eMammal Final Report

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Executive Summary

From December 2015-February 2016, eMammal worked with citizen scientists to conduct a camera trap mammal survey of Averasboro Battlefield, Camassia Slopes Preserve, Duke Forest, Goodwin State Forest, and PeeDee National Wildlife Refuge. We set a total of 73 cameras distributed randomly throughout each property. All animals in the captured photographs were identified to species by the volunteers, reviewed by experts to verify the species identification, and uploaded to the eMammal data repository housed at the Smithsonian Institution. In this report we present baseline information regarding the presence, activity, and site use for all mammal and ground bird species captured on our cameras and compare these with other nearby sites that eMammal has sampled in the past. We present detection maps for common species as well as measures of species richness and intensity of use of the commonly detected species and make some comparisons between a site and others nearby.

The survey was conducted over a period of three months resulting in a total of 1,494 camera nights of survey effort and over 1,000 animal detections. Of the 11 species detected by our cameras, white-tailed deer was the most common followed by eastern cottontail, coyote, and eastern gray squirrel. The most rarely detected species were red fox, wild turkey, and bobcat. We also detected both domestic dogs and domestic cats. Species richness was highest at Averasboro Battlefield and PeeDee National Wildlife Refuge (8 species) and lowest at Goodwin State Forest (5 species). White-tailed deer were detected at all sites but activity varied widely, being highest at PeeDee National Wildlife Refuge and lowest at Goodwin State Forest.

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1.0 Introduction

1.1 General Background

Most mammals possess large home ranges and are affected by ecological processes that occur on a fairly large scale. Studying the ecology of those species is most relevant at the large, landscape scales; however, studies of wildlife on these larger scales are rare. This is because data collection on the larger scales (landscape, regional, national, global) is generally constrained by budget and manpower. Citizen Science represents a new avenue for conducting large-scale biological studies because volunteers provide the manpower; thus, larger volumes of data can be collected for less money. While Citizen Science offers some clear advantages to biological data collection, there are also potential challenges. Variation in volunteer skills can lead to variation in sampling efforts and data quality, which can be a major concern for this type of work. Rigorous training and a simple sampling design is key to getting the most out of Citizen Science collected data. Despite the challenges, Citizen Science projects are valuable not only because of the important scientific data they collect, but also because of their involvement with the community in nature and sciences. The success of this approach is most obvious in birds, where a long history of bird monitoring programs such as Christmas Bird Counts or Breeding Bird Surveys have not only provided important long-term data on bird populations (Sauer 2008), but also help build large communities of bird-watchers who care greatly about the preservation of nature. Modern web technology has allowed for a great expansion in this type of work, with the eBird site receiving now over 1.5 million bird records per month (Sullivan et al. 2009). Mammals are more difficult to see; thus, they have not been subject to as many Citizen Science efforts. Motion-sensitive camera traps offer a new opportunity to engage citizens in collecting survey data on mammal communities. The success of our early Citizen Science work along the Appalachian Trail shows that this activity is fun for participants (90+% return rate from year to year), and also that it can produce rigorous scientific data (Erb et al. 2012). Indeed, the pictures from camera traps are analogous to museum specimens, providing a photographic voucher of a particular species recorded at a particular place and time.

1.2 Project Sites

We surveyed a total of 73 sites between December 2015 and February 2016 (Figure 1). Sites were chosen at random while avoiding high human traffic areas and maintaining a spacing of at least 200m between adjacent cameras. All cameras ran continuously for approximately 3 weeks. Survey effort totaled 1494 camera nights.

1.3 Contents of this Report

This report represents the results of the eMammal project to survey mammal intensity of use and activity along an urban-rural gradient around the city of Raleigh, NC. These results include descriptive statistics and maps of animal detections within Averasboro Battlefield, Camassia Slopes Preserve, Duke Forest, Goodwin State Forest, and PeeDee National Wildlife Refuge. The data presented here do not incorporate any estimates of detection probability and may not reflect true abundance. Future analyses of these data will involve occupancy modeling, which will allow us to address our questions of the effect of consumptive and non-consumptive recreation on wildlife. Occupancy modeling takes into account detection probability, which allows us to control for site-specific differences that might affect how animals are detected by cameras. In this way, we will be able to make an inference using data collected over all sites. However, these analyses will take some time and are therefore not included in this report. We will make the results of these analyses available to all agency and volunteer participants in the form of a peer-reviewed publication by the end of 2017.

2.0 Materials and Methods

Field work began in December 2015. Seventy-three cameras were set by eMammal volunteers and left for 3 weeks between December 2015 and February 2016. All volunteers who helped set cameras for the project were trained either in person or online to ensure that all camera protocols were standardized. All pictures were identified and uploaded using eMammal software to be stored in the Smithsonian Data Repository.

2.1 Volunteer recruitment and training

We recruited student volunteers by working with professors at NCSU to integrate eMammal into the classroom. We recruited Citizen Science volunteers by advertising on blogs, radio shows and newspaper articles. Most of our citizen scientists were adults, although some minors did participate with the supervision of a parent. In total, 30 volunteers participated in this project, contributing a total of 200 volunteer hours. The eMammal team had volunteers complete an online, video-based training course. Trainings were comprehensive and included how to use a GPS, how to setup and use a camera trap, how to use the eMammal software and how to identify mammal species. Volunteers were provided with all necessary equipment, including the cameras, memory cards, batteries and camera locks.

2.2 Camera surveys

Camera locations were chosen by the eMammal team in as random a fashion as possible. Adjacent cameras were spaced at least 200m apart to maintain sample independence. Seventy-three sites were sampled over the course of the project. All cameras ran for 3 weeks.

Figure 1: A map of all camera sites sampled by the eMammal Project from December 2015-February 2016.

2.3 Animal data collection and verification

To transfer data from the volunteers to eMammal staff, volunteers used a custom software application called “Leopold” to identify animal pictures and upload the data to a cloud storage location. The eMammal team used a web-based data review tool to verify and, if necessary, correct volunteer identifications. Past projects have shown that the average volunteer success in species identification is quite high (97.2%) (Forrester et al. *in review*). The Smithsonian Institution has developed a data repository to store all camera trap photos as digital museum “specimens” that will be curated as a publically accessible Smithsonian collection. This repository is accessible to other institutions to store, search, and analyze their own camera trap data.

2.4 Data analysis

The analyses presented in this report focus on raw animal counts and rates. Raw counts and rates are presented in a number of basic, descriptive ways: species richness, community composition, and activity over time of day. Species richness is the number of species present in a community and is the simplest representation of diversity. To measure species richness, we simply count the number of difference species detected in each protected area. Community composition is another representation of diversity and incorporates the relative abundance of species within the community. This is more accurately a measure of the relative activity level of each species at the site. We used the raw animal count data to generate proportional histograms to illustrate the active time of each species in each protected area by time of day. This information allows us to compare activity patterns between species and look for indications of attraction or avoidance.

3.0 Results

PeeDee National Wildlife Refuge was notable for having the highest white-tailed deer and eastern cottontail activity, and the only eastern fox squirrel detections of all the sites sampled. Camassia Slopes preserve had the most Virginia opossum activity and the only red fox detections. Averasboro Battlefield had the most coyote and grey fox activity of all sites, and Goodwin Forest had the only wild turkey detections.

3.1 Species Richness

Over the entire study, we detected 11 different mammal species. Species richness (diversity) was highest in Averasboro Battlefield and PeeDee National Wildlife Refuge, with 8 different species detected, and lowest in Goodwin State Forest with 5 different mammal species detected (Figure 2). We note that species richness is directly related to the amount of sampling

done in each site (Table 1), and therefore species richness reported here is most likely not a complete count of all species that use each site.

3.2 Community Composition and Activity

Accounting for the amount of time each camera ran (number of days) provides a more accurate index of animal activity/relative abundance than raw counts. Activity indices combining all sites sampled show that white-tailed deer were the most commonly detected species overall, followed by eastern cottontail, coyote, and eastern gray squirrel. The least commonly detected species over all sites sampled were red fox, wild turkey, and bobcat (Figure 4). To illustrate animal activity, we mapped average detection rate for the most commonly detected species and displayed the results using proportional symbols (Figures 7-9).

