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Diversity And Distribution Of Birds On The Kwame Nkrumah University Of Science & Technology Campus, Kumasi-Ghana

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Abstract: ***Kwame Nkrumah University of Science and Technology in Ghana has undergone transformation of the natural habitat into residential, offices and classrooms over the years but this appears to have created favorable conditions for the development of certain species of wildlife. By identifying bird calls and point count technique, the diversity and distribution of bird species on the campus were determined from 15 randomly selected sites in December, 2015 and January, 2016. Total of 101 species of birds belonging to 39 families were recorded. Out of these, 80 species and 34 families occurred in the Senior Staff residential areas. The Faculty had 31 families (61 species) and 27 families (41 species) in the Botanic garden. From Similarity indices, there was significant level of comparative resemblance between most study plots. Pied Crow (Corvus albus) was most abundant with relative abundance of 11.24(11%) followed by Cattle Egret (Bubulcus ibis), 9.86(10%), Laughing Dove (Spilopelia senegalensis), 6.11(6%), Bronze Manikin (Lonchura cucullata) 5.54(5%) in that order. A significant proportion of the bird species on the campus were generalists, with few specialists mostly in the Botanic Garden. The rich bird diversity could be due to availability of food, vegetation cover and absence of hunting activities.***

Keywords: Corvus albus, Kumasi, bird diversity, Botanic garden.

I. OVERVIEW

Birds form part of the fauna of all habitat types, and since they respond to change in habitat factors, their diversity and abundance can reflect ecological trends in habitat (Kremen and Colwell, 1993). Birds become increasingly intolerant of slight ecosystem disturbance because of their highly-specific habitat requirement. Thus, the evaluation of high abundance and diversity of bird species in an ecosystem therefore serve as indication of the quality of environmental health in and around forest reserves **(**Broadmeadow and Nisbet, 2004).

The degree of urbanization in a landscape correlates negatively with the abundance of bird species and diversity (Melles, *et al*., 2003).

Within different ecosystems, birds often execute a role of top level predators, and if these species start to decline in numbers, they highlight wider glitches within the food chain, enabling the Wildlife division to act (Prugh *et al*., 2009. For instance, declines in certain seabird species may notify conservationists that there are essential problems with marine ecosystems. Within habitats in the built-up areas, such as the Campus of KNUST, which is barely anticipated to have significant bird species and to some extent, might be illustrative of the continuous destruction of natural vegetation for academic facilities and the dense nature of human population on the campus. This notion that necessitated this research to ascertain the species diversity on the campus of KNUST.

A. ECOLOGY OF BIRD DIVERSITY

KNUST campus is located at a very ideal place with a unique ecosystem in Kumasi. The school has an estimated four – mile square of aesthetic beauty, a rising and falling

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landscape, a wide range of trees, stretches of well-kept lawns and a very conspicuous flora, buildings of different types for academic purposes, student hostels and places for commercial activities. Even though the campus has a 15 hectare botanic garden which encompass a protected area with diverse plant species and expected to provide a comfortable habitat for different species of birds as indicated by Tews *et al.*, (2006), this might not be a reality on this campus. From their study, niche diversity is enhanced as a result of increasing the complex nature of vegetation, floristic composition and heterogeneity of birds and vice versa.

The landscape of the Kwame Nkrumah University of Science and Technology has been undergoing major changes due to rapid urbanization driven by a fast growing human population on the campus. Human density in this area may reach 40,000 and it is projected that a higher figure could be obtained in the near future. The fragmented nature of KNUST campus is expected to have some influence on the abundance of bird species Hobson *et al*., (2000).

