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Sub-habitat structure preferences between built environments and regenerated forests in Lusaka National Park with respect to bird species diversity, richness, and relative abundance

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Abstract

Forests play a crucial role in maintaining terrestrial ecological diversity. In this study, two distinct forest types—built environments (Forest Reserve 27) and regenerated forests (Lusaka National Park)—in Lusaka, Zambia, are compared with respect to their bird species diversity and concentration. Predicting the bird species' preferred sub-habitat structure is another objective of this study. To evaluate species richness and species diversity, two ecological indicator indices were employed: The Simpson's Diversity Index (D) and the Shannon-Weiner Diversity Index (H'). Eight days in all, four days at each site, were dedicated to gathering data. To acquire data, an analytical experimental strategy utilizing transect formulation, geo-referencing, and mapping in a naturalistic observational study.

In addition, the International Union for Conservation of Nature red list categories were examined, order categorization, diet, habitat type, and migration status. Forest 27 and Lusaka National Park yielded a total of 241 individual bird sightings. These totaled 79 observations, of which 35 (at 95% confidence interval 33.6-45.6%) came from Forest 27 and 44 (55.7%) from Lusaka National Park (95% confidence interval 44.4 – 66.4%). The species richness and species diversity of Lusaka National Park were measured at H' = 3.5 and D = 28.5, respectively, whereas Forest 27 saw H' = 3.2 and D = 23.1 for species richness and diversity, respectively. Although they highlight different facets, Simpson's and Shannon-Wiener diversity indices both quantify biodiversity. While Shannon-Wiener takes into account both richness and evenness, with higher values suggesting higher diversity, Simpson's concentrates on dominance, with higher values indicating lower diversity. It was concluded that a variety of variables, including climate, fragmentation, noise pollution, affecting Forest 27 are probably responsible for Lusaka National Park's greater species richness and diversity.

This covers government policies on the forest reserve: 1. Sustainable use – Utilization of forest resources in a sustainable manner must be the focus as well as balancing wood extraction with the preservation of ecosystem services such as biodiversity conservation and carbon sequestration. 2. Biodiversity Protection- forest reserves are designed for the safeguard of threatened species and important ecosystems. In regards to forest reserves and protected areas, policy re-evaluation would be advised. Conservation strategies should focus on a variety of ground-nesting, canopy nesting and insectivorous bird species that are negatively impacted by logging. Conducting another assessment a few years from now would be recommended to further conclude whether Lusaka National Park would still compete or hold a higher amount of diversity and abundance compared to forest 27or other forest reserves in the Lusaka area.

Keywords: Sub-Habitat Structure Preference; Species Richness and Diversity; Built Environments; Regenerated Forests

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1. Introduction

Numerous studies have looked into how growing cities affect local and regional bird populations in the wake of increasing urbanization. Ecologists have generally found that native avian species suffer from increased urbanization (Aronson et al., 2014). Perhaps the most direct cause of a species' decline in the context of urbanization is the fragmentation and loss of native bird habitat that follows from the conversion of forest habitat to urban areas (Mckinney, 2006). This is particularly true for specialist species that cannot effectively adapt to fill new functional niches in urban environments or that need extensive forested regions to reproduce (Luck and Smallbone, 2010).

Numerous factors contribute to Zambia's deforestation and forest degradation. According to the Reducing of Emissions from Deforestation and Forest Degradation (REDD+) approach, unsustainable charcoal manufacturing and conversion to agricultural land are the two main causes of Zambia's deforestation and forest degradation (Vinya et al.2011). There are four primary causes: fires, infrastructure (urbanization, settlements, and industrialization); wood extraction (charcoal production, fuelwood gathering, and logging); and agricultural growth. A similar list of drivers is found in other literature sources. However, out of all the literature, the two primary drivers are wood extraction and agriculture, these seemed to be applicable everywhere throughout Zambia, whereas the other drivers such as mining infrastructure in the key mining provinces had local or regional significance (Wathum et al. 2016).

