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Coyote Occupancy and Movement in Hanover County, Virginia

Richard S. Groover, George Mason University, rgroover@gmu.edu

ABSTRACT

Although the coyote (*Canis latrans*) is native to North America, we have limited understanding of its presence in Virginia. Coyote range expansion is linked to anthropogenic factors, including habitat fragmentation and the extirpation of apex predators. Information on coyote adaptations to Virginia habitats is scarce, and eastern coyotes may have unique adaptations for colonizing an area. Anecdotal evidence suggests that coyotes are abundant in Hanover County (north of Richmond, VA), but this has not been confirmed. This study was conducted over an 18-month period with multiple survey sites throughout Hanover County, each equipped with game camera stations and 20% with scent lures. Coyote detection probability and occupancy was estimated using the "Unmarked" package in "R". With a low detection rate of 16.8%, the study found that coyotes occupied 76.8% of the County. Sixty-one percent of detections may support movement along powerlines, game trails, and fire roads versus movement in dense forest and open fields. This study is the first to provide insight into the occupancy, detection, and movement of the eastern coyote in Hanover County, Virginia. Some movement observations were made and are offered in this study.

Keywords: coyote presence, coyote movement, Hanover County

INTRODUCTION

In Virginia, the coyote (*Canis latrans*) is a non-indigenous, naturalized wild canid. It occupies a variety of habitats (Bekoff, 1977). The local and targeted extinctions of gray wolves (*Canis lupus*), red wolves (*C. rufus*), eastern wolves (*C. lycaon*), and mountain lions (*Puma concolor*) allowed for the expansion of coyotes which previously were not able to compete with these larger predators (Bekoff and Gese, 2003). Home range and territory vary and depend on food availability and habitat (Bekoff, 1977). Hanover County, Virginia is a suitable habitat for eastern coyotes.

The coyote is an opportunistic feeder with smaller mammals being most often eaten. Coyotes may prefer agriculturally modified lands compared to forests (Hinton et al, 2015).

How habitat composition and size of home-range expansion influence coyote populations, however, is not known.

Coyotes' expansion into areas populated by humans increases the risk of wildlife-human conflict. There has been a documented increase in the number of cattle taken by coyotes in the eastern United States since 1991 (Mastro 2011). Wildlife management reports, anecdotal evidence, and overall public concern suggest that coyotes are a threat to livestock.

The purpose of this study was to verify that coyotes are present and to estimate their occupancy and detection rates in Hanover County, Virginia. Anecdotal evidence by local people suggests that coyotes exist in high densities. This study sought to confirm their presence throughout the county and to increase the understanding of the occupancy and detection rates of the eastern coyote. The data also allowed inferences regarding where coyotes often moved in their habitats.

MATERIALS AND METHODS

Hanover County, VA, is approximately 12 miles north of Richmond and is 474 km^2 in size (38.09083333° N, 77.80638889° W). Daily temperatures vary from 32° to 35°C in the summer, and -8° to 8°C in the winter. Hanover County is a mixture of suburban but mostly rural landscapes, and it includes forests, open fields for agriculture, and numerous preserved areas, including several National Battlefield Parks. Along with coyotes, common terrestrial mammals include white-tailed deer (*Odocoileus virginianus*), red fox (*Vulpes vulpes*), gray fox (*Urocyon cinereoargenteus*), bobcat (*Lynx rufus*), black bear (*Ursus americanus*), eastern gray squirrel (*Sciurus carolinensis*), opossum (*Didelphis virginiana*), skunk (*Mephitis mephitis*), raccoon (*Procyon lotor*), and various smaller mammals like moles, voles, and rabbits. Dogs (*Canis lupus familiaris*) and cats (*Felis catus*) are also present, as well as feral cats in some areas.

