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EFFECTS OF HABITAT FRAGMENTATION ON SPECIES DIVERSITY USING BUTTEERFLY AS A-CASE STUDY IN OWERRI, IMO STATE NIGERIA

[*1]Nmezi Stella N., [2]Nwadike Onyinyechi., [1]Nwoko Magnus C., [1]Ezea Celestine O., [1]Ubah Venatius C., [1]Nwachukwu Michael O., [1]Chiegboka Nneamaka A., [1]Okwueze Ogechukwu E., [1]John Luka., [3]Liwi Odey M., [1]Okoro Jane C., [4]Nwachukwu Confidence I.

1. Department of Biology, Federal University of Technology Owerri
2. Department of Environmental Standard Ce-sPESS, Federal University of Technology Owerri.
3. Institute of Human Virology, Abuja Nigeria.
4. Department of Biotechnology, Federal University of Technology Owerri

Corresponding Author: Stella Nmezi Email: nmezistella19@gmail.com., Stella.nmezi@futo.edu.ng

ABSTRACT

This study assessed the effects of habitat fragmentation on species diversity in Owerri, Imo State, Nigeria, using butterflies as ecological bio-indicators in an urbanizing landscape. The study area was classified into three habitat types based on fragmentation intensity: protected habitat (Old Zoo Reserve), semi-disturbed habitat (Nekede peri-urban green patch), and highly fragmented habitat (Nekede built-up mosaic). Butterfly data were collected through standardized line transect walks over a one-week sampling period, with species identified through direct observation supported by smartphone photography and reference identification materials. A total of 405 individual butterflies belonging to 24 species and 5 families were recorded across all habitats. Species richness and abundance declined with increasing habitat fragmentation, from 21 species and 176 individuals in the protected habitat to 12 species and 90 individuals in the highly fragmented habitat. Diversity analysis revealed a reduction in Shannon–Wiener index values from 2.68 in the protected habitat to 2.03 in the fragmented habitat, while Simpson's diversity index declined from 0.91 to 0.82, accompanied by a decrease in evenness from 0.83 to 0.71. One-way ANOVA confirmed that differences in butterfly abundance among habitats were statistically significant ($F(2,12) = 8.74$, $p < 0.01$). Forest-dependent species such as *Euphaedra medon* and *Charaxes varanes* were restricted to the protected habitat, whereas disturbance-tolerant generalists such as *Junonia oenone* and *Eurema hecabe* dominated fragmented sites. The findings demonstrate that habitat fragmentation associated with urban development significantly reduces butterfly species diversity in Owerri and highlight the importance of conserving semi-natural and protected green spaces for sustaining urban biodiversity.

Keywords: Habitat fragmentation, butterfly diversity, urban ecology, species richness.

INTRODUCTION

Background of the Study

The continued expansion of human infrastructure, particularly road construction, has emerged as a major driver of ecological disturbance and biodiversity loss in many regions globally. In Nigeria, and specifically in Imo State. The increasing demand for connectivity, urban growth, and economic development has necessitated the construction of both rural and urban roads. While these infrastructural developments support socioeconomic progress, they often come at an environmental cost, particularly through the fragmentation of natural habitats. Habitat fragmentation refers to the breaking up of continuous natural ecosystems into smaller, isolated patches due to anthropogenic activities such as road construction, deforestation, urban sprawl, and agricultural expansion (Zabbey et al 2021). Across the globe, the expansion of road networks into previously undisturbed ecosystems has led to significant disruptions in the structure, composition, and distribution of biological communities (Hong et al 2025). Roads construction not only serve as physical barriers that inhibit the movement of species, but also alter micro-climatic conditions, introduce pollutants, and foster the spread of invasive species. These consequences influence key ecological processes such as gene flow, species interactions, feeding behaviors, and reproductive dynamics. In Imo State, where a considerable portion of land is undergoing rapid transformation due to infrastructural projects, road-induced habitat fragmentation remains under explored despite its growing significance in shaping ecological patterns.

Studies from comparable ecological regions have provided valuable insights into how anthropogenic pressures such as road construction reduce habitat quality and alter population dynamics. For example, a study on mangrove ecosystems in Nigeria found that clearing for electric tower right-of-way, significantly altered species richness and diversity, with observable thermal stress and changes in community structure in macro-zoo-benthic populations (Zabbey et al 2021). Similarly, investigations in Basilicata, Italy, indicated that proximity to roads and industrial areas negatively influenced species composition, leading to ecological homogenization and reduced biological specialization (Cassola et al 2025).

In the Nigerian context, changes in land cover and land use — particularly driven by built-up expansion and infrastructure development — have been shown to cause substantial loss in natural vegetation and forest cover (Ancha et al 2021; Jande et al 2022). In Yenagoa, Bayelsa State, road-related land cover changes were identified as a leading cause of the reduction in tree species diversity, a trend which mirrors the ecological risks posed to forested regions of Imo State (Alao et al 2023). These activities disrupt the continuity of ecological landscapes, resulting in fragmented habitats that can no longer sustain viable populations or support natural dispersal and migration processes.

