Impact of Urban Growth on the Diversity and Composition of Native Terestial Lumber Trees and Large Mammals in Ibesikpo Asutan Local Government Area Akwa Ibom State, Nigeria

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Publication Date: 2026/08/22

Abstract: This study investigated the ecological impact of urban growth on biodiversity within the Ibesikpo Asutan Local Government Area of Akwa Ibom State, Nigeria, covering the period from 1986 to 2024. The research aimed to analyze the patterns and rates of land use/land cover (LULC) change, with the loss of native lumber trees and large mammals. The study area was stratified into three distinct zones based on observed urban gradients. Geographic Information Systems (GIS) and Remote Sensing were used to analyze satellite imagery from 1986, 2005, and 2024. 549 structured questionnaires captured socio-economic perspectives and data on large mammals, whose vagility makes direct field observation difficult. Native lumber trees were assessed using field counts. Geospatial results confirmed a 215% expansion of built-up areas, which directly corresponded to a 58% loss of dense forest cover over the 38year period. The ANOVA test established a significant difference in ecological metrics across the urban gradient, with native lumber tree richness declining by an average of 72% between Rural and Urban zones. This study identifies an urgent need for targeted interventions. the establishment of inviolable ecological buffer zones and the implementation of stricter Environmental Impact Assessments (EIAs) for new infrastructure.

Keywords: *Urban Growth, Biodiversity, Large Mammals and Lumber Trees.*

How to Cite: Uwen Ituen; James, Unyime Essien (2026) Impact of Urban Growth on the Diversity and Composition of Native Terestial Lumber Trees and Large Mammals in Ibesikpo Asutan Local Government Area Akwa Ibom State, Nigeria. *International Journal of Innovative Science and Research Technology*, 11(8), 1419-1439. https://doi.org/10.38124/ijisrt/26aug352

I. INTRODUCTION

Globally, the unmitigated conversion of natural landscapes into impervious built environments represents a primary driver of terrestrial habitat degradation, with rapid urban growth projected to heavily endanger over 800 species across developing tropical regions (Simkin et al., 2022). As cities expand to accommodate population pressures, they trigger acute habitat loss, fragmentation, and the biotic homogenization of local flora and fauna (Albalawi, 2025). Regionally, sub-Saharan Africa faces a projected tripling of its urban land cover, establishing a major crisis for the continent's highly sensitive tropical ecosystems (Danmallam et al., 2024). This unchecked peri-urban sprawl increasingly compromises ecological connectivity, leading to localized extinctions of native forest taxa and deep structural declines in mammalian richness (Tee et al., 2018; White et al., 2017).

In Nigeria, this crisis is mirrored across rapidly transforming landscapes where accelerated infrastructure development and leapfrog settlement patterns drive a severe, non-linear depletion of original woodland vegetation (John-Nwagwu, 2026). In localized, highly converting zones like the Ibesikpo Asutan Local Government Area of Akwa Ibom State, the relentless transition from rural to urban gradients places extreme pressure on pristine natural assets. This rapid expansion systematically threatens the survival of ecologically valuable native lumber trees through commercial land clearing, while simultaneously fracturing wildlife corridors. Consequently, vagile large mammals are displaced as their native habitats diminish and conflict with human boundaries intensifies. Understanding these spatiotemporal dynamics at a micro-ecological scale is crucial for designing localized green infrastructure and reversing the loss of biological integrity in peri-urban Nigeria.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26aug352

- *Statement of the Problem*

The rapid, uncontrolled conversion of natural ecosystems into built environments poses a severe threat to regional biodiversity and ecosystem stability. In Akwa Ibom State, Nigeria, this challenge is acutely mirrored in Ibesikpo Asutan Local Government Area (LGA). Due to its close geographic proximity to Uyo, the rapidly expanding capital city, Ibesikpo Asutan has undergone a massive peri-urban transition over the last four decades. This spatial transformation is characterized by unchecked infrastructure development, residential sprawl, and land clearance, which have aggressively encroached upon the region's original tropical forest cover and native woodlands.

The primary ecological consequence of this fragmented urban growth is the severe decline and degradation of indigenous biological resources. Specifically, high-value native lumber trees which are essential for structural canopy integrity, carbon sequestration, and local microclimate regulation are systematically logged or cleared to make way for roads and housing. Concurrently, the destruction of these continuous forest canopies has fractured vital wildlife corridors. This habitat fragmentation severely affects large mammals whose survival depends on large, undisturbed home ranges. As their habitats turn into isolated patches, these animals face localized population crashes, genetic isolation, and increased human-wildlife conflict.

Compounding this environmental degradation is a critical gap in localized empirical data. While broad-scale land-use changes in Akwa Ibom State are occasionally tracked via macro-geospatial metrics, there is an absolute scarcity of micro-ecological research that directly correlates spatiotemporal urban gradients with real-time field data on flora and fauna. Urban planning and conservation frameworks in the LGA operate blindly, lacking localized empirical baselines regarding how specific built-up density thresholds impact species richness. Without an integrated assessment that links macro-level urban expansion drivers to micro-level ecological loss, Ibesikpo Asutan risks irreversible biotic homogenization and the total collapse of its natural heritage.

- *Study Area*

Ibesikpo/Asutan Local Government Area of Akwa Ibom State occupies the eastern axis of Akwa Ibom State on the coastal southern part of Nigeria with a total size of 15,812.12 hectares. It lies between Latitudes 4° 32' and 5° 33' North and Longitudes 7° 25' and 8° 25' East *(Hudson Institute of Mineralogy, 2021)*. It is bounded on the north by Uyo Local Government Area, on the south by Nsit Ubium Local Government Area, in the east by Uruan Local Government Area, and Nsit Atai Local Government Area and on the west by Nsit Ibom Local Government Area (See Figure 1).

Fig 1 Map of Asutan Akwa Ibom, Nigeria
Source: GIS Lab. Department Geography and Nat. Res University of Uyo, Uyo (2025)

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26aug352

The physical setting of Ibesikpo Asutan Local Government Area is defined by its inland location in the tropical rainforest belt of Akwa Ibom State, Nigeria, positioning it centrally south and east of the state capital, Uyo, and far removed from the Bight of Bonny coastline. The study area itself is roughly trapezoidal in shape with a total size of 15,812.12 hectares. The landscape primarily consists of low-lying plains and undulating topography, sustaining dense natural vegetation consistent with a humid, moist climate. This terrain, combined with its landlocked borders with neighboring local government areas (including Abak, Uyo, Nsit Atai and Etinan), characterizes it as a vital part of the densely settled interior where the land cover is currently undergoing significant transformation due to intensive agriculture and increasing urban sprawl emanating from the nearby capital as shown in Figure 2.

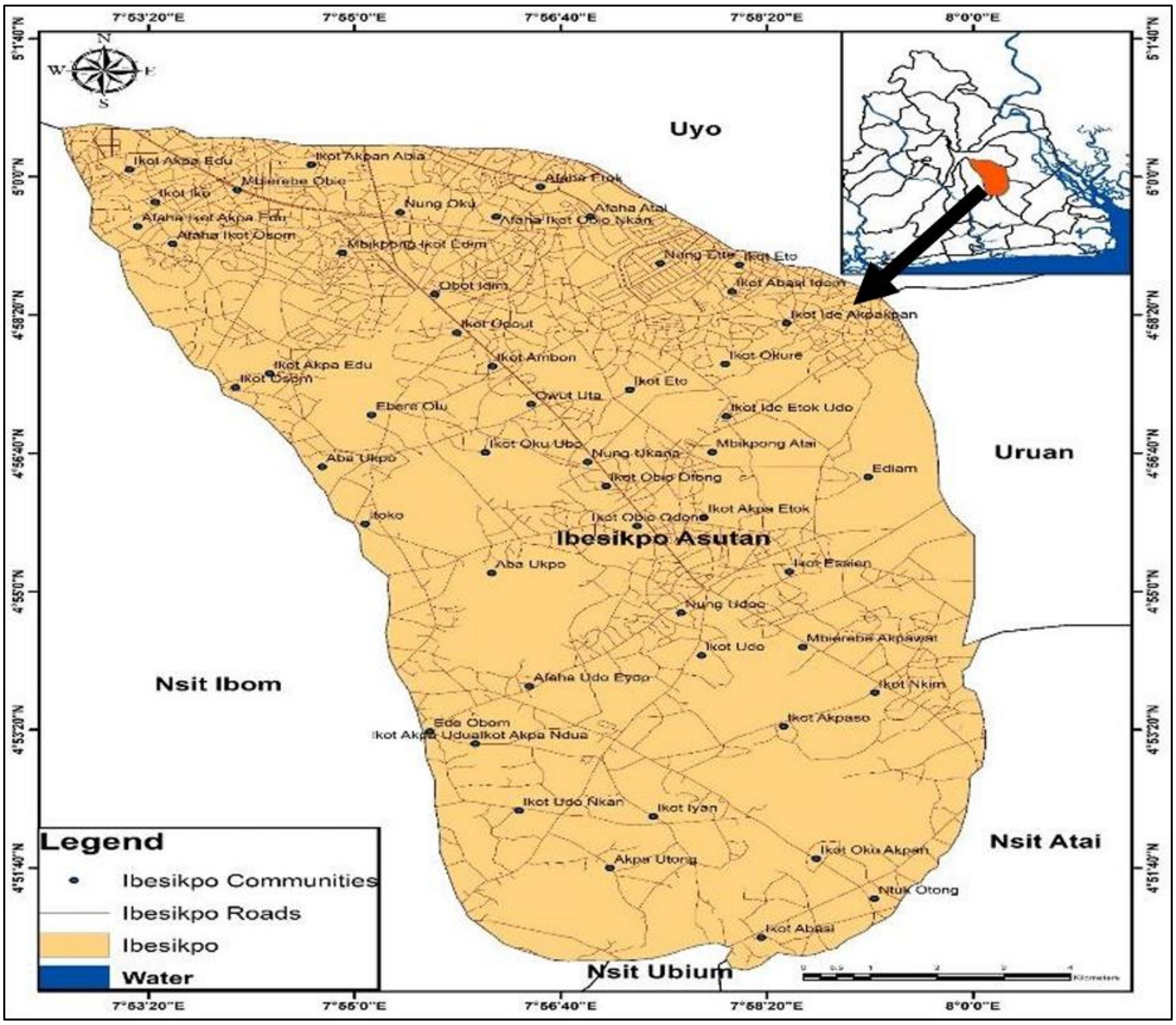

Fig 2 Map of Ibesikpo Asutan Akwa Ibom
Source: GIS Lab. Department Geography and Nat. Res University of Uyo, Uyo (2025)