This study was conducted over two ten-month periods from April 2019 to January 2020 and continued during the same time frame from April to January in 2020 to 2021. The study was designed based on previous low-density carnivore studies, with increased area per sampling site, and less sampling effort per area (Kelly and Holub 2008). A site is a data capture station. Figure 1 provides a site map where data were collected. In most cases only one game camera was placed at a selected location/site. Location selection for camera traps followed an *a priori* methodology where sites were at first selected based on where coyote sightings were originally reported. Later additional sites were randomly selected across the County for the camera trap placement. With some knowledge of coyote habits favoring movement along power line areas and farm roads or trails, assumed for easy travel, some placement of cameras occurred at such sites. Some cameras were also placed along edges of pastures at some surveyed sites. At some locations, cameras were placed in dense forest settings on observed deer trails.

Permission was granted from landowners for all game cameras deployed on private property. All landowners were promised that exact camera locations would not be publicized and GPS locations would be kept confidential because many feared harassments by local hunters who want to kill the coyotes. Actual GPS locations can be provided for science purposes.

All game cameras were Stealth Cam ® model STC-G26NGX trail camera set at 1 image per 5 sec., per trigger. The cameras were secured to a tree, if available, or on a stake. All cameras were placed one meter above ground level and directed towards open spaces, clearings, and trails to increase trap success for medium-sized carnivores (Kolowski and Forrester 2017). GPS coordinates, habitat type, and weather conditions were recorded for each site. Camera trap success was tested through the use of bait for low-density carnivores (Linden et al. 2017), but this method did not result in coyote images. A second method for camera trapping employed a fake fox-hole-like structure, with available wood over the hole, and a coyote trapping lure of concentrate fluid (O'Gormans Wiley-E Fox Urine) was squired in the hole. The fake hole was circular 10 cm wide, 15 cm deep, and a human dug hole; some sticks or small logs were placed over the top. Approximately 20 ml of fox urine was sprayed in the hole. This data collection method resulted in a 50% increase in the confirmed coyote images. Each camera deployment occurred for 14 consecutive days. In total 39 locations across the County were used for game camera deployments. Camera placements were not repeated at the same locations.

The Presence ® software "R" was used with the package "Unmarked" to estimate occupancy and probability of detection. All camera trap observations were used to create a binary detection history (detection = 1, no detection = 0) of coyotes at each location. Days where coyotes were not present at a site were coded as "no detection" in the model. Detectability of individuals were accounted for in the likelihood that species were present at a site, but were undetected using a single-species, single-season occupancy model. Several of the detected sites included images from hunters and were excluded from the analysis for having an unconfirmed recording date. Due to limited sites with positive detections, instead of using a multi-season model, two seasonal covariates based on deployment date (May-September and October-December) were assigned to each site. A two-step methodology suggested by MacKenzie et al. (2018) was used where detection probability was first estimated, followed by a null model (occupancy) and a second model including season as a covariate (MacKenzie et al. 2018). The model of best fit was selected based on the lowest Akaike Information Criterion (AIC_c) value (95% confidence interval).

Some examination of the type of locations were used for coyote movement activity; a statistic of Catch Per Unit Effort was applied. The three categories considered were: powerline, farm roads/game trails, and pasture edges. No analysis was made regarding proximity to aquatic resources. Dense forests game trails yielded no data from the deployed cameras.

RESULTS

Twenty-three of the 39 sites had at least one detection from the camera trap images during each 14-day data collections. Some sites had multiple images. Coyote occupancy across Hanover County was estimated at 76.80% (± 9.69% SE) with a detection probability of 16.8% (± 2.38% SE). The AIC for the null model (omitting ownership type) was 341.2658, and the AIC for our null model with ownership as a covariate was 335.94. Land ownership and human activity was therefore found to be a factor in coyote detection, however the difference between each model's AIC is small (DAIC = 5.32).

Figure 1, Results of Hanover County Coyote Research, shows the 39 sites where either cameras were deployed or private landowner's images were provided. The detection notation is the location where camera images of coyotes were captured; the no-coyote detection notation is a location where no coyote image was captured over a fourteen-day period.

