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ABUNDANCE OF BIRDS IN SIX SELECTED HABITATS

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ABSTRACT

Bird species world over are faced with the problem of habitat changes. Conservation of birds in fragments of habitats is increasingly important due to the diverse uses of the environment. To meet this challenge, predicting abundance of bird species in relation to specific vegetation taxa in the habitats is required .This study determined bird species abundance and their relationship with habitat variables of tree, shrub and herb abundance. Study conducted in the forested bitumen belt of Ode-Irele, Ondo state, Nigeria evaluated habitat use by birds using 20- minutes birds point count to a radius of 30 meters, carried out in six selected habitats. The vegetation cover was sampled using 5x5-meters and 1m^{2}quadrants. Data collected were subjected to t-test of independent variables with LSD in ANOVA for birds' use of habitats and linear regression for the dependence of birds' abundance on habitats' variables.88 bird species belonging to 31 families were associated with the study area. The abundance of birds was significantly affected by habitat types (P<0.05) and predicted by habitat variables. The study would assist decision makers in the management and conservation of habitats' variables critical to the survival of bird species during the bitumen development phase.

Keywords: Abundance, Birds, Bitumen, Conservation, Habitats, Nigeria

INTRODUCTION

Conversion of natural habitats by man in the tropics, especially through change in land use poses a great threat to biodiversity (Green *et al* 2005). Habitat modification which results from growth in human population and human development activities are the leading cause of biodiversity loss. Finding from Blair (2004) has revealed an increase in species richness and diversity of birds at moderate levels of urbanization. The abundance of birds, however, tends to reduce in transformed landscapes and is not suitable for birds seeking cover and food (Robinson and Wilcove, 1994; José *et al*, 2009). Isolated patches of habitats are seen as islands and managed as such with the different associated environmental conditions (Wiens, 2008). The impact of deforestation in the tropics is a serious problem on the breeding habitats of neotropical migrants. The density of some bird species may be high in urban landscapes as their abundance was positively predicted by shrub and tree cover in urban landscapes, but, with shrubs being preferred over low-laying trees, while several other species were positively associated with tall vegetation (Kalinowski and Johnson 2010; Abu Baker*et al* 2015; Garwood *et al* (2015). Farming practices have an indirect relationship with the abundance of birds in cashcrop farmlands which are similar regardless of crop type, such that birds' population tend to decline as the birds leave the area due to lack of desirable cover (Graham and Des Granges 1993; Boutin *et al* 1994; Brenda, 2005). Bird species' abundance and richness in forest community have been known to be significantly influenced by dense shrub cover and tree cover,

especially by within-patch habitat characteristics of these variables (Laiolo *et al* 2004; Watson *et al* 2011; Labbe and King 2014; Baker*et al* 2015). Tree cover is the most important factor that enhances the abundance of birds in riparian habitat and forest fallows, with considerable numbers of trees in fallow land and boundary of agricultural land accommodating large number of bird's population (Harvey *et al* 2006; Mariappan *et al* 2013). According to Douglas *et al* (2014), the dependence of birds in farmland on trees, especially native trees, which suggests the retention or planting of native trees as an important tool for the conservation of forest birds within farmland was confirmed. This abundance of birds in farmlands can further be enhanced by edge features which positively influence food supply (Evans*et al* 2016). However, Zurita *et al* (2012) revealed a downward trend on birds' population at the assemblage level in ecotone bordering tree plantations. Herbaceous plant species are more abundant in integrated farmlands, which enhance the abundance of birds (Štefanová and Šálek 2014). The diversified vegetation composition and structure in riparian habitats, especially shrubs and the edge effect created are the key factors which influenced the abundance of bird species in this habitat (Larue *et al* (1995; Rajpar and Zakaria 2011). Reliable prediction of birds' abundance by the abundance of tree, shrub and herb layers in heterogeneous habitats, therefore, is critical to decision makers, land users and managers. For example, the prediction of animal species abundance to habitat composition and edge effect was carried out by Brand *et al* (2006). Therefore, quantifying the abundance of such birds on the edges of habitats especially arable farmland, and cash crop farms will enhance their conservation value in response to human disturbance and land fragmentation.

The main aim of the study was to examine the potential of three-dimensional plant types of trees, shrubs and herbs in improving birds' abundance models in heterogeneous habitats which could be applied to large areas. This will to a large extent give more insight into the relationship between vegetation type and the abundance of bird species in heterogeneous habitats. The study hypothesised the significant difference in birds' abundance and richness in selected habitats .This was tested with the use of t-test of independent variables to detect whether the abundance of birds assemblage differ from one another in all the selected habitats.