Every year, there is a net loss of forest cover in the tropics as a result of deforestation brought on by logging, increased agriculture, and cattle grazing (Food and Agriculture Organization of the United Nations, 2012). Secondary forests are on the rise in Zambia due to large amounts of deforestation. If biodiversity in built environments is not managed well and some portions of the area are not kept in their original condition to conserve the remaining species, then there will be a decline of the richness and abundance of avian species in built environments. Studying bird species abundance and diversity across different types and stages of forest environments provides critical information for conservation, ecosystem management, and understanding ecological processes. The study aimed at investigating the composition of avian species found in the built environment in comparison to those found in the regenerated forest (Lusaka National Park) bearing in mind factors affecting the composition of these species.

2. Methodology

The study was conducted on two sites, the Primary site being Lusaka National Park, figure 1 and the secondary site, Built Environment (Forest Reserve 27) figure 2 and figure 3 The Lusaka National Park (15°31'04"S 28°25'29"E) is located About 30 kilometers to the southeast of Lusaka city. Founded in 2011 and accessible to the public in June 2015, it is the most recent national park. At 6,715 hectares, it's also the smallest national park in Zambia. Lusaka National Park is a regenerated forest managed by Department of National Parks and Wildlife, who have integrated different types of wildlife within the park such as; Giraffe, Sable antelope, Bushbuck, Impala, and plenty more. It was established over an area that was forest reserve and is entirely fenced (Lusaka National Park, 2020).

Figure 1 Map of Lusaka National Park obtained from Google earth Pro Application

The secondary site was the Built Environment represented by Forest Reserve 27. This area is located in the about 30 kilometers from Lusaka City Centre. In order to save the headwaters of the Caliban River, which drains the majority of the region east of the city and runs eastward to its confluence with the Chongwe River south of Chongwe town, the Lusaka East Forest Reserve, also known as Local Forest 27, was established. The highest point in the reserve is the survey beacon Nama biro, which is located close to Trot over Farm at 1342 meters. The lowest point is the Caliban crossing the eastern boundary at 1220 meters. Lusaka Forest No. 27 was created in 1957.

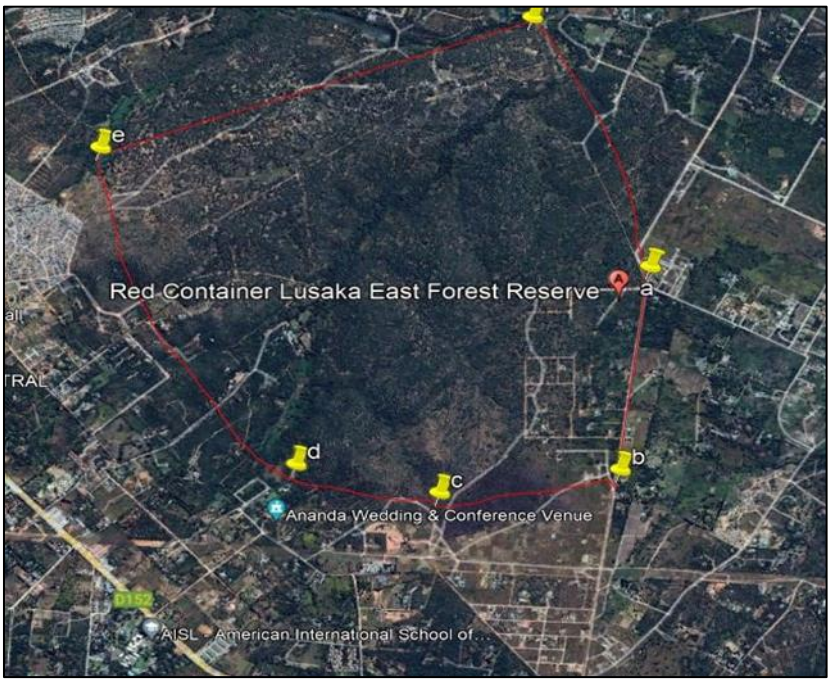

Figure 2 Built Environment – Lusaka East Forest Reserve/ Forest 27 obtained from Google Earth Pro

Figure 3 Lusaka East Forest Reserve, captured by Tusakine Mbao

A Naturalistic observational study will be carried out to better understand the distribution and structure preference of the birds in the two different ecosystems. The study was conducted with an analytical experiment approach, using mapping, plotting, georeferencing and a combination of point counts and line transects where used in the two different land types. The study was conducted on two types of land: Regenerated Forest and Built environments (Forrest reserve 27). To reflect whether there is a difference in avian species due to the fact one land type possess native flora and fauna while the other is restored. The two sites are 12 kilometers apart. The 3 lines transect measuring about 2 kilometers

were formulated for the Built environment (Forest reserve 27) while 2 line transects were formulated measuring about 2 kilometers for the Lusaka National Park.