As a result of the invaluable role of birds in the sustainability and conservation of ecosystem and biodiversity at large, people make efforts to safeguard them in order to help avert many biological threats on the communities. Insectivorous species and raptors regulate disease vectors, including mosquitoes and rodents (Whelan *et al*., 2008). Scavengers such as vultures provide such an excellent ecosystem service by removing diseases from the environment as they consume carrion. Fruit-eating birds play an important role in seed dispersal of fleshy fruit-producing plants. Others like sunbirds, mannikins, are pollinators and so enhance reproduction of plants. There are other important parts of birds such as the feathers, usually obtained and used in a number of industrial applications as a medium for culturing microbes, biodegradable polymers and production of enzymes (Kanchana *et al.*, 2013). Feathers of large birds such as geese are used to make quill pens and an adhesive for wood board (Acda *et al*., 2010).

Birds such as hooded vulture, *Necrosyrtes monachus*, cattle egret, *Bubulcus ibis* and canary, *Serinus canaria*, are also used as indicator species for monitoring biodiversity in the community so that any changes that probably arise within the habitat are reflected by the indicator species (Balmford, 2013).

II. MATERIALS AND METHODS

A. STUDY AREA

Surveying of birds was carried out on the campus of KNUST, Kumasi. (Ashanti Region has semi-deciduous forest vegetation with an average minimum daily temperature (per annum) of 21.57°C, average maximum daily temperature (per annum) of 30.65°C and average rainfall pattern of 116.9mm per annum. It has the longitudes and latitudes of 6°41'5.67"N 1°34'13.87"W (6.6849083°N, 1.5705194°W) respectively. KNUST has a total land area of 554, 492 hectares (ha)

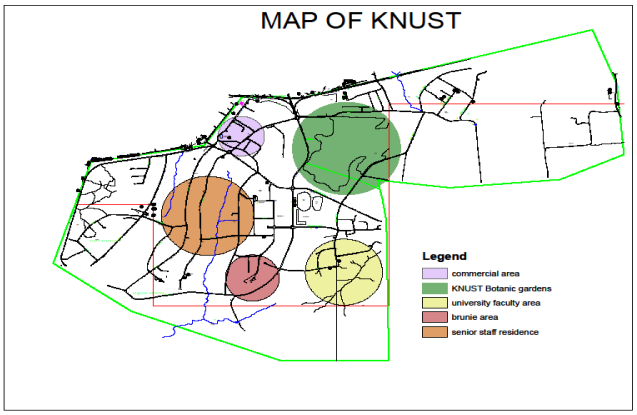

Figure 1: Map of KNUST showing the study areas

B. SELECTION OF PLOTS

The campus was divided into five (5) sites; The Botanic garden (site 1), Faculty area (site 2), Lecturers residence (site 3), Commercial area (site 4), and Brunei (site 5). Within each section were randomly selected plots of sizes 100m x 100m where birds were identified and recorded.

a. DESCRIPTION OF SITES

The KNUST Botanic Garden is a reserved area with minimal human activities. It has a dense forest stratification (i.e. forest floor, understory, canopy and emergent). Trees in the botanic garden are very tall, most of them with heights ranging from 28m to 30m, some indigenous and few exotic in origin. It covers an area of 15 hectres (ha)

University Faculty area: this is the site with the highest human activities especially during the day. It is dominated by ornamental plants found in both wet and dry lands such as sedges (*Carex* spp.) and willow species (*Salix* spp.). Vegetation in this area is constantly changing due to numerous construction activities and revamps. The vegetative cover is characterized by a lot of ornamental plants, tall trees, grassland, lawns, farmlands and wetlands.

Lecturers Residence; a formal settlement area with buildings (Staff bungalow), tall trees as well as lawns giving it a dense nature. Human activities are minimal in this area.

Commercial area: this site is dominated by edifices, such as shopping mall, banking halls, administrative offices and small shrubs that are few and far in between. It is a place with a lot of commercial activities but periodically subjected to construction and renovations.

Brunei: Stretches of grasslands and some trees form part of this stretch of land. It is also subjected to some construction farming on small scale.