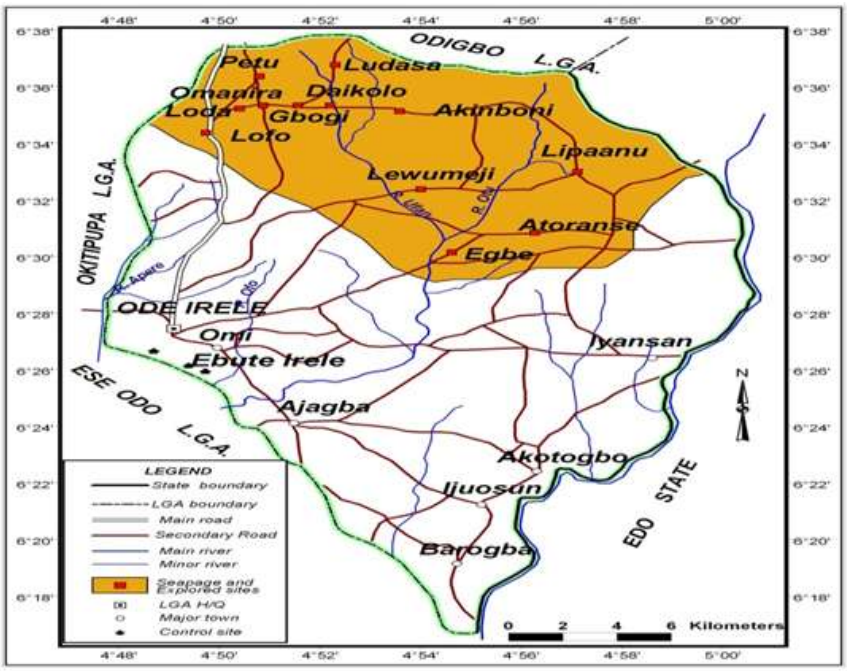

Fig 1: Bitumen Exploration Belt of Ode-Irele, Ondo State, Nigeria

METHODOLOGY

Study was conducted in the forested bitumen exploration belt of Ode-Irele, Ondo state, Nigeria (Fig 1). The exploration was undertaken by Jerex Energy, Canada in 1995. It is located in the Southern fringe of the state between Longitudes 04^0 47^1 E to 05^0 10^1 E, and Latitudes 06^0 16^1N to 06^0 40^1 N, (fig 1). The area falls within the Tropical Rainforest ecological zone. A distinctive feature of this forest is that it is constantly undergoing modifications due to intensive farming. This has led to fragmentation of the once large and contiguous landscape and natural forest into notable six heterogeneous habitats comprising of fallow land, high forest (islands), arable farmland (edge), cashcrop farmland, riparian habitat, and urban arboreta. What now remains are fragments, patches and islands of the landscape.

Fallow Land

Fallow land has been used for cropping for about one or two years. This has now been left for not less than five years for natural restoration. This habitat was in its early succession stage. Asteraceae, poaceae, moraceae, tiliaceae, ulmaceae, bombacaceae and combretaceae were indicator species of the habitat (Norgrove and Hauser 2016).

High Forest (Islands)

The islands of high forest are habitats that are left of the natural forest cover from use of the land in farming activities. This has led to patches of small land areas of forest which are no longer contiguous.

Arable Farmland (Edge)

This is the most common habitat found in this area. It comprises of different food crops grown in mixed stands, sharing boundaries with the other habitats.

Cash crop Farmland

Cash crop farmland is a land use pattern that has to do with monocrop plantations of cocoa, oil palm and kola. These are the notable and commonest crop plantations in the study area. This habitat is under annual or biannual row slashing and circle weeding which modifies the understorey cover for birds. This may be likened to thinning which negatively affect food supply, cover and nesting for birds.

Riparian Habitat

Riparian habitat is area of land that borders water body. The habitat is dominated by lush growths of aquatic vegetation. The habitat scattered all over the area is the remaining abode where wildlife now use as covers.

Urban arboreta

Urban arboreta were patches of vegetation left within towns and villages comprising of tall trees. Populations of shrubs and herbs are sparse underneath the trees, except where there are few tree covers.

2.8. Survey Design

Bird Survey

Data of bird abundance were gathered using 20-minutes birds point count to a radius of 30 meters. Each point was separated with at least 200m from all other points to avoid double count of same bird at the same point. 12 point-counts were made for each of selected six habitats namely, fallow land, high forest (islands), arable farmland (edge), cashcrop farmland, riparian habitat, and urban arboreta. A total of 72 point-counts were, thus, made in the six habitats. The habitats selected were mostly patches and islands of fragmented forest brought about by the farming land use pattern of the study area. This study, therefore, was set up to evaluate the importance of habitat patch use by birds as a research framework for the management and conservation of birds in fragmented landscapes. The objectives of this study were to determine bird species abundance and their relationship with habitat variables of tree, shrub and herb abundance. Sampling of birds took place in the same habitat where vegetation sampling was done. All species heard or seen, or flushed within each habitat (of 30 m-radiuses) were then recorded as described by Benoit *et al*, 1996. Unique methods for cryptic bird species such as early morning/late evening display flight counts for long-tailed nightjar as described by Innes *et al*, 2004, or call-counting for nocturnal species such as owls was used where these or other cryptic species are present. Flying birds were, however not recorded. The bird species in each census plots were identified and listed. The species were then grouped into families. The mean of total number of individuals in each of the habitats for the number of censuses taken was used to get the relative abundance of the birds.

Vegetation Assessment

The vegetation variables were sampled using 5x5-M quadrants at the selected six habitats simultaneously at the sites where the birds were censured. 12 point-counts were made for each of the selected six

habitats. Records were then taken of the plants occurring in the quadrants. In each of the quadrants, the number of vegetation type in terms of trees (plants with 10 dbh), shrubs (plants up to 2m in height) and herbs (plants less than 2m in height) were as far as possible identified using field guides and listed. Those not immediately identified were taken to the herbarium, Department of Botany in University of Ibadan, Ibadan, Nigeria for identification. However, 1-m^2 sub-plot was used to survey herb cover within each of the 5x5 – m quadrant. The plant species in each census plots were identified and listed. The species were then grouped into families to know which of them are the most abundant, and could be the possible ecological factors that influenced the abundance of birds. The mean of total number of individual plants in each of the habitats for the number of censuses taken was used to get the relative abundance of the birds.

Data Analysis

Data collected on birds for all the habitats were subjected to t-test of independent variables to detect whether the abundance of birds differ from one another in all the selected habitats. LSD method was used in ANOVA to create confidence intervals for mean levels of habitat pairwise differences in birds' use of the habitats. Post-test correction was used to adjust for multiple comparisons to determine if all the means were really equal or that one or more were significant by chance. Data on trees, shrubs and herbs as well as birds were described using frequency distribution.