In both the National Park and the Built environment (Forest reserve 27) point counts were conducted in two different areas within the sites respectively. This was done due to the fact the during trial sampling, they concentration of avian species in the National Park for example was around water points, and very low sighting during surveys along line transects. To make an even count we also conducted point counts in the Built environment (Forest reserve 27). We surveyed avian species and vegetation on all line transects and point counts per site. Using the mean abundances for each species, we calculated species diversity as the Shannon-Wiener (Shannon) diversity index (H0) and Simpson diversity index (D) in vegan.

3. Bird Surveys

The bird counts trial begun in November 2023 (beginning of the rain season) while the actual data recorded session began at the end of February 2024. This is presumed to be during raining season in Zambia, though during the period of the year little to no rain was present. Average temperatures were between 27-30 degrees Celsius determined using a mobile weather application (Apple weather). Four days of surveys were conducted per site, the surveys were conducted in the early hours of the morning, time was between 6am-9am.

The majority of bird species that use lowland deciduous woodland for breeding may be identified after six visits, and a solid grasp of the number and distribution of species present can be attained. Therefore, eight visits are thought to constitute a proportionate survey effort for both freshwater and terrestrial ecosystems. For this reason, a total of eight survey visits were done in both the Lusaka National Park and the Built Environment (Forest reserve 27). Counts along line transects and point counts were conducted every morning and during every survey session.

A random sequence was followed when visiting the sites. To give the birds time to settle, we waited a few minutes before beginning a transect in Forest 27. In the National Park, we drove between transects and point counts for five to ten minutes. After that, we walked at a steady pace, recording every bird heard and seen within 100 meters on either side. Bird species were observed using a Nikon D56312 BJ binocular and captured using a Canon 60D with 70mm – 200mm and 10mm – 45mm lenses. The Vocal recordings were taken through a mobile application – The Cornell Lab Merlin Bird ID, all captured and recorded birds were referenced through the Birds of Zambia application and written down in logbooks alongside the corresponding GPS coordinates. This process took an hour for each transect/point count.

4. Results

A total of 241 individual birds were spotted from the two study regions, Forest 27 and Lusaka National Park (LNP). These comprised 79 observations in total, of which 44 (55.7%) came from Lusaka National Park at 95% confidence interval (44.4 – 66.4%), and 35 came from Forest 27 at 95% confidence interval (33.6 – 55.6%). When species distribution was taken into account, a proportionate collinearity of fitted values at 95% Confidence Interval indicated was demonstrated with LNP having higher values of similar species (Figure 4).

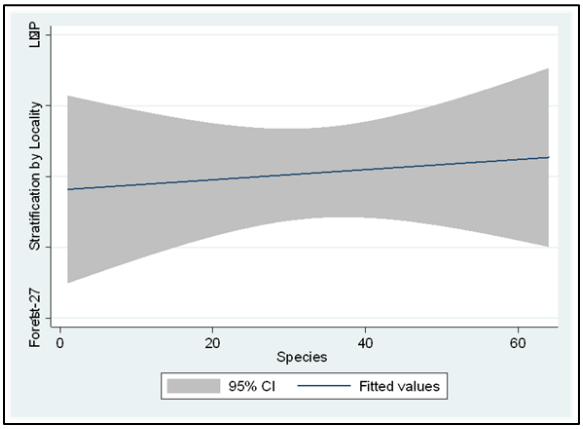

Figure 4 Bird species in Forest 27 and LNP when quantified along a regression line, they showed collinearity

The species richness and species diversity of Lusaka National Park were measured at H' = 3.5 and D = 28.5, respectively, whereas Forest 27 saw H' = 3.2 and D = 23.1 for species richness and diversity, respectively. When the overall sightings of the bird species were taken into consideration, a non-significant difference between species was observed in the two study areas.