C. CENSUSES

Birds were surveyed from the periods of December 2015 to January 2016. Surveys took place in two sessions, early in the mornings before sunrise at 5:30am and ended at 8:30am and late afternoon from 3:00pm to 4:00pm. . In each study site 3 plots were selected and a total of fifteen (15) plots were obtained at random with dimensions 100m x 100m. "Point

count method" and identification of bird calls were adopted for the survey of the birds (Jiguet and Frede, 2009).

D. POINT COUNT

This involves seeing the bird, pointing, counting (taking down records), and capturing a footage along a walking transect (i.e. systematic walk along a defined path across a project area). The boundaries as well as the point count station were marked by white tape to make them visible. General observation of the surrounding vegetation was done. At a location within a plot all birds encountered (both visually and vocally) were systematically recorded with counts, moving along the walking transect. Each count was conducted for 30 minutes and survey of each plot took place on two different occasions within two weeks.

E. IDENTIFICATION OF BIRDS

Using the field record sheet all birds seen or heard to the sides of the walking transect were recorded. Footages of birds were taken using both Panasonic-Lumix and Nikon camera for better clarification and precise identification. The same timing was maintained in all visits. Identification of birds was done by using a pair of binoculars for closer viewing. Some of the birds were also identified from literature (Borrow and Demey, 2013) and (Perlo, 2002), and their calls.

F. DATA ANALYSIS

Bird community diversity for each section and the correlation between the different study areas were calculated using Shannon Wiener (H′) index whilst the similarities in the five sections were calculated using Jaccard Index, (Cj) given that:

$$H = -\sum_{x=1}^{n} \left[\left(\frac{n_i}{N}\right) * \ln\left(\frac{n_i}{N}\right)\right] \text{.....1}$$

$$D = \sum_{x=1}^{n} \left[\frac{n_i(n_i-1)}{N(N-1)}\right] \text{.....2}$$

$$C_j = \frac{j}{(a+b-j)} \text{.....3}$$

The relative abundance (RA) of each species in the different sections was also calculated by the formula

$$R.A\ (\%) = \frac{n_i}{N} \times 100 \text{.....4}$$

Where,

n = total number of organisms of each species (thus, n_i= number of individuals in the i^{th} species)

N = total number of organisms of all species

j = number of species found in both sites,

a = number of species in site 'A'

b = number of species in site 'B'.

R.A = relative abundance

a. SHANNON DIVERSITY INDEX

Shannon diversity index (H) which is commonly used to characterize species diversity in a community accounts for both abundance and evenness of species present. **(**Equation 1)

b. SHANNON'S EQUITABILITY OR EVENNESS

$E_H = H/ H_{max}$

Where

E_H = Shannon's equitability or Evenness

H_{max}= Maximum diversity possible (lnS)

S = Number of Species *****

c. JACCARD SIMILARITY INDEX

Jaccard similarity index (Jaccard similarity coefficient) is the quotient between the intersection and the union of the pairwise compared variables among two objects. It is sometimes used for Jaccard dissimilarity and known as Jaccard distance. A value is "0" indicates that the documents are completely dissimilar and "1" suggests identity. Values between "0" and "1" represent the degree of similarity.

$$Cj = \left[\frac{j}{a+b-j}\right]$$

The size of the intersection divided by the size of the union of the sample sets:

$$*(J,B) = \frac{|A \cap B|}{|A \cup B|} = \frac{|A \cap B|}{|A|+|B|-|A \cup B|}$$

If A and B are both empty, then J (A, B) = 1.

$0 \leq J(A, B) \leq 1$.

