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Full Length Research

Influence of Different Land Use Types on Bird Species Diversity and Richness in Two Agro-Ecological Zones of Edo state Nigeria

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This research study examined the influence of different land use types in Leventis Foundation Farm Weppa- Agenebode, Edo state Nigeria. The farm is the largest privately owned in Nigeria. The farm was divided into three compartments for the purpose of this study, Arable crop unit, Agroforestry unit, and wetland. The crop grown in the farm are as follows, rice, cassava, maize and soya bean. Others are cashew, mango citrus, oil palm, and teak. Point count method was used to collect data on bird species. Counting stations or predefined spots were established in roosting sites, wetland and feeding sites as well as forest edges. Counting bands of the 50m radius were used for all the stations. The minimum distance between two counting each study sites stations was 200m. The number of counting stations was determined by the site size. In all, 30 counting station were used, 15 counting stations in each compartment were laid out. PAST model was used to analyze the diversity index, SHE analysis, diversity profile and plot the diversity index in different compartments. A total of 902 bird encounters were made with one hundred twenty (120) bird species belonging to forty-eight (48) families and sixteen (16) orders were observed in the study area. Agroforestry unit has higher bird species diversity of (52) bird species than Arable crop unit (27) and Wetland (42). Arable crop unit has bird species richness (324) followed by Agroforestry unit (234) and wetland (115). Within Arable crop unit compartment the result indicates that rice plot has the highest (218) bird species richness, followed by maize plot (155) and the least was soya bean plot (40). This was followed by maize. In agroforestry unit, Citrus plantation has the highest bird species richness (71) followed by cashew plantation (67) and the least was Teak plantation (29). Diversity in Shannon_H dex indicates that Agroforestry unit has the highest index of 3.578 followed by wetland unit 3.567 and Arable crop unit has 2.946 which was the smallest.

Key Words: Land use, Crop types, Bird species, Richness and Diversity and conservation.

INTRODUCTION

Many countries in the developing world are experiencing rapid population growth, with associated pressure on natural habitat and their native flora and fauna including avian species

(Sodersrom et al., 2003). Habitat loss, destruction, and degradation are major threats to avian species richness and diversity (Birdlife International, 2000). This loss of habitats can be as a result of human or natural causes. Human activities contribute more to habitat destruction. Newton (1988) acknowledged the fact that, in the last 400 years, human actions alone have eliminated about 127 of approximate 96720 species of modern birds.

Activities like firewood collection, logging, agriculture, farming, drainage destruction of wetlands, human settlement, the building of infrastructures and industries among others have altered lots of habitats (Birdlife International, 2000). Myers (1996) reported that the loss of tropical ecosystem is of particular concern because the biome contains over half of the world species. Agricultural encroachment and unsustainable silvicultural practices have been implicated in these losses (Blockhus et al., 1992). Many studies have examined the impact of habitat loss and fragmentation due to agriculture on tropical bird communities (Hughes et al., 2002, Naidoo, 2004, Marsden et al., 2006). Relatively few have focused on bird communities in Africa (Mangnall and Crowe, 2003; Ratcliffe and Crowe 2001). The problem of forest fragmentation is extremely severe in West Africa due to rapid population growth and land-use changes (Manu et al., 2007). The vegetation of West Africa, is typically described as consisting of forest and savanna, nearly all of the forest vegetation within populated areas in Nigeria have now been largely converted into savanna through cultivation and burning (Agbelusi, 1995). Okosodo, et al., (2016) reported that over 350,000 ha of forest and natural vegetation are being lost annually due to farming. The implication of these activities is the loss of biodiversity in which avifaunal are key species.

Most Nigerians are not aware that many of our birds and other life forms are threatened by intense pressures from various human-related activities such as farming, logging, and wildfires. For example, the Bannerman's weaver (*Ploceus bannermani*) and the White-throated Mountain Babbler *(Kupeoruis gilberti)* are threatened by the loss of important forest patches in their highland forest habitat on the Obudu Plateau (Ezealor, 2002). Presently, about 37 of the bird species that occur in Nigeria are among the biological resources the world may lose as a result of the threat from these activities (Ezealor, 2002).

The study is seeking to understand the rich diversity of bird species in different land use types across the major ecological systems of Nigeria in Edo State; a state with a rapidly growing population and with a lot of the natural environment rapidly transforming through agriculture.

