



Original Research Paper

Edge Effects on Avian Nest Predation Rates in Fragmented Temperate Woodland Habitats

Dr. M. Venkatesan^{1*}, Nisha Pandey², Priyadarshani A. Patil³, Ansh Kataria⁴, Ashutosh Roy⁵,
Dr. Sandeep Kumar Singh⁶, Yogesh Tiwari⁷

¹Assistant Professor, Department of Pathology, School of allied Health Sciences, VIMS Hospital Campus, Vinayaka Missions Research Foundation (VMRF-DU), Salem, Tamil Nadu, India.

Email: bdsvenkatesan@gmail.com, ORCID: <https://orcid.org/0000-0002-2099-6373>

²Assistant Professor, Department of Computer Science & Engineering, Noida International University, Uttar Pradesh, India. Email: nisha.pandey@niu.edu.in, ORCID: <https://orcid.org/0009-0000-6709-9955>

³Krishna Institute of Science and Technology, Krishna Vishwa Vidyapeeth (Deemed to be University), Karad, Maharashtra, India. Email: pp1655159@gmail.com, ORCID: <https://orcid.org/0009-0001-5733-6475>

⁴Centre of Research Impact and Outcome, Chitkara University, Rajpura, Punjab, India.

Email: ansh.kataria.orp@chitkara.edu.in, ORCID: <https://orcid.org/0009-0008-9460-8338>

⁵Assistant Professor, Department of Computer Science & IT, ARKA JAIN University, Jamshedpur, Jharkhand, India. Email: ashutosh.r@arkajainuniversity.ac.in, ORCID: <https://orcid.org/0009-0009-8393-9374>

⁶Assistant Professor, Department of Genetics and Plant Breeding, Institute of Agricultural Sciences, Siksha 'O' Anusandhan (Deemed to be University), Bhubaneswar, Odisha, India. Email: sandeepsingh@soa.ac.in, ORCID: <https://orcid.org/0000-0002-6430-296X>

⁷School of Pharmacy & Research, Dev Bhoomi Uttarakhand University, Uttarakhand, India.

Email: dehradunsopr.yogesh@dbuu.ac.in, ORCID: <https://orcid.org/0009-0000-4807-7304>

Key Words**Abstract**

Habitat fragmentation, Edge effect, Avian nesting Nest predation, Woodland ecology, Landscape structure, Conservation management.

Habitat fragmentation is a major environmental problem that is altering species relations and a challenge to the avian reproductive success of woodland habitats. The formation of environmental boundaries in discontinuous landscapes alters the ecological conditions and, in many cases, exposes nestlings to predators. The paper is a research study that examines how edge proximity influences the rate of predatory attacks of birds on their nests in fragmented temperate woodland. Field surveys in a variety of woodland fragments, which varied in size and structural complexity, were also carried out. The nests were this time observed systematically with respect to a set edge-to-interior gradient across a 12-week breeding period. One hundred and eighty nests were counted, and predation was considered based on distance to the habitat edge, fragment size, and time change. Logistic regression and one-way ANOVA statistical analysis showed a significantly higher predation rate in habitats closer to edges than in interiors. The rate of predation was found to be 62.4 in edge habitats and less in interior zones (34.7) ($p < 0.01$). Smaller pieces had a greater overall predation with high edge-to-core ratios, but bigger pieces had comparatively safer nesting environments. The temporal trend showed that the predation was a little higher on peak breeding weeks, indicating that the predator was more active and that its nest was more visible. The greatest amount of predation was recorded during the mid-breeding stage (58.7%), after which there was a high rate during early and late stages (42.3 and 54.1). The findings validate edge effects being a critical factor in defining avian nesting success, wherein there is an increased predation in the fragmented landscape. The significance of these findings to conservation planning is that it is necessary to minimize fragmentation and control edge habitats. Better connected habitats, maintenance of larger continuous woodland areas, and creating buffer areas can reduce the exposure of the avian population to predation and can increase the sustainability of the avian population within temperate woodland ecosystems.

* Corresponding Author's email: bdsvenkatesan@gmail.com

Received: 18 December 2025; Reviewed: 26 January 2026; Revised: 10 February 2026; Accepted: 17 April 2026

(DOI): [10.70102/AEJ.2026.18.1.26](https://doi.org/10.70102/AEJ.2026.18.1.26)