The ecological outcomes of fragmentation also extend to animal populations. For instance, research in Ethiopia highlighted how increased human development, including road intrusion, exacerbated primate-human conflicts and altered population densities of vulnerable species such as black colobus monkeys and Anubis baboons (Anshebo et al 2025). Likewise, amphibian populations in China were shown to be highly sensitive to changes in habitat structure, proximity to human activities, and temperature gradients induced by land clearing (Hong et al 2025). These findings stress the relevance of evaluating the influence of roads on species diversity and population dynamics across diverse ecological zones, including those in southeastern Nigeria. Fish populations in Nigerian rivers have also demonstrated susceptibility to environmental stressors linked to human development, including road-induced sedimentation and pollution. Edegbene et al (2025) observed strong correlations between altered habitat conditions and changes in the length–weight relationships and health of fish species. Similar associations have been drawn from studies of insect and bird populations, where dust, noise, and altered vegetation structure in road-adjacent zones significantly impacted species abundance and richness (Addae 2022, Miller 2021). These dynamics collectively point toward the far-reaching consequences of linear infrastructure like roads, and how they contribute to both direct and indirect forms of habitat fragmentation and biodiversity loss.

Moreover, habitat fragmentation often results in population isolation, which has genetic consequences over time. Fragmented patches limit the range of individual movements, reduce genetic exchange between populations, and increase the likelihood of inbreeding depression (Beekmann, 2025). For larger mammals like lions in East Africa, habitat fragmentation has disrupted migratory corridors and contributed to increased incidences of human-wildlife conflict (Kibet, 2024). While such mega-fauna may not be present in Imo State, the underlying processes affecting population dynamics remain consistent, emphasizing the importance of studying these patterns across species and locations. Given these realities, it becomes evident that the continued neglect of ecological considerations in road construction planning could lead to irreversible damage to local ecosystems. The significance of this research is therefore rooted in its potential to illuminate the ecological footprint of road development in Imo State and contribute to policy interventions that balance development with sustainability. There is an urgent need for empirical evidence to guide biodiversity conservation in road-planning frameworks, particularly as Imo State continues to experience infrastructural expansion.

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METHODOLOGY

Research Design

This study adopted a descriptive ecological research design combined with comparative analysis to assess the effects of habitat fragmentation on butterfly species diversity in Owerri, Imo State. The design involved comparing butterfly diversity between fragmented habitats (highly urbanized and disturbed areas) and less-fragmented or semi-natural habitats. This approach is suitable for ecological studies seeking to establish relationships between habitat conditions and species diversity without experimental manipulation. Both field-based observations and secondary ecological data were used to provide robust and reliable findings.

Area of the Study

The study was conducted in Owerri, the capital city of Imo State, Nigeria. Owerri lies between latitude 5°27′–5°30′N and longitude 7°00′–7°05′E. The city has experienced rapid urban expansion characterized by road construction, housing development, vegetation clearance, and land-use change, all of which contribute to habitat fragmentation. Selected study sites included urbanized zones with high habitat disturbance and semi-natural areas with relatively continuous vegetation cover within Owerri Municipal and its surrounding environments.

Target Population

The target population for this study consisted of butterfly species (Order: Lepidoptera) occurring within selected fragmented and less-fragmented habitats in Owerri. Butterflies were chosen because of their sensitivity to habitat changes, dependence on vegetation, and ecological importance as pollinators and bio-indicators. The study focused on all butterfly species encountered during the sampling period within the defined study locations.

Sample Size and Sampling Technique

A purposive sampling technique was used to select study locations based on the degree of habitat fragmentation. Study sites were categorized into:

- Fragmented habitats (roadsides, built-up areas, isolated green patches)
- Less-fragmented habitats (parks, institutional green areas, semi-natural vegetation)

Within each site, line transect sampling was employed for butterfly observation. Transects of fixed length were walked slowly during suitable weather conditions, and all butterflies observed within a defined distance were recorded. This method is appropriate for butterfly diversity studies and allows for standardized comparison across habitats.

To identify and classify fragmented habitats within selected locations in Owerri.

Field surveys were conducted across selected locations in Owerri through direct observation and reconnaissance walks. Habitats were identified and classified based on observable land-use characteristics, vegetation continuity, canopy cover, and intensity of human activities. Three distinct habitat types were recorded during the field survey period.

Identification and classification of butterflies within selected locations in Owerri.

Direct field observation of butterflies using the Pollard Walk (transect count) method. Observations were conducted during peak butterfly activity periods (between 9:00 am and 3:00 pm) under favourable weather conditions such as sunny or partly cloudy skies with minimal wind. Butterflies encountered along each transect were identified visually using standard butterfly identification guides and photographed where necessary to aid identification, classification, species composition and richness, assess the effect of fragmentation and compare species diversity. Species names and counts were recorded systematically for each habitat type.