MATERIALS AND METHODS

Study area

Leventis Foundation Farm

Leventis Foundation Farmland is a privately owned farm with coordinates of 6° 41' East and 7.02' North is located in Weppa Agenebode in Edo state Nigeria, 5km western bank of River Niger. It is the largest privately owned farm in Nigeria with a land mass of 6000ha. The farm is divided into two major parts, the arable farmland and cash crop unit (Isichei, 1995). The Ogbudu and Obe rivers form the northern boundaries of the farm. Small rivers run through the farm with the result the area is usually flooded during the wet season. Annual rainfall is between 1200 and 2500ml. February and March are the driest months and the wettest months are July and September. The mean annual temperature is 30°C. The mean annual relative humidity is not below 25% in the driest months and 100% during the wet seasons (Megistu and Salami, 2007). The soil is typical of alluvial soil varying from sandy (zero clay content through every intermediate type to clay 60% plus clay content (Keay, 1989). The vegetation is a mixture of southern Guinea savanna, riparian, with Guinea-Congo Forest affiliation and open, cultivated or fallow fields (Keay, 1989). The most obvious natural resource of Leventis Foundation Farmland is the trees, varied because the zone is the transition between the high forest and savanna. Contemporary, climate conditions might be described as either southern moist Guinea savanna where drainage is good or peat swamp where it is impeded. A third zone is very obvious enough for the small tree *Mytragyna intermis* to be unique gallery forest along the banks of the rivers that are tributaries or sub-tributaries to river Niger. Here, are found high forest trees such as *Nauclea diderichii, Ceiba pentandra*. The lower galleries are dominated by *Petrocarpus santalinoides* which are flooded in

June to October (Ogunjemite 2016). The woodland in the south of the farm which is 7000 hectares is Daniella oliverii woodland. Throughout this woodland can be found the locust bean *Parkia biglobosa, Lophira lanceolota*, and *Vitex donniana.* In certain areas in the woodland, *Pterocarpus erinecous* is found mixed with *Daniela oliveri* in equal numbers (Ewers and Didham, 2006). Other savanna tree species include *Etanda africana*, typical of dry open areas, *Pilostigma thoningii* of degraded areas and the Borassus palm (*Borasus aethiopium*) as a good indicator of seasonal wetlands. Also, *Kigelia africana*, with its conspicuous hanging. The arable farmland is divided into compartments of four hectares and with fallow edge separating each compartment. Mix cropping system is practiced here and the crops were grown are as follows; maize, rice, cassava, soya beans, oil palm, mango and citrus and fish family by local settlers (Figure 1).

Data Collection

The study area was divided into three compartments which include the Arable farm area, Agroforestry unit, and Wetland for the purpose of this study. Counting stations (Sutherland, 2009) was used to collect data on bird species richness and diversity counting stations or predefined spots were established in roosting sites, wetland and feeding sites as well as forest edges. Counting bands of the 50m radius were used for all the stations. The minimum distance between two counting each study sites stations was 200m. The number of counting stations was determined by the site size. In all, 45 counting stations were used, 15 counting stations in each compartment were laid out. On arrival at the sites, birds were allowed to settle before recording all the birds seen or heard for a predetermined time (20 min). Bird calls were also recorded with a voice recorder and played back later for confirmation. Physical features of birds were sighted but could not be identified immediately when taken, field guidebook of West African birds (Burrow and Demey, 2011) was used to identify the bird species and bird calls was used to confirm the presence of nocturnal bird species within the study site.

From the data collected, avian species diversity was calculated using Shannon diversity index, (Usher, 1991) which is given as Where: Hi = diversity index Pi = is the proportion of the ith species in the sample
In Pi = is the natural logarithm of the species proportion.

Species relative population density

The relative population density of bird species at various sites and seasons were determined as outlined by Bibby et al., (1992) as Follows:
Hi = - Σ Pi In Pi
D = n1 + n2Loge [n1 + n2]
πr2m n2
Where: D = density
r = radius of the first zone.
n1 = number of birds counted within the zone.
n2 = number of birds counted beyond zone and m = number of the replicate count in such area.

Statistical Analysis

Data obtained from the field survey were entered into Excel (version 15) spreadsheet prior to both descriptive (tables, frequency and percentage frequency, graph, pie and bar charts) and analytical statistics. The computer PAST Model version 3 was used to analyze bird species diversity, Rarefaction, and SHE analysis.