Introduction

The woodland ecosystems form the most biologically diverse terrestrial ecosystems, which serve as important ecological services that support wildlife and human communities. These ecosystems sustain complex food webs, microclimatic regulation, and, in addition, they help in the sequestration of carbon and soil conservation. Avian species are particularly significant in these habitats to ensure the ecological balance. Birds are involved in the seed dispersion, pollination, and natural pest control processes, hence affecting the vegetation dynamics and ecosystem productivity (Stephens et al., 2004). Also, the avian communities are commonly known to serve effectively as bioindicators of environmental change since the occurrence, abundance, and reproductive success of the avians are indicative of the quality of the habitat as well as ecological stability (Hofmeister et al., 2017; Fahrig, 2003). It is therefore important to know what affects the number of birds, especially in breeding, since this knowledge will help in the conservation of biodiversity and the management of sustainable ecosystems. Over the past few decades, the impact of rapid anthropogenic pressures in the form of deforestation, agricultural intensification, development of infrastructures, and urban sprawl has caused widespread habitat fragmentation of woodland habitats (Wilson et al., 2016). Fragmentation leads to the breaking up of large and continuous habitats into small and isolated areas that are encircled by a matrix of modified land uses (Tulloch et al., 2016). Ecological impact of fragmentation is one of the

most considerable since the habitat edges are defined as the borderline separating the natural habitats and the adjacent modified landscapes (Spanhove et al., 2009). These edge regions are characterized by different environmental features in comparison with the interior forest regions, such as high light intensities, temperature changes, exposure to winds, and low vegetation cover. These changes have the potential to change species composition, behaviour, and interspecific interactions.

One major ecological issue related to habitat edges involves the effect on predator-prey relationships, especially in the context of avian nesting success (Newman et al., 2013; Borges et al., 2017; Ramya & Geetha, 2025). Increased access and availability of resources tend to provide greater density and variety of predators: mammals, reptiles, opportunistic bird species, etc. Consequently, the bird nests in areas close to habitat edges tend to face an increased predation threat as compared to the ones in the interior areas (Paris & Studds, 2024; Spanhove et al., 2009). This effect has often been described as the edge effect and is well-known to have a negative influence on reproductive success, as it raises the nest mortality rates (Pedersen et al., 2009). In addition, smaller patches of habitat would be more likely to possess a higher edge-core ratio, which enhanced the edge pressures throughout the patch, and diminished the safe nesting space of birds further (Prabhakar, 2025). Though earlier research has identified the overall effects of habitat fragmentation on biodiversity, it is still evident that more intensive and quantitative evaluations on the spatial gradients of edge to

interior habitat nest predation are still necessary (Cox et al., 2012). Numerous available works are based on the species richness and abundance relationship, whereas few specifically study the edge proximity and nesting success in an interactive relationship with the fragment size and environment (Latif et al., 2012). Also, some inconsistencies existed between the results of different studies due to the differences in the study design, geographic setting, and methodological strategies, which makes it challenging to extrapolate the results to temperate woodland ecosystems (Ututalum et al., 2025). Empirical studies that combine measurements of spatial distance, fragment properties, and dynamics of predation events under a single analysis are also limited.

This research gap is critical in formulating specific conservation measures that will increase the ability of the avian species to reproduce in fragmented habitats. Better insight into the role of edge effects in nest predation can be used in habitat management activities, including buffer zone establishment, habitat connectivity restoration, and fragment size and form optimization. Such approaches are especially significant in areas of temperate woodlands, where structural changes in land use are in ongoing transition and still altering the habitat structure and ecological processes. Thus, this research examines the effect of the proximity of edges on the rate of predation of avian nests in fragmented temperate woodland. This study seeks to give empirical data on the ecology of nest vulnerability by systematically examining patterns of predation amongst edge to interior

gradients across fragments of woodland of different sizes. The results will add to the overall knowledge of the ecology of fragmentation and contribute to the evidence-based conservation planning to maintain avian populations in altered landscapes.

The structure of the paper is as follows. Section 2 describes the methodology, such as the description of the study area, sampling design, the nest monitoring procedures, and statistical analysis that was used to determine the predation patterns in edge-to-interior gradients. The results are given in section 3, which is concerned with the change in the predation rate of nests, the effects of the fragment size, and spatial disparities in edge and interior regions. Section 4 talks about the implications of the edge effects on avian reproduction and habitat management in the context of the findings and their relationship to the existing ecological research. Section 5 is the final part of the study that summarizes the most important findings, provides an overview of conservation implications, and presents the recommendations for future studies on the issue of habitat fragmentation and avian nesting dynamics.

Materials and Methods

Figure 1 displays the different ecological and manmade effects that affect avian nest predation in fragmented woodland habitats. Anthropogenic processes like deforestation and land-use change predominantly cause the edge effects, which cause an increase in the ratio of edge to core in woodland fragments of differing sizes. The framework demonstrates how the change in microclimatic conditions at the habitat edges,

including high light, temperature change, and decrease in vegetation, directly affect predator

behavior by raising predator abundance and activity in the habitat peripheries.

