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Research Article

Urbanization and its Impact on Birds of Prey in Makurdi Metropolis, Benue State, Nigeria

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Abstract— Urbanization is rapidly altering ecosystems worldwide, presenting both challenges and opportunities for biodiversity conservation. Birds of prey, as top predators and indicators of environmental health, are particularly sensitive to anthropogenic disturbances. This study investigates Urbanization and its impact on birds of prey in the Makurdi metropolis of Benue State, Nigeria, across several categories of land usage. The Timed Species Count technique was applied across various urban land-use types, including Highways, Residential areas, Tertiary institutions, Commercial centers, and the Airport. Diversity among avian species was assessed by means of the Shannon Diversity Index, Simpson's Index, Gini-Simpson Diversity Index, and Pielou's Evenness Index. Results indicate the occurrence of various, raptor species including the Lizard Buzzard, Black Kite, Marsh Harrier, African Goshawk, and Pearl Spotted Owlet. The Black Kite was the most abundant species, with the airport exhibiting the highest abundance of birds of prey. Infrastructure such as masts, electric poles, and rooftops were utilized by these birds for perching while tree species were used for nesting. Diversity indices varied across different land-use types, suggesting habitat-specific preferences among bird of prey species. It highlights the adaptability of some bird of prey species to urban environments, likely due to the availability of resources and nesting habitats. Although urbanization poses threats to biodiversity, birds of prey create new habitats within urban landscapes, contributing to their resilience. Understanding species habitat behavior is crucial for effective habitat management, conservation, and ecosystem preservation in the face of environmental changes. Urbanization influences the spatial arrangement and population size of raptors, with some species thriving in urban environments. The study underscores the importance of green spaces and noise levels in urban areas for avian diversity. Recommendations include the conservation of green areas and the implementation of measures to mitigate anthropogenic impacts on bird of prey populations.

Keywords— Birds of Prey, Urbanization, Impact, Habitat disturbance, Diversity indices, Conservation, Raptors.

1. Introduction

Urban ecosystems are playing a bigger role in influencing ecological processes as cities spread throughout the world. Urbanization is the most irreversible of all anthropogenic disturbances [28-29,34]. While urbanization significantly reduces biodiversity, many fauna species that are reliant on the unique features of the urban environment might find new homes and food supplies in urban and peri-urban areas. An extinction crisis has resulted from human activity's acceleration of biodiversity loss worldwide [5]. Many species are declining along with the number of extinctions, which raises the possibility that biodiversity losses could impair ecosystem services and have an impact on human well-being [1,35]. The dramatic fall in vulture populations over the Indian subcontinent after diclofenac was prescribed as a cattle medication in the 1990s [17], and the rise in rabies cases in humans and feral dog populations that followed [13] are now a well-known illustration of the dangers of species extinction. In addition to the well-researched ecosystem services offered by scavengers and predators [18], raptors, such as hawks, harriers, kites, eagles, falcons, owls, and vultures, can shape biological communities and serve as cultural emblems. They are also markers of biodiversity and environmental health [9]. Raptors are more vulnerable to manmade risks and extinction than most other bird species because of their high trophic level and relatively delayed life history [30]. Finally, because they can be hard to spot and occur at low population densities, raptors are more challenging to monitor than most other birds. Raptors are at risk from a variety of factors, such as habitat loss or alteration, deliberate killing [4], purposeful and accidental poisoning [11], electrocution [15], and climate change [12]. Laws have been put in place in many nations and areas to shield birds including raptors from these dangers. Certain laws, like the Bald and Golden Eagle Protection Act (1940) in the United States, are especially intended to protect raptor species. To reduce raptor mortality, best practices and designated habitats have been designed specifically for