RESULT

From the result obtained in this research study, it revealed that different land use types affected the bird species richness and diversity in the study area. A total of 902 bird encounters were made with one hundred and twenty (120) bird species belonging to forty-eight (48) families and sixteen (16) orders were observed in the study area. The result of bird species richness in the study area indicates. Arable Crop unit has the highest (524) bird species richness, followed by agroforestry unit (234) and Wetland (115) (Figure 2). In Arable crop unit, rice plot has the highest bird species richness (218), this is followed by maize plot (155), cassava (111) and soya bean plot (40) (Figure 3). In Agroforestry unit Citrus plantation has the highest bird species richness (71) this is followed by Cashew plantation (67), Mango plantation (63), oil palm plantation (43) and Teak Plantation (29) Figure 4. The result of the family composition of bird species in the study area shown that 48 families were observed. The family

Satellite Imagery Map of the study area.

Accipitridae has the highest number (10) bird species, this is followed by *Nectariniidae* which have 7 bird species. While, these *families Alaudidae, Apodidae, Caprimulgidae, Diceruridae, Emberizidae, Fringillidae, Helliornithidae, Jacanidae, Lannidae, Numidae, Mosophagidae, halacrocoracidae, Phsianidae, Pycnonotidae, Recurvirostidae, Scolopacidae, Scopidae, Strigidae, Sturnidae*, *Timalidae, and Turdidae* has 1 bird species each which is the lowest in the study area (Figure 5). From the result obtained in the Shannon_H diversity index, of the three compartments indicates that Agroforestry has the highest (3.578), Arable compartment has (2.946) and wetland (3.567) Table 1, The SHE analysis and Rarefraction is shown in Figures 6a,b and 7.

DISCUSSION

The bird species richness in this study differed between land uses. The higher bird species richness was observed in Arable Crop Compartment probably due to due to the food resource availability in this land use type. A number of of-of farming activities conducted in this compartment which influence the availability of food for birds from fresh rice, and maize grain to dry rice grain seeds which are favored by most bird species. Moreover, the Wetland compartment was made up of bird species

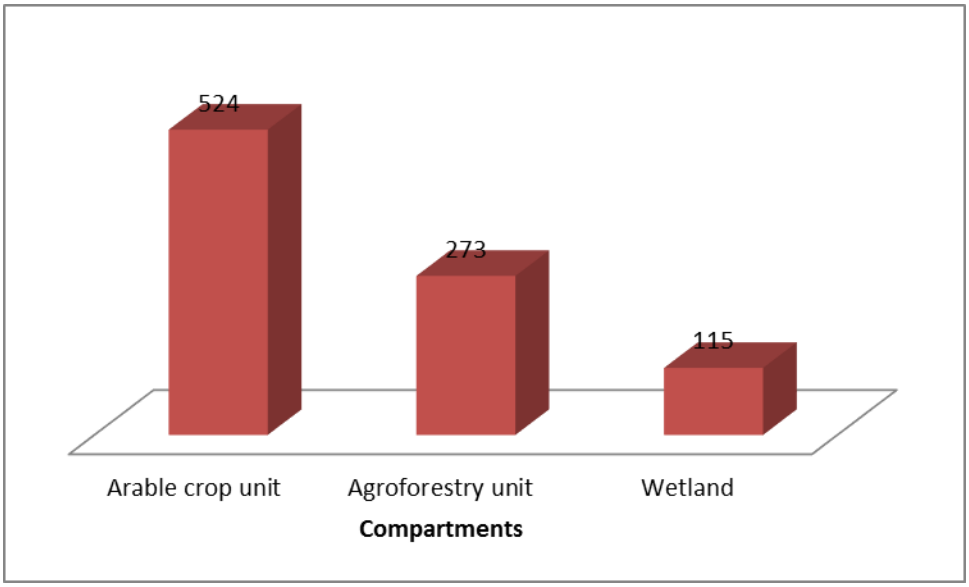

Figure 2. Number of individual Bird Species in each Compartment in the Study Area.