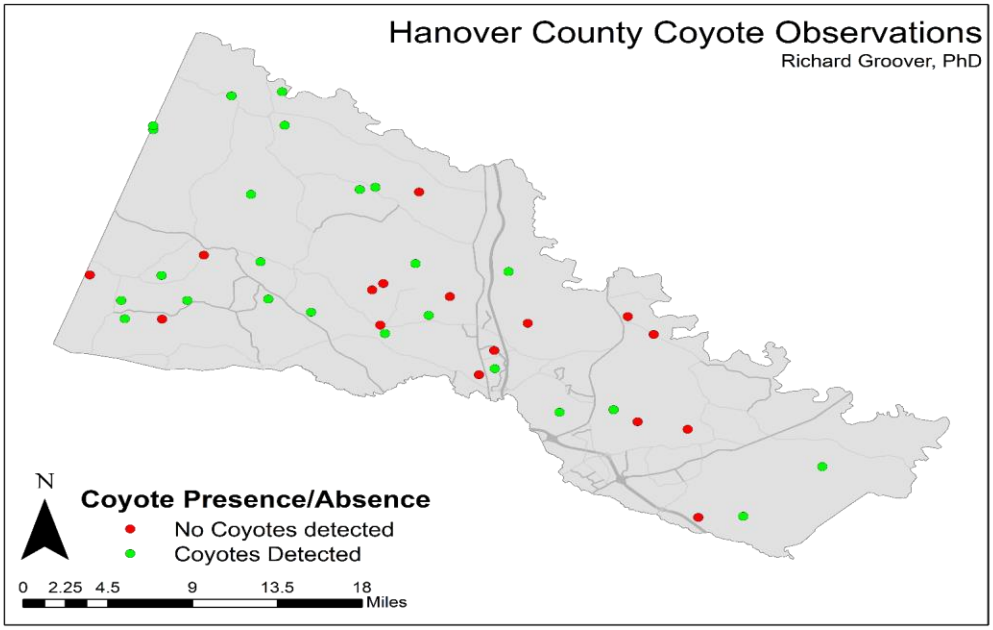

Figure 1. Preliminary sites within Hanover County, VA where camera traps were deployed from April 2019 to January 2021. Each coordinate had a camera with a coyote detected (green dot) or not detected (red dot). Three additional detected sites were images from hunters but were excluded from the analysis for having an unconfirmed deployment period. Exact GPS locations are confidential as requested by most landowners.

Further analysis of collected data reveals that 61% (28 + 33) of the detected coyotes occurred combining powerlines, farm roads, and game trail data. This is noted in Figure 2, Comparison of Coyote Sightings by Location Type. Thirty-nine percent of sightings occurred at pasture edge locations.

