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CONTRIBUTIONS OF UNIVERSITY OF IBADAN BOTANICAL GARDENS TO AVIFAUNA DIVERSITY CONSERVATION

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Abstract

Rapid urbanization poses the greatest threat to bird populations due to habitat loss and fragmentation. Managed habitats including nature gardens remain one of the likely areas to host displaced species and serve as secondary habitat options. This depends strongly on floristics and vegetation structure which are strong determinants of bird species distribution. This paper presents a review of bird diversity in the botanical gardens, University of Ibadan, and assesses effect of vegetation parameters on patch utilization within the garden. Point-count method and circular plots were used for bird and vegetation survey. Ten point-counts selected from the upper course and developed section of the garden were visited 37 times each, in the mornings (0630-0930 hrs) and evenings (1600-1900hrs). Fifty-five (55) bird species belonging to 23 families were recorded. A total of 1344 plants belonging to 69 species were identified within sampling points. There was significant difference in bird richness across points (P<0.05). The patch around point 6 had the highest mean bird richness and plant abundance; showing a possible positive correlation between both factors. A significant relationship between ground cover, litter cover, canopy cover and bird species diversity was observed. Total families of plants identified were thirty-two (32) with Amaranthaceae having the highest frequency (401) while Malvaceae, Polygalaceae and Sapotaceae had the least frequency. Management practices in gardens such as introduction and re-introduction of indigenous plant species, prunning, grass clearing, can potentially affect a gardens' ability to host bird species. Proper understanding on this relationship is vital to sustaining bird populations.

Key Words: *Botanical garden, Vegetation structure, Wildbirds, Green space, Urbanization*

Introduction

The 21st century has been characterised globally by rapid urbanization. Urban city sprawls, and intensification of agriculture in rural areas are resulting in decimation of wildlife populations and defaunated natural areas (Adeyanju *et al*., 2014; Coleman, 2016;

Coleman and Barclay, 2016; McKinney, 2008). Vital habitats are being lost or fragmented, with patches increasing in isolation distances hence reducing their previous potentials to support complex indigenous communities (Yu and Guo, 2013). In the southwestern zone of Nigeria like Ibadan and Lagos, high forests have been converted for agricultural and plantation crop fields for other beneficial economic purposes (Mensah, 2014). Such homogenization affects specialist/strictly stenotopic species that require undisturbed areas to thrive such as hornbills, turacos, *etc* (Adeyanju *et al*., 2014).

Most wilderness areas which provide much needed space for wildlife to thrive exist in rural areas. It becomes pertinent to protect quality patches within urban areas where some substantial amount of native vegetation in form of habitat remnants and gardens (Parson *et al.*, 2006; Waltert *et al.,* 2005), are available. These quality patches when available and sufficient, serve as corridors providing cover offering greater resilience to wildlife populations locked up within the current land use grab in expanding cities (Cushman *et al*., 2013; Lindenmayer, 1999). Urban areas such as Ibadan metropolis have been researched upon for wildlife in form of plants, birds (Adeyanju *et al.*, 2014; Elgood, 1988; Neuenschwander *et al.*, 2015), butterflies (Larsen, 2005) *etc*., showing the potential richness and diversity of wildlife in this region. Evidence of such research should be transformed to working document to limit excesses of the expanding populace, which if not halted, continue to decimate indigenous wildlife and green spaces (Mensah, 2014).

Educational centres of excellence are today accustomed to protecting some space for preserving plant species diversity (gene banks) either actively via-forest reserves, botanical gardens or wildlife parks, watersheds or passively via-bush or presently unused lands (Cilliers *et al.*, 2014). Wildlife have found such areas whether passively or actively managed the only available buffer and niche for their survival. It is not uncommon to observe areas that have been left unused over 20-30years develop from farmland status to woodlands or secondary forests in the tropical forest biome (Adeyanju *et al*., 2014). If gardens can be managed to promote a diversity of indigenous species, it may provide a valuable secondary function for conserving wildlife populations (Parson *et al*., 2006).

