



Assessment of Habitat Characterization, Population and Nesting of Black Kite (*Milvus Migrans*) in St. Augustinian Forest Reserve, Benue State, Nigeria

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ABSTRACT

Raptors are excellent bio-indicators and are central to conservation efforts. The purpose of the study was to assess habitat characteristics, population, and nesting patterns of *Milvus nigrans* at St. Augustinian Forest Reserve. The study was conducted from September to November 2024. The point count method and total enumeration of trees were adopted, and data were analyzed using descriptive statistics, diversity indices, and Pearson correlation. The results show a total of 8 tree species (66 individuals) across 6 families, with *Daniellia oliveri* (30.3%) the most dominant species. The mean abundance of *Milvus nigrans* was higher in November (9.60, SD = 5.68). There is a weak negative relationship between September and October in the *Milvus nigrans* population, which is not statistically significant ($r(5) = -.320$, $p = .599$), and a moderate negative relationship between October and November, also not statistically significant ($r(5) = -.453$, $p = .443$). Tree height ranges from 10.5 m to 23.8 m, and the total number of nests built within the study period was 77. A correlation analysis between tree height and the number of nests revealed a regression slope of $0.706 + 0.399$, a correlation of 0.557, and an R of 0.310, respectively. Conservation of the remaining trees that support the *Milvus nigrans* species should be considered.

Keywords: Bio-indicator, Habitat and Forest Reserve

INTRODUCTION

Urban environments are well known shelters and conserved areas for many wild species across the world (Machovsky-Capuska et al., 2015). The sustaining of all such wildlife, especially raptors in an urban environment, is because of continuous food supply from human generated wastes and their discards (Newsome and van Eeden, 2017). On the other hand, some processes have been often reported to affect the avian community adversely in the urban environments (Skrzypan et al. 2021). As cities expand, there is an increased concern regarding the decline of native wildlife, including avifauna, due to habitat fragmentation, pollution, and human

disturbance (Yu et al., 2025). Bird population structure is a vital indicator of ecosystem health and resilience (McCloy et al., 2024). Studies have shown that the population density of bird communities in cities is influenced by factors such as green space availability, habitat heterogeneity, and anthropogenic activities (Zhang et al., 2023).

The black kite *Milvus migrans* (Boddaert, 1783) is a bird of prey (Family: Accipitridae), locally known as 'Kalo cheel' (Inskipp et al., 2016). This gregarious and scavenger bird attains the length of 55 – 60cm which can be easily identified with its highly streaked dark brown covert, angled wing and forked tail

(Andreyenkova et al., 2025). Black kite is a summer resident in Asia and Europe that winters mostly in western Africa (Panuccio et al., 2014). In winter, they form large communal roosts, breed in more tropical regions and often remain in the same area year-round if resources remain abundant. The kites play a significant role in maintaining biological balances in the ecosystem (Orta et al., 2020), an excellent bio-indicators of ecosystem health. Kites usually live in colonies and communally roost during the evening, having interspecific clepto-parasitism observed at a dumping area (Sharma and Soni, 2017). They are common residents and passage migrants (Grimmett et al., 2014; Ovcariakova et al., 2020 and Skyrpan et al., 2021).

The utilization of plant materials for nesting is common among bird species and the presence of artificial materials in birds' nests has been reported (Luna et al., 2022, Jagiello et al., 2023). Four main sections of nest are observed among birds nesting structure commonly exist to include attachment, outer layer (decorative), structural layer (support of the structure), and lining (Hugo et al., 2025). Anthropogenic nesting materials (ANM) are most utilized now because of scarcity or absence of natural materials in the vicinity of nesting sites (Hiemstra et al., 2021). This suggests a long-time approach towards urban flora conservation and reforestation.

In Nigeria, rapid urbanization and population growth have catalysed profound landscape

transformations around critical infrastructure, resulting to habitat fragmentation and the creation of anthropogenic food subsidies which fundamentally alter avian community structures, potentially elevating the population potentials of species (Adeola et al., 2020; Banerjee et al., 2021; Soni et al., 2025 and Józefaciuk et al., 2026). The protection of wildlife inhabiting human-modified landscapes ought to receive more attention in natural conserved areas (Chen et al., 2022).