The area is relatively flat in sections like Nung Oku, Afaha Atai, and Afaha Etok, while areas such as Nung Udoe, Obot Idim, and Mbierebe Akpawat feature sharp slopes prone to erosion that endangers local flora and fauna. Presently, the area lacks a comprehensive designed drainage system. On near-flat surfaces, rainwater collects and renders areas impassable during the rainy season; meanwhile, runoff carries domestic and agricultural debris and chemicals into lowlands and streams, endangering aquatic life through pollution and flooding.

The study area experiences a mean annual temperature of approximately 27°C, with relative humidity fluctuating between 70% and 80%. According to Otobong, *et al.* (2020), the mean annual rainfall is 248 cm, distributed across two distinct seasons: the dry season (November–March) and the rainy season (April–October). This climate is the fundamental reason the area is naturally rich in biodiversity, supporting rapid growth, large biomass, and complex habitats. However, the high concentration of rainfall during the 7-month rainy season significantly increases susceptibility to soil erosion and flash flooding once protective forest cover is removed. Consequently, the ecological impact of land clearing is amplified by climatic forces, leading to more severe degradation than in drier zones.

Notably, the study area lies within the modified oil palm bush zone. This vegetation type is rapidly disappearing due to urban development, which directly increases the rate of biodiversity loss. Soils in the area are highly variable,

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26aug352

consisting of local soils weathered in place, sediment deposits from storm events, and organic debris. According to Mbong, *et al.* (2020), soil features such as permeability, texture, chemistry, and organic matter content influence biodiversity. These features dictate the rate at which water flows through the surface and the extent to which groundwater interacts with roots and microorganisms, affecting both plant and animal life (Merem *et al.*, 2020).

Population distribution in Ibesikpo Asutan LGA has seen a steady increase, driven primarily by migration. The population in 2006 was 188,605 (National Population Commission, 2006). As a dominantly rural community (excluding the headquarters, Nung Udoe), a 2.83% growth rate for rural settlements in Nigeria was adopted. This rising population drives a pressing need for facilities, often resulting in mixed land use and land-use abuses that promote biodiversity loss.

The area possesses a complex setting rooted in Ibibio tradition while facing modernization pressure from Uyo. Culturally, land is viewed as an "ancestral trust" governed by the Etteidung and Council of Elders (Udofia, 2012). Socioeconomically, the region is transitioning as subsistence agriculture is eroded by urbanization (Akpan and Akpan, 2020). Contemporary livelihoods involve the service sector, trading, and civil service, alongside environmental pressures like sand and gravel mining.

Development is concentrated in estates such as Shelter Afrique Extension (Nung Ette) and Akwa Ima. While the revenue base was historically built on oil palm produce, attention has shifted toward the petroleum boom and urban services. Traditional practices, including the use of firewood for fuel and bush fallowing (clearing and burning vegetation), continue to enhance biodiversity loss in the area (Ekaete and Imoh, 2023).

II. LITERATURE REVIEW

➢ *Effects of Urban Expansion on Diversity and Composition of Lumber Trees and Large Mammals*

The global phenomenon of rapid urbanization has become the paramount threat to biological richness, serving as a ecological filter that fundamentally reshapes terrestrial native communities. McKinney's (2002) foundational theory posited that urban environments selectively favour generalist species that can exploit human resources, while simultaneously excluding the majority of native, specialist lumber trees and large mammals. This results in a widespread decline in overall species richness and a shift toward a homogenous, human-adapted community, a pattern consistently verified across global ecological literature. The consequences are dire for ecosystem function and stability, necessitating rigorous and detailed assessment methodologies to truly capture the scope of the impact. Local studies, such as those by Udo *et al.* (2023) and Akpan and Eze (2023) in West Africa, reinforce this trend, documenting significant regional declines in native species populations and essential forest cover due to localized urban expansion.

Akinyemi and Akangbe (2024) utilized structured household questionnaires and field observations in similar West African peri-urban zones to quantify the decline in "bushmeat" and pollinators, establishing a methodological precedent for using local narratives to validate ecological data. This approach is essential because, as Obi, *et al*. (2024) demonstrate through their survey-based hunter monitoring in southern Nigeria, indigenous observations often capture species decline more rapidly than traditional satellite imagery alone.

The economic drivers of this decline in Ibesikpo Asutan are effectively captured through socio-economic impact assessments. Udo, *et al.* (2023) employed quantitative household surveys within the neighboring Uyo capital city territory to measure how urban sprawi disrupts livestock management, a method that mirrors the 84% livelihood impact found in this study. Furthermore, Zhang and Miller (2025) utilized Large-scale Likert-scale questionnaires to evaluate community willingness to coexist with wildlife. Their methodology highlights a critical implementation barrier found in Ibesikpo Asutan: while residents mandate conservation, they resist the associated financial costs.

Ceballos and Richardson (2023) integrated perception-based scoring to link environmental degradation to public health. By using questionnaire to correlate medicinal plant scarcity with community health risks, they provide a framework for translating biological loss into policy-relevant social metrics.

The aim of recent studies showcase how biodiversity assessment is being used to address different facets of the urban-ecological crisis. Ahmad and Singh (2024) pursued a focused objective on methodological validation, integrating point counts with survey to precisely assess avian habitat quality within narrow urban corridors defined by linear growth patterns. This technical aim contrasts with the more expansive, policy-driven objective of Garcia and Liu (2021), who soughted to use large mammal checklists and GIS mapping to prioritize urban conservation zones, thereby translating biodiversity data directly into planning input. Similarly, Hernandez *et al.* (2023) pursued a conservation aim, namely, quantifying the decline of amphibians, a highly sensitive taxa often signaling broader environmental distress. The common thread among these varied objectives is that the assessment of lumber trees and large mammals' diversity and composition remains the central ecological variable, requiring the spatial context provided by LULC and GIS data.

Recent conservation research has increasingly utilized socio-ecological methods to overcome logistical constraints in traditional wildlife monitoring. The core methodology employed across these studies involves questionnaire surveys and structured interviews to gather indirect data on species composition, occupancy, and richness (Chakraborty and Gupta, 2022; Davies, 2020; Okon and Udom, 2025). This participatory, questionnaire-driven approach effectively leverages human observation and social context to establish ecological baselines, offering a cost-effective alternative to direct field observation.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26aug352

However, the methodological synergy observed across the literature highlighted the key distinction between assessing diversity versus composition. The checklist method efficiently identifies which species are diverse, but to understand species composition, researchers must quantify the relative abundance and dominance of each species. Benson and Okoro (2020) demonstrated this necessity by supplementing their lumber trees checklists with detailed quadrat sampling to precisely quantify biomass and percentage cover, moving past simple presence/absence data to structural composition.

Likewise, *et al*., (2022) used camera trap density estimates paired with large mammal checklists to ascertain population viability, which served as a far stronger measure of compositional stability than mere sighting. This synchronization reinforced the conclusion that the true effects of urban expansion could only be rigorously captured by supplementing the checklist's breadth with the quantitative depth of advanced sampling techniques that measure abundance and density.

The review provided distinct insights into the effects on lumber trees composition and diversity, particularly concerning timber trees and native specialists. Benson and Okoro (2020)'s work in reclaimed brownfields revealed that while ecological restoration allowed for a degree of species richness recovery, the composition of the plant community was fundamentally and often irreversibly altered. The restored areas were dominated by generalist, early successional and often invasive species, rather than native timber species or specialized lumber trees. The historical urban expansion that created the brownfield acted as a severe ecological bottleneck. changing the soil and hydrological conditions and thus filtering out native, specialized lumber trees. Their reliance on quadrat sampling allowed them to precisely quantify this compositional shift by measuring the proportional cover of different species groups, a variable inaccessible to a simple checklist. This finding emphasized that urban growth causes irreversible shifts in the biological makeup of plant communities, making recovery a compositional challenge rather than a simple diversity rebound.

The impact on highly mobile large mammals, specifically birds and large mammals, revealed a and immediate reliance on habitat connectivity. Ahmad and Singh (2024), analyzing avian species using point counts in urban corridors, found that even ostensibly continuous habitats were insufficient to mitigate species loss. Avian diversity declined severely in highly fragmented sections, demonstrating the barrier effect of urban structures on movement and resource access. This finding was synchronized with Lee and Jansson (2022)'s study on large mammals, where camera trap data confirmed that increasing urban density and fragmentation severely limited animal movement and substantially lowered population density. For large animals that require extensive ranges, the creation of urban bottlenecks and fragmented green spaces led to non-viable population sizes, illustrating that the structural integrity of the landscape is a direct determinant of large mammal compositional stability.