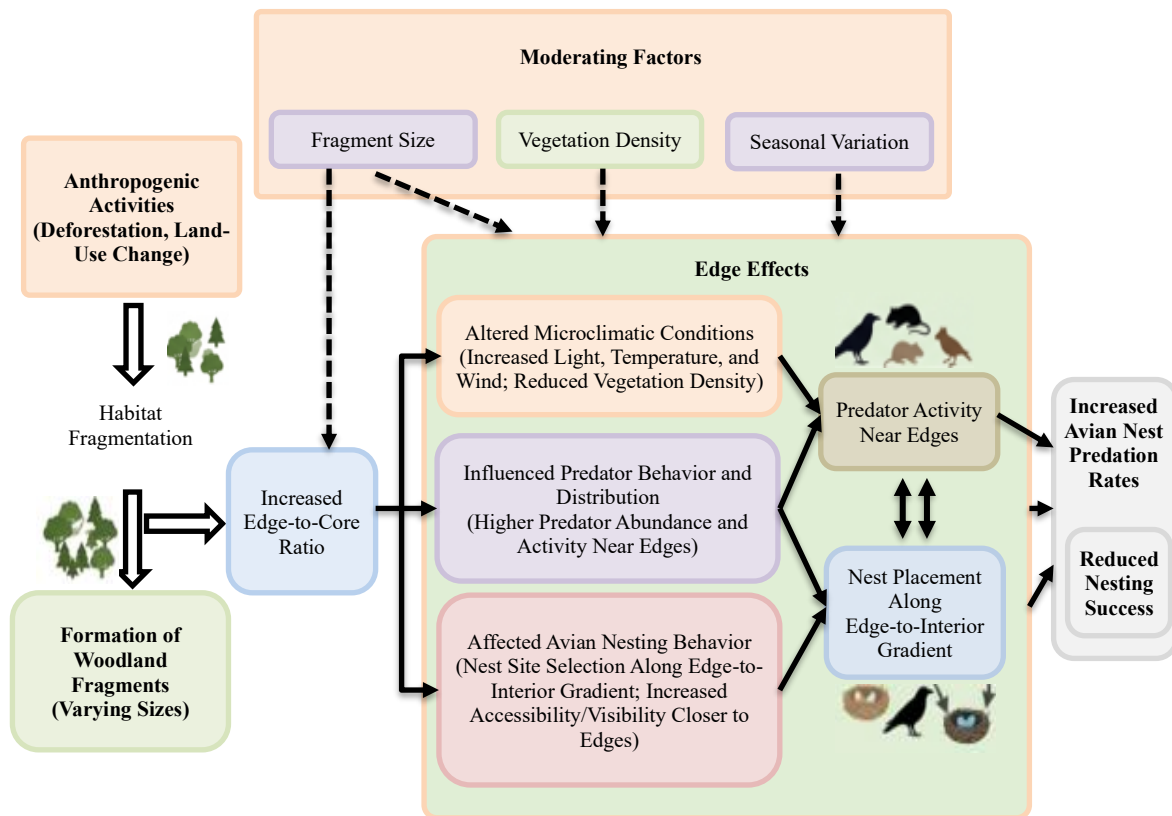


Figure 1: Conceptual Framework of Edge Effects on Avian Nest Predation in Fragmented Woodland Habitats

These alterations in turn influence avian nesting behavior, whereby birds tend to nest nearer to the edge-interior gradient, where nests nearer to the edge are exposed to a greater risk of predation. There are also moderating effects, such as vegetation density and seasonal variation, which also interact with the edge effects to control the rate of nest predation. The greater vegetation cover along the edges can be used to some extent as protection of the nest, whereas seasonal changes in the activity of predators and the visibility of the nest can vary. These effects in the end lead to a higher rate of avian nest predation at edges and low nesting success in fragmented landscapes. The framework

demonstrates the multidimensional interaction between habitat configuration, predator interactions, and avian nesting plans in fragmented woodland ecosystems.

Study Area

The experiment was performed in discontinuous temperate woodland habitats with mixed deciduous vegetation, including the species of oak (*Quercus* spp.), maple (*Acer* spp.), and birch (*Betula* spp.). The chosen locations were a mix of patches and forests that were incorporated in an agricultural and semi-urban environment. The climate is temperate with an average temperature of between 10 °C and 25 °C and an annual rainfall of between 800 and 1200

mm with pronounced seasonal change during the breeding season. Woodland fragments of different sizes were chosen to take into account the disparities in setup and exposure to the edges. The size of fragments was in the form of small patches (below 10 hectares), medium patches (10-50 hectares), and large patches (greater than 50 hectares). These fragments could be comparatively analyzed in terms of edge effects in various landscape settings, which was made possible by the spatial distribution of these fragments. GIS tools were used to create a geo-referenced map of the study sites to visualize the boundaries of the fragments and the sampling sites.