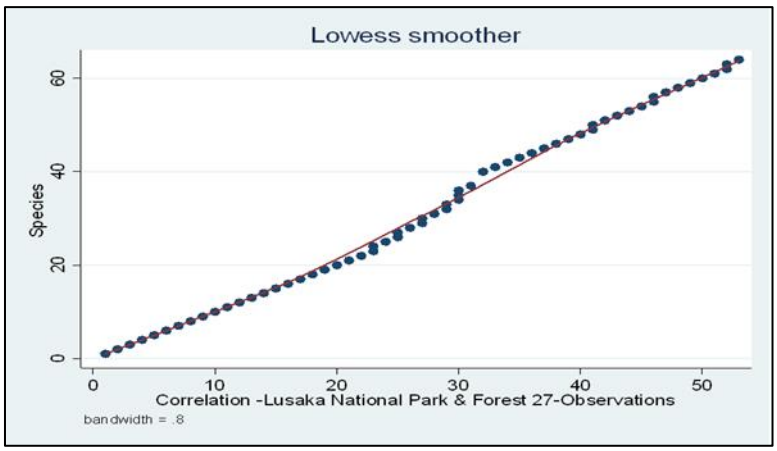

Figure 5 Correlation analysis graph between species observed in Lusaka National Park and Forest 27

To further look closely between Lusaka National Park and Forest 27, Box plot and whiskers were constructed and they indicated that both the upper and lower limits of species observed within Lusaka and Forest 27 did not vary. The Box plot of Lusaka National Park was wider than Forest 27 by 25%, indicating a higher species density and distribution within Lusaka National Park than Forest 27 (Figure 6).

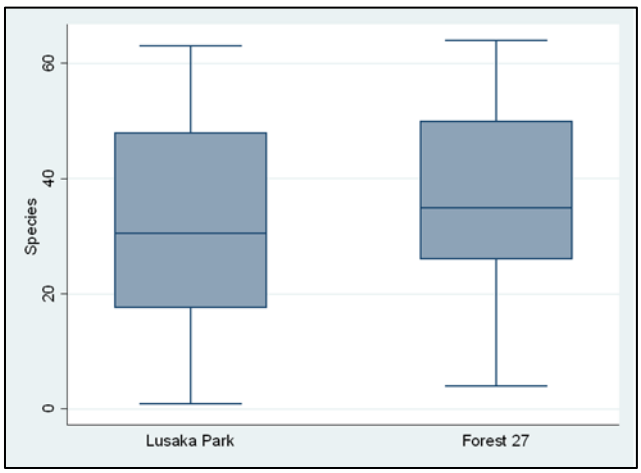

Figure 6 The Box plot and whiskers indicating the upper and lower limits of species observed within Lusaka and Forest 27

When genus level assessment was conducted using the Box plot and whiskers, the results indicate that both the upper and lower limits at genus level observed within Lusaka and Forest showed slight variation with the Box plot of Lusaka National Park being wider than Forest 27 by 25%, indicating a higher genus distribution within Lusaka National Park (Figure 7).

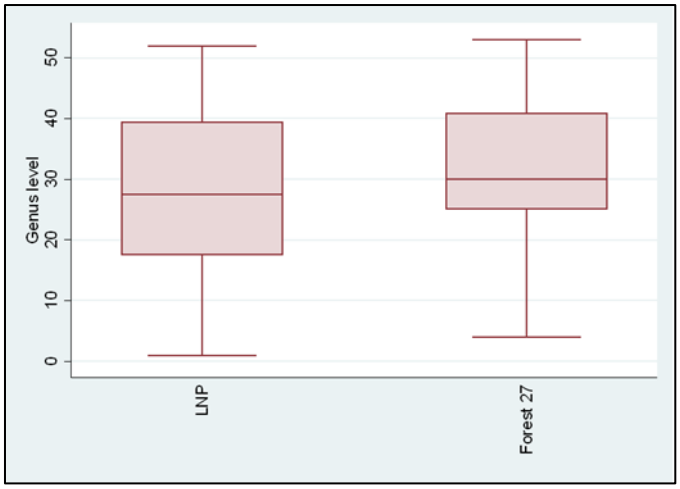

Figure 7 The Box plot and whiskers indicate that both the upper and lower limits at genus level observed within Lusaka and Forest 27 indicating a higher genus distribution within Lusaka National Park

4.1. Conservation Status

Bird species have been placed into categories depending on their conservation status around the world. Table 1 shows the conservation status of birds' species found in the two study sites. Table 2 shows a proportion of the two population of birds observed and their conservation status. Least Concern – Unknown: Extremely Low risk: does not fall into a higher risk category and is not anticipated to face a danger anytime soon, many and widely distributed taxa.

