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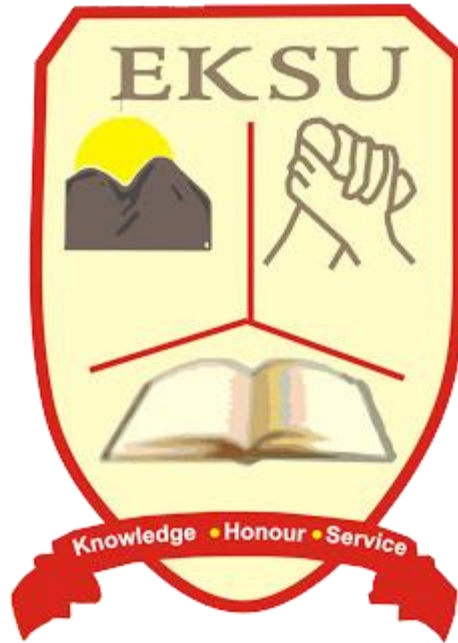
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Comparative Evaluation of Bird Species Diversity in Different Ecosystems of Akure Forest Reserve, Ondo State

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Abstract

Birds are crucial to maintenance of the balance in many ecosystems by providing various ecological services. The comparative evaluation of different ecosystems to bird species diversity and structure were investigated in different ecosystems in Akure Forest Reserve, Ondo State, Nigeria, to elucidate the effect of habitat modification on bird communities. Point count method was employed to identify bird species in three plantations between June and July, 2017 for comparative evaluation of avifauna abundance and diversity. A total of 55 bird species belonging to 11 Orders and 23 families were recorded in the plots. The highest number of birds was recorded in the Queen's plot (34) followed by the Enrichment plots (33) and the Cocoa plantation (29). On the whole, 281 individual bird species were counted and the abundance of birds varied between the three ecosystems. The Enrichment plots recorded the highest number of individual birds (114) while Cocoa plantation and Queen's plot recorded 97 and 70 respectively. Among the three ecosystems, the highest species diversity was found in Queen's forest (3.37) while the least was recorded in cocoa plantation (3.13). The species composition of Queen's and Enrichment plots were more similar than the cocoa plantation. The community structure of birds was dominated by insectivores with 41.2% in the Queen's plot, 33.3% in Enrichment plot and 24.1% in the Cocoa plantation plot. The study has shown that different types of ecosystems would alter birds' community structure and that maintenance of vegetation of the ecosystems is paramount to conservation of the native and ecologically-important bird species.

Keywords: Bird species, diversity, ecosystem, community structure, abundance

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Introduction

Habitat loss and numerous undesirable environmental disturbances associated with agricultural practices have spurred conservation scientists to conclude that agriculture is one of the major contributors towards biodiversity loss (Sala et al., 2001). Musters et al., (2001) asserted that roughly one-third of the world land area has been taken over by agricultural systems while Tilman et al., (2002) reported that the world's demand for food is expected to be twice the present trend in demand and more land area is expected to be cleared for agricultural practices. Conservation in the tropics has it focus and attention on natural,

undisturbed habitats like the rainforests (Raman, 2003) while lesser attention is given to the agricultural landscape in ecological and conservation research (Naidoo, 2004). With the advancement of civilization and development of socio-economic infrastructure demanded by rapid urbanization and population growth, the natural habitats have been encroached upon causing decrease in area and large numbers of species of wild creatures have no alternative than to depend on the same land heavily used by man.

The types and scale of agriculture systems being practiced are reported to have significant roles to

play on the populations of wild creatures whose ecosystems fall within the agricultural areas (Chamberlin et al., 2000; Benton et al., 2000).

As the rate of clearing of pristine habitats for agricultural practices increases, the survival of diversity of species that depend on them either decreases or increases. Thus, the patterns of land use and the types of crops planted in agricultural landscapes determine the extent of species diversity. This implies that the effects of various patterns of agricultural land use on wildlife species and populations must be adequately studied in order to incorporate them into conservation management plans. The future increase in agricultural areas has been predicted to be mostly concentrated in the lowland rainforest where majority of the planet's most important conservation areas are located (Myers, 1998, Myers et al. 2000).

One can, therefore, infer that the pertinent challenges that will confront nature conservationists in the nearest future will be the correlation existing between the changing environments and how agriculture as a major driving force in the alteration of pristine ecosystems can be managed effectively to accommodate both human needs and biodiversity conservation. Hence, there is the need to establish the contribution of the various forms of agricultural system on the sustainability of bird species diversity in different ecosystem.

Materials and Methods

Study area

This study was carried out in Akure Forest Reserve and its surroundings in Ondo East Local Government Area of Ondo State, Southwest Nigeria (Fig. 1). It lies between latitudes 7° 16' and 7° 18' N of the Equator and longitudes 5° 9' and 5° 11' E of the Greenwich Meridian. The forest reserve covers an area of about 600 hectares (Adeduntan, 2007). The area experiences humid tropical climate characterized by rainy season between March and November and dry season from December and February; the mean annual temperature is about 26°C (minimum 19°C and maximum 34°C) and annual rainfall of up to 2500 mm. It is located within the rainforest ecological zone with vegetation dominated by broad-leaved hardwood trees that form dense, layered stands. This portion of Akure Forest Reserve was carved out and designated as a Strict Nature Reserve (SNR) in 1954 by the Forestry Research Institute of Nigeria (FRIN).