Methodology

Data were collected only in the developed section of the garden which covers an area of *c*. 24acres. The developed section here refers to the part of the garden which is currently being managed according to the stipulated mandates of operation for the botanical gardens. Ten points each 100m apart were marked systematically within the garden to reduce duplication and improve accuracy of results. A Garmin Etrex 20 device was used to take coordinates of points. A pair of 8x42 binoculars and Helm's field guide to birds of Western Africa were used to view and identify birds to species level (Borrow and Demey, 2008)**.**

Bird Survey

A total of ten minutes was spent on each point, two minutes for settling time and eight minutes for documenting bird species identified. All birds seen and heard within a 30 m radius were documented. Each of ten point was visited

37 times, once in the morning (between 0630hrs and 1000hrs) and evening (between 1630hrs and 1900hrs), five times a week for four (4) weeks.

Vegetation Survey

For the vegetation sampling, circular plots were used. Sampling with laid out quadrants plots with a radius of 15 m with reference to each marked point count. Metre tape was used to take measurement of DBH. In each round quadrants, the extent of canopy cover, ground cover and litter cover were determined in percentages**.** All the plant species within the quadrants were identified up to the species level by a plant taxonomist.

Data Analysis

The bird species seen and heard on the field were pooled and an estimate for which bird species richness was deduced. We estimated bird species diversity using Simpson and Shannon-Weiner diversity indices. All the identified plant species were compiled based on abundance and family. Percentage contribution of each point of sampling to the plant species richness was also determined.

Results

Bird Species Inventory

A total of fifty-five (55) bird species from twenty-three (23) families were recorded for the botanical gardens, university of Ibadan during our study from September 23rd to October 22nd, 2016 (Table 1). Some of which include African Pied hornbill *Tockus fasciatus*, Yellow-mantled weaver *Ploceus tricolor*, Velvet mantled drongo *Dicrurus modestus*, Variable sunbird *Cinnyris venustus*, Olive-bellied sunbird *Cinnyris chloropygius*. The number of species per sample is a measure of richness, hence the more species are present in a sample, the 'richer' the sample. The highest mean bird species richness was recorded at point 6 while point 1 had the lowest mean bird species richness. Point 6 was observed to be the richest patch for birds in this study and point 1 the poorest patch, characterized by exotic flowers and human activity.

Table 1 : Species checklist for University of Ibadan Botanical garden

Species	Scientific Name	This study	Uwatt 2014	Adeyanju & Adeyanju 2012
Ardeidae				
Cattle egret	*Bubulcus ibis*	-	X	X
Accipitridae				
Black-shouldered kite	*Elanus caeruleus*	X	-	X
Yellow-billed kite	*Milvus migrans*	X	X	X
African goshawk	*Accipiter tachiro*	X	X	X
Lizzard buzzard	*Kaupifalco mongrammicus*	-	X	X
Falconidae				
Common kestrel	*Falco tinnunculus*	-	X	X
Phasianidae				
Double spurred francolin	*Francolinus bicalcaratus*	X	X	X
Heliornithidae				
African finfoot	*Podica senegalensis*	-	-	X
Columbidae				
Tambourine wood dove	*Turtur tympanistra*	X	-	-
Blue-spotted wood dove	*Turtur afer*	X	X	X
Speckled pigeon	*Columba guinea*	-	X	X
Red-eyed dove	*Streptoptelia semitorquata*	X	X	X