2.10. Regression Model Development

Simple linear regression was used to develop equations for predicting bird abundances for all bird species from the habitat variables. The procedure was used to identify the subset of habitat variables that accounted for the variation in the bird abundance data. Linear regression was used to determine the best fit for the dependence of birds on trees, shrubs and herbs.

RESULTS

Relative Abundance of Birds

Relative abundance of birds typical of the study area is presented in Table 1. 68 bird species from 31 families were associated with the study area. Urban arboreta had the highest abundance followed respectively by arable farmland (edge), riparian habitat, fallow land, and high forest, while cashcrop farmland had the least. The result indicated that birds abundance was significantly affected by habitat type ($P<0.05$). Test of significant difference showed that the abundance of birds in cashcrop farm, high forest and fallow land were not significantly different from one another. Riparian habitat, arable farmland, and urban arboreta were also found not to be significantly different from one another.

The result of abundance showed that 27 families, 62 species and 230 individuals were associated with fallow land. However, *Ploceidae*, was the most abundant family with 29 individuals followed by *Accipitridae* (22 individuals), *Sturnidae* (14 individuals), *Nectarinidae* and *Prionopidae* (13 individuals each), *Pycnonotidae* (12 individuals), *Columbidae* and *Zosteropidae* (10 individuals each) respectively. Relatively at species level purple glossy starling and village weaver were the most abundant followed by yellow white – eye, Green Wood Hoopoe, Broad – billed roller, Brown Barbler, Common bulbul, and Red – headed malimbe respectively. In Islands of High Forest 25 families, 53 speciesand 192 individuals were found to be associated with the habitat, with*accipitridae* having the highest abundance of 30 individuals followed by*ploceidae*(25 individuals) *pycnonotidae* (16 individuals),*nectarinidae* (11 individuals), *cuculidae* (10 individuals), and *columbidae* (9 individuals), and *alcedinidae* (7 individuals) respectively. At species level, abundance of birds was found to be highest for chestnut-and-black weaver. This was respectively followed by village weaver, yellow white -eye, puff-back shrike, pied crow, palm swift, allied hornbill, and palm bulbul.

The result also showed that arable farmland (edge) had 23 families, 53species and 384 individuals with *ploceidae* as the most abundant (160 individuals). This was respectively followed by families of *motacillidae* (29 individuals), *sturnidae* (23 individuals), *turdidae* (22 individuals), *sylviidae* (20 individuals), *accipitridae* (15 individuals), *columbidae* and *nectarinidae* (14 individuals each), and *alcedinidae* (13 individuals). Village weaver was the most abundant in this habitat. This is respectively followed by chestnut-and-black weaver, red–headed dioch, violet backed starling, European wheat–ear, and red-faced grass warbler, African pied-wagtail, yellow wagtail, purple–glossy starling, and Bronze manikin. Also, white-throated bee-eater, grey

plantain-eater and Kurrichane thrush, African hawk eagle, green wood hoopoe, black kite, tooth-billed barbet, common bulbul, and pied crow were high in abundance in farmlands.

The abundance of birds in cash crop farmlands as presented also revealed that 15 families, 28 species with 133 individuals were surveyed in this habitat. Among the families, species abundance was highest for *ploceidae* (35 individuals). This was followed by *accipitrida*e (24 individuals), *sylviidae* (17 individuals), *motacillidae* and *turdidae* (eight individuals each), and *musophagidae* and *prionopidae* (7 individuals each) respectively. Chestnut-and-black weaver was the most abundant species in this habitat. This was followed respectively by bronze manikin, rufous-faced grass warblers, grey plantain eater, kurrichane thrush, Casins hawk eagle, African hawk Eagle, green wood hoopoe, and common bulbul.

For riparian habitat, 24 families, 48 species, 257 individuals were surveyed in this habitat .*Ploceidae* had the highest abundance of 71 individuals. This was followed respectively by *accipitridae* and *sturnidae* (21 individuals each), *columbidae* (14 individuals), *prionopidae* (13 individuals), *alcedinidae* (11 individuals), while *pycnonotidae* and *phoeniculidae* had 10 individuals each. Abundance was highest for chestnut-and-black weaver. This was followed by violet-backed starling, and white throated bee-eater, grey parrot, green wood hoopoe, and pied crow respectively. Also, green fruit Pigeon, common bulbul and yellow white-eyed, had high species abundance.

22 families of birds, 56 species and 385 individuals were associated with urban arboreta. The result showed that, *ploceidae* had the highest abundance with 104 individual birds. This was respectively followed by *hirundidae* and *motacillidae* (32 individuals each), *ardeidae* (26 individuals),*micropodidae* (25 individuals), *accipitridae* (20 individuals), *sturnidae* (19 individuals), *Sylviidae* (17 individuals), *turdidae* (16 individuals), *nectarinidae* (15 individuals), and *alcedinidae* (12 individuals).Out of the 56 species associated with this habitat, species abundance was highest for chestnut-and-black weaver, followed by Cattle Egret, European swallow, red-headed dioch, little African swift, palm swift, rufous-chested swallow, and bronze manikin, yellow-wagtail, and violet-back starling, kurrichane thrush, and ayres hawk Eagle respectively.