METHODOLOGY

The Study area

The Augustinian Institute (forest reserve) lies between latitude 8.32E and 7.40N and longitude 8.34E and longitude 7.45N (Figure 1) and is located within Kanshio-ga along Alide road. The climate of the tropical wet (April to October) and dry (November to March) exists, with an average annual rainfall of 1,173 mm (Ikyaagba et al., 2020). The temperature ranges from 28.2°C to 34.1°C (Labe et al., 2018). Over time urbanization has caused a decrease in the major urban trees. The vegetation is characterized by savannah woodland with *Daniellia oliveri*, *Vitex doniana* association dominate. Average means annual rainfall and temperature ranged between 1000mm-15000mm and 29°C-30°C, respectively. While relative humidity is between 60% and 80%.

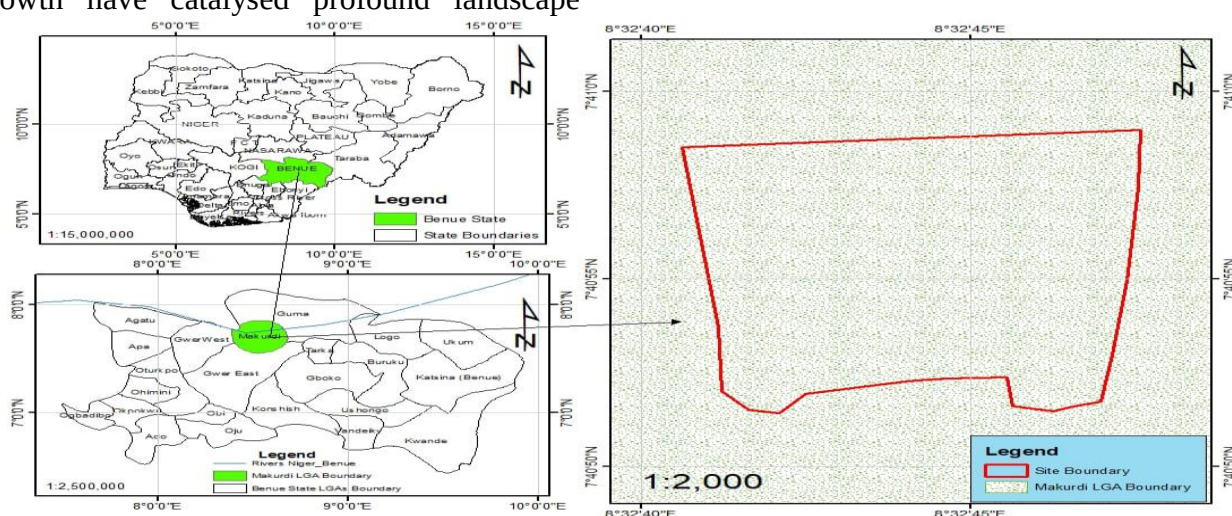


Figure 1. Map Benue State showing St. Augustinian
Source: Aondona et al. (2026)

Sampling Procedures and Data Collections

Field work covered Five land use point types in the area. The Point counts method was adopted as used by Yakubu et al., (2024). Five (5) points namely P1, P2, P3, P4 and P5 were identified randomly with a minimum distance of 500m to avoid possible double counting respectively and each point was visited twice in a month for three months. The technique was employed to assess the abundance and association of raptor species within the study sites.

