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Spatiotemporal Activity Patterns of Red Foxes and Coyotes in Wilderness Park, Lincoln, Nebraska.

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Spatiotemporal Activity Patterns of Red Foxes and Coyotes in Wilderness Park, Lincoln, Nebraska.

An Undergraduate Thesis Project

By

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Spatiotemporal Activity and Avoidance Patterns of Red Foxes and Coyotes in Wilderness Park

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ABSTRACT

Wildlife species that share a landscape may vary their use of time, space, and resources, thereby enabling sympatry between species. Interspecific relationships among sympatric canids are often inferred through temporal and spatial activity patterns. Body size is an important influence on interspecific relationships, as it affects competition, access to prey, resources, and vulnerability to predation. Coyotes and red foxes are canids that differ in body size and occur sympatrically in Wilderness Park, which suggests that they interact and could imply competition. In and around Lincoln, the number of coyote sightings has increased in recent years, Although the ecology of both species has been studied individually, more information is needed about how intraguild competition and interactions with coyotes (*Canis latrans*) affect the distribution and temporal activity of red foxes (*Vulpes vulpes*). To assess these interactions, I investigated the temporal and spatial activity patterns of coyotes and red foxes in Wilderness Park in Lincoln, Nebraska, using eight trail cameras deployed from 1 March to 11 April 2023. I detected co-occurrence of coyotes and red foxes at 3 of 8 camera locations. At 2 of the 3 sites where the species co-occurred, red foxes were detected at a rate greater than or equal to that of coyotes. However, the presence of coyotes appeared to have some impact on the detection rate of red foxes, as 4 of the 5 camera sites where coyotes were detected, red foxes were detected at a rate less than or equal to the rate of detections of coyotes. Throughout the park, both species were detected at nocturnal and crepuscular hours. Coyotes and red foxes had modest temporal overlap at the camera with the most detections

of both species (Δ_1=0.51), and moderate temporal overlap across all camera sites combined in Wilderness Park (Δ_1=0.52). Avoidance-attraction ratios implied temporal avoidance of coyotes by red foxes at the camera with the most spatial overlap. The temporal distribution of red foxes was not uniform across the 24-hour cycle (RST $.01<P<.05$) and red fox activity was primarily nocturnal and crepuscular. However, temporal activity patterns of coyotes did not differ from a uniform distribution (RST $0.05<P<0.10$), although their activity appeared to be primarily nocturnal and crepuscular. Furthermore, the temporal activity patterns of coyotes and red foxes did not significantly differ from one another (WT $P > 0.1$). These results overall suggest that red foxes may be avoiding coyotes through both fine-scale temporal and spatial avoidance. However, low statistical power from a short study period and low number of detections limited the inferences possible with these data. Nonetheless, the study contributed to a better understanding of how red foxes and coyotes interact in Wilderness Park, and can help guide future research. Future researchers focused on spatiotemporal activity patterns of these species should obtain larger datasets across larger spatial extents where the species co-occur to build on these results and provide a greater understanding of the interactions between red foxes and coyotes.

Acknowledgements

I want to thank John Benson and Megan Baldissara for their advising and assistance throughout the project’s duration. I thank Dave Gosselin for his support and guidance throughout the development of this project. I thank Larkin Powell for lending me the cameras for this project. I thank Chris Meyers at Lincoln Parks and Recreation for permission to use camera traps in wilderness park. Lastly, I want to thank my friends and family for their support throughout my undergraduate experience.

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INTRODUCTION

Wildlife species that share a landscape may vary their use of time, space, and resources, thereby enabling sympatry between species. As interspecific competition intensifies, such behavioral adaptations may become more prominent (Karanth et al., 2017). These behavioral adaptations may include avoiding other competing animals in space or time, partitioning resources, or a combination of these factors to reduce competitive encounters (Zanni et al., 2021). Camera traps are an effective method to study spatial and temporal activity patterns of sympatric species, as they are a non-invasive method to document what time of day species use different locations across the landscape (Frey et al, 2017).

Interspecific relationships among sympatric canids are often inferred through temporal and spatial avoidance / activity patterns (Major & Sherburne, 1987). Red foxes (*Vulpes vulpes*) and coyotes (*Canis latrans*) are two omnivorous canid species that are sympatric across much of the United States (Harrison et al., 1989). They are both canids with similar body structures that hunt small mammals for food, but they differ in size and exhibit some differences in their dietary preferences and behavioral patterns. Red foxes are omnivorous, often hunt alone, and tend to feed on smaller prey like rodents, rabbits, birds, and insects. Coyotes are also omnivorous but are primarily carnivorous and are capable of feeding on larger prey, such as deer and pronghorn antelope (Gese & Ruff, 1999). Coyotes have been observed scavenging in urban areas as well as working together to bring down larger prey (Bekoff, 1977). With these differences aside, there is still overlap in their prey selection, use of other resources, and habitat preferences between the two species, which can lead to intraguild competition between them.