raptors [7-8]. In accordance with the United Nations Convention on the Conservation of Migratory Species of Wild Animals (CMS), raptors that migrate throughout Africa and Eurasia are protected by the Memorandum of Understanding on the Conservation of Migratory Birds of Prey in Africa and Eurasia, or the "Raptors MoU," a legally non-binding international agreement.Raptors, sometimes known as birds of prey, are bird species that mostly hunt and consume vertebrates that are enormous in comparison to the hunters [2]. They also have powerful, curved beaks for shredding flesh, muscular feet with talons for grabbing or killing prey, and good eyesight for spotting food from a distance or while flying. They are a crucial instrument for concentrating conservation efforts on a local, regional, and international level. Even in far-flung places, raptor distribution or abundance changes can be used to gauge human influence on the environment. A greater diversity of bird species—which serve as prey for numerous raptor species—may be encouraged by urban and suburban environments. The fact that these urban areas may have higher bird and rodent numbers than the native habitats of the area could result in a net higher biomass of potential prey items for raptors, which may be more significant for raptors than species richness. Several raptor species seem to actively seek out urban areas [19]. The Mississippi Kite (*Ictinia mississippiensis*), Merlin (*Falco columbarius*), Cooper's Hawk (*Accipiter cooperii),* Sharp-shinned Hawk (*Accipiter striatus*), Eurasian Kestrel (*Falco tinnunculus*), and Eastern Screech Owl (*Megascops asio*) are just a few of the more than 25 species that have been documented to reside and breed in cities [31]. These species might occasionally be found in cities rather than their native environments. The most well-known example is the Peregrine Falcon (Falco peregrinus), which is most commonly known in many areas for being a raptor that lives in cities. These kinds of species usually do well in cities because they have plenty of food and habitat, are not subject to persecution or natural predators, and can flourish there. As more and more cases of raptors such as the Crested Goshawk (Accipiter *trivirgatus),* Crowned Eagle (*Stephanoaetus coronatus*), Northern Goshawk (*Accipiter gentilis),* Eurasian Sparrowhawk (*Accipiter nisus*), and Black Sparrowhawk (*Accipiter melanoleucus*) are reported, the trend of raptors colonizing urban areas is increasing [14]. On the other hand, a large number of other raptors are more susceptible to the negative effects of urbanization and are predicted to decrease as a result of things like electrocution, collisions with windows or cars, predation by domesticated animals, a lack of adequate prey or habitat, persecution, and poisoning. Even for those species that do not appear to be at risk, cities may present more subtle physiological concerns to raptors, effectively in city settings. Even in the face of biodiversity challenges, urban environments might be a good place for raptors to set up shop. Sufficient food sources and adequate nesting habitat are essential for the survival of many raptor species, and urban and suburban settings provide both in large quantities. We must study entire populations of raptors to comprehend how they react to changing environmental conditions and stressors. More attention is also necessary given their declining numbers and economic connections.[32] This study intends to identify the human structures that are utilized by raptors and explore the quantity, distribution, and effects of urbanization on raptors in Makurdi metropolises across various land-use types.

2. Related Work

To comprehend how urbanization affects prey species' habitats, behaviours, and populations, Ref [24] examined how urbanization affects different bird species globally. They examined the distribution and abundance of raptors in urban regions, as well as the major variables influencing the success or failure of raptors in urban settings. They also analysed how successfully conservation initiatives worked to lessen the detrimental effects of urbanization on raptors' prey. To comprehend how urbanization impacts Peregrine Falcons' breeding ecology and reproductive results, The findings reveal that urban-rural habitat edges support diverse bird communities, influenced by habitat structure and resource availability. Accordingly, recommendations emphasize the importance of management practices focused on maintaining habitat connectivity and enhancing edge habitats to bolster urban bird populations. Ultimately, the conclusions underscore how urbanization creates unique ecological niches at habitat edges, highlighting the necessity for landscape-level conservation approaches in urban areas. Ref [26] concentrated on the nesting success of these birds in urban settings. They looked into how urbanization affects the choice of nest sites for Peregrine Falcons, as well as the reproductive characteristics and success rates of these birds in urban versus natural environments. They also looked into possible risks and stressors linked to urbanization that may affect Peregrine Falcon populations, The findings highlight various factors influencing population trends and management strategies for Peregrine Falcons nesting in urban areas, including habitat availability, prey abundance, and human disturbance. In response, recommendations propose integrating measures into urban management plans aimed at reducing disturbances to nesting Peregrine Falcons and improving habitat quality within urban settings. Ultimately, the conclusions underscore the nuanced responses of Peregrine Falcons to urban environments, emphasizing the importance of tailored conservation efforts to secure their continued presence in urban landscapes. The goal of Ref [25] was to synthesize the literature that has already been written about the cumulative effects of urbanization on diurnal raptor species and quantify the overall impact of urban development on these birds. they also identified variations in the responses of various raptor species to urbanization and explored potential mechanisms that may underlie the observed impacts, such as habitat alteration, prey availability, and human disturbance to compare the foraging, roosting, and breeding behaviours of nocturnal raptors in urban and rural landscapes and evaluate the effects of artificial light pollution on nocturnal raptor behaviour and physiology, The findings indicate that diurnal birds of prey display diverse distribution patterns along urban gradients, reflecting species-specific habitat preferences and responses to urbanization. In light of this, recommendations advocate for prioritizing habitat conservation and restoration initiatives to uphold biodiversity and ecosystem functioning