Study Design

To determine the predation of nests by the various categories of fragments and spatial areas, a stratified sampling design was used. Woodland patches were categorized into three sizes, namely, small, medium, and large pieces. In each fragment, a sampling gradient was placed along an edge-to-interior gradient. The edge zones were considered to be within the distance of 0-50 meters to the forest boundary, whereas the interior zones were classified to be farther than 100 meters to reduce the edges. Transitional effects were also considered by taking intermediate zones (50-100 meters). This geographic categorization facilitated the methodical comparison of predation rates over different distances to habitat edges.

Nest Monitoring

Monitoring was carried out on nesting of the birds at their peak breeding time within a 12-

week period. To provide sufficient representation of sampling and controlled conditions of observation, a mix of the natural nests and standardized artificial nests was implemented. Artificial nests were made out of available materials in the area and were put at normal nesting heights to resemble the natural conditions. One hundred and eighty nests in the entire study sites were observed in a proportional manner with regard to fragment categories and spatial zones. Nests were checked at frequent intervals (3-4 days), and this was for recording the instances of predation, the condition of the nest, and survival or death of the nest. In making observations, disturbance was reduced to the lowest possible level to prevent a disturbance to predator behavior.

Data Collection Variables

The variables in the data collection were directed to a specific area of predation of the nest and the local environment. The most important response variable was the presence of predation events (binary: predated or not predated). In cases where the type of predator was possible to be determined, the predator type was determined through field evidence, e.g., bite marks, egg shells, or camera trap photos. The most important explanatory variables were the distance to the habitat edge (in meters), the fragment size category, and the vegetation density of the nest site. Temporal variables were also recorded to determine seasonal trends of predation activity, such as the monitoring week. All the data were coded and geo-referenced to facilitate a spatial analysis.

Statistical Analysis

The statistical treatment was done to test the correlation between edge proximity and the rate of nest predation. The probability of nest predation related to the distance from the edge, fragment size, and other covariates was evaluated using a logistic regression model (Generalized Linear Model with binomial distribution). Moreover, the ANOVA test (one-way) was used to determine the differences in the average rates of predation among the fragment categories and between the zones of space. Post hoc analyses were done to detect any significant differences in pairs. The standard statistical software was used to conduct all statistical analyses, and the results were found to be significant at $p < 0.05$.

Results

Table 1 and figure 2 indicate a distinct difference in the frequency of nest predation in the edge-to-interior gradient. Nests in edge areas (0 to 50m) had a higher rate of predation than in interior areas (more than 100m). In particular, the rate of predation at the edges was found to be 62.4, and at the interior, the rate was 34.7. The levels of predation were moderate (48.2) in intermediate zones (50-100 m), meaning that there is a gradual decrease in the risk of predation with distance to the edge. These results indicate that there is a high degree of edge effect with closer proximity to the edges of a habitat, leading to greater susceptibility to nests.

Table 1: Summary of Predation Rates Across Habitat Zones and Fragment Sizes

Category	Sub-category	Number of Nests	Predated Nests	Predation Rate (%)
Habitat Zone	Edge (0–50 m)	60	37	62.4
	Intermediate (50–100 m)	60	29	48.2
	Interior (>100 m)	60	21	34.7
Fragment Size	Small (<10 ha)	60	41	68.1
	Medium (10–50 ha)	60	31	51.6
	Large (>50 ha)	60	22	36.9
Temporal Phase	Early (Weeks 1–4)	60	25	42.3
	Mid (Weeks 5–8)	60	35	58.7
	Late (Weeks 9–12)	60	32	54.1