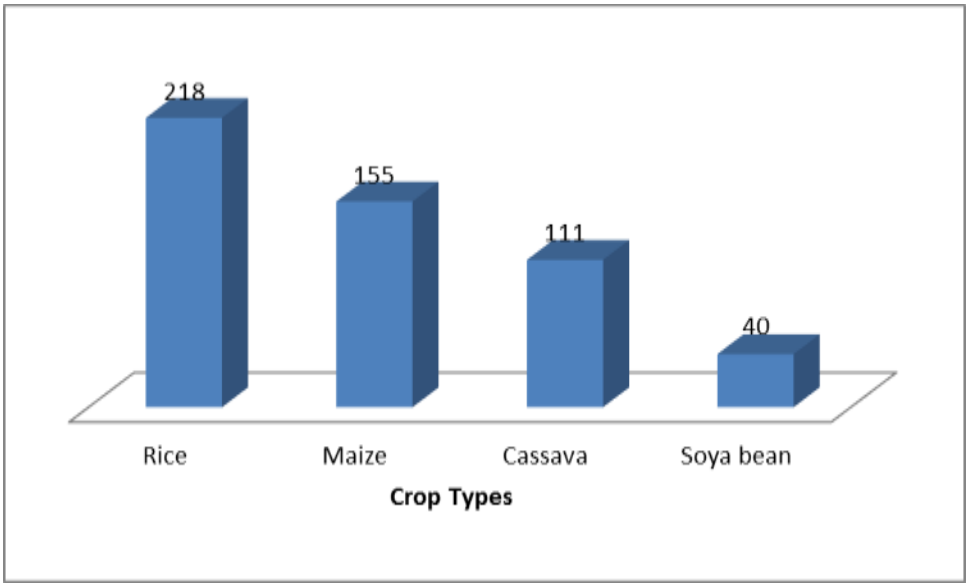

Figure 3. Number of Individual Bird Species in each crop plot within Arable Compartment.

with large because there was available to support them. These findings are consistent with previous studies, which suggested a high volume availability of preferred food in the cultivated areas than the uncultivated areas (Kormar 2006). Arable land provides essential foraging opportunities to many European farmland birds (Bos et al., 2009; and Atkinson et al., 2002). Arable land provides essential foraging opportunities to many European farmland birds (Bos et al., 2009 and Robinson et al., 2001). Non-crop vegetation in arable fields provides an important source of seeds, but perhaps as

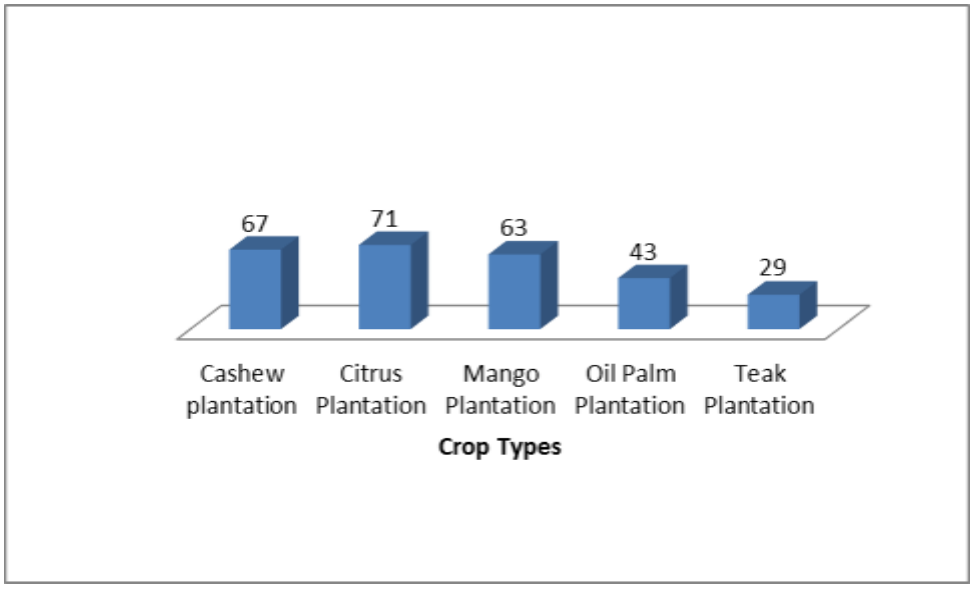

Figure 4. The Number of Individual Bird Species in each crop plantation in Agroforestry Compartment.