The population trend 'Unknown" Absence of knowledge about their population condition, classification, or the effects of threats. Least Concern- Stable: Low risk, many and widely distributed taxa, the population trend 'Stable' refers to a population with a constant rate of natural expansion. Least Concern- Rapid Decline: Low risk many and widely distributed taxa, the population trend 'Rapid Decline' refers species abundance being reduced drastically over the last century. Least Concern- Increasing: Low risk, many and widely distributed taxa, the population trend 'Increasing' refers to the increase in abundance over the last century. From the two study sites, the majority of the birds are under the low-risk category (Table 1).

Table 1 International Union for Conservation of Nature (IUCN) – Red list Categories for Birds observed in Lusaka National Park and Forest 27 respectively

IUCN Classification	**Lusaka National Park**	**Forest 27**	**Total**
Least Concern- Unknown	2	1	3
Least Concern- Stable	25	22	47
Least Concern- Rapid Decline	10	10	20
Least Concern- Increasing	7	2	9
Total	44	35	79

Table 2 International Union for Conservation of Nature (IUCN) – Red list Categories for overall Birds observed

IUCN Classification	***n*= 79**	**Proportion (%)**	**95% Confidence Interval**
Least Concern-Unknown	3	3.8	1.2 – 11.4
Least Concern – Stable	47	59.5	48.1 – 70
Least Concern-Rapid Decline	20	25	16.8 – 36.3
Least Concern-Increasing	9	11.4	5.9 -21

4.2. Habitat Preference

Table 4, Pearson's chi square comparing habitat type between Lusaka National Park and Forest 27 showed that there is no significant difference in the two different sites when it pertains to habitat type. Though bird species were observed on more different types of habitats in Lusaka National Park compared to Forest 27. Overall habitat type percent proportions of represented totals are shown in Table 3 showed that trees where the most inhabited habitat type by bird species in both areas combine

Table 3 Comparison of Habitat type between the two study sites

Habitat Type	**Lusaka National Park**	**Forest 27**	**Total**
Tree	27	31	58
Ground	6	0	6
Shrub	2	2	4
Water	1	0	1
Dead Standing tree	3	1	4
Rock	1	0	1
Tree/Ground	2	0	2
Tree/DST/Ground	1	0	1
Tree/Shrub	1	1	1

On overall combined habitat preference of the bird species observed under the two study areas, 73% of the birds were sighted from trees (Figure 8).

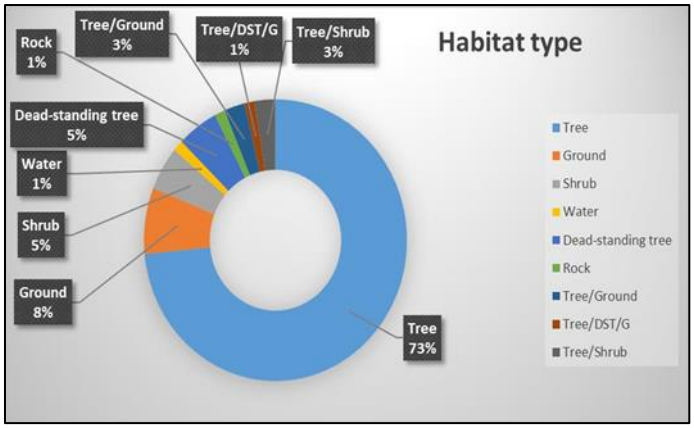

Figure 8 Habitat preference of total birds observed represented by proportion percentage

4.3. Migration Status

Figure 9 shows a 3D pie chart representing the migration status of the total birds observed by percent proportion. The Migrant status is recorded using the duration they spend migrating before most species start breeding. The migration status recorded is denoted as follows: SD- short distance (37% of the observed bird species were categorized under this group of short distance or local migrants), tens of kilometers are usually involved in this kind of migration. MD- Medium Distance, bird species that migrate hundreds of kilometers. LD – Long distance, birds that migrate thousands of kilometers. YR- Year-round, birds that migrate irregularly year-round were the least at 4% of the observed total species. R- Resident, birds that do not migrate but are commonly found in a particular region. A sizable portion of the birds observed are Palearctic migrants- Any bird species, or group of species, that breeds in Asia or Europe and routinely migrates south during the nonbreeding season.

