Squirrel Threat Assessment on Institution Campus

Abstract

This study looks at the behavioral responses of fox squirrels to human interactions on the institution campus known for its squirrel-friendly environment. The hypothesis states that campus squirrels, due to frequent human exposure, exhibit reduced fear and tolerate closer human proximity compared to their off-campus counterparts. Observations were conducted on both campus and off-campus squirrels, with variables including the number and identity of surveyors. Using a golf rangefinder, we measured the distance at which squirrels initiated flight. Analysis via a General Linear Model revealed significant effects of location and the number of surveyors on flight initiation distance. The findings from this study highlight wildlife adaptability to urbanized environments and suggest implications for urban wildlife management and biodiversity conservation.

Introduction

Institution, widely recognized for its squirrel-friendly environment, has adopted the fox squirrel as a campus mascot. This unique aspect of campus culture has inspired us to explore the ecological dynamics between humans and squirrels within this academic setting. Specifically, we want to examine how these relationships differ on the college campus compared to areas outside its boundaries, where these interactions are less common. In ecological studies, the concept of prey risk assessment—which explores how animals respond to potential threats—provides a background on how organisms' decisions govern these interactions. Historical research shows that animals engaging more frequently and positively with humans often perceive them as less threatening (Ydenberg and Dill, 1986). Given the campus squirrels' day-to-day presence around students and faculty, we hypothesize that these squirrels exhibit a reduced fear of humans and, therefore, will tolerate closer human proximity than squirrels found in "wilder" environments. This paper aims to experimentally assess whether the squirrels inhabiting Institution's campus are more comfortable with student interactions than those living off-campus. By observing these behavioral patterns, we hope to contribute valuable insight into wildlife adaptations in urban environments.

Methods

To explore the interaction dynamics between humans and squirrels, our study looked at the differences between two primary environments (Area) at Institution: on-campus and off-campus. Additionally, the specific surveyors involved in the approach—either as an individual or a pair—were considered as a variable (Person). Observations were conducted during warm, sunny afternoons, aligning with squirrels' peak ground activities, as mentioned by Wassmer & Refinetti (2016), with the hope that the squirrels were most active and visible.

For the distance measurements, a golf rangefinder was used to measure, in yards, when the squirrel began to flee as surveyors directly approached their location. Two roles were assigned within the survey team: one surveyor measured the distance using the rangefinder while the other monitored the squirrel's position from when it fled. The survey conditions—featuring different combinations of surveyors (Ainsley, Deepit, or Both)—were altered at each location to reduce potential confounding factors. This approach helped the collection of evenly sampled data across varying conditions.

We kept track of the squirrels who had fled to trees and moved locations throughout the day to avoid surveying them multiple times because there could be a confounding element of learned danger that would cause previously surveyed squirrels to flee sooner. We noted that squirrels rarely left their tree after a survey event, so we can be fairly confident that all 18 were novel.

In total, 18 squirrels were surveyed, allowing for three observations under each specific combination of location and surveyor type. The data from these trials were subsequently analyzed using Proc GLM in SAS version 9.4, aiming to pinpoint significant variances in the distances at which squirrels fled in response to human approaches across different settings. This method was somewhat simple, but it still thoroughly examined how squirrel behavior might be influenced by human activity and presence in distinct campus areas.

Results and Analysis

Our analysis used a General Linear Model (GLM) to examine the distance at which squirrels would flee away from humans on and off the Institution campus. The analysis focused on two main effects: the location (on-campus vs. off-campus) and the identity of the person approaching (Ainsley, Both, Deepit), as well as their interaction.

The results from the GLM revealed significant effects for both the location (F-value = 27.24, $p = 0.0002$) and the person (F-value = 37.15, $p < 0.0001$) approaching the squirrels. This indicates that squirrels on campus allowed humans to approach much closer than those off campus. At the same time, further contrast analysis for the Person variable revealed that while the individual (Ainsly, Deepit) did not have significant variation, a single person approaching could get much closer than Both. The interaction between location and person also indicated a slight influence, though not statistically significant (F-value = 3.48, $p = 0.0642$).

On average, on-campus squirrels allowed a closer approach (mean distance = 7.78 yards) than their off-campus counterparts (mean distance = 16.00 yards). Notably, the presence of both surveyors approaching together (Both) resulted in the greatest flee initiation distance (mean = 21.33 yards), suggesting that squirrels perceive a more significant threat from multiple people approaching them.

The model accounted for significant variability in the squirrels' response distances (R-squared = 0.9004). This high R-squared value indicates that the model and variables effectively captured the factors influencing when squirrels choose to flee.

The findings support our hypothesis that squirrels on the Institution campus are more accustomed to human presence, allowing closer human proximity before fleeing. This adaptation is likely due to their frequent exposure to students and faculty moving on campus, contrasted with the more isolated off-campus environments. Additionally, the distinct responses based on the number of approaching individuals suggest that squirrels can discern different threat levels associated with varying numbers of humans.