3.3 Animal Activity Compared to Nearby Protected Areas

We noted interesting differences in animal activity in these protected areas. Overall, PeeDee National Wildlife Refuge had the highest rate of mammal detections, and Goodwin State Forest had the lowest (Figure 3). From Figures 5 and 6, we can observe the relative levels of animal activity within each site. White-tailed deer were the most commonly detected species in all five sites. Averasboro Battlefield had the highest activity of coyote, grey fox, and northern raccoon compared to all sites. Camassia Slopes Preserve had the most Virginia opossum activity and the only detections of red fox. While animal activity was relatively low in Duke Forest and Goodwin State Forest, Duke Forest had the second highest rate of northern raccoon activity and Goodwin State Forest was the only site in which we detected wild turkeys. PeeDee National Wildlife Refuge had the highest rates of white-tailed deer, eastern cottontail, and eastern gray squirrel activity of all the sites, and was the only site in which we detected eastern fox squirrel. Figures 10-15 show how the detection rates of the most commonly detected species varied between sites.

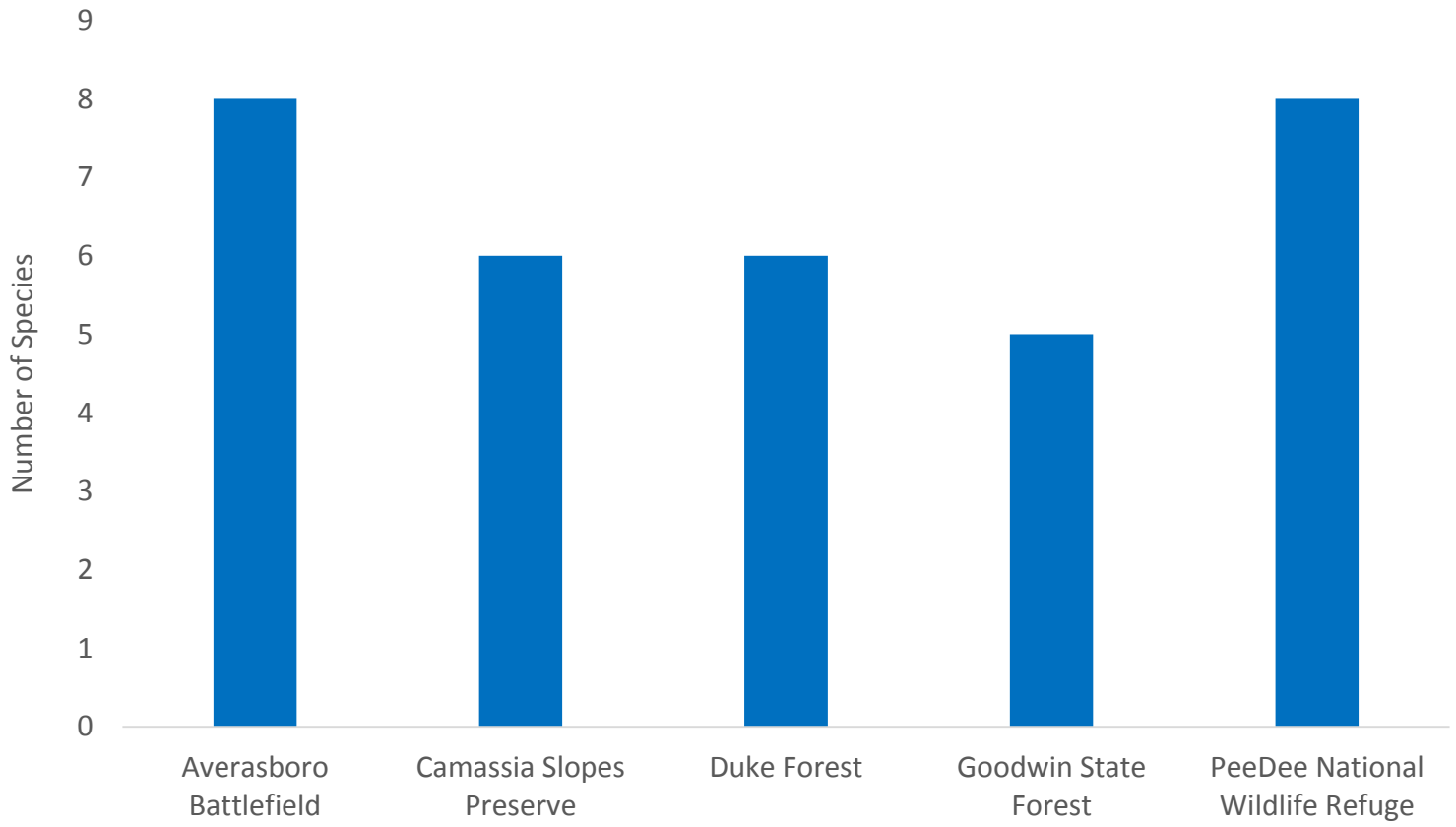


Figure 2: Species richness: the number of mammal species detected within each site from December 2015-February 2016.

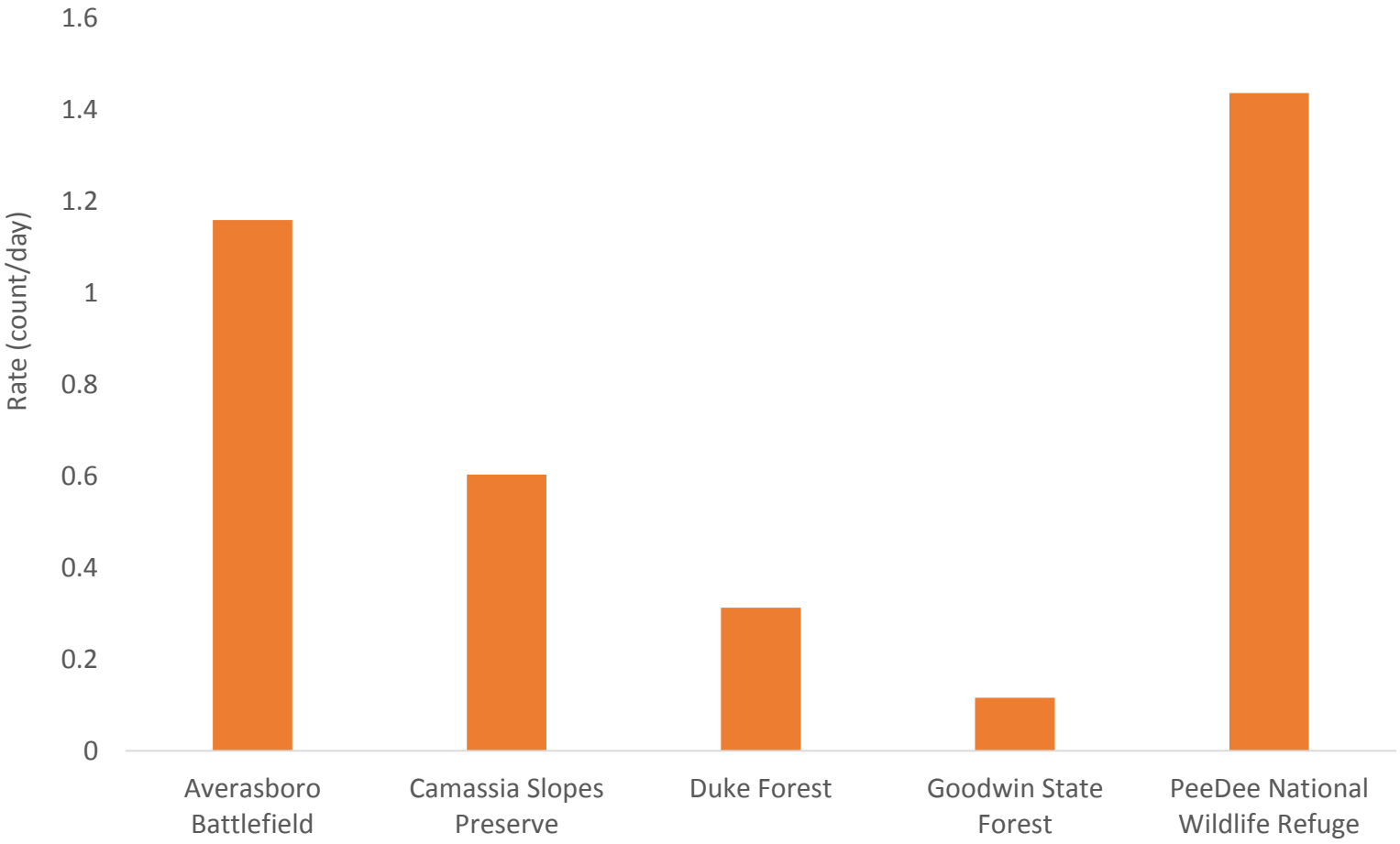


Figure 3: The average count/day of mammal species within each site from December 2015-February 2016.