within urban landscapes. Ultimately, the conclusions underscore how urbanization shapes the spatial distribution of diurnal raptors, emphasizing the necessity for adaptive management strategies to mitigate habitat fragmentation and loss in urban environments. Ref [21] examined how urbanization influences the behavior and ecology of nocturnal raptors, with a focus on species like owls and nightjars. Additionally, looking into how urban environments might serve as obstacles or havens for populations of nocturnal raptors, according to their findings, urbanization poses both opportunities and problems for nocturnal raptors, thus adaptive management techniques are needed to mitigate its negative consequences. Furthermore, their findings suggest that urbanization has a significant impact on the nocturnal raptors' community structure and foraging ecology, which alters the distribution of prey and the availability of habitat. To support nighttime raptor populations, they advise directing conservation efforts toward the preservation of appropriate habitats and minimizing human disturbance in urban areas. Ref [22] evaluated the conservation and implications of urbanization for raptor populations, emphasizing the opportunities and challenges posed by the urban landscape. They also explored the role of citizen science initiatives and community engagement in monitoring and conserving urban raptor populations, and they evaluated the efficacy of conservation strategies, such as habitat restoration and the provision of nesting sites, in urban areas for supporting raptor populations. Additionally, they identified potential conflicts between raptors and humans in urban settings and proposed strategies for mitigation, their findings indicates that urbanization fosters the expansion of avian predators, offering ample food resources and nesting sites within urban landscapes. Recommendations suggest that conservation efforts should strive to reconcile the advantages of urban habitats for avian predators with potential conflicts arising from human interactions and urban infrastructure. Ultimately, the conclusions underscore the substantial influence of urbanization on the distribution and abundance of avian predators, emphasizing the need for comprehensive management strategies to promote their coexistence with human populations. Ref [23] investigated how changes in urbanization affect the diversity and abundance of prey species for birds of prey, with implications for the ecology and population dynamics of raptors. They quantified changes in prey availability in urban habitats relative to natural environments, looked into how birds of prey adapt their diets and hunting techniques in response to these changes in prey communities, and evaluated the possible domino effects of altered prey dynamics on raptor population dynamics and community structure. Assessing genetic differentiation and population structure of raptor species across urban and rural landscapes, as well as examining the impact of habitat isolation and fragmentation of genetic diversity and gene flow in urbanized areas, the findings highlight that success of bird species in urban environments is linked to inter-individual variability in fear of humans and relative brain size. Recommendations suggest that conservation efforts need to account for individual differences in behavioral responses to urbanization when devising strategies to address human-wildlife conflicts. Conclusions emphasize that the capacity of bird species to acclimate to urban settings varies depending on individual traits, underscoring the significance of integrating behavioral ecology into urban wildlife management practices. Ref [27] investigated how urbanization affects the genetic diversity and gene flow of populations of birds of prey, taking into consideration the implications for their long-term viability and adaptability. Finally, the study examined the possibility of genetic adaptation to urban environments in populations of birds of prey over a period of time, The findings reveal that urbanization significantly shifts the trophic structure of avian communities, primarily through changes in prey availability and resource distribution. In response, recommendations advocate for ecosystem-based management strategies that prioritize the conservation of habitat diversity and ecological connectivity within urban environments, aiming to sustain avian biodiversity. Ultimately, the conclusions highlight how urbanization reshapes food webs and resource dynamics, underscoring the imperative of integrating trophic interactions into urban ecology and conservation planning efforts.

3. Materials and Methods

3.1 Study area

Makurdi spans across both banks of the Benue River, bordered to the West by Keana, North by Lafia and Doma Local Governments in Nasarawa State, East by Guma Local Government, and South by Gwer and Gwer-West Local Governments. Positioned at latitude 7°43'60" N and longitude 8°31'60"E of the Greenwich meridian, Makurdi serves as both a local government headquarters and the state capital. It comprises 11 council wards with an approximate population of 500,797 individuals [33].