Data Analysis

Descriptive statistics, diversity indices and Pearson correlation

Shannon-Wiener Index (H') – The index depends on species richness and evenness.

$$H' = -\sum \left(\frac{n_i}{N} \times \ln \frac{n_i}{N} \right) \quad 1$$

Pilou evenness (J) compares the actual diversity value

$$J = \frac{H'}{H_{max}} \quad 2$$

$$EH = \frac{H'}{\ln S} \quad 3$$

Margalef's index (MI) – The higher the index the greater the richness

$$MI = \frac{n-1}{\ln N} \quad 4$$

Where: n_i = the number of individuals (or amount of biomass) of each of the i species and N = the total number of individuals (or biomass) for the site

Simpson's Index (λ)- This is a measure of dominance and expressed as the reciprocal ($DS=1-\lambda$)

$$\lambda = \sum \frac{n_i(n_i-1)}{N(N-1)}$$

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RESULTS AND DISCUSSION

Tree species Composition

The result of this study showed the composition of trees in the urban ecosystem of Makurdi metropolis as presented in Table 1. Sixty-six (66) individual trees belonging to 8 species in 6 families were encountered and recorded. The species with the highest number of individuals was *Daniellia oliveri* with relative abundance of 30.3%, followed by *Azadirachta indica* (16.7%) and *Vitellaria paradoxa* (10.6%), while *Burkea africana* (3.0%) was the least tree species. The family with the highest number of species in the ecosystem was Fabaceae and Anacardiaceae with two species each, respectively. The tree species population identified was relatively moderate in number but valuable to the urban ecosystem. Research has shown that less tree population is characterized as heavily disturbed by the ecosystem (Adebowale et al., 2025). The composition of tree species like *Daniellia oliveri* which is a significant species in West African ecosystems, offers critical ecological services, particularly within urban and peri-urban landscapes. It acts as a resilient shade tree, a pioneer species for reforesting degraded areas, and a valuable source of biodiversity support and nesting.

Table 1: Plant Species Recorded within the Sample Study Area

S/N	Comon Name	Scientific name	Family	Frequency	Percentages (%)
1.	African copaiba balsam tree	<i>Daniellia oliveri</i>	Fabaceae	20	30.3
2.	Shea tree	<i>Vitellaria paradoxa</i>	Sapotaceae	10	15.2
3.	African mahogany	<i>Azadirachta indica</i>	Fabaceae	4	6.1
4.	Wild seriga	<i>Burkea africana</i>	Caesalpiniaceae	2	3.0
5.	Black plum	<i>Vitex doniana</i>	Lamiaceae	7	10.6
6.	Neem	<i>Azadirachta indica</i>	Meliaceae	11	16.7
7.	Cashew	<i>Anacardium orientale</i>	Anacardiaceae	5	7.6
8.	Mango	<i>Mangifera indica</i>	Anacardiaceae	7	10.6
Total				66	100

Source: Field survey (2024)

Table 2 revealed the tree species that support *Milvus migrans* nesting in the study area, including tree height and the number of nests for each species. The result indicates four major tree species namely *Daniellia oliveri*, *Vitellaria paradoxa*, *Afzelia africana* and *Vitex doniana* that strongly support nesting of black kites. *Daniellia oliveri* supported 53 nest, *Vitellaria paradoxa* had 8 nest, *Afzelia africana* had 9 and *Vitex doniana* supported with 16 nests. The result showed that *Milvus nigrans* predominantly colonized trees of the *Daniellia oliveri* species with the highest number in November. This implies that *Daniellia oliveri* provides an appropriate structure and height that kites may prefer, maybe for improved visibility and safety. The remaining portion of the of the unfelled trees

in the reserve with good canopy supported and create the most suitable place for the kites. Many researchers like Onrubia and martin (2021); Babura and Muhammed, (2021); Sabo and Salisu (2023); Badmus *et al.*, (2024) and Yakubu *et al.*, (2024) observed the impact of habitat of the distribution and abundance of raptors birds among others. Precisely *Milvus nigrans* prefer tall trees for nesting and other activities. The mean tree height of *Daniellia oliveri* was 22.3, *Vitellaria paradoxa* was 18.9 and *Vitex doniana* with 13.4, respectively. Human disturbances have exacerbated biodiversity collapse and habitat characterization, and suitability is key to the existence, survival and continuity of biodiversity including bird species.