Table 1: Abundance of Birds in Sampled Habitats

S/No.	Common Name	*Scientific Name*	Family	FL	HF	AF	CF	RH	UA
1	Black kite	*Milvus migrans*	Accipitridae	3	5	6	4	4	3
2	Black- shouldered kite	*Elaneus caerulens*	"	4	4				
3	Africa hawk Eagle	*Hieraaetus spilogaster*	"	4	4	7	5	5	4
4	Ayres hawk Eagle	*Hieraaetus dubius*	"	3	4		4		8
5	Casins hawk Eagle	*Spizaetus africanus*	"	4	4		7	3	
	Harrier hawk	*Polybroides typus*	"	-	2				
6	African long tail hawk	*Urotriochis macrourus*	"	-	2			4	
7	Lizzard buzzard	*Kaupifalco monogrammicus*	"	4	2		2	4	2
8	Shikra	*Accipiter badius*	"	-	3	2	2		3
9	African Monkey Eagle	*Stephanoetus coronatus*		-	-	-	-	1	
10	Green fruit Pigeon	*Treron australls*	Columbidae	2	4				
11	Red - eyed turtle Dove	*Streptopelia semi torquata*	"	2	1	4		3	4
12	Red -billed wood Dove	*Tutur afer*	"	5	4	4		2	3
13	Laughing Dove	*Stigmatopelia senegalensis*	,,	1		4		3	1
14	Green fruit pigeon	*Treron australis*	"	-	4	2		6	
15	Grey plantain- eater	*Crinifer piscator*	Musophagidae	7	5	8	7		8
16	Levaillant Cuckoo	*Climator levaillanti*	Cuculidae	2	4	3	2	2	2
17	Didric Cuckoo	*Lampromorpha caprius*	"	2	3	2	3	2	
18	Senegal Coucal	*Centropus senegalensis*	"	3	3			3	3
19	Akin eagle Owl	*Bubo leucostictus*	Strigidae	4	3				
20	Pel's fishing owl	*Scotopelia peli*	,,	-	-	-	-	4	

S/No.	Common Name	*Scientific Name*	Family	FL	HF	AF	CF	RH	UA
21	Little African swift	*Colletoptera affinis*	Micropodidae						13
22	Palm swift	*Cysiurus parvus*	,,	7	8				12
23	Broad billed roller	*Eurystormus afer*	Coracidae	8	5	5		5	
24	Green wood Hoopoe	*Phoeniculus erythrorhyncus*	Phoeniculidae	8	3	7	5	8	
25	Allied Hornbill	*Lophocerus semifasciatus*	Bucerotidae	7	6	5			
26	Pigmy kingfisher	*Ispidina picta*	Alcedinidae	1	1	3		4	2
27	Striped kingfisher	*Halcyon chelicuti*	"	1	1	3			4
28	Senegal kingfisher	*Halcyon senegalensis*	"	1	3	4		3	3
29	Blue breasted kingfisher	*Halcyon malimbicus*	"	1	2	3		4	4
30	White- throated bee eater	*Aerops albicolis*	Meropidae	6	1	9	4	9	6
31	Tooth -billed barbet	*Pogornornis bidendatus*	Capitonidae	5	2	6		2	1
32	Yellow- fronted tinker bird	*Pogoniulus chrysoconus*	"	1	2		2	2	
33	Grey Parrot	*Psittacus erithracus*	Picidae	-	5			8	
34	Yellow-bellied Parrot	*Poicephalus senegalus*	"		5				
35	Grey wood pecker	*Dendropicos goertae*	,,	2	2			2	
36	Gabon wood pecker	*Dendropicos gabonensis*	"	1					
37	Cardinal woodpecker	*Dendropicos fuscescens*	"	1			1		
38	Fire- bellied wood pecker	*Dendropicos pyrrhogaster*	"	2		2	2		
39	African pied wagtail	*Motacilla aguimp*	Motacillidae			10			9
40	Yellow wagtail	*Budytes flavus*	,,			10			10
41	Plain-Backed Pipit	*Anthus leucophrys*	,,			5	4		9
42	Yellow Throated Long claw	*Macronyx croceus*	,,			4	4		4
43	Brown barbler	*Turdoides plebeja*	Timalidae	8				5	
44	Common bulbul	*Pycnonotus barbatus*	Pycnonotidae	8	5	6	5	6	7
45	Palm bulbul	*Thescelocichla leucopleura*	,,	-	6			4	
46	Yellow- throated leaf love	*Pyrrhurus Flavicollis*	"	4	5				
47	Striped fly catcher	*Muscicapa striata*	Muscicapidae	1					
48	Spectacled flycatcher	*Platysteira cyanea*	"	1	2			2	
49	Spotted flycatcher	*Muscicapa striata*	,,			1			1
50	Grey -backed paradise fly catcher	*Tchitrea smithii*	"	3	3	4		3	3
51	Snowy- headed robin chat	*Cossypha niveicapilla*	Turdidae	5				4	2
52	European wheat ear	*Oenanthe oenanthe*	,,			12			4
53	Kurrichane thrush	*Turdus libonyanus*	,,			8	7		8
54	Whinchat	*Saxcola rubeila*	,,			2	1		2
55	Willow warbler	*Phylloscopus trochilus*	Sylvildae	3		1			2
56	White -bellied crombec	*Sylvietha flaviventris*	"	3		3			2
57	Grey -backed Camaroptera	*Camaroptera brevicaudata*	"	2	1	4	4	1	2
58	Red- faced grass warbler	*Cisticola erythrops*	,,			12	13		
59	Rufuos -faced grass warbler	*Dicrurus adsimilis*	Dicruridae			4			11
60	Velvet- mantled Drongo	*Dicrurus adsimilis*	,,	3	2				3
61	Fiscal Shrike	*Lanius collaris*	Prionopidae	3					4
62	Puff back Shrike	*Dryoscopics gambensis*	"	4	7			4	
63	Gonolek	*Laniurus barbatus*	"	2		3		4	
64	Bush Shrike	*Tchagra senegala*	"	3		4	3		2
65	Bell Shrike	*Laniurus ferrugineus*	,,	1			4	5	2
66	Black-winged Oriole	*Oriolus nigripennis*	Oriolidae	2	2			3	
67	Pied Crow	*Corvus albus*	Corvidae	5	7	6		8	8
68	Violet- backed Starling	*Cinnyricinclus leucogaster*	Sturnidae	2		17		17	10