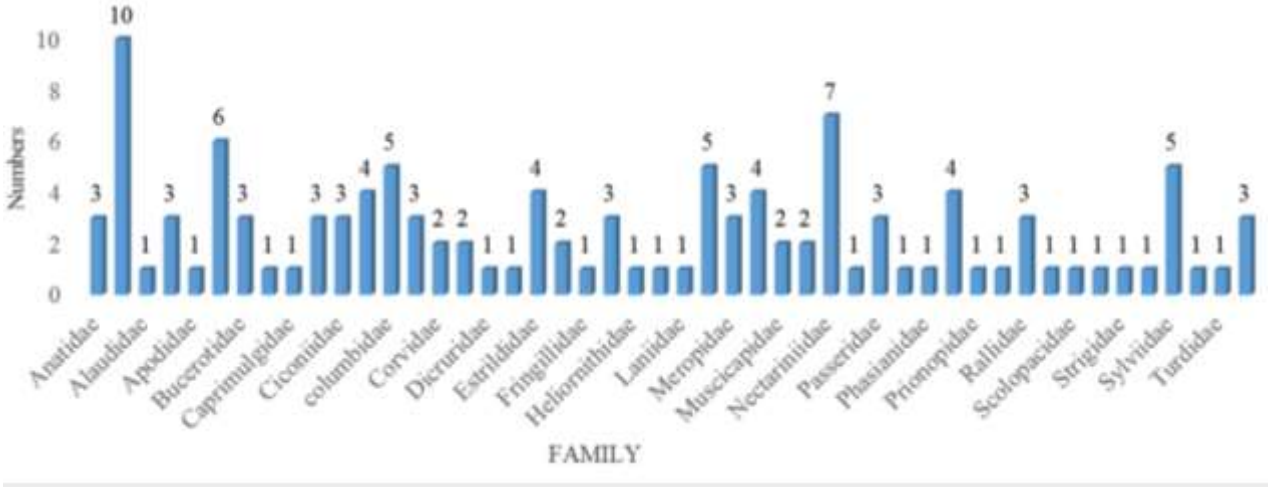

Figure 5. Family composition of Bird Species in the Study Area.

importantly, it recruits insects (Marshall et al., 2003). Different groups of bird species seem to respond differently to land analyzed uses. Insectivores are known present marked responses to land use change (Walter et al., 2005) which was for annual agricultural areas were insectivores mean a number of recordings per visit decayed by 50% in relation controls. Arable land provides essential foraging opportunities to many European farmland birds (Robinson et al., 2001). Non-crop vegetation in arable fields provides an important source of seeds, but perhaps as importantly, it recruits insects (Marshall et al., 2003). Yet, recent changes in farming practices have reduced the value of arable cropland as a food source. A shift to fall planting (Evans and Green, 2007) and increased nitrogen inputs (Billeter et al., 2008) resulted in increased density of crop vegetation, limiting many species'

Table 1. Diversity Index of Bird Species in the Three Compartments.

Diversity Index	Agroforestry compartment	Arable Crop Compartment	Wetland
Taxa_S	52	27	41
Individuals	233	524	115
Dominance_D	0.03686	0.06414	0.03244
Shannon_H	3.578	2.946	3.567
Evenness_e^H/S	0.6882	0.705	0.8633
Brillouin	3.256	2.841	3.096
Menhinick	3.407	1.18	3.823
Margalef	9.356	4.152	8.43
Equitability_J	0.9054	0.8939	0.9604

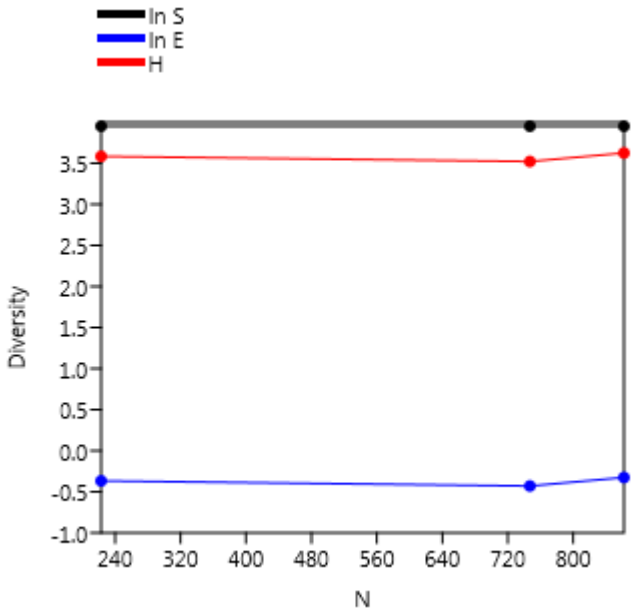

Figure 6a. SHE Analysis of Bird Species in the Study Area.