III. RESULTS

BIRD SPECIES IDENTIFIED

In all, 101 bird species were identified on KNUST campus and these were made up of 39 families. 80 bird species were recorded at Lecturers residence, 63 at Faculty area, 41 at Brunei (student's hostel area), 38 at Botanic Garden and 24 at Commercial area (Fig. 3)

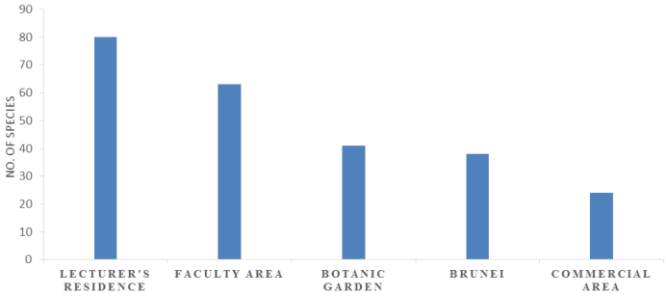

Figure 2: Number of Bird species identified on study plots

ABUNDANCE OF BIRD SPECIES ON KNUST CAMPUS

The most abundant bird species on the campus of KNUST was pied crow *(Corvus albus)* with a relative abundance of 11.24 which was followed by Cattle egret (*Bubulcus ibis*) with relative abundance of 9.86. Laughing dove (*Spilopelia senegalensis*) is the third with a relative abundance of 6.11; this were followed by Bronze manikin (*Lonchura cucullata*) with relative abundance of 5.54. The remaining bird species have relative abundance of less than 5 (Fig 2)

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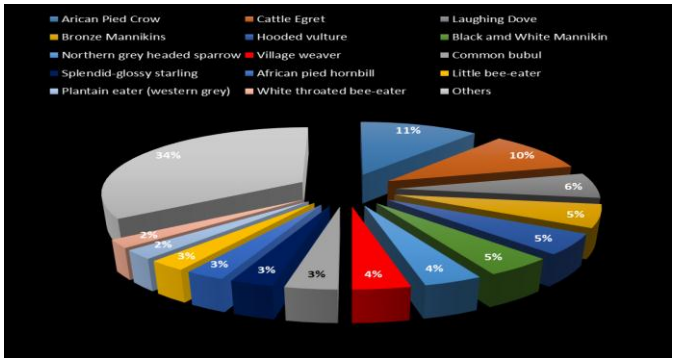

Figure 3: Abundance of bird species on KNUST campus

ABUNDANCE OF BIRD FAMILIES ON KNUST CAMPUS

Entirely, the dominant family was Estrildidae, comprising 12% of the total number of families, followed in order by Corvidae (11%), Ardeidae (11%), Accipitridae (6%), Ploceidae (6%). Fig.3 6 indicates the abundance of bird families identified

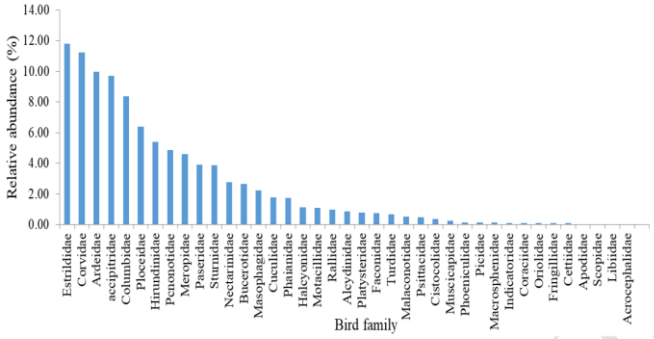

Figure 4: Relative abundance of bird families

IV. DEGREE OF DIVERSITY

An indication of the extent to which every study site was diversified and how the birds were distributed is presented in the Table 1 below. Shannon-Wiener indices (H) indicates that the Faculty area is most divers whilst the commercial area is least diverse.

Study Area	Number of bird species	Shannon wiener index (H′)	Evenness
Faculty Area	63	3.37	0.88
Lecturers Residence	80	3.25	0.74
Botanic Garden	41	3.18	0.86
Brunei	38	2.92	0.82
Commercial Area	24	2.59	0.80

Table 1: Species diversity

SIMILARITY BETWEEN COMPARED SITES

Table 2 below depicts that there is high level of similarity amongst all the sites, although Faculty and Brunei shows the greatest of similarity with 0.87 which could probably be due to dissimilarity of the two sites.

