EFFECTS OF URBANIZATION ON WILDLIFE DIEL ACTIVITY AT SUNY PURCHASE COLLEGE

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ABSTRACT

As urbanization continues to increase across the globe, it is important to understand the effects that anthropogenic activity will have on local wildlife communities in urban areas. Our study was used to determine the species diversity and general abundance on SUNY Purchase College Campus, and examine the diel activity of said species. Trail cameras were used to observe both human and animal occurrences, in order to study spatial and temporal avoidance of wildlife. In support of other studies, animals display an increasingly nocturnal diel activity pattern, with the exception of the smallest mammals observed, squirrels and chipmunks, a diurnal species that was seen predominantly throughout the day, regardless of human frequency.

Keywords: *synanthropic, generalist, diel activity, diurnal species, nocturnal*

INTRODUCTION

Throughout human history, people have chosen to live within close proximity to one another, forming cities with centers of trade and commerce, and creating an atmosphere of safety and power through strength in numbers; this phenomenon has come to be called 'urbanization'. Today's world is increasingly urban, more than 2/3^{rds} of the world's population is expected to live in cities by 2050 (United Nations. 2018). The process of urbanization inherently includes changes in landscape and land usage, as well as human population density in a given area. The demolition of natural lands and increased presence of humans has been shown to have a range of consequences on wildlife communities; local wildlife in areas with continued development suffer from habitat loss and changes in forest structure, as well as increased competition and evolutionary pressures due to novel environmental changes. Species are often forced to either migrate or adapt to the changes in their environments if they survive them at all.

There are many outcomes of urbanization that are known to present challenges to wildlife survival, including: increased noise pollution, habitat fragmentation, loss of food sources, and increased light pollution, among other things. Many studies have proven the loss of species richness, diversity, and abundance in correlation with increasing urbanization; only some species, known as 'generalists' have been seen thriving in urban spaces. It has been theorized

that most animals view humans as the ultimate predator, fearfully avoiding them in almost all instances, making human presence a direct cause of behavioral change as species avoid humans both spatially and temporally (Gaynor et al. 2018). Humans have also domesticated a native predator of many small mammals, the dog, and although most small mammals fear dogs, they still fear humans even more, avoiding them even without the presence of dogs (Parsons et al. 2016).

The various characteristics of urban environments have different effects on each species, depending on what presents the greatest problem. For example, birds use song to communicate, which is incredibly important to their survival. In urban areas, noise pollution due to human activity can mask the sounds of birds calling to one another, forcing them to modify the pitch, amplitude, or even the sequence of their songs (LaZerte et al. 2017). Larger species like coyotes choose to spatially avoid urban areas as much as possible, but due to habitat fragmentation must occasionally exploit urban environments for food in the form of trash, ornamental plant produce, and domestic cats- which are highly active and often left to roam in tight-knit urban spaces (Larson et al. 2020). While these adaptations may not be ideal, they are necessary for the survival of our native species in an increasingly urban world.

Some animals have found ways to thrive in urban environments by using them as shelter from mesocarnivores that humans tend to fear, persecute, and therefore exclude, as well as eat the fruits of ornamental plants, or garbage from our trash. Species that develop the ability to exploit or thrive within urban environments are called *synanthropic* species- or habitat generalists (Cove et al. 2019). Some species with synanthropic tendencies/abilities include squirrels, skunks, raccoons, and other small to medium sized mammals. Though there are many different species who've developed specific ways to overcome the challenges of living in an urban environment. Some of the most prominent behaviors observed by many wildlife species in the presence of humans are spatial and temporal (spatio-temporal) avoidance. Spatial avoidance refers to the amount of space an animal chooses to keep between themselves and their perceived predators, and temporal avoidance refers to the amount of time between hiding from predators it takes to return to their original location or resume activity. Many studies report increasing nocturnality as a result of urbanization, implying that human activity during the day forces wildlife to wait until night time to do their activities, many times using dormant urban areas to find food and shelter (Dunagan et al. 2019).

SUNY (State University of New York) Purchase College is, by definition, an urban environment (>2500 people km^{-2}), which has been heavily landscaped and densely populated over the years; land usage is daily and frequent, as the student body and faculty go about their business (Fusaro et al. 2017). The campus is home to many wildlife species, as there is some forest around the border of campus, much of which has been preserved for over 100 years. Although it is known that there are animals that frequent, use, and potentially live on our campus, species diversity and abundance is not fully known. Our study was not only designed to examine the effects of urbanization on Purchase College campus and the behavioral patterns of our local wildlife, but to observe what species inhabit our campus and where they spend their

time. Trail cameras were used to capture wildlife activity around the campus, and Rstudio was used to analyze species richness, disturbance, and occurrences over time.