Laughing dove	*Streptopelia senegalensis*	-	X	X
Musophagidae				
Western grey plantain eater	*Crinifer piscator*	X	X	X
Cuculidae				
Black cuckoo	*Cuculus clamosus*	-	X	-
Common cuckoo	*Cuculus canorus*	-	-	X
Klass's cuckoo	*Chrysococcyx klaas*	X	X	-
Didric cuckoo	*Chrysococcyx caprius*	X	-	-
Senegal coucal	*Centropus senegalensis*	X	X	X
Apodidae				
African Palm swift	*Cypsiurus parvus*	-	X	X
Alcedinidae				
Blue-breasted kingfisher	*Halcyon malimbica*	X	-	-
Woodland kingfisher	*Halcyon senegalensis*	X	X	X
African pygmy kingfisher	*Ceyx pictus*	-	-	X
African dwarf kingfisher	*Ceyx lecontei*	-	X	X
Bucerotidae				
African pied hornbill	*Tockus fasciatus*	X	X	X
Capitonidae				
Yellow-throated tinkerbird	*Poginiulus subsulphureus*	X	X	X
Yellow-rumped tinkerbird	*Pogoniulus bilineatus*	X	-	-
Double-toothed barbet	*Lybius bidentatus*	-	-	X
Bearded barbet	*Lybius dubius*	-	-	X
Picidae				
Cardinal woodpecker	*Dendropicos fuscescens*	-	-	X
Grey woodpecker	*Dendropicos goertae*	X	-	-
Hirundinidae				
Ethiopian swallow	*Hirundo aethiopica*	-	X	X
Motacillidae				
African pied wagtail	*Motacilla agiump*	-	X	X
Pycnonotidae				
Little greenbul	*Andropadus virens*	X	-	-
Golden greenbul*	*Calyptocichla serina*	X	-	-
Simple leaflove	*Chlorocichla simplex*	X	X	X
Swamp palm bulbul	*Thescelocichla leucopleura*	X	-	-
Leaflove	*Pyrrhurus scandens*	X	X	X
Common bulbul	*Pycnonotus barbatus*	X	X	X
Muscicapidae				
Snowy crown robin chat	*Cossypha niveicapilla*	-	X	X
Turdidae				
African thrush	*Turdus pelios*	X	X	X
Sylviidae				
Grey-backed camaroptera	*Camaroptera brachyura*	X	X	X
Olive green camaroptera	*Camaroptera chloronota*	X	-	-
Tawny-flanked prinia	*Prinia subflava*	-	-	X
Green crombec	*Sylvietta virens*	X	-	X
Willow warbler	*Phylloscopus trochilus*	-	-	X
Muscicapidae				
Northern black flycatcher*	*Melaenornis edolioides*			
Red-bellied paradise flycatcher	*Terpisiphone rufiventer*	X	-	X
Platysteiridae				
Chestnut wattle-eye	*Dyaphorophyia castanea*	X	-	-
Common wattle-eye	*Platysteira cyanea*	X	-	-
Nectarinidae				

Brown sunbird	*Anthreptes gabonicus*	X	-	-
Green sunbird	*Anthreptes rectirostris*	X	-	-
Green-headed sunbird	*Cyanomitra verticalis*	X	-	X
Western Olive sunbird	*Cyanomitra obscura*	X	-	-
Collared sunbird	*Hedydipna collaris*	X	X	X
Olive-bellied sunbird	*Cinnyris chloropygius*	X	X	X
Variable sunbird	*Cinnyris venustus*	X	X	X
Superb sunbird	*Cinnyris superbus*	X	-	-
Splendid sunbird	*Cinnyris coccinigastrus*	X	X	X
Copper sunbird	*Cinnyris cupreus*	X	X	X
Malaconitidae				
Tropical boubou	*Laniarius aethiopicus*	-	X	X
Prionopidae				
White helmet shrike	*Prionops* caniceps	X	-	-
Oriolidae				
Western black-headed oriole	*Oriolus brachyrhynchus*	X	-	X
Dicruridae				
Square-tailed drongo	*Dicrurus ludwigii*	X	-	-
Velvet-mantled drongo	*Dicrurus modestus*	X	X	X
Corvidae				
Pied crow	*Corvus albus*	X	X	X
Sturnidae				
Narrow-tailed starling	*Poeoptera lugubris*	X	-	-
Chestnut-winged starling	*Onychognathus fulgidus*	-	X	-
Splendid glossy starling	*Lamprotornis splendidus*	X	X	-
Passeridae				
Northern grey-headed sparrow	*Passer griseus*	-	X	X
Ploceidae				
Slender-billed weaver	*Ploceus pelzelni*	X	-	-
Black-necked weaver	*Ploceus nigricollis*	X	X	X
Village weaver	*Ploceus cucullatus*	X	X	X
Yellow-mantled weaver	*Ploceus tricolor*	X	-	X
Red-vented malimbe	*Malimbus scutatus*	X	X	X
Red-headed malimbe	*Malimbus rubricollis*	X	X	X
Blue-billed malimbe	*Malimbus nitens*	X	-	-
Estrildidae				
Western bluebill	*Spermophaga haematina*	-	X	-
Orange-cheeked waxbill	*Estrilda melpoda*	-	-	X
Bronze mannakin	*Spermestes cucullatus*	-	X	X
Black and White mannakin	*Spermestes bicolor*	-	X	X
Pin-tailled wyhdah	*Vidua macroura*	-	X	-
		55	46	54

Names of families in bold; 'X' represents species present and '–'absent in the respective articles. Species listed according to (Borrow and Demey, 2001)

Plant Abundance, Richness and Points

A total of one thousand, three hundred and forty-four (1344) plants belonging to 69 species were identified within sampling areas (Table 2). Of all the 69 species, *Alternanthera* sp. had the highest abundance. Plant species such as *Abrus precatorus, Afzelia africana, Albizia lebbeck, Azadirachta indica, Capolobia lutea, Entandrophragma cylindricum, Ficus capensis, Gmelina arborea, Lecanodiscus cupanioides, Malacantha alnifolia, Newbouldia laevis, Parquetina nigrescens, Secamone afzelii, Terminalia*

superba, Triplochiton scleroxylon and *Vocanga Africana* had the least abundance and were singly represented in plots. The total families of plant identified were thirty two (32) with Amaranthaceae having the highest frequency (401) while Malvaceae, Polygalaceae and Sapotaceae had the least frequency (Figure 1).