Competition between red foxes and coyotes may vary based on the availability of resources like food or territory, the season, and the presence of other predators. Competition between these species is increased in areas where their home ranges, resources, and diets overlap (Sargeant & Allen, 1989). Coyotes and red foxes may avoid one another in time or space to reduce intraguild competition. Sargeant et al. (1987) found that coyotes and red foxes with overlapping territories avoided interspecific encounters (Sargeant & Allen, 1989). The presence of coyotes appears to affect the behavior and presence of red foxes. This is likely because coyotes are larger and have been known to prey on red foxes (Harrison et al., 1989). Sargeant & Allen (1989) reported observations that coyotes are often overtly antagonistic towards red foxes, whereas they reported no evidence of red foxes being antagonistic to coyotes except when attacked or defending their pups from coyotes. Red foxes have also been observed to avoid suitable habitats within coyote territories, and this avoidance may result in a reduction in home ranges sizes for red foxes and could even limit their populations or distributions (Harrison et al., 1989).

In this way, coyotes can displace red foxes from their territories (Gese & Ruff, 1999). In sympatric populations, the home ranges of red foxes tend to straddle the periphery or are located largely outside the territories of coyotes. According to Gosselink et al. (2003), coyotes are capable of exerting top-down predation and competition pressures on both their prey and smaller sympatric predators. A global study of the spatial co-occurrence of sympatric mammalian carnivores found that co-occurrence decreased in pairs of mammals that included a larger-bodied carnivore compared to other species pairs (Davis et al. 2018). Avoidance of coyotes by red foxes to prevent predation or competition is believed to be the principal cause of spatial or temporal separation of these species where there is shared space (Sargeant & Allen, 1989). Generally, we have an understanding that red foxes and coyotes partition their resource and habitats to some extent, but we lack a clear understanding of the mechanisms by which these resources are partitioned. Although we understand much about the ecology of both coyotes and red foxes individually, less is known about the factors that facilitate coexistence, and how interactions between these species influence the distribution and temporal or spatial activity of the smaller carnivore (Lesmeister et al., 2015). It is not entirely understood if red foxes and coyotes partition their resources more through spatial or temporal avoidance, or some combination of the two. To be effective, wildlife management needs to better understand how sympatric red foxes and coyotes partition their temporal and spatial activity. It is important to understand the interactions between these species because carnivore guilds play a central role in ecological communities through stabilizing or destabilizing food webs, and red fox populations may decrease as a result of increased intraguild predation and resource competition by coyotes (Lesmeister et al., 2015).

In and around Lincoln, Nebraska, coyotes and red foxes are two predominantly crepuscular and nocturnal predators that frequently share urban and rural habitats. They are adaptable and opportunistic predators that live in and move through the landscape in Wilderness Park in southwest Lincoln. Wilderness Park in Lincoln, Nebraska, presents an opportunity to observe the avoidance and activity patterns of predators of different sizes, specifically coyotes and red foxes. Wilderness Park provides some of the only wildlife habitat available around Lincoln for several miles, surrounded by the city on one side and extensive croplands on the other. There is native vegetation in the corridor that reflects the natural landscape that existed just a short 100 years ago (Lower Platte South NRD, 2022). Additionally, there has been an increase in number of coyote sightings in the park and across Lincoln in recent years (Figure 2), and red foxes are listed as inhabitants of the park with dens and home ranges within the park (Friends of Wilderness Park, 2021). The presence of coyotes and red foxes living in and passing through the natural habitat located in Wilderness Park provides an opportunity to observe their interactions and patterns in time and space. An increase in the understanding of the behaviors and interactions between these two species in Wilderness Park can help inform future developments decisions and wildlife management.

I used camera traps to investigate the spatial and temporal activity patterns of coyotes and red foxes in Wilderness Park to better understand how these two species compete and whether red foxes avoid coyotes in time or space. I hypothesized that if two predators coexist in the same landscape, then the smaller species should shift their temporal and spatial activity patterns to avoid the larger species to prevent mortality and competition. I predict that detections of coyotes and red foxes do not occur at the same camera sites, due to spatial avoidance of coyotes by red foxes (P1). Also, I predict that if coyotes and red foxes are detected in the same area, red foxes shift their temporal activity patterns from crepuscular towards a more diurnal or nocturnal pattern, to avoid coyotes which are usually strongly crepuscular (P2). Understanding intraguild interactions can help provide insight on how coyote and red fox distribution may be impacted by potential competition. It may also aid in the management and understanding of populations of prey species that are affected by the presence of red foxes and coyotes.