Plantations of indigenous and exotic tree species were established at the boundaries and buffer zone of the reserve. The Strict Nature Reserve is bounded on one side by a river which has reduced accessibility to the forest. There are several rural communities around the reserve which are involved in its management and protection. All the anthropogenic activities, namely, organized taungya farming, collection of falling twigs and branches as firewood and gathering of other non-timber forest products (NTFPs) were restricted to the buffer zone of the reserve with adequate monitoring and effective patrol by forest guards.

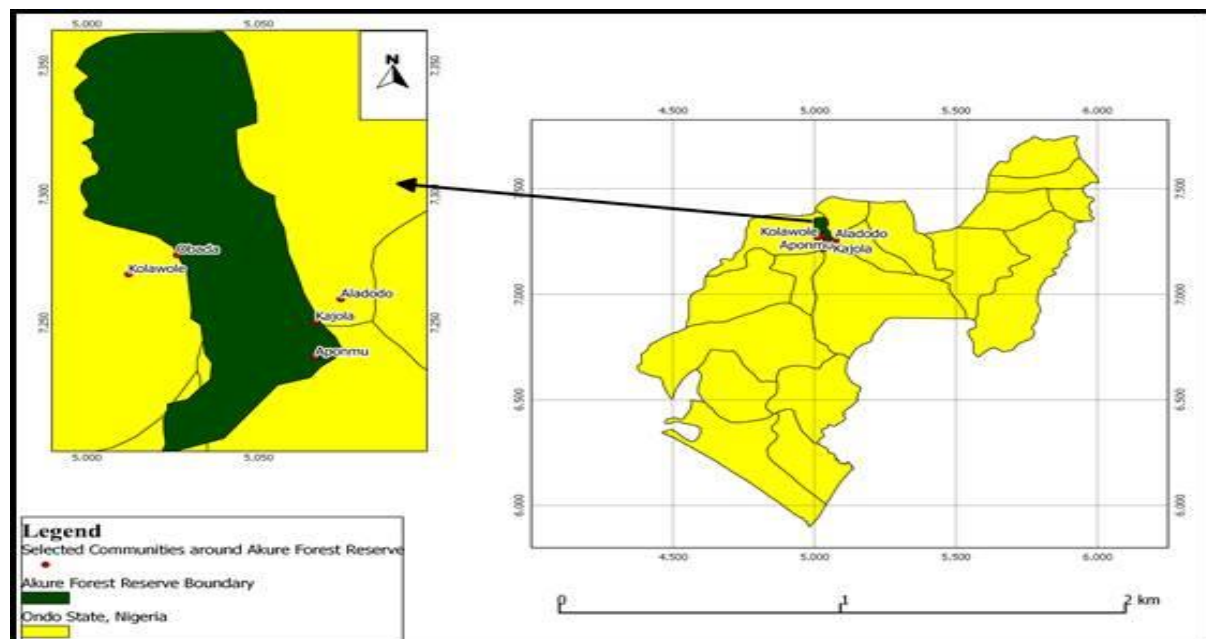


Fig. 1: The Akure Forest Reserve

Bird Assessment

The survey assessment of abundance and diversity of bird species of agro-ecosystems: cocoa plantation and natural forest habitat in Akure Forest Reserve and its surroundings was carried out between June and July, 2017. Point counts method as described by Bibby *et al.* (2000) was used for the collection of data on bird species diversity and abundance in the sample sites. This method involves the location of seven sampling points in each of the three habitats. Birds were observed within 50 m radius at each sampling point for 30 min on clear mornings between sunrise and 09 30 hours (Ogunyemi, 2012). During each survey, all birds were counted and The abundance scores employed were ≤ 1.0 (rare), 1.1 – 2.0 (uncommon), 2.1 - 10 (frequent), 10.1 – 40.0 (common) and 40 (abundant). Two-way analysis of variance (ANOVA) was used to analyse the data based on the general linear model (GLM) procedure of SAS (2002). The means of variables whose F-value showed significant differences were compared using Duncan's multiple range tests. Diversity and evenness were calculated on the identified bird and plant species to describe the abundance of species and individuals within the study habitat. Birds' diversity was calculated using Shannon-Weiner diversity index (H') which was calculated using formula:

$$\text{Shannon-Wiener index of diversity } (H') = -\sum p_i \log p_i$$

where p_i is the proportion of i th species to total abundance value

Species Richness index (D) was calculated by with the following equation:

$$D = \frac{S-1}{\ln N}$$

where D = Species Richness Index,
 S =Total number of species
 N =Total number of individuals

recorded as they were seen from the centre of the 50 m used as a cut off for bird observations. The sampling points were spaced about 500 m apart (Oksanen, 2001).

Data analysis

The cumulative list of birds' species recorded in the varying ecosystems was used as basic measures of avian richness. All bird species were grouped according to their main habitat. The relative abundance of avian species was determined using encounter rates that gives crude ordinate scales of abundance (Bibby *et al.*, 2000). The encounter rate incorporates the field period of observation and number of individuals of each species observed.

The bird community similarity among habitats was determined by calculating the Sorensen's coefficient represented as:

$$C = \frac{2W}{A+B+C} \times 100$$

$$A+B+C$$

where C = index of similarity

W = No of species common to both sample

A = No of species in sample A

B = No of species in sample B

C = No of species in sample C

The graphs and maps are presented as figures while result of analysis of variance and mean separation are presented in tables.

Results

Table 1 shows that a total of 55 bird species was recorded in the three habitats of the study area. The birds belong to 11 Orders and 25 families. Not all the bird species were recorded at every location and the highest number of birds was recorded in the Queen's plot (34) compared to 33 in Enrichment plot and 29 in Cocoa plantation (Table 2).