Table 2: Plant species identified in the sampling areas

Scientific name	Family	Abundance
Abrus precatorus	Fabaceae	1
Achornea cordifolia	Euphorbiaceae	4
Afzelia africana	Fabaceae	1
Ageratum conyzoides	Asteraceae	200
Albizia ferruginea	Fabaceae	4
Albizia lebbeck	Fabaceae	1
Albizia zygia	Fabaceae	3
Allophylus africana	Sapindaceae	9
Alternanthera sp.	Amaranthaceae	361
Antiaris africana	moraceae	63
Azadirachta indica	Meliaceae	1
Bambuza vulgaris	Poaceae	50
Blighia sapida	Sapindaceae	4
Boherhavia diffusa	Nyctaginaceae	18
Bosqueia angolensis	moraceae	6
Calopogonium mucunoides	Fabaceae	8
Canthium sp.	Rubiaceae	2
Capolobia lutea	Polygalaceae	1
Centrosema pubescens	Fabaceae	2
Chromolaena odorata	Asteraceae	7
Cidrela odorata	Meliaceae	74
Cissus quadrangularis	Vitaceae	13
Cocus nucifera	Arecaceae	2
Cola millenii	Sterculiaceae	4
Combretum racemosun	Combretaceae	19
Comelina diffusa	Commelinaceae	57
Dalbergia latifolia	Fabaceae	2
Delonix regia	Fabaceae	5
Elaeis guineensis	Palmae	14
Entandrophragma cylindricum	Meliaceae	1
Enterolobium cyclocarpum	Fabaceae	74
Euphorbia sp.	Euphorbiaceae	4
Ficus capensis	Moraceae	1
Ficus exasperata	Moraceae	3
Ficus sp.	Moraceae	2
Ficus thoningii	Moraceae	2
Gmelina arborea	Lamiaceae	1
Greenwayerodendron suaveolans	Annonaceae	5
Holarhena floribunda	Apocynaceae	3
Icacina trichanta	Icacinaceae	4
Laportea aestuans	Urticaceae	2

Lecanodiscus cupanioides	Sapindaceae	1
Leucaena leucocephala	Fabaceae	30
Malacantha alnifolia	Sapotaceae	1
Mangifera indica	Anacardiaceae	2
Margaritaria discoidea	Phyllanthaceae	4
Microdesmis puberula	Pandaceae	3
Morinda lucida	Rubiaceae	7
Nauclea laxiflora	Rubiaceae	33
Newbouldia laevis	Bignoniaceae	1
Parquetina nigrescens	Asclepiadaceae	1
Peltophorum pterocarpum	Fabaceae	6
Peperoma pelucida	Piperaceae	2
Petivera aliacea	Petiveriaceae	90
Polyalthia longifolia	Annonaceae	3
Pupalia lappacea	Amaranthaceae	40
Raffia hookeri	Arecaceae	2
Rauvolfia vomitoria	Apocynaceae	*9*
Secamone afzelii	Asclepiadaceae	*1*
Sena alata	Fabaceae	*7*
Solenostemon monostachyus	Lamiaceae	*36*
Spathodia campanulata	Bignoniaceae	*2*
Talinum fruticosum	Talinaceae	*5*
Terminalia superba	Euphorbiaceae	*1*
Trichilia heudelotii	Meliaceae	*4*
Trichilia monadelfa	Meliaceae	*3*
Tridax procumbens	Asteraceae	*10*
Triplochiton scleroxylon	Malvaceae	*1*
Vocanga africana	Apocynaceae	*1*