METHODS

Field Methods

I set up trail cameras in Wilderness Park in Lincoln, Nebraska to collect data. Wilderness Park is a 1,472 acre reserve that follows Salt Creek along southwest Lincoln. Wilderness Park provides habitat for many insects, birds, mammals, and invertebrates, and serves as a movement corridor for wildlife species. I placed the cameras away from trails, buildings, and railroad tracks in locations in the park where wildlife frequently passes through, based on animal trails, tracks, and waste left by animals moving through the park. I deployed eight cameras throughout Wilderness Park (Figure 1) for 41 days (1 March – 11 April 2023) at each site. The average spacing between each of the cameras was 1.05 km.

I placed one camera at each site. Each camera was a Moultrie D-35 Trail Camera with an eighty-foot infrared flash range for night-time photos, and a sixty foot motion detection range. When the motion sensor is triggered, the infrared flash, camera, and 3-photo burst activates with a thirty second delay between bursts. I attached the cameras to a tree at each site ~one foot off the ground and set them to be active for 24 hours a day. I set the cameras to face either north our south to prevent any direct sunlight from east or west from interfering with the picture quality. Also, I removed or flattened any grass or branches in the detection area to avoid falsely setting off the motion detector. Once the motion detector detects an animal and the photos are taken, the trail camera records the date, time, and temperature of when the images were captured on each photo. I applied Reuwsaat's Private Stock Fox Pure Urine around six feet in front of the camera to function as an attractant. I checked the cameras every two weeks, downloaded the captured photos, and reapplied fox urine to the site. I used Microsoft Excel to organize data, recording each species detected, number of detections, temperature at time of capture, location, time, and date.

Spatial Activity Patterns

To analyze the spatial activity patterns of coyotes and red foxes, I estimated the detection rates of both species at each camera site. I estimated detection rates by dividing the total number of detections for each species at each camera site by the total number of sample days (41 days). This allowed me to compare detection rates of coyotes and red foxes between camera sites to investigate whether red foxes might be spatially avoiding sites where coyotes were detected (P1).

Temporal Activity Patterns

Data from camera traps that record the time of day and date at which photographs are taken are used widely to study daily activity patterns of wildlife predator and prey species (Ridout & Linkie, 2009). I performed most temporal analyses in R, version 4.2.2 (R Core Development Team 2021). I used the "overlap" package in R (Ridout & Linkie, 2009) to estimate temporal activity patterns of red foxes and coyotes and to quantify the overlap between these patterns. Specifically, I estimated the coefficient of overlap, where a value of 1 represents a complete overlap in the activity patterns of two species, and a value of 0 represents no shared period of activity between the two species (Monette et al. 2020). I used Rao's spacing test of uniformity to evaluate the temporal patterns of each species and whether these patterns differed significantly from a uniform distribution across the 24-hour cycle. I investigated potential significant differences between the temporal activity patterns of red foxes and coyotes using Watson's U2 test. I conducted Rao's spacing test of uniformity and Watson's U2 test with the package "circular" in R (Agostinelli & Lund, 2022). These tests allowed me to compare the temporal activity patterns to investigate whether or not red foxes were shifting their activity patterns to avoid coyotes temporally (P2).

Lastly, to investigate potential temporal avoidance of red foxes by coyotes I used avoidance-attraction ratios (AAR; Parsons et al., 2016). The AARs for red foxes and coyotes are obtained by estimating (T2/T1) and (T4/T3). T1 is the time between an initial red fox detection and a subsequent coyote detection. T2 is the time from that subsequent coyote detection to the next red fox detection. If multiple coyotes pass before the next red fox is detected, T2 is still taken from the first coyote detection. T4 is the sum of T1 and T2, representing the time between successive red fox detections with a coyote passage in between. T3 is the time between successive red fox detections without a coyote passage in between. The ratio of T2/T1 may be influenced by the attraction of coyotes to red foxes, while the ratio of T4/T3 is influenced only by the avoidance of red foxes by coyotes (Parsons et al., 2016).

RESULTS

Across eight camera trap locations over a 41-day sample period, I obtained 11 detections of red foxes and 11 detections of coyotes. I obtained the most detections at two camera locations. At camera site 3, I obtained 5 detections of red foxes and 4 detections of coyotes. At camera site 1, I obtained 2 detections of each species (Table 2).