Data Analysis

Data collected on land-use characteristics and vegetation structure were analyzed using descriptive analysis. Field observations and GPS coordinates were used to categorize each study site into fragmented and less-fragmented habitats based on the level of vegetation continuity and human disturbance. Simple descriptive statistics such as frequency counts and percentages were used to summarize the number of sites within each habitat category.

Butterfly species recorded from field observations were compiled into species lists for each habitat type. Species richness was determined by counting the total number of butterfly species present in fragmented and less-fragmented habitats. The species composition of each habitat was described using tabular presentation showing species presence and abundance.

Butterfly species diversity was analyzed using Shannon–Wiener Diversity Index (H′) and Simpson's Diversity Index (D). These indices were calculated separately for fragmented and less-fragmented habitats to measure diversity levels. The calculated diversity values were compared to evaluate the effect of habitat fragmentation on butterfly diversity. All index calculations were performed using standard ecological formulas and basic statistical tools. A t-test was used to compare mean diversity values between fragmented and less-fragmented habitats. The test was conducted at a 0.05 level of significance. This analysis helped establish whether habitat fragmentation significantly influences butterfly species diversity within the study area.

RESULTS

Table 1: Raw Field Classification of Study Habitats in Owerri

Habitat Code	Location Name	Observed Habitat Type	Level of Fragmentation	Visible Field Characteristics
H1	Old Zoo Reserve	Protected habitat	Low	Dense vegetation, closed canopy, minimal disturbance
H2	Nekede Peri-urban Green Patch	Semi-disturbed habitat	Moderate	Mixed shrubs, footpaths, partial clearing
H3	Nekede Built-up Mosaic	Highly fragmented habitat	High	Roads, buildings, isolated vegetation

Protected Habitat (H1): This habitat was characterized by continuous forest cover, dense under-story vegetation, shaded microclimate, and minimal signs of human interference. Vegetation structure appeared intact with little evidence of clearing.

Semi-disturbed Habitat (H2): The semi-disturbed habitat showed partial vegetation removal, presence of footpaths, mixed grasses and shrubs, and moderate human activity. Canopy cover was discontinuous, resulting in edge effects.

Highly Fragmented Habitat (H3): This habitat was dominated by built infrastructure such as roads and residential buildings, with vegetation occurring only in isolated patches. Canopy cover was largely absent, and human activity was intense.

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Photographic Documentation of Identified Habitats

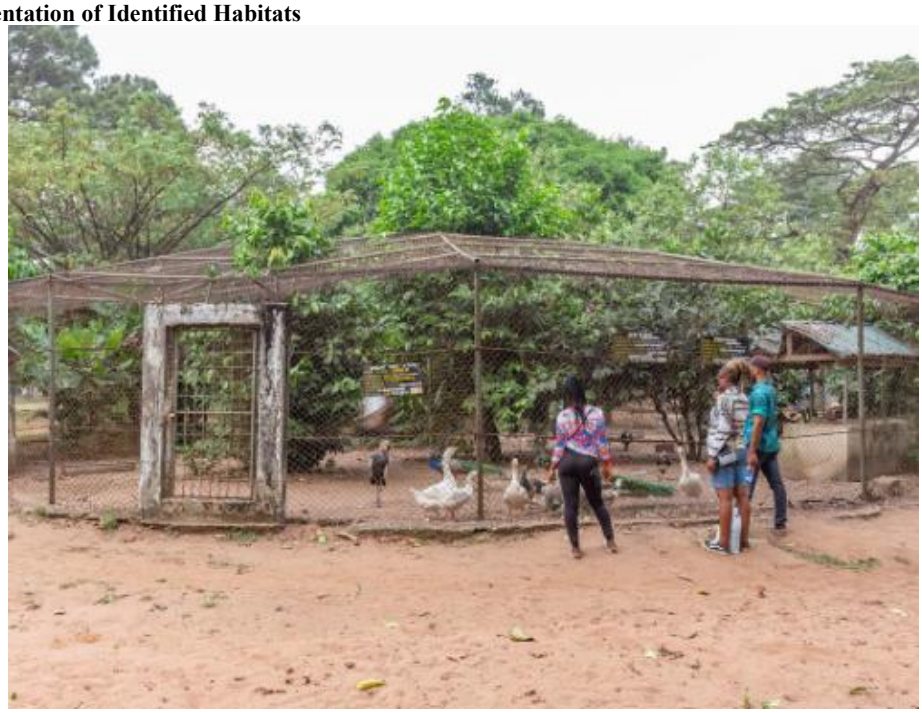

Plate 1: Protected habitat (Old Zoo Reserve)

