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The Green Street: Prospects for Avifauna Conservation in Calabar Metropolis, Nigeria

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Abstract: **Increasingly the benefits of green streets are being better defined and quantified through scientific research. The importance of this factor is still lagging behind in most metropolitan setting studies. The aim of this study is to examine the prospect for avifauna conservation in Calabar Metropolis, Nigeria using the green street concept. The study delineated the green street network, ascertains the area of buffer zone polygon, obtained data on bird species richness and developed manuscript map of green street buffer zone polygon for the study area. Twenty streets and forty bird species were used for this study. Data on bird species richness was obtained using the time-species count technique along transects at local time (10.00am-11.00am). The total length of the green street network was 62.96 km with 33.80 km^2 (21.58% of the total landmass) as total buffer zone polygon, six routes with pristine emergent trees recorded between 40 – 85 per cent of the bird species richness in the study area. It was observed that forest birds such as *Andrea cinerea* (Grey heron), *Egretta alba* (Great White heron), *Alcedo atthis* (Common Kingfisher), *Halcyon malimbica* (Blue-breasted Kingfisher), *Milvis migrans* (Black Kite) *Polyboroides typus* (African Harrier-hawk) and *Pica pica* (Pied Crow) have found the green street buffers as alternative to their forest habitats that are under threat. Also in this category are *Streptopelia senegalensis* (Laughing Dove), *Stretopelia semitorguata* (Red-eyed Dove), and *Tockus nasutus* (African Hornbill). *Estrilda astrild* (Common Waxbill), *Musicapa epulata* (Little Grey-flycatcher), *Terpsiphone rufiventa* (Black-headed Paradise Flycatcher) and *Musicapa caerulescens* (Ashy Flycatcher) that are catholic in their feeding habits are important residents of Calabar Metropolis. Generally, the result of this study shows that there are prospects for conservation of avifauna in Calabar Metropolis. In line with the above finding, this paper recommends that metropolitan planning should contain explicit goals with respect to green streets. Furthermore, systematic greening of larger parcels of open spaces need strengthened and developers should be encouraged to conserve more forest trees at development sites.**

Keywords: **Green Street, Systematic greening, Avifauna, Biodiversity, Conservation.**

I. INTRODUCTION

Urban ecology has significantly played important role in understanding the importance of species conservation. It sets watershed-based goals for managing the biodiversity on a site-by-site basis, providing strategies for incorporating conservation management. The magnitude of impacts due to the loss of green space in metropolis demonstrates the vital role of street in conservation of biodiversity. Special management techniques need to improve metropolitan quality. Components that facilitate this include plant diversity, structure, canopy, faunal species composition, and relationship to natural ecosystems.

Open space in urban environment provides sports and recreation, preservation of natural environments; provision of green space and urban storm water management. Hence, green spaces are key consideration to urban planning if the health of a city, its people and nature are important. Different explanations have been put forward on what constitutes the green

concept. This is based on different defined criteria; ranging from that advanced by the international community, financial agents, environmental pressure groups, to industries. For each of these, the focus varies ranging from the criteria of what are green, metrics and assessment systems. The environmental pressure groups based the criteria on what is green on: (i) having a top-level commitment to reduce environmental impact, (ii) setting targets and making progress in achieving them, and (iii) reducing material emissions and waste at source and undertaking recovery activities.

Green is a concept used by many across different sectors of the society in a loose manner; one of those words that most people find difficult to define with precision. As a metaphor, it encompasses what is best for the environment. Over the years, conservation movements have developed ideas of species preservation and conservation of nature reserves on national and regional levels to mitigate the human impacts on nature caused by development. In spite of the good intentions within the field of nature conservation, restructuring of land use, market gardening and building of huge road networks have caused fragmentation of natural areas. These have given rise to the deterioration of ecosystems, loss of natural habitats and habitat structures, and extinction of species (Stanners and Bourdean, 1995). The result is that the natural habitats look as if they were isolated islands. The smaller and more isolated these habitat islands are because of the ever-increasing land use and road network, the more likely species are to decline.

