Foraging and feeding behavior of the Eastern Grey Squirrel (*Sciurus carolinensis*)

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The eastern grey squirrel (*Sciurus carolinensis*) is a prime example of scatter hoarding behavior, storing food in small hoards underground. Our research aimed to see how the spatial distribution of food affects the foraging behaviors of *S. carolinensis*, which is something that has not previously been researched. The experiments lasted from April - May 2013 on the University of Maryland, College Park campus, in an area with known squirrel populations. Our research group looked at *S. carolinensis'* preference of either scattered or clustered hoards of peanuts, as it may tell us how they store food in response to the surrounding environment. The results showed no statistical correlation between the presence of different distributions of food, which disproved our research group's theory that *S. carolinensis* prefers clustered food hoards. These inconclusive results suggest that the question may need to be approached from a different direction, as it is still a pertinent query on the foraging behavior and ecology of *S. carolinensis*.

Keywords: cluster, disperse, feeding habit, forage, hoard, peanut, *Sciurus carolinensis*, grey/gray squirrel, spatial distribution, University of Maryland

Scarcity of food availability in certain seasons has influenced some animals to hoard caches of food for later use (Shuttleworth 2000). The eastern grey squirrel (*Sciurus carolinensis*) is an example of one of these animals that hoard food. In particular, grey squirrels exhibit scatter hoarding, a caching strategy where the animal buries many small caches of food in different locations. Because the hoards cannot be guarded, they are usually of low cache density, to minimize the potential loss if a cache were to be found by another animal (Brodin 2010).

Grey squirrels inhabit most of the eastern United States, living in a range of habitats from deciduous forests to more urban locales such as parks within cities. The primary food source for grey squirrels is tree seeds, and the distribution and availability of seeds vary in different seasons, habitats, and climates (Gurnell 1996). Grey squirrels, therefore, hoard food for future use when food availability is high. However, foraging is a constant trade-off between actively searching for and consuming food and remaining vigilant to protect against predators (Brown 1999). Grey squirrels face predation by other eastern animals such as owls, weasels, and foxes. Because squirrels must also take the time to bury some of their food, they face increased predation risk because that time cannot be spent being vigilant.

Our experiment aimed to address a question that has not been previously researched in squirrel foraging behavior: how does the spatial distribution of food affect foraging behavior? Grey squirrels must spend time burying caches of food in addition to searching for the food, so they are at increased risk of predation. We hypothesized that given the choice to forage at sites where food is either in a clustered distribution or dispersed distribution, grey squirrels would prefer to forage at the clustered site. At this site, less time would have to be spent searching for food, and more time could be spent being vigilant.

MATERIALS AND METHODS

The study was conducted at two sites on the University of Maryland, College Park campus. The sites selected were marked five-foot by five-foot squares of grass, approximately twenty yards away from each other, located behind Francis Scott Key Hall. The sites were partially shaded by trees, grassy, and had low foot traffic from human pedestrians.

Given that squirrels are crepuscular, trials were conducted twice a day for thirty minutes per trial at approximately 7 a.m. and 7 p.m. At the clustered distribution site, one cup of unsalted peanuts (in the shell) was placed in a pile at the center of the site. At the dispersed distribution site, one cup of unsalted peanuts (in the shell) were evenly scattered throughout the square of grass. We were sure to remove any other sources of food (acorns, berries, etc.) from the site before trials began. We alternated which food distribution was used at each site every other trial.

Trials were conducted simultaneously (i.e. one observer would sit at a designated location and collect data for the two sites at the same time). We recorded the number of times a squirrel entered the site (counted as a squirrel entering the marked area and handling a nut) and the number of nuts that were taken or eaten at the site. We conducted a total of 6 trials, 3 at 7 a.m. and 3 at 7 p.m.

To analyze the data collected, a one sample *t*-test was used for both sets of data to test the significance of a clustered distribution of food versus a dispersed distribution of food.

RESULTS

We calculated significance using a *t*-test since we conducted multiple trials and wanted to compare the means of the two treatment types. For the first dependent variable, number of visits to each site, our null hypothesis was: “There is no significant difference between the number of visits by *S. carolinensis* to either the clustered or spaced distribution sites. Any difference in

number of visits is due to chance." Based on our results, we accepted our null hypothesis that no significant difference ($p = 0.05$) existed between number of visits by *S. carolinensis* to either the clustered site or the spaced site (Table 1). For the second dependent variable, number of peanuts taken from each site, our null hypothesis was: "There is no significant difference between the number of peanuts taken by *S. carolinensis* from either the clustered or spaced distribution sites. Any difference in number of visits is due to chance." The number of peanuts taken by *S. carolinensis* also did not significantly differ ($p = 0.05$) between the clustered and spaced sites (Table 2), thus we accepted our second null hypothesis.