SITES	JACCARD'S INDEX
Faculty & Brunei	0.87
Faculty & Lecturers' residence	0.86
Commercial area & Brunei	0.84
Lecturers' residence & Botanic Garden	0.82
Botanic Garden & Faculty	0.81
Lecturers' residence & Brunei	0.77
Brunei & Botanic Garden	0.75
Faculty & Commercial area	0.69
Lecturers' residence & Commercial area	0.69
Botanic Garden & Commercial area	0.66

Table2I: Jaccard's similarity indices for sites

TOTAL NUMBER OF BIRD SPECIES ON KNUST CAMPUS

In all 101 bird species were identified. Pied crow, *Corvus albus* was the most abundant, a few of them were frequent and the majority being rare.

Scientific Name	**Common Name**	**Family**	**Status**
Streptopelia roseogrisea	African collared dove	Columbidae	R
Ispidina lecontei	African dwarf kingfisher	Alcednidae	R
Oriolus auratus	African golden oriole	Oriolidae	R
Treron calvus	African green pigeon	Columbidae	R
Cypsiurus parvus	African palm swift	Apodidae	R
Tockus fasciatus	African pied hornbill	Bucerotidae	R
Motacilla aguimp	African pied wagtail	Motacillidae	R
Ispidina pica	African pygmy kingfisher	Alcednidae	R
Turdus pelios	African thrush	Turdidae	C
Porphyrio alleni	Allen's gallinule	Rallidae	R
Lagonosticta rufopicta	Bar breasted finch	Estrildidae	R
Bias musicus	Black & white flycatcher	tyrannidae	R
Lonchura bicolor	Black and white manikin	Estrildidae	C
Turtur abyssinicus	Black billed wood dove	Columbidae	R
Amaurornis flavirostra	Black crake	Rallidae	R
Tchagra senegala	Black crowned tchagra	Malaconcotidae	R
Ploceus melanocephalus	Black- headed weaver	Ploceidae	R
Milvus migrans	Black kite	Accipitridae	R
Rhinopomastus aterrimus	Black scimitarbill (hoopoe)	Phoeniculidae	R
Ploceus nigricollis	Black-necked weaver	Ploceidae	R
Centropus monachus	Blue headed cuocal	Cuculidae	R
Turtur afer	Blue spotted dove	Columbidae	R
Lagonosticta rubricate	Blue-billed fire finch	Estrildidae	R
Halcyon malimbica	Blue-breasted Kingfisher	Halcyonidae	R
Eurystomus gularis	Blue-throated roller	Coraciidae	R
Lonchura cucullata	Bronze manikin	Estrildidae	C
Tchagra australis	Brown crowned tchagra	Malaconcotidae	R

