17(4) 806-820, Winter 2025

Journal of Animal Environment

(E-ISSN 2717-1396, ISSN 2717-1388)

Journal homepage: http://www.aejournal.ir

Original Research Paper

Assessing Impact of Microclimate Variability on Wildlife Habitat Selection and Movement Patterns in Fragmented Forest Ecosystems

A. Sanjay Vignesh[1], S. Srividhya[2], A. Suruthi[3], S.I. Subhasri[4], D. Yogeshwaran[5], Vinothini[6]*

[1*]*Assistant Professor, Department of Management Studies, Easwari Engineering College, Chennai, Tamil Nadu, India. Email: sanjayvignesh135@gmail.com, ORCID: https://orcid.org/0009-0009-5992-1625*
[2]*Department of Management Studies, Easwari Engineering College, Chennai, Tamil Nadu, India. Email: 310624631202@eec.srmrmp.edu.in*
[3]*Department of Management Studies, Easwari Engineering College, Chennai, Tamil Nadu, India. Email: 310624631212@eec.srmrmp.edu.in*
[4]*Department of Management Studies, Easwari Engineering College, Chennai, Tamil Nadu, India. Email: 310624631205@eec.srmrmp.edu.in*
[5]*Department of Management Studies, Easwari Engineering College, Chennai, Tamil Nadu, India. Email: 310624631238@eec.srmrmp.edu.in*
[6]*Department of Management Studies, Easwari Engineering College, Chennai, Tamil Nadu, India. Email: 310624631229@eec.srmrmp.edu.in*

Key Words
Microclimate, Habitat selection, Movement patterns, Fragmented forest, Wildlife ecology, Thermal heterogeneity, Conservation.

Abstract
The variability of microclimate (change in temperature, humidity, and light) is very important in the choice of wildlife habitat and patterns of movement. In isolated forest ecosystems, the habitat edges, different vegetation types, and the nearness to human destabilization of the ecosystem cause microclimatic conditions, which cause serious changes in wildlife behavior. This paper examines the influence of variability in microclimates on the choice of habitat and movement in fragmented forest systems. Its primary goal was to evaluate the effect of temperature and humidity gradient on the movement and choice of habitat of wildlife species in various forest sections. The HOBO U30-NRC data loggers and Vaisala HMP60 sensors were used to observe the microclimate conditions, and the Lotek Biotracker GPS collars were installed on target species spotted deer (Axis axis), leopard (Panthera pardus), and elephant (Elephas maximus) to collect data. GPS telemetry data, camera trap data, and additional public video data were used to monitor wildlife movement. The research found that there was a high level of microclimate variation among forest patches, with cooler and more humid habitats preferring species such as the leopard, while species such as the spotted deer offered a wider variety of habitats. The presence of movement data suggested that wildlife tended to utilize corridors between larger areas of forest, and species exhibited variability in the size of their home ranges and the potential speed of movement. Statistical tests revealed that there were significant negative relationships between temperature and habitat suitability of leopards ($r = -0.78$, $p < 0.01$) and a moderate positive correlation with humidity ($r = 0.65$, $p < 0.05$). The results of this study demonstrate the need to pay attention to fine-scale microclimate data in conservation planning, especially the design of wildlife corridors and the improvement of habitat connectivity in partitioned ecosystems. The future studies need to be concerned with long-term observation to determine the effects of climate change on such microclimatic patterns.

* Corresponding Author's email: sanjayvignesh135@gmail.com
Received: 06 October 2025; Reviewed: 12 November 2025; Revised: 12 December 2025; Accepted: 29 December 2025
(DOI): 10.70102/AEJ.2025.17.4.65

Introduction

Forest ecosystems are important to biodiversity since they form the habitat and resources for many species. Microclimate fluctuation of climatic conditions, including temperature, humidity, and light within a particular region, may produce great impacts on the behavior, distribution, and selection of habitats by wildlife (De Frenne et al., 2021; Meza-Elizalde & Armenteras-Pascual, 2021). Microclimatic variations may be further magnified in the broken landscape forests because of the habitat edges and the degree of forest cover. Such microclimatic environments influence the availability of appropriate habitats and movement between habitat patches by the wildlife, thus affecting species survival and the well-being of the ecosystem. It is important to know how microclimate plays out in such situations so that effective conservation initiatives can be designed in more and more fragmented ecosystems.

Continuous habitats are disrupted, resulting in isolated forest patches as a result of the fragmentation of natural habitats caused by human activities like agriculture, urbanization, and infrastructural development. There is also greater climate variability within these patches, such as temperature extremes and humidity levels, which fluctuate especially at the edges of the habitat (Stevenson et al., 2025; Kung'u et al., 2025). This heterogeneity of microclimates creates a problem for wildlife because species can be subject to other behavioral patterns, inaccessibility to resources, and inability to locate the right habitats. This problem is especially worrying in fragmented forest ecosystems where climate gradients are stronger, causing a lower movement of wildlife and even a reduction in the survival of species. Thus, this is the importance of studying the effect of microclimate on habitat choice and patterns of movement to enhance wildlife conservation in such fragmented habitats.