The attached interaction plot (see Appendix Fig 2) illustrates the combined effects of location and person on the proximity at which squirrels begin to flee. It shows that squirrels on campus (represented by 1 on the x-axis) tend to flee at shorter distances than those off campus. This visual representation aligns with our statistical analysis, emphasizing the significant differences in squirrel behavior triggered by human interactions on and off the Institution campus.

Discussion

Our study reveals that squirrels on Institution campus tolerate closer human presence before fleeing than those living off-campus, suggesting a behavioral adaptation to frequent human interactions. The changes based on the number of people approaching may indicate adaptations to group hunting threats.

Squirrels are a uniquely adaptable species, making them a good model for studies on urban wildlife. While Institution is not considered "urban," the population density reflects that of a city

and, therefore, can be treated as such for ecological studies (Eckhart, 2023). Animal threat assessment has been compared to economics before, as an animal must decide when the perceived danger of a threat outweighs the energy expended by fleeing (Ydenberg and Dill, 1986). Non-adaptations mean squirrels would flee constantly, lowering their evolutionary fitness. The observed behavioral changes in campus squirrels indicate an ability to respond rapidly to a new environment. This may facilitate smoother species integration in an increasingly urbanized world and enhance biodiversity. However, this lack of fear also extends human-wildlife interactions and can lead to adverse outcomes such as attacks from larger urban-adapted animals (bears or coyotes) and disease spread.

This study has limitations that must be considered. The small sample size (18 squirrels, with only three observations per group) limits the generalizability of our findings. Additionally, our method of classifying locations as merely “on” or “off” campus fails to account for the potential variety of human interaction levels in other public spaces like parks, where squirrels still have some level of human familiarity. Furthermore, the smaller-than-expected sample size meant we did not formally randomize which individuals approached the squirrels; instead, we decided once the first squirrel in each area was spotted and cycled for an even number of observations.

Future research should expand on these findings by including larger sample sizes, a formalized randomization method, and more diverse urban and wild settings to better capture the complexity of wildlife responses to human presence.

Appendix

Figure 1. *Squirrel survey methodology under single approach conditions. Under the "both" approach condition, both individuals walk toward the squirrel with similar division of tasks*

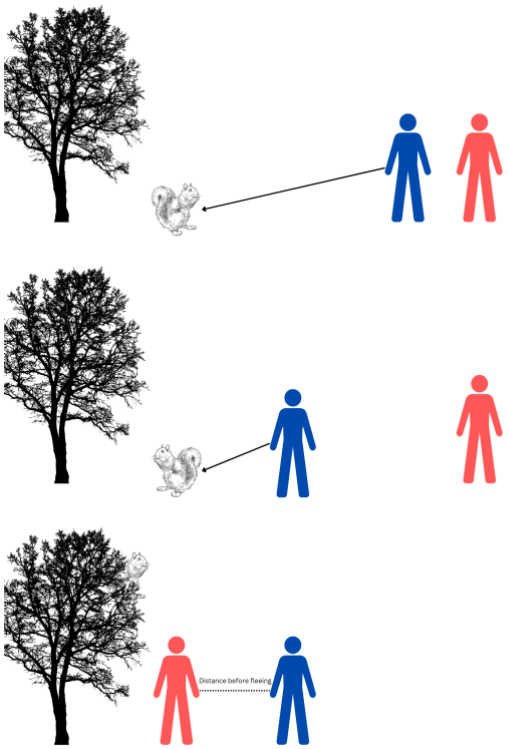


Figure 2. *Interaction plot between location and person. 0 represents off-campus sites, while 1 represents on-campus sites.*

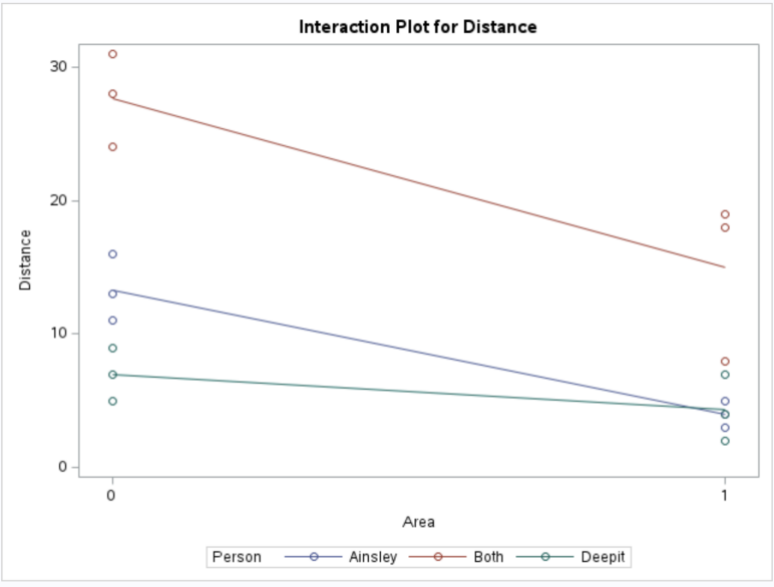


Figure 3. This table represents the output of the General Linear Model (GLM) procedure