METHODS

Field Location. – Six sites were chosen haphazardly across campus with various vegetation structures and levels of human activity. The sites are listed as follows: *Music*- located on the northwest side of campus with a large center clearing, *Alumni*- located on the northeast side of campus with late successional vegetation, *Softball*- located in a small path made up of edge plant species and otherwise open due to sports field clearings, *East 1*- located alongside sports fields on the southeastern side of campus, *Woods*- Same side of campus, further removed from sports fields, and *Loop*- at the southernmost side of campus, separated furthermost from sports fields.

Field Sampling. – Wildlife Trail Cameras. On September 16th, 2022, in order to observe general activity of both humans and wildlife at each site, we set up trail cameras (Browning Strike Force HD Pro Sub Micro Series; Model BTC-5HDP) with the settings of: 1 photo at a time with a one second capture delay, with multi-shot and rapid fire off, and infrared flash in fast motion mode for the evenings. Trail cams were wrapped around trees 0.5m above ground and leaned slightly forward, then let run for weekly intervals before SD card was switched, for the entirety of the study. Photos taken were organized in Google Sheets by counting the number of people, dogs (leashed/unleashed), vehicles, and animal species (chipmunks, squirrels, rabbits, raccoons, opossums, skunks, deer, coyotes, and bobcats) per hour. Photograph sets taken over 1 minute apart were counted as separate events and therefore separate animal/disturbance sightings. Disturbances included: humans, bikes, cars, and both leashed and unleashed dogs. Trail camera observation period began on September 16th, 2022 and concluded on October 21st, 2022.

Analysis. – For the wildlife trail camera data, graphs were made on R Studio using the GGPlot package, and analyzed diel (throughout the day-24 hours) wildlife activity, the frequency of disturbances, which included humans, leashed and unleashed dogs, and vehicles, and number of photos taken by date. The small mammal baited camera data was turned into a graph analyzing the daily activity of small mammals over the three days of photos on Rstudio, using the same GGPlot package as before.

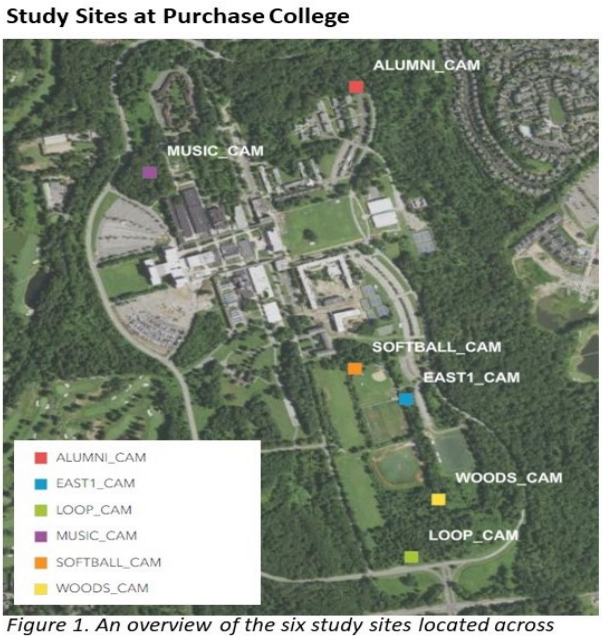

Figure 1. An overview of the six study sites located across Purchase College Campus

RESULTS

The species we observed on our trail cams include bobcats, chipmunks, coyotes, deer, opossums, rabbits, racoons, skunks, and squirrels. The species observed the most frequently are squirrels, followed by deer, chipmunks, racoons, rabbits, opossums, coyotes, skunks, and finally bobcats (Table 1 & Figure 1). Most species, except for squirrels and chipmunks, who are diurnal species, followed a nocturnal-leaning activity pattern in which they were more active at night and in the early morning, at times when human activity was at its lowest (Figures 2 & 3). Deer were also active during the day at higher rates than most other animals; as we have a dense deer population on campus, deer are actually seen on average within every hour of the day (Fig. 1).

Figure 2 is a graph of the average daily activity of all wildlife species observed, throughout the day, mostly squirrels and chipmunks are active, and in such high numbers, allow for activity of wildlife species to be higher overall throughout the day. You can see individual diel activity of species in Figure 4, which shows that there has been some rabbit, bobcat, and coyote sightings during the day, aside from the deer, chipmunks, and squirrels, but numbers were very low in comparison. Be sure to note the difference in scale of the y axes of figure 4. Figure 5 can be used for comparison against figure 2, to show how different wildlife species usage looks with them included in the graph. This will also be used for comparison against diel activity of wildlife based on species type (size, diet).

Table 1. A list of the total number of images captured of each species, in descending order. Squirrels were the most 'populous', with 637 total images taken by the trail camera, followed by deer, and then chipmunks.