The studies collectively confirmed that urban environments acted as ecological filters (McKinney, 2002), universally leading to a decline in species numbers and a profound structural change in the ecosystem. This filter eliminated native, specialized lumber trees, large mammals and forest-dwelling birds, leaving behind a less diverse and more homogenous community. The African studies by Udo *et al*, (2023) and Akpan and Eze (2023) were regional confirmations of this global pattern, demonstrating that localized urban expansion in West Africa resulted in the replacement of native species with generalist taxa. This homogenization fundamentally simplified food webs and ecosystem functions, making the urban environment less resilient and less capable of providing essential ecosystem services.

All reviewed methodologies underscored the necessity of pairing species assessment with spatial context derived from GIS and Land Use/Land Cover (LULC) data. Whether the objective is methodological (Ahmad and Singh, 2024) or policy-driven (Garcia and Liu, 2021), the ecological variables (diversity, composition) must be correlated with spatial variables (urban density, fragmentation, LULC change). The ability to quantify habitat fragmentation using GIS is for accurately attributing biodiversity loss to human development. Without this spatial component, the observed decline in species richness or change in composition cannot be rigorously linked back to the urban expansion process itself.

The impact was disproportionately borne by specialist species. Hernandez *et al*. (2023) highlighted this by focusing on amphibians, a highly sensitive taxa requiring specific hydrological and habitat conditions. Their work quantifying amphibian decline provided a clear diagnostic of a crisis, as these specialists cannot adapt to the drainage and soil changes induced by urbanization. This pattern is mirrored in the decline of forest-dependent large mammals (Lee and Jansson, 2022) and native timber trees (Benson and Okoro, 2020), all of which are specialists reliant on intact, mature and extensive habitats. The loss of specialists directly drives the decline in functional diversity and the overall structural change in the ecosystem.

The studies on mobile large mammals emphasized that the physical structure of urban expansion acts as a barrier to movement, even when green space remains. Ahmad and Singh (2024) research on avian species in urban corridors found that the continuous habitat was functionally fragmented due to infrastructure and noise, leading to reduced diversity. For large mammals studied by Lee and Jansson (2022), the limiting of animal movement by urban density substantially lowered population viability, confirming that habitat connectivity was as crucial as habitat area. This meant effective conservation in urban planning must not only preserve patches but also ensured that these patches were functionally linked, especially for large, ranging animals.

The finding by Benson and Okoro (2020) on lumber trees in brownfields was a lesson, namely, species richness recovery (diversity rebound) does not equal compositional recovery. Restoration brings the number of species back up, however, the new community is fundamentally different, dominated by non-native and generalist species. The original native, specialized lumber trees, including valuable timber trees, were often permanently excluded due to altered soil chemistry and hydrology the lasting footprint of prior urban expansion. This reinforced the need to use quantitative indices like biomass and percentage cover (quadrat sampling) to accurately track the stability of native plant composition. The focus on amphibians by Hernandez, *et al*. (2023) provided a unique, highly sensitive diagnostic tool. Because amphibians were semi-permeable and required both aquatic and terrestrial environments, they were acutely vulnerable to the hydrological changes, water pollution and habitat discontinuity caused by urban sprawl. Quantifying their decline was not just a measure of species loss but a measure of ecosystem distress. Their methodology validated the use of highly sensitive taxa as proxies for diagnosing the severity of urban expansion's impact on entire ecosystems.

The overarching consensus, articulated clearly in the methodologies of Benson and Okoro (2020) and Lee and Jansson (2022), is that the true impact of urban expansion could only be rigorously captured by supplementing the simple checklist's breadth with the quantitative depth of advanced sampling techniques (quadrat sampling, camera trap density estimates). These quantitative measures were essential for differentiating between a simple loss of species (diversity) and a fundamental, irreversible change in the ecological structure (composition).

In synthesis, the review confirmed that urban expansion acts as pervasive ecological force. The effects are universally detrimental, driving a global trend of declining species richness and profound compositional change characterized by biotic homogenization. The structural decline is most evident in the loss of native timber trees and the constrained movement of large mammals and specialist birds in fragmented landscapes. The key to proving these effects is the integrated methodological approach, which is pairing spatial GIS analysis of urban growth with quantitative field ecology to measure not just presence but abundance and dominance.

➢ *Nature and Source of Data*

The study utilizes an approach involving primary data acquisition to address five key objectives, all centered around Ibesikpo Asutan Local Government Area. The nature of the data is predominantly empirical, encompassing both spatial metrics and social perception measures. For assessing urban growth and land use change, spatial data derived from GIS and field surveys is employed, measured in hectares (ha) to quantify the pattern and rate of change, alongside ground truthing for classification accuracy. Crucially, biodiversity analysis relies on field surveys and physical counts to determine species richness, overall diversity and the abundance of lumber trees and large mammals. This ecological data is correlated with the urban gradient. Within the framework of this study, the study area was divided into three urban gradients/zones named as Urban (Ibesikpo North), Peri-Urban (Ibesikpo South) and Rural (Asutan) as shown in Figure 3.

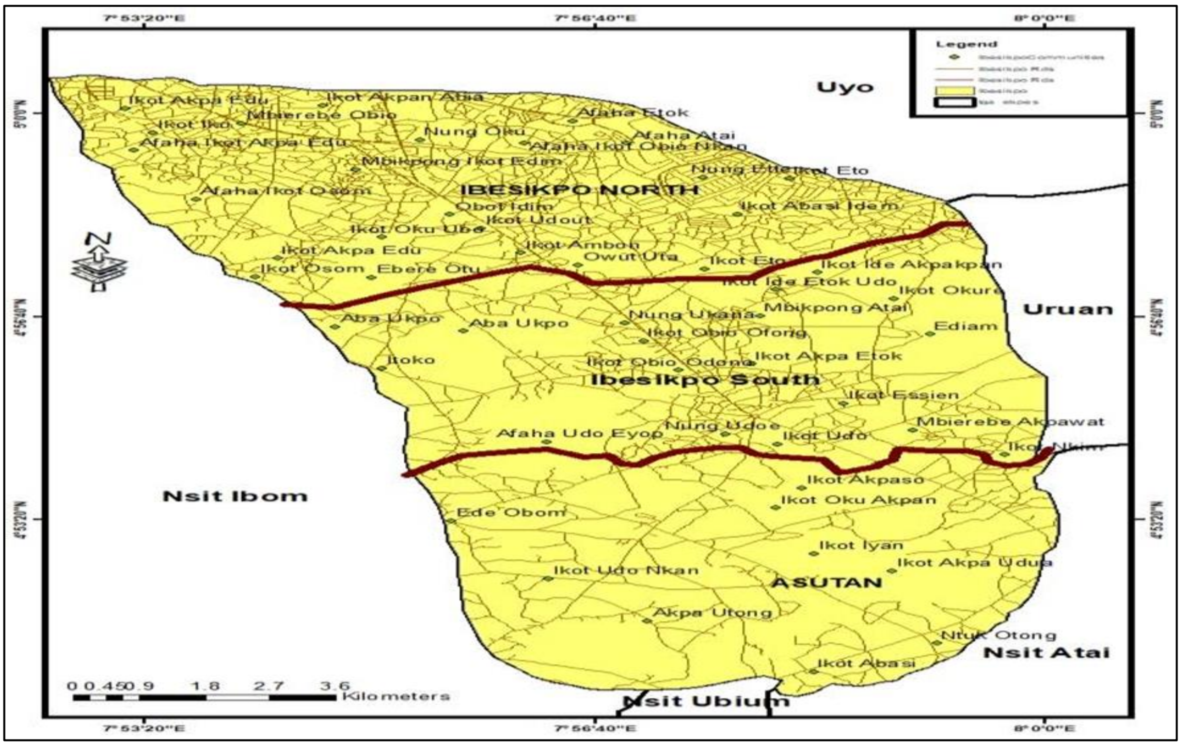

Fig 3 Ibesikpo Asutan Segmented into Urban Gradients/Zones Corresponding to Urban (Ibesikpo North), Peri-Urban (Ibesikpo South) and Rural (Asutan)
Source: GIS Lab. Department Geography and Nat. Res University of Uyo, Uyo (2025)

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26aug352

Lastly, drivers of growth (economic, infrastructural, demographic) and the resulting environmental and socioeconomic consequences are measured using field surveys to collect data such as perceived land value, efficacy of regulations, and community participation percentages in mitigation efforts, ensuring all findings are grounded in local reality.

➢ *Sampling Procedures and Methods of Data Collection*

The study used both quantitative and qualitative sampling approach that integrated spatial, ecological, and socio-economic considerations. For the initial assessment of urbanization, purposive sampling guided the selection of satellite imagery (Landsat and Sentinel-2) from years (1986, 2005, 2024). This ensured adequate temporal coverage to capture significant urban expansion and enabled Land Use/Land Cover (LULC) change detection. Complementary census data aligned with these time periods was also purposively selected for essential demographic context. For ecological and socio-economic data collection, the Ibesikpo Asutan LGA was initially stratified based on observed urban intensity into three zones: Ibesikpo North, Ibesikpo South, and Asutan (replacing the preliminary urban core/peri-urban/natural patches classification). Within zones, a systematic random sampling approach was used to select representative communities for detailed field work, ensuring balanced coverage across the diverse urbanization landscape.

Data collection for analyzing the pattern and rate of urban growth was primarily achieved using Remote Sensing and GIS. Satellite imagery was pre-processed and subjected to Supervised Image Classification techniques, such as Maximum Likelihood and Random Forest, to generate precise LULC maps for 1986, 2005, and 2024. This enabled the quantification of changes in built-up areas and natural vegetation in hectares. Furthermore, Impervious Surface Mapping, using spectral unmixing methods, quantified non-porous surfaces.