Chalcomitra adelberti	Buff-throated sunbird	Nectariniidae	R
Andropadus curvirostris	Cameroon sombre green bulbul	Pycnonotidae	R
Bubulcus ibis	Cattle egret	Ardeidae	A
Hedydipna collaris	Collared sunbird	Nectariniidae	R
Pycnonotus barbatus	Common bulbul	Pycnonotidae	F
Cuculus canorus	Common cuckoo	Cuculidae	R
Delichon urbicum	Common house martin	Hirundinidae	R
Falco tinnunculus	Common Kestrel	Faconidae	R
Gallinula chloropus	Common Moorehen	Rallidae	R
Lamprotornis cupreocauda	Copper-tailed glossy starling	Sturnidae	R
Gallus gallus domesticus	Domestic fowls	Phasianidae	C
Muscicapa comitata	Dusky blue flycatcher	Muscicapidae	R
Cercotrichas leucosticte	Forest Scrub robin	Muscicapidae	R
Dendropicos gabonensis	Garbon woodpecker	Picidae	R
Acrocephalus arundinaceus	Great Reed (warbler)	Acrocephalidae	R
Butorides virescens	Green backed heron	Ardeidae	R
Campethera cailliautii	Green backed woodpecker	Picidae	R
Sylvietta virens	Green crombec (warbler)	Macrosphenidae	R
Cyanomitra verticalis	Green headed sunbird	Nectariniidae	R
Hylia prasina	Green hylia(warbler)	Cettiidae	R
Phoeniculus purpureus	Green wood hoopoe	Phoeniculidae	R
Camaroptera brevicaudata	Grey backed camaroptera	Cettiidae	R
Falco ardosiaceus	Grey Kestrel	Faconidae	R
Scopus umbretta	Hamerkop	Scopidae	R
Necrosyrtes monachus	Hooded vulture	Accipitridae	C
Phyllastrephus icterinus	Icterine greenbul	Pycnonotidae	R
Clamato jacobinus	Jacobin cuckoo	Cuculidae	R
Macrosphenus kempi	Kemps longbill (warbler)	Macrosphenidae	R
Spilopelia senegalensis	Laughing dove	Columbidae	A
Merops pusillus	Little bee-eater	Meropidae	U
Ixobrychus minutus	Little bittern	Ardeidae	R
Campethera maculosa	Little green woodpecker	Picidae	R
Eurillas virens	Little greenbul	Pycnonotidae	R
Lonchura fringilloides	Magpie	Estrildidae	R
Corythornis cristatus	Malachite kingfisher	Alcednidae	R
Tchagra minutus	Marsh tchagra	Malaconcotidae	R
Passer griseus	Northern grey headed sparrow	Passeridae	F
Dryoscopus gambensis	Northen puff-backed	Malaconcotidae	R
Cinnyris chloropygia	Olive- bellied sunbird	Nectariniidae	R
Cinnyris jugularis	Olive sunbird	Nectariniidae	R
Camaroptera chloronota	Olive-green camaroptera	Cettiidae	R
Corvus albus	Pied Crow	Corvidae	VA
Anthus leucophrys	Plain backed pipit	Motacillidae	R
Ardea purpurea	Purple heron	Ardeidae	V
Streptopelia semitorquata	Red-eyed dove	Columbidae	A
Psittacula krameri	Rose-ringed parakeet	Psittacidae	C
Cecropis semirufa	Rufous-chested swallow	Hirundinidae	A
Chalcomitra senegalensis	Scarlet-chested sunbird	Nectariniidae	R
Crithagra gularis	Seed eater (streaky headed)	Fringillidae	R
Centropus senegalensis	Senegal coucal	Cuculidae	C
Alcedo quadribrachys	Shinny blue kingfisher	Alcednidae	F
Megabyas flammulatus	Shrike flycatcher	Platysteiridae	R
Phyllastrephus scandens	Simple leaflove	Pycnonotidae	R
Ploceus pelzelni	Slender billed weaver	Ploceidae	R
Pogoniulus scolopaceus	Speckled thinkerbird (barbet)	Lybiidae	R
Cinnyris coccinigastrus	Splendid sunbird	Nectariniidae	R
Lamprotornis splendidus	Splendid-glossy starling	Sturnidae	F
Prinia subflava	Tawny-flanked prinia	Cettiidae	R
Psittacus erithacus timneh	Timneh-grey parrot	Psittacidae	V
Cinnyris minullus	Tiny sunbird	Nectariniidae	R
Ploceus nigerrimus	Vieillot's black weaver	Ploceidae	R
Ploceus cucullatus	Village weaver	Ploceidae	F
Ploceus vitellinus	Viteline masked weaver	Ploceidae	U
Crinifer piscator	Western grey plantain eater	Masophagidae	A
Saxicola rubetra	Whinchat	Muscicapidae	U
Cisticola lateralis	Whistling cistocola	Cettiidae	R
Gorsachius leuconotus	White backed night heron	Ardeidae	R
Corythornis leucogaster	White bellied Kingfisher	Meropidae	C
Merops albicollis	White throated bee-eater	Pycnonotidae	V
Phyllastrephus albigularis	White throated greenbul	Alcednidae	V
Indicator willcocksi	Willcock's honeyguide	Indicatoridae	R
Halcyon senegalensis	Woodland Kingfisher	Halcyonidae	F
Milvus aegyptius	Yellow billed-kite	Accipitridae	A
Motacilla flava	Yellow wagtail	Motacillidae	V