Spatial Activity Patterns

The presence and number of species varied across the 8 camera sites. One site, camera 6, had no detections of either coyotes or red foxes (Table 2). Of the remaining sites, 3 detected co-occurrences of the two species while 4 did not (Table 1). Of the sites without co-occurrence, 2 detected only red foxes, and 2 detected only coyotes (Tables 1, 2), suggesting some spatial avoidance. Though, the presence of coyotes did not entirely deter the presence of red foxes, as at 2 of the 3 sites where the species co-occurred, the detection rate of red foxes (12.19%; Table 1) was higher than that of coyotes (9.75%; Table 1) in one location and was equal to that of coyotes in one other location. However, 4 out of 5 locations that detected coyotes had either no detections of red foxes or a lower or equal detection rate of red foxes (Table 1). Camera 3 had the highest detection rates and spatial overlap of both species, with 5 detections of red foxes and 4 detections of coyotes (Table 2).

Temporal Activity Patterns

Red foxes and coyotes dectected at camera 3 had temporal activity pattern curves with peaks in activity that were about two hours apart. At camera 3, the activity pattern of coyotes had peaks near 3:00am and 9:00pm, while red fox activity patterns had peaks near 1:00am and 7:00pm (Figure 3). Coyotes and red foxes had moderate temporal overlap at camera 3 (Δ_1=0.51; Figure 3). Across all camera sites, there was intermediate overlap between the two species (Δ_1=0.52; Figure 6). I had enough successive detections to apply the AAR at only two camera sites, cameras 1 and 3. The AAR at camera 3 suggests temporal avoidance of coyotes by red foxes (T4/T3=23.37, T2/T1=5.92; Table 3). The AAR at camera 1 suggests slight temporal avoidance of coyotes by red foxes but could also imply attraction of coyotes to red foxes (T4/T3=47.6, T2/T1=1.28; Table 3). The temporal activity patterns of red foxes overall throughout the park were nocturnal and crepuscular, peaking around 1:30am, decreasing during the day before increasing again around 6:00pm, which is within an hour of sunrise. (Figure 4). The total sample size of red foxes was 11 detections and their temporal activity patterns differed from a uniform distribution (RST $0.01<P<0.05$). The temporal activity patterns of coyotes overall throughout the park were also nocturnal and crepuscular, with activity peaking around 09:00pm before decreasing to half of the peak density until 06:00am when it declined for the rest of the daylight hours (Figure 5). The total sample size of coyotes was also 11 detections, but their activity did not differ from a uniform distribution (RST $0.05<P<0.10$). The activity patterns of red foxes and coyotes across all camera sites had nocturnal and crepuscular peaks, with red fox activity peaking near 2:30am and 7:00pm and coyote activity peaking near 5:30am and 9:00pm. Throughout the 24-hour cycle across all sites, red fox temporal activity peaked about two hours before both peaks in coyote temporal activity (Figure 6). Across all detections in the park, coyotes and red foxes did not significantly differ in their temporal activity patterns (WT $P>0.1$).

DISCUSSION

I hypothesized that if two predators share a landscape, the smaller species would shift their temporal and spatial activity patterns to avoid the larger species to prevent competition and reduce the risk of mortality. Although my sample sizes and data collection duration were relatively small, it is still possible to draw conclusions from these data. Red foxes did not appear to strongly spatially avoid locations where coyotes were detected but did appear to exhibit some temporal avoidance of hours of peak coyote activity.

Spatial Activity Patterns

The data did not strongly support my first prediction that detections of both species would not occur at the same camera sites, implying spatial avoidance of coyotes by red foxes (P1).

Coyotes and red foxes were detected at the same cameras at 3 of the 7 total sites where at least one of the species was detected. The detection rate of coyotes did not seem to strongly affect the detection rate of red foxes at the same sites. At 2 of the sites with co-occurrence, the detection rate of red foxes was equal to or greater than the detection rate of coyotes (Table 1). However, at 4 other sites only one of either species was detected, suggesting some spatial avoidance. Camera 3, which had the most detections of both species, was located closer to Salt Creek than any other camera. Prior studies have found that Red Fox home ranges were associated with riparian zones, but they also found that red foxes did not use these areas when they were associated with coyote territories (Harrison et al., 1989). However, I had multiple detections of both species near the creek. A possible cause of these unexpected results could be prey and resource densities in Wilderness Park. Temporal and spatial overlap of carnivores has been found to be higher in areas of lower prey densities (Karanth et al., 2017). Also, overlap in prey selection between coyotes and red foxes in Wilderness Park may contribute to increased spatial overlap, as they may be pursuing similar prey. Comparing spatial activity and avoidance at camera sites proved difficult due the short sampling duration and low total number of cameras and individual detections of each species. It is also possible that either foxes or coyotes visited a location, but were not captured in front of a camera trap, or that their spatial behaviors were impacted by urban activity.