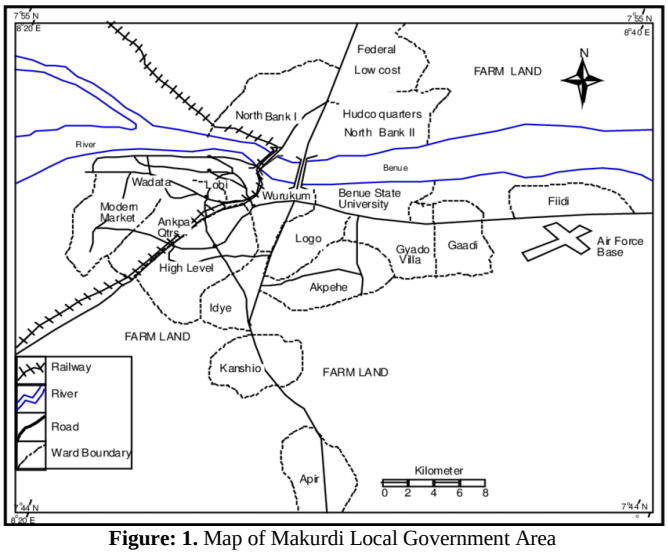

Figure: 1. Map of Makurdi Local Government Area
Source: Benue State Ministry for Lands and Survey

3.1.2 Climate

The climate of Makurdi Local Government Area, where the study area is situated, exhibits two distinct seasons. There is a dry season from November to April, followed by a rainy or wet season from May to October, with the peak rainfall typically occurring from late July to September each year.

Temperatures in Makurdi are at their highest during the dry season and lowest during the rainy season, with mean monthly maximum temperatures ranging from 39.4ºC to 30.6ºC and mean monthly minimum temperatures ranging from 26.7ºC to 18.4ºC. The average annual rainfall is approximately 1238mm, and the relative humidity generally exceeds 78% [16].

4. Experimental Method

Field work covered Five land use types in urban settlements, namely: (1) Highways (2) Residential areas (3) Tertiary institutions (4) Commercial centres (5) Airport. The study sites were visited fortnightly for six months.

The "Timed Species Count (TSC)" technique of bird's survey developed by (Pomeroy and Tengecho, 1989) and adopted by Ref [20]. The technique was employed to assess the abundance and distribution of raptor species within the study sites. Point counts or predetermined locations were established across various land use types sampled within urban settlements. A minimum distance of 500m was maintained between each counting point. A total of 100 counting points were utilized, comprising 20 stations per land use type. Upon reaching the sites, observed raptor species were recorded within a predetermined timeframe (10 minutes). Physical characteristics of birds that could not be immediately identified were documented, and a field guidebook of West African birds [3] was consulted for species identification. Additionally, structures utilized by the observed raptor species were noted.

4.1 Data Analysis

Pielou's Evenness Index (J), Simpson's Index (λ), and the Shannon diversity index as adopted by Ref [19] were used to calculate the diversity of avian species based on the obtained data.

5. Results

Table 1 shows the five raptor species that have been identified in the research area, the Pearl Spotted Owlet, African Goshawk, Marsh Harrier, Black Kite, and Lizard Buzzard.

Table 1: Checklist Of Birds of Prey Recorded in the Study Area

Family	Common Name	Scientific Name	Iucn Status
Accipitridae	Lizard Buzzard	*Kapifalco monogrammicus*	Least Concern
	Black Kite	*Milvus migran*	Least Concern
	Marsh Harrier	*Circus aeruginosus*	Least Concern
	African Goshawk	*Accipiter tachiro*	Least Concern
Strigidae	Pearl Spotted Owlet	*Glaucidium perlatum*	Least Concern

Table 2 shows species and number of individuals observed across different Land-use types in the study area with the Black Kite as the most abundant bird of prey in the research area, and the airport was the land use type where the most abundant bird of prey was found.

Table 2: Species and Number of Individuals Observed across Different Land-Use Types in the Study Area.

Common Name	H/W	T/I	C/A	R/A	A/P	Total	Abundance%
Lizard Buzzard	12	9	4	8	11	44	19.81
Black Kite	7	11	9	9	34	70	31.53
Marsh Harrier	8	9	9	8	9	43	19.36
African Goshawk	9	8	9	6	13	45	20.27
Pearl Spotted Owlet	5	6	2	1	6	20	9.00
TOTAL	41	43	33	32	73		

Key: H/W=Highways, T/I=Tertiary Institutions, C/A=Commercial Areas, R/A=Residential Area, A/P= Airport

Table 3 The Tertiary institution consistently shows the highest diversity indices, indicating greater species richness, evenness, and diversity. Conversely, the Commercial area tends to have the lowest diversity indices, suggesting lower species richness and uneven distribution of individuals among species.