KEY

Very Abundant (VA) Above 100 may be seen or heard in suitable habitat per day

Abundant (A) 11-100 may be seen or heard in suitable habitat per day

Common (C) 1-10 may be seen or heard in suitable habitat per day

Frequent (F) often seen but not every day

Uncommon (U) several records per year

Rare (R) one record per several years (resident species)

Vagrant (V) one record per several years (non-residents.

Table 3: List of bird species on KNUST Campus

ISSN: 2394-4404

V. DISCUSSION

In concurrence with Paillet *et al.*, (2010), unique landscapes on KNUST campus correlated with differences in bird species abundance. The Lecturers residence portrayed by streams, scattered shrubberies and a few trees, warm natural surroundings and the wealth of insects represented the moderately most elevated in species abundance. Among different capacities, wetland fills in as an appropriate natural surroundings for all bird species as it gives a wellspring of drinking water, sustaining, shield, and other social interactions. This is the reason some aquatic birds, for example, bittern and black crake which have adjusted to wetlands were discovered.

Once more, grassland gives significant living spaces to an assortment of different birds of upland waterfowls, songbirds and raptors amid the reproducing season for courtship, nesting, rearing young ones, and perching.

Similarly, the high abundance of bird species in the school's Faculty area is conceivably because of the assortment of plant assets combined with human nearness. These plant assets incorporate blossoms that create nectar, natural product bearing trees and bushes that draw in birds, for example, sunbirds, starlings etc. The vegetation of the school's Faculty is depicted by farmlands, grasslands, and Lecture Halls. The high piece of sustenance and waste deposits in a few sections of Brunei offer a one of a kind open door for predators, for example, Swallows and African thrush. Birds that feast upon fish and some aquatic invertebrate, for example, hamerkop (*Scopus umbretta*) and allen's gallinule (*Porphyrio alleni*) were found around the stream behind Brunei as a result.

KNUST Botanic garden showed that heterogeneous nature of forests is likely to be favorable to only the specialists. On the contrary to the generalists, the forest canopy closure might be unfavorable. This might be because of the confined advancement of flowering and some herbaceous plant species in the understory. Strikingly, the shade structure in the Botanic garden fills in as an appropriate perching place for bats. Consequently there was high abundance of bats occupying the Garden which could be the reason for low wealth of even the specialists as studies have demonstrated that a few types of bat go after little flying creatures (Ibáñez, *et al.*, 2001). The less number of bird species recorded at the Commercial area could be represented by the less differentiated vegetation and high disturbance influences caused by a few human activities in the area. For this reason, 24 species belonging to 18 families were observed.

Jaccard's file was utilized to look at the closeness between every two locales and the result demonstrated more elevated amount of similitude of bird species among all the studied areas. This could likely be because of the nearness of one site to the next. In any case, there are somewhere in the range of couple of species, for example, the Rose-ringed parakeet, *Psittacula krameri*, Allen' gallinule, *Porphyrio alleni* that were limited to certain territory sorts.

Pied Crow (*Corvus albus*) was the most abundant species on KNUST campus and had all the earmarks of being the most adjusted to human-dominated places. For example, dissimilar to numerous other bird species on the Campus Pied Crow was close to numerous human facilities, for example, local yards and refuse dumping sites. Also, the Crows were seen near the wellspring of sustenance, including little reptiles, little warm blooded creatures, pieces of human nourishment, natural products, insects, and other little spineless creatures, which were for the most part accessible. Once more, it was discovered that the Campus was a breeding grounds for the crows and coincidentally their breeding season, which requires blending and mating was due. This therefore presumably pulled in a large number of these to the KNUST campus.