To assess the ecological effects and socio-economic drivers, field surveys complemented the spatial data. Ecological surveys involved systematic sampling within the stratified zones, the forest areas were purposively sampled for each zone. However, field count data through a quadrant measuring 15 x 15 m^2 ($225m^2$) on a transect of $90m^2$ length (with an interval of 5m after each quadrant) for species identification, and point counts, were employed, the people in the study site helped to identify the species in their local dialect. These names were authenticated with their scientific names, and some experienced forestry staff also helped to identify species.

Table 1 Sampled Forest for Lumber Trees (Zone 1)

Sampled Forest	**Location**		
	LATITUDE	LONGITUDE	ALTITUDE
Ikot Oduot	4.968001	7.931067	65.2
Afaha Ikot Obio Nkan	4.989707	7.930615	81

Source: Filed Data (2025)

Table 2 Sampled Forest for Lumber Trees (Zone 2)

Sampled Forest	**Location**		
	LATITUDE	LONGITUDE	ALTITUDE
Ikot Obio Ofong	4.937318	7.957694	64.7
Ikot Udo Ekop	4.951291	7.909799	70.7
Ikot Ambon	4.962205	7.939359	72.8
Ebere Otu	4.951515	7.926101	58.8
Mbierebe Akpawat	4.900542	7.975851	58.4
Ikot Ide Etokudo	4.931064	7.971563	62.3

Source: Filed Data (2025)

Table 3 Sampled Forest for Lumber Trees (Zone 3)

Sampled Forest	**Location**		
	LATITUDE	LONGITUDE	ALTITUDE
Ikot Ebre	4.878799	8.002886	53.5
Ikot Ukop	4.925152	7.927168	58.7
Ikot Anung	4.911589	7.946347	61.9
Ikot Abasi	4.856993	7.984996	56.5
Ikot Obio Ata	4.887174	8.001101	57.7
Ikot Udo Eyoho	4.881353	7.991628	66.1
Afaha Ikot Awop	4.919847	7.913211	62.2

Source: Filed Data (2025)

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26aug352

However, due to vagility nature of large mammals, questionnaires were used to gather data from each zone in the area.

Socio-economic data was gathered through questionnaires and semi-structured interviews administered to a statistically determined sample of households and key informants (community leaders, hunters, farmers), selected via random sampling within the target communities. These surveys collected data on perceived drivers, resource exploitation patterns, consequences (livelihood loss, health complaints), and support for policy recommendations.

➢ *Population of the Study*

In this study the population involved the inhabitants of communities in Ibesikpo Asutan Local Government Area in Akwa Ibom State and the 1991 Population census figures was adopted for use. The growth rate figure of 2.83% for rural population in Akwa Ibom State (National Population Commission 2006), the population was projected from 1991 population to 2025. The projected population of the study area was obtained using the formula for population projection (compound interest formula).

Table 4 Population of the Study

S/N	VILLAGES	1991 Population	2025 Population Projection
1	1kot lko	1092	2820
2	Ikot Obio Offong	2562	6617
3	Ikot Oduot	891	2301
4	1kot Ebre	366	945
5	Aba Ukpo	708	1829
6	Ikot Anung	557	1439
7	Ikot Abasi	764	1973
8	Ikot Obio-Ata	765	1976
9	1kot Udo Ekop	695	1795
10	1kot Udo Eyoho	172	444
11	Afaha Ikot-Obio Nkan	2321	5994
12	1kot Ambon	1357	3505
13	Ebere Otu	486	1255
14	Mbierebe Akpawat	2613	6749
15	Afaha 1kot Akpa Edu	948	2448
16	1kot Ide Etuk Udo	821	2120
17	Ikot Ukop	766	1978
18	Ikot Abasi Idem	440	1136
19	Nung Oku	2321	5994
20	Afaha Etok	1484	3833
21	1kot Akpan Abia	1276	3296
22	Mbikpong Ikot Edim	1447	3737
23	Afaha Ikot Owop	364	940
	TOTAL	25216	65125

Source: Field Survey (2024)

➢ *Sample Size*

To ensure the research findings were statistically representative of the urban-rural gradient and geographically, a multi-stage stratified random sampling process was executed based on the 79 officially recognized villages within Ibesikpo Asutan LGA (NPC, 1991). The study first divided the LGA into three distinct zones based on observed urban intensity, Ibesikpo North, Ibesikpo South, and Asutan (corresponding to Urban Core, Peri-Urban, and Rural zones, respectively). A highly rigorous 30% sample was adopted, exceeding the 10% minimum to select 23 total communities, significantly reducing the standard error and increasing precision. To ensure geographical balance and proportional representation, the sample of 23 was divided into 3 (the three stratified zones), specifically resulting in an allocation of 8, 8, and 7 communities in each zone.

Within each respective zone, the villages were first arranged alphabetically and assigned corresponding numerical identifiers. The table of random numbers was then systematically applied to each zone to select the required number of representative communities, ensuring that the final 23 selected communities provided balanced geographical coverage across the diverse urbanization landscape. For the final stage of sampling within these communities, the target respondents were heads of households, with the total population converted into household numbers by applying the established 2006 NPC average household size of six persons per household.

Applying the established 2006 NPC average household size of six persons per household, the total population was converted into the number of households, allowing for the direct identification and targeting of household heads for data collection.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26aug352

III. PRESENTATIONAND DISCUSSION OF RESULTS

➢ *Pattern and Rate of Urban Growth and Land Use Change in Ibesikpo Asutan Local Government Area from 1986 to 2024*

To analyse the pattern and rate of urban growth and land use change in Ibesikpo Asutan Local Government Area from 1986 to 2024 were presented in Figure 4 to 7.

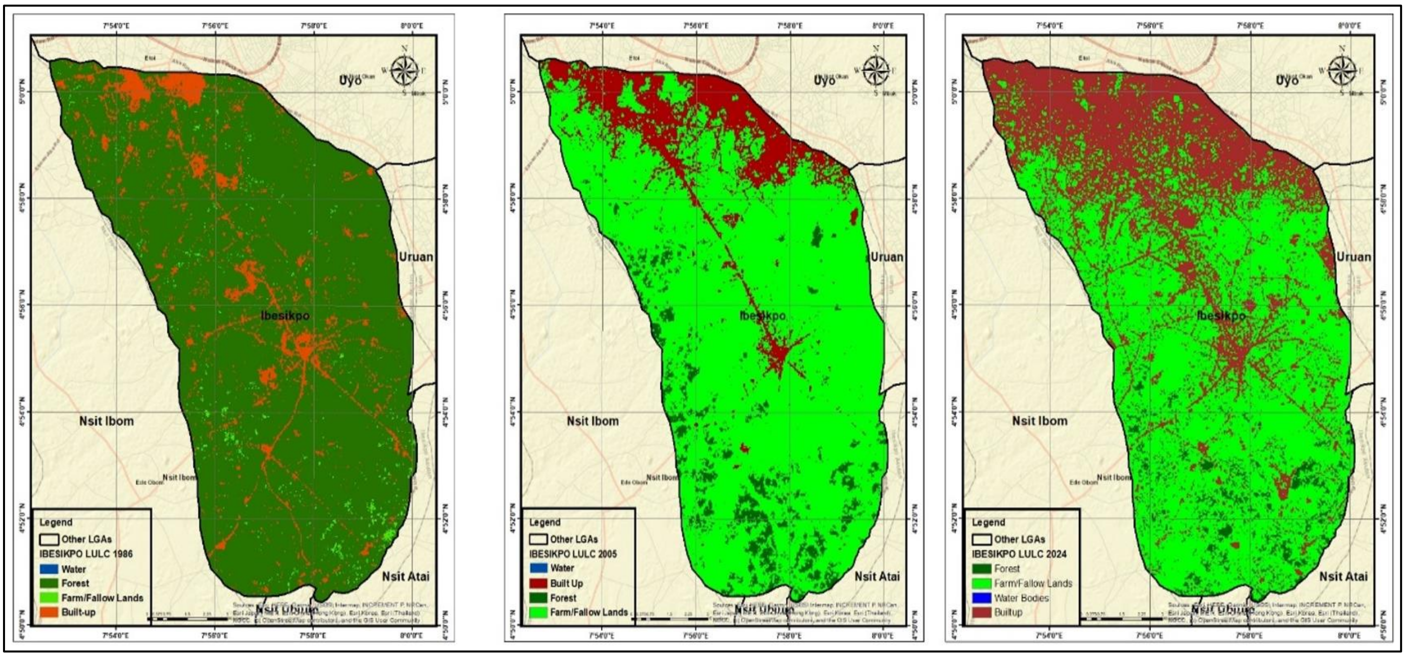

Fig 4-7 Land Use/Land Cover of Ibesikpo Asutan Local Government Area (1986, 2005 and 2024)
Source: GIS Lab. Department Geography and Nat. Res. University of Uyo, Uyo

The land use/land cover of Ibesikpo Asutan Local Government Area in 1986 was presented in Table 5.

Table 5 Land Use/Land Cover of Ibesikpo Asutan Local Government Area (1986)

Land use land cover	**Area (Hectares)**	**Percentage (%)**
Water bodies	485.67	3.07
Forested area	7,254.23	45.86
Built-up area	2,132.81	13.48
Farm/Fallow Land	5,943.94	37.58
Total	15,816.65	100.00

Source: Field Data (2025)

Table 5 indicates the 1986 land use/land cover (LULC) analysis for the Ibesikpo Asutan Local Government Area established a landscape predominantly characterized by natural and agricultural land, serving as the rural baseline for the study. The Forest category was the overwhelmingly dominant land cover class, occupying 7,254.23(45.86%) hectares, which represented nearly half of the total area of 15,816.65 hectares. The second largest component was Farm/Fallow Land, covering a significant 5,943.94 (37.58%) hectares, further confirming the area's rural profile. Crucially, the Built-up area, the metric for urbanization, accounted for only 2,132.81(13.48%) hectares, representing a relatively small proportion of the local government area. This indicated that in 1986, the local government area maintained extensive natural habitats and had not yet undergone rapid urban expansion.