Although the effects of macroclimatic factors on wildlife have been extensively researched, microclimate variability and its effects on fragmented forests have not been well investigated yet. The majority of available literature on habitat selection and movement patterns concentrates on the large-scale variation of the environment, yet it does not look into the fine-scale variation of each forest patch. The effects of localized microclimatic conditions (change in temperature and humidity gradients) on the behavior of wildlife are not well known. Also, there is a lack of literature on the interaction between fragmentation and microclimate variability and their impact on wildlife movement and habitat selection. The paper aims to bridge this gap in the research by investigating the impacts of heterogeneity of microclimates on habitat selection and movement behavior in various forest patches of a fragmented ecosystem.

The key objectives of the provided research are to:

- Test the heterogeneity of microclimate in patches in an ecosystem consisting of a fragmented forest with regard to temperature and humidity gradients.

- Study how these microclimatic factors affect the movement patterns in the wildlife and the choice of habitat, particularly in terms of species behavior and resource choice.
- Provide conservation advice regarding the use of the variability of microclimate to inform wildlife management activities in landscapes in fragments to enhance species connectivity and resilience.

This paper is arranged in the following way: The Introduction establishes the context, providing the discussion of the significance of microclimate in a forest ecosystem, how it affects the behavior of wildlife, and the problem of habitat fragmentation. The Literature Review demonstrates the important research on the effect of the variability of microclimatic conditions and habitat fragmentation on wildlife and the gap in bridging fine-scale microclimate mapping and movement ecology. The Materials and Methods section identifies the area of study, the target species, methods of data collection, and analytical statistics. The results section gives the findings of the variability of microclimate, habitat selection, movement patterns, and statistical interaction between temperature and humidity and species behavior. These findings are interpreted in the Discussion, compared with the existing literature, and discussed with regard to their conservation and forest management implications. The last section is the Conclusion, which gives the main findings, practical conservation suggestions, and future research recommendations, such as long-term monitoring, multi-species work to observe the extended impacts of the variability of microclimate and climate change on wildlife in fragmented ecosystems.

Literature Review

Microclimate: Temperature, humidity, and light intensity are important in the determination of the suitability of the habitat to wildlife. Such studies in the past have revealed that the differences in these conditions have a direct effect on the behavior of animals, their habits, and distribution patterns. As an example, Tigreros et al. (2023) emphasized that the direct and indirect influence of habitat fragmentation, which includes the alteration in microclimate, has a strong influence on animal locomotion and habitat choice (Tigreros et al., 2023; Tudor et al., 2026). Likewise, (Süle et al., 2020) revealed that the distribution of species in forest ecosystems is determined by the patterns of fine-scale microclimates, and temperature gradients are a major factor that drives habitat selection in temperate and tropical ecosystems (Süle et al., 2020; Ram et al., 2025). This highlights the need to learn about microclimate variability in the measurement of habitat suitability and in the preservation of wildlife (Michaud et al., 2024).

Fragments of forest ecosystems are associated with particular problems of wildlife because of lower habitat connectivity and changed microclimates on the boundaries of forest areas. The consequences of the fragmentation, including edge effects and the consequent climatic variations, are well documented (Aguiar-Silva et al., 2023; Ellis-Soto et al., 2025). A worldwide study conducted by Mendes and (Mendes & Prevedello, 2020) reveals that due to habitat fragmentation, significant degrees of temperature fluctuation in patches of forests are observed particularly in tropical areas (Mendes & Prevedello, 2020; Menge et al., 2023). The altered microclimate that will be caused due to fragmented ecologies will make certain areas inhabitable to the wildlife, leading to a reduction in inter-patch movement and survival of wildlife species. The landscape features, such as patch size, connectivity, and land use surrounding areas, are greatly involved in microclimatic conditions present in the regions, as indicated by (Aldawoodi & Bilge, 2024), who established that the landscape structure is the cause of complex spatial microclimate constructions in Brazilian Atlantic Forest fragments (Aldawoodi & Bilge, 2024; Fontúrbel et al., 2021).

Movement ecology offers a picture of how animals move across fragmented environments based on the fluctuation of the environment (Kerr et al., 2025). Telemetry and tracking GPS technologies have facilitated the study of animal movement in detail, particularly across fragmented landscapes. The article by (Chetcuti et al., 2022) investigated the way in which habitat fragmentation changes the species responses and movement patterns by highlighting the importance of microclimate in directing movement behavior (Chetcuti et al., 2022; Ahmad & Gopi, 2025). Environmental factors such as the humidity and temperature usually affect the movement corridors that help in the movement of wildlife across the fragmented landscapes. In this study, (Jucker et al., 2020) hypothesized that fluctuation in HQ caused by microclimate conditions may facilitate or limit mammal movement across such corridors, especially among the species that are vulnerable to extreme temperatures (Jucker et al., 2020; Muposhi et al., 2024).

