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BIODIVERSITY ASSESSMENT AND SPECIES DISTRIBUTION OF WILD ANIMALS ACROSS ECOLOGICAL ZONES IN NIGERIA

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Abstract
Biodiversity assessment provides critical insights into species distribution and ecosystem integrity, particularly in regions experiencing increasing anthropogenic pressure. This study investigated the distribution and diversity of wild animal species across three ecological zones of Nigeria Akwa Ibom (South-South), Nasarawa (North-Central) and Oyo (South-West). Data were collected from local markets and hunters' catches, and analyzed using descriptive statistics, biodiversity indices and inferential statistics. Species richness and diversity were estimated through Shannon–Wiener and Simpson's indices, while a Chi-square test of independence was employed to examine whether species distribution significantly differed across ecological zones. Symmetric measures, including Phi coefficient and Cramer's V, were further applied to assess the strength of association between species occurrence and ecological zones. The results revealed marked differences in species distribution, with grasscutter (Thryonomys swinderianus), antelope (Cephalophus maxwellii and Tragelaphus spp.), and giant rat (Cricetomys gambianus) contributing the highest proportions across zones. Akwa Ibom exhibited the highest relative abundance, while Oyo showed comparatively lower diversity. Biodiversity indices confirmed moderate diversity across all zones, with the Shannon index values ranging from 1.75 to 2.10 and Simpson's index indicating low dominance of individual species. The Chi-square test indicated that species distribution was not independent of ecological zones ($p < 0.05$), suggesting ecological and anthropogenic factors jointly shape wildlife occurrence. Symmetric measures showed a moderate association between species and zones, reinforcing the spatial influence on biodiversity composition. The study highlights the ecological importance of monitoring faunal distribution across heterogeneous landscapes. Findings provide baseline data for conservation planning and underscore the need for policies that integrate local hunting practices, habitat protection, and sustainable wildlife utilisation. Such evidence-based interventions are essential for balancing biodiversity conservation with rural livelihoods in Nigeria.

Keywords: Biodiversity, Species distribution, Ecological zones, Chi-square test, Wildlife conservation, Nigeria

Introduction
Biodiversity plays a fundamental role in maintaining ecological stability, regulating ecosystem processes, and supporting human livelihoods. Biodiversity provides valuable bioresources that support the existence of man on earth (Aguilera 2019). In addition, biodiversity also provides unquantifiable services to humans. These services include nutrient and water cycling, soil formation and retention, resistance against invasive species, pollination of plants, and regulation of climates as well as pest and pollution control by ecosystems (Imarhiagbe *et al*., 2020). In tropical regions such as Nigeria, wildlife constitutes a vital component of biodiversity, serving as both an ecological resource and a socio-economic asset (Bode *et al*., 2025). Wild animals contribute to food security,

cultural practices, and ecosystem functioning, but their distribution and abundance are increasingly shaped by ecological heterogeneity and human activities (Ruikar *et al*., 2024). Understanding how species are distributed across landscapes is therefore essential for developing sustainable conservation and management strategies.

Ecological zones in Nigeria differ markedly in climate, vegetation, and land-use intensity, factors that strongly influence wildlife composition. While some species are broadly distributed, others exhibit spatial restrictions linked to habitat specificity, resource availability, or anthropogenic pressures such as hunting, deforestation, and agricultural expansion (Audu and Ayuba 2016). Assessing faunal distribution within these zones provides insights into ecosystem health and highlights areas of conservation priority (FME, 2015; Imarhiagbe and Egboduku, 2019).

Biodiversity indices, including species richness, Shannon–Wiener diversity and Simpson's index, are widely applied to evaluate community structure across ecological gradients (Supriatna, 2018). These metrics not only quantify diversity but also reveal dominance patterns and evenness in species distribution, offering a holistic perspective of ecological balance. However, descriptive indices alone may not fully capture the ecological processes driving distributional patterns. Statistical approaches such as the Chi-square test of independence and symmetric measures (Phi coefficient, Cramer's V) provide additional insights by quantifying the extent to which species occurrence is associated with ecological zones. Such analyses are particularly valuable in biodiversity studies where small sample sizes and uneven species distributions may bias descriptive metrics.