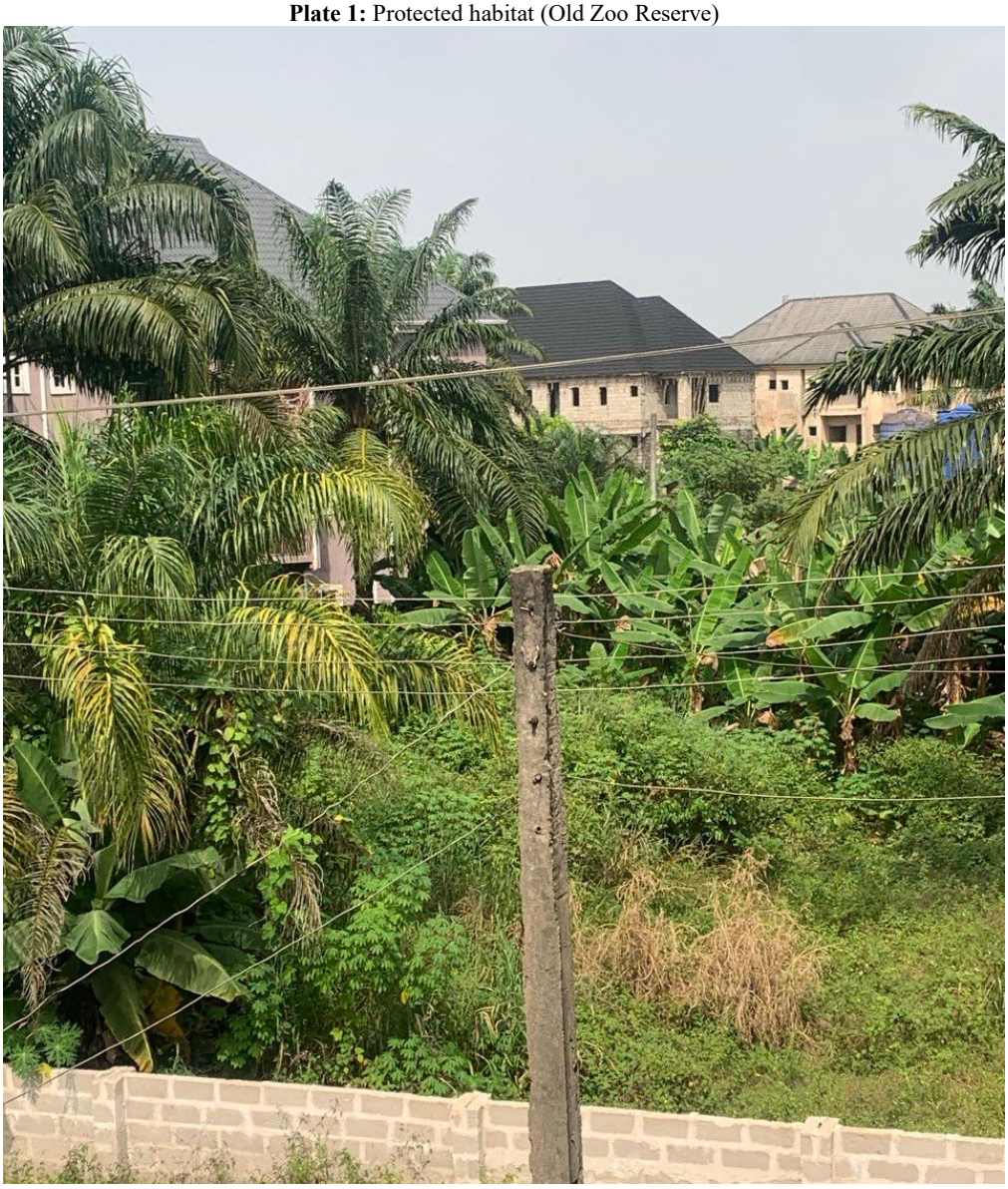

Plate 2: Semi-disturbed habitat (Nekede peri-urban green patch)

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Plate 3: Highly fragmented habitat (Nekede built-up mosaic)

To determine butterfly species composition and richness in fragmented and less-fragmented habitats in Owerri.

Table 2: Raw Field Data on Species Richness and Abundance

Habitat Type	Number of Species (Species Richness)	Total Number of Individuals (Abundance)	Mean Abundance per Transect
Protected Habitat (Old Zoo Reserve)	21	176	35.2
Semi-disturbed Habitat (Nekede Green Patch)	17	139	27.8
Highly Fragmented Habitat (Built-up Mosaic)	12	90	18.0