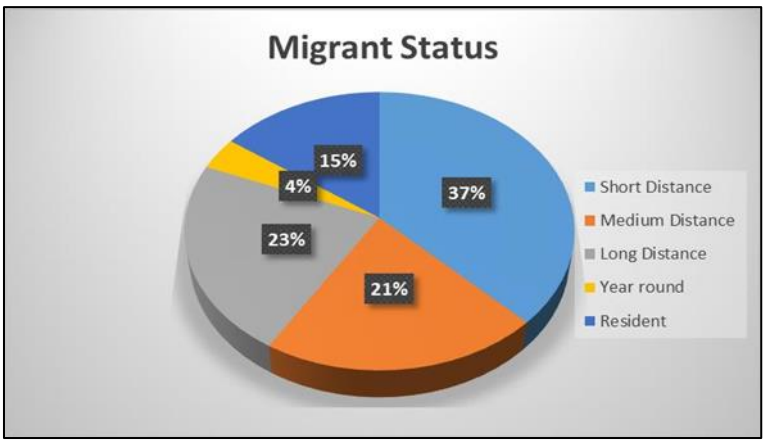

Figure 9 Migration status, represented by proportion percentage.

4.4. Order Classification

Table 4 shows the order of classification of all bird's species observed. The highest observed order from a combination of both sites was order Passeriformes with 70.89% of the total population at 95% confidence interval (60 – 80). Figure 10 presents the data in a sunburst chart.

Table 4 Order Classification of total bird species observed

Order	*n*= 79	Proportion (%)	95% Confidence Interval
Passeriformes	56	70.89	60 – 80
Bucerotiformes	1	1.27	0.2 – 9
Gruiformes	1.	1.27	0.2 – 9
Columbiformes	4	5.06	2 – 13
Coraciiformes	6	7.59	3.4 – 16.1
Piciformes	7	8.86	4.2 -17.7
Anseriformes	1	1.27	0.2 – 9
Accipitriformes	1	1.27	0.2 – 9
Galliformes	2	2.53	0.6 – 10

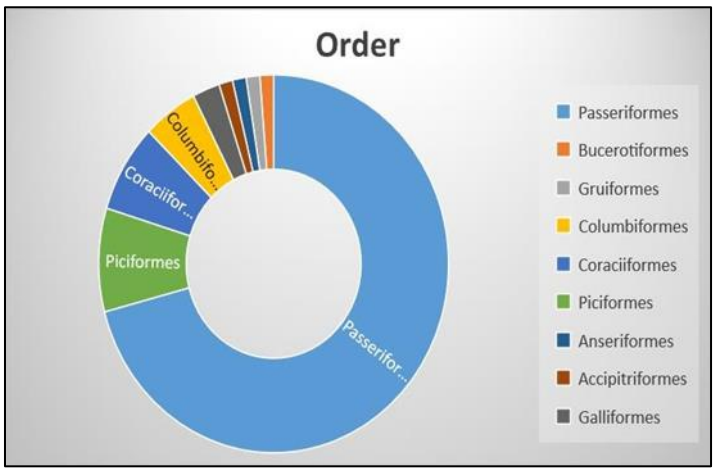

Figure 10 Sunburst of Order classification represented by proportion percentage

4.5. Diet Type

Table 5 represents the diets of all the bird species observed. The highest diet type were the insectivores making up 49.37 % of the total population at 95% confidence interval (38.3 – 60.5).

Table 5 Diet type of all bird species observed.

Diet	*n*=79	Proportion (%)	95% Confidence Interval
Insectivore	39	49.37	38.3 – 60.5
Frugivore	2	2.53	0.6 – 10
Granivore	1	1.27	0.2 – 9
Carnivore	1	1.27	0.2 – 9
Omnivore	2	2.53	0.6 – 10
Insectivore/Frugivore	16	20.25	13 – 31
Insectivore/Granivore	9	11.39	6 – 21

Insectivore/Herbivore	1	1.27	0.2 – 9
Insectivore/Carnivore	3	3.80	1.2 – 11.4
Granivore/Insectivore/Frugivore	5	6.33	2.6 – 14.6