My results of spatial co-occurrence seem especially inconsistent with the results of two studies. Specifically, Major & Sherburne (1987) used radio-telemetry data to show that coyotes and red foxes showed little or no spatial overlap in a 1,300km^2 study area. The other study, by Harrison et al. (1989), never detected red foxes in core portions of coyote territories throughout 7,000 trap nights. Something important to consider in Wilderness Park, is that it is only approximately 6km^2, around 10km long, and it is only 0.45-0.65km wide. It is essentially a wildlife movement corridor. The park being so narrow and relatively small while also being some of the only natural habitat in the area may be important factors to include when considering the ability of these species to spatially avoid one another. The average home range of red foxes in Lincoln is ~2km^2 (Dougherty, 2019), whereas the average home range size for coyotes in the south-eastern United States is 10-40km^2 (Chamberlain et al., 2021). If shared space between the species in Wilderness Park is not large enough for them to use home ranges of sufficient size to acquire necessary resources, it may limit the amount of spatial avoidance they can exercise. Collecting additional data could improve the understanding of spatial avoidance patterns of smaller predators to larger predators in limited environments.

Temporal Activity Patterns

My results conveyed only partial support for my second prediction, as red foxes were detected at nocturnal and crepuscular hours where coyotes were detected. The data may be representative of finer scale avoidance between the species rather than a more substantial shift in temporal activity across the 24-hour cycle as I predicted (P2). Although red foxes and coyotes had the highest spatial overlap at camera 3 and were both detected at nocturnal and crepuscular hours, they had different peaks in activity and only moderate temporal activity pattern overlaps (Δ_1=0.51; Figure 3). Additionally, the avoidance-attraction ratio at camera 3 suggests temporal avoidance of coyotes by red foxes. Across all cameras, both species were detected at nocturnal and crepuscular hours but also had peaks in activity separated by two to three hours and only had intermediate temporal overlap (Δ_1=0.52; Figure 6). I had expected less temporal overlap at sites where both species were detected, especially when considering many of the detections came from sites where coyotes and red foxes had overlapped spatially. In a study examining the coexistence of sympatric mesocarnivores, researchers observed temporal avoidance at a fine-scale level, which could potentially aid in their coexistence (Zhao et al., 2020). It is possible that red foxes in Wilderness Park are able to coexist with coyotes partly due to temporal avoidance, as was found in Harrison et al. (1989). However, more data in Wilderness Park and across Lincoln more broadly would be needed to thoroughly investigate this hypothesis.

SUMMARY & CONCLUSION

The results of my research may suggest partial spatial and fine-scale temporal avoidance of coyotes by red foxes in Wilderness Park, but also could represent red foxes engaging in riskier behaviors in a landscape with limited habitat. Both of my predictions were only partially supported, as many of my detections occurred at sites where the species co-occur in space and both species were being detected at nocturnal and crepuscular hours with moderate temporal overlap (Δ_1=0.52; Figure 6) across all cameras. When detecting red foxes at the same camera sites as coyotes, I had anticipated a more dramatic shift in temporal activity times. Instead, I found that rather than a full shift in temporal activity across the 24-hour cycle, red foxes appeared to avoid times of peak activity of coyotes more narrowly in Wilderness Park. Urban activity, similarity in prey selection, resource availability, and temperature and season, all may have contributed to these temporal activity patterns. While the data do suggest some spatial avoidance with coyotes and red foxes (4 sites with only one species), I was surprised to find that red foxes and coyotes were detected at the same location at 3 camera sites, contrary to my prediction. The camera with the highest detection rates of both species was also the camera nearest to Salt Creek that runs through the park, which may suggest overlap in habitat selection. It is possible that factors like prey density and selection, resource availability, as well as Wilderness Park being relatively small and narrow may limit the ability of these predators to avoid one another spatially. Also, given the apparent increase of coyote sightings in and around Lincoln, it may be increasingly difficult for red foxes to completely avoid coyotes in time or space. More data on the activity patterns of coyotes and red foxes throughout the park may help to evaluate patterns of spatial avoidance more fully.

The presence of humans, dogs, and urban activity in and around the park, could have also impacted my results by creating multiple sources of risk and disturbance for red foxes and interfering with their ability to completely avoid coyotes in time or space.

Future studies in this area could expand on these results by sampling more locations with longer monitoring durations and making comparisons among sympatric and allopatric predator populations. Studies looking into the spatiotemporal activity and avoidance patterns of coyotes and red foxes in the future should also consider using GPS collars or radio telemetry to track their behavior more intensively than what is possible with camera traps. Major & Sherburne (1987) used radio telemetry and were able to evaluate the interspecific relationships of coyotes, red foxes, as well as bobcats, more effectively in time and space. Lastly, having cameras spaced out to avoid multiple detections of the same individual as well as having an estimate for how many total individuals of each species are in Wilderness Park would aid in understanding how these two species interact with each other.