The land use/land cover of Ibesikpo Asutan Local Government Area in 2005 was presented in Table 6.

Table 6 Land Use/Land Cover of Ibesikpo Asutan Local Government Area (2005)

Land use land cover	**Area (Hectares)**	**Percentage (%)**
Water bodies	309.88	1.96
Forested area	5,049.24	31.92
Built-up area	3,814.36	24.12
Farm/Fallow Land	6,643.64	42.00
Total	15,816.65	100.00

Source: Field Data (2025)

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26aug352

Table 6 shows the Land Use/Land Cover (LULC) analysis of the Ibesikpo Asutan Local Government Area in 2005 revealed that the area was predominantly characterized by natural and agricultural land uses, totalling 15,817.12 hectares. The most extensive category was Farm/Fallow Land, which covered 6,643.64 (42.00%) hectares of the entire landmass. The Forest cover remained substantial, occupying 5,049.24 (31.92%) hectares of the area. The urban footprint, identified as the Built-up Area, constituted 3,814.36 (24.12%,) hectares, indicating a significant but not yet dominant level of urbanization. The remaining land was negligible, with Water bodies comprising the smallest fraction at 309.88 (1.96%) hectares. This distribution established a significant natural and agricultural base within the local government area at the start of the study period.

The land use/land cover of Ibesikpo Asutan Local Government Area in 2024 was presented in Table 7.

Table 7 Land Use/Land Cover of Ibesikpo Asutan Local Government Area (2024)

Land Use/Land Cover	Area (Hectares)	Percentage (%)
Water bodies	286.03	1.81
Forested area	3,029.14	19.15
Built-up area	4,953.36	31.32
Farm/Fallow Land	7,543.59	47.69
Total	15,816.65	99.97

Source: Field Data (2025)

Table 7 shows the Land Use/Land Cover (LULC) analysis for the Ibesikpo Asutan Local Government Area in the year 2024 established a landscape heavily dominated by agricultural and urban land uses. Farm/Fallow Land constituted the largest category, covering a significant 7,543.59 (47.69%) hectares of the total area. This indicated that nearly half of the local government area remained under cultivation or in transitional use. Following closely, the Built-up area formed the second largest class, occupying 4,953.36 (31.32%) hectares of the land, confirming extensive urbanization. The remaining natural habitats were limited, as Forest cover stood at only 3,029.14 (19.15%) hectares. Finally, Water bodies made up the smallest portion, recorded at 286.03 (1.81%) hectares of the total measured area of 15,812.12 hectares.

Table 8 Summary of Land Use/Land Cover Change in the Study Area from 1986 – 2024

Item	1986	2005	2024
Water bodies	485.67	309.88	286.03
Forested area	7,254.23	5,049.24	3,029.14
Built-up area	2,132.81	3,814.36	4,953.36
Farm/Fallow Land	5,943.94	6,643.64	7,543.59

Source: Field Data (2025)

Table 8: revealed a massive built-up expansion from 2,132.81ha to 4,953.36ha, resulting in the loss of over 4,200ha of forest land. Corroborating Anifowose *et al.*, (2023), this sprawl outpaces planning capacity, driving a "concentric" biodiversity decline similar to patterns observed in the Uyo metropolis. The observed reduction in water bodies and conversion of natural landscapes reinforce findings by Ibe and Nwosu (2020). Ultimately, this study validates that exponential urban expansion is the fundamental pressure driving high species compositional distance, proving that ecological damage progressively worsens along a continuous gradient from the forest edge to the urban core.

- *To Assess the Effects of Urban Expansion on the Diversity and Composition of Lumber Trees and Large Mammals within Ibesikpo Asutan*

The analysis for assessing the effects of urban expansion on lumber trees and large mammal diversity is fundamentally based on linking independent spatial variables to dependent ecological metrics, this was used to calculate ecological metrics, including species richness (count), Overall Diversity (Shannon Index, H').

H' $=\sum_{l-1}^{\beta}(Pi\ In\ Pi)$

Where, Pi = the proportion of the total sample represented by species i(n/N)

In = the natural logarithm

β = the total number of species

And relative abundance

$Relative\ Abundance = \frac{Total\ count\ \ of\ specific\ species\ in\ a\ zone\ 1\ andlysis)}{Total\ sum\ of\ all\ species\ counts\ is\ that\ sa}$ X 100,

Dissimilarity index measures the difference in species composition between sites and was calculated as BCij =1 - $\frac{2Cij}{Si+Sj}$

Where, Cij = the sum of the lesser counts for species found in both site

Si and Sj are the total number of individuals in the i and j

The relationship between the urban gradient (urban core, peri-urban and rural groups) and these metrics was tested using ANOVA to compare mean diversity values.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26aug352

IV. RESULT AND DISCUSSION

➢ *Assessment of the Effects of Urban Expansion on Diversity and Composition of Terrestrial Lumber Trees and Large Mammals within Ibesikpo Asutan Local Government Area*

To assess the effects of urban expansion on diversity and composition of terrestrial lumber trees and large mammals within Ibesikpo Asutan Local Government Area, we need the urban gradient (independent variable) and species richness, relative abundance and compositional dissimilarity index (dependent variables) by physical inspections.

The dependent variables were systematically determined for both the flora and fauna components of the study. For Lumber Trees data was acquired through direct physical counting and enumeration within the established field transects and quadrats, with the resulting species list and abundance detailed in Table 5 to 7 base on zones. For Large Mammals, where direct observation is often challenging due to their elusive nature, data was obtained through the administration of structured questionnaires designed to capture accurate local ecological knowledge (LEK) from community people and hunters and other stakeholders. The resulting large mammal species richness and abundance data are presented base on zones in Table 12 to 14.

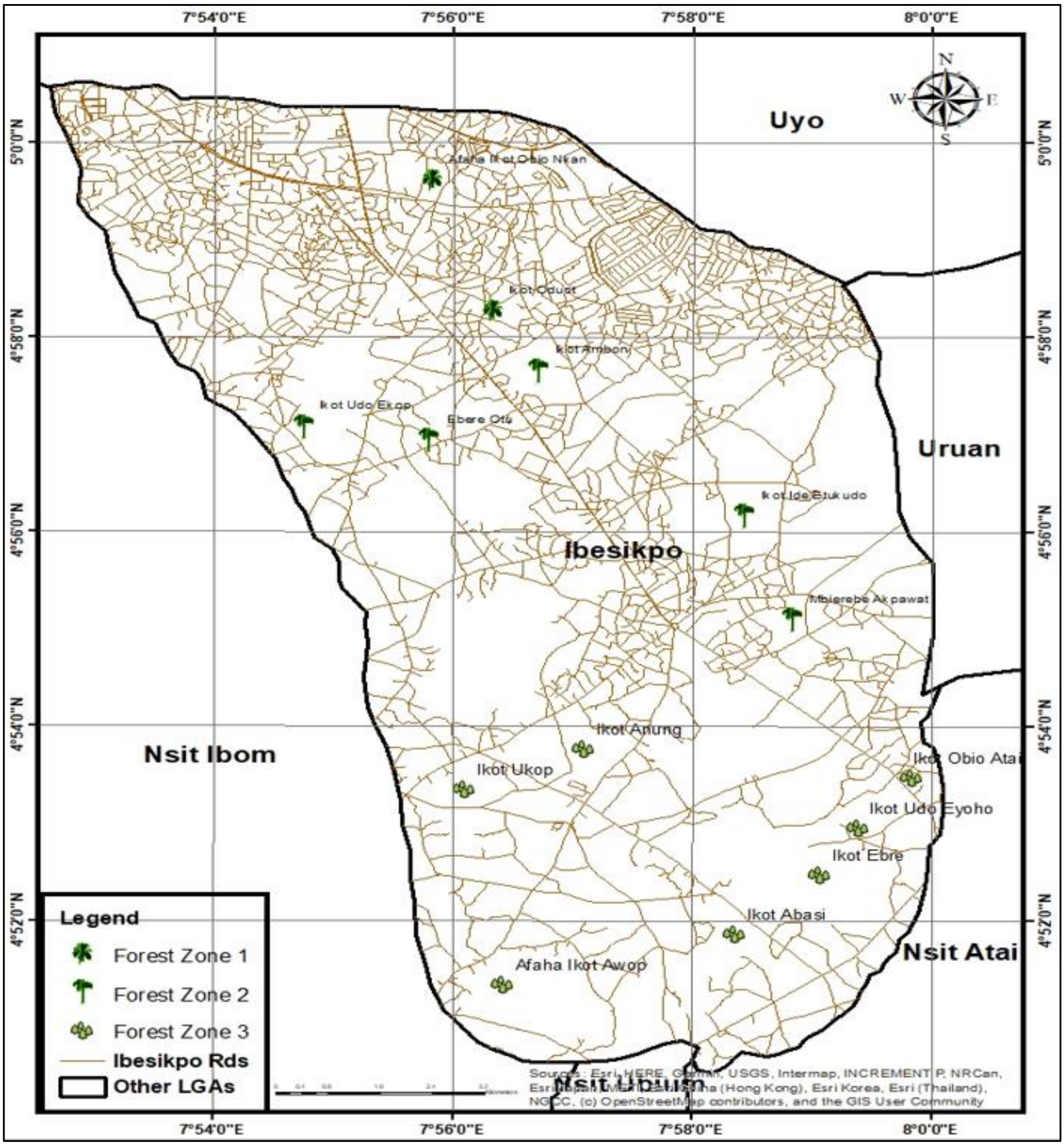

Fig 8 Forest Areas in the Different Zones of the Study Area
Source: Compiled by the Researcher in GIS Lab -University of Uyo (2025)