Species survival is dependent on habitat quality, food availability and for most species the ability to move through the landscape. According to Bennett (1998) and Opstal (1999), species move daily to avoid unfavourable environment, and for foraging, rest, shelter and reproduction. When environmental condition change, it is obvious that many species depend on their ability to colonize new areas. In this respect, there is reason to make the claim that landscape's connectivity is important and physically expressed in ecological network. This brings to focus the importance of 'green street' in response as one of the strategies of conserving the existing, more isolated landscape to the conservation and restoration of interconnected natural areas of a metropolitan setting.

Green Street is an ecological pathway that accommodates vehicular flow without interjecting with the rights of other species are migrants in the same environment. It is a representation of ecological network erroneously referred to as greenway. Greenway is a term referring to linear open space established along natural corridors such as riverfront, stream valley, a canal or scenic road. The idea about ecological networks have developed into various concepts for terrestrial systems of ecological stability, network of linear habitat connecting habitat islands on different geographical levels. While studying the European cities, Pysek (1998) observed that there is a balance between native and alien tree in the city core than the exurban. Godefroid (2001) further observed that most alien birds favoured in city core have increased tolerance of nitrogen, light, drought, heat and alkaline soil.

The relationship between urban morphology and planning is poorly developed along the line of urban greening in the developing countries. This is particularly evident in the weak representation of flora in both the theory and practice of planning of urban morphology hence species erosion of avifauna.

II. AIM AND OBJECTIVES

The aim of this study is to ascertain the prospects of biodiversity conservation using the green streets in Calabar metropolis, Cross River State (CRS), Nigeria with focus on avifauna. The study objectives are to:

1. Delineate the green streets network in the study area,
2. Ascertain the area of buffer zone polygons of green streets,
3. Assess the avian richness in the green streets buffer zone polygons, and
4. Develop manuscript map of green streets of the study area.

III. EVOLUTION OF THE 'GREEN STREET' IN CALABAR METROPOLIS

Calabar Metropolis lies within Latitude $4^{o}57^{/}$N and $5^{o}5^{/}$ and Longitude $8^{o}19^{/}$ and $8^{o}26^{/}$, located at the premonitory etched and washed by the Great Kwa and Calabar rivers and the Creeks of Cross River. It has a temperature range, 25^{o} – 28^{o}C, which remains relatively constant throughout the year with little variation between day and night temperatures. Annual rainfall is little above 3,000mm and the mean monthly rainfall ranging between 38 and 455mm with double maxima

yearly while the mean relative humidity is between 82 – 92 per cent (Oka and Bassey, 2017). The landscape of Calabar Metropolis is dominated by the bold Marina Escarpment and mangrove swamps. The escarpment extends to about three Kilometers along the waterfront of Old Town and Duke Town, rising vertically to about 30.5m above the Marine Terrace with a width of about 30.5m to 122m. The marshy tracts and extensive swamp along the riverbanks to the east and west of Calabar Metropolis constitute a major barrier to urban expansion along the waterfront. The early developments in the metropolis were along the center of the metropolis (Inyang, Usoro, Abasiekong and Sule, 1975). Calabar was chosen as the capital of Southern Nigeria Protectorate in 1901, a position it lost to Lagos in 1906 when the latter became the seat of Colony and Protectorate of Southern Nigeria. Following the establishment of the port of Port Harcourt in 1916, Calabar lost most of its economic hinterland. For a period of about 60 years, there was a steady decline of its political and economic activities but increase in plant and animal species along the creeks and hinterland vegetation belt.

In 1967, Calabar became the capital of South-eastern State; it provided administrative and commercial functions, and other services for its growing population. In addition to the older residents mainly of indigenous people (Efiks, Quas and Efuts), new residential areas were created; having housing estates, satellite towns, with enlarged road networks. Currently the landmass of Calabar is about 156.65Km^2 with a population of approximately 375,515 (2006, Nigeria National Population Census). The urban sprawl of 1967 to 1997 began to shrink the already existing ecosystem and species diversity. This led to a high frequency of species erosion.

