014	0.0014	0.0013	0.2429	Shannon index