Table 3: Diversity Indices of Birds of Prey in the Study Area

Habitat Type	Shannon Diversity Index (*'H'*)	Simpson Diversity Index (*D*)	Gini-Simpson Diversity Index	Pielou's Evenness Index (*J*)
H/W	1.717	0.648	0.352	0.792
T/I	1.761	0.668	0.332	0.874
C/A	1.624	0.611	0.389	0.798
R/A	1.641	0.602	0.398	0.813
AP	1.718	0.648	0.352	0.799

Key:H/W= Highways, T/I=Tertiary Institutions, C/A=Commercial Areas, R/A=Residential Area, A/P= Airport

Table 4 provides information on the infrastructure utilized and activities observed by different species of birds of prey across various land-use types within the study area

Table 4: Infrastructures utilized and activity by Birds of Prey across Different Land-Use Types in the Study Area

Species Name	Structure Utilized	Activity Observed
Lizard Buzzard	Mast, Electric pole,	Perching
Black Kite	Rooftop, Electric pole, Mast,	Perching Nesting
Marsh Harrier	Mast, Rooftop	Perching
African Goshawk	Rooftop, Electric pole, Tree	Perching

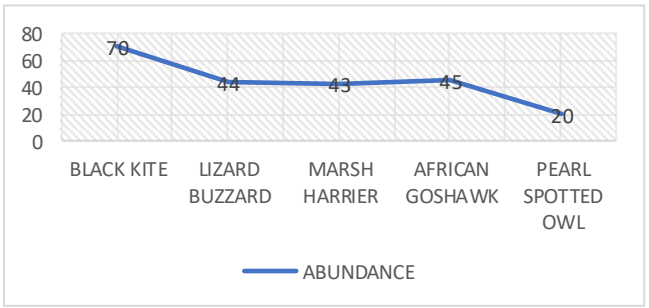

Figure: 2 Bird species abundance in the study Area.

Figure 2 illustrates birds of prey abundance in the study area, revealing the Black Kite as the most abundant species and the Pearl Spotted Owl as the least abundance

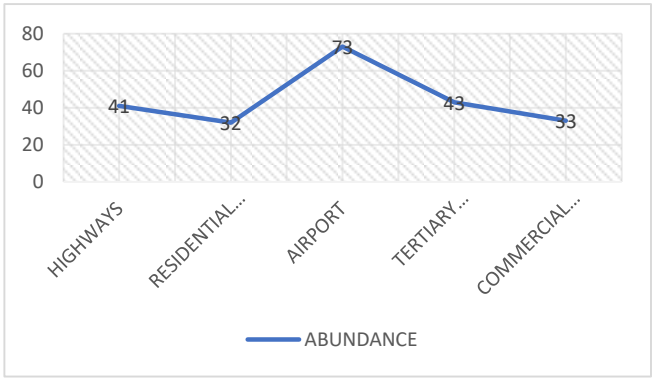

Figure: 3 Bird species abundance across different Land use types.

Figure 3 illustrates that the Airport exhibited the highest frequency of sightings of birds of prey species, whereas Residential areas recorded the least occurrence of these raptors.