Structure and ecological characteristics of wildlife species affect their biological diversity (Acevedo-Charry and Aide, 2019; Ekerette *et al*., 2021). However, despite growing awareness of biodiversity loss in Nigeria, few studies have systematically compared wildlife distribution across ecological zones using a combination of diversity indices and statistical association measures. Most previous efforts have focused on single species or localised surveys, leaving a knowledge gap regarding community-level patterns across broader landscapes. Addressing this gap is critical for evidence-based conservation planning, especially in regions where bushmeat hunting and land-use change threaten wildlife populations.

This study therefore investigates the distribution and diversity of wild animal species across three ecological zones in Nigeria: Akwa Ibom (South-South), Nasarawa (North-Central), and Oyo (South-West). Specifically, it (i) documents species abundance and relative contribution across zones, (ii) compares biodiversity indices to evaluate community structure, and (iii) applies Chi-square analysis and symmetric measures to test whether species distribution is dependent on ecological zones. By integrating biodiversity metrics with statistical tests, the study provides a robust framework for understanding spatial patterns of wildlife communities and identifying region-specific conservation priorities.

Materials and Methods

The study was conducted across three ecological zones in Nigeria: Akwa Ibom (South-South), Nasarawa (North-Central), and Oyo (South-West) (Figure 1). These zones represent distinct ecological and anthropogenic conditions that influence wildlife distribution. Field surveys were carried out in representative forested and agricultural landscapes within each zone. Opportunistic sampling was adopted in collaboration with local hunters, and direct observations were made in open habitats to document wild animal species harvested for bushmeat or observed in the wild. Identification was confirmed using morphological keys and local taxonomic references.

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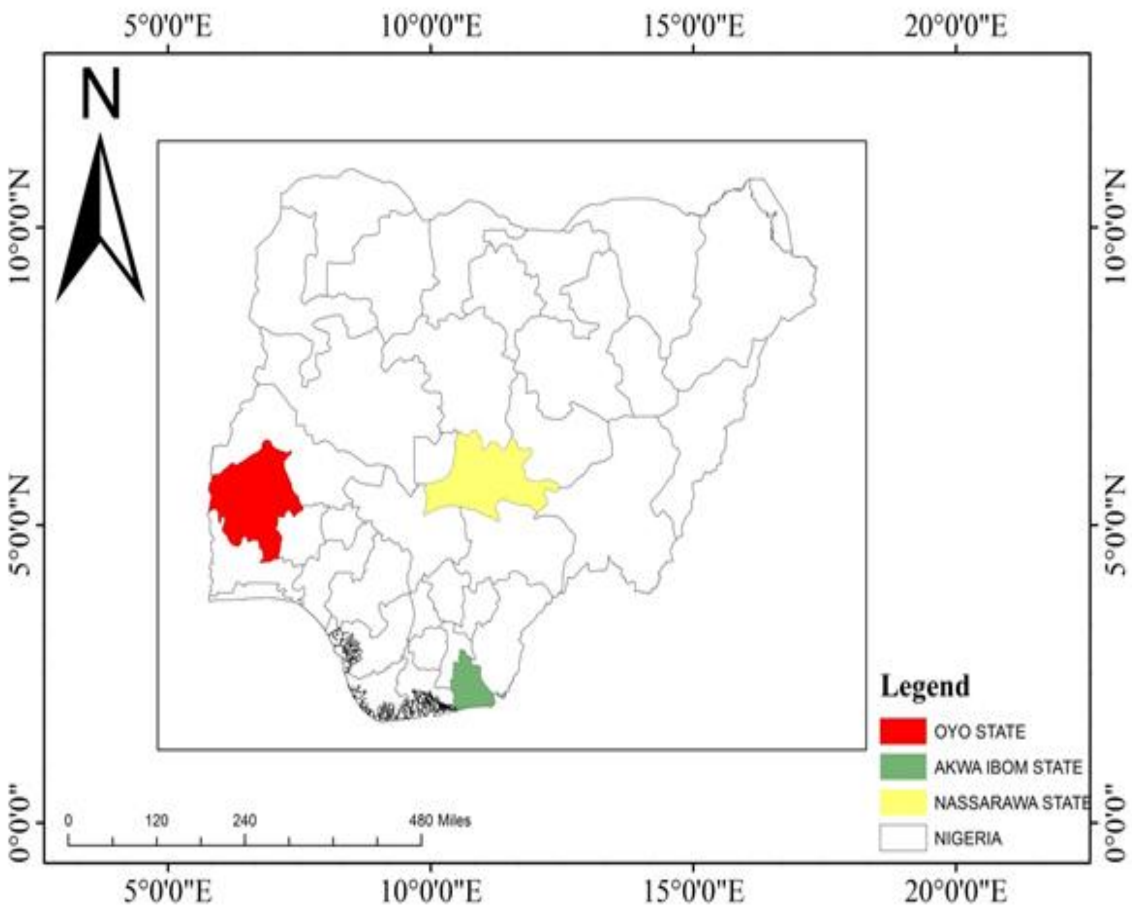