Table 1: Avian distribution based on family, order and species composition in the study area

S/N	Species	Scientific Name	Family	Order
1	Yellow-fronted tinkerbird	<i>Pogoniulus chrysoconus</i>	Lybiidae	Piciformes
2	Little greenbul	<i>Eurillas virens</i>	Pycnonotidae	Passeriformes
3	African grey parrot	<i>Psittacus erithacus</i>	Psittacidae	Psittaciformes
4	Blue-spotted wood dove	<i>Turtur afer</i>	Columbidae	Columbiformes
5	Puff-throated sunbird	<i>Anthreptes griseigularis</i>	Nectariniidae	Passeriformes
6	Black bee-eater	<i>Merops gularis</i>	Meropidae	Coraciiformes
7	Piping hornbill	<i>Ceratogymna fistulator</i>	Bucerotidae	Bucerotiformes
8	Red-bellied paradise flycatcher	<i>Terpsiphone rufiventer</i>	Monarchidae	Passeriformes
9	African emerald cuckoo	<i>Chrysococcyx cupreus</i>	Cuculidae	Cuculiformes
11	Black and White casqued Hornbill	<i>Ceratogymna subcylindricus</i>	Bucerotidae	Bucerotiformes
12	Collared sunbird	<i>Hedydipna colyaris</i>	Nectariniidae	Passeriformes
13	Splendid sunbird	<i>Cinnyris coccinigastrus</i>	Nectariniidae	Passeriformes
14	Olive-green camaroptera	<i>Camaroptera chloronota</i>	Cisticolidae	Passeriformes
15	Blue-headed wood dove	<i>Turtur breimeri</i>	Columbidae	Columbiformes
16	Yellow-throated tinkerbird	<i>Pogoniulus subsulphureus</i>	Lybiidae	Piciformes
17	Black spotted barbet	<i>Capito niger</i>	Pycnonotidae	Passeriformes
18	Narina trogon	<i>Apaloderma vittatum</i>	Trogonidae	Trogoniformes
19	White-tailed flycatcher	<i>Cyornis concretus</i>	Muscicapidae	Passeriformes
20	African pied Hornbill	<i>Tockus fasciatus</i>	Bucerotidae	Bucerotiformes
21	African green pigeon	<i>Treton calvus</i>	Columbidae	Columbiformes
22	Black-winged oriole	<i>Oriolus nigripennis</i>	Oriolidae	Passeriformes
23	Bronze manikin	<i>Lonchura cucullata</i>	Estrildidae	Passeriformes
24	Cassin's flycatcher	<i>Muscicapa cassini</i>	Muscicapidae	Passeriformes
25	Common bulbul	<i>Pycnonotus barbatus</i>	Lybiidae	Passeriformes
26	Forked-tailed drongo	<i>Dicrurus adsimilis</i>	Dicruridae	Passeriformes
27	Green hylia	<i>Hylia prasina</i>	Sylviidae	Passeriformes
28	Green turaco	<i>Tuaraco persa</i>	Musophagidae	Musophagiformes
29	Grey-backed camaroptera	<i>Camaroptera brachyura</i>	Cisticolidae	Passeriformes
30	Lizard buzzard	<i>Kaupifalco monogrammicus</i>	Accipitridae	Accipitriformes
31	Yellow casqued Hornbill	<i>Ceratogymna elata</i>	Bucerotidae	Bucerotiformes
32	Olive sunbird	<i>Cyanomita olivacea</i>	Nectariniidae	Passeriformes
33	Red-checked wattle-eye	<i>Dyaphorophya blissetti</i>	Monachidae	Passeriformes
34	Red-rumped tinker bird	<i>Pogoniulus atroflavus</i>	Lybiidae	Piciformes
35	Tambourine dove	<i>Turtur tympanistria</i>	Columbidae	Columbiformes
36	White-crested Hornbill	<i>Tockus albocristatus</i>	Bucerotidae	Bucerotiformes
37	White-tailed ant thrush	<i>Neocossyphus poensis</i>	Turdidae	Passeriformes
38	Yellow-rumped tinker bird	<i>Pogoniulus bilineatus</i>	Lybiidae	Piciformes
39	Yellow-whiskered greenbul	<i>Andropadus latirostris</i>	Pycnonotidae	Passeriformes
40	Splendid sunbird	<i>Cinnyris coccinigastrus</i>	Nectariniidae	Passeriformes
41	Black dwarf Hornbill	<i>Tockus hartlaubi</i>	Bucerotidae	Bucerotiformes
42	Little bee-eater	<i>Meropus pusillus</i>	Meropidae	Coraciiformes
43	Swamp boubou	<i>Laniarius bicolor</i>	Malaconotidae	Passeriformes
44	Red-headed malimbe	<i>Malimbus rubricollis</i>	Ploceidae	Passeriformes
45	Tawny- flanked prinia	<i>Prinia subflava</i>	Cisticolidae	Passeriformes
46	Malachite king fisher	<i>Corythonis cristatus</i>	Alcedinidae	Coraciiformes
47	Black casqued Hornbill	<i>Ceratogymna atrata</i>	Bucerotidae	Bucerotiformes
48	Swamp palm bulbul	<i>Thescelocichla leucopleura</i>	Pycnonotidae	Passeriformes
49	Moustached-tinkerbird	<i>Pogoniulus leucomystax</i>	Lybiidae	Piciformes
50	African finfoot	<i>Podica senegalensis</i>	Heliornithidae	Gruiformes
51	Blue-shouldered robin chat	<i>Cossyphya cyanocampter</i>	Muscicapidae	Passeriformes
52	Forest robin	<i>Stiphromis erythrorhox</i>	Muscicapidae	Passeriformes
53	Green crombec	<i>Sylvietta virens</i>	Macrophendae	Passeriformes
54	Grey-headed negrofinch	<i>Nigrita canicapillus</i>	Estrildidae	Passeriformes
55	Western bluebill	<i>Sailia Mexicana</i>	Estrildidae	Passeriformes