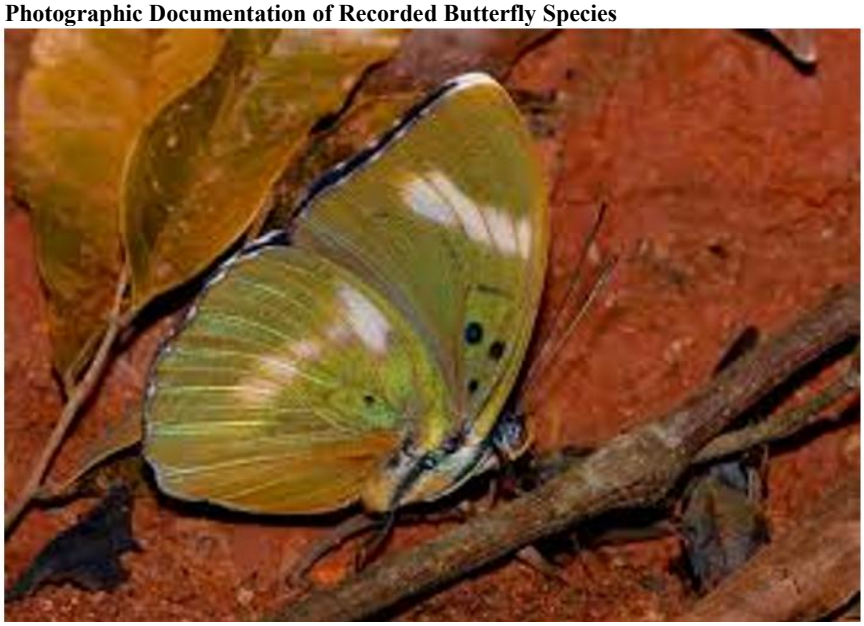
Table 3: Field Classification of Butterfly Species by Ecological Group

Ecological Category	Representative Species	Dominant Habitat Type
Forest Specialists	*Euphaedra medon*, *Charaxes varanes*, *Bicyclus smithi*	Protected habitat
Edge-associated Species	*Catopsilia florella*, *Bicyclus dorothea*	Semi-disturbed habitat
Generalist Species	*Junonia oenone*, *Eurema hecabe*, *Papilio demodocus*	Fragmented habitat

Butterfly species recorded were grouped based on their ecological preferences and field occurrence patterns.

1. **Protected Habitat (Old Zoo Reserve):** Species recorded included forest-associated and shade-tolerant butterflies such as *Euphaedra medon*, *Charaxes varanes*, *Bicyclus smithi*, along with other forest interior species.
2. **Semi-disturbed Habitat (Nekede Green Patch):** Species recorded included a mixture of forest-edge and open-habitat butterflies such as *Catopsilia florella*, *Bicyclus dorothea*, *Junonia oenone*, and *Papilio demodocus*.
3. **Highly Fragmented Habitat (Built-up Mosaic):** Species recorded were predominantly generalists and disturbance-tolerant species including *Junonia oenone*, *Eurema hecabe*, and *Papilio demodocus*.

Photographic Documentation of Recorded Butterfly Species



Photographic records of butterflies were obtained using a smartphone camera during **Plate 4:** *Euphaedra medon* (In the Protected habitat)

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Plate .5: *Charaxes varanes*

Plate 6: *Charaxes varanes*

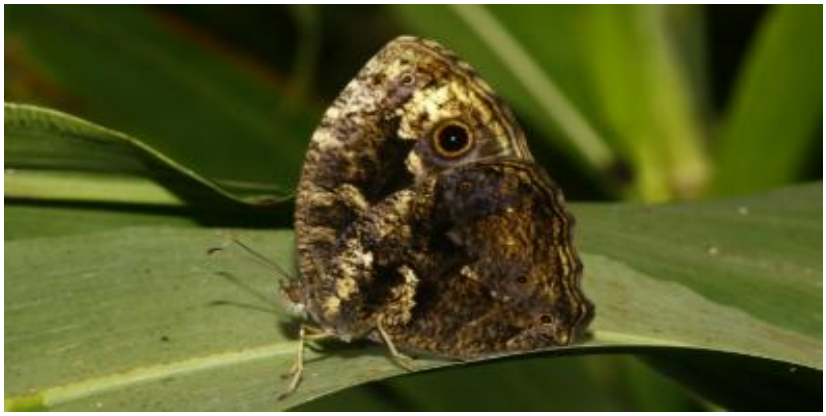

Plate 7: *Bicyclus smithi*

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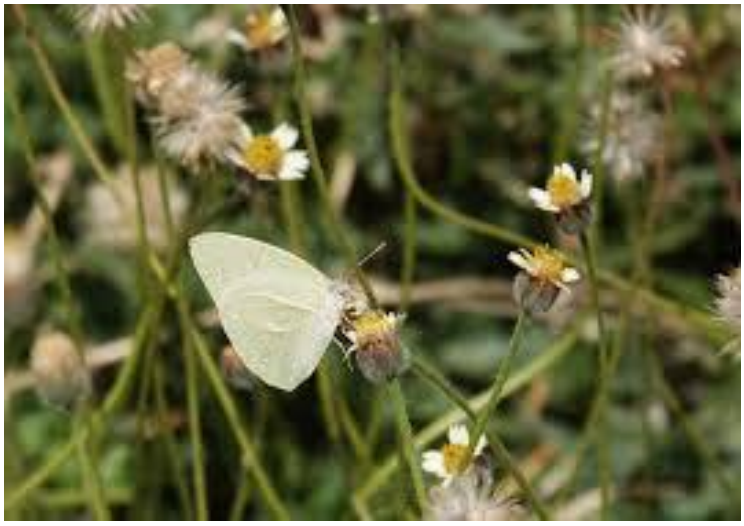

Plate 8: *Catopsilia florella*

To assess the effect of habitat fragmentation on butterfly species diversity in Owerri.