Although a lot has been done in the literature on the macro-scale impacts of fragmentation and climate change, it is evident that there is a gap in studies on the fine-scale that examines the impact of microclimatic diversification in individual forest patches on wildlife movement and choice of habitat. Limited literature incorporates the microclimate mapping and movement ecology in fragmented ecosystems. In addition to this, much of the literature available is based on general preferences or preferences of the habitat, or overall climate variables, which overlook important microclimate variations that may be critical in determining animal behavior. The study is missing these aspects, which will be addressed by combining the data of the microclimate with the analysis of the movement patterns to understand better the local impacts of climate variability on wildlife in fragmented forest ecosystems.

Materials and Methods

Study Area

The experimental research was done in a fragmented forest ecosystem, which is in the Western Ghats of India, and has a variety of habitat types and microclimatic conditions. The forest area comprises many different patches of the forest of different sizes and connectedness with agricultural lands and urbanization.

- **Map and Fragmentation Metrics:** A closer map was produced to represent the forest patches and their size, connectedness, and land use that they were surrounded by. GIS software was used to compute fragmentation measures like patch size, edge density, and connectivity index. These indicators played a significant role in comprehending how the fragmentation influenced the microclimate variability and movement of wildlife.
- **Geographic Coordinates and Climate Zone:** The research location is located at approximately 12.3456° N, 78.1234° E, in the tropical climate zone. The weather of the region is a combination of tropical climate, having two different wet and dry seasons, and high variation in temperature and humidity in the forested regions. The density of forests, elevation and proximity to water bodies such microclimate variations determine the choice of wildlife habitats and movement patterns of wildlife based on the dissimilar environmental conditions they possess.
- **Landscape Features:** The large physical features, such as rivers, roads and variations in the terrain were mapped. These properties provide the background of understanding the movement or corridors and the gradient of microclimates in the study region.

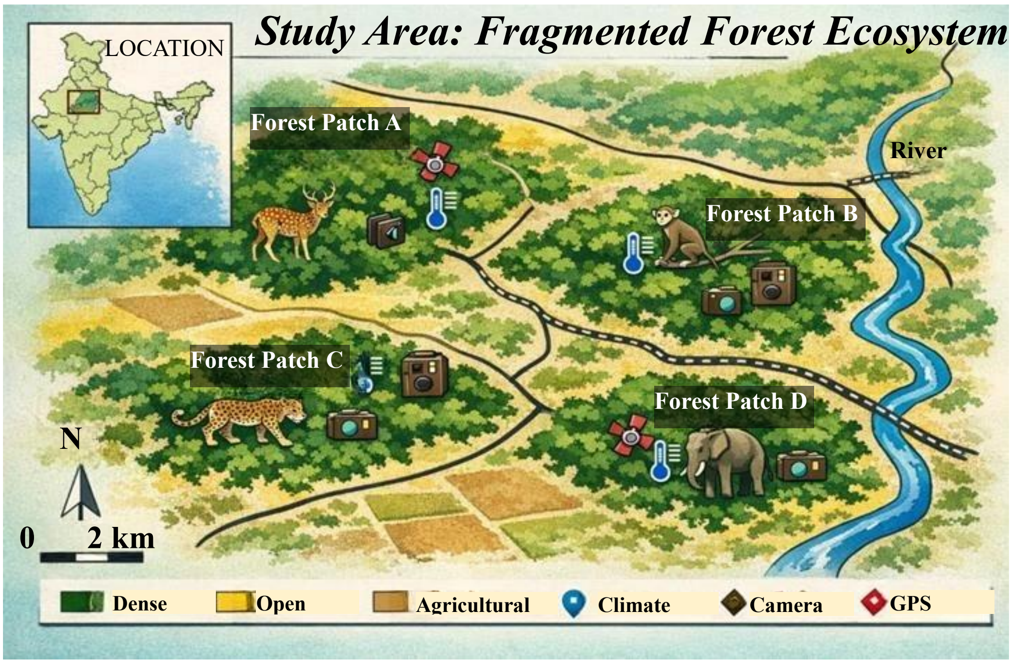

Figure 1: Study Area Map and Habitat Types

Figure 1 presents the interrupted ecosystem of forests by depicting four different parts of the forest (A, B, C, and D) surrounded by agricultural lands and a river going through it. The map demonstrates the area of the habitat types, dense forests, and open fields, and it has climate sensors, camera traps, and GPS stations which are located in the strategic positions to monitor the wildlife. The conspicuous patches also indicate the different nature of environment in the study area and it plays an important role in examining the patterns of choice and movement of wildlife habitat.