5. Discussion

Five species of raptors the Lizard Buzzard, Black Kite, Marsh Harrier, African Goshawk, and Pearl Spotted Owlet are identified on the checklist as being present in the research area. Every species has an IUCN conservation status and is linked to a particular family. To lay the groundwork for future investigations and conservation initiatives aimed at preserving birds of prey, this baseline inventory offers vital details about the bird community in the study area. Because of the limited human access and disturbance, raptors, or birds of prey, are among the most vulnerable taxa to habitat disturbance. The majority of raptors that have been observed are found at airports, particularly on the runways, where their survival is aided by the abundance of rodents and other small mammals. This aligns with Ref [6], which states that the distribution of birds was mostly influenced by the availability of cover, water, and food. The distribution of bird species among various land-use types offers information about resource availability, habitat preferences, and possible interactions between humans and wildlife. It emphasizes how crucial it is to take habitat variability into account when developing conservation planning and management plans. Birds of prey species' varying abundances in Makurdi Metropolis's various land use types at different times can only be explained by the behavior of the species in their habitats, not by the habitat's physical characteristics. By focusing on species habitat behavior, insights are gained into the ecological functioning of ecosystems, species interactions, and the dynamic relationships between organisms and their environments. This understanding is crucial for effective habitat management, species conservation, and ecosystem preservation in the face of environmental changes and anthropogenic impacts. The Black Kite was the most abundant bird of prey in the research area, and the airport was the land use type where the most abundant bird of prey was found. These findings contradict Ref [19] which stated that Mean abundance was highest at Commercial centers. Diversity indices varied across different land-use types, The diversity indices suggest that certain habitat types, such as Highways and Tertiary Institutions, support higher species diversity and evenness of birds of prey compared to others like Commercial Areas and Residential Areas. This implies that birds of prey might exhibit habitat preferences based on factors such as food availability, nesting sites, and human disturbance levels. The presence of birds of prey in urban habitats like Highways and Commercial Areas highlights their adaptability to human-modified environments. Understanding the distribution and diversity of these species in urban areas is crucial for urban planning, conservation efforts, and mitigating human-wildlife conflicts. Higher species diversity and evenness in certain habitats may indicate healthier ecosystems with diverse prey populations and suitable environmental conditions. Monitoring changes in bird of prey diversity over time can serve as an indicator of ecosystem health and help identify potential environmental disturbances or habitat degradation.it is suggesting habitat-specific preferences among bird of prey species. It highlights the adaptability of some bird of prey species to urban environments, likely due to the availability of resources and nesting habitats. Urbanization is giving rise to new habitats for a number of species, as evidenced by the fact that birds of prey species have been observed using rooftops, electric poles, and masts—a finding that is consistent with the discovery made by Ref [10]. Despite the fact that habitat loss caused by human activity has an adverse effect on the population of birds of prey, the birds continue to establish new, suitable habitats. The presence of birds of prey utilizing man-made structures such as Electric poles and Rooftops highlights their adaptation to urban environments. Monitoring their interactions with human infrastructure is crucial for mitigating potential conflicts and promoting coexistence. Understanding the infrastructure utilized and activities performed by raptors offers information about their ecological requirements, behaviour, and potential interactions with human infrastructure. This information can inform habitat management and conservation strategies to mitigate conflicts and enhance habitat suitability for these species.

6. Conclusion and Future Scope

Urbanization causes environmental changes that have direct impact on biodiversity, particularly affecting bird populations. Birds may relocate or migrate due to urban development. However, certain species have adjusted to urban settings, thriving and even growing in numbers. Factors such as the presence of green spaces and noise levels play significant roles in shaping the urban avian community. Green areas tend to enhance bird diversity, although there might be fewer species of birds of prey, their individual numbers often increase. This phenomenon is observable in species such as such as Black kite, African Goshawk as well as Lizard Buzzard. The study underscores the importance of green spaces and noise levels in urban areas for avian diversity. The conservation of green areas and the implementation of measures to mitigate anthropogenic impacts on bird of prey populations is imperative to protect this bioindicator.

Future scope

This baseline inventory provides essential information about the avian community in Makurdi Metropolis, serving as a foundation for further research and conservation efforts targeting birds of prey.

Data Availability

Raw monthly data collected to put together the table for species and number of individuals observed across different land-use types in the study area have not been displayed in this work for private policy and confidentiality reasons. They are in the possession of the author and will be provided on request when contacted on the above email and mobile phone

Conflict of Interest

All authors involved in this article declare that they have no conflicts of interest throughout the entirety of their work.

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Authors' Contributions

The contributing authors contributed in various capacities, including data collection, data analysis, typesetting, and manuscript review. Meanwhile, the lead author was responsible for organizing and overseeing the study's execution.

References

[1] A. Amar, R. Buij, J. Suri, P. Sumasgutner, M. Z. Virani. "Conservation and ecology of African raptors" in J.H. Sarasola, J.M. Grande, J.J. Negro (Eds.), Birds of Prey: Biology and Conservation in the XXI Century,Springer-Verlag, New York, NY, pp.**419-455, 2018**.

[2] S. Bashir, S. Babura, M. Salisu, and Z. K. Mustapha. "A Comparative Study of Raptors Species Diversity between Protected and Unprotected Areas of Hadejia Nguru Wetlands, Nigeria." *Confluence Journal of Environmental Studies*, Vol.**14**, Issue.**1**, **2021**.

[3] N. Borrow and R. Demey. "Field Guide to the Birds of Western Africa" **2014**.