ability to forage. The increased use of pesticides and shift to fall planting lowers both seed and insect food resources (Boatman et al., 2004). Similarly, the loss of winter stubble, resulting from a shift to fall planting, reduced the availability of seeds for granivorous farmland birds (Evans, 2003). The introduction of genetically modified crops is engineered to limit weed and insect populations, further impacting avian food resources (Wilson et al., 2009). Including arable fields in conservation efforts is important because the needs of many farmland species are best met by arable fields that in the past provided sufficient food and cover but are now being lost to intensification (Butler et al., 2010). Foraging and nesting opportunities can be improved by providing both spatial and structural vegetative heterogeneity within a field (Morris et al., 2004) such as incorporation of greater disturbance to produce an abundance of seeds (Wilson et al., 2010).

From the result, it was found that diversity of bird species in home garden land use was the highest in Agroforestry compartment. This is due to the presence of varieties of microhabitats which provide a niche for different species of birds. The higher diversity in home garden land use was due to high numbers of individuals in some bird species and diverse vegetation types as microhabitats which favored varieties of bird species. Vegetation cover has been reported to have a strong influence on avifauna diversity (Radford, 2005). Also, vegetation is among the factors which influence bird diversity in tropical Africa depends on (Sodhi, 2004).

As observed during the period of this study, fertilizers herbicides and pesticides were used in rice and maize plots. The use of these chemicals could be responsible for decrease diversity of bird species in Arable Crop Compartment. This finding is consistent with the following authors Arcos, et al., (2008); Eraud and Boutin, (2002); Chamberlain et al., (2006), reported that increased use of pesticides and fertilizers affects reproduction and mortality both directly and indirectly. Direct effects occur instantly via failed reproduction or immediate mortality. Indirect effects impact via reduced food supplies. For example, the use of herbicides decreases weed populations and hence also weed seed availability

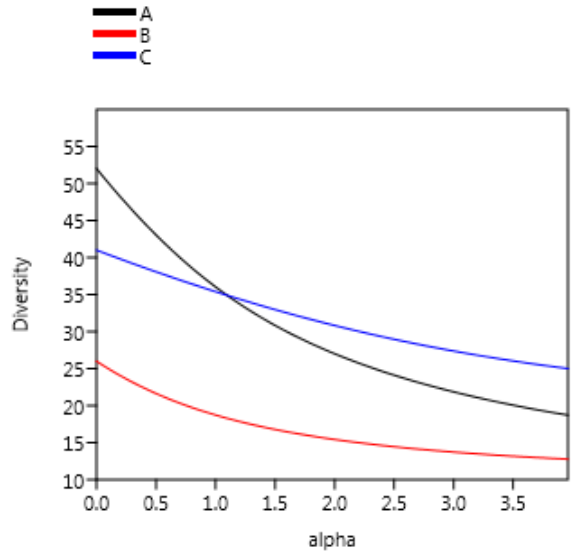

Figure 6b. Diversity of Bird Species in the Study Area.

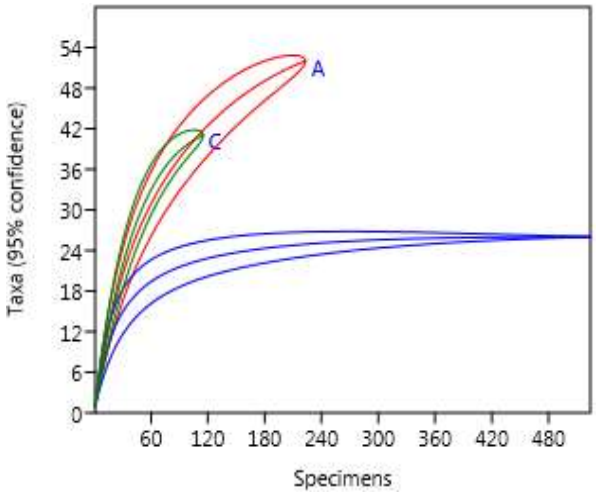

Figure 7. Rarefaction Analysis of Bird Species in the Study.

in agricultural areas, reducing food supply in both the short and long term. Weeds also support insects, another important component in the diet of birds. The use of fertilizers benefits the growth of improved agricultural crops at the expense of wild plants, resulting in uniform fields with dense crop canopies that are less accessible to farmland birds for use as foraging or breeding habitat. There is a strong observed correlation between country wide declines of farmland birds and loss of woody edges (Wilson et al., 2009). One-quarter of the risk to farmland birds is attributed to the loss of margins and hedgerows (Butler et al., 2010).