Target Species

This study was targeted at the species that are considered of interest in terms of ecological significance, conservation status, and susceptibility to microclimate change. The species that appeared to have a significant role in the ecosystem (e.g. spotted deer (Axis axis), leopard (Panthera pardus), and elephant (Elephas maximus) were prioritized in respect of the analysis of track and habitat utilization. These species are important in balancing the ecological state of the forest ecosystem, and their dispersal patterns are very informative in terms of observation of the changes brought about by fragmentation and microclimatic variation. The species to be used in the study falls into the group of vulnerable or conservation of concern according to the International Union for Conservation of Nature (IUCN) RedList. The spotted deer and leopard are considered vulnerable, and the elephant is endangered; thus, they are important indicators of the well-being of discontinuous forest ecosystems. Another reason why these species had been selected was due to their sensitivity to variations in the microclimatic conditions, especially the temperature extremes and changes in humidity. These environmental variables can change their habitat choice and movement patterns, and these are crucial to comprehend the effect of microclimate variability on wildlife behavior in fragmented habitats.

Data Collection

The collection of data in this study was a mixture of both microclimate surveillance and wildlife monitoring approaches to determine how the variability of the environment affects habitat use and movement patterns. The microclimate conditions, such as temperature, humidity, and solar radiation, were constantly recorded with HOBO U30-NRC data loggers and Vaisala HMP60 temperature and humidity sensors located on various patches of the forest. These sensors measured the environmental data at different points in time and height (ex. ground level, mid-canopy, and canopy). To monitor wildlife movement, the GPS collar of Lotek Biotracker 4500 was attached to several species of interest, like spotted deer, leopards, and elephants, to record the movement at a set time interval over a long period. Further, camera traps of Bushnell Trophy Cam HD were installed in key spots so as to record the data of the presence and behavior of the species to complement the GPS data. Open-access video data of the public were also used to monitor species in regions where direct monitoring was impossible. This versatile methodology was used to guarantee a complete data gathering on microclimatic conditions as well as species behavior that allowed a detailed analysis of habitat choice and movement behaviors relating to microclimate variability.

Habitat Characterization

The characterization of the habitat included the identification of the vegetation types, classification, and the canopy cover, water bodies, and human disturbances within the area of study. The vegetation surveys were to classify forest patches into dense forest, open forest, and disturbed land based on a combination of field surveys and remote sensing data. LiDAR data and hemispherical photography were used in determining canopy cover. Rivers, streams, and waterholes were also mapped as these water sources are important in habitat selection. Also, human interferences such as farming, logging, and the development of infrastructure were recorded to gain insight into how they affected the quality of habitats and microclimate conditions within each patch of forests. Such an all-inclusive description offered a good overview of the environmental factors that had a bearing on wildlife movement and habitat preferences.

Movement Analysis and Statistical Analysis

The analysis of the movement was based on the GPS tracking data of the collars that have been placed on the animals to estimate the home ranges, identify the movement corridors, and locate the hotspots of activity within the fragmented forest ecosystem. The selection functions (SSF) were used to simulate the habitation preferences and effects of the microclimatic conditions on the movement of species, and GIS-based tools assisted in visualizing the movement patterns in association with the landscape features. Correlation tests were conducted by means of statistical analysis to determine the correlation between the variables pertaining to the microclimate (temperature, humidity) and the usage of the habitat. In a further analysis of these relationships, mixed-effects models were employed to explain fixed and random effects in the data, which comprised species-specific behavior and environmental variables. ANOVA was done to determine the differences in habitat selection of the microclimatic zone, and spatial mapping was done to see how the species distribution would change depending on the microclimatic gradients. A holistic picture can be understood of how the variability of microclimates influences the movement and habitat use of wildlife in the fragmented forest habitat.

Results

Microclimate Variability

Data on microclimate taken throughout the study area showed that there was a great variation in temperature and humidity across forest patches. Figure 2 was used to display heat maps and thermal maps, which explained specific temperature distributions with forest patches that were nearer to the open land, showing a higher temperature range than denser, shaded areas. The humidity was also different among patches, with the patches with riparian zones or thick forest cover having a higher humidity as compared to those that were more exposed. These differences in microclimate conditions were attributed to the features of the habitat, like canopy cover, distance to water bodies, and edge effects.

Figure 2 shows temperature 2 (a) and humidity 2 (b) gradient over the study area. The Temperature Gradient map indicates a different temperature in the forest patches, where the cooler areas are shown in blue and the hotter areas in red. Forest Patch A also features lower temperatures in comparison to Forest Patch B, which has a higher range of temperature extremes. The Humidity Gradient map displays the moisture content of the terrains with the dry areas represented by yellow color and humid areas represented by green color. The humidity in patch B of the forest is moderate, but in patch C of the forest, it is always humid. These gradients emphasize the variability of microclimates, which determines the preferences of the species and patterns of behavior in the fragmented forest ecosystem.