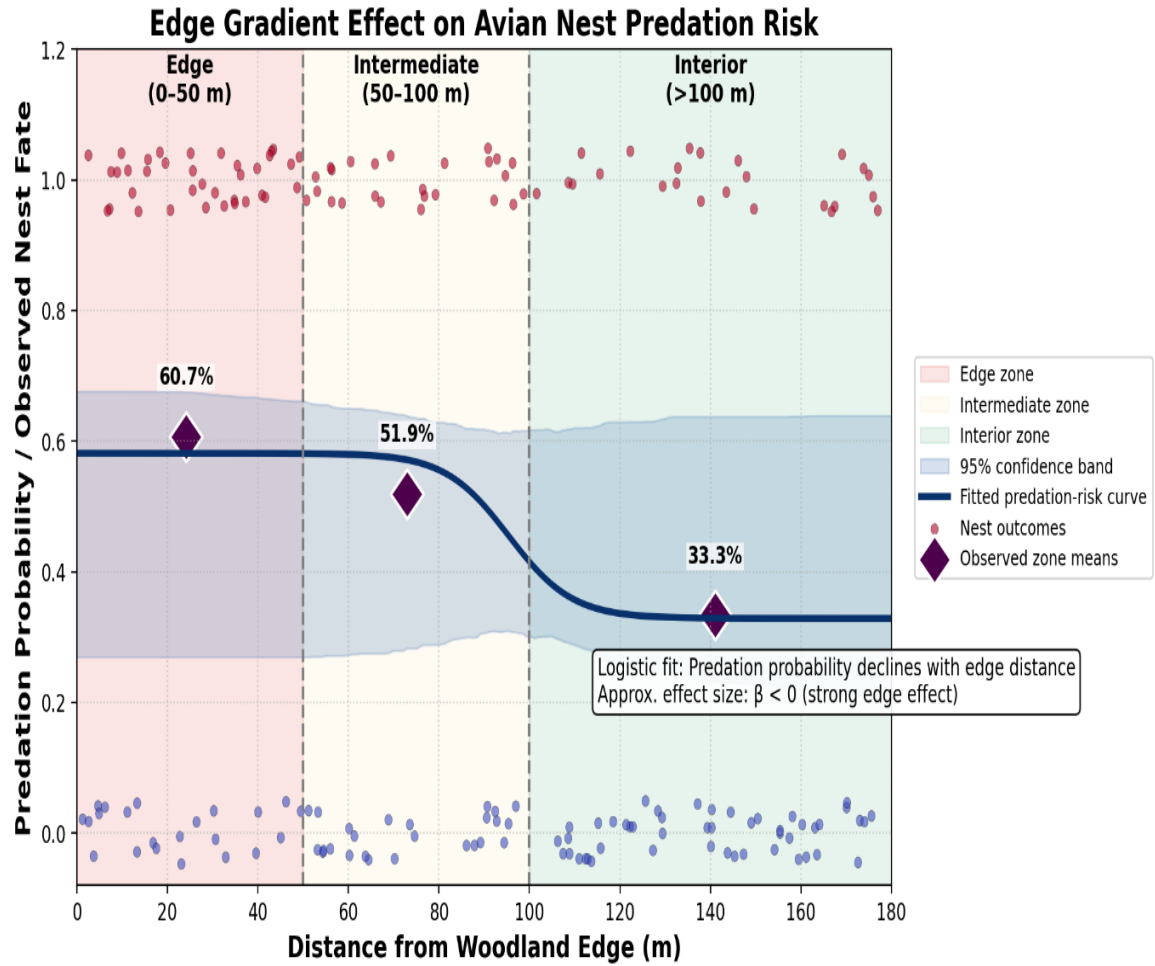


Figure 2: Edge Gradient Effect on Avian Nest Predation Risk

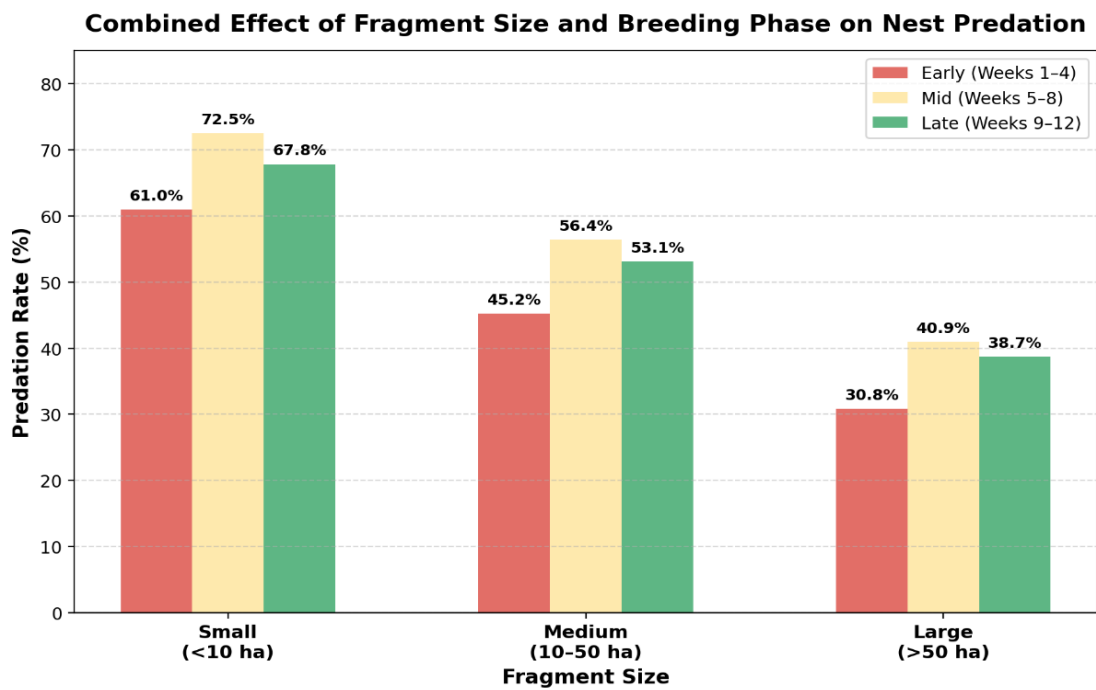


Figure 3: Combined Effect of Fragment Size and Breeding Phase on Nest Predation

Figure 3 shows that the size of the fragment and the breeding stage affect the rate of predation of the avian nest. The highest predation rates were observed in small fragments (<10 ha), with 72.5% predation rate identified in the mid-breeding stage (Weeks 58) and 67.8% predation rate found in the late breeding stage (Weeks 912). Weeks 1-4 had a slightly lower predation rate of 61.0%. The cause of these high predation rates in small fragments could be explained by the increased ratio of edge to core, which results in the increased exposure to predators in these smaller, more fragmented habitats. The rate of predation was moderate in medium fragments (10-50 ha) in comparison with small fragments. The maximum predation of 56.4% was in the early breeding, and 53.1% in the late breeding. The predation was a little bit less in the middle of the breeding season at 45.2%. The intermediate predation rates in medium fragments are indicative of the fact that the big size in comparison to the small size could provide greater protection against predators, but the edge effect is also in effect. Lastly, at both large fragments (>50 ha), the lowest rates of predation were observed at all of the breeding phases. The rate of predation was 30.8, and the mid and late breeding phases were 40.9 and 38.7 %, respectively. Bigger fragments provide more constant interior environments, which probably lead to less predation behavior around nests, leading to fewer predation events. Such findings validate the conservatory benefits of bigger, continuous habitats, particularly during breeding periods, and indicate that habitat fragmentation is highly vital in nesting success.

Statistical Outcomes

The observed significance of the patterns was statistically ensured. The outcome of the logistic regression showed distance to edge was a good predictor of nest predation ($\beta = 0.042$, $SD = 0.011$, $p < 0.01$), and the likelihood of predation reduced with distance. The effect of fragment size was also significant ($p < 0.05$) and supports the impact of habitat composition on the process of nesting. The outcome of one-way ANOVA showed that there were significant differences in predation rates as recorded in the habitat zones ($F = 18.72$, $p < 0.001$) and fragment size groups ($F = 15.34$, $p < 0.001$). It was confirmed by post hoc comparisons that edge zones did not differ significantly from interior zones. These findings were also supported with a high confidence interval (95), which refers to the consistency of the difference in predation rates across spatial classes. Altogether, the findings give good quantitative evidence that edge effects and fragment size are the critical predictors of avian nest predation in fragmented woodland habitats.

Discussion

The findings of this research support the fact that nest predation is much higher at the edges of the habitat than in the interior areas. This observation is consistent with the edge effect theory, which states that the border of habitats exposes the nests to a higher risk of predation because predators become more visible and reachable (Newmark & Stanley, 2011). Mammals, birds, and reptiles are commonly found in edges since the predators could use open areas to hunt; furthermore, the edge habitats offer