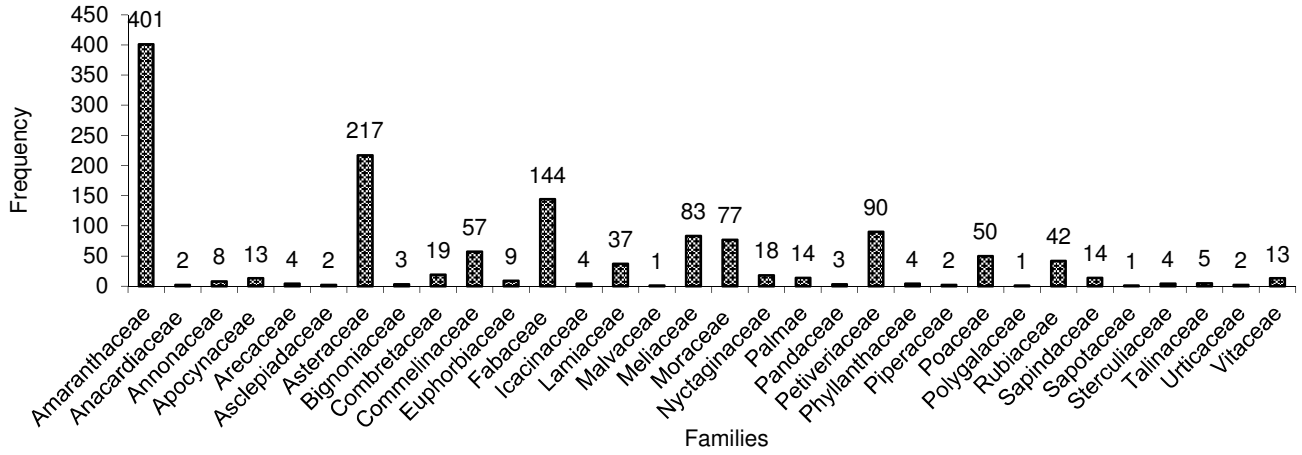

Fig. 1. Distribution of the plant species by family identified in sampling plots within the botanical gardens, University of Ibadan

The mean plant abundance was observed to be highest in point 6 showing a possible positive relationship between bird species and plant abundance. Point 7 had the lowest mean plant abundance. Similarly, point 6 contributed most (14%) to the plant species richness of the site (Figure 2). This is closely followed by point 5 (13%) and the point 8 happened to have the lowest contribution (3%) to the plant species richness (Figure 2).

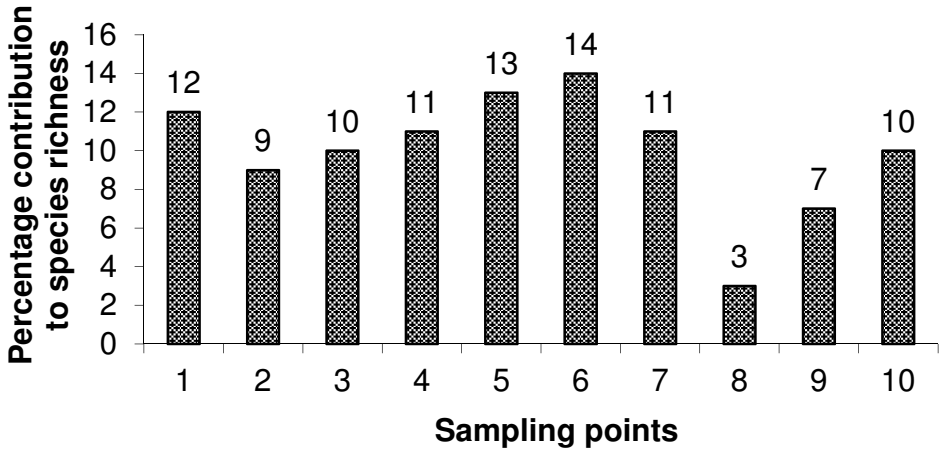

Fig. 2. Distribution of the sampling points by percentage contribution to plant species richness within the botanical gardens, University of Ibadan

Effect of Time of Day on Bird Species Richness

The mean bird species richness was generally observed to be higher in the morning period than in the evening period. In both periods bird species richness was highest at point 6, followed by point 8 in the morning, and point 5 in the evening.