CONCLUSION AND RECOMMENDATION

The study concludes that difference in uses of land has huge influences on bird species diversity. The study revealed further that the wetland is very important to the bird communities. Of the five dominant land uses, the arable zone had the highest abundance bird species this may be probably as a result of availability food in the compartment. There was a greater variation in species richness between land use types. Habitat destruction due to the increase in land use imposed a net negative effect on the population of birds. From the study on the richness, and diversity of tree species in relation to land use, it can be concluded that agroforestry compartment land use has the highest diversity. The human disturbance had a significant effect on tree diversity and richness in different land use type.

In order to maintain the avifauna diversity of the area, land use planning that both protects the native tree species and emphasizes on bird friendly landscape design may enhance avian and tree species diversity within the area. Strict law enforcement on farming practices that will have negative effects on avifauna in the area should be encouraged. Community education and promotion of alternative income generating activities should be encouraged. This should go hand in hand with the restoration of the ecosystem through reforestation in most degraded areas.

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Appendix 1

Family	Scintific Name	Common Name
Anatidae	Dendrocygna viduata	White Faced Whistling Duck
	Pteronetta hartlaubii	Hartlaub's Duck
	Sarkidiornis melanotos	Knob Bellied Duck
Accipitridae	Aviceda cuculoides	African Cuckoo Hawk
	Haliaeetus vocifer	African Fisheagle
	Polyboroides typus	African Harrier Hawk
	Aquila spilogaster	African Hawk Eagle
	Circusranivorus	African Marsh Harrier
	Elanus caeruleus	Black Shouldered Kite
	Milvus migrans	Black Kite
	Kaupifalco monogrammicus	Lizard Burzard
	Lophaetus occipitalis	Long Crested Eagle
	Buteo auguralis	Red Neck Burzard
Alaudidae	Mirafra cantillans	Singing Bush Lark
Alcedinidae	Halcyon malimbica	Blue Breasted Kingfisher
	Alcedo cristata	Malachite Kingfisher
	Halcyon senegalensis	Senegal Woodland Kingfisher
Apodidae	Cypsiurus parvus	African Palm Swift
Ardeidae	Ardea cinerea	Gray Heron
	Bubulcus ibis	Cattle Egret
	Ardea alba	Great Egret
	Lsobrychus minutes	Litle Bitten
	Egretta garzetta	Little Egret
	Ardeola ralloides	Squaco Heron
Bucerotidae	Tockus fasciatus	African Pied Hornbill
	Tockus nasutus	Grey Hornbill
	Ceratogymna fistulator	Pipping Hornbill
Burhinidae	Burhinus senegalensis	Senegal Thick Knee
Caprimulgidae	Caprimulgus nigriscapularis	Black Shouldered Nightjar
Charadriidae	Vanellus senegallus	African Wattled Lapwing
	Pluvianus aegyptius	Egyptian Plover
	Vanellus leucurus	White Tailed Lapwing
Ciconiidae	Anastomus lamelligerus	Africa Openbill
	Ciconia ciconia	White Stork
	Ciconia episcopus	Woolly Neck Stork
Cisticonidae	Camaroptera brachyuran	Grey Backed Camaroptera