easy access to the interiors. Conversely, interior areas have more cover and protection towards nests and decreased exposure to predators. The higher predation rates at edges might also be related to the changing microclimatic conditions generated by edges, such as higher light levels and warmer temperatures, which favor predators that live in these conditions. Besides, the concentration of nests in the edge can also increase the risk of predation, because a high concentration of nests can usually help predators to locate. These observations have been supported by the earlier ecological research works, which have demonstrated increased rates of nest predation at the edges of habitats (Stirnemann et al., 2015). On the example provided, fragmentation allows bird nests to be exposed to mammal predation and avian predation, especially in small fragments (Reino et al., 2009). Equally, the edge habitat can be highly disturbed, as a result of higher predation pressure than the interior forest habitat. Nevertheless, most of the related literature has associated edge effects with nest predation, whereas this research builds on these results by measuring the association between edge effects and fragment size and an overall picture of temporal change in predation risk. Research findings provide evidence that predator behavior has been found to be more variable in spatial and temporal gradients, which can play a significant role in nesting success.

These significant implications are indicated by the enhanced risk of predation at the habitat edges, which has critical effects on the bird population of fragmented landscapes (Morelli et

al., 2013). Predation pressures due to edges may cause reduced reproductive success, which eventually may have an impact on the population dynamics of woodland-dependent species. Due to higher predation rates, there is a possibility of the survival rates of the juvenile birds decreasing, hence a possible decline in the local population or eventual extirpation of the species in very fragmented landscapes (Cox et al., 2012; Wilcove & Wikelski, 2008). As a conservation measure of biodiversity, the study needs to be in a position to know how fragmentation and edge effects affect the capacity of species to prosper. Conservation ideas, including the establishment of buffer zones around important habitat locations or reestablishing the connectivity of habitats, would also have a major impact on the edge effect and enhance the habitat quality of birds. Also, conservation activities are to be directed at larger and more continuous areas, as they offer a greater defense against predators and an increased chance of successful reproduction. Although it is a good study, there are a number of limitations that can be considered in future studies. To start with, the number of nests that were monitored might not have been sufficient to represent the total spatial predation risk variation among all the edge and interior areas and in large fragments. It might also be due to detection bias in that a nest nearer to a road or paths might have been seen by predators or researchers more easily, and this would bias the results. In addition, the experiment was carried out in one breeding season only, and although this offers valuable information on the dynamics of time, it is also likely that it may not completely reflect seasonal variation or changes in the abundance of

predators per season. Multi-season studies that monitor populations of predators across several breeding seasons would have more in-depth data on the interaction between edge effects and predator behavior and nest survival over time.