DISCUSSION

The results do not support our original hypothesis that a significantly greater number of squirrels would visit and retrieve nuts from a clustered distribution, as opposed to a spaced distribution. Analysis of the data shows that there was no significant difference in the number of visits or nuts taken from the two types of distributions. Therefore, our data provides no evidence to prove our initial idea that squirrels prefer foraging from a site that takes less time and energy to gather food from. However, there are many factors that could have affected our results.

After reconsidering the experiment, there are some aspects that could be improved in order to achieve more conclusive results. One factor is the number of trials conducted. We had a limited amount of time to conduct our experiment, with various obstacles faced within that time period. We were able to run six separate trials. For more conclusive data, it would have been better to conduct many more trials. That way we could provide our results with greater confidence. Another factor that could be improved is the length of observation time for each trial. We found that in 30 minutes we observed a decent amount of squirrel activity, so we felt comfortable with conducting 30 minute trials. However, if each trial was conducted for a longer

amount of time, our data would have been more reliable. One more aspect that could be improved is when our trials were conducted. Three of our trials were conducted at 7:00am, and three trials were conducted at 7:00pm. In order to have more consistent and reliable data, it would have been best to run each trial at the same time. But we were able to avoid time-of-day as a confounding variable since we had an equal number of trials for each time.

Many areas for improvement may have been avoided if it were not for the issues we faced while trying to conduct our trials. As mentioned before, we were only able to conduct six separate trials. This is because the original site we chose (a very wooded and secluded area) did not yield any squirrels during initial observations. We decided to change our testing site and start over with data collection. This new area was more centered on campus and had some light pedestrian traffic, but we do not think this interfered with our results. Also, on days when the weather was bad, we were not able to conduct trials. Due to these issues we decided to collect data during the morning as well as the evening in order to maximize our opportunities to conduct trials. While it would have been better to conduct all trials at the same time, we were still successful in collecting data during the times of day for peak squirrel activity.

When considering the results, we must also account for possibilities of experimental error. One aspect of the experiment that may have contained error was exactly how each clustered and spaced distribution was set up by each group member. Although we all agreed on a method of placing clustered nuts and spaced-out nuts, our arrangements may have varied slightly. So our trials were not perfectly consistent.

Although there are areas for improvement and possibilities for error, we were successful in avoiding error in many aspects of the experiment. Many factors were kept constant, such as plot size, amount of nuts used, and length of time for each trial. Also, there was a possibility of

plot location as a confounding variable, since both distribution types were tested at once, at two different plots. But this error was avoided by alternating which distribution type was placed in each plot for every trial. These factors aided in giving our results some credibility.

The goal of our study was to better understand the strategy of how squirrels collected food. We had hoped to find a pattern of food retrieval that was justified by factors such as amount of energy output and length of time. This information could have been beneficial since a lot is already known about how squirrels store food, but not much information can be found about how they seek out and collect food. For further research studies, we suggest that researchers could replicate our experiment, but with the improvements discussed above. If this experiment could be conducted again with many more trials of longer duration, in more consistent conditions, different results may be obtained. However, this concept could be further examined with consideration of other factors, such as vigilance. With the consideration of other factors, a different hypothesis may be justifiable. Whether squirrels have a set strategy for food collection or not is unclear at this point. But more research in the future could find conclusive answers to this question.

LITERATURE CITED

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TABLES AND FIGURES

	Number of Visits to Site		Number of Nuts Taken from Site	
	Treatment			
Observation	Clustered	Spaced	Clustered	Spaced
1	0	25	0	27
2	4	4	14	13
3	16	6	20	9
4	21	12	28	16
5	3	17	2	14
6	8	18	5	11

Table 1. Number of visits and number of peanuts taken from either the clustered or spaced distribution sites.

	n	Average	DIFFERENCE ($n_C - n_S$)	ST. DEV.	ST. $DEV_{.combined}$	$t_{calculated}$	$t_{critical}$
Clustered	6	8.67	5	8.19	4.65	1.08	12.7
Spaced	6	13.67		7.92			

Table 2. Number of visits to the clustered and spaced distribution sites. (*P<0.05)*.

	n	AVERAGE	DIFFERENCE ($n_C - n_S$)	ST. DEV.	ST. $DEV_{.combined}$	$t_{calculated}$	$t_{critical}$
Clustered	6	11.50	3.5	11.10	5.22	0.67	12.7
Spaced	6	15.00		6.36			

Table 3. Number of peanuts taken from either the clustered or spaced distribution sites. (*P<0.05)*.