Insectivore - Animals whose main food source is small insects only, Frugivore – Animals whose main food source is fruits only, Granivore – Animals whose main food source is seeds and grain only, Carnivore – Animals with a min food source of small reptiles and other animals only, Omnivore – an animal whose main food source derives from both plant and animal origin, Insectivore/Frugivore – an animal whose main food source comprises of both insects and fruits, Insectivore/Granivore – an animal whose main food source comprises of insects, seed and grain, Insectivore/Herbivore – an animal whose main food source comprises of both insects and plants, Insectivore/Carnivore – an animal whose food source is derived from both insects and other animals, Granivore/Insectivore/Frugivore - an animal whose main food source comprises of insects, seed and grain, and fruits.

5. Discussion

This study has shed some light on the intricate relationships between habitat structures, avian biodiversity within the Lusaka National Park and Forest 27. Lusaka National Park is a regenerative forest which is playing a crucial role in the biodiversity of avian species near the city, whilst Forest 27 was previously a pristine forest, but is rapidly becoming more of a built environment. This study has shown that the bird assemblages in both study sites display similar structures in terms of density, distribution as well as forest habitats intimating on responses linked with the landscape context as well as land use. However, a closer observation has shown that Lusaka National Park yielded more bird species than Forest 27.

This may in part indicate loss of diversity in the built area and increase of the same in the regenerating forest. However, these results are very interesting as this is a first study to determine the effects of habitat fragmentation alongside restoration on the avian species. When quantified along a regression line the two sites showed collinearity, meaning since there is a significant correlation between them, it is challenging to accurately estimate each of their independent regression coefficients, but these results can form a strong baseline study of fragmentation and restoration happening alongside each other.

6. Conclusion

In summary, even though Forest 27 is a forest reserve, the Lusaka National Park has a higher species diversity and richness than the Forest 27. This difference can be attributed to a number of factors, including the urbanization of the Forest 27 area and the government's recent review of its gazette forest reserve policies. After years of unclear rules about the land on which the forest is located, Forest 27 was only recently degazetted. As a result, parts of the forest have been subdivided into residential and commercial plots, leaving just a small portion of the original forest.

During data collection of this site, it was quite noticeable how small the forest reserve is becoming. From an interior part of the forest, you are able to hear construction vehicles outside the reserve. We can further conclude that Lusaka National Park is currently working well in terms of avian species diversity and abundance as a regenerated forest compared to forest 27.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declare they have nothing to disclose.

Statement of ethical approval

Ethical clearance was obtained from Excellence in Research and Science Converge (ERES). REF: 2023-May-011.

Statement of informed consent

Permit to conduct research in a protected area was obtained from the Department of National Parks and Wildlife.

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References

[1] Ahern J. 2012. Urban landscape sustainability and resilience: the promise and challenges of integrating ecology with urban planning and design. Landscape Ecology, 28(6), 1203–1212.

[2] Allender C. 2011. The Second Report on the State of the World's Plant Genetic Resources for Food and Agriculture. Rome: Food and Agriculture Organization of the United Nations (2010), pp. 370, Experimental Agriculture, 47(3), 574–574.

[3] Anon (n.d.) Biodiversity / Zambia | Interactive Country Fiches.

[4] Aongola L. Bass S., Chileshe J., Daka J., Dalal-Clayton B., Liayo I., Makumba J., Maimbolwa M., Munyinda K., Munyinda N., Ndopu D., Nyambe I., Pope A. and Sichilongo M. 2009. Creating and protecting Zambia's wealth: experience and next steps in environmental mainstreaming. Natural Resource Issues No. 14. International Institute for Environment and Development. London, UK

[5] Archer J. M. J., Hostetler M. E., Acomb G., and Blair R. 2019. A systematic review of forest bird occurrence in North American forest fragments and the built environment. Landscape and Urban Planning, 185, 1–23.

[6] Aronson M. F., Sorte F. A., Nilon C. H., Katti M., Goddard M. A., Lepczyk C., ... Dobbs C. 2014. A global analysis of the impacts of urbanization on bird and plant diversity reveals key anthropogenic drivers. Proceedings of the Royal Society B: Biological Sciences, 281.

[7] Bates D., MCachler M., Bolker B.M., Walker S.C., 2015. Fitting linear mixed- effects models using lme 4. J. Stat. Software 67, 1–48.