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	Prinia subflava	Twany Flanked Prinnia
	Apalis flavida	Yellow Breasted Apalis
	Cisticola lateralis	Whistling Cisticola
Columbidae	Treron calva	African Green Pigeon
	Turtur brehmeri	Blue Spotted Wood Dove
	Streptopelia capicola	Laughing Dove
	Streptopelia semitorquata	Red Eye Dove
	Streptopelia vinacea	Vinaceous Dove
Coraciidae	Coracias abyssinica	Abyssinian Roller
	Coracias cyanogaster	Blue Bellied Roller
Corvidae	Corvus albus	Pied Crow
Cuculidae	Centropus grillii	Black Coucal
	Centropus senegalensis	Senegal Coucal
Dicruridae	Dicrurus adsimilis	Fork Tailed Drongo
Emberizidae	Emberiza flaviventris	African Golden Breasted Bunting
Estrildidae	Lagonosticta rubricata	Blue Billied Firefinch
	Spermestes cucullatus	Bronze Mannikin
	Estrilda melpoda	Orange Cheeked Waxbill
	Pytilia afra	Orange Winged Pytillia
	Lagonosticta senegala	Red Billed Firefinch
Falconidae	Falco tinnunculus	Common Kestrel
Fringillidae	Linurgus olivaceus	Oriole Finch
Glareolidae	Glareola pratincola	Collard Pratincole
	Glareola cinerea	Grey Pratincole
	Cursorius temminckii	Temminck's Courser
Heliornithidae	Podica senegalensis	African Finfoot
Jacanidae	Actophilornis africanus	African Jacana
Laniidae	Lanius senator	Woodchat Shrike
Melaconotidae	Tchagra senegala	Black Crowned Tchagra
	Malaconotus blanchoti	Grey Headed Bush Shrike
	Laniarius leucorhynchus	Sooty Boubou
	Laniarius barbarous	Yellow Crowned Gonolek
	Dryoscopus gambensis	Northern Puffback
Meropidae	Merops pusillus	Little Bee Eater
	Merops malimbicus	Rosy Bee Eater
	Merops albicollis	Whitethroated Bee Eater
Motacillidae	Anthus leucophrys	Plain Backed Pipit

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	Anthus trivialis	Tree Pipit
	Macronyx croceus	Yellow Throated Longclaw
	Motacilla flava	Yellow Wagtail
Muscicapidae	Terpsifhone rufiventer	Red Bellied Paradise Flycatcher
	Saxicola rubetra	Whinchat
Musophagidae	Crinifer piscator	Western Grey Plantain Eater
Nectariniidae	Chalcomitra amethystine	Amethyst Sunbird
	Cinnyris pulchellus	Beautiful Sunbird
	Hedydipna collaris	Collared Sunbird
	Cyanomitra verticalis	Green Headed Sunbird
	Cinnyris venustus	Variable Sunbird
	Anthreptes gabonicus	Mouse Brown Sunbird
	Cinnyris coccinigaster	Splendid Sunbird
Numididae	Numida meleagris	Helmented Guinea Fowl
Passeridae	Petronia dentate	Bush Petronia
	Passer montanus	Erusian Tree Sparrow
	Passer griseus	Grey Headed Sparrow
Phalacrocoracidae	Phalacrocorax africanus	Long Tailed Commorant
Phasianidae	Francolinus bicalcaratus	Double Spurred Francolins
Ploceidae	Ploceus melanocephalus	Black Headed Weaver
	Euplectes franciscanus	Northern Red Bishop
	Ploceus cucullatus	Village Weaver
	Ploceus tricolor	Yellow Mantled Window Bird
Prionopidae	Prionops plumatus	White Hekmet Shrike
Pycnonotidae	Pycnonotus barbatus	Common Bulbul
Rallidae	Crecopsis egregia	African Crake
	Porphyrio alleni	Allen's Gallinule
	Amaurornis flavirostris	Black Crake
Recurvirostridae	Himantopus himantopu	Black Winged Stilt
Scolopacidae	Tringa nebularia	Common Greenshank
Scopidae	Scopus umbretta	Harmmerkop
Strigidae	Scotopelia bouvieri	Vermiculated Fishing Owl
Sturnidae	Lamprotornis purpureiceps	Purple Glossy Starling
Sylviidae	Melocichla mentalis	African Moustached Warbler
	Sylvia borin	Garden Warbler
	Sylvietta virens	Green Comec
	Hyptergerus atriceps	Oriole Warbler

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	Hyliota flavigaster	Yellow Bellied Hyliota
Timaliidae	Illadopsis fulvescens	Brown Illadopsis
Turdidae	Turdus pelios	African Thrush
Viduidae	Vidua macroura	Pin Tailed Whydah
	Vidua chalybeate	Village Indigobird
	Anomalospiza imberbis	Cuckoo Finch