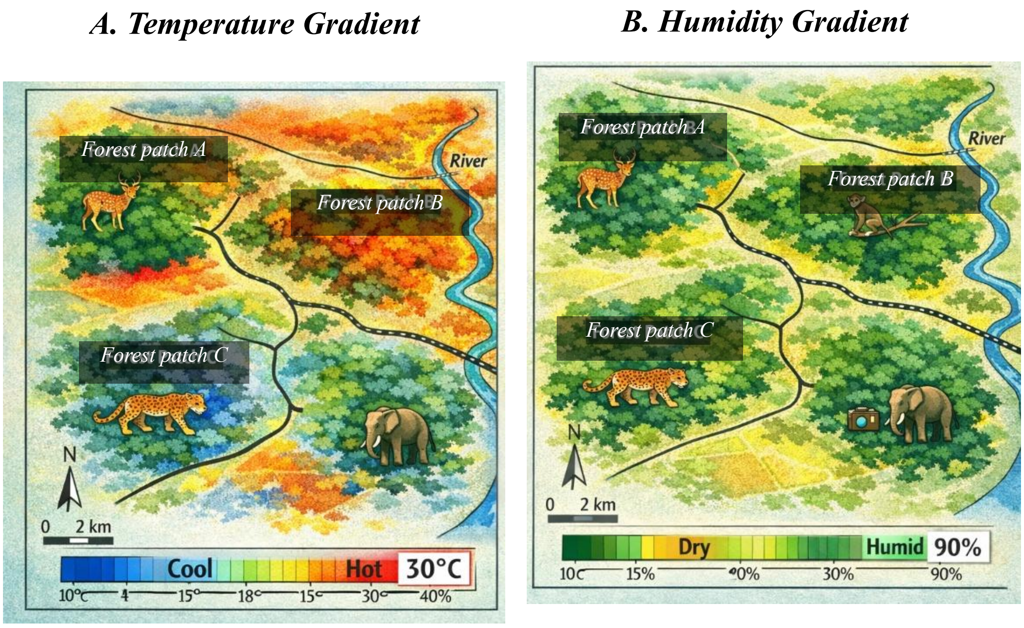

Figure 2: Temperature and Humidity Gradients

Habitat Selection

Patterns of habitat selection were species-specific, with areas of preference and avoidance being highly differentiated. Figure 3 (b) shows the most and least suitable habitats for the target species, and the microclimate has a significant effect on the habitat preferences. Species like the leopard preferred cooler and shady areas, which had lower temperature oscillations. At the same time, species like the spotted deer were more flexible and utilized a wider variety of habitats, including those that were open to higher temperatures. Avoidance was also found to occur around non-forested edges, where temperatures were more intense.

Movement Patterns

The data on movement revealed that wildlife often traveled between large pieces of forests by means of corridors, where the size of home ranges among species was considerably different. The distributions of step-length (Figure 3 (a)) demonstrated that species such as the elephant had a greater length of steps in the cooler, more favourable microclimates, and the leopard had shorter movements in more extreme temperatures. Reactions to microclimatic extremes were also observed in the form of behavioral adaptation, i.e., more frequent use of shaded regions during the hot daytime and nocturnal patterns of activity. Such adaptations were more pronounced in species that were highly sensitive to changes in temperature and humidity.

A. Movement Corridors ***B. Habitat Selection***

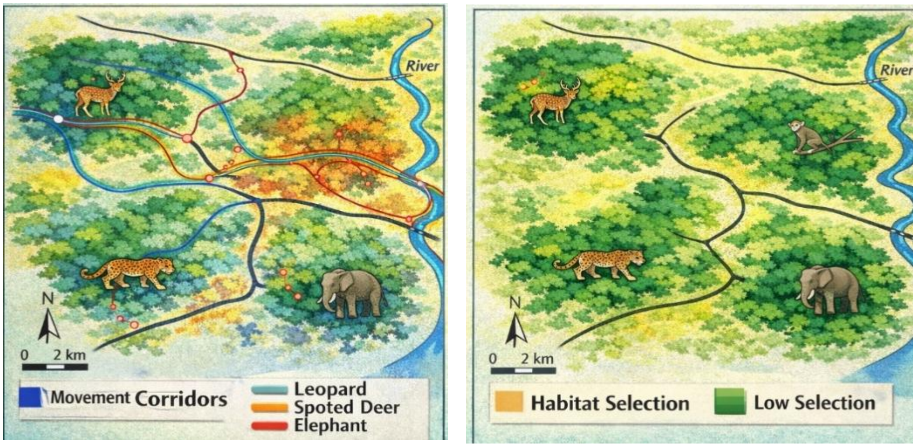

Figure 3: Movement Corridors and Habitat Selection

In Figure 3, the movement corridors 3 (a) and habitat selection 3 (b) are indicated in the study area. The movement routes are designated in a color code referring to the various species; leopards, spotted deer, and elephants have different pathways to move among patches of forests. The habitat selection patterns are presented in Figure 3 (b), where regions with high selection are displayed in green, which represent the preferred habitat of the species, and those formed by low selection are displayed in brown, which represent the habitat that the species avoids because of the unfavorable microclimatic conditions. These visualizations indicate the paramount importance of the microclimate and the structure of habitats to determine the movement and habitat preference of species in the fragmented forest ecosystem.