[8] Battin J., 2004. When good animals love bad habitats: Ecological traps and the conservation of animal populations. Conserv. Biol. 18, 1482-1491.

[9] Bibby C.J., Burgess N.D., Hill D., Mustoe S., 2000. Bird Census Techniques, second ed. The Wilson Bulletin. Academic Press, London.

[10] Borges S. H., and Stouffer P. S. 1999. Bird communities in two types of anthropogenic successional vegetation in central Amazonia. Condor 101: 529–536.

[11] Blair R. B. 1999. Birds and butterflies along an urban gradient: Surrogate taxa for assessing biodiversity? Ecological Applications, 9, 164–170.

[12] Block W. M., Franklin A. B., Ward J. P., Ganey J. L., and White G. C. 2011. Design and Implementation of Monitoring Studies to Evaluate the Success of Ecological Restoration on Wildlife. Restoration Ecology, 9(3), 293–303.

[13] Carey C. 2009. The impacts of climate change on the annual cycles of birds. Philosophical Transactions of the Royal Society B: Biological Sciences, 364(1534), 3321–3330.

[14] Catterall C., Freeman A. N. D., Kanowski J. J., and Freebody K. 2012. Can active restoration of tropical rainforest rescue biodiversity? A case with bird community indicators. Biological Conservation.

[15] Chain-Guadarrama, A., Martínez-Salinas, A., Aristiz abal, N., Ricketts, T.H., 2019. Ecosystem services by birds and bees to coffee in a changing climate: a review of coffee berry borer control and pollination. Agric. Ecosyst. Environ. 280, 53–67 Chazdon, R. L. 2008. Beyond Deforestation: Restoring Forests and Ecosystem Services on Degraded Lands. Science, 320(5882), 1458–1460.

[16] Christie K., Stokes V. L., Craig M. D., and Hobbs R. J. 2013. Microhabitat Preference of Egernia napoleonis in Undisturbed Jarrah Forest, and Availability and Introduction of Microhabitats to Encourage Colonization of Restored Forest. Restoration Ecology, 21(6), 722–728.

[17] Clare D.S., Spencer M., Robinson L.A., Frid, C.L.J., 2016. Species-specific effects on ecosystem functioning can be altered by interspecific interactions. PloS One 11, 1– 17.

[18] Clearing House Mechanism 2018. Sixth National Report: Zambia

[19] Cockle K. L., Martin K., and Drever M. C. 2010. Supply of tree-holes limits nest density of cavity-nesting birds in primary and logged subtropical Atlantic forest. Biological Conservation, 143(11), 2851–2857.

[20] Cristescu R. H., Frère C., and Banks P. B. 2012. A review of fauna in mine rehabilitation in Australia: Current state and future directions. Biological Conservation, 149(1), 60–72.

[21] Donnelly R., and Marzluff J. M. 2006. Relative importance of habitat quantity, structure, and spatial pattern to birds in urbanizing environments. Urban Ecosystems, 9(2), 99–117.

[22] Ewers R.M., and Didham R.K 2006. Confounding factors in the detection of species responses to habitat fragmentation. Biological Reviews, 81(01), 117.

[23] Food and Agriculture Organization of the United Nations. 2012. State of the world's forests. https://www.fao.org/4/i3010e.pdf

[24] Luck G.W., and Smallbone, L.T. 2010. The impact of urbanization on taxonomic and functional similarity amonmg bird communities. Journal of Biogeography, 38,894-906.

[25] Lusaka National Park. 2020, Zambia Tourism. https://www.zambiatourism.com/destinations/national-parks/lusaka-national-park/

[26] McKinney ML. 2006. Urbanization as a major cause of biotic homogenization. Biological Cnservation, 127, 247-260. – References- Scientific Research Publishing.

[27] Vinya R, Syampungani S, Kasumu E.C, Monde C and Kasubika R. 2011. Preliminary study on the drivers of deforestation and potential for REDD+ in Zambia. A consultancy repot prepared for Forest Department and FAO under the national UN-REDD+ programme Ministry of Lands and Natural Resources. Lusaka, Zambia.

[28] Wathum G, Seebauer M, Carodenuto S and Zambia Intergrated Forested Landscape Program. 2016. Drivers of deforestation and forest degradation in Eastern Province, Zambia.