Understanding spatiotemporal activity and avoidance patterns of sympatric predators of different sizes has important implications for future development projects and wildlife management. These carnivore guilds play important roles in ecosystems through their ability to stabilize or destabilize ecosystems through cascading trophic effects. To be effective, wildlife management must understand how changes in coyote densities influence habitat partitioning between two canid species. (Lesmeister et al, 2015).

My results suggested moderate spatial and temporal avoidance between two predator species in Wilderness Park. With the right improvements to this study system, questions regarding the interactions of coyotes and red foxes can more effectively be answered. I hope that this study may function as a basis for future studies to improve upon with more data.

FIGURES

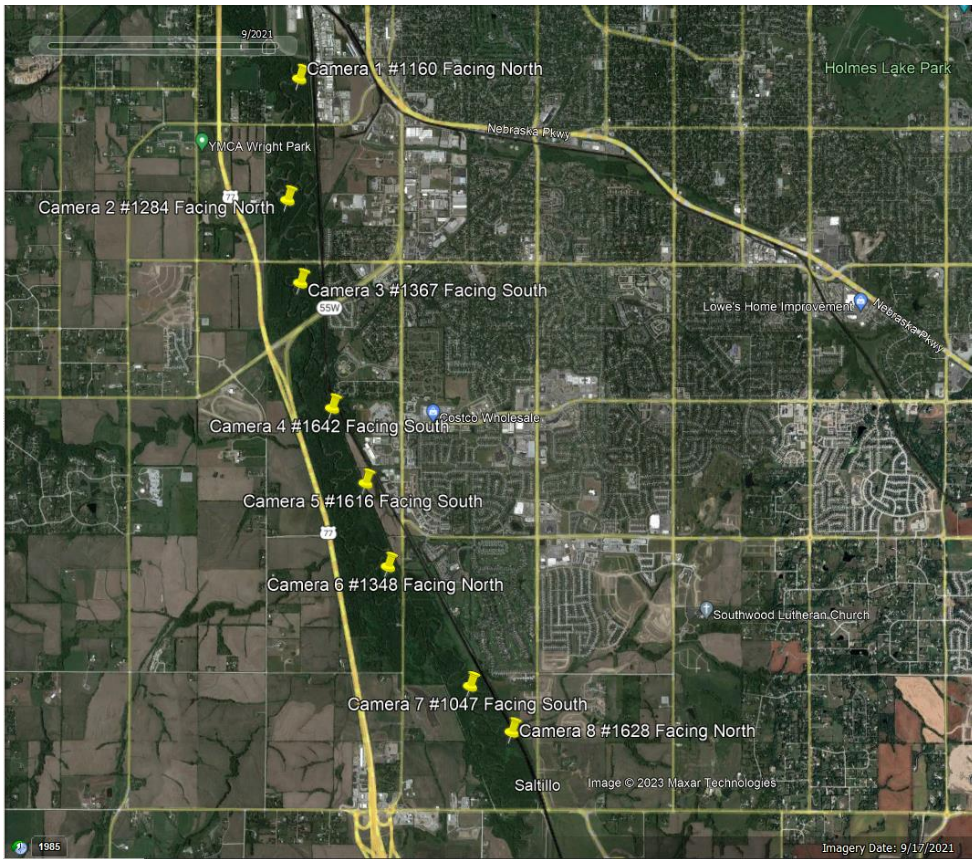

Figure 1: Map of all eight camera locations and the directions they face- located throughout Wilderness Park in Lincoln, Nebraska from 1 March – 11 April 2023.