Total Number of Images per Species	
Species	**No. of Images**
squirrels	637
deer	274
chipmunks	172
raccoons	148
rabbits	109
oppossum	44
coyotes	35
skunks	10
bobcats	10

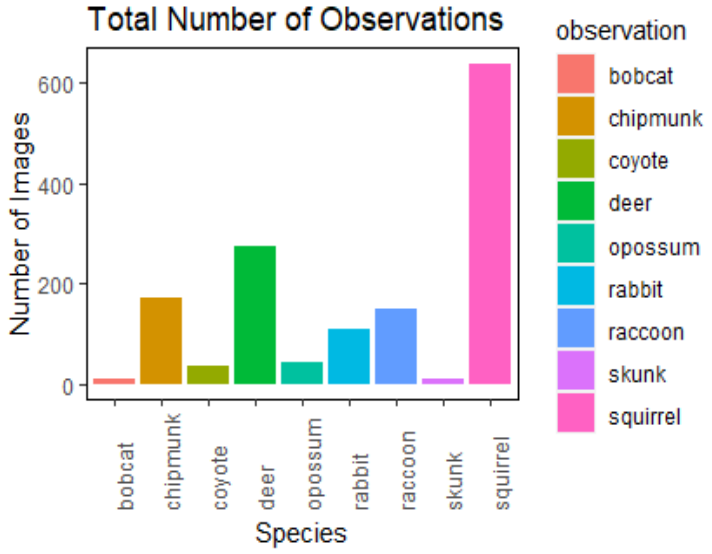

Figure 1. GGPlot bar graph of the total number of images taken per species. A visual representation of the data presented in Table 1

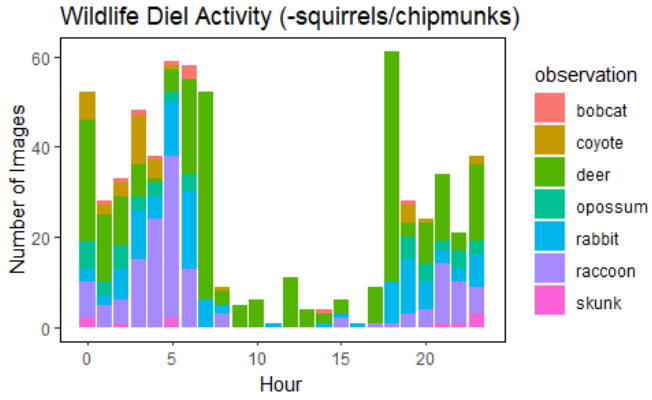

Figure 2. Average wildlife activity over a 24-hour period, with the exception of chipmunks and squirrels, who were the smallest mammals included in our study and therefore likely to have different diel activity patterns than the other, mid-sized mammals.

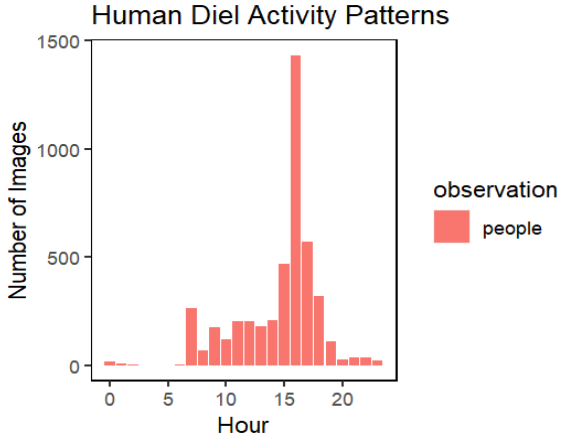

Figure 3. Average Daily human activity over a 24-hour period. High activity begins at about 7am and becomes moderate to low from 19hrs (7pm) and halts completely from 3-6 am.

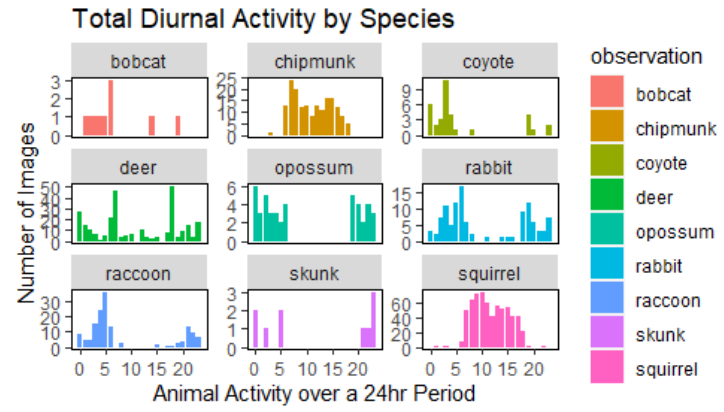

Figure 4. Average daily activity by species, be sure to note difference in individual y-axes scales.