Figure 1: Nigeria map showing the ecological zones selected for assessment of wildlife biodiversity (Source: Field survey)

Biodiversity Indices

Biodiversity was quantified using several indices to capture richness, diversity, and community structure across the zones. Species richness (Taxa S), Margalef's index, Shannon–Wiener diversity index (H), Simpson's index (1–D), and evenness ($e^{H/S}$) were computed using PAST 4.0 (Paleontological Statistics Software). These indices provide complementary perspectives: richness reflects the number of species present, Shannon and Simpson capture both richness and evenness, while Margalef emphasizes the influence of species number relative to sample size.

Statistical Analysis

To test whether species distribution was associated with ecological zones, a Chi-square test of independence was conducted. The null hypothesis (H_0) stated that species occurrence is independent of ecological zone, while the alternative hypothesis (H_1) stated that species distribution significantly differs across zones. The significance of the Chi-square test was evaluated at 5% level ($p < 0.05$). To address small expected counts, the likelihood ratio was also computed to validate results.

Strength of Association

To measure the strength of association between species and ecological zones, symmetric association measures (Phi coefficient and Cramer's V) were calculated. While Phi is sensitive to table size, Cramer's V standardizes the association (0–1 scale), making it more appropriate for larger contingency tables. Both were interpreted based on Cohen's effect size benchmarks, where values

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above 0.50 indicate strong associations. All statistical analyses were performed using SPSS version 20 while biodiversity indices were generated with PAST 4.0.

Results and Discussion

The distribution of wild animal species across the three ecological zones revealed substantial variation in abundance and composition (Table 1). A total of 141 individual wild animals, comprising eight species, were recorded across the three zones. For each ecological zone, species abundance (number of individuals) was documented and used to estimate relative abundance. Species identified included cane rat (*Thryonomys swinderianus*), giant rat (*Cricetomys gambianus*), pangolin (*Manis* spp.), porcupine (*Hystrix* spp.), antelope (*Cephalophus maxwellii* /*Tragelaphus* spp.), bush dog (*Speothos venaticus*), civet cat (*Civettictis civetta*), and deer (*Cervidae* spp.). Antelope (*Cephalophus maxwellii*/*Tragelaphus* sp.) and cane rat (*Thryonomys swinderianus*) were the most dominant species, accounting for 30.50% and 29.79% of the total animals, respectively. In contrast, deer (*Cervidae* sp.) and civet cat (*Civettictis civetta*) were rarely encountered, contributing less than 5% of the total sample. Oyo State (South-West) recorded all eight species, including unique occurrences such as civet cat and deer, while Akwa Ibom (South-South) and Nasarawa (North-Central) recorded only five and four species, respectively. These patterns suggest that Oyo harbors a richer faunal community, possibly due to more heterogeneous habitats, that include two ecological zones such as *savannah and rainforest (Akano et al. 2023*), whereas the limited composition in Nasarawa (savanna ecological zone) may reflect either ecological constraints or intense anthropogenic disturbance, as well as Akwa Ibom which lies in tropical rainforest zone of Nigeria (Etuk *et al*. 2020).

Table 1. Distribution of wild animal species sampled across ecological zones in Nigeria (n = 141).