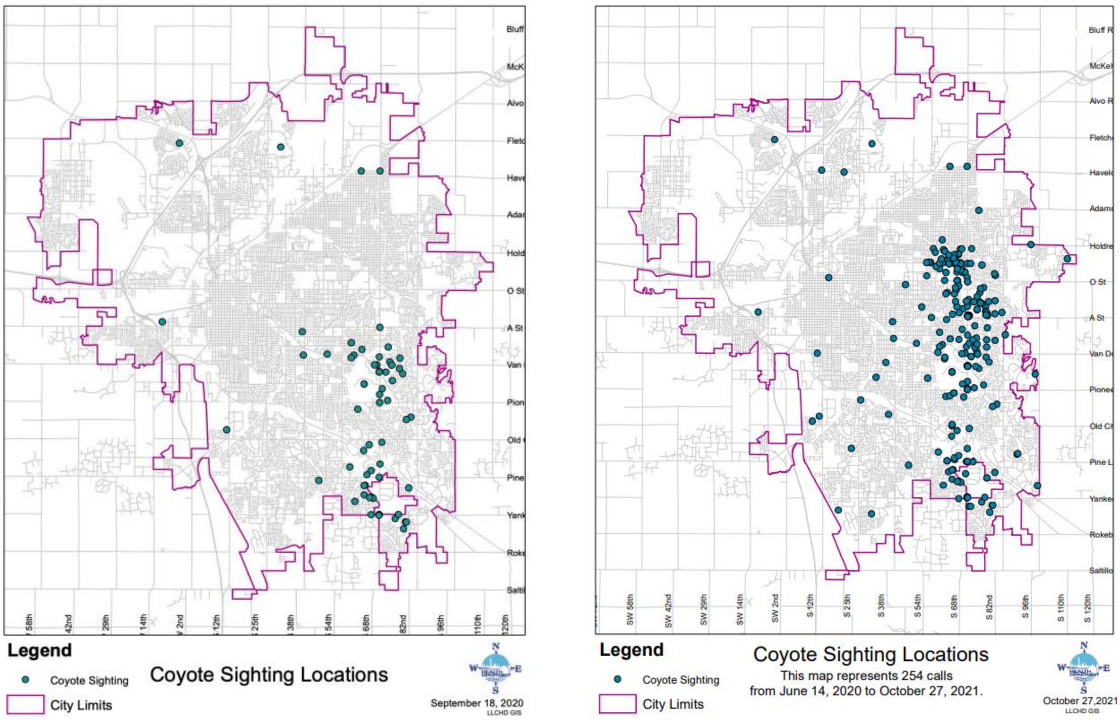

Figure 2: Two maps of locations of calls reporting coyote sightings to Animal Control, showing an increase in coyote sightings in Lincoln from September 16, 2020 – October 27, 2021.

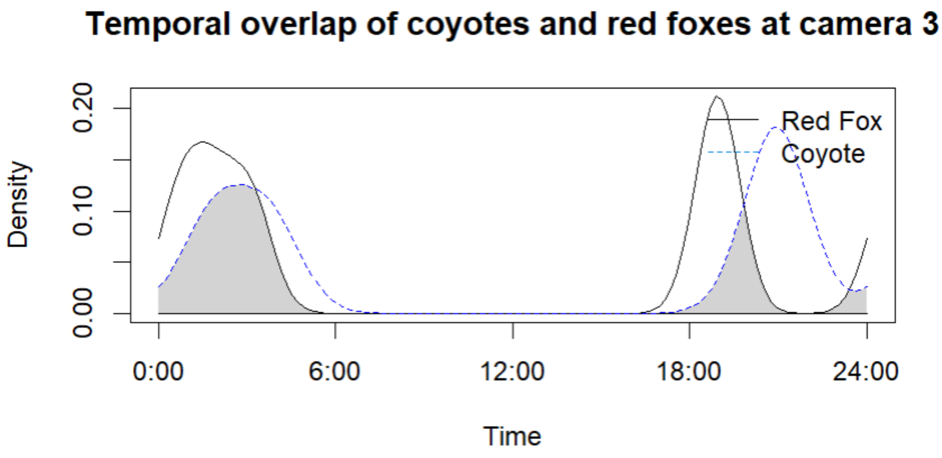

Figure 3: Overlap plot of temporal activity patterns of red foxes and coyotes detected at camera 3 from 1 March – 11 April 2023 in Wilderness Park, Lincoln, Nebraska.

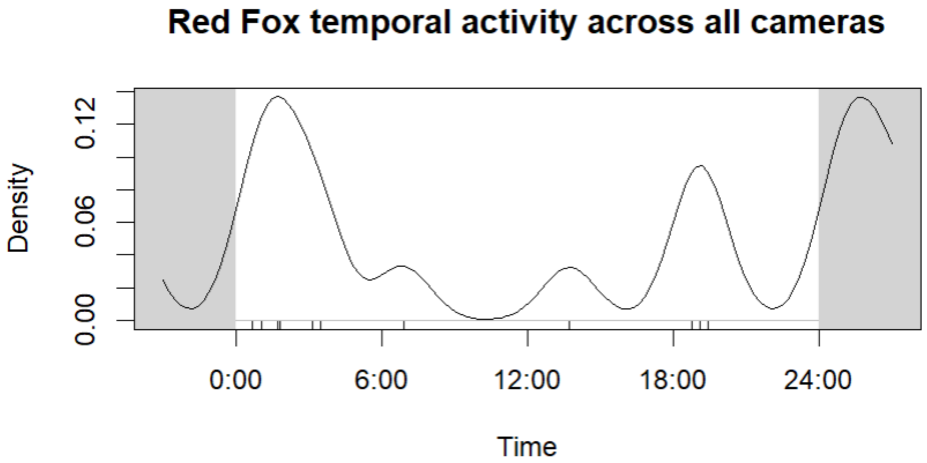

Figure 4: Temporal activity plot of red fox detections gathered across all 8 cameras from 1 March – 11 April 2023 in Wilderness Park, Lincoln, Nebraska.