Effect of Canopy Cover, Litter Cover and Ground Cover on Bird Diversity

There was no significant effect of canopy cover and ground cover on bird species richness (Table 3). However, there was a significant effect of ground cover and litter cover on Shannon bird diversity H (Table 4a &b and Table 5a &b) and Simpson bird diversity (Table 6a &b and Table 7a &b)

Table 3: Univariate analysis of variance showing effect of canopy cover and ground cover on bird species richness within the botanical gardens, University of Ibadan

Source	SS	df	MS	F	P
Corrected Model	34.30	2	12.15	.171	.84
Intercept	81.06	1	81.06	1.14	.30
Canopy Cover	20.89	1	20.89	.29	.59
Ground cover	18.89	1	18	.27	.61
Error	1206.65	17	89		
Total	8113.00	20	70		
Corrected Total	1230.95	19	98		

Adjusted R Square=-0.96

Table 4a: Univariate analysis of variance showing effect of canopy cover and ground cover on Shannon diversity H, within the botanical gardens, University of Ibadan

Source	SS	df	MS	F	P
Corrected Model	1.89	2	.95	9.90	.00
Intercept	2.81	1	2.81	29.43	.00
Ground cover	.98	1	.98	10.31	.00
Canopy Cover	.01	1	.01	.09	.76
Error	1.62	17	.09		
Total	63.19	20			
Corrected Total	3.51	19			

Adjusted R Square=.48

Table 4b: Parameter Estimates

Parameter	B	Std Error	t	P	95% Confidence Interval	
Intercept	2.24	.41	5.42	.00	1.37	3.11
Canopy cover	-.01	.00	-3.21	.00	-.02	-.00
Ground cover	.00	.01	.31	.76	-.01	.01

Table 5a: Univariate analysis of variance showing effect of Litter cover on Shannon diversity H, within the botanical gardens, University of Ibadan

Source	SS	df	MS	F	P
Corrected Model	1.72	1	1.73	17.56	.00
Intercept	3.31	1	3.31	33.55	.00
Litter Cover	1.73	1	1.73	17.56	.00
Error	1.78	18			
Total	63.19	20			
Corrected Total	3.51	19			

Adjusted R Square=-0.47

Table 5b: Parameter Estimates

Parameter	B	Std Error	t	P	95% Confidence Interval	
Intercept	1.04	.18	5.79	0.00	.66	1.41
Litter cover	.01	.00	4.19	.00	.00	.02

Table 6a: Effect of Ground cover and Canopy cover on Simpson diversity Ds, within the botanical gardens, University of Ibadan

Source	SS	df	MS	F	P
Corrected Model	.10	2	.05	10.22	.00
Intercept	.00	1	.01	1.77	.20
Ground cover	.07	1	.07	12.93	.00
Canopy cover	.00	1	.00	.04	.84
Error	.09	17	.01		
Total	1.88	20			
Corrected Total	.19	19	1	.98	.01

Adjusted R Square=-0.49

Table 6b: Parameter Estimates

Parameter	B	Std Error	t	P	95% Confidence Interval	
Intercept	.13	.09	1.33	.20	-.07	.33
Canopy cover	.00	.00	3.59	.00	.00	.01
Ground cover	.00	.00	202	.84	-.00	.00

Table 7a: Effect of Litter cover on Simpson diversity Ds, within the botanical gardens, University of Ibadan

Source	SS	df	MS	F	P
Corrected Model	.09	1	.09	16.93	.00
Intercept	..62	1	.62	115.68	.00
Litter Cover	.09	1	.09	16.93	.00
Error	.09	18	.00		
Total	1.88	20			
Corrected Total	.19	19			

Adjusted R Square=-0.46

Table 7b: Parameter Estimates

Parameter	B	Std Error	t	P	95% Confidence Interval	
Intercept	.45	.04	10.76	.00	.36	.54
Litter cover	-.00	.00	-4.11	.00	-.00	-.00

Discussion

Bird species richness and points

A total of 55 bird species belonging to 23 families were recorded for the botanical gardens, university of Ibadan during this study between the period September to October, 2016. A total of 32 bird species were recorded for the same area by (Dehinbo and Morenikeji, 2003), 54 bird species by (Adeyanju and Adeyanju, 2012), and 46 bird species recorded by (Uwatt, 2014). In the latter two studies, survey was carried out for the whole campus area of the university of Ibadan in which the botanical gardens was only included to represent a 'forest' biotype. In all a total of about 83 bird species are the current up to date checklists for the university of Ibadan botanical garden. This shows the profitability of consistent monitoring of green spaces as effort is accumulated over time. Birds move consistently and often evade observers in any single outing. Adeyanju *et al.* (2014) gave an in depth discussion of birdlife around Ibadan bird hotspot over fifty years. Multiple outings well spread out over time give the best overview of bird species richness over time. Observer technique differences and expertise detection variation will also help to remove false positives and reduce to the nearest minimum absence of species (false negatives) that actually occur at any given site.