In 1998, Government's attempt at landscape planning demonstrated a certain degree of awareness concerning the protection of resources based on linear territorial pattern. This established the basis for the development of cultural landscape aimed at 'greening' the streets in Calabar Metropolis. Different plans developed by successive administrations in since 1998 until date are major evidence of the use of linear structure such as road networks to improve the landscape. This plan advocates the need for a network system that would guide urban expansion and employ the garden city concept. The green street concept becomes significant instrument for protecting landscape quality by focusing on areas where most of the valuable and fragile resources are located. This move gave little or no attention to fauna loss. This gap has influenced the importance CRS government gave to plans and projects that are environmental friendly and improving the quality of urban ecology and biodiversity.

IV. METHODOLOGY

The data used in the study was obtained from established road network, buffers created by tree canopies and bird species richness within Calabar Metropolis. Orthophotographs of Calabar (2003, 2013) and ground truthing was used to ascertain the street network and buffer zone polygons of the designated green streets. A combination of the road network and the tree canopy form a thematic layer representing a new polygon referred to as green street buffer zone polygon. The choice of sampled streets was based on two premises: streets in the city center with high density of trees and streets linking exurban with city centers. Data on bird species richness were obtained through observation, identification and enumeration using Time-Species Count (TSC) technique. This is because the technique is important where sites are reasonably homogeneous and open. From the 40 bird species common in the study area based on data collected during the reconnaissance, all species positively identified in each sampled site were listed in the order seen. Data on bird richness was collected between 10.00am to 11.00am, when anthropogenic activities are low. All observations took place the same time and species flying over each sampled site are listed if it is using the site for roosting, feeding or nesting. At each site, observations were made until when no additional bird species is obtained. Captive birds did not form part of the enumeration. The choice of birds was because birds are important components of many ecosystems, catholic, penetrating and most conspicuous group among animals. Furthermore, birds are the most important environmental indicators; particularly useful in unexpected changes, monitoring and integrating cumulative changes (Pomeroy, 1992). This makes birds' key components of environmental Impact Assessment (EIA). The manuscript map of the 'green streets' was highlighted by simple cartographic principles and the area of the buffer zone polygon calculated after imposing the traced polygon on a metric graph sheet.

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V. RESULT AND DISCUSSION

Table I: Data Collected Along the Buffer Zone Polygon of 'Green Streets' In Calabar Metropolis

Street code	Street name	Status	Approximate length (Km)	Area of buffer zone polygon (Km^2)	Bird species richness	Percentage representation of bird species
001	Murtala Mohammed	4 Lanes	13.65	6.56	13	32.5
002	Ndidem Usang Iso	4 Lanes	4.50	1.44	8	20.0
003	Ibrahim Babangida	4 Lanes	2.55	1.40	14	35.0
004	Mary Slessor	4 Lanes	2.10	0.60	9	22.5
005	Eta Agbor Street	4 Lanes	1.65	0.72	10	25.0
006	Palm Street	2 Lanes	2.85	1.60	10	25.0
007	Goldie Street	2 Lanes	3.00	0.60	7	17.5
008	Dan Archibong Street	2 Lanes	1.62	0.80	7	17.5
009	Ekpo Abasi Street	2 Lanes	0.93	0.80	5	12.5
010	Uwanse Street	2 Lanes	1.80	0.84	7	17.5
011	MCC Road	2 Lanes	3.33	2.24	5	12.5
012	Library-Eastern Highway	2 Lanes	2.40	1.36	12	30.0
013	Target- Chamley Street	2 Lanes	1.88	0.24	20	50.0
014	Lemna Road	2 Lanes	2.10	1.64	34	85.0
015	Atekong	2 Lanes	1.20	0.56	9	22.5
016	Marina Street	2 Lanes	3.35	2,64	19	47.5
017	Anantigha Street	2 Lanes	1.35	1.72	16	40.0
018	Atimbo Road	2 Lanes	2.40	1.88	23	57.5
019	Access Road	2 Lanes	1.80	1.80	17	42.5
020	Old Odukpani Road	2 Lanes	8.40	4.36	8	20.0
		TOTAL	62.96	33.80		

Source: Authors' fieldwork, 2016.