Raw Diversity Index Values Across Habitat Types

Table 5: Verbatim Diversity Indices Calculated for Each Habitat Type

Diversity Index	Protected Habitat	Semi-disturbed Habitat	Highly Fragmented Habitat
Shannon–Wiener Index (H′)	2.68	2.41	2.03
Simpson's Index (1–D)	0.91	0.87	0.82
Evenness	0.83	0.78	0.71

Using butterfly abundance data obtained from the transect counts in each habitat type, species diversity indices were calculated to determine how habitat fragmentation influenced butterfly community structure across the study area.

The indices calculated included:

- Shannon–Wiener Diversity Index (H′)
- Simpson's Diversity Index (1–D)
- Species Evenness

Raw Comparative Species Richness and Abundance Data

Table 6: Comparison of Butterfly Richness and Abundance Between Semi-Natural and Urbanized Habitats

Habitat Category	Component Habitat	Species Richness	Total Abundance
Semi-Natural Habitat	Protected forest	21	176
Urbanised Habitat	Semi-disturbed	17	139
Urbanised Habitat	Highly fragmented	12	90

Raw Comparative Diversity Index Values

Table 7: Comparison of Diversity Indices Between Semi-Natural and Urbanized Habitats

Habitat Category	Shannon Index (H′)	Simpson's Index (1-D)	Evenness
Semi-Natural Habitat	2.68	0.91	0.83
Urbanised (Semi-disturbed)	2.41	0.87	0.78
Urbanized (Fragmented)	2.03	0.82	0.71

Indicator Species Recorded Across Habitat Categories

Indicator species were identified based on frequency of occurrence, habitat specificity, and restriction to particular habitat categories during field sampling.

Verbatim Indicator Species Records

Table 8: Indicator Butterfly Species by Habitat Category

Habitat Category	Indicator Species Recorded
Semi-Natural Habitat	*Euphaedra medon*, *Charaxes varanes*, *Bicyclus smithi*
Urbanised (Semi-disturbed)	*Catopsilia florella*, *Bicyclus dorothea*
Urbanised (Highly fragmented)	*Junonia oenone*, *Eurema hecabe*, *Papilio demodocus*

Discussions

The classification of the study area into protected, semi-disturbed, and highly fragmented habitats confirms that the landscape in Owerri is now organized along a clear fragmentation gradient driven largely by urban expansion and associated infrastructure. The protected habitat (Old Zoo Reserve) retained relatively continuous forest cover with closed canopy and low disturbance, whereas the semi-disturbed and highly fragmented habitats showed increasing levels of vegetation clearance, built-up structures, and road networks.

This pattern is consistent with previous work that has identified road construction and built-up expansion as key drivers of habitat fragmentation and ecological degradation. For instance, the fragmentation of mangrove forests for a powerline corridor at Oproama Creek in the Niger Delta area of Nigeria, resulted in the breaking up of continuous mangrove stands into isolated patches and led to altered microclimates and reduced biodiversity in macro-zoo-benthos communities (Zabbey et al 2021). Within Nigeria, the observed fragmentation gradient in Owerri agrees with evidence that rapid urbanization and land-use change are driving forces for forest loss and habitat subdivision. Work in Bayelsa State Nigeria, showed that built-up expansion associated with road development drastically reduced forest cover and tree species composition, effectively converting continuous vegetation into fragmented patches (Alao et al 2023). Similar trends of forest resource decline with urban growth have been reported in Otukpo and Oju Local Government Areas of Benue state Nigeria, where urban infrastructure spread led to shrinking natural habitat blocks and increasing disturbance at edges (Ancha et al 2021, Jande et al 2022).

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The pattern documented in Owerri also agrees with broader conceptual views that linear infrastructure such as road acts as a fragmentation agent in dissecting previously continuous habitats into "islands" surrounded by developed land (Cassola et al 2025; Zabbey et al 2021). In that sense, the three habitat classes identified in this study reflect a local expression of the island-like fragments described under the Theory of Island Biogeography, where more intact patches (protected forest) are expected to hold more species than small, highly isolated patches embedded in an urban matrix.Overall, the classification results provided a local empirical support that Owerri's rapid urban growth and road network expansion—already highlighted in demographic and spatial analyses of Imo State (CityPopulation, 2025; Macrotrends, 2025)—are translating into real, structural fragmentation of habitats that can influence fauna groups such as butterflies.