Animal species	Akwa Ibom	Nasarawa	Oyo	Total Abundance	Relative Abundance (%)
Cane rat	17	10	15	42	29.79
Giant rat	7	0	7	14	9.93
Pangolin	0	13	4	17	12.06
Porcupine	6	0	3	9	6.38
Antelope	16	12	15	43	30.50
Bush dog	4	5	0	9	6.38
Civet cat	0	0	6	6	4.26
Deer	0	0	1	1	0.71
Total	50	40	51	141	100.00

Biodiversity indices provided further insights into community structure across the zones (Table 2). Oyo exhibited the highest species richness (S = 7), Shannon diversity (H = 1.688), and Simpson index (1–D = 0.7843), confirming its ecological importance as the most diverse site. This is in agreement with the reports of Ajagbe *et al*. (2021) that Simpson Index of heterogeneity values approximately to 1, indicating high diversity. The Margalef index (1.526) also indicated greater richness in Oyo compared to Akwa Ibom (1.022) and Nasarawa (0.8133). Interestingly, Nasarawa recorded the highest evenness (0.9481), suggesting that although it supported fewer species, their distribution was more balanced. By contrast, Akwa Ibom showed moderate richness with signs of dominance (D = 0.2584), reflecting the prevalence of a few highly abundant species.

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Table 2. Biodiversity indices of wild animals sampled across ecological zones

Index	Akwa Ibom	Nasarawa	Oyo
Taxa S (Richness)	5	4	7
Individuals (n)	50	40	51
Dominance D	0.2584	0.2737	0.2157
Simpson (1–D)	0.7416	0.7263	0.7843
Shannon H	1.463	1.333	1.688
Evenness (e^H/S)	0.8639	0.9481	0.7724
Margalef	1.022	0.8133	1.526

Statistical analysis supported these ecological observations. The chi-square test of independence revealed a significant association between animal distribution and ecological zones ($\chi^2 = 771.807$, df = 77, $p < 0.001$) (Table 3). This indicates that species occurrence was not random but strongly dependent on the ecological context (Goberna and Verdu, 2022; Imarhiagbe and Egboduku, 2019). Although a high proportion of cells had expected counts below five due to the rarity of some species, the significance of the test underscores the spatial structuring of species across the landscape.

Table 3. Chi-square test of independence for animal species distribution across ecological zones.

Test Statistic	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-square	771.807	77	.000
Likelihood Ratio	417.984	77	.000
N of Valid Cases	141		

The strength of this relationship was further confirmed by symmetric measures (Table 4). Cramer's V value of 0.884 indicated a very strong association between animal species and ecological zones (Wu *et al*., 2021), while the Phi coefficient (2.340) reinforced this conclusion. Such strong effect sizes highlight the importance of ecological variation in shaping species distributions and stress the need for conservation strategies tailored to specific ecological zones.

Table 4. Symmetric measures for strength of association

Measure	Value	Approx. Sig.
Phi	2.340	.000
Cramer's V	0.884	.000
N of Cases	141	

Taken together, the findings show that Nigeria's ecological zones differ significantly in species richness, diversity, and distribution (Meer and Tella, 2018). Oyo supports a relatively high diversity and unique species, making it a priority for conservation, while Nasarawa, despite lower richness, maintains more balanced community structures. Akwa Ibom lies between these extremes, dominated by a few species. The strong statistical associations reinforce the idea that habitat heterogeneity, resource availability, and anthropogenic pressures drive these patterns. Conservation interventions should therefore adopt region-specific approaches to sustain biodiversity and protect ecologically sensitive species.

Conclusion

This study highlights the ecological structuring of wild animal diversity and distribution across three major ecological zones in Nigeria. Species richness and diversity were highest in Oyo State, reflecting the role of heterogeneous habitats in sustaining faunal communities, while Nasarawa, though less rich, exhibited higher evenness, suggesting a more balanced but constrained ecological system.

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Akwa Ibom fell between these extremes, characterized by moderate richness but dominance of a few species. The significant chi-square results and the strong associations demonstrated by symmetric measures confirm that species occurrence is not random but strongly influenced by ecological conditions. These findings underscore the critical influence of habitat heterogeneity, resource availability, and anthropogenic pressures on wildlife distribution. From a conservation standpoint, the results point to the need for regionally adaptive management strategies. In Oyo, conservation efforts should focus on maintaining habitat complexity to preserve species richness and unique taxa. In contrast, strategies in Nasarawa and Akwa Ibom should prioritize mitigating human-induced disturbances and restoring ecological balance to sustain wildlife communities. By establishing clear evidence of spatial structuring in species diversity, this study provides a scientific basis for targeted conservation planning and emphasises the necessity of adopting species and habitat specific policies for sustainable wildlife management in Nigeria's diverse ecological zones.

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