From the 20 streets (FIG 1) and 40 bird species used in this study, result show that Murtala Mohammed Highway (13.65Km) with buffer zones of about $6.56Km^2$ accommodated 32.5 per cent from the baseline list. The shortest street, Ekpo Abasi Street, 0.93km with buffer zone polygon, $0.80Km^2$, recorded 12.5 per cent of the total birds. The highest percentage of bird species richness, 85 per cent, was observed along Lemna Road; Anantigha Street, Access Road, Marina Way, Target-Chamley Street and Atimbo Road recorded between 40 -57.5 per cent bird species richness. It was also observed that along these routes are emergent and pristine trees where forest birds found within Calabar Metropolis roost and nest. Eighteen (18) forest bird species observed in this study represents 45 per cent of birds used in the baseline list (APPENDIX 1). From this trend, the study inferred that the original habitats of these birds in the wild are under threat, hence, the migration to the Metropolis. Prominent among these are *Andrea cinerea* (Grey heron), *Egretta alba* (Great White heron), *Alcedo atthis* (Common Kingfisher), *Halcyon malimbica* (Blue-breasted Kingfisher), *Milvis migrans* (Black Kite) *Polyboroides typus* (African Harrier-hawk) and *Pica pica* (Pied Crow). Also in this category are *Streptopelia senegalensis* (Laughing Dove), *Stretopelia semitorguata* (Red-eyed Dove), and *Tockus nasutus* (African Hornbill).

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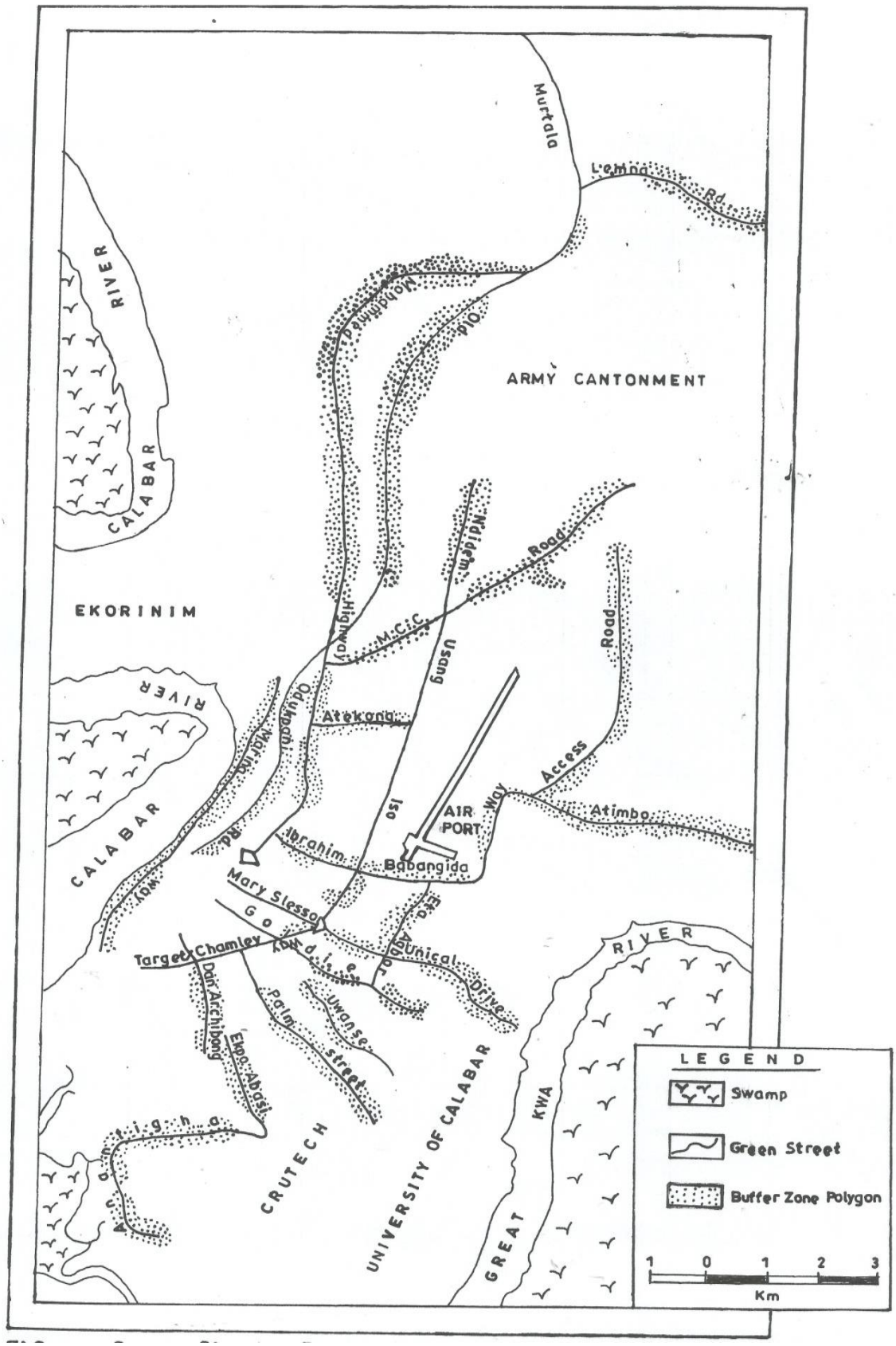