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26aug352

Table 9 Physical Count of Lumber Trees (Zone 1)

Common name Botanical name Local name/Community	African oil bean	Walnut	Palm tree		Bitter cola	Bush mango	Dragon tree	African nutmeg	Gold-coast bombax
	Pentaclethra macrophylla	**Juglans regia**	**Eyop**	**Ndiya**	**Efiat**	**Uyo**	**Okono**	**Abakan**	**ukim**
	Ukáná	**Ekom**	**Elaeis guineesi**	**Cola lepidota**	**Garcinia kola**	**Irvingea gabonensis**	**Dracaena arborea**	**Pycnanthus angolnsis**	**Bombax buonopozense**
1kot lko	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**
Ikot Oduot	1	A	3	4	A	A	1	A	A
Afaha Ikot-Obio Nkan	A	A	A	A	A	A	A	A	1
Ikot Abasi Idem	A	A	A	A	A	A	A	A	A
Nung Oku	A	A	A	A	A	A	A	A	A
Afaha Etok	A	A	A	A	A	A	A	A	A
1kot Akpan Abia	A	A	A	A	A	A	A	A	A
Mbikpong Ikot Edim	A	A	A	A	A	A	A	A	A
Total	**1**	**0**	**3**	**0**	**0**	**0**	**1**	**0**	**1**

Source; Field Data (2025)

Table 9, survey across zone 1 revealed a low presence of flora, with most species marked absent ("A"). Only four species, Palm tree, African oil bean, African nutmeg, and Gold-coast bombax were recorded, predominantly in Ikot Oduot and Afaha Ikot-Obio Nkan. This scarcity suggests severe biodiversity depletion or localized distribution, necessitating urgent conservation efforts for these indigenous species.

Table 10 Physical Count of Lumber Trees (Zone 2)

Common name Botanical name Local name/Community	African oil bean	Walnut	Palm tree		Bitter cola	Bush mango	Dragon tree	African nutmeg	Gold-coast bombax
	Pentaclethra macrophylla	**Juglans regia**	**Eyop**	**Ndiya**	**Efiat**	**Uyo**	**Okono**	**Abakan**	**ukim**
	Ukáná	**Ekom**	**Elaeis guineesi**	**Cola lepidota**	**Garcinia kola**	**Irvingea gabonensis**	**Dracaena arborea**	**Pycnanthus angolnsis**	**Bombax buonopozense**
Ikot Obio Offong	**3**	**A**	**6**	**A**	**A**	**A**	**1**	**A**	**A**
1kot Udo Ekop	1	A	4	3	A	A	2	A	A
1kot Ambon	1	A	2	1	A	A	3	A	A
Ebere Out	2	A	2	1	A	A	2	A	1
Mbierebe Akpawat	3	3	5	3	A	A	4	A	1
Afaha 1kot Akpa Edu	A	A	A	A	A	A	A	A	A
1kot Ide Etuk Udo	2		3	A	A	A	1	A	1
Ikot Ukop	A	A	A	A	A	A	A	A	A
Total	**12**	**3**	**22**	**8**	**0**	**0**	**13**	**0**	**3**

Source; Field Data (2025)

Table 10 exhibits a diverse but uneven distribution of timber resources across its eight communities. The Palm tree (*Elaeis guineensis*) dominates the landscape with a total count of 22, followed by the Dragon tree at 13 and African oil bean at 12. Notably, Mbierebe Akpawat serves as a primary biodiversity hub, while Bitter cola, Bush mango, and African nutmeg are entirely absent, signaling specific ecological gaps or localized over-exploitation within this zone. This means if trend continues in the next 20 years the zones will loss significant number of lumbers like zone 1.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26aug352

Table 11 Physical Count of Lumber Trees (Zone 3)

Common name Botanical name Local name/Community	**African oil bean**	**Walnut**	**Palm tree**		**Bitter cola**	**Bush mango**	**Dragon tree**	**African nutmeg**	**Gold-coast bombax**
	Pentaclethra macrophylla	**Juglans regia**	**Eyop**	**Ndiya**	**Efiat**	**Uyo**	**Okono**	**Abakan**	**ukim**
	Ukáná	**Ekom**	**Elaeis guineesi**	**Cola lepidota**	**Garcinia kola**	**Irvingea gabonensis**	**Dracaena arborea**	**Pycnanthus angolnsis**	**Bombax buonopozense**
1kot Ebre	2	1	4	5	1	2	3	1	2
Aba Ukpo	4	2	6	5	A	A	4	A	A
Ikot Anung	4	A	6	2	A	A	4	A	1
Ikot Abasi	2	A	3	2	A	A	1	A	1
Ikot Obio-Ata	2	A	4	2	1	A	3	1	1
1kot Udo Eyoho	3	1	2	2	A	A	2	1	2
Afaha Ikot Owop	2	A	4	3	A	A	3	A	1
Total	**19**	**3**	**29**	**21**	**2**	**2**	**20**	**3**	**8**

Source: Field Data (2025)

Table 11 indicated Palm tree (29) and Monkey Kola (21) as the most dominant floral species, whereas Bitter cola and Bush mango are rare (2). This disparity implies a localized depletion of specialized trees, suggesting that urban pressures have shifted the forest composition toward resilient.

To determine the overall dominance of lumber tree species across the study areas. First, the researcher calculated the total count (n) for each species by summing the total provided in each zone.

Table 12 Relative Abundance of Lumber Trees in each Zones

Common Name	**Zone 1 (ni)**	**Zone 2 (n2)**	**Zone 3 (n3)**	**Total**
African Oil Ban	1	12	19	32
Walnut	0	3	3	6
Palm Tree	3	22	29	54
Monkey Kola	0	8	21	29
Bittter Cola	0	0	2	2
Bush Mango	0	0	2	2
Dragon Tree	1	13	20	34
African Nutmeg	0	0	3	3
Gold Coast Bomban	1	3	8	12
Total Population (N)	**6**	**61**	**107**	**174**

Source: Field Data (2025)

Table 12, presented the relative abundance of lumber trees (174) across the study area is dominated by Palm Trees (31.0%) and Dragon Trees (19.5%), while Bitter Cola and Bush Mango remain rare (1.2%). The stark concentration of 61.5% of all floral resources within Zone 3, compared to a negligible 3.4% in Zone 1, implies a severe geographic imbalance in ecosystem services due to urban expansion. This disparity suggests that intense urban growth have historically targeted specific zones, resulting in a landscape where primary lumber resources are now sequestered in shrinking ecological refugia, threatening regional forest sustainability.

However relative abundance is calculated as:

$$Relative\ Abundance\% = \frac{Species\ Count\ (n)}{Total\ Population}\ x\ 100$$

For instant Palm tree 54/174 X 100= 31.03%

Table 13 Relative Abundance of Each Species

Common Name	**Total Count (n)**	**Relative Abundance %**
Palm Tree	54	31.03
Dragon Tree	34	19.54
African Oil Bean	32	18.39
Ndiya	29	16.67
Gold Coast Bombax	12	6.90
Walnut	6	3.45

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26aug352

African Nutmeg	3	1.72
Bitter cola	2	1.15
Bush mango	2	1.15
Total	174	100

Source: Field Data (2025)

Table 13 revealed a concentrated floral distribution, where the Palm Tree, Dragon Tree, and African Oil Bean collectively dominate nearly 70% of the 174 recorded individuals. Conversely, species like Bitter Cola and Bush Mango exhibit minimal representation (1.15% each). This disparity suggests a moderate level of dominance, requiring targeted conservation efforts to maintain the area's ecological balance.

Table 14 Zones Summary Count for Dissimilarity Index for Lumber Tree

Common Name	**Zone 1 (n1)**	**Zone 2 (n2)**	**Zone 3 (n3)**
African Oil Ban	1	12	19
Walnut	0	3	3
Palm Tree	3	22	29
Monkey Kola	0	8	21
Bittter Cola	0	0	2
Bush Mango	0	0	2
Dragon Tree	1	13	20
African Nutmeg	0	0	3
Gold Coast Bomban	1	3	8
otal Population	**6**	**61**	**107**

Source: Field Data (2025)

Table 14, reveals a gradient in resource abundance, with Zone 3 (107) nearly doubling the population of Zone 2 (61) and vastly exceeding the depleted Zone 1 (6). The high density of Palm trees and African Oil Bean in Zone 3 implies a resilient canopy, whereas the total absence of Bitter Cola and Bush Mango in Zones 1 and 2 signals a localized extinction of high-value timber and species. Consequently, this floral collapse in Zone 1 suggests that unchecked urban encroachment has severed the traditional ecological ties essential for indigenous livelihood sustainability.

However, dissimilarity index is calculated as BCij =1 - $\frac{2Cij}{Si+Sj}$

Table 15 Dissimilarity Index for Lumber Tree

Pair	**Calculation**	**Dissimilarity index**
Zone 1and 2	1-(12/67)	0.821
Zone 2 and 3	1 – (122/168)	0.274
Zone 1 and 3	1 – (12/113)	0.894

Source: Field Data (2025)

Table 15, indicates significant ecological variation across the three locations, specifically highlighted by the high dissimilarity between Zone 1 and 3 (0.894) and Zone 1 and 2 (0.821). In contrast, Zone 2 and 3 demonstrate a much lower index of 0.274, suggesting substantial species overlap. These results imply that while Zones 2 and 3 share similar environments, Zone 1 remains ecologically distinct.