Bird species richness varied significantly across points. Point six (6) was observed to be the richest patch of all ten points, possibly showing it holds more resources that can accomodatebird species. Fewer and small-sized trees were observed in this point, however understorey vegetation was predominant. Since feed for bird such as insects and grubs live mostly in understorey layer, high bird species richness can be attributed to increased foraging opportunities in that patch. The point with

the lowest bird species richness was point one (1), this area was characterised predominatly by tall trees with low ground cover and high litter cover. Perhaps the low activities of birds in the area is due to low feed availability as a result of high litter cover and high energy needed by birds to fly to tall trees in search of food. Hence, birds prefer areas with high ground cover and few, but small trees.

Existing Vegetative Characteristics of the University of Ibadan Botanical Garden

Following the relatively higher proportion of the herbaceous life-form to tree and shrub components which higher impact and contribution to the greenery of the environment, the University of Ibadan botanical garden requires some management practices to improve its vegetative characteristics for optimum biodiversity benefits Report (White *et al.*, 2014) has shown that trees and shrubs plant habits provide better and suitable habitat for the survival of bird than the other growth habit. Therefore, any management practice such as enrichment planting that increases the diversity of the tree component should be encouraged to maximize the ecotourism potential of garden, because the higher the tree diversity, the higher the avifauna component (White *et al*., 2014). On the other hand, the existing vegetative nature of the garden is gradually mimicking that of natural environment by having Fabaceae as the most dominant family in the study. This agrees with Ciocarlan, (2015), who reported similar finding at the botanical garden (Institute) of ASM.

Litter cover showed a significant but negative relationship with ground cover and plant abundance, and a positive relationship with canopy cover, $P<0.05$. This implies that litter cover was low where there was high ground cover and high plant abundance, and high where there was high canopy cover.

Ground cover showed a significant but negative relationship with canopy cover and a positive relationship with plant abundance implying that higher ground cover was observed where canopy cover was low. This may be as a result of the fact that reduced canopy cover leads to increased sunlight penetration and growth of understorey vegetation (i.e ground cover) and more plants generally.

Plant abundance was high in areas where ground cover was high, and where canopy cover was low. However, there was no significant relationship between plant abundance and canopy cover $P=-.282$ ($P>0.05$).

Effect of Canopy Cover, Ground Cover and Litter Cover on Bird Diversity

There was a significant effect of ground cover and litter cover on bird species diversity but no significant relationship between canopy cover and bird species diversity. There was a significant effect of ground cover, canopy cover and litter cover on bird species diversity. Higher canopy cover and ground cover led to increased bird diversity, this can be attributed to the fact that increased vegetation cover provides more foraging opportunities for birds due to the presence of insects, and other feed types. This conforms with the findings of most studies (Ferger *et al*., 2014) showing that the most important factor influencing bird species richness is the amount of vegetation cover. Litter cover and bird diversity were also positively related.

Conclusion and Recommendations

The botanical garden serves as an ideal ecotourism site with its collection of vast plant forms and the fauna species. People from far and near can identify and appreciate these life forms in an ecologically friendly manner. There are about 10 sections within the garden namely rock garden section, conserved forest section, water and bog section, arboretum section, nursery section, children garden section, open field, medicinal section, ornamental plant section and rose garden section. Each section and its unique features provide areas for relaxation and recreation. The presence of over eighty species of birds and numerous plants as observed in this study depicts the viability of the botanical garden, University of Ibadan to support nature tourism. Wih increased influx of ecotourists to the university of Ibadan botanical gardens, funds can be generated for optimum management of the gardens and payment of staff such as the curators, care takers, security personnels among others. Pocket sized guidebooks as the common birds and plants of IITA, will lure general novices into the rich diversity of birds in our greenspaces. Visits at the botanical garden could be improved if the site is made accessible for nature clubs and courses in the University that are plant or ecological in orientation, as well as regular update of her website and social media handles.

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Field data was collected by LMF and ATE. Unfamiliar bird calls and sightings on the field were recorded by digital recorder and camera for confirmation by AAT. All plants seen within the area were identified to species level with the help of forest resources expert OAO. Statistical analysis were carried out by AAT and OAO.