S/No.	Common Name	*Scientific Name*	Family	FL	HF	AF	CF	RH	UA
69	Purple- glossy Starling	*Lamprocolius purpureus*	"	11		10		4	5
70	Chestnut- winged Starling	*Onychognatus fulgidus*	"	1	1		1		4
71	Yellow white- eye	*Zosterops senegalensis*	Zesteropidae	10	9			6	
72	Splendid Sunbird	*Cynnyris coccinigaster*	Nectarinidae	3	3	4		2	3
73	Olive-bellied Sunbird	*Cynnyris chloropygius*	"	3	2	5	2	3	4
74	Green-headed Sunbird	*Cyanomitra verticallis*	"	4	4	1		4	4
75	Collard Sunbird	*Anthreptis collaris*	"	3	2	4			4
76	Grey-headed Sparrow	*Passer griseus*	Fringilidae	1	1	5		5	8
77	Chestnut-&-black weaver	*Cinnamopteryx castaneofuscus*	Ploceidae	4	11	42	16	63	60
78	Village weaver	*Plesiositagra cucullatus*	"	11	10	71			
79	Spec. Weaver	*Hyphanturgus brachypterus*	"	4		3		2	8
80	Red-headed Malimbe	*Malimbus rubricollis*	"	8	2	2	4	3	
81	Grey-crowned negro Finch	*Nigrita canicapilla*	,,	2	2	2		3	2
82	Red- headed dioch	*Quelea erythrops*	,,	-	-	25			18
83	Bronze manikin	*Spermestes cucullatus*	,,	-	-	10	15		12
84	Pin -tailed whydah	*Vidua macroura*	,,	-	-	5			4
85	Long- tailed night jar	*Scotornis climacurus*	Caprimulgidae	-	-	-	-	3	-
86	Rufous- chested swallow	*Hirundo semirufa*	Hirundidae	-	-	-	-	-	12
87	European swallow	*Hirundo rustica*	,,	-	-	-	-	-	20
88	Cattle egret	*Bubulcus ibis*	Ardeidae	-	-	-	-	-	26
Relative Abundance	--	--	-	230	192	384	133	257	385
No of species	88	88		62	53	53	28	48	56
No of family	--	--	31	27	25	23	15	24	22

N.B: FL=Fallow Land, HF=High Forest (island), AF=Arable Farmland (edge), CF=Cashcrop Farmland, RH=Riparian Habitat, UA=Urban Arboreta

Relative Abundance of Trees

The relative abundance of trees in the study area is presented in Table 2. The result showed that 34 families of trees were associated with the study area. In fallow land there were17 families with *leguminosae; caesalpinoideae* having the highest abundance of 30 individuals. The result also revealed that out of 18 families that are associated with high forest, *boraginaceae* had the highest abundance of 7 individuals. For arable farmland, *leguminosae caesalpinioidae* had the highest abundance of 30 individual trees from among 23 families. In cashcrops farmland the family of *sterculiaceae* had the highest species abundance, followed by *boraginaceae* and *palmae*. The result showed that out of 15 families, species abundance was highest for *palmae* (11 individuals) in riparian habitat. Table 2 also showed the abundance of tree species in Urban Arboreta. In urban arboreta, out of 15 families, *musacaceae* was the most abundant as it was represented by 13 individual trees.

Table 2: Abundance of Trees in Sampled Habitats

S/No	Family	Abundance					
		FL	HF	AF	CF	RH	UA
1	Anarcardiaceae	1	1	1	-	-	6
2	Euphorbiaceae	9	4	4	-	2	1
3	Leguminosae: caesalpiniodae	30	4	30	-	9	-
4	Leg: mimosoideae	11	1	11	-	5	-
5	Meliaceae	2	2	5	-	-	2
6	Myristicaceae	2	2	-	-	1	-
7	Apocynaceae	9	-	8	-	-	-
8	Rubiaceae	5	3	8	-	6	-
9	Ochnaceae	-	1	2	-	-	-
10	Olacaceae	-	2	2	-	-	-
11	Rutaceae	3	-	-	-	-	3
12	Moraceae	8	1	4	-	-	1
13	Boraginaceae	10	7	7	12	2	5
14	Sapindaceae	2	-	1	-	-	-
15	Bombacaceae	2	2	5	-	-	-
16	Sterculaceae	-	-	-	16	3	3
17	Palmae	4	1	4	3	11	2
18	Moringaceae	1	1	2	-	4	-
19	Irvingaceae	-	3	1	-	-	-
20	Sapotaceae	-	-	-	-	-	1
21	Chrysobalanaceae	1	1	1	-	3	-
22	Samydaceae	2	1	3	-	2	-
23	Bignoniaceae	-	-	1	-	-	3
24	Myrtaceae	-	-	2	-	-	1
25	Loganiaceae	-	-	4	-	2	-
26	Compositae	-	-	-	-	1	-
27	Guttiferae	-	-	-	-	3	-
28	Combretaceae	-	3	-	-	-	2
29	Passifloraceae	-	-	2	-	-	-
30	Annonaceae	-	-	2	-	-	-
31	Papilionaceae	-	-	-	-	4	-
32	Verbenaceae	-	-	-	-	-	4
33	Musacaceae	-	-	-	-	-	13
34	Caricaceaea	-	-	-	-	-	2
Number of species		40	33	41	3	22	24
Number of family		17	18	23	3	15	15

Relative Abundance of Shrubs

The relative abundance of shrubs is presented in Table 3. The result revealed that a total of 32 families were associated with the study area. In farm fallow, among the 18 families associated with it, *euphorbiaceae* was the most abundant with 27 individuals. In high forest where there were 16 families, *euphorbiaceae* was the most abundant with 24 individuals. The result also showed that out of 19 families, *asteraceae* and *icacinaceae* had the highest

abundance with 31 individuals each in arable farmland (edge). It was revealed that, the family of *malvaceae* had the highest abundance (23 individuals) from among 17 families in cashcrop farmland. The result also revealed that out of 20 families, *euphorbiaceae* was the most abundant (31 individuals) in riparian habitat. In urban arboreta, out of 13 families, *malvaceae* had the highest abundance (94 individuals).