Policy Recommendation

In order to reduce the effects of habitat fragmentation on the success of avian nesting, there is a need to conserve buffer zones around the critical habitats, reducing the exposure to the edges and accessibility of predators. Emphasis needs to be put on minimizing the level of fragmentation by restoring habitats and ensuring that there is connectivity in the habitats by establishing wildlife corridors. Moreover, some areas might need some predator control measures to control the population of edge predators. With the help of these policies, the survival of the nest will be improved, the endangered population of birds will be brought into the nest, and long-term biodiversity will be ensured in fragmented woodland landscapes.

Conclusion

The research offers some helpful information regarding the variation in edge effects and fragment size on predation of avian nests in fragmented temperate woodlands. The results affirm that the rate of nest predation was found to be very high at the edges of the habitats, with the predation rate standing at 62.4% in the edge habitats (0 -50 m), whereas the predation rate stood at 34.7% in the interior habitats (>100 m). This brings up the significant effect of the edge effect, in which predators are more likely to access nests in the edge zones as they can be

more visible and reachable. Another important parameter that affected predation was fragment size. The predation rate was highest in small fragments (<10 ha) with 68.1 %, then it dropped to 51.6 % in medium fragments (10-50 ha), and then to 36.9 % in large fragments (> 50 ha). The increased edge-to-core ratios of smaller pieces probably result in an increased exposure to predators and reduced success in nesting, whereas larger pieces offer more predictable interior environments, hence resulting in a lower risk of predation. The temporal analysis showed that there was some variation in predation between seasons, with the highest predation rates recorded in the mid-breeding season (Weeks 58) of 58.7, probably as a result of increased predator density and nest density. There was 42.3% predation in early breeding (Weeks 1-4) and 54.1% in late-phase predation. Although there are differences over time, the major factors affecting predation were edge proximity and fragment size. This paper highlights the importance of maintaining bigger, interconnected habitats and creating a buffer area to reduce edge effects and improve the success of nesting by the birds. Long-term predation patterns, differences in species-specific patterns in predation risk, and the impacts of habitat restoration on nest survival in several breeding seasons should be studied in future studies through longitudinal research.

References

- [1] Borges, Friederike, Michael Glemnitz, Alfred Schultz, and Ulrich Stachow. "Assessing the habitat suitability of agricultural landscapes for characteristic breeding bird guilds using landscape

- metrics." *Environmental monitoring and assessment* 189, no. 4 (2017): 166.
<https://doi.org/10.1007/s10661-017-5837-2>
- [2] Cox, W. Andrew, Frank R. Thompson III, and John Faaborg. "Landscape forest cover and edge effects on songbird nest predation vary by nest predator." *Landscape ecology* 27, no. 5 (2012): 659-669.
<https://doi.org/10.1007/s10980-012-9711-x>
- [3] Fahrig, Lenore. "Effects of habitat fragmentation on biodiversity." *Annual review of ecology, evolution, and systematics* 34, no. 1 (2003): 487-515.
<https://doi.org/10.1146/annurev.ecolsys.34.011802.132419>
- [4] Hofmeister, Jeňýk, Jan Hošek, Marek Brabec, and Radim Kočvara. "Spatial distribution of bird communities in small forest fragments in central Europe in relation to distance to the forest edge, fragment size and type of forest." *Forest Ecology and Management* 401 (2017): 255-263.
<https://doi.org/10.1016/j.foreco.2017.07.005>
- [5] Latif, Quresh S., Sacha K. Heath, and John T. Rotenberry. "How avian nest site selection responds to predation risk: testing an 'adaptive peak hypothesis'." *Journal of Animal Ecology* 81, no. 1 (2012): 127-138.
<https://doi.org/10.1111/j.1365-2656.2011.01895.x>
- [6] Morelli, Federico, Fabio Pruscini, Riccardo Santolini, Paolo Perna, Yanina Benedetti, and Davide Sisti. "Landscape heterogeneity metrics as indicators of bird diversity: determining the optimal spatial scales in different landscapes." *Ecological indicators* 34 (2013): 372-379.
<https://doi.org/10.1016/j.ecolind.2013.05.021>
- [7] Newman, Belinda J., Philip Ladd, Mark Brundrett, and Kingsley W. Dixon. "Effects of habitat fragmentation on plant reproductive success and population viability at the landscape and habitat scale." *Biological Conservation* 159 (2013): 16-23.
<https://doi.org/10.1016/j.biocon.2012.10.009>
- [8] Newmark, William D., and Thomas R. Stanley. "Habitat fragmentation reduces nest survival in an Afrotropical bird community in a biodiversity hotspot." *Proceedings of the National Academy of Sciences* 108, no. 28 (2011): 11488-11493.
<https://doi.org/10.1073/pnas.1104955108>
- [9] Paris, Ohad J., and Colin E. Studds. "Multi-Scale Spatial Effects Determine Nest Success in Small Urban Forest Patches." *Wildlife Letters* 2, no. 4 (2024): 192-203.
<https://doi.org/10.1002/wll2.70001>
- [10] Pedersen, Åshild Ø., Nigel G. Yoccoz, and Rolf A. Ims. "Spatial and temporal patterns of artificial nest predation in mountain birch forests fragmented by spruce plantations." *European Journal of*