Source: Authors' fieldwork, 2016

FIG 1: Green streets buffer zone polygon of Calabar Metropolis

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Source: Authors' fieldwork, 2016

FIG 2: Manuscript map of green streets of Calabar Metropolis

It was observed that bird species that are catholic in their feeding habits are quite successful coming in terms with anthropogenic changes in the metropolis. Birds found in this category include *Estrilda astrild* (Common Waxbill), *Musicapa epulata* (Little Grey-flycatcher), *Terpsiphone rufiventa* (Black-headed Paradise Flycatcher) and *Musicapa caerulescens* (Ashy Flycatcher).

Habitat diversity and life-support conditions vary greatly across urban core-exurban gradient in Calabar Metropolis. For conservation purpose, it is important to establish a spectrum of environmental conditions from urban core to exurban when plan is anticipated. This can be achieved by introducing urban green street concept. Oka *et al.* (2016) ascertain that because of the location of Calabar in a biodiversity hotspot, it is rich with bird species. This study has shown further that there is a consensus on low diversity of native species of bird within the metropolis with exception of routes with emergent and pristine trees. Calabar is witnessing land disturbance and conversion of impervious surfaces, removal of native vegetation and isolation of remaining natural areas. Streets designated green buffer zone polygons are richer in bird species diversity than other streets within the metropolis.

VI. CONCLUSION

Efforts to manage urban biodiversity should focus on minimizing, mitigating those impacts, protect, and connect the remaining and created natural habitats. This will enhance the restoration of damaged natural areas as highlighted by Bryant and Randolf (2002). The green street will serve in the actualization of the conservation status. Green streets also contribute environmentally; critical to providing healthy habitats for wildlife and plant in densely built areas. Hence, green streets are vital to preserving regional ecosystems amid growing cities. Green streets can create energy efficient cities that can help slow global warming effects on birds. Every tree helps to fight global warming by reducing the amount of greenhouse gases in the atmosphere and help cool cities.

There is a growing interest in defining a trajectory for avian/green street transition based on a share vision of what our future relationships with green streets could look like. One program designed to protect the rainforest involve creating roads under shade. In this method, roads are constructed beneath shady trees of the native rainforest rather than cutting down trees. This has many environmental benefits; demonstrate how solving one environmental problem can bring about additional environmental and economic benefits. There are numerous health benefits associated with access to Green Street: better-perceived general health, reduced stress levels and reduced depression.