Table 3: Abundance of Shrubs in Sampled Habitats

S/No	Family	Abundance					
	Family	**FL**	**HF**	**AF**	**CF**	**RH**	**UA**
1	Malvaceae	10	13	29	23	17	94
2	Asteraceae	9	-	31	31	19	21
3	Cleomaceae	7	1	3	7	3	2
4	Combretaceae	8	22	4	-	3	-
5	Dennstaedtiaceae	3	6	4	1	1	4
6	Hippocrataceae	-	-	6	-	-	1
7	Icacinaceae	11	9	31	18	9	22
8	Loganiaceae	-	-	-	6	-	-
9	Euphorbiaceae	27	24	12	9	31	14
10	Solanaceae	-	-	-	-	-	6
11	Sphenocleaceae	11	-	16	6	6	7
12	Tiliaceae	-	9	4	7	2	7
13	Sterculiaceae	-	-	5	-	2	-
14	Olacaceae	3	7	7	6	8	-
15	Annonaceae	-	9	-	-	2	-
16	Moringaceae	3	-	-	-	3	-
17	Flacourtiaceae	2	6	5	5	1	-
18	Ochnaceae	-	-	-	-	4	-
19	Lecythidaceae	1	2	2	-	2	-
20	Chailletiaceae	10	3	8	-	5	-
21	Papilionaceae	4	10	12	2	11	-
22	Lauraceae	-	2	-	-	-	-
23	Acanthaceae	4	-	-	4	1	-
24	Fabaceae	-	-	2	2	2	8
25	Mimosaceae	-	-	1*	-	-	-
26	Rubiaceae	3	8	-	6	-	-
27	Menispermaceae	4	5	-	-	-	-
28	Compositae	-	-	-	-	-	3
29	Guttiferae	-	-	-		-	1
30	Verbenaceae	-	-	7	-	-	-
31	Polygalaceae	3	-	-	4	-	-
32	Scrophulacceae	-	-	-	6	-	-
Number of species	--	26	27	30	25	31	25
Number of family	--	18	16	19	17	20	13

Relative Abundance of Herbs

The relative abundance of herbs in the study area is presented in Table 4. The result showed that 40 families of herbs were associated with the habitat. In farm fallow, there were 12 families. *Asteraceae* had the highest abundance with 18 individual herbs. The result also showed that among 9 families, *athyraceae* family was the most abundant in high forest with 17

individuals. In arable farmland with 16 families, *asteraceae* had the highest abundance (124 individuals). The result indicated that out of 18 families, *poaceae*, which consists of 117 individuals, was the most abundant in cashcrop farmland. The result also showed that, out of the 14 families associated with riparian habitat, the family of*poaceae* had the highest abundance with 97 individual herbs. The abundance of herbs in urban arboreta showed that 20 families were associated with this habitat. Among these families, the highest species abundance was recorded for *cyperaceae* (97 individuals).

Table 4: Abundance of Herbs in Sampled Habitats

S/No	Family	Abundance					
		FL	HF	AF	CF	RH	UA
1	Asteraceae	18	-	124	45	17	18
2	Musciceae	-	15	-	-	-	-
3	Convolvulaceae	4	-	15	8	12	3
4	Marchantiaceae	-	3	8	-	-	-
5	Polypodiaceae	-	4	-	-	-	
6	Cyperaceae	3	4	68	52	86	97
7	Melastomaceae	-	-	-	-	28	-
8	Onagracceae	-	-	-	-	18	-
9	Poaceae	17	3	65	117	97	53
10	Rubiaceae	2	-	19	19	9	9
11	Sterculaceae	-	-	-	2	11	-
12	Tiliaceae	-	-	-	-	6	-
13	Acanthaceae	2	-	3	13	-	3
14	Amaranthaceae	8	-	-	27	13	8
15	Passiflorae	-	-	-	5	-	-
16	Euphorbiaceae	-	-	12	5	-	28
17	Boraginaceae	6	-	-	-	-	7
18	Cleomaceae	-	-	-	-	-	1
19	Cucurbitaceae	-	-	-	-	-	1
20	Fabaceae	2	-	14	8	-	14
21	Lamiaceae	-	-	-	-	-	4
22	Loganiaceae	-	-	-	18	-	-
23	Scrophulaceae	-	-	-	-	-	4
24	Lamiaceae	-	-	25	-	-	-
25	Nytaginaceae	-	-	-	-	-	13
26	Portulacaceae	-	-	-	-	-	9
27	Solanaceae	6	-	2	-	-	-
28	Urticaceae	-	-	11	3	10	1
29	Commelinaceae	3	-	18	37	71	5
30	Smilacaceae	-	-	2	-	-	-
31	Athyraceae	15	17	-	3	-	-
32	Pedaliaceae	-	-	-	7	-	-
33	Leguminosae	-	-	12	4	-	-
34	Sellaginelaceae	-	5	-	-	-	-
35	Marantaceae	-	2	-	-	-	-
36	Araceae	-	5	-	3	-	13
37	Asclepiadaceae	-	-	-	-	6	-
38	Cannaceae	-	-	-	-	9	-
39	Ulmaceae	-	-	6	-	-	-
40	Piperaceae	-	-	-	-	-	22
Number of species		30	16	53	37	34	46
Number of family		12	9	16	18	14	20

Prediction of Bird's abundance as influenced by trees, shrubs and herbs

The influence of trees' abundance on the abundance of birds as indicated on Table 5 showed that arable farmland has the best fit followed respectively by

fallow land, riparian habitat, high forest and urban arboreta, while the least was recorded for cash crop farmland. Also the influence of shrubs' abundance on the abundance of birds as indicated on Table 5 revealed that arable farmland had the best fit or predicted value. This was respectively followed by urban arboreta, high forest, cash crop farmland, fallow land and riparian habitat. The result also showed that `the mean values for confidence level of the influence of shrub abundance on the abundance of birds were not significantly different for all the habitats.