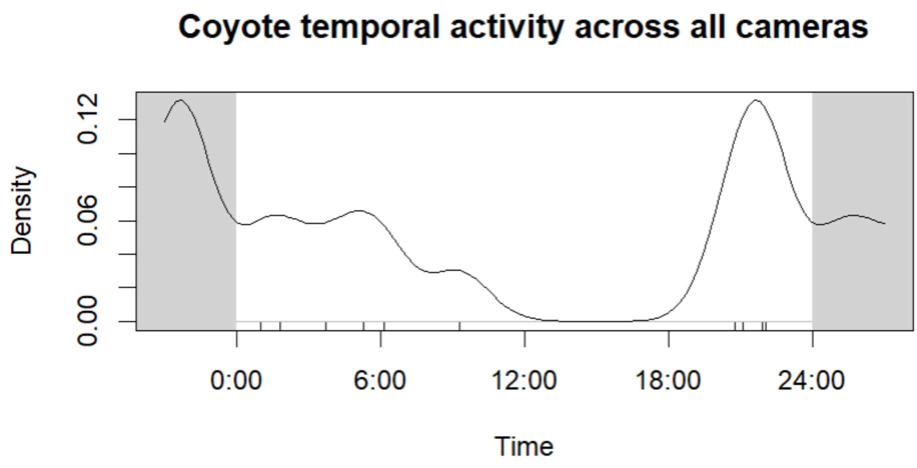

Figure 5: Temporal activity plot of coyote detections gathered across all 8 cameras from 1 March – 11 April 2023 in Wilderness Park, Lincoln, Nebraska.

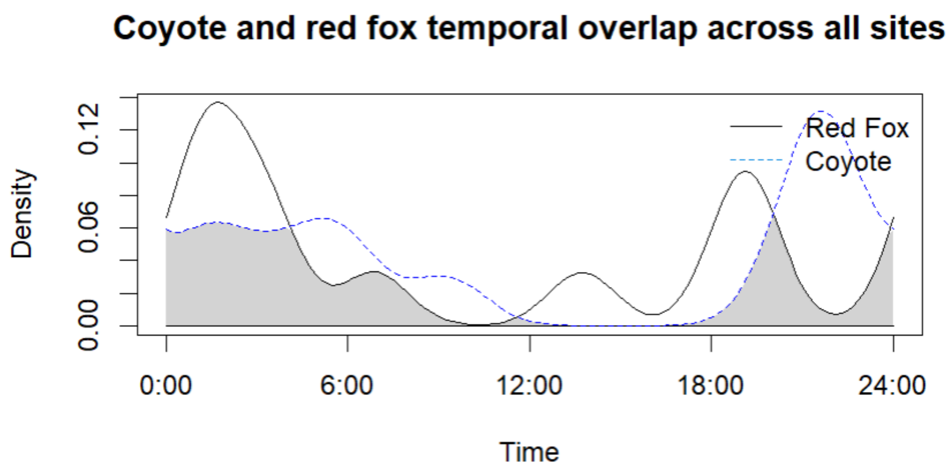

Figure 6: Temporal Activity overlap of Coyotes and Red Foxes across all 8 cameras from 1 March – 11 April 2023 in Wilderness Park, Lincoln, Nebraska.

Camera #	Coyote Detection Rate ((# of detections per camera) / (# of sample days))	Red Fox Detection Rate ((# of detections per camera) / (# of sample days))	Co-occurrence (Yes / No)
1	4.87%	4.87%	Yes
2	4.87%	0%	No
3	9.75%	12.19%	Yes
4	0%	4.87%	No
5	4.87%	2.43%	Yes
6	0%	0%	N/A
7	2.43%	0%	No
8	0%	2.43%	No

Table 1: Detection rates of coyotes and red foxes at each camera location from 1 March – 11 April 2023 in Wilderness Park, Lincoln, Nebraska, with each site checked for co-occurrence.

Camera #	1	2	3	4	5	6	7	8
# Of red fox detections	2	0	5	2	1	0	0	1

Camera #	1	2	3	4	5	6	7	8
# Of coyote detections	2	2	4	0	2	0	1	0

Table 2: Recorded number of detections of red foxes and coyotes at each camera location from 1 March – 11 April 2023 in Wilderness Park, Lincoln, Nebraska.

Camera #	((T2)/(T1))	((T4)/(T3))
1	47.6	1.28
3	5.92	23.37
5	N/A not enough detections	N/A not enough detections

Table 3: AAR for camera sites where it could be applied (cameras 1 and 3) with detections from 1 March – 11 April 2023 in Wilderness Park, Lincoln, Nebraska.

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