Table 2. Avian distribution and relative abundance of bird species in the three study habitats

S/N	Common names	Q.P	E.P	C.P	Ordinal Scale
1	African emerald cuckoo	+	+	-	Uncommon
2	African finfoot	+	-	-	Rare
3	African green pigeon	+	+	+	Frequent
4	African pied hornbill	+	+	+	Frequent
5	Black-winged oriole	+	+	-	Uncommon
6	Blue-headed wood dove	+	+	-	Uncommon
7	Blue-shouldered robin chat	+	-	-	Rare
8	Blue-spotted wood dove	+	+	+	Frequent
9	Blue-throated brown sunbird	+	+	-	Rare
10	Bronze manikin	-	+	-	Rare
11	Cassin's flycatcher	+	+	-	Frequent
12	Collared sunbird	+	+	+	Frequent
13	Common bulbul	+	+	+	Frequent
14	Forest robin	+	-	-	Rare
15	Forked-tailed drongo	+	+	-	Rare
16	Green crombec	+	-	-	Rare
17	Green hylia	+	+	+	Uncommon
18	Green turaco	+	+	-	Rare
19	Grey-backed camaroptera	-	+	-	Uncommon
20	Grey-headed negrofinch	+	-	-	Rare
21	African grey-parrot	+	+	-	Rare
22	Lizard buzzard	+	+	+	Uncommon
23	Yellow casqued Hornbill	+	+	-	Rare
24	Olive sunbird	-	+	-	Rare
25	Olive-green camaroptera	+	-	-	Rare
26	Pipping hornbill	+	+	+	Frequent
27	Red-bellied paradise fly catcher	+	+	+	Frequent
28	Red-checked wattle-eye	+	+	-	Uncommon
29	Red-rumped tinker bird	+	+	-	Frequent
30	Tambourine dove	-	+	-	Frequent
31	White-crested hornbill	+	+	-	Frequent
32	White-tailed ant thrush	+	+	-	Uncommon
33	Yellow-rumped tinker bird	-	+	+	Frequent
34	Yellow-throated tinkerbird	+	+	-	Uncommon
35	Yellow-whiskered greenbul	+	+	-	Rare
36	Splendid sunbird	-	+	+	Frequent
37	Yellow-fronted tinker bird	+	+	-	Frequent
38	Little greenbul	+	+	+	Frequent
39	Black dwarf Hornbill	+	+	-	Uncommon
40	Little bee-eater	+	+	-	Uncommon
41	Narina trogon	-	-	+	Rare
42	Puff throated sunbird	-	-	+	Uncommon
43	Swamp boubou	-	-	+	Rare
44	Black spotted barbets	-	-	+	Frequent
45	Black-bee eater	-	-	+	Uncommon
46	Red-headed malimbe	-	-	+	Rare
47	Tawny-flanked prinia	-	-	+	Rare
48	Malachite kingfisher	-	-	+	Rare
49	Western bluebill	-	-	+	Rare
50	Little greenbull	-	-	+	Rare
51	Blackk casqued Hornbill	-	-	+	Rare
52	Swamp palm bulbul	-	-	+	Frequent
53	Bruce's green pigeon	-	-	+	Rare
54	White-tailed flycatcher	-	-	+	Rare

55	Moustached-tinkerbird	-	-	+	Rare
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Q.P = Queen's plot; E.P = Enrichment plot; C.P = Cocoa plantation

The Orders, Families and species composition of bird species in the study plots were not homogenous (Table 3). The Enrichment plot had the same number of Order as the Queen's plot (9) but a higher number of families (16) while Queen's plot and Cocoa plantation plot had the same number of families. The Enrichment plot and

Queen's plot had the same number of species (34) while the Cocoa plantation plot had the least (28). The exclusive bird species were more prevalent in the Cocoa plantation followed by the Queen's plot while the Enrichment plot had the least number at 15, 6 and 3 representing 62.5, 25.0 and 12.5 % of the bird species respectively.

Table 3. Orders, families, species and number of exclusive species in three ecosystem types of Akure Forest Reserve

Ecosystem Type	Order	Family	Species	Individuals	Exclusive species	
					Numbers	%
Cocoa Plantation	8	15	28	97	15	62.5
Queen's Plot	9	15	34	70	6	25.0
Enrichment Plot	9	16	34	114	3	12.5