The result of the influence of herbs' abundance on the abundance of bird species also indicated on Table 5that cash crop farmland had the best fit, followed by arable farmland, riparian habitat, urban arboreta, fallow land and high forest respectively. The result also showed that `the mean values for confidence level of the influence of herb abundance on the abundance of birds were really equal for all the habitats.

Table 5: Prediction of Birds' Abundance As Influenced By Trees, Shrubs and Herbs

Influence of Tree Abundance on Bird Abundance							
Habitat	**Tree**	**Bird**	**Best fit**	**Mean1-mean2**	**95% CL of difference**	**Sig**	**T**
FL	16	29	46.82	-13	-69 to +43	No	0.97
HF	4	28	40.30	-24	-80 to +32	No	1.79
AF	18	59	47.91	-41	-97 to +15	No	3.10
RH	8	51	42.47	-43	-99 to +13	No	3.22
CF	2	27	39.21	-25	-81 to +31	No	1.87
UA	4	63	40.30	-59	-115 to -3	Yes	4.41
Influence of Shrub Abundance on Bird Abundance							
Habitat	Shrub	Bird	Best fit	Mean1-mean2	95% CL of difference	Sig	T
FL	22	29	36.09	-7	-91 to+77	No	0.35
HF	31	28	44.37	+3	-81 to +87	No	0.15
AF	40	59	52.64	-19	-103 to +65	No	0.96
RH	19	51	33.34	-32	-116 to +52	No	1.61
CF	29	27	42.53	+2	-82 to +86	No	0.10
UA	35	63	48.04	-28	-112 to +56	No	1.41
Influence of Herb Abundance on Bird Abundance							
Habitat	Herb	Bird	Best fit	Mean1-mean2	95% CL of difference	Sig	T
FL	11	29	35.16	-18	-228 to +192	No	0.36
HF	7	28	34.04	-21	-231 to +189	No	0.42
AF	62	59	49.48	+3	-207 to +213	No	0.06
RH	50	51	46.11	-1	-211 to +209	No	0.02
CF	64	27	50.04	+37	-173 to +247	No	0.74
UA	36	63	42.18	-27	-237 to +183	No	0.54

DISCUSSION

Influence of tree abundance on birds

Test of significant difference showed that the abundance of birds in urban arboreta, arable farmland (edge) and riparian habitat was not significantly different from one another .Fallow land, high forest and cash crop farm were also not significantly different from one another.

Since there was no significant difference in the post test correction to adjust for multiple comparisons of means for the dependence of birds on trees in all the habitats, it therefore implied that the abundance of birds were dependent on the abundance of trees for all the habitats considered. But, arable farmland (edge) had the best fit followed by fallow land, riparian habitat, high forest, urban arboreta and cash crop farmland.

The abundance of birds was predicted by the abundance of trees on the edges of arable farmland. The ecological factors that possibly influenced the abundance of birds were the abundance of trees in 23 families (most diversified with 41 species) among which are *Leguminosae: caesalpinioidae, Leguminosae: mimosoidae,Euphorbiaceae, Apocynaceae,Rubiaceae*, and *Boraginaceae*, which must have been helpful in enhancing bird abundance as reported in the finding of Harvey *et al* (2006).The most abundant bird species on the edges of arable farmland which wasvillage weaver, a species that was associated with tree stands on which it usually builds its nest. Some previous studies have demonstrated the positive relationship between farmland bird species with both the total number of native trees and number of large native trees; and the diversity and biomass of invertebrate food potential of edge features (Douglas *et al.*, 2014; Evans*et al.*, 2016).The edge effects could also have played a marked role in the population dynamics of the birds in this habitat (Zurita *et al.*, 2012; Evans *et al.*, 2016).

The result also indicated that the abundance of birds in urban arboreta, arable farmland (edge) and riparian habitat was not significantly different from one another. The abundance of birds in urban arboreta and riparian habitat was therefore, also in the same way influenced by the abundance of tree.

The abundance of birds such as Chestnut-and-black weaver , Cattle Egret , European swallow, red-headed Dioch ,little African swift, palm swift, rufous-chested swallow ,bronze manikin, yellow-wagtail, violet-back starling ,kurrichane thrush, and ayres hawk eagleand others in urban arboreta as predicted by the abundance of tree cover might be due to the proportions of the tree cover at an urban site which could have predicted total abundance of birds positively, with several species positively associated with tall vegetation (Kalinowski and Johnson 2010).

The abundance of birds such as chestnut-and-black weaver ,violet-backed starling and white throated bee-eater, grey parrot, green wood hoopoe and pied crow, green fruit pigeon, common bulbul and yellow white-eye and others that were associated with riparian habitat as predicted by the abundance of tree cover might be occasioned majorly by the presence of such tall trees. Chestnut-and-black weaver was especially noted to build their nests on trees especially tall ones. This type of finding had also been reported by Harvey *et al* (2006) in which greatest numbers of bird species were associated with riparian and secondary forest, forest fallows, and pastures with tree cover.