References

Adeyanju, A.T., Ottosson, U., Adeyanju, T.E., Omotoriogun, T.C., Hall, P., Shiiwua, M., … Bown, D. (2014). Birds of the International Institute for Tropical Agriculture campus, a stronghold of avian diversity in the changing Ibadan area (Nigeria) over the last 50 years. *Malimbus*, 36(2): 76–105.

Adeyanju, T.E. and Adeyanju, A.T. (2012). Avifauna of University of Ibadan Environs, Ibadan, Nigeria. *People and Biodiversity Conservation in 21st Century*. Presented at the Proceedings of 3rd Annual Seminar of Nigeria Tropical Biology Association (NTBA)held at the University of Ibadan on 25th September, 2012.

Borrow, N. and Demey, R. (2001). *Identification Guide: Birds of Western Africa*. Christopher Helm.

Borrow, N. and Demey, R. (2008). *Handbook to the Birds of Western Africa* (Vol. 1). Christopher Helm.

Ciocarlan, N. (2015). Taxonomic Diversity of Medicinal Plant collection from Botanical Garden (I) of ASM. *Journal of Botany*, 11(2): 85–90.

Coleman, J. (2016). *Urbanization and the abundance and diversity of Prairie bats*. (June). https://doi.org/10.1007/s11252-011-0181-8

Coleman, J.L., and Barclay, R.M.R. (2016). Prey availability and foraging activity of grassland bats in relation to urbanization. *Journal of Mammalogy*, 94(5): 1111–1122.

https://doi.org/10.1644/12-MAMM-A-217.1

Cushman, S.A., Mcrae, B., Adriaensen, F., Beier, P., Shirley, M. and Zeller, K. (2013). *Biological corridors and connectivity*.

Dehinbo, A.J. and Morenikeji, O.A. (2003). The Survey of Birds in the University of Ibadan. *The Zoologist*, 2(1): 62–69.

Elgood, J.H. (1988). Rediscovery of *Malimbus ibadanensis* Elgood. *Bulletin of The British Ornithologists' Club*, *108*, 184–185. Retrieved from http://biostor.org/reference/112342

Ferger, S.W., Schleuning, M., Hemp, A., Howell, K.M. and Böhning-Gaese, K. (2014). Food resources and vegetation structure mediate climatic effects on species richness of birds. *Global Ecology and Biogeography*, *23*(5), 541–549. https://doi.org/10.1111/geb.12151

Larsen, T.B. (2005). *Butterflies of West Africa*. Stenstrup: Apollo Books.

Lindenmayer, D.B. (1999). Future directions for biodiversity conservation in managed forests: Indicator species, impact studies and monitoring programs. *Forest Ecology & Management*, 115(2–3): 277–287. https://doi.org/10.1016/S0378-1127(98)00406-X

McKinney, M.L. (2008). Effects of urbanization on species richness: A review of plants and animals. *Urban Ecosystems*, 11: 161–176.

Mensah, C.A. (2014). Urban green spaces in Africa: Nature and challenges. *International Journal of Ecosystem*, *4*(1), 1–11. https://doi.org/10.5923/j.ije.20140401.01

Neuenschwander, P., Bown, D., Hedegbetan, G.C. and Adomou, A. (2015). Long-term conservation and rehabilitation of threatened rain forest patches under different human population ... *Nature Conservation*, 13(January 2016), 21–46. https://doi.org/10.3897/natureconservation.13.6539

Parson, H., Major, R.E. and Kris, F. (2006). Species interactions and habitat associations of birds inhabiting urban areas of Sydney, Australia. *Austral Ecology*, 31: 217.

Uwatt, A. (2014). *Avifauna diversity of University of Ibadan Environs* (MSc dissertation Department of Wildlife and Ecotourism Management). University of Ibadan., Ibadan.

Waltert Bobo, K.S., Sainge, N.M., Fermon, H. and Mühlenberg, M.M. (2005). From forest to framland: Habitat effects on afrotropical forest bird diversity. *Ecological Applications*, 15(4): 1351–1366. https://doi.org/10.1890/04-1002

White, J.G., Fitzsimons, J.A., Palmer, G. C. and Mark, J.A. (2014). Surviving urbanization: Maintaining bird species diversity in urban Melbourne. *Birds in the Urban Environment*, *126*, 73–78.

Yu, T. and Guo, Y. (2013). Effects of Urbanization on Bird Species Richness and Community Composition. *Pakistan Journal of Zoology*, 45(1): 59–69.