The GLM Procedure

Dependent Variable: Distance Distance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	1211.777778	242.355556	21.70	<.0001
Error	12	134.000000	11.166667		
Corrected Total	17	1345.777778			

R-Square	Coeff Var	Root MSE	Distance Mean
0.900429	28.10739	3.341656	11.88889

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Area	1	304.2222222	304.2222222	27.24	0.0002
Person	2	829.7777778	414.8888889	37.15	<.0001
Area*Person	2	77.7777778	38.8888889	3.48	0.0642

Figure 4. Residuals vs Predicted Values Plot

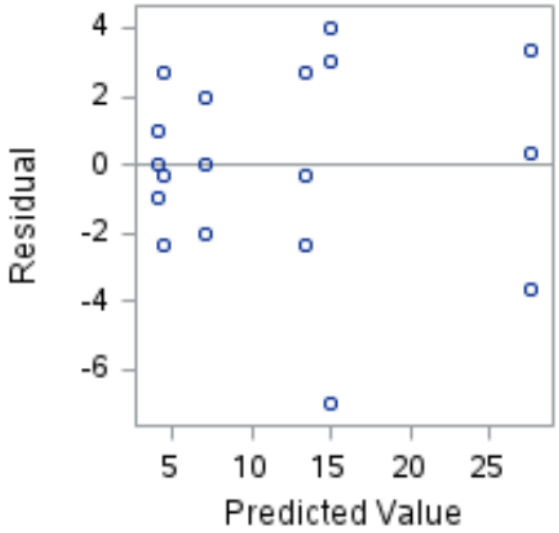


Figure 5. Normal QQ-plot

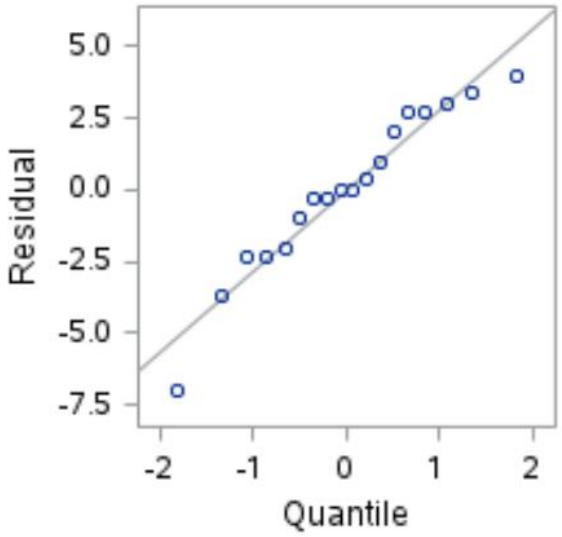
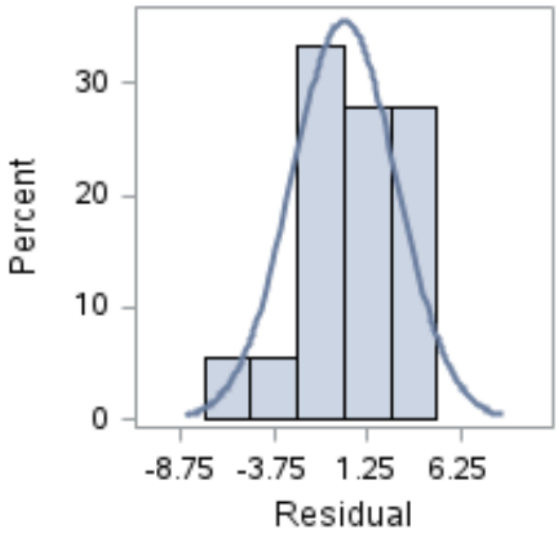


Figure 6. Distribution of Residuals



References

Eckhart, Vince. “Studies in Urban Ecology.” Class lecture, Bio 368: Ecology, Institution, Institution IA, October 2023.

Wassmer, T., & Refinetti, R. (2016). Daily activity and nest occupation patterns of fox squirrels (Sciurus niger) throughout the year. *PLoS ONE*, 11(3), e0151249. https://doi.org/10.1371/journal.pone.0151249

Ydenberg, R., & Dill, L. (1986). The economics of fleeing from predators. *Advances in the Study of Behavior*, 16, 229-249. https://doi.org/10.1016/S0065-3454(08)60192-8