[4] A.L. Brochet, W. Van Den Bossche, V. R. Jones, H. Arnardottir, D. Damoc, M. Demko, G. Driessens, K. Flensted, M. Gerber, M. Ghasabyan, D. Gradinarov, J. Hansen, M. Horvath, M. Karlonas, J. Krogulec, T. Kuzmenko, L. Lachman, T. Lehtiniemi, P. Lorge, U. Lotberg, J. Lusby, G. Ottens, J. Y. Paquet, A. Rukhaia, M. Schmidt, P. Shimmings, A. Stipnieks, E. Sultanov, Z. Vermouzek, A. Vintchevski, V. Volke, and G. S. H. M. Willi Butchart. "Illegal killing and taking of birds in Europe outside the Mediterranean: assessing the scope and scale of a complex issue. *Bird Conservation International*, pp.**1-31, 2017.**

[5] G. Ceballos, P. Ehrlich, and R. Dirzo. "Biological annihilation via the ongoing sixth mass extinction signaled by vertebrate population losses and declines." *Proceedings of the National Academy of Sciences*, article **04949, 2017**.

[6] A.U. Cletus, S.B. Mathias, and E.O. Johnbless. "Survey of Avian Species Diversity in Bali, Taraba State Nigeria." *International Journal of Research Studies in Zoology*, Vol.**3**, Issue.**1**, pp.**1-5, 2016.**

[7] CMS."Power Lines and Migratory Birds."UNEP/CMS/Resolution, 10.11, 2011.

[8] CMS."Review and Guidelines to Prevent the Risk of Poisoning of Migratory birds."UNEP/CMS/COP11/Doc.1.2, pp.**54, 2014**

[9] J. A. Donázar, A. Cortés-Avizanda, J. A. Fargallo, A. Margalida, M. Moleón, Z. Morales-Reyes, R. Moreno-Opo, J. M. Pérez-García, J. A. Sánchez Zapata, I. Zuberogoitia, and D. Serrano. "Roles of raptors in a changing world: from flagships to providers of key ecosystem services." *Ardeola*, Vol.**63**, pp.**181-234, 2016.**

[10] P. O. Egwumah, I. M. Iwar, and L. Ogbonna. "A Survey of The Wild Avi-Fauna Within Makurdi Metropolis of Benue State, Nigeria." *Journal of Research in Forestry, Wildlife and Environment*, Vol **1**, No.**1**, pp.**75- 83, 2009**.

[11] R. Garbett, M. G. Herremans, R. P. Maude, A. Reading, and A. Amar. "Raptor population trends in northern Botswana: a re-survey of road transects after 20 years." *Biological Conservation*, Vol.**224**, pp.**87-99, 2018.**

[12] K. J. Iknayan and S. R. Beissinger. "Collapse of a desert bird community over the past century driven by climate change."*Proceedings of the National Academy of Sciences*, Article 05, pp.**123, 2018**.

[13] A. Markandya, T. Taylor, and A. Longo. "Counting the cost of vulture declines – economic appraisal of the benefits of the Gyps vulture in India."*Ecological Economics*, Vol.**67,** pp.**194-204, 2008**.

[14] R. O. Martin, L. Sebele, A. Koeslag, O. Curtis, F. Abadi, and A. Amar. "Phenological shifts assist colonization of a novel environment in a range-expanding raptor."*Oikos*, Vol.**123,** pp. **1457-1468, 2014**.

[15] E. K. Mojica, J. F. Dwyer, R. E. Harness, G. E. Williams, and B. Woodbridge. "Review and synthesis of research investigating golden eagle electrocutions."*Journal of Wildlife Management*, Vol.**82**, pp.**495-506, 2018.**

[16] NIMET. "Nigeria Meteorological Agency, Headquarters, Tactical Air Command, Makurdi-Airport Data."**2016-2017.**

[17] J. L. Oaks, M. Gilbert, M. Z. Virani, R. T. Watson, C. U. Meteyer, B. A. Rideout, H. L. Shivaprasad, S. Ahmed, M. J. I. Chaudhry, M. Arshad, S. Mahmood, and A. Ali, A. A. Khan. "Diclofenac residues as the cause of vulture population decline in Pakistan." *Nature*, Vol.**427**, pp.**630-633, 2004**.

[18] C. J. O'Bryan, A. R. Braczkowski, N. L. Beyer, N. H. Carter, J. E. M. Watson, and E. McDonald-Madden."The contribution of predators and scavengers to human well-being." *Nature Ecology and Evolution*, Vol.**2,** pp.**229-236, 2018**.