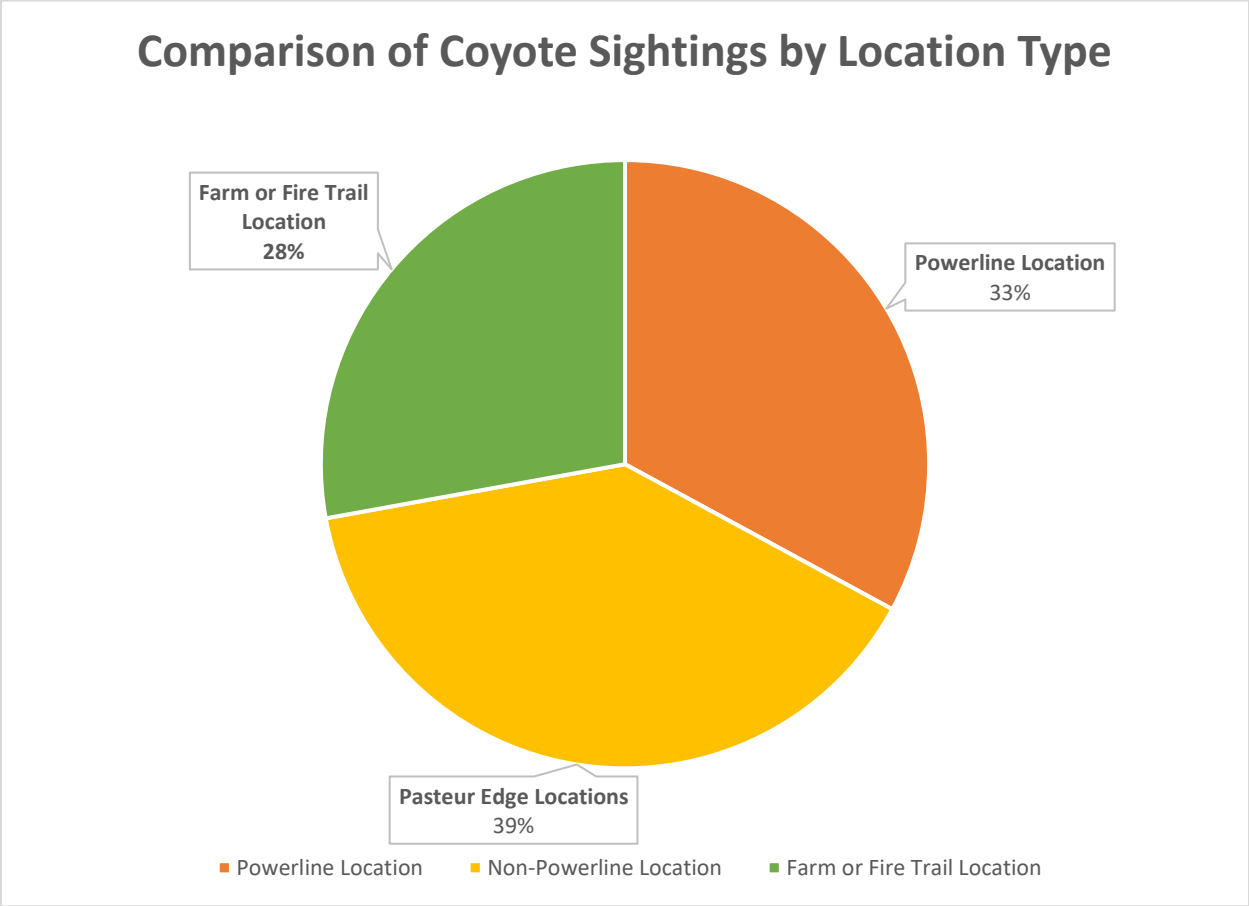

Figure 2. Comparison of Coyote Sightings by Location Type. Data were analyzed using a Catch Per Unit Effort statistic.

In this study coyotes were observed during the daytime and at night. Figure 3 provides an image of a coyote active at 9:30 AM, ET.