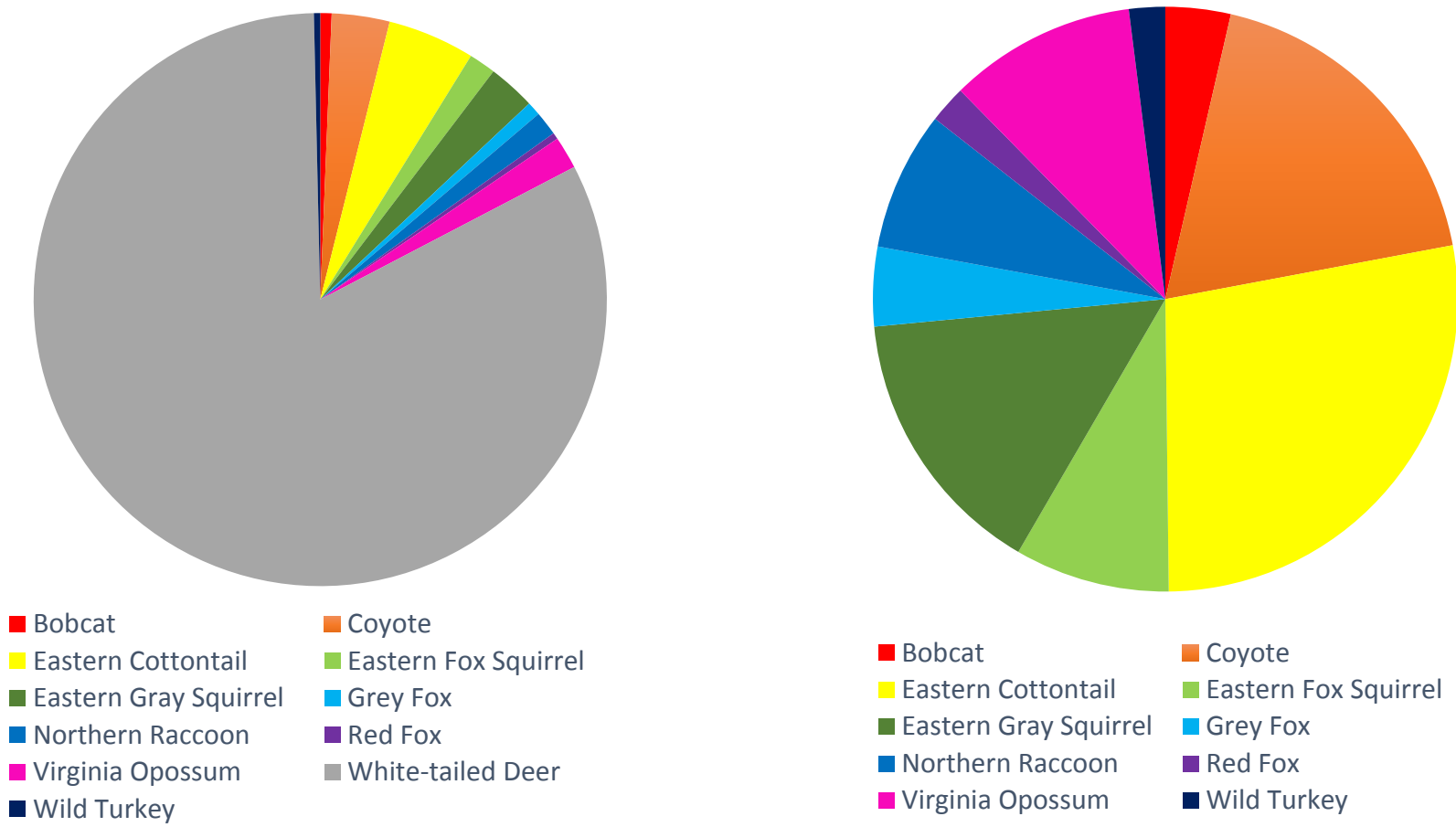


Figure 4: Pie chart showing the overall relative detection rates (count/day) for mammal species in all five sites (Averasboro Battlefield, Camassia Slopes Preserve, Duke Forest, Goodwin State Forest, and PeeDee National Wildlife Refuge) from December 2015-February 2016. The chart on the left includes all mammal species detected, while the chart on the right omits all white-tailed deer detections to better view the relative detections of the other mammal species.

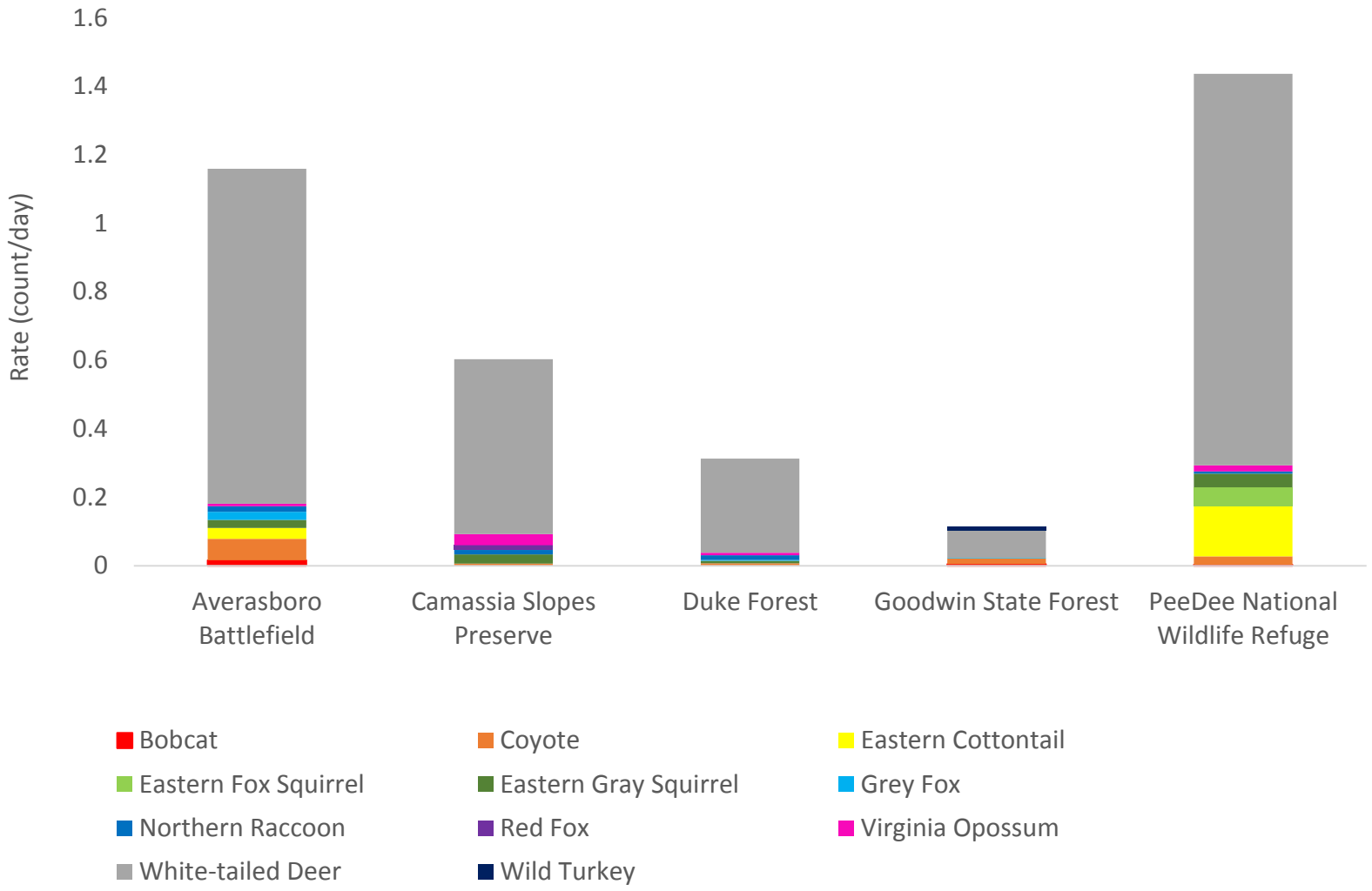


Figure 5: Stacked graph showing the relative detection rates (count/day) for all mammal species in each site sampled by eMammal from December 2015-February 2016.