Overall number of species varied across different habitats ranging from 24 in the commercial area to 80 in the Lectures residence. This was in agreement with the mean of bird abundance which was highest in the Lectures residence, followed by Faculty area Botanic garden, Brunei and commercial area in that order. The Shannon-Wiener index ranged from 2.59 to 3.37. The highest Shannon-Wiener index recorded at the University Faculty area and Commercial area the lowest supported the logically well-known thought that decent variety of bird species in the developed areas can be as high as that in indigenous habitats (Melles *et al.*, 2003). As proposed by Pautasso and Marco, (2007), human populace and bird species abundance relate emphatically.

This study has shown that present untamed life protection endeavors don't match with ranges of the highest abundance of bird species diversity in urban zones. This was obviously buttressed by the number of bird species recorded on the campus of KNUST as against that which was recorded at Abiriw Sacred forest (Kesse *et al.*, 2005). The study along these lines justifies the need to ensure not just for the natural habitats of native wildlife yet in addition semi-regular and developed territories where birds are especially more successive.

The transient bird species recognized in the study site were regular dry season guests from Palearctic regions. Cattle Egret *Bubulcus ibis* and the Bee-eaters (*Merops apiaster*), had beforehand been located in the work done by Alphonsus and Mireku, (2015). The discoveries of this study empower the improvement of fledgling watching exercises in the provincial capitals at large, which might be exceptionally compelling to worldwide tourists because of the high number of urban-living, and accordingly effortlessly watched, restrictive bird species.

VI. CONCLUSIONS

The hypothesis that bird species inhabit thicket more than built-up areas was not supported in this study. This may be due to the natural landscape features and heterogeneity of the land use. Most of the time, these communities cultivate ornamental plants, as well as garden trees with extensive shade which provide habitat for both endemic and migrant birds.

Even though some habitats within open fields such as the Commercial area, which is highly dominated by human activities have a low number of bird species. This locale provides insufficient feeding opportunities for wildlife especially bird species and is therefore not a suitable habitat

for bird species as it may, for instance, expose small-sized birds to predators (Tews *et al*., 2004).

This study contributes to the knowledge of bird diversity and provides one of the most recent statuses of bird diversity on KNUST campus. Our findings confirm that bird diversity in urban areas can be as great as that in surrounding natural forests. The bird species diversity of this area can also be associated with the landscape feature of the environment, which significantly contribute to high abundance of urban tolerant species. Endemic birds such as Common bulbuls and hornbills in addition to many others were found as resident species. Similarly, a number of migratory birds were found on KNUST campus. Purple heron *Ardea purpurea* and Timneh grey parrot *Psittacus timneh* that had not been previously recorded on KNUST Campus were found for the first time. This study therefore justifies the necessity of protection not only for the natural habitats of native wildlife but also semi-natural and built up areas where birds are particularly more frequent. When the reserved habitat components are maintained for birds, these species would be conserved.

Lecturers' residence and University faculty area had the highest species diversity indices and abundance relative to Commercial area, Botanic garden and Brunei. It was noticed in this study that riverbank landscapes house the most specialized bird fauna. Example, black crake, *Amaurornis flavirostra* common moorhen, harmerkop, *Scopus umbretta* and other species that are limited to marshland environments and forests. It is anticipated that severe alteration of habitat through anthropogenic activities such as felling of trees, clearing of land for infrastructure and other construction works will tend to contribute the loss of bird species on KNUST campus.

VII. RECOMMENDATIONS

It is recommended that the development of institutional grounds and city land-use plans be duty-bound to consider biodiversity and maintain plant communities. Also, a database of bird species of KNUST should be kept for conservation action and forthcoming research follow-ups.

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