To determine the Overall Diversity of the study area table 4.21 was analyzed.

Table 16 Pooled Species Counts

Species	**Total Count (n)**	**Proportions (Pi)**	**Pi X In (Pi)**	**Pi2**
African Oil Ban	32	0.1839	-0.3114	0.0338
Walnut	6	0.0345	-0.1162	0.0012
Palm Tree	54	0.3103	-0.3632	0.0963
Monkey Kola	29	0.1667	-0.2989	0.0278
Bittter Cola	2	0.0115	-0.0514	0.0001
Bush Mango	2	0.0115	-0.0514	0.0001
Dragon Tree	34	0.1956	-0.3190	0.0382
African Nutmeg	3	0.0172	-0.0699	0.0003
Gold Coast Bomban	12	0.0690	-0.1845	0.0048
Total	174	1.0000	-1.7656	0.2026

Source: Field Data (2025)

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26aug352

➢ *Shannon-Wiener Index (H)*

Based on the provided species distribution data for the 174 individuals sampled, the following ecological indices describe the community structure:

Shannon-Wiener Diversity Index (H')

Calculated as H' = -∑Pi ln(Pi)

H' = -(-1.7656)

H' = 1.7656, However, this value indicates a moderate level of species diversity within the area.

Simpson's Index of Dominance (D)

Calculated as D = ∑Pi2 = 0.2026

However, this represents the probability that two individuals selected at random belong to the same species.

Simpson's Index of Diversity (1 - D*)*

1-D = 0.7974

This suggests a relatively high probability (79.7%) that two randomly selected individuals will belong to different species, indicating a well distributed community despite the dominance of a few species.

➢ *Community Composition Highlights*

Most Abundant: The Palm Tree (n = 54, Pi = 0.3103) and Dragon Tree (n = 34, Pi = 0.1956) are the most dominant species in the sample.

- Least Abundant: Bitter Cola and Bush Mango are the rarest, each represented by only 2 individuals (Pi = 0.0115).

Table 17 Extracted Large Mammals (Zone 1)

Common, Local and Botanical Names/Communities	**Monkey**	**Dwarf mongoose**	**Porcupine**	**Chevrotain**	**King genet**	**Blue duiker**	**Bush buck**	**African civet**	**Grasscutter**
	Ebok	**Nkukwa**	**Ebiong**	**Esoh**	**Atan**	**Aso**	**Okoyo**	**Ekiko**	**Ineh**
	Cercopithecus mona	**Crassarchus abscurus**	**Antherusus africans**	**Hyemoschus aquaticus**	**Genetta poensis**	**Philantomba monticola**	**Tragelaphus scriptus**	**Xivetticts civetta**	**Thryonomys swinderianus**
1kot lko	**A**	**A**	**A**	**A**	**A**	**P**	**A**	**A**	**A**
Ikot Oduot	A	Rare	Rare	Rare	Rare	P	A	Rare	p
Afaha Ikot-Obio Nkan	A	A	A	A	A	A	A	A	A
Ikot Abasi	A	A	A	A	A	A	A	A	A
Nung Oku	A	A	A	A	A	A	A	A	A
Afaha Etok	A	A	A	A	A	A	A	A	A
1kot Akpan Abia	A	A	A	A	A	A	A	A	A
Mbikpong Ikot Edim	A	A	A	A	A	A	A	A	A
Total	0	1	1	1	1	2	0	1	1

Source: Field Data (2025)

Table 17, revealed a ecological decline in Ibesikpo Asutan LGA, where urban growth has led to a near-total displacement of large mammals in Zone 1. With an 87.5% absence rate across sampled communities, species like the Monkey and Bush buck are entirely extirpated. Only Ikot Oduot retains marginal biodiversity, while seven communities remain biological voids. This data confirms that rapid urban expansion and habitat fragmentation have surpassed environmental thresholds, necessitating urgent conservation interventions to protect remaining indigenous wildlife corridors.

Table 18 Extracted Large Mammals (Zone 2)

Common, Local and Botanical Names/Communities	**Monkey**	**Dwarf mongoose**	**Porcupine**	**Chevrotain**	**King genet**	**Blue duiker**	**Bush buck**	**African civet**	**Grasscutter**
	Ebok	**Nkukwa**	**Ebiong**	**Esoh**	**Atan**	**Aso**	**Okoyo**	**Ekiko**	**Ineh**
	Cercopithecus mona	**Crassarchus abscurus**	**Antherusus africans**	**Hyemoschus aquaticus**	**Genetta poensis**	**Philantomba monticola**	**Tragelaphus scriptus**	**Xivetticts civetta**	**Thryonomys swinderianus**

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26aug352

Ikot Obio Offong	**A**	**P**	**A**	**A**	**Rare**	**P**	**A**	**A**	**P**
1kot Udo Ekop	A	P	A	A	P	A	A	RARE	P
1kot Ambon	A	RARE	A	A	A	A	A	A	RARE
Ebere Out	A	RARE	A	A	RARE	A	A	A	RARE
Mbierebe Akpawat	A	P	A	A	P	A	A	A	P
	A	A	A	A	A	A	A	A	A
Afaha 1kot Akpa Edu	A	RARE	A	A	RARE	A	A	A	RARE
1kot Ide Etuk Udo	A	RARE	A	A	A	A	A	A	RARE
Ikot Ukop	A	RARE	A	A	A	A	A	A	RARE
Total	0	8	0	0	5	1	0	1	8

Source: Field Data (2025) P=Present, A= Absent

Table 18, indicated a slightly higher ecological resilience compared to Zone 1, though significant biodiversity loss persists. While larger primates and bovids like the Monkey and Bush buck remain entirely absent due to urban encroachment, Dwarf mongoose and Grasscutters are the most resilient, appearing in all sampled communities, albeit frequently in "rare" status. This pattern suggests that fragmented green corridors in Zone 2 still support opportunistic species despite mounting urban pressures and if this encroachment is not checked the remaining animal will disappear.

Table 19 Extracted Large Mammals (Zone 3)

Common, Local and Botanical Names/Communities	**Monkey**	**Dwarf mongoose**	**Porcupine**	**Chevrotain**	**King genet**	**Blue duiker**	**Bush buck**	**African civet**	**Grasscutter**
	Ebok	**Nkukwa**	**Ebiong**	**Esoh**	**Atan**	**Aso**	**Okoyo**	**Ekiko**	**Ineh**
	Cercopithecus mona	**Crassarchus abscurus**	**Antherusus africans**	**Hyemoschus aquaticus**	**Genetta poensis**	**Philantomba monticola**	**Tragelaphus scriptus**	**Xivettictis civetta**	**Thryonomys swinderianus**
1kot Ebre	P	P	P	P	P	P	P	P	P
Aba Ukpo	Rare	P	Rare	RARE	P	A	A	RARE	P
Ikot Anung	A	P	A	A	RARE	RARE	A	RARE	P
Ikot Abasi	A	P	RARE	RARE	P	P	A	P	P
Ikot Obio-Ata	RARE	P	P	P	P	P	A	P	P
1kot Udo Eyoho	A	P	RARE	P	P	P	A	P	P
Afaha Ikot Owop	A	Rare	Rare	Rare	Rare	P	A	Rare	p
Total	3	7	5	6	7	6	1	7	7

Source: Field Data (2025) P=Present, A= Absent

Table 19, revealed a notably higher level of biodiversity compared to Zones 1 and 2. While species like the Monkey and Bush buck have largely vanished from earlier zones, they maintain a presence in Zone 3 with total counts of 3 and 1, respectively. Notably, the Dwarf mongoose, King genet, African civet, and Grasscutter are present across all seven communities surveyed (Total: 7). This suggests that Zone 3 serves as a more resilient habitat and a refuge for large mammals within the region.

To determine the relative abundance (RA%), the researcher used the following formula:

$$Relative\ Abundance = \frac{Total\ count\ of\ specific\ species\ in\ a\ zone\ 1\ andlysis)}{Total\ sum\ of\ all\ species\ counts\ is\ that\ sa} \text{ X 100}$$

Zone 1 Analysis

Total individual observation in Zone 1

0 + 1 + 1 + 1 + 1 + 2 + 0 + 1 + 1 + 1 = 8

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26aug352

Table 20 Analysis of Large Mammal Biodiversity (Zone 1)

Common Name	Total Count	Relative Abundance (%)
Blue duiker	2	25.0
Dwarf mongoose	1	12.5
Porcupine	1	12.5
Chevrotain	1	12.5
King genet	1	12.5
African civert	1	12.5
Grass cutter	1	12.5
Monkey/bush buck	0	0.0
Total	**8**	**100**

Source: Field Data (2025)

Table 20 of Zone 1 reveals a low mammalian density, with the Blue duiker exhibiting the highest relative abundance at 25.0%. The remaining species show a precarious, uniform distribution (12.5%), while larger primates and bovids were entirely absent (0%). This sparse distribution implies severe habitat degradation due to urban encroachment, suggesting that Zone 1 has reached an ecological tipping point where biodiversity can no longer support indigenous livelihoods.