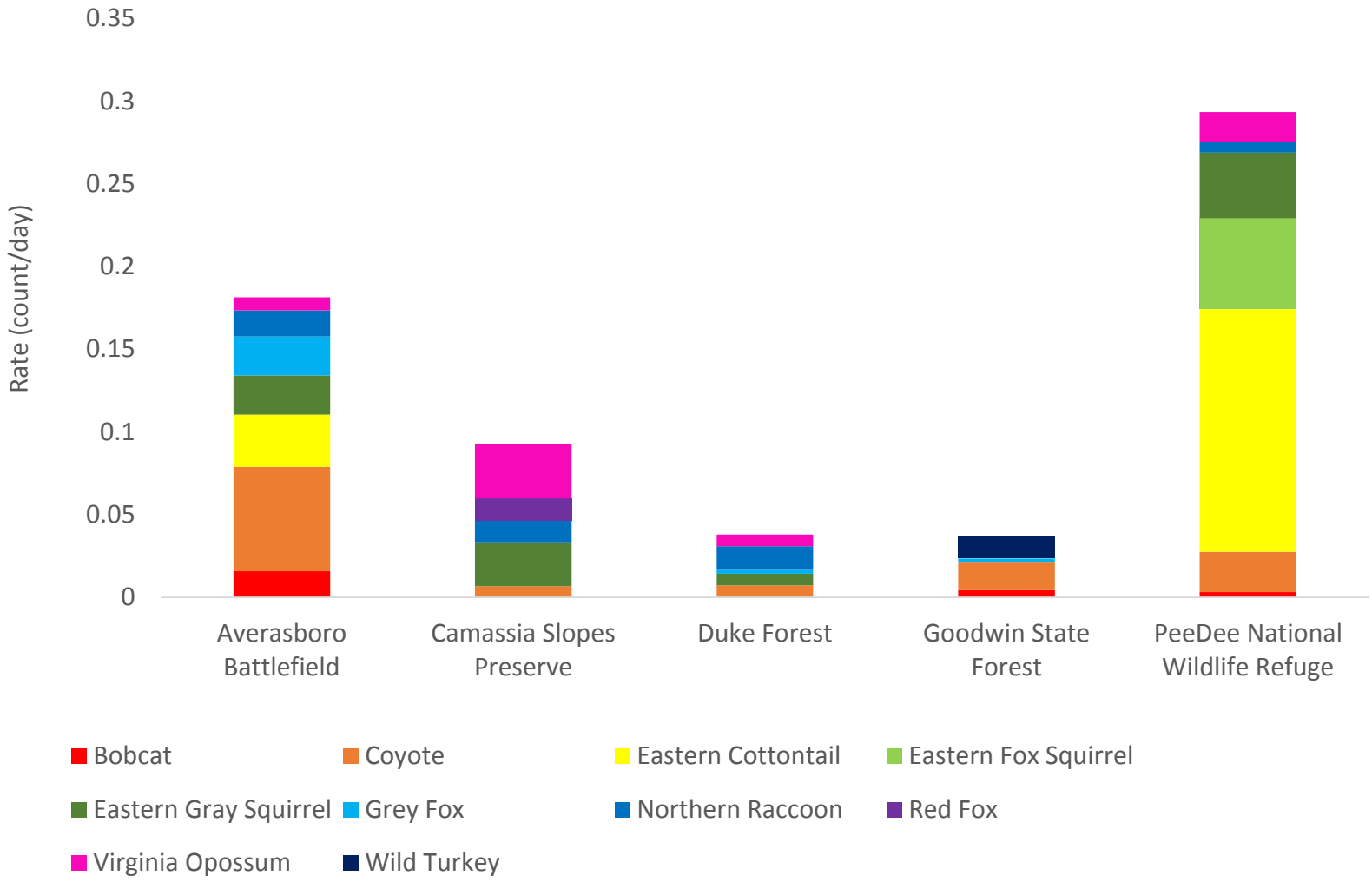


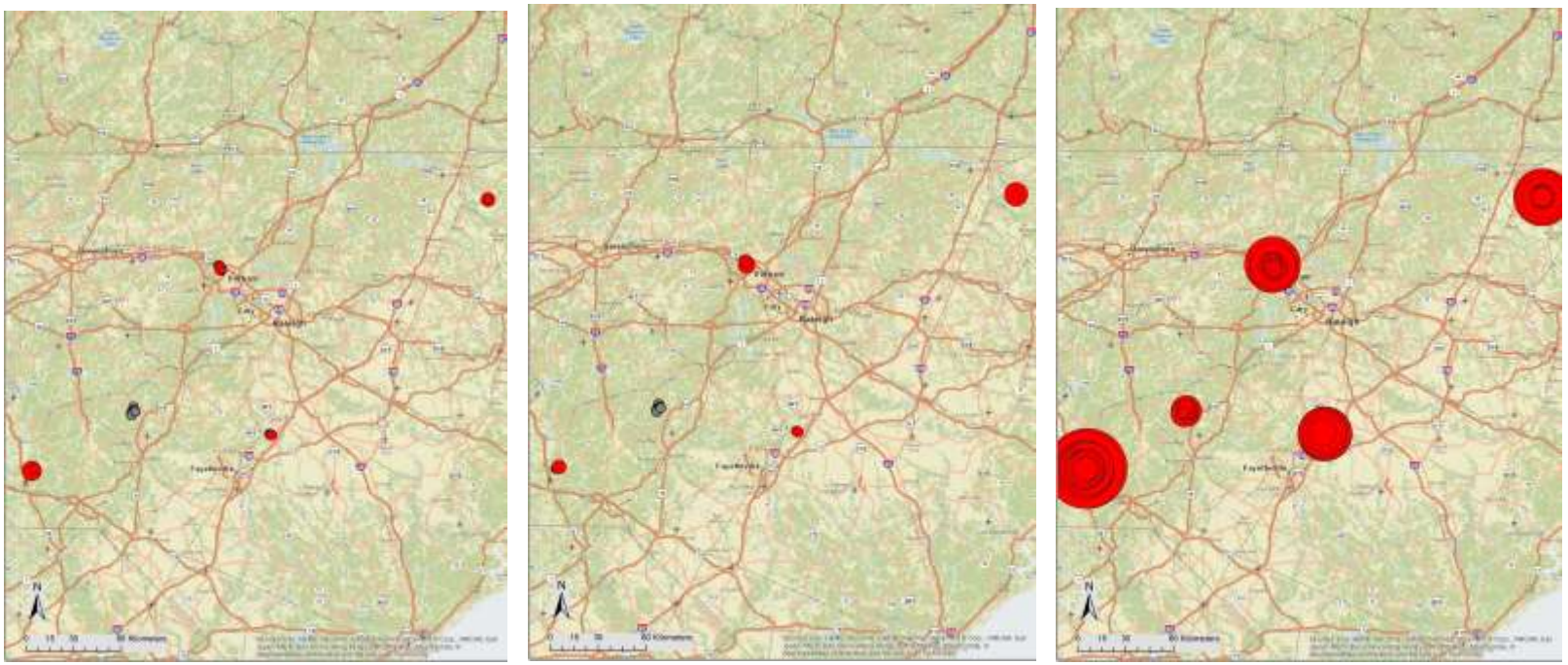
Figure 6: Stacked graph omitting all white-tailed deer detections to better view the relative detection rates (count/day) for the other mammal species in each site sampled by eMammal from December 2015-February 2016.

Bobcat Coyote Eastern Cottontail

Figure 7: Average bobcat, coyote, and eastern cottontail detection rate (count/day) at each camera site in Averasboro Battlefield, Camassia Slopes Preserve, Duke Forest, Goodwin State Forest, and PeeDee National Wildlife Refuge from December 2015-February 2016. The size of the circles is proportional to the average detection rate at that location. Gray circles denote sites where that species was not detected.

Eastern Fox Squirrel | Eastern Gray Squirrel | Grey Fox

Figure 8: Average eastern fox squirrel, eastern gray squirrel, and grey fox detection rate (count/day) at each camera site in Averasboro Battlefield, Camassia Slopes Preserve, Duke Forest, Goodwin State Forest, and PeeDee National Wildlife Refuge from December 2015-February 2016. The size of the circles is proportional to the average detection rate at that location. Gray circles denote sites where that species was not detected.