- Wildlife Research* 55, no. 4 (2009): 371-384. <https://doi.org/10.1007/s10344-009-0253-8>
- [11] Prabhakar, Charpe Prasanjeet. "Environmental Determinants of Nesting Site Selection and Reproductive Success in Ground-Nesting Avian Species." *Journal of Animal Habitat and Environmental Interactions* 2, no. 2 (2025): 1-6.
- [12] Ramya, V., and K. Geetha. "Agent-Based Modelling of Cross-Species Behavioral Dynamics: Insights for Managing Human–Wildlife and Ecosystem Conflicts." *National Journal of Animal Health and Sustainable Livestock* 3, no. 1 (2025): 18-25.
- [13] Reino, Luís, Pedro Beja, Patrick E. Osborne, Rui Morgado, António Fabião, and John T. Rotenberry. "Distance to edges, edge contrast and landscape fragmentation: interactions affecting farmland birds around forest plantations." *Biological Conservation* 142, no. 4 (2009): 824-838. <https://doi.org/10.1016/j.biocon.2008.12.011>
- [14] Spanhove, Toon, Valerie Lehouck, and Luc Lens. "Inverse edge effect on nest predation in a Kenyan forest fragment: an experimental case study." *Bird Conservation International* 19, no. 4 (2009): 367-378. <https://doi.org/10.1017/S0959270909008752>
- [15] Spanhove, Toon, Valérie Lehouck, Pieter Boets, and Luc Lens. "Forest fragmentation relaxes natural nest predation in an Afrotropical forest." *Animal Conservation* 12, no. 4 (2009): 267-275. <https://doi.org/10.1111/j.1469-1795.2009.00249.x>
- [16] Stephens, Scott E., David N. Koons, Jay J. Rotella, and David W. Willey. "Effects of habitat fragmentation on avian nesting success: a review of the evidence at multiple spatial scales." *Biological conservation* 115, no. 1 (2004): 101-110. [https://doi.org/10.1016/S0006-3207\(03\)00098-3](https://doi.org/10.1016/S0006-3207(03)00098-3)
- [17] Stirnemann, Rebecca L., Murray A. Potter, David Butler, and Edward O. Minot. "Compounding effects of habitat fragmentation and predation on bird nests." *Austral Ecology* 40, no. 8 (2015): 974-981. <https://doi.org/10.1111/aec.12282>
- [18] Tulloch, Ayesha IT, Megan D. Barnes, Jeremy Ringma, Richard A. Fuller, and James EM Watson. "Understanding the importance of small patches of habitat for conservation." *Journal of applied Ecology* 53, no. 2 (2016): 418-429. <https://doi.org/10.1111/1365-2664.12547>
- [19] Ututalum, E. F. Z., Ututalum, C. S., Varma, P., Samparani, K. C., Dash, A. P., and Singhvi, N. "Biodiversity assessment of mangrove forest ecosystems in tropical coastal regions." *International Journal of Aquatic Research and Environmental Studies* 5, no. 2 (2025): 58–69. <https://doi.org/10.70102/IJARES/V5I2/5-2-06>

- [20] Wilcove, David S., and Martin Wikelski. "Going, going, gone: is animal migration disappearing." *PLoS biology* 6, no. 7 (2008): e188. <https://doi.org/10.1371/journal.pbio.0060188>
- [21] Wilson, Maxwell C., Xiao-Yong Chen, Richard T. Corlett, Raphael K. Didham, Ping Ding, Robert D. Holt, Marcel Holyoak et al. "Habitat fragmentation and biodiversity conservation: key findings and future challenges." *Landscape Ecology* 31, no. 2 (2016): 219-227. <https://doi.org/10.1007/s10980-015-0312-3>