This study recorded 24 butterfly species and 405 individuals across the three habitats, with species richness and abundance declining from the protected habitat (21 species; 176 individuals) to the semi-disturbed habitat (17 species; 139 individuals) and further down to the highly fragmented habitat (12 species; 90 individuals). Forest-dependent species such as *Euphaedra medon*, *Charaxes varanes* and *Bicyclus smithi* were restricted to the protected habitat, while disturbance-tolerant generalists such as *Junonia oenone*, *Eurema hecabe* and *Papilio demodocus* dominated the fragmented urban mosaic. This pattern follows the classical response of biodiversity to fragmentation described in multi-taxon work from other regions. In Basilicata, species richness of mammals, birds, reptiles and invertebrates decreased with proximity to industrial roads, while generalist species increased in dominance in areas with higher human pressure (Cassola et al 2025).

The observed replacement of forest specialists by disturbance-tolerant butterflies in fragmented Owerri habitats mirrors this shift, but in a butterfly-specific context.The decline in butterfly richness with increasing fragmentation was also consistent with studies that documented biodiversity loss in plant and insect communities under anthropogenic disturbance. In Yenagoa, built-up expansion driven by road and urban development led to a decline in native tree species composition and diversity, indicating that more disturbed areas retain fewer specialized species (Alao et al 2023). Likewise, research on insect communities in a quarry landscape in Ghana showed that operational zones subjected to dust, blasting and vegetation clearance had lower insect species richness compared to less disturbed sites (Addae, 2022). The present study results agreed with these findings that heavily modified butterfly habitats in Owerri (roadside, built-up mosaics) support fewer species and are dominated by generalists.Comparable fauna responses have been recorded in other taxa. Amphibian diversity in the Huangshan Mountain region of China was found to decrease with increasing proximity to roads and farmland, with sensitive species being replaced by more tolerant ones (Hong et al 2025). In the Niger Delta, macro-zoo-benthos diversity declined sharply in mangrove areas cleared for infrastructure, and sensitive species were lost from disturbed sites (Zabbey et al 2021). The butterfly assemblages in Owerri behave similarly, forest specialists disappear as habitats become more open, hotter and more disturbed, suggesting that butterflies are responding to fragmentation in the same way other fauna and invertebrate groups have been reported to respond in different ecosystems.Furthermore, the coexistence of both forest-associated and generalist butterflies in the semi-disturbed habitat resembles the "transition zones" or ecotones described in other ecological studies, where intermediate disturbance allows both interior species and open-habitat species to occur together before specialists are eventually lost as disturbance intensifies (Cassola et al 2025., Addae, 2022). Diversity analysis showed that butterfly diversity decreased systematically along the fragmentation gradient. Shannon–Wiener (H′) values dropped from 2.68 in the protected habitat to 2.41 in the semi-disturbed and 2.03 in the highly fragmented habitat, while Simpson's index (1–D) declined from 0.91 to 0.87 and 0.82 respectively. Evenness also fell from 0.83 in the protected area to 0.71 in the fragmented habitat, indicating a shift from relatively balanced communities to assemblages dominated by a few tolerant species.