For the green streets to achieve full potential in the conservation of bird species in Calabar Metropolis, trees along the road networks should not be homogeneous. On this premise, green streets will serve as agents capable of changing the urban ecology and increase the bird richness. Green streets are natural option capable of preventing loss of biodiversity and creating an ecological sustainable environment within Calabar Metropolis as shown on the manuscript map (FIG 2).

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APPENDIX - 1

	SPECIES /COMMON NAME	COMMON NAME	SPECIALIST	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
1	*Pica pica*	Pied Crow	Forest										x		x	x	x			x	x	x	x	8
2	*Corvus albicollis*	White-naped Raven	Forest													x	x			x		x		4
3	*Ploceus cucuiiatus*	Village weaver		x		x									x	x	x			x	x	x	x	9
4	*Hirundo lucida*	Red-cheasted Swallow		x		x											x							3
5	*Ceratogymna atrata*	Black-casqued Hornbill														x	x					x		3
6	*Alcedo atthis*	Common Kingfisher													x		x		x		x			4
7	*Bulbulcus ibis*	Cattle Egret		x													x			x	x			4
8	*Andrea cinerea*	Grey Heron	Forest			x									x	x	x		x				x	6
9	*Egretta alba*	Great White-heron	Forest			x									x				x					3
10	*Cathartes aura*	Turkey Vulture			x	s	x	x	x							x	x		x	x		x		9
11	*Milvus migrans*	Black Kite	Forest	x			x	x	x	x	x		x		x	x	x		x	x	x	x	x	15
12	*Streptopelia senegalensis*	Laughing Dove	Forest				x		x						x	x	x	x	x	x	x	x	x	10
13	*Streptopelia semitorguata*	Red-eyed Dove	Forest														x							1
14	*Cypsiurus paevus*	African Palm-swift									x				x		x		x	x	x			6
15	*Halcyon malimbica*	Blue-brested Kingfisher	Forest														x		x	x	x	x		5
16	*Apus apus*	Common Swift		x		x		x		x	x													5
17	*Colius striata*	Speckled Mousebird															x			x	x			3
18	*Hirundo ristica*	Common Swallow						x	x								x					x		4
19	*Ardea melanocephala*	Black-headed Heron	Forest	x				x									x							3
20	*Macronyx croceus*	Yellow-throated Longclaw															x				x			2
21	*Motacilla flava feldegg*	Black-headed Wagtail				x											x		x		x			4
22	*Vidua macroura*	Pin-tailed Whydah				x											x		x		x			4
23	*Estrilda astrilder*	Common Waxbill		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	20
24	*Serinus canaries*	Canery	Forest	x	x											x	x					x		5
25	*Nectarina olivacea*	Olive Sunbird	Forest	x		x										x	x	x						5
26	*Nectarina orilis*	Cameroon Sunbird	Forest													x		x			x	x		4
27	*Nectarina verticolis*	Green-headed Sunbird	Forest													x		x			x	x		4
28	*Nectarina regia*	Regal Sunbird				x										x		x			x	x		5
29	*Sturnus vulgaris*	Starling		x	x	x	x	x	x	x	x	x	x	x										11
30	*Indicator minor*	Lesser Honeyguide															x							1
31	*Polyboroides typus*	African Harrier-hawk	Forest				x									x	x		x		x			5
32	*Vireonidea griseus*	White-eyed Vireo															x				x			2
33	*Tockus nasutus*	African Grey-hornbill	Forest													x	x							2
34	*Musicapa epulata*	Little Grey-flycatcher		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	20
35	*Musicapa caerulescens*	Ashy Flycatcher		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	20
36	*Terpsiphone ruftventer*	Black-headed Paradise-flycatcher	Forest	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	20
37	*Stiphrornis erythrothorax*	Forest Robin	Forest														x		x	x	x			4
38	*Ploceus nigerrimus*	Vieillot's Black-weaver	Forest		x											x	x		x	x	x			6
39	*Quela quela*	Common Weaver															x		x					2
40	*Euplectes hartlaubi*	Marsh Whydah															x		x					2
				13	8	14	9	10	10	7	7	5	7	5	12	20	34	9	19	16	23	17	8	