Table 2: Tree Species Supporting Nesting of *Milvus nigrans* in the Sampled Study Area

Point	Scientific name	Tree height (M)	Number of Nest
1.	<i>Daniellia oliveri</i>	22.5	15
	<i>Daniellia oliveri</i>	22.3	20
	<i>Daniellia oliveri</i>	20.5	10
	<i>Daniellia oliveri</i>	23.8	8
	Mean = 22.3		Total= 53
2.	<i>Vitellaria paradoxa</i>	19.2	5
	<i>Vitellaria paradoxa</i>	18.5	3
	Mean = 18.9		Total= 8
3.	<i>Afzelia africana</i>	12.5	9
4.	<i>Vitex doniana</i>	10.5	3
5.	<i>Vitex doniana</i>	16.3	4
	Mean = 13.4		Total = 16
Total nest observed			77

Source: Field survey (2024)

Abundance and Diversity of *Milvus nigrans*

The abundance and distribution of *Milvus nigrans* is presented in Table 3. The month of November with 48 individuals was dominant, followed by the month of September with 34 individuals. Mean abundance and A pearson correlation was done to examine the relationship between the distribution and abundance of *Milvus nigrans* in September, October and November (Table 4 and 5). The mean for September 4.40 (SD = 1.95), October 6.80 (SD = 3.56) and November was 9.60 (SD = 5.68) obtained. Research into

the abundance and distribution of the Black Kite (*Milvus migrans*) indicates that November is a critical transition period, marked by the arrival of winter migratory populations in warmer regions and the stabilization of sedentary, urban-adapted populations (Ghulam *et al.*, 2025). The results in Table 5 showed a positive strong relationship between September and November and statistically significant ($r(5) = .884$, $p = .047$). There is a weak negative relationship between September and October and not statistically significant ($r(5) = -.320$, $p = .599$). The result revealed a moderate

negative relationship between October and November and not statistically significant ($r(5) = -.453$, $p = .443$). A weak negative relationship between environmental variables (e.g., wind, rain) or, in some studies, between habitat suitability and occupancy in early

autumn (September) versus late autumn (October), often reflects that these birds are highly adaptable and facultative, meaning they do not rely strictly on precise timing or specific weather conditions to move.

Table 3: Distribution and Abundance of *Milvus nigrans* Per Month in the Study Area

Point	September	October	November
Point 1	5	6	10
Point 2	5	6	4
Point 3	7	4	8
Point 4	3	13	19
Point 5	2	5	7
Total number observed	22	34	48

Source: Field survey (2024)

Table 4: Mean Abundance of *Milvus nigrans* per Month in the Study Area

Descriptive Statistics			
	Mean	Std. Deviation	N
September	4.40	1.949	5
October	6.80	3.564	5
November	9.60	5.683	5

Source: Field survey (2024)

Table 5: Pearson Correlations Abundance of *Milvus nigrans* per Month in the Study Area

		September	October	November
September	Pearson Correlation	-0.320	1	-0.453
October	Pearson Correlation	0.884*	-.453	1
November	Pearson Correlation	1	-0.320	0.884*

Key: * = Correlation is significant at the 0.05 level (2-tailed).