Virginia Opossum | Northern Raccoon | White-tailed Deer

Figure 9: Average Virginia opossum, northern raccoon, and white-tailed deer detection rate (count/day) at each camera site in Averasboro Battlefield, Camassia Slopes Preserve, Duke Forest, Goodwin State Forest, and PeeDee National Wildlife Refuge from December 2015-February 2016. The size of the circles is proportional to the average detection rate at that location. Gray circles denote sites where that species was not detected.

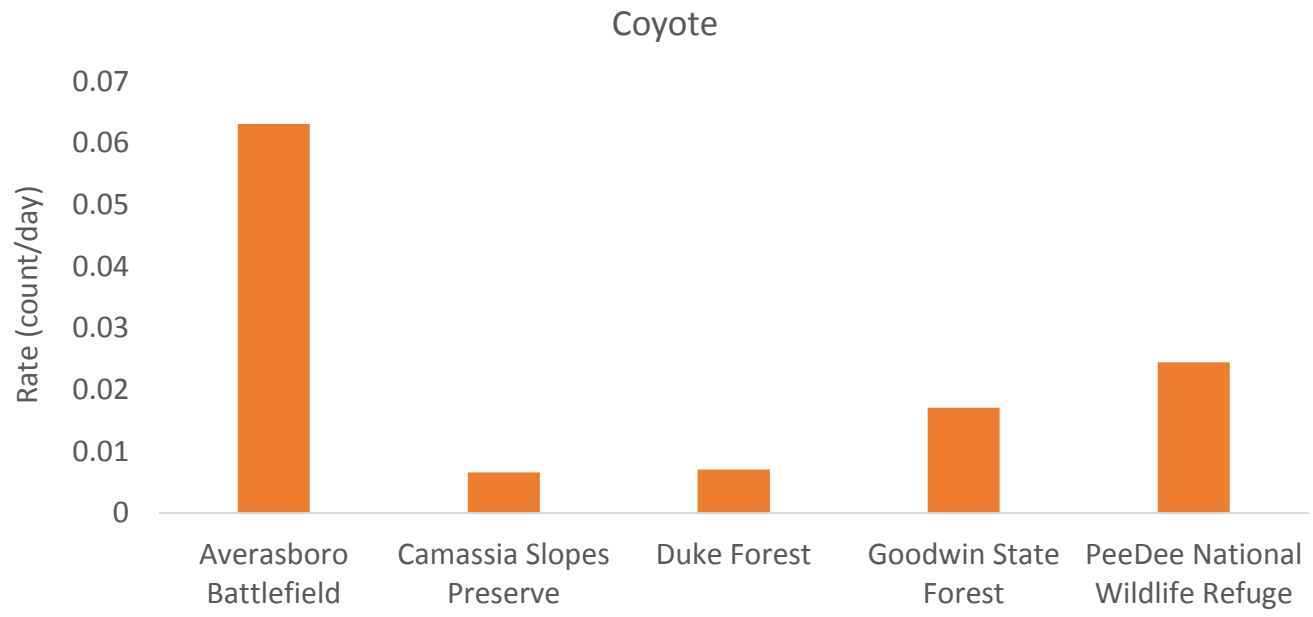


Figure 10: Coyote activity (count/day) compared between each site from December 2015-February 2016.

Figure 11: Eastern cottontail activity (count/day) compared between each site from December 2015-February 2016.

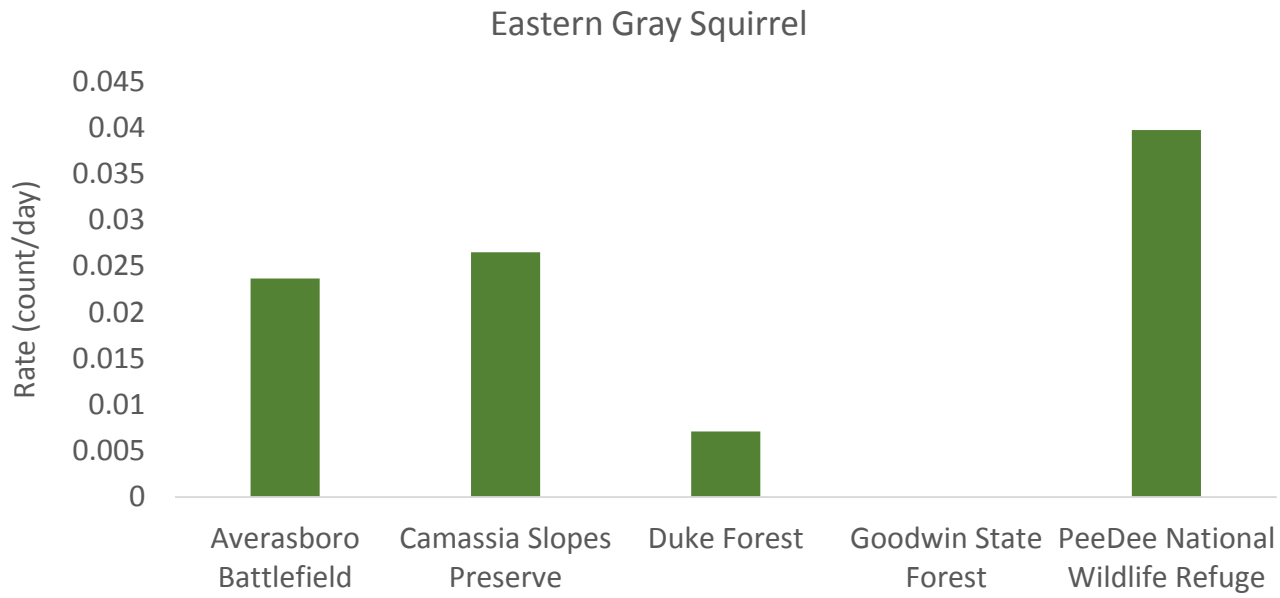


Figure 12: Eastern gray squirrel activity (count/day) compared between each site from December 2015-February 2016.

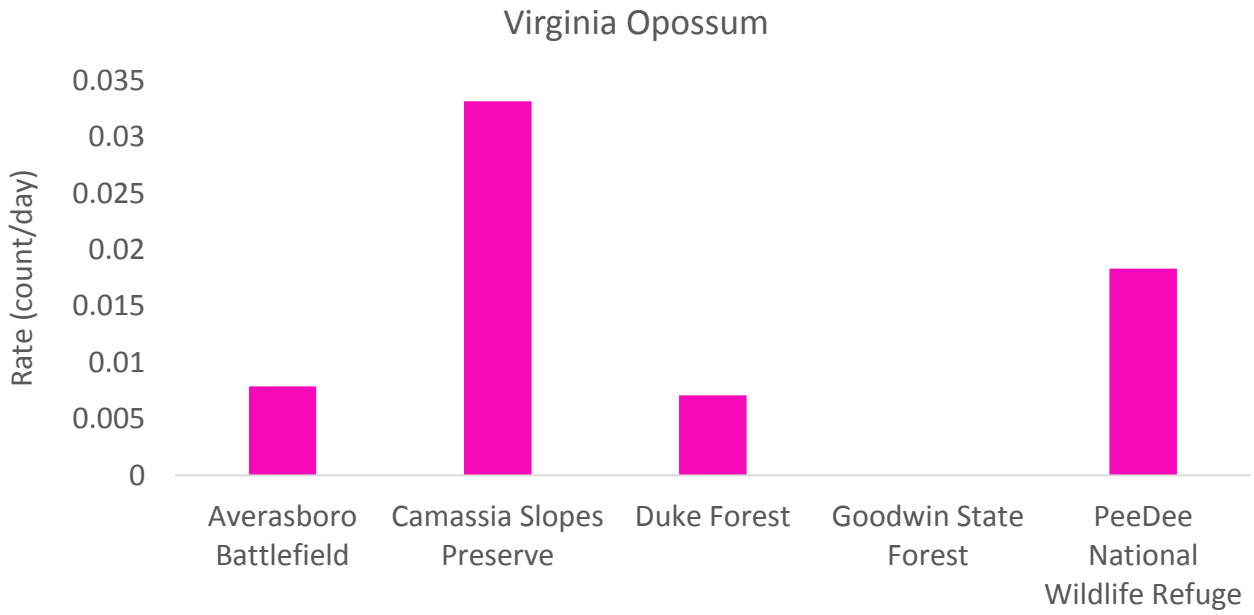


Figure 13: Virginia opossum activity (count/day) compared between each site from December 2015-February 2016.

