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Campus Landscapes and Features: Factors Influencing Squirrels' Habitat Selection

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Abstract. Squirrels, especially the grey squirrels (Sciurus), are ubiquitous within the campus across North America. This widespread squirrel population suggests that campuses are able to provide highly ideal and suitable habitats for them rather than environment like forests. This literature review integrates multiple findings from ecological studies to identify the key features of campuses that attract squirrels. Several major factors emerge at the same time. First, the natural landscape, especially the density of green spaces, such as tree canopy, provides both shelter for survival. Moreover, levels of anthropogenic activities can also lead to stability of food resource and decreasing in predation death. Third, stable food source, including both natural fruits and human discarded food, play an important role in maintaining their energy level. All in all, the interaction of these factors, dense canopy covers, reliable food resources, and human activities, transforms the campuses into a stable and ideal habitat that supports and sustains a high squirrel population.

Keywords: habitat Selection, squirrels, campus landscapes.

1. Introduction

Urban development has dramatically changed natural landscapes, leading to changes of species habitat selection. Squirrels are one of the mammal species that are commonly seen in parks and gardens, where the overall environment is warm and trees are abundant, and they might have also been affected due to the development and environmental change. Additionally, squirrels are specifically notable on college campuses across America and Canada as well. Reference [1]'s survey discovered that 95% of surveyed campuses had one single squirrel species, and 40% hosting three or more species, which highlights the campuses as significant squirrel habitats. Moreover, study suggests that squirrels prefer places that are near trees and human activities, which makes campuses ideal environment [2]. However, despite the overall campus attraction to squirrels, it is still unclear which specific feature, such as landscape, buildings, tree density, and human activity. This gap highlights that deeper investigations should be invested into the ecological factors that attract squirrels to college campuses. This literature review synthesizes current researches on specific attraction features of college campuses on squirrels, including tree density, food resources, and human activity, that supports squirrels' survival.

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2. Method

To identify the major features on campus that attract squirrels, an organized literature review was conducted using the PRISMA method. Initial searches online were conducted using general phrases such as "squirrels on campus" and "urban squirrel habitat", studies including the basic distribution of squirrels [1] and foraging behavior [3] were found. To further contextualize the features on campuses, the ecological concept "competitive exclusion" was used to understand how interactions between species may influence the habitat selection [4]. However, these findings provided limited information and ideas on why specifically campuses are attractive to squirrels as their habitat. Thus, the search strategy for the subsequent research used more targeted and specific phrases such as "tree density" and "features favor squirrels." This process helped to identify more diverse and detailed articles on habitat selection mechanism for squirrels [5], such as the importance of green space [6], and the urban environment relationship with humans [7]. Through the refinement of the keywords, more diverse and targeted articles highlight the reasons of campuses being ideal habitats for squirrels, including landscape features, human activities, and species behaviors.

3. Result

Methods have been used to identify the specific features that attract squirrels among the literature reviews, but they converge on two primary approaches: landscape correlation and population assessment. Researchers commonly utilize observational field studies to record squirrels across campuses. This method typically includes the recordings of squirrel abundance and a specific area of campus, then analyzing the data for evaluating relationship between these two factors. For example, Reference [5] chose to conduct their study by combining their visual observations with detailed GIS data on tree density and ground cover. The results showed a positive relationship: higher tree density leads to a higher squirrel population. Similar methods have been used in other studies. Reference [1] conducted surveys across different campuses, recording squirrels' presence and distribution patterns. Reference [7] measured human activities to assess how the activities interact with the environmental factors and influence squirrel density.

3.1. Arboreal structure and density

The most significant feature for their habitat selection is the presence of trees, some specific types of trees particularly. Squirrels are extremely reliant on high-energy food such as nuts and seeds, and these resources are usually near trees. Campuses, fortunately, provide an ideal food source for the squirrels due to the existence of highly dense trees, especially oaks. Reference [8] stated that the abundance of preferred genera like oak could be a strong predictor of the squirrel population. In his study, he found that squirrels have a higher density in places where oak presence are higher than in urbanized areas with few trees (1.08 vs 0.15 squirrels per hectare). Moreover, squirrels are more likely to travel between trees to avoid ground predators. Reference [9] found that the arrangement of the trees is indeed more important than the total number of trees in a specific area. Continuous canopy layers allow squirrels to travel through places with minimal exposure to predators and greatly increase their survival rate. More trees indicate that squirrels have more options to choose their shelter and breeding sites, making them safer and better.

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3.2. Food abundance

Campuses often provide stable and predictable ideal food sources for squirrels, especially some high-energy food such as acorns, nuts, and seeds [8]. In addition, human activities increase the local carrying capacity and foraging behavior. Some of the squirrels actually concentrate on human food waste as their major food source [10]. Particularly during winter, over 50-60% of observed food resources are from anthropogenic food waste, including bread and snacks. It is also being shown that double to triple the frequency of squirrels that live in urban environment will feed on human food resources more than those that live in forests. While intense human activity can reduce the foraging frequency of squirrels, predictable human activities are correlated with increasing food resource and higher squirrel density [7]. Thus, campuses, in this case, serve a role where humans and squirrels coexist and even benefit the squirrels to enhance their foraging efficiency.

3.3. Reduction in risks

Campuses, besides a place where provide abundant food, are also an environment where risks are minimized. Obviously, campuses have a low density of predators, such as foxes and hawks. For instance, GUDs are significantly higher when there are possible risks near squirrels such as domestic animals, including dogs and cats [3].. This leads to the predator release effect, which can be defined as the limitation that predators can greatly increase the population abundance of the prey, and the red squirrels in this study consistently have a higher density in urban areas than in rural areas [11]. Moreover, over 131 small mammals in 79 studies showed that roads have a negative impact on them. In this case, squirrel abundance usually decreases when near major roads and large pavements due to the traffic issues [12]. Campuses, on the other hand, do also have roads and pavements, but less traffic issues because of the speed restrictions and the connection between canopy layers.

3.4. Coexistence between two species

The abundant resources in campuses are may facilitate coexistence as well, which might explain that why sometimes three or more species will be present in a single campus at the same time. Studies suggest grey squirrels prefer to live in core forest area, where contains denser trees, and fox squirrels prefer to choose their habitat in more open woodlands [13]. In conclusion, campus is a place that allows multiple species to thrive.

Looking through all the studies, there are several common points being stated regarding the campus's environmental structure. First, reference [1] discussed that squirrels are almost ubiquitous among campuses, which can be said, campuses provide suitable habitats for them and continuously producing generations. Next, the GIS method used by reference [5] shows that tree density and large spaces of green spaces has a positive relationship with squirrel population, indicating that vegetation abundance is important for squirrels. Finally, reference [7] shows that food resource and human activities are also able to influence squirrels' density, usually increasing the population.

4. Conclusion

Overall, this literature review shows that college campuses serve as highly suitable habitats for squirrels to live in because of the highly dense green areas, human activity, and food availability. The perfect arboreal landscape provides ideal resources for them to forage, nest, and avoid predators. Moreover, campuses offer abundant and stable food resources, such as nuts and seeds for them to enhance their forage efficiency. Additionally, the low predator pressure by consistent human

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activity creates a stable environment, for the squirrels to reduce their danger and increase their density. Taking all these factors together, campuses became an ecological hotspot for the squirrels, supporting high populations, and sometimes even multiple species on the same campus.

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