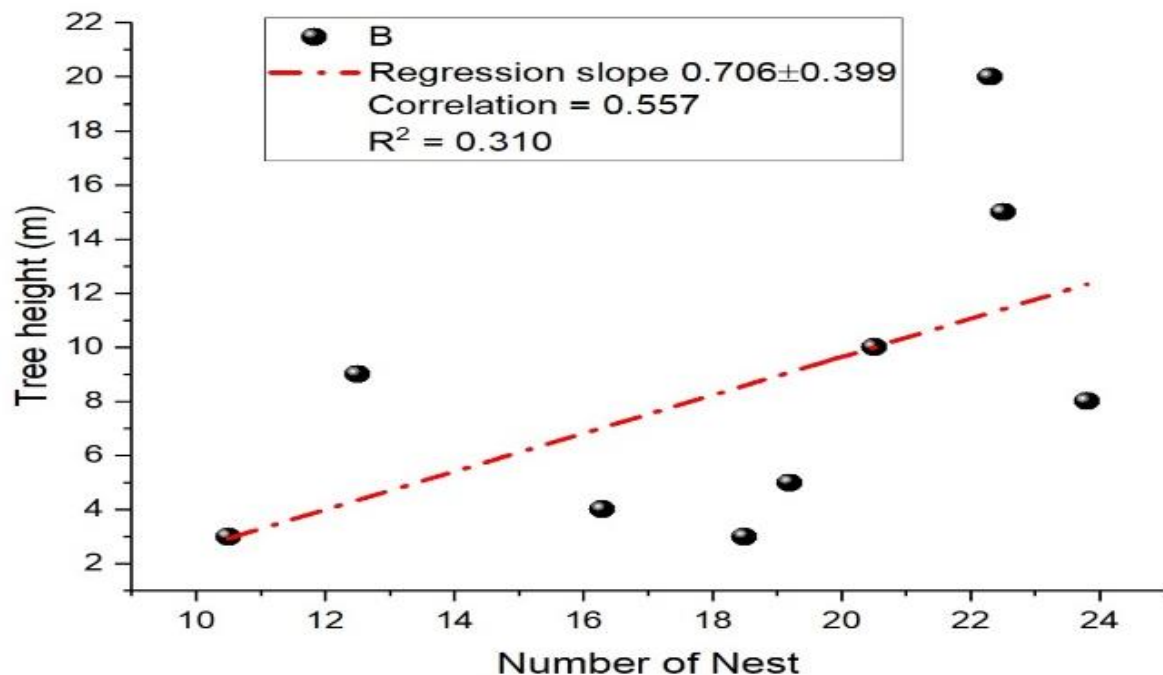
The result of the diversity indices of *Milvus nigrans* given in Table 6 indicated higher diversity index ($H' = 1.53$), evenness ($E = 0.92$) and richness ($R = 1.29$), respectively in the month of September. The high diversity ($H' = 1.53$), evenness ($E = 0.92$), and richness ($R = 1.29$) indices for *Milvus nigrans* in September suggest a period of optimal foraging, resource availability, and population stability for the species. These findings imply that the surveyed habitat supports a balanced, thriving population during the post-monsoon period. The

regression slope and correlation analysis between Tree height and number of nests given in Figure 2 revealed a regression slope of $0.706 + 0.399$, Correlation of 0.557 and R of 0.310 respectively. The presence of the preferred trees species for nesting contributed to the moderate population abundance of the *Milvus nigrans* nest in the area. All the colonized trees were located between 10.5m to 23m height. Also, the proximity of the study location to water not only ensures hydration but also provides suitable foraging opportunities.

Table 6. Diversity Indices of *Milvus nigrans* per Month in the Study Area

	September	October	November
Taxa_S	5	5	5
Individuals	22	34	48
Dominance_D	0.2314	0.2439	0.2561
Simpson_1-D	0.7686	0.7561	0.7439
Shannon_H	1.528	1.513	1.48
Evenness_e^H/S	0.9213	0.9085	0.8787
Margalef	1.294	1.134	1.033

Source: Field survey (2024)

**Figure 2: Scatter Plot, Regression Slope and Correlation Analysis between Tree Height and Number of Nests**

CONCLUSION

Studies in the St. Augustinian Forest Reserve in Benue State, Nigeria, indicate that the area offers a suitable, heterogeneous habitat for *Milvus nigrans* (Black Kite), supporting a stable or nesting population due to favorable foraging opportunities and nesting sites, acting as the dominant nesting substrate. The findings highlight a dynamic population of *Milvus nigrans*, which showed higher abundance in November; however, the lack of statistically significant negative correlations between months suggest that the population fluctuations were not strong predictable or consistent within the study period. The findings emphasize the species'

adaptability, with nesting and foraging behavior strongly correlated with vegetation structure and proximity to human-modified landscapes. Furthermore, the data shows a moderate positive relationship between tree height and the number of nests (correlation of 0.557), suggesting that taller trees are preferred for nesting, though they are not the sole determining factor for nest selection.

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Plate 1: Adult black Kite and Nesting site of Black Kite
Source: Field Survey (2024)