Zone 2 Analysis

Total individual observation in Zone 2

0 + 8 + 0 + 0 + 5 + 1 + 0 + 1 + 8 = 23

Table 21 Analysis of Large Mammal Biodiversity (Zone 2)

Common Name	Total Count	Relative Abundance (%)
Dwarf mongoose	8	34.8
Grass cutter	8	34.8
King genet	5	21.7
Blue duiker	1	4.35
African civert	1	4.35
Others (monkey, porcupine, etc)	0	0.00
Total	**23**	**100**

Source: Field Data (2025)

Table 21, exhibits a moderate mammalian population (23) dominated by the Dwarf mongoose and Grass cutter, which together constitute 69.6% of the total abundance. The significant presence of these resilient, mammals alongside the sharp decline of specialized species like the Blue duiker (4.35%) implies a shifting ecological structure. This transition suggests that while Zone 2 maintains basic ecosystem functions, increasing habitat fragmentation is favoring urban-adapted generalists over sensitive native wildlife.

Zone 3 Analysis

Total individual observation in Zone 3

3 + 7 + 5 + 6 + 7 + 6 + 1 + 7 + 7 = 49

Table 22 Analysis of Large Mammal Biodiversity (Zone 3)

Common Name	Total Count	Relative Abundance (%)
Dwarf mongoose	7	14.3
King genet	7	14.3
African civert	7	14.3
Grass cutter	7	14.3
Chevrotain	6	12.2
Blue duiker	6	12.2
Porcupine	5	10.2
Monkey	3	6.1
Bush buck	1	2.0
Total	49	100

Source: Field Data (2025)

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26aug352

Table 22 demonstrated the highest mammalian density (49) and species richness, characterized by a balanced distribution of generalists and specialists. The presence of sensitive taxa like Monkey (6.1%) and Bush buck (2.0%), alongside high counts for duikers and civets, implies a more stable and intact forest structure. This indicates that Zone 3 serves as a vital refuge, capable of sustaining complex biodiversity and supporting long-term indigenous livelihoods if conservation is maintained.

Table 23 Summary Comparison

Matric	**Zone 1**	**Zone 2**	**Zone 3**
Total Diversity Count	8	23	49
Most Abundance Species	Blue duiker	Dwarf mongoose/ Grasscutter	Multiple (mongroose, genet, civet, Grasscutter)
Species Richness	7 Species	5 Species	9 species

Source: Field Data (2025)

Table 23, presented comparative assessment of mammalian biodiversity across the three designated zones highlights a progressive ecological gradient. Zone 3 emerges as the most resilient habitat, exhibiting superior species richness with nine distinct species and a total diversity count of 49. In contrast, Zone 1 displays significant environmental degradation with only eight individuals recorded. While Zone 2 demonstrates specialized recovery through the dominance of the Dwarf mongoose and Grasscutter, Zone 3 maintains a balanced distribution of multiple high-abundance species, signifying optimal ecological integrity.

- Hypothesis (Ho1): The biodiversity is homogenous across all the three levels of urban gradient/zones in Ibesikpo Asutan Local Government Area.

Table 24 The Mean Density Increases Across the Urban Gradient

Descriptives								
DENSITY								
					95% Confidence Interval for Mean			
	N	**Mean**	**Std. Deviation**	**Std. Error**	**Lower Bound**	**Upper Bound**	**Minimum**	**Maximum**
ZONE 1	9	.6667	1.00000	.33333	-.1020	1.4353	.00	3.00
ZONE 2	9	6.7778	7.62853	2.54284	.9140	12.6416	.00	22.00
ZONE 3	9	11.8889	10.37358	3.45786	3.9151	19.8627	2.00	29.00
Total	27	6.4444	8.55450	1.64631	3.0604	9.8285	.00	29.00

Source: Field Data (2025)

Table 25 Tests of Homogeneity of Variances

Tests of Homogeneity of Variances					
		Levene Statistic	**df1**	**df2**	**Sig.**
DENSITY	Based on Mean	18.060	2	24	.000
	Based on Median	6.004	2	24	.008
	Based on Median and with adjusted df	6.004	2	16.421	.011
	Based on trimmed mean	16.630	2	24	.000

Source: Field Data (2025)

Table 26 ANOVA Table

ANOVA					
DENSITY					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	568.222	2	284.111	5.110	.014
Within Groups	1334.444	24	55.602		
Total	1902.667	26			

Source: Field Data (2025)

Table 24 - 26, revealed a significant biodiversity decline across the urban gradient [F(2, 24) = 5.11, p = .014]. Mean density decreased from Zone 3 (11.89) to Zone 1 (0.67). Post-hoc Tukey HSD tests confirmed a significant collapse specifically between Zone 3 and Zone 1 (p = .011), proving that high urbanization significantly reduces biodiversity density within Ibesikpo Asutan LGA. However, Null Hypothesis (H0): Biodiversity is homogeouse across all the three levels of urban zones in Ibesikpo Asutan LGA is rejected since the ANOVA table shows a significance value of 0.014 which is less than 0.05. However, there is a statistically significant difference in biodiversity density between the three urban zones.

The quantitative findings from the LULC change analysis, which revealed a massive expansion of the built-up area from 2,132.81ha to 4,953.36 ha between 1986 and 2024, directly corroborates the macro-level scholarly discourse on

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26aug352

urban growth in developing nations. This rapid expansion, achieved at the expense of over 4,200 ha of forest land, aligns perfectly with the conclusions of Anifowose and Olorunfemi (2023) and Akpan and Eze (2023), who highlighted the environmental consequences of accelerated urban sprawl outpacing planning capacity. Specifically, the data mirrored the micro-level findings of Udo *et al.* (2023) in the nearby Uyo metropolis, where similar satellite imagery analysis documented a significant decline in forest cover alongside a expansion of built-up areas. Furthermore, the observed decline in Water bodies (from 485.67 to 286.03 km) and the compensatory expansion of farm/fallow Land reinforce the finding that land conversion is a multi-faceted process, confirming the patterns noted by Ibe and Nwosu (2020) and demonstrating how urban influence drives changes in both natural and agricultural landscapes.

This synthesis of the quantitative LULC data with existing literature is crucial for understanding the Ecological Distance Index findings. The documented loss of mature forest land established the causal context for the observed biodiversity decline, reinforcing the result that ecological damage is driven by physical proximity to the urban edge. The continuous growth pattern identified here, which aligns with the "concentric pattern" described by Udo et al. (2023), explains why the Ecological Distance Index functioned as a continuous gradient, rather than a sharp boundary effect (this means that the biodiversity loss is not a simple "on/off" switch (healthy habitat to destroyed habitat). Instead, the ecological damage progressively worsens as you move from the intact forest to the urban core). Therefore, the land-use change analysis validated the study's core conclusion that uncontrolled, exponential urban expansion particularly the conversion of forest is the fundamental, quantifiable pressure leading to the high species compositional distance observed in the fragmented study communities.

The findings on the effects of urban expansion on lumber trees and large mammals confirmed that biodiversity in the area decrease with increase in urban expansion which afirms the established ecological theory that urbanization acts as an ecological filter (McKinney, 2002), driving a process of biotic homogenization. The study's LULC analysis, which documented a loss of over 4,200 units of Forest cover by 2024, provided the tangible spatial context for this filter's operation. This destructive pattern aligns directly with regional studies by Udo *et al.* (2023) and Akpan and Eze (2023), which confirm widespread decline in native species populations across West Africa due to such urban expansion. The core ecological consequence is not just a loss in the total number of species (diversity), but a profound compositional change, the urban environment selectively eliminates specialized, forest-dependent species such as native timber trees and large mammals while favoring hardy, non-native generalists.

The impact mechanisms vary between lumber trees and large mammals, yet both confirm a specialist decline due to fragmentation. For lumber trees, Benson and Okoro's (2020) work demonstrated that even if a degree of species richness recovers in disturbed areas, the resulting community composition is permanently altered, with native timber trees and specialized lumber trees filtered out by the lasting changes to soil and hydrology. For highly mobile large mammals, the variable is habitat connectivity. Studies on avian species (Ahmad and Singh, 2024) and large mammals (Lee and Jansson, 2022) confirm that urban infrastructure and density impose a barrier effect that severely restricts animal movement and access to resources, leading to non-viable population densities. This structural fragmentation is the direct cause of the decline in specialized, wide-ranging species. Therefore, the literature collectively validates the necessity of the study's integrated approach, pairing quantitative species composition data with GIS-based LULC analysis (Garcia and Liu, 2021) to rigorously link urban sprawl to the specific, measurable ecological reorganization observed.

Fig 9 Socioeconomic Consequences of Biodiversity Decline
Source: Field Data (2024)

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26aug352

Fig 10 Picture Showing the Effect of Urbanization (Increase in Population after Conversion of Wetland to Commercial/Residential Area)
Source: Field Survey (2024)

V. CONCLUSION AND RECOMMENDATIONS

Urban expansion between 1986 and 2024 led to a substantial (4,200 ha) loss of forest land, directly resulting in a continuous, high-intensity ecological damage gradient (Ecological Distance Index) driven by proximity to the rapidly expanding Built-up edge. Urban expansion acts as an ecological filter, causing severe compositional change by eliminating specialized native lumber trees and large mammal populations in favour of non-native generalists. This structural decline is directly attributable to habitat fragmentation and the barrier effect of urban infrastructure on animal movement. Biodiversity loss has resulted in an immediate socio-economic and public health crisis for the community, with 84% reporting negative livelihood impacts and 85% perceiving significant environmental decline. This validates the study's ecological findings through local experience and traditional knowledge.

Implement immediate, legally binding urban growth boundaries and greenbelts to halt further conversion of Forest and Water bodies, specifically focusing on enforcing strict habitat protection and zoning (supported by 78.32 mean score). Institutionalize formal Restoration Program Support (80.97) and Education and Awareness (81.04) campaigns to target reintroduction of specialized native species, leveraging local ecological knowledge (TEK).

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