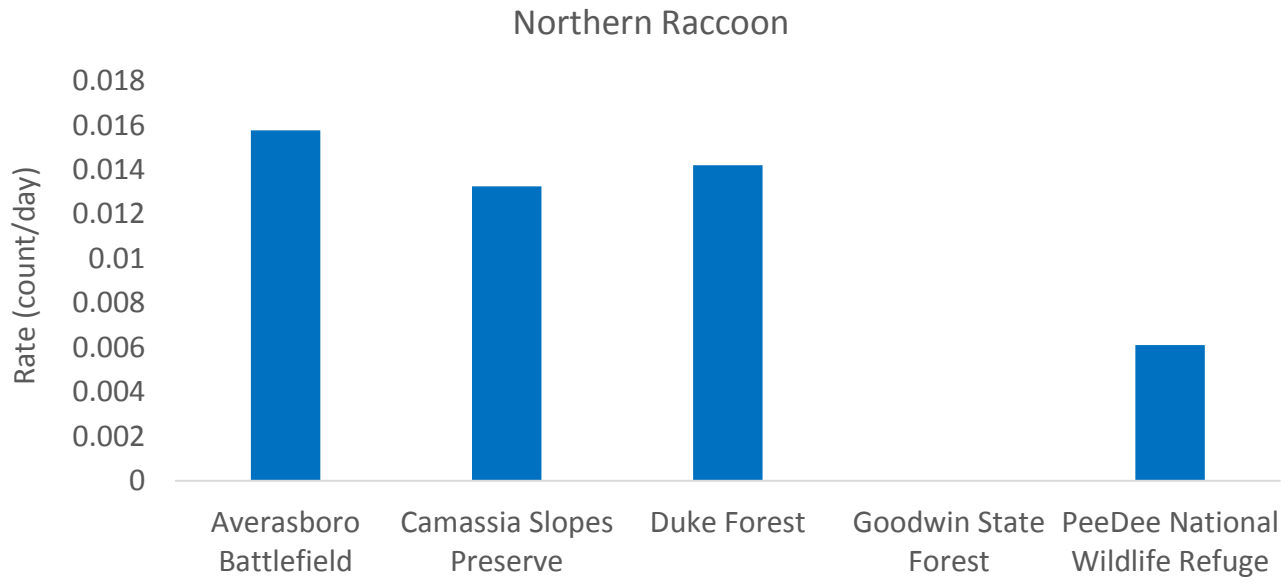


Figure 14: Northern raccoon activity (count/day) compared between each site from December 2015-February 2016.

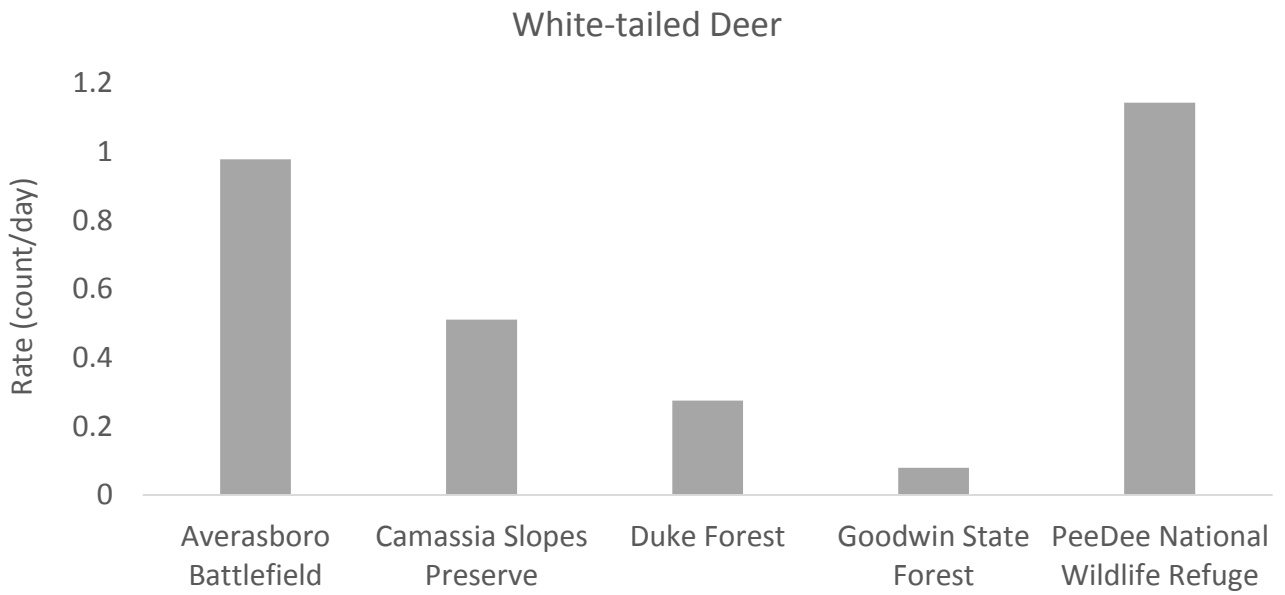


Figure 15: White-tailed deer activity (count/day) compared between each site from December 2015-February 2016.

3.5 Daily Activity Patterns

Animal activity patterns represent the times of day that different species are more commonly detected; thus, they are likely more active. Figures 16-22 show the activity patterns for the most common species detected in Averasboro Battlefield, Camassia Slopes Preserve, Duke Forest, Goodwin State Forest, and PeeDee National Wildlife Refuge from December 2015 to February 2016. As expected, eastern cottontail, northern raccoon, and Virginia opossum were primarily nocturnal over all sites sampled. While coyotes are usually nocturnal species, they showed a large spike in afternoon activity from our sample sites. Eastern fox squirrel was primarily diurnal and the normally diurnal eastern gray squirrel showed a more crepuscular pattern. White-tailed deer showed a crepuscular pattern as expected.

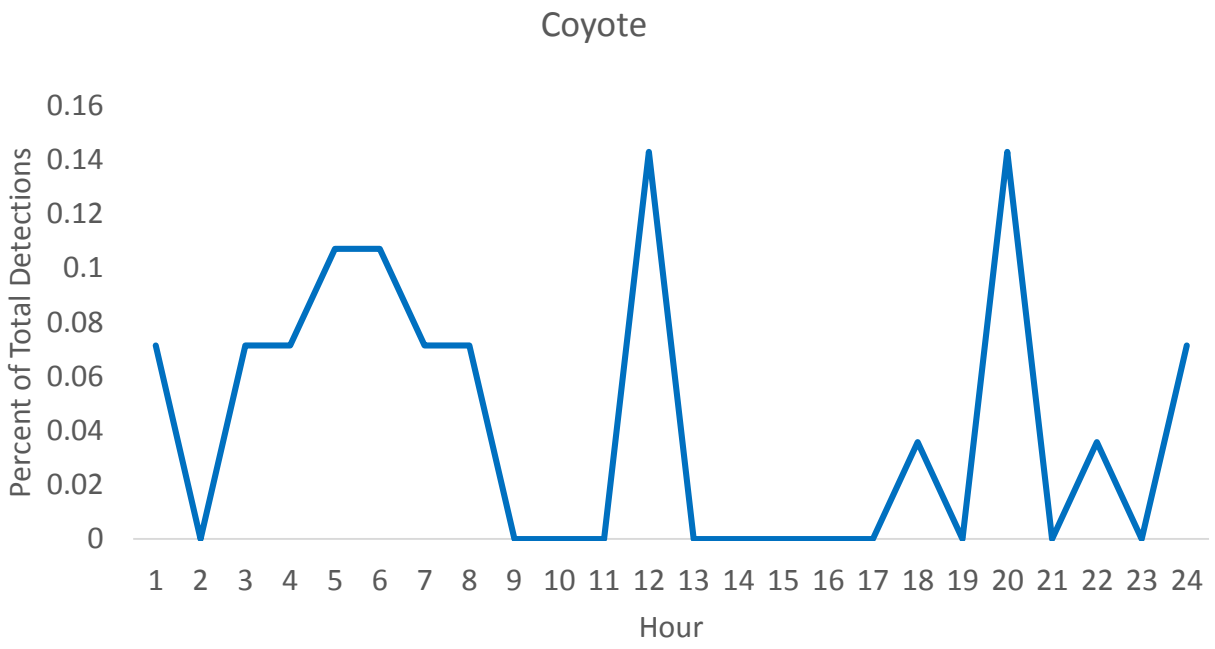


Figure 16: Activity pattern (percent of detections by time of day) for coyote in all five protected areas from December 2015-February 2016