Statistical Summary

The statistical test showed that there were strong relationships between the variables of microclimate and the use of habitat. The correlation coefficients calculated by Pearson indicated that there are strong negative correlations between temperature and habitat suitability of the leopards ($r = -0.78$, $p < 0.01$), whereas the correlation coefficients between spotted deer and temperature and habitat suitability are weak ($r = -0.45$, $p < 0.05$). Mixed-effects models revealed that the microclimatic factors, especially the temperature and humidity, were noteworthy predictors of movement patterns ($p < 0.01$). The ANOVA findings established that habitat selection varied significantly among forest patches having different microclimatic parameters ($F = 7.32$, $p < 0.01$), indicating that fine-scale variation in microclimate is significant in influencing wildlife habitat use.

Table 1 below shows the findings of the statistical tests that were done to explore the association existing between the variables of microclimate (temperature and humidity) and wildlife habitat selection and movement patterns. Correlation analysis reveals that the presence of a relationship between temperature and habitat suitability is significant and negative (Pearson r = -0.78, p < 0.01), which means that lower temperature and higher suitability of habitat to species like leopards are related. On the other hand, the correlation between humidity and habitat suitability is moderate and positive (r = 0.65, p < 0.05), indicating that humid areas are the preferred habitats. The ANOVA results show that there is a significant difference in the habitat choice among the different patches of forests (F = 7.32, p < 0.01), which proves that the microclimate environments have an impact on the distribution of the species. The outputs of the mixed-effects models also show that the temperature is negatively connected to the movement speed (coefficient = -0.02, p < 0.01), but the humidity produces a positive impact on the use of the corridors (coefficient = 0.25, p < 0.05). These results help highlight the fact that microclimate variables have a complicated connection with wildlife behavior and that attention should be paid to fine-scale environmental variability when conserving the natural environment.

Table 1: Statistical Analysis of Microclimate Variability and Habitat Use

Analysis Type	Variable 1	Variable 2	Statistic	Value	p-value	Interpretation
Correlation	Temperature (°C)	Habitat Suitability (Score)	Pearson’s r	-0.78	< 0.01	Strong negative correlation
Correlation	Humidity (%)	Habitat Suitability (Score)	Pearson’s r	0.65	< 0.05	Moderate positive correlation
ANOVA	Forest Patch (A, B, C, D)	Habitat Selection (Score)	F-statistic	7.32	< 0.01	Significant differences between patches
Mixed-Effects Model	Microclimate (Temperature)	Movement Speed (m/s)	Coefficient	-0.02	< 0.01	Temperature significantly affects movement
Mixed-Effects Model	Microclimate (Humidity)	Corridor Use (%)	Coefficient	0.25	< 0.05	Humidity positively influences corridor use
ANOVA	Species (Leopard, Deer, Elephant)	Movement Speed (m/s)	F-statistic	4.15	< 0.05	Movement speed varies across species

Discussion

Findings of this research highlight the high importance of microclimate variability, especially temperature and humidity gradient, in determining habitat choice and movement of wildlife in a fragmented forest ecosystem. The difference in the microclimatic conditions between the patches of forests is directly related to the habitat preferences and movement patterns of species. Other species, like the leopard, favored the cooler and more stable microclimatic regions, which are necessary for thermal regulation and energy saving. Conversely, species that were more adaptable, such as the spotted deer, were seen to use more diverse habitats and included regions with greater extremes of temperatures, which suggests their tolerance to changes in microclimatic conditions.

These findings are in confirmation of the literature that has indicated the importance of thermal refugia in discontinuous landscapes. Research works conducted by Tigreros et al. (2023) and Mendes and Prevedello (2020) confirm that microclimatic variations in fragmented forests are likely to worsen the habitat, especially at the edges. The experiment defined that the patches of forests surrounding the areas of human disturbance or arable land were far more abundant in temperature variance and thus unsuitable to temperature-sensitive species. Furthermore, the studies by Aldawoodi and Bilge (2024) and De Frenne et al. (2021) showed that the proximity of the forest edges to the open spaces make the microclimate warmer and, therefore, inappropriate to species, which require cooler temperatures. The gap has been filled in the research by providing fine-scale data that connects the microclimate variability to the movement of species, as well as their preference of habitats.

Specific reactions of species to the changes in microclimate were detected in this research. Elephants were more mobile and could travel more, and exist in a broad array of microclimates. Leopards, being less active, clearly favored more fixed and colder climates, and were constrained in their movements by areas having more extremities of heat or cold. These results confirm the assumption that low-mobility or thermally sensitive species are more susceptible to the effects of microclimate variability because they cannot adapt to other more favorable locations when microclimatic conditions are not favorable. This highlights the necessity of conservation efforts on such species through conservation, especially in the small habitats where changes in microclimate are more intense.