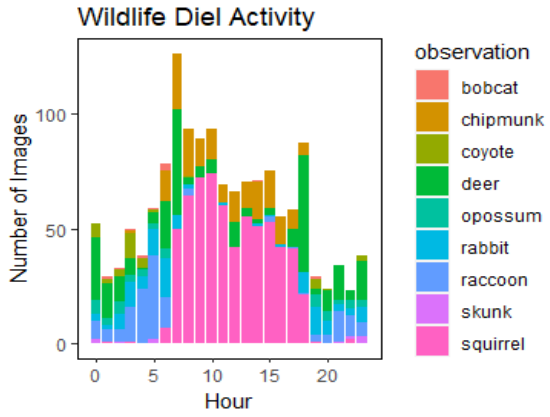

Figure 5. Average daily activity of all wildlife species.

DISCUSSION

Our results show that our campus has a diverse wildlife population, seeing as this is without accounting for the avian community and smaller mammals that may not have been noticed by our trail cameras. These species all use our campus in different ways, but mostly for food and shelter, and mostly at times when humans are not active (Fig. 2 & 3). As seen in other studies, small mammals, in this case squirrels and chipmunks, find shelter and food in abundance within urban environments, as they are frequently seen on the trail paths moving about campus. Squirrels and chipmunks are both diurnal species, and are known to be active during the day and less so at night. Large mesocarnivores such as coyotes and bobcats were seen very infrequently, as most coyotes prefer to avoid urban environments, only using them as means of transportation from one place to another, or for food- either way- they also followed a nocturnal leaning diel pattern (Gehrt et al. 2009).

The wildlife species seen on our campus were all in some way using its resources, though it is not possible to say which, their presence on campus trail paths shows that they are there, and mostly when we are not around to see them. Deer are populous on campus and are seen at all hours of the day throughout the study period. Our results support studies that show small, diurnal mammals, benefit from the shelter provided from predators in urban areas. At night, when the predators are seen on campus, small mammals were not, apart from rabbits. It is likely that raccoons and skunks, opossums, potentially even coyotes, may have been seen in even more urban areas such as the dining halls, where trash for eating is in high abundance. Dominant presence of squirrels and chipmunks support theories that they are a synanthropic species (Cove et al. 2019)

Human daily activities were most frequent during the times of 7am to 7pm, a time where wildlife were, likely purposefully, absent. This is proof of temporal and spatial avoidance, as animals were never seen in the same photo (therefore the same place), as humans. This is also evidence of increasing nocturnality among species, as a result of urbanization and population density. In essence, mammals use shared spaces during the times of day where humans, their perceived predators, are absent, many even risking predation, like rabbits.

Some errors necessary to discuss in this study include a lack of data due to camera malfunctions at the Loop site on October 7th until the end of the observations on October 21st. Numbers of images taken of species and disturbance alike in the wildlife trail camera data was separated by hour, photos taken of the same person, vehicle, or species separated by a minimum of one minute are considered as separate sightings, which is important when thinking of the intervals in which people walk back and forth past the camera, or even remain idling in the area, causing the camera to be triggered multiple times, only depending on when a person is in its range of view. The southernmost side of campus caught a large number of people due to track meets in which runners passed through the Woods, Softball, and East 1 sites on November 21st, 2022.

In future studies, I would recommend placing trail cams within the urban forests that our trail paths were paved between, in order to see what animals may be behind the bushes and avoiding the trail path. There is also the forested area that borders our campus, which could be home to the coyote and bobcat species we observed exploring campus, which would be important to study to determine if wildlife species are more abundant in these areas and what differences in species they may have to the results of our study.

CONCLUSION

Our data supports the theory that urbanization is changing the diel patterns of local wildlife species. As they avoid humans at all costs, they lose important daylight hours which would normally be used for foraging and feeding. Increasing urbanization has already diminished the presence, richness, and abundance of our native species, and puts many others at risk if they are unable to adapt to the challenges of living in an urban environment. Coyotes and bobcats both generally prefer to reside in forested areas, and sightings of them on our campus can either imply that it needs to move across this space or that they are using our campus for food (Gehrt et al. 2009).

It is important to study the effects of urbanization on wildlife communities. The fact that mesocarnivores are eating garbage, invasive species' fruits, and domestic animals for food is already a drastic change from their original hunting and feeding habits, and the effects of these foods on their health is yet to be discovered (Larson et al. 2020). As natural land continues to be converted for human usage, we must remember to protect the local wildlife communities we are altering.

ACKNOWLEDGEMENTS

I would like to thank Dr. A. Jackson for all of her assistance with this project, which could not have been done without her. I would like to thank my fellow researchers who participated in this project with me, and Dr. G. Kraemer for his useful articles on urbanization which helped me to write this paper.

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