Influence of Shrubs on Birds Abundance

The mean values for confidence level of the influence of shrub abundance on the abundance of birds were equal for all the habitats. This implied that the abundance of shrubs is vital to the abundance of birds in all the habitats. Edge of arable farmland, however, had the best fit or predicted value. This implied that birds' abundance in the edges of arable farmland was the most influenced by the abundance of shrubs.

The result highlighted the importance of shrub layer abundance from 19 families (second most diversified with 30 species) among which were *asteraceae, icacinaceae, malvaceae, sphenocleaceae, euphorbiaceae* and *papilionaceae*in explaining the abundance of *ploceidae, motacillidae, sturnidae, turdidae, sylviidae, accipitridae, columbidae, nectarinidae*, and *alcedinidae* families of birds in arable farmland (edge). Shrubs did not only promote structural heterogeneity, but were also sources of cover and gleaning for the birds (Golet *et al*., 2001; Baker*et al.*, 2015; Laiolo *et al.*, 2004).The abundance of shrubs as it influenced the abundance of birds such as village weaver, chestnut-and-black weaver, red-headed dioch, violet backed starling, and othersin arable farmland (edge) is in agreement with the findings of Morelli (2013) and, Kalinowski and Johnson (2010) which stated the proportions of shrub cover at a site predicted total abundance of birds positively.

Since test of significance showed that the abundance of birds in urban arboreta, arable farmland (edge) and riparian habitat was not significantly different from one another, the abundance of birds in urban arboreta and riparian habitat were also in the same way influenced by the abundance of shrubs.The abundance of birds in urban arboreta which was well predicted by the abundance of shrubs could possibly be due to the use of the shrubs as the source of cover and foraging by the birds as revealed in the finding of Abu Baker*et al* (2015).The abundance of birds in riparian habitat as predicted by the abundance of shrubs could largely be due to the natural conditions prevailing along the riparian sites which created what is perceived as being an "edge effect" in the finding of Larue *et al.*,(1995).

Influence of Herbs on Birds Abundance

The mean values for confidence level of the influence of herb abundance on the abundance of birds were equal for all the habitats. Thus, the abundance of herbaceous layer of plants enhanced the abundance of birds in all the habitats considered. However, Cashcrop farmland had the best fit. The predictor metric showed that the abundance of birds was most influenced by the abundance of herbs in cashcrop farm land Test of significant difference, however, showed that there was no variation in the abundance of birds in fallow land, high forest and cash crop farm land .This implies that the abundance of birds in the three habitats was predicted the same way by the abundance of herbaceous cover. Although, the result highlighted that cash crop farmland had the least species abundance. In the study area, cash crop farmland was always under annual or biannual row slashing and circle weeding. This might be likened to thinning which negatively affected food supply, cover and nesting for birds (Christian *et al*., 1996; Hayes *et al*., 2003). Many other studies have also focussed on the physical aspects of cash crops which did not produce desirable cover and might have a direct effect on birds breeding in monoculture farms (Graham and Des Granges 1993; Boutin *et al.,* 1994; Brenda 2005). But, as the plants recover this may result into thick undergrowth of herbaceous layer. Such layer could provide food and cover for bird species.

In this study, the abundance of herbaceous plants in 18 families (second most diversified with 37 species in the study area) among which are*poaceae*, *cyperaceae,asteraceae, commelinaceae, amaranthaceae, loganiaceae, acanthaceae,* and *convolvulaceae* in cashcrop farmland, had possibly contributed to the abundance of bird families of *ploceidae, accipitridae, sylviidae, motacillidae, turdidae,musophagidae* and *prionopidae* in cashcrop farmland.This influence of herbs abundance on the abundance of birds agreed with the finding of Štefanová and Šálek (2014). The abundance of birds such as Chestnut- and-black weaver, bronze manikin, rufous-faced grass warblers, grey plantain eater, kurrichane thrush, casins hawk eagle, African hawk Eagle, green wood hoopoe and common bulbul, in cash crop farmland might have been enhanced by the species abundance and diversity of the herbal communities. This finding was supported by that of Diaz (2006).

The abundance of birds in fallow land as predicted by the abundance of herbs, however, contrasts with the finding of Mariappan *et al* (2013) that the considerable numbers of trees in fallow land and boundary of agricultural land accommodated large number of bird's population. Notwithstanding, the abundance of herbaceous layer alongside tree cover in this habitat could have complemented tree stands in enhancing the abundance of the birds. The abundance of birds in high forest (islands) as influenced by the abundance of herbs agreed with the finding of Harvey ,*et al* (2006) in which it was stated that the abundance of forest birds was influenced by within-patch habitat characteristics.

CONCLUSION

This study has advanced understanding of the relative importance of habitat structure and heterogeneity on bird abundance in the tropical rainforest. It has also demonstrated that:

i. Abundance of trees and shrubs best predicted the abundance of birds in arable farmland (edge). In cash crop farmland, the abundance of herbs best predicted the abundance of birds. While the abundance of birds which was highest in urban arboreta was enhanced by the abundance of trees and shrubs.

ii. The results revealed that tropical forest birds have developed special adaptation to habitat patch characteristics of vegetation structure with trees, shrubs and herbs as key factors that influenced the abundance of the bird species. The abundance of birds in the patches of habitats such as edges of arable farmland, cash crop farmland, islands of high forest and urban arboreta is also a pointer to the theory that islands of habitats or small reserves brought about by impacts of human disturbance, land fragmentation and habitat alteration may have significant conservation value.

iii. Since this study was carried out in the belt where there are bitumen deposits in Ondo state, Nigeria, these findings will assist decision makers in the management and conservation of relicts of habitats that are critical to the survival of bird species that will definitely be under more serious threat during the bitumen development phase.

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