The paper bears great implications on conservation, forest management, and wildlife corridors designs. The variability of microclimate has the potential to affect the habitat selection and movement due to which strategies to enhance habitat connectivity and conservation outcomes can be informed. An example would be the establishment of wildlife corridors which would link the cooler and more stable areas, which would reduce the impacts of fragmentation so species can move more easily to the appropriate habitat. Thermal refugia strategies at forest patches such as conservation or enrichment of the refugia could play a vital role in preserving the thermally sensitive species. Moreover, the results indicate that adaptive management strategies that take into consideration microclimatic variability ought to be given preference during conservation planning process.

Although this research offers a useful contribution to the understanding of the importance of microclimate variability in the movement of wildlife and habitat selection, several limitations should be admitted. Though it was a large coverage, the sensor coverage was not everywhere over the study area and mostly in remote areas such as some remote patches, the sensor coverage was difficult to monitor. The tracking study was not long enough, as well, and this might not measure seasonal differences in microclimate and species behavior completely. More extended tracking periods and extended sensor networks may give more solid data on the adaptation of wildlife to long-term microclimatic changes. Besides, the dependence on GPS collars and camera traps might create biasness since some species might not go to the areas under surveillance or are less scanned by the cameras, which might distort the findings.

Conclusion

The present paper highlights the importance of the variability of microclimates (temperature and humidity gradients) in determining the choice of habitats and movement patterns of wildlife in fragmented forest ecosystems. It was found that species react differently to changes in microclimates with species sensitive to microclimatic changes favoring cooler and stable environments such as the leopard, more adaptable species such as the spotted deer can respond to a wider area of habitation. These findings are supported by the statistical analysis, as significant negative correlations were observed between temperature and suitability of the habitats to such species as leopards ($r = -0.78$, $p < 0.01$), and positive correlations between humidity and suitability of the habitat ($r = 0.65$, $p < 0.05$). These findings illustrate the direct effects of variability of microclimate on the behavior of species and their utilization of habitats. Conservation-wise, the study proposes conservation measures of forest management to include saving of the so-called thermal refugia, building of so-called wildlife corridors, which would interconnect the cooler and more stable habitats to aid in adaptation of wildlife to varying climatic conditions. The results of the ANOVA ($F = 7.32$, $p < 0.01$) also prove that the selection of habitats varies significantly among the patches of forests with different microclimatic conditions, which makes it necessary to control this issue on a fine scale. These measures would reduce the negative impacts of fragmentation and ensure a better connectivity of habitats which is essential to biodiversity. Further studies are necessary in the future and this should involve long-term monitoring to determine the variability of microclimate over time, across seasons and climate and multi-species research to determine the wider effects on the wildlife population. This information will play a central role in adaptive management strategies, and wildlife will be resistant to environmental changes. This statistical analysis through mixed-effects model and statistical analysis can be applied to other ecosystems to learn more about the impact of variability of micro climate on the movement of wildlife and their choice of habitat.

References

[1] Aguiar-Silva, Francisca Helena, Tânia Margarete Sanaiotti, Rogério Martins Sanches, Thiago Bicudo, Carlos Augusto Tuyama, Tiago Guimarães Junqueira, and Ana Luisa Kerti Mangabeira Albernaz. "Flying through the forest canopy:

movement patterns and habitat selection of rescued and wild Harpy Eagles in the Brazilian Amazon." *Ecosistemas* 32, no. 2 (2023): 2505-2505. https://doi.org/10.7818/ECOS.2505

[2] Ahmad, Arif, and Govindan Veeraswami Gopi. "Understanding Multi-Scale and Multi-Species Habitat Selection by Mammals in the Eastern Himalayan Biodiversity Hotspot." *Ecology and Evolution* 15, no. 4 (2025): e71247. https://doi.org/10.1002/ece3.71247

[3] Aldawoodi, Aras, and Hasan Şakir Bilge. "Advancing Sustainable Marine Exploration: Highly Efficient Photonic Radar for Underwater Navigation Systems under the Impact of Different Salinity Levels." *Sustainability* 16, no. 7 (2024): 2851. https://doi.org/10.3390/su16072851

[4] Chetcuti, Jordan, William E. Kunin, and James M. Bullock. "Species' movement influence responses to habitat fragmentation." *Diversity and Distributions* 28, no. 10 (2022): 2215-2228. https://doi.org/10.1111/ddi.13623

[5] De Frenne, Pieter, Jonathan Lenoir, Miska Luoto, Brett R. Scheffers, Florian Zellweger, Juha Aalto, Michael B. Ashcroft et al. "Forest microclimates and climate change: Importance, drivers and future research agenda." *Global change biology* 27, no. 11 (2021): 2279-2297. https://doi.org/10.1111/gcb.15569

[6] Ellis-Soto, Diego, Andrea Flack, Ariana Strandburg-Peshkin, Timm A. Wild, Hannah J. Williams, and M. Teague O'Mara. "From biologging to conservation: Tracking individual performance in changing environments." *Proceedings of the National Academy of Sciences* 122, no. 31 (2025): e2410947122. https://doi.org/10.1073/pnas.2410947122