All the birds utilize the three habitat types but the abundance of birds varied from one habitat to another (Table 4). The highest percentage of individual sightings was recorded in the Enrichment plot and comprised 40.57% (n=114) of the total number of individuals, followed by Cocoa plantation plot at 34.52% (n=97) while the Queen's plot recorded the least (34.91%) (n=70). In the Enrichment plot, 114 individuals belonging to 33 species were recorded and African green pigeon (*Treton calvus*) was the most frequently recorded species representing 9.65% of the total sightings, followed by African pied hornbill (*Tockus fasciatus*) (7.02%) and Tambourine dove (*Turtur tympanistria*) (6.14%). There were three (3) bird species exclusive to the Enrichment plot (Table 3). In the Cocoa plantation plot, 97 individuals, representing 28 bird species, were recorded. The Nectarinidae and Columbidae were the most represented families with 4 species each (4.1%) followed by families Mycrononidae, Lybiidae and Cisticollidae with 2 species each (2.1%) while the rest of the families were represented by 1 bird species each. The order Passeriformes constituted the predominant group representing (38.40%) of families (n=29) and 52.7% of species, whereas remaining orders exhibited lower percentages (Table 1). The family with the highest number of species is Bucerotidae n=7 and Nectarinidae n=5. At species level, African green pigeon (*Treton calvus*), African pied hornbill (*Tockkus faciatus*), Blue-spotted wood dove (*Turtur afer*), Common bulbul (*Pcynonotus barbatus*), Pipping hornbill (*Ceratogymna fistulator*) and Yellow-rumped tinkerbird (*Pogoniulus bilineatus*) were the

dominant species with 15,19,12,12,9, and 10 number of individuals respectively, contributing 27.40% of the total bird abundance of the study area. (Table 7). Bucerotidae was the most species-rich family with 7 bird species, namely Black and White casqued hornbill (*Ceratogymna subcylindricus*), White-crested hornbill (*Tockus albocristatus*), Piping hornbill (*Ceratogymna fistulator*) Black casqued hornbill (*Ceratogymna atrata*), Yellow-casqued hornbill (*Ceratogymna elata*), Black dwarf hornbill (*Tockus hartlaubi*) and African pied hornbill (*Tockus faciatus*). Three species: Yellow-throated tinkerbird (*Pogoniulus subsulphureus*) Red-bellied paradise flycatcher (*Terpsiphone rufiventer*) and Blue spotted wood dove (*Turtur afer*) were the most often-sighted species and represented 11.39% of the total number of individuals (Table 7).

Species diversity and community similarity

The Queen's plot had the highest values of species diversity ($H'=3.37$) and species richness ($D'=7.77$) compared to the Enrichment plot and Cocoa plantation plots with $H'=3.30$ and 3.13, and $D'=6.97$ and 5.9 respectively. The index of species evenness (E) for the three habitat types slightly varied between the Queen's plot and Cocoa plantation plots but the difference in distribution was higher while comparing Queen's and Enrichment plots and Cocoa plantation and Enrichment plots (Table 4). Comparison of bird species between study sites were made by using Sorenson's quotient of similarity, Queen's and Enrichment plots were found to be more similar with the highest value of 0.82 whereas lowest similarity was calculated between Queen's and

Cocoa plots (Table 8). Queen's and Enrichment plots shared 82% of their bird species composition, whereas Cocoa and Enrichment

plots shared 39% and Queen's and Cocoa plots shared 32%.

Table 4: Diversity indices of bird species observed in the three study plots

Diversity Indices	Queens' Plot	Enrichment Plot	Cocoa Plantation Plot
No of species (S)	34	34	29
Total no of individuals (N)	70	114	97
Shannon-Wiener index (H')	3.37	3.30	3.13
Evenness (E)	0.85	0.79	0.82
Margalef Species richness (D')	7.77	6.97	5.90

Relative abundance of birds

Based on the relative abundance scores, 25 birds (47.3%) were rare species, 14 birds (23.6%) as uncommon species while 16 (29.1%) were

frequent species (Table 5). Majority of the bird species had low population sizes and was grouped under rare species.

Table 5: The relative abundant categories of bird species in the three land use types

Ecosystem Type	Rare	Uncommon	Frequent
Queen's Plot	18	4	12
Cocoa Plantation	17	3	8
Enrichment Plot	23	3	8

Avifauna foraging structure

A feeding guild is a group of species that exploits similar food resources in a habitat, and its characterization is based on the types of food being consumed, which would determine the feeding behaviour of the different birds' species and the availability of food resources. Foraging guild is highly useful in making comparison between changes in species rich communities because their functional organization can be investigated even if no species are shared. In the present study, 9 types of feeding guilds were identified: insectivore-frugivore (IF), carnivore (C), frugivore (F), nectarivore (N), frugivore-granivore (FG), omnivore (O), granivore-insectivore (GI), nectarivore-insectivore, (NI) and insectivore (I). The entire ecosystem types were dominated by insectivores at 41.2, 33.3 and 24.1% in the Queen's plot, Enrichment plot and Cocoa plantation plot respectively (Table 6). African green pigeon (*Treton calvus*), pipping hornbill (*Bycansistes fistulator*), red-rumped tinkerbird (*Pogoniulus atroflavus*) and yellow-throated tinkerbird (*Pogoniulus subsulphureus*) were the most

common insectivore species occurring in the study habitat types.

The similarity in feeding guild structure was greater between Enrichment Plot and Cocoa Plantation at 65.27% similarity compared to Queen's Plot (42.73%). The frugivore bird species were the next most abundant bird species in the three habitat types with 6, 7 and 6 species in the Queen's, Enrichment and Cocoa plantation plots respectively. The most abundant frugivore in the Enrichment plot was African Green Pigeon (*Tockus fascitus*) which was frequently observed foraging on fruiting trees with small and ripe fruits in the Cocoa plantation plot. The yellow-throated tinkerbird (*Pogoniulus subsulphureus*) was the most abundant insectivore species followed by red-bellied paradise fly catcher (*Terpsiphine rufiventer*) and green hylia (*Hylia prasina*). Only one species of carnivores: lizard buzzard (*Kaupifalco monogrammicus*) was recorded in the three habitat types.