[19] O. S. Odewumi, O. E. Adekola, and O. A. Aladesiun. "Diversity and Abundance of Birds of Prey in Akure Metropolis, Ondo State, Nigeria."*Journal of Forest Science and Environment*, Volume **5,** pp.**1–10, 2020**.

[20] E. F. Okosodo, J. O. Orimaye, and O. S. Odewumi. "Diversity and Abundance of Birds of Prey and Owls in Four Selected Areas in South Western Nigeria". *International Journal of Environment, Agriculture and Biotechnology*. Vol-**1**, Issue-**2** Princeton University Press, United States, **2016.**

[21] J.M. Álvarez-Martínez and E. Orellana. "The impact of urbanization on the community structure and foraging ecology of nocturnal raptors." *Diversity and Distributions*, Vol.**26**, Issue**3**, pp.**306-318, 2020**.

[22] R. Buij and H.A. Jansman. "The role of urbanization in the expansion of avian predators."*Animal Biodiversity and Conservation*, Vol.**31**, Issue.**1**, pp.**67-75, 2008.**

[23] M. Carrete and J.L Tella. "Inter-individual variability in fear of humans and relative brain size of the species are related to contemporary urban invasion in birds." *PLoS One*, Vol.**6**, Issue.**4**, **e18859, 2011.**

[24] S. DeStefano and R.M. DeGraaf. "Urban habitats and bird conservation: a study of urban-rural habitat edges." *Conservation Biology*, Vol.**17**, Issue **2**, pp.**681-687, 2003**.

[25] A. Sorace and M. Gustin. "Distribution of diurnal birds of prey along an urban gradient in Northern Italy."*Landscape and Urban Planning*, Vol.**89**, Issues.**1-2**, pp.**54-64, 2009**.

[26] C.M. White and N.J. Clum. "Urban raptor ecology: a review of factors affecting population trends and management of Peregrine Falcons nesting in cities." *Journal of Raptor Research*, Vol.**5**1, Issue.**4**, pp.**377-385, 2017**.

[27] A.E. Johnson and J.W. Williams. "Urbanization affects the trophic structure of avian assemblages." *Ecology*, Vol. **96**, Issue **2**, pp **462-473, 2015**.
[28] V.C.Radeloff."The rise of novelty in ecosystems." *Ecological Applications*, Vol.**25**, pp. **2051-2068, 2015**.
[29] C.E. Ramalho, R.J. Hobbs. "Time for a change: dynamic urban ecology." *Trends in Ecology & Evolution*, Vol.**27,** pp. **179-188, 2012.**
[30] F. Sergio, T. Caro, D. Brown, B. Clucas, J. Hunter, J. Ketchum, K. McHugh, F. Hiraldo. "Top predators as conservation tools: ecological rationale, assumptions, and efficacy." *Annual Review of Ecology, Evolution, and Systematics*, Vol.**39,** pp. **1-19, 2008.**
[31] P. Sumasgutner, C.H. Schulze, H.W. Krenn, and A. Gamauf. "Conservation-related conflicts in nest site selection of the Eurasian Kestrel (Falco tinnunculus) and the distribution of its avian prey." *Landscape and Urban Planning*, Vol.**127,** pp. **94-103, 2014.**
[32] F. Zilio, A. Bolzan, A. de Mendonça-Lima, C. Oliveira da Silva, L. Verrastro, and M. Borges-Martins. "Raptor Assemblages in Grasslands of Southern Brazil: Species Richness and Abundance and the Influence of the Survey Method." *Zoological Studies*, Vol**.52**, pp. **27, 2013**.
[33] National Population Commission (NPC) (**2006**) Nigeria National Census.
[34]T. Mohanta, H.A. Ahmed, "Some Reflections on the Modern Environmental Ethics," *International Journal of Scientific Research in Multidisciplinary Studies*, Vol.**3**, Issue.**3**, pp.**7-9, 2017.**
[35]Ogunrinde Olayemi. Segun and Owoyemi jacob.Mayowa, "Sustainable Management of Nigerian Forest through Efficient Recovery 0f HarvestingResidues," *International Journal of Scientific Research in Multidisciplinary Studies* , Vol.**2**, Issue.**1**, pp.**1-6, 2016**

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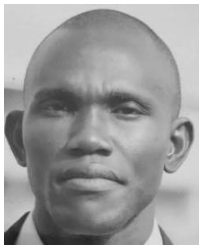

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