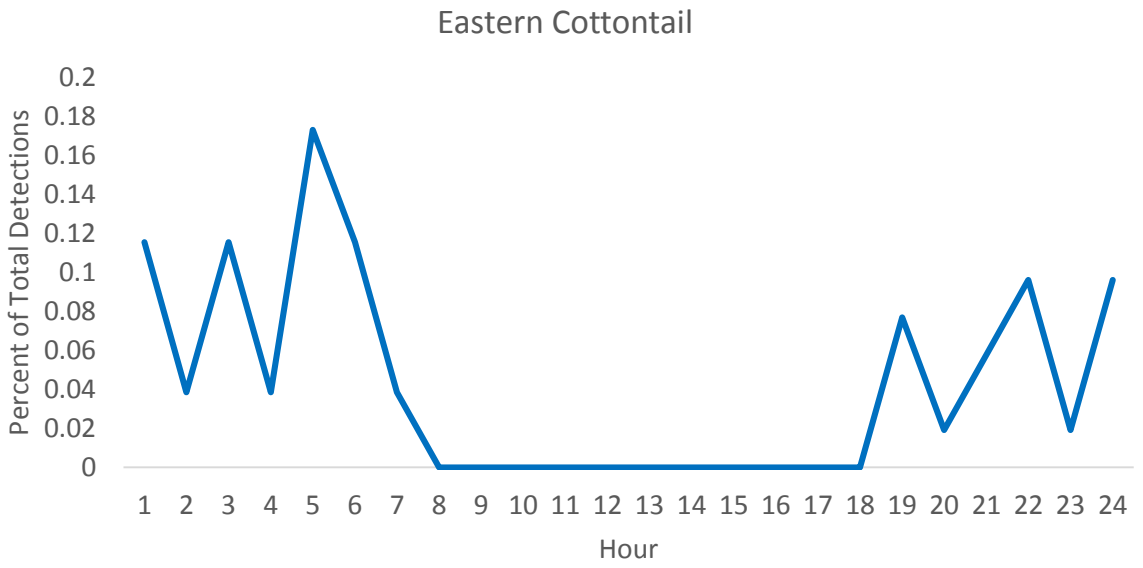


Figure 17: Activity pattern (percent of detections by time of day) for eastern cottontail in all five protected areas from December 2015-February 2016.

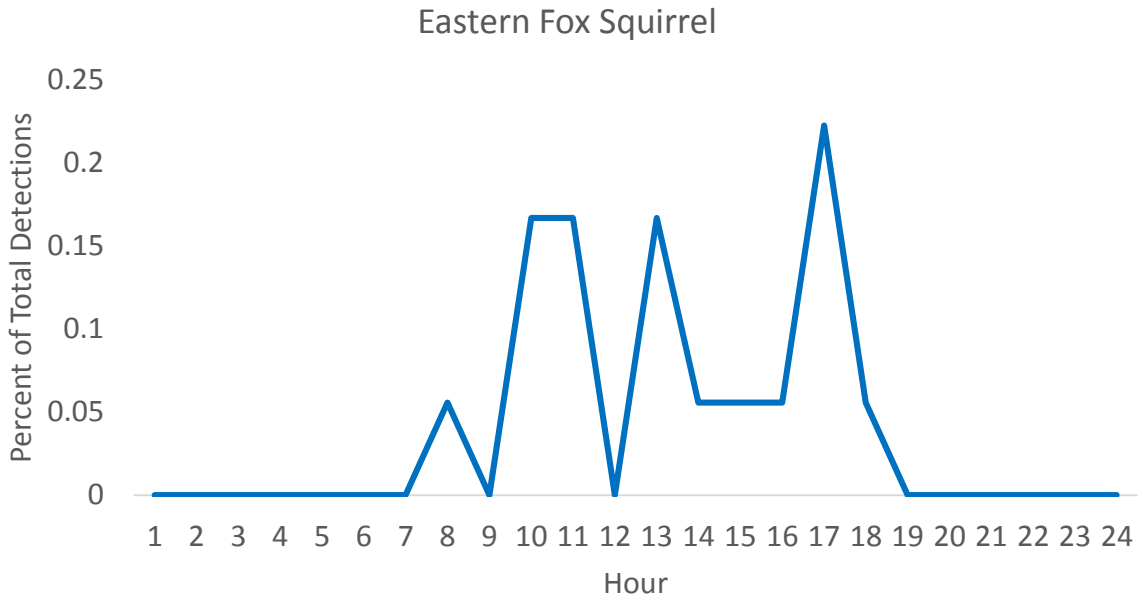


Figure 18: Activity pattern (percent of detections by time of day) for eastern fox squirrel in all five protected areas form December 2015-February 2016.

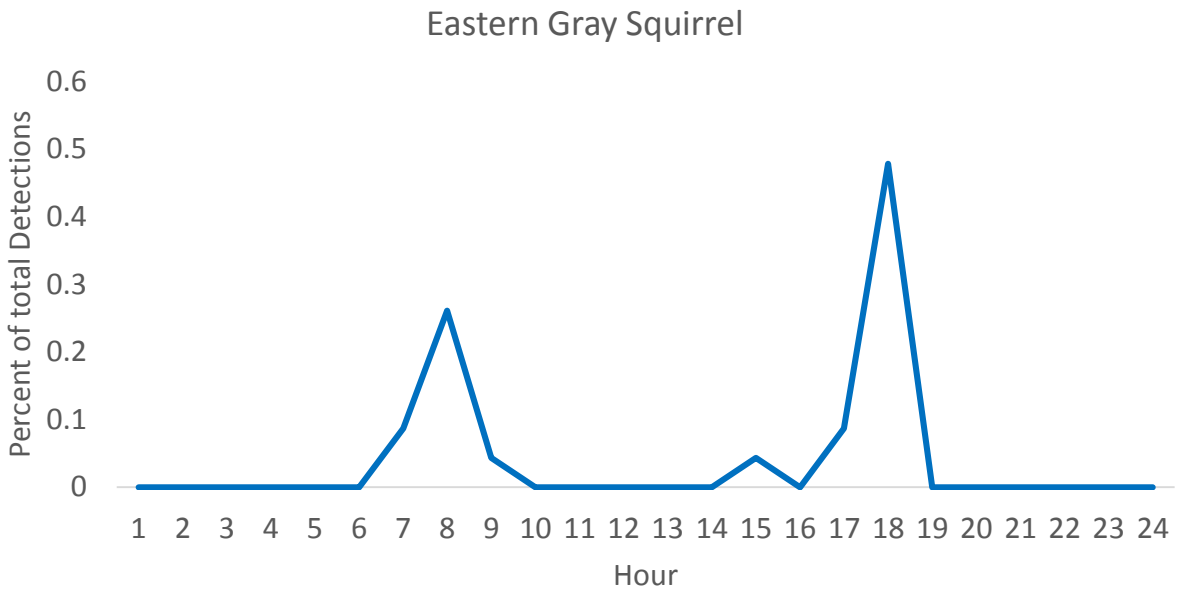


Figure 19: Activity pattern (percent of detections by time of day) for eastern gray squirrel in all five protected areas from December 2015-February 2016.