Table 6: Feeding guilds distribution in the three ecosystem types

Trophic Guilds	Number of Individual Birds			Total
	Queen's Plot	Enrichment Plot	Cocoa Plantation	
Insectivore-frugivore (I.F)	4	3	3	10
Carnivore (C)	1	1	1	3
Frugivore (F)	6	7	6	19
Nectarivore (N)	1	0	0	1
Frugivore-granivore (F.G)	4	4	3	11
Omnivore (O)	2	2	4	8
Granivore-insectivore (G.I)	0	2	2	4
Nectarivore-insectivore (N.I)	2	3	3	8
Insectivore (I)	14	11	7	32

TABLE 7. Avian Species observed in the three Ecosystem types

SN	Common names	Scientific names	Queen's plot	Percent %	Enrichment plot	Percent %	Cocoa plantation	Percent %
1	African Emerald cuckoo	<i>Chrysococcyx cupreus</i>	4	5.71	1	0.88	0	0
2	African finfoot	<i>Podica senegalensis</i>	2	2.86	0	0	0	0
3	African green pigeon	<i>Tretron calvus</i>	3	4.29	8	7.02	8	8.25
4	African pied hornbill	<i>Tockus fasciatus</i>	1	1.43	11	9.65	3	3.09
5	Black-winged Oriole	<i>Oriolus nigripennis</i>	3	4.29	1	0.88	0	0
6	Blue-headed wood dove	<i>Turtur brehmeri</i>	2	2.86	4	3.51	0	0
7	Blue-shouldered Robin chat	<i>Cossyphya cyanocampter</i>	1	1.43	0	0	0	0
8	Blue-spotted wood Dove	<i>Turtur afer</i>	4	5.71	6	5.26	2	2.06
9	Blue-throated Brown sunbird	<i>Cyanomitra cyanolaema</i>	1	1.43	1	0.88	0	0
10	Bronze manikin	<i>Lonchura cucullata</i>	0	0	2	1.75	0	0
11	Cassin's flycatcher	<i>Muscicapa cassini</i>	2	2.86	6	5.26	0	0
12	Collared Sunbird	<i>Hedydipna collaris</i>	3	4.29	3	2.63	3	3.09
13	Common Bulbul	<i>Pcynonotus barbatus</i>	2	2.86	6	5.26	4	4.12
14	Forest Robin	<i>Stiphrornis erythrothorax</i>	2	2.86	0	0	0	0
15	Forked-tailed Drongo	<i>Dicrurus adsimilis</i>	1	1.43	2	1.75	0	0
16	Green Crombec	<i>Sylvietta virens</i>	3	4.29	0	0		
17	Green Hylia	<i>Hylia prasina</i>	1	1.43	3	2.63	2	2.06
18	Green Turaco	<i>Tuaraco persa</i>	1	1.43	1	0.88	0	0
19	Grey-backed camaroptera	<i>Camaroptera brachyyura</i>	0	0	4	3.51	0	0
20	Grey-headed Negrofinch	<i>Nigrita canicapillus</i>	1	1.43	0	0	0	0
21	African grey-parrot	<i>Psittacus robustus</i>	1	1.43	2	1.75	0	0
22	Lizard buzzard	<i>Kaupifalco monogrammicus</i>	0	0	1	0.88	5	5.15
23	Yellow casqued Hornbill	<i>Ceratogymna elata</i>	1	1.43	2	1.75	0	0
24	Olive sunbird	<i>Cyanomita olivacea</i>	0	0	3	2.63	0	0
25	Olive-green Camaroptera	<i>Cametoptera chloronota</i>	2	2.86	0	0	0	0
26	Pipping hornbill	<i>Ceratogymna fistulator</i>	1	1.43	4	3.51	4	4.12
27	Red-bellied paradise fly catcher	<i>Terpsiphone rufiventer</i>	2	2.86	2	1.75	6	6.19
28	Red-checked wattle-eye	<i>Dyaphorophya blissetti</i>	4	5.71	1	0.88	0	0
29	Red-rumped tinker bird	<i>Pogoniulus atroflavus</i>	3	4.29	5	4.39	0	0
30	Tambourine Dove	<i>Turtur tympanistria</i>	0	0	7	6.14	0	0
31	White-crested Hornbill	<i>Tropicicus albocristatus</i>	1	1.43	5	4.39	0	0