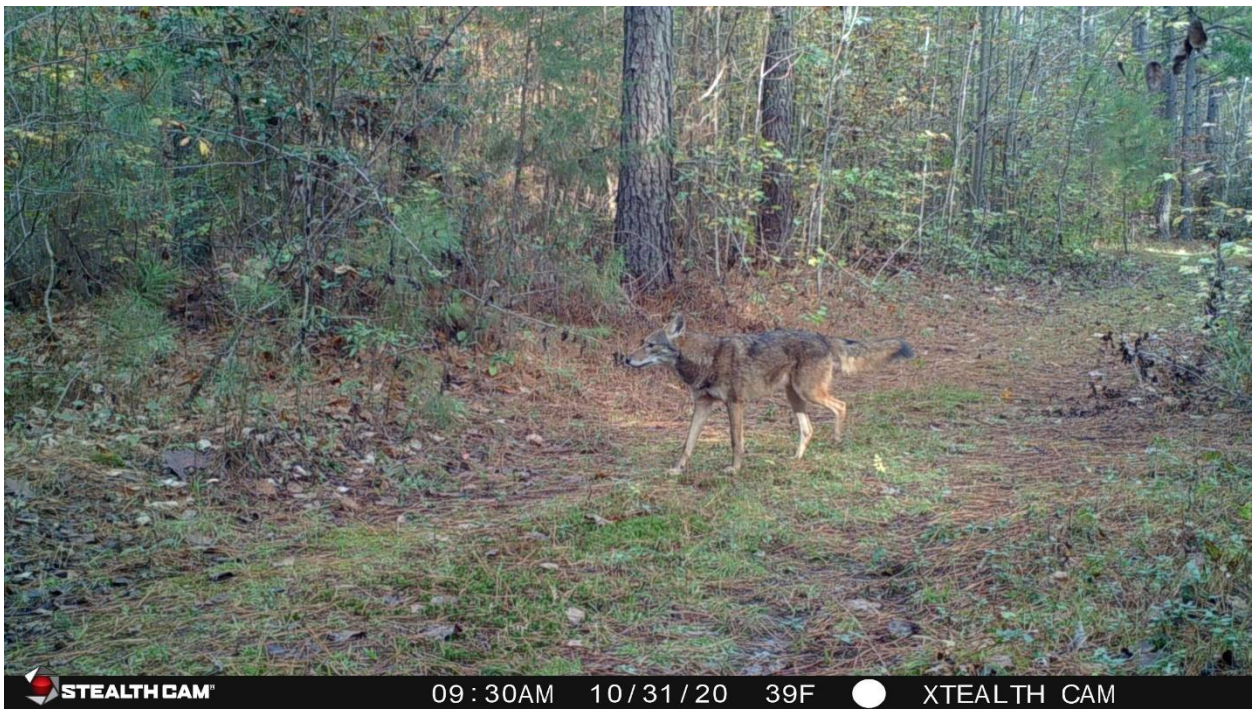

Figure 3. Coyotes were camera trapped during the daytime and at night. This image was at 9:30AM ET on October 31, 2020, captured as it moved along a farm road in western Hanover County.

DISCUSSION

The goal of this study was to provide preliminary information on the occupancy of coyotes in Hanover County. It is verified by this study that coyotes are found in Hanover County, Virginia, and are possibly annual residents. How many might be transient is unknown. Data on dens numbers, den locations, and annual fecundity was not addressed or intended in this study. Additional reports regarding hunting reveal that over 100 coyotes are killed annually in Hanover. Surviving females will repopulate their habitat within one year, unless the killed number drops below 60% (Fies 2019). An actual population count of coyotes in Hanover County cannot be made by this study, but the population continues to be sustained.

Determining density is difficult since individuals may move as much as 8.05 km per day, as Bekoff (1977) and Parker (1995) have identified as a dynamic condition. Home ranges will change during the year, based on the availability of food resources and human development pressures.

How transient and resident coyotes may influence the Hanover County population and their occupancy estimates is not clear. Transients may be less likely to contribute to the population as they produce less pups, but they may facilitate metapopulation dynamics and gene flow by replacing residential coyotes in a pack if mortality occurs (Hinton et al. 2015). Resident coyotes in urban Tucson, Arizona had an average range size that was approximately 27 km^2 less than suburban individuals, likely due to more barriers to movement or higher food availability from human sources (Grubbs and Krausman 2009). The Virginia Department of Wildlife Resources estimates the State has 50,000 coyotes, but range studies and actual density in Hanover are unknown. In two more mountainous counties of Bath and Rockingham, the densities were 0.22 mi^2 and 0.14 mi^2 respectively (Knox 2019).

Coyotes can thrive in anthropogenic habitats along the rural-urban gradient. Coyotes are responsible for loss of livestock, with 298 sheep, 34 goats, and 54 calves killed by coyotes on 187 farms, statewide, in 2017 (Fies 2019). Future studies might consider how different habitat covariates can influence coyote occupancy (forest coverage, suburban land use, proximity to a water source). Mackenzie et al. (2018) suggests having 30 detections per covariate for robust statistical power, so the number of survey sites could be increased to gain more information on what factors influence coyote occupancy in Hanover County, VA.

Several Hanover County locations had no coyote camera images collected during this study, yet citizens had heard or had seen coyotes from time to time at those locations. Placement of camera equipment could have affected this data. Further sampling at such locations could be made using sound detection, such as sound responses with a siren to elicit vocal responses by coyotes near the tested site. This method of detection has been acknowledged by Okoniewski and Chambers (1984).

Movement patterns were not a specific focus of this study, but some inference might be considered due to the data collected; 61% of the coyotes imaged traveled along powerlines, game trails, and farm roads. More research as to movement behavior might be continued. No images were collected from cameras that were placed in dense forest settings on observed deer trails.

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