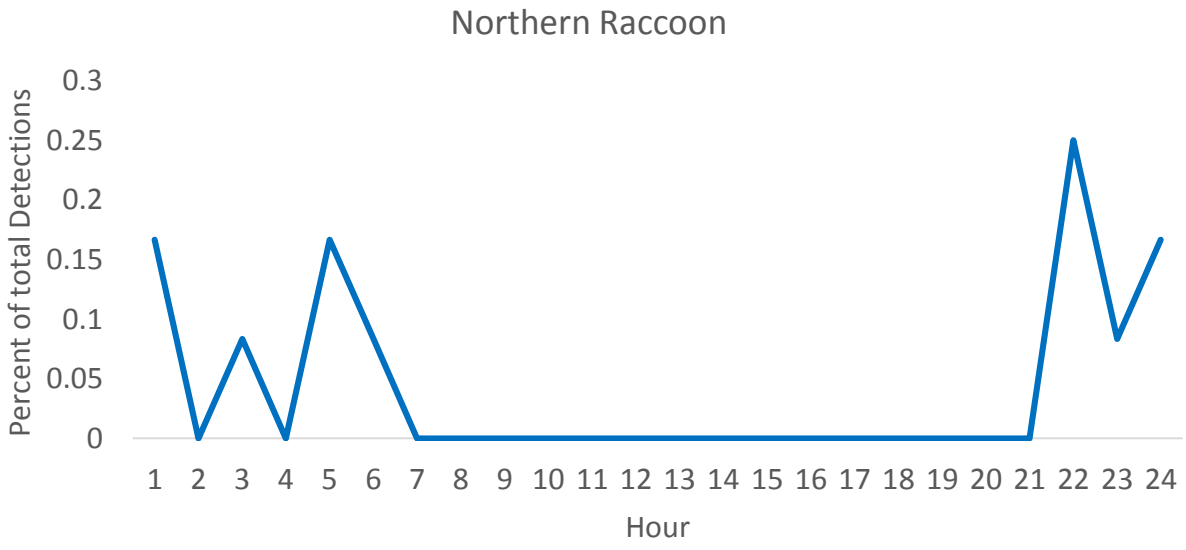


Figure 20: Activity pattern (percent of detections by time of day) for northern raccoon in all five protected areas from December 2015-February 2016.

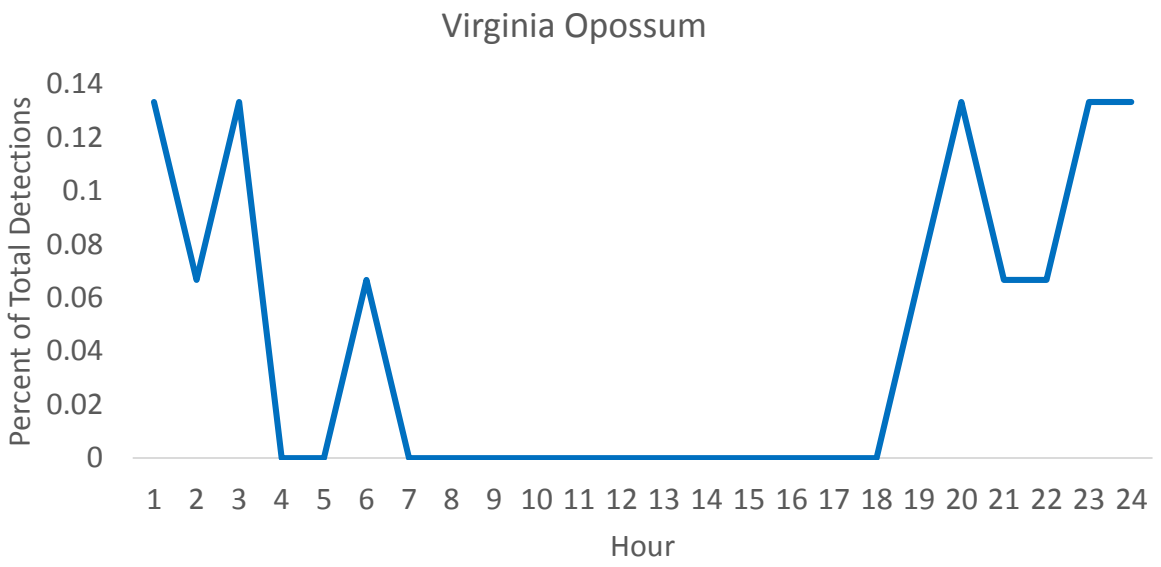


Figure 21: Activity pattern (percent of detections by time of day) for Virginia opossum in all five protected areas from December 2015-February 2016.

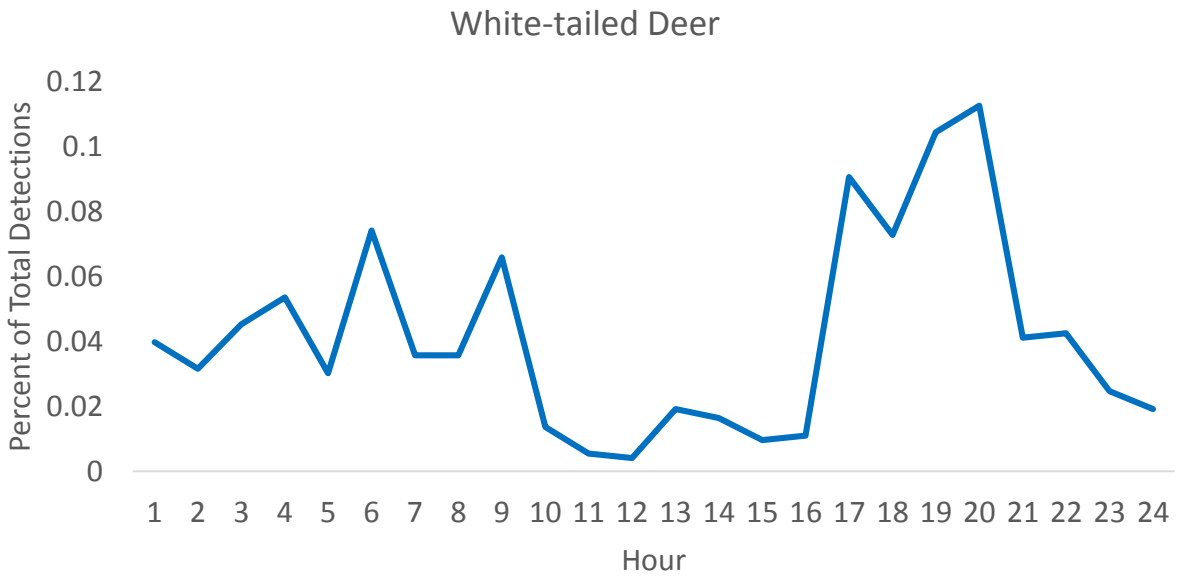


Figure 22: Activity pattern (percent of detections by time of day) for white-tailed deer in all five protected areas from December 2015-February 2016.

5.0 Discussion

Our cameras were able to document a number of species within Averasboro Battlefield, Camassia Slopes Preserve, Duke Forest, Goodwin State Forest, and PeeDee National Wildlife Refuge. When comparing this dataset to past data eMammal collected in Triangle protected areas, species richness was similar, with 11 different mammal species detected. Overall species richness varied between sites, and was highest in both Averasboro Battlefield and PeeDee National Wildlife Refuge, but PeeDee National Wildlife Refuge had the highest level of animal activity as well. Some species were spread out between sites while others were not. For example, white-tailed deer were the overall most commonly detected and most ubiquitous species, accounting for the majority of mammal detections in every site. Second to white-tailed deer, coyote were the only other species found in every site. On the other hand, some species were very rare, such as the red fox that was only detected in Camassia Slopes Preserve and wild turkey that were only detected in Goodwin State Forest. Also to note, bobcat detections were very low, but they were detected in 3/5 sites. In general, we note that the sampling effort in each individual site was low and thus is not representative of all species that may use that area; it is simply a representation of the wildlife activity during that small window of time at the locations where the cameras were placed. However, Averasboro had the least number of cameras set, but had the highest species richness and second highest rate of animal activity. On the other hand, Goodwin State Forest had the highest number of cameras set, but had the lowest species richness and rate of animal activity. Duke Forest also had a high number of cameras set, but second lowest rates of animal activity (Table 1).

We detected some slight deviations from expected daily activity patterns for coyotes and eastern gray squirrels. Coyotes are normally a nocturnal species but we detected a relatively large amount of activity in the afternoon over our sites. All of this activity took place in Averasboro and Goodwin, suggesting something about those sites that makes coyotes less wary of diurnal activity. Eastern gray squirrels are normally a diurnal species, but we detected very little gray squirrel activity in the middle of the day between 9am and 3pm over our sites. This could be due to the relatively low eastern gray squirrel detections, resulting in an incomplete picture of typical daily activity patterns at these sites.

Table 1: A list of all the five sites used in the research with the number of camera traps used at each site.

Site	Number of Cameras	Development Zone	Address
Averasboro Battlefield	6	Rural	8540 Burnett Road Dunn, NC 28334
Camassia Slopes Preserve	8	Wild	Garibaldi Road Jackson, NC 27845
Duke Forest	20	Suburban	Research Drive, Durham, NC 27710
Goodwin State Forest	24	Wild/Rural	Bethlehem Church Road, Carthage, NC 28327
PeeDee National Wildlife Refuge	15	Wild	5770 Hwy. 52 N, Wadesboro, NC 28170

6.0 References

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