32	White-tailed Ant Thrush	<i>Neocossyphus poensis</i>	1	1.43	4	3.51	0	0
33	Yellow-rumped tinker bird	<i>Pogoniolus bilineatus</i>	3	4.29	3	2.63	4	4.12
34	Yellow-throated tinkerbird	<i>Pogoniulus subsulphureus</i>	3	4.29	2	1.75	5	5.15
35	Yellow-whiskered greenbul	<i>Andropadus latirostis</i>	1	1.43	1	0.88	0	0
36	Splendid sunbird	<i>Cinnyris coccinigastus</i>	0	0	1	0.88	7	7.22
37	Yellow-fronted tinker bird	<i>Pogoniulus chrsoconus</i>	6	8.57	1	0.88	0	0
38	Little greenbul	<i>Eurillas virens</i>	1	1.43	6	5.26	1	1.03
39	Black dwarf Hornbill	<i>Tockus hartlaubi</i>	1	1.43	3	2.63	0	0
40	Little bee-eater	<i>Meropus pusillus</i>	2	2.86	2	1.75	0	0
41	Narina trogon	<i>Apaloderma vittatum</i>	0	0	0	0	2	2.06
42	Puff throated sunbird	<i>Anthreptes griseigularis</i>	0	0	0	0	6	6.19
43	Swamp boubou	<i>Laniarius bicolor</i>	0	0	0	0	1	1.03
44	Black spotted barbet	<i>Capito niger</i>	0	0	0	0	8	8.25
45	Black-bee eater	<i>Merops gularis</i>	0	0	0	0	4	4.12
45	Red headed malimbe	<i>Malimbus rubricollis</i>	0	0	0	0	2	2.06
46	Tawny-flanked prinia	<i>Prinia subflava</i>	0	0	0	0	3	3.09
47	Malachite kingfisher	<i>Corythonis cristatus</i>	0	0	0	0	3	3.09
48	Western bluebill	<i>Sailia Mexicana</i>	0	0	0	0	1	1.03
49	Little greenbull	<i>Eurillas virens</i>	0	0	0	0	2	2.06
50	Black casqued Hornbill	<i>Ceratogymna atrata</i>	0	0	0	0	2	2.06
51	Red-billed Dwarf hornbill	<i>Tockus camurus</i>	0	0	0	0	1	1.03
52	Swamp palm bulbul	<i>Thescelocichla leucopleura</i>	0	0	0	0	8	8.25
53	Black and White casqued Hornbill	<i>Ceratogymna subcylindricus</i>	0	0	0	0	1	1.03
54	White-tailed flycatcher	<i>Eminia albicauda</i>	0	0	0	0	3	3.09
55	Moustached tinkerbird	<i>Pogoniulus leucomystax</i>	0	0	0	0	1	1.03

Table 8: Sorenson's coefficient of similarities among the birds' community structure of the three study plots

Compared Plots	Sorenson's quotient
Queen's & Enrichment	0.82
Enrichment & Cocoa	0.39
Queen's & Cocoa	0.32

Discussion

The results of this study show the higher bird diversity in the Queen's plot than in Cocoa plantation and Enrichment plot which agrees with Azman *et al.* (2011) that the mixture of tall trees, fruit bearing trees with wide canopy cover favours higher diversity with regard to structure of bird communities in different land-use types. The high abundance of individual bird species in the Enrichment plot might have been influenced by the presence of important resources like food, nesting materials, nesting sites that allow birds to tolerate disturbance due to land use change. Most species of bird sighted in this land use types were residents and forest dependent. The Shannon- Weiner diversity index was higher in Queen's plot than the Enrichment plot and Cocoa plantation plot. This might indicate that bird species inhabiting the vegetation of Queen's plot might be associated with the floristic composition that could create variations in food sources, nesting and protection cover. Mengesha and Bekele (2008) were of opinion that highest avian species diversity might be linked with the type of plant species and feeding habits of birds. The African green pigeon (*Treron calvus*) was the most abundant and this species belongs to the Columbidae family, a group important and noted for the role play in forest restoration due to their efficient seed dispersal activity. The result of this study agrees with Harvey and Villalobos (2007) that mixed proportion of agricultural trees with forest plants contain bird assemblages that are as abundant, species-rich and diverse like the natural forests as found in the Enrichment plot of the study.

However, the structure of the bird community was altered with fewer forest-dependent species and different dominant generalist species, in a view of which bird diversity was more closely related to structural and floristic characteristics of the different land use types. Waltert *et al.* (2005) found that young secondary forests and agro forests sustain high numbers of bird species that are similar to the adjacent, near primary forests. The lowest species diversity was recorded in the monoculture Cocoa plantation. Greater conservation value found in agro forest system is

due to the often complex nature and the ability to support diversity than monocultures. However, the high level of wild biodiversity may often depend on the proximity to the natural habitat which is still most favourable to many wildlife species, especially birds (Mcneely and Schroth 2006; Harvey and Villalobos 2007).

The foraging habits of the birds were used to explore the variation in avifauna composition among the habitat types. According to Pearman (2002), the variation in structure affects the distribution of bird foraging guilds. Out of the nine feeding guilds identified in the study, the insectivore bird species were the most dominant group. The insectivorous feeding guild composed of species from families Monarchidae, Meropidae and Muscicapidae. In Queen's plot, the insectivore and frugivore birds were the most abundant species while in the Cocoa plantation plot, insectivore birds were the most abundant species. The insectivore birds were relatively more in Enrichment and Queen's plots compared than cocoa plantation plot. The low population of insectivorous bird species in Cocoa plot might be ascribed to the frequent usage of agrochemicals in the management of cocoa farms which has resulted in drastic reduction in the insect population. Devine and Furlong (2007) reported significant population decline on birds as a result of indirect impacts of insecticides which have exhibited population declines changes in birds' abundance and distribution. According to Blake and Loiselle (2001), insectivore bird species are most abundant in tropical forests which provide ready availability of a variety of food sources for both adult and young. Besides, safe habitats for nesting are important for the occurrence and abundance of insectivorous species (Krizler, 2015). The frugivores which ranked next in abundance were found more in the Enrichment plot compared to the Queen's and Cocoa plantation plots because of the readily available food resources. The abundance and richness of fruiting plants is important and associated with the diversity of frugivorous bird species and foraging behaviours in certain habitat types (Moegenburg and Levey, 2003). The nectarivores were the least abundant

in the three habitat types with only one (1) species present which may be due to the non-availability of flowering resources and the seasons of flowering.