[7] Fontúrbel, Francisco E., José I. Orellana, Gloria B. Rodríguez-Gómez, Catalina A. Tabilo, and Gabriel J. Castaño-Villa. "Habitat disturbance can alter forest understory bird activity patterns: A regional-scale assessment with camera-traps." *Forest Ecology and Management* 479 (2021): 118618. https://doi.org/10.1016/j.foreco.2020.118618

[8] Jucker, Tommaso, Tobias D. Jackson, Florian Zellweger, Tom Swinfield, Nichar Gregory, Joseph Williamson, Eleanor M. Slade et al. "A research agenda for microclimate ecology in human-modified tropical forests." *Frontiers in Forests and Global Change* 2 (2020): 92. https://doi.org/10.3389/ffgc.2019.00092

[9] Kerr, Jeremy T., Susan CC Gordon, I-Ching Chen, Gabrielle Ednie, Wendy Foden, Tim Newbold, Ashley R. Reynolds, Andrew J. Suggitt, John S. Terblanche, and Matthew J. Watson. "Effects of microclimate variation on insect persistence under global change." *Nature Reviews Biodiversity* 1, no. 8 (2025): 532-542.

[10] Kung'u, Gladys Nyakeru, Christina Fischer, Janne Heiskanen, Laurence Cousseau, Mwangi Githiru, Jan Christian Habel, Kim G. Mortega et al. "Habitat

disturbance alters movement behaviour in a social Afrotropical forest bird." *Biological Conservation* 302 (2025): 110996. https://doi.org/10.1016/j.biocon.2025.110996

[11] Mendes, Clarice B., and Jayme A. Prevedello. "Does habitat fragmentation affect landscape-level temperatures? A global analysis." *Landscape Ecology* 35, no. 8 (2020): 1743-1756. https://doi.org/10.1007/s10980-020-01041-5

[12] Menge, Joscha H., Paul Magdon, Stephan Wöllauer, and Martin Ehbrecht. "Impacts of forest management on stand and landscape-level microclimate heterogeneity of European beech forests." *Landscape Ecology* 38, no. 4 (2023): 903-917.

[13] Meza-Elizalde, María C., and Dolors Armenteras-Pascual. "Edge influence on the microclimate and vegetation of fragments of a north Amazonian forest." *Forest Ecology and Management* 498 (2021): 119546. https://doi.org/10.1016/j.foreco.2021.119546

[14] Michaud, Albert, Kevin S. White, Sandra Hamel, Julien H. Richard, and Steeve D. Côté. "Of goats and heat, the differential impact of summer temperature on habitat selection and activity patterns in mountain goats of different ecotypes." *Oecologia* 206, no. 3 (2024): 359-379.

[15] Muposhi, Victor K., Mkululi Ndlovu, Kudzai S. Mpakairi, Keoikantse Sianga, Admire Chanyandura, Chiedza C. Zembe, and Gregory Chiyangwa. "Herbivore Space-Use and Habitat Selection in Human-Mediated Ecosystems: Implications on Restoration Initiatives." In *Environmental Change and Biodiversity Conservation in sub-Saharan Africa: Volume 1*, pp. 73-102. Cham: Springer Nature Switzerland, 2024.

[16] Ram, Mohan, Aradhana Sahu, Nityanand Srivastava, Rohit Chaudhary, Lahar Jhala, and Yashpal Zala. "Long-Ranging Movements of Asiatic Lions: Implications for Conservation and Management in Gujarat, India." *Ecology and Evolution* 15, no. 7 (2025): e71811. https://doi.org/10.1002/ece3.71811

[17] Stevenson, Suzanne, Laura Finnegan, Chris Johnson, and Tracy McKay. "Differential responses of woodland caribou to fire and forestry across boreal and montane ecosystems—a literature review." *Forestry: An International Journal of Forest Research* 98, no. 4 (2025): 478-493. https://doi.org/10.1093/forestry/cpae053

[18] Süle, Gabriella, János Balogh, Szilvia Fóti, Bernadett Gecse, and László Körmöczi. "Fine-scale microclimate pattern in forest-steppe habitat." *Forests* 11, no. 10 (2020): 1078. https://doi.org/10.3390/f11101078

[19] Tigreros, Natasha, Giorgi Kozhoridze, Goggy Davidowitz, and Yaron Ziv. "Influence of the direct and indirect effects of habitat fragmentation, via microclimate change, on animal locomotion." *Landscape Ecology* 38, no. 3 (2023): 847-859.

[20] Tudor, Emily P., Adam T. Cross, and Sean Tomlinson. "Forest structure and microclimate predict nesting activity and reproductive success of cavity-nesting Hymenoptera." *Forest Ecology and Management* 604 (2026): 123495. https://doi.org/10.1016/j.foreco.2025.123495