Statistical testing further confirmed that these differences were not random. The one-way ANOVA produced a significant result ($F(2,12) = 8.74$, $p < 0.01$), leading to the rejection of the null hypothesis that habitat fragmentation has no significant effect on butterfly diversity. This directly supports the hypothesis that fragmentation significantly affects species diversity in the study area and matches expectations laid out in the methodological design.These findings agreed strongly with earlier work that has linked habitat fragmentation and anthropogenic disturbance to reductions in species diversity and community structure. The butterfly pattern in Owerri declining diversity with increasing fragmentation and a shift towards common generalists reflects this same homogenization process.From a theoretical perspective, the observed decline in butterfly diversity in smaller, more disturbed habitat fragments is in line with the Theory of Island Biogeography, which predicts that smaller and more isolated "islands" (in this case, remnant habitat patches surrounded by urban development) support fewer species and face higher extinction risks than large, well-connected areas (MacArthur & Wilson, as referenced in the theoretical framework). The dominance of generalist butterflies in the smallest, most fragmented habitats reflects the replacement of sensitive species predicted when immigration rates fall and local extinctions rise in isolated patches. The results also agree with findings from other fauna systems where population structure and diversity respond negatively to fragmentation. For example, lion populations in Eselenkei Group Ranch declined as land-use change and roads disrupted migration routes and reduced habitat quality (Kibet, 2024), while avian communities in the Gulf of Guinea showed strong shifts in composition across fragmented elevation zones, with specialist birds restricted to more intact interior habitats (Miller, 2021). Although the present study focuses on butterflies rather than mammals or birds, the direction of diversity response is consistent across taxa.When habitats were grouped into semi-natural (protected forest) and urbanized (semi-disturbed and highly fragmented) categories, butterfly diversity was clearly higher in the semi-natural habitat. The protected forest supported the greatest species richness (21 species), highest total abundance (176 individuals) and highest diversity indices ($H' = 2.68$; $1–D = 0.91$). In contrast, the urbanized habitats, particularly the highly fragmented built-up mosaic, had fewer species, lower abundance and reduced diversity values. Indicator species analysis further reinforced this pattern. Forest-dependent butterflies such as *Euphaedra medon*, *Charaxes varanes* and *Bicyclus smithi* were found only in the semi-natural protected habitat, while disturbance-tolerant generalists such as *Junonia oenone*, *Eurema hecabe* and *Papilio demodocus* were characteristic of the urbanized, highly fragmented habitat. Edge-associated species such as *Catopsilia florella* and *Bicyclus dorothea* were most frequent in the semi-disturbed peri-urban green patch, which structurally lies between intact forest and heavily built-up areas. These findings are in strong agreement with previous researches that has shown urbanization and built-up expansion to be major drivers of biodiversity loss and community simplification. In Yenagoa, the growth of built-up areas led to a reduction in native tree species diversity and the simplification of forest structure, illustrating that urban land-use conversion is detrimental to species-rich, structurally complex habitats (Alao et al 2023). Similar conclusions were drawn in studies of urbanization impacts on forest resources in Benue State, where increasing urban spread was linked with declining forest cover and ecological degradation (Ancha et al 2021., Jande et al 2022). The present butterfly data showed that these vegetation-level impacts translate directly into fauna responses; semi-natural patches in Owerri act as reservoirs for specialist butterflies, while urbanized zones favour a few generalist species. The dominance of generalists and the reduced diversity observed in urbanized habitats also align with findings that anthropogenic pressures near roads and settlements leads to ecological homogenization, where a small set of tolerant species comes to dominate communities (Cassola et al 2025). In Ghana's quarry landscapes, insect assemblages in operational zones were similarly dominated by tolerant species with overall lower richness compared to less disturbed areas (Addae, 2022). The pattern in Owerri's urban butterfly communities suggested that the same process is at work in a Nigerian urban context.The fact that semi-natural green spaces still support both forest-linked and generalist butterflies indicates that these areas may function as buffer zones or stepping-stones, a role that has been emphasized in wider biodiversity and conservation discussions. For example, in the Congo Basin, the loss of keystone species and forest structure due to land-use change has highlighted the importance of maintaining intact patches for ecosystem functioning (Beekmann, 2025).

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Studies of large carnivores and other wildlife in East Africa have also underscored the role of habitat corridors and less-developed patches in sustaining populations under fragmented landscapes (Kibet, 2024). In the present study, the semi-natural habitat in Owerri shows similar importance for butterflies: it still harbors specialists that are absent from the urban core, indicating that conserving such patches is critical for maintaining local butterfly diversity.Overall, the diversity analysis in this study empirically validates the assertion that road-driven habitat fragmentation significantly affects species diversity in the study area and supports broader regional and global evidence on the ecological consequences of fragmentation (Cassola et al 2025., Hong et al 2025., Zabbey et al 2021., Addae, 2022). Finally, the strong contrast between semi-natural and urbanized habitats supports in Owerri, calls for integrated land-use planning and green infrastructure to mitigate biodiversity loss associated with road construction and urban growth. Recommendations in previous work have included establishing buffer zones, maintaining green corridors, and incorporating biodiversity safeguards into infrastructure planning (Zabbey et al 2021., Kibet, 2024., Edegbene et al 2025., Seki, 2023).

Conclusion

The identification and classification of habitats within the study area revealed a clear gradient of fragmentation, ranging from relatively intact forest in the Old Zoo Reserve to severely disturbed urban environments dominated by roads and buildings. This confirmed that Owerri's landscape has undergone significant structural modification consistent with patterns reported for rapidly urbanizing cities. The analysis of butterfly species composition and richness demonstrated that habitat fragmentation has a strong influence on the distribution and abundance of butterfly species in Owerri. Overall, this research demonstrated that habitat fragmentation associated with urban development in Owerri has measurable and significant effects on butterfly species diversity, supporting both the analytical framework and theoretical expectations underpinning this study.

Declarations

Acknowledgement

We acknowledge all the authors for their immense contribution towards this work.

Authors contributions

The work was conducted in collaboration among all authors. Authors NSN and NO designed the study, wrote the first draft of the manuscript, CNA and NMC managed the analysis of the study. Authors NMO and JL did the statistical analysis. Authors UVC, NCI and ECO managed the literature searches, LOM did the photography and OOE and OJC did the proof-reading. All the authors read through the manuscript and approve the publication.

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Data availability statement

All data generated or analyzed during this study are included in this published article.

Conflict of interest

All the authors declare that there is no conflict of interest and agreed to the publication of the work.

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