Conclusion

Birds are essential to the sustainability of ecosystems where they function as bio-monitors, alerting people about what is going wrong in an ecosystem. Therefore, it is necessary to elucidate the effects of habitat modification on bird communities especially the ability to perform ecosystem functions. The result of this study shows species composition and abundance varied among the ecosystems. Bird species diversity and abundance was highest in Queen's and Enrichment plots respectively while the diversity and abundance of bird species was relatively low in the

Cocoa plantation. This suggests more ecological stability in the Queen's and Enrichment plots which have higher similarity in species composition. The differences that exist in resources availability between the ecosystems may be responsible for restriction of some species to certain ecosystem type while allowing others to be ubiquitous. The study further provides evidence that though ecosystem modification may lead to low diversity, yet the Enrichment plot and Cocoa plantation are important part of the ecosystem that support bird community structure dominated by insectivorous species. If a substantial part of bird community of Akure Forest Reserve surroundings is to be maintained, efforts must be geared towards conservation of in the natural ecosystem and adjoining modified agro-ecosystems.

References

- Adeduntan, S.A. (2007). Diversity and Abundance of Insect Herbivores in Akure Forest Reserve, Ondo State, Nigeria. Ph.D. Thesis, Federal University of Technology Akure, Nigeria, 138pp.
- Azman, N.M., Latip, N.S.A., Sah, S.A.M., Akil, M.A.M.M., Shafie, N.J. and Khairuddin, N.L. (2011). Avian diversity and feeding guilds in a secondary forest, an oil palm plantation and a paddy field in riparian areas of the Kerian River Basin, Perak, Malaysia. *Tropical Life Sciences Research* 22(2): 45-64.
- Benton, T.G., Bryant, D.M., Cole, L. and Crick, H.Q.P. (2002). Linking agricultural practice to insect and bird populations: A historical study over three decades. *Journal of Applied Ecology* 39: 673-687
- Bibby, C.J., Burgess, N.D., Hill, D.A. and Mustoe, S.H. (2000). *Bird Census Techniques*. Academic Press, London.
- Blake J.G and Loiselle, B.A. (2001). Bird assemblages in second-growth and old-growth forests, Costa Rica: Perspectives from mist nets and point counts. *The Auk* 118 (2): 304-326.
- Borrow, N. and Demey, R. (2004). Birds of Western Africa, published by Helm, C. An imprint of A and C-Black Publishers Ltd., 37 Soho Square, London WSD 3 QZ.
- Chamberlain, D.E., Fuller, R.J., Bunce, R.G.H., Duckworth, J.C. and Shrubbs, M. (2000). Changes in the abundance of farmland birds in relation to the timing of agricultural intensification in England and Wales. *Journal of Applied Ecology* 37: 771-788.
- Devine, G.J and Furlong, M.J. (2007). Insecticide use. Contexts and ecological consequences. *Agriculture and Human Values*. 24:281-306
- Harvey, C.A. and Villalobos, J.A.G. (2007). Agroforestry systems conserve species-rich but modified assemblages of tropical birds and bats. *Biodiversity and Conservation* 16(8): 2257-2292.
- Krizler, C.T., John, A.F., Maricel, E.A. and Zabide, M.A. (2015). Bird diversity and structure in different land-use types in Lowland South-Central Mindanao, Philippines. *Journal of Tropical life Sciences Research* 26(2): 85-103.
- McNeely, J.A. and Schroth, G. (2006). Agroforestry and biodiversity conservation-traditional practices, present dynamics, and lessons for the future. *Biodiversity and Conservation* 15(2): 549-554.
- Moegenburg, S.M. and Levey, D.J. (2003). Do frugivores respond to fruit harvest? An experimental study of short-term responses. *Ecology* 84(10): 2600-2612.
- Musters, C.J.M., Graaf, H.J. and Keurs, W.J. (2001). Can protected areas be expected to be expanded in Africa? *Science* 287: 1759-1760.
- Myers, M. (1998): Threatened biotas: Hot spots in tropical forests. *Environmentalist* 8: 187-208.

- Myers, N., Mittermeier, E.A. and Kent, J. (2000). Biodiversity hotspots for conservation priorities. *Nature* 403: 853-858.
- Naidoo, R. (2004). Species richness and community composition of Songbirds in tropical forest- agriculture landscape. *Animal Conservation* 7: 93-105.
- Oksanen, L. (2001): Logic of experiments in ecology: Is pseudo-replication a pseudo-issue? *Oikos* 94: 27-38.
- Ogunyemi, O.O. (2012). *Ecological Diversity and Abundance of Birds in the Wetlands of Ekiti State*. Unpublished Ph.D. Thesis, Federal University of Technology, Akure, Nigeria.
- Pearman, P.B. (2002). The scale of community structure: habitat variation and avian guilds in tropical forest understory. *Ecological Monographs* 72(1): 19-39.
- Raman, T.R.S. (2003). Assessment of census techniques for interspecific comparisons of tropical rainforest bird densities: a field evaluation in the Western Ghats, India. *Ibis* 145: 9-21.
- Sala, O.E., Chapin, F.S. and Armesto, J.J. (2001). Global biodiversity scenarios in the year 2100. *Science* 287: 1770-1774.
- Tilman, D., Cassman, K.G., Matson, P.A., Naylor, R. and Polasky, S. (2002). Agricultural sustainability and intensive production practices. *Nature* 418: 671-677.
- Waltert M., Bobo, M.S. Sainge, N.M., Fermon, H. and Mühlenberg, M. (2005). From forest to farmland: Habitat effects on afrotropical forest bird diversity. *Ecological Applications*. 15(4): 1351-1366.