

Resource defense and territorial behavior in Ruby-Throated Hummingbirds (*Archilochus colubris*)

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Abstract

The purpose of this study was to record the behavior of polygynous ruby-throated hummingbirds (*Archilochus colubris*) along the shoreline of Douglas Lake in Pellston, Michigan. Eight artificial feeding sites were created, and four of the feeding sites contained three times more feeders than the other four. Territorial behaviors of vocalization, chasing, and guarding were recorded for both sexes at each of the eight sites, four times a day, for three days. Our main hypothesis was that male ruby-throated hummingbird vocalization and chasing would occur more frequently at triple-feeder sites than at single-feeder sites. With this in mind, we also tested to see whether female territorial behaviors would occur at single-feeder sites more frequently than triple-feeder sites. Our data showed significant evidence that males exhibit more territorial behaviors at the triple-feeder sites and females exhibit more territorial behaviors at the single-feeder sites. This evidence suggests that male hummingbirds base their territory selection on the amount of resources available. In addition, more female behavior at the single-feeder sites suggests that they can hold territories, too, but are unable to compete with the territorial males.

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Introduction

Territories with abundant resources are expected to be more desirable for organisms. Areas with sufficient resources have shown to enhance the reproductive success of both males and females in polygynous bird species (Rousseu et al. 2014). In polygynous species, there is a difference in reproductive success due to competition over mates, leading to males having more mating partners than females (Darwin 1871). This competition for mates can influence the behavior of males and females over resources, which are important for reproductive success. The ruby-throated hummingbird (*Archilochus colubris*) is a polygynous bird species, recognized as the only species of hummingbird to breed east of the Mississippi River (Nemeth and Moore 2012). Although individuals only weigh approximately 3.5 g, their breeding range is larger than that of any other species of hummingbird in North America (NRCS 1999). Nests need to be around 60 m apart (Pickens 1944) while a male's actual territory is around 970 m² and is centered on a food supply (Pitelka 1942).

We are interested in studying territorial behaviors of ruby-throated hummingbirds during their breeding season, which begins in late May (Rousseu et al. 2014). To achieve research objectives, we observed chasing, guarding, and vocal behaviors in different territories containing different amounts of food resources. We observed hummingbird behavior within the migratory range for ruby-throated hummingbirds in northern Michigan. For this study, two types of feeding sites were created so that different sites varied in resource quantity: sites with only one feeder and sites with three feeders. We decided that an area with three times more resources than other nearby areas might result in more intense territorial behaviors in males. Based on previous knowledge regarding the polygynous behavior of ruby-throated hummingbirds and our site set up, we hypothesize that male ruby-throated hummingbird aggression and territorial behavior will occur at a greater intensity near the triple-feeder sites than the single-feeder sites due to the

greater availability of resources. We predict that triple-feeder sites may be better territories than single-feeder sites because resource availability influences reproductive success. Therefore, females will want to mate with a male who holds more resources, and males will compete for a territory that has more resources. We also predict to see more female interaction near single-feeder sites than triple-feeder sites because studies have found that female hummingbirds can hold a territory before they build their nests. However, female territorial behaviors are not as fully developed as the behaviors of males and they cannot successfully compete with the territorial behavior of males (Pitelka 1942).

Methods and Materials

Feeding Sites

We conducted this research from late May to early June at the University of Michigan Biological Station in Pellston, Michigan. We plotted eight feeding sites along the southeast coast of South Fishtail Bay in Douglas Lake, and separated each feeder by 60 m. A total of 16 red hummingbird feeders were used for this study. Four sites contained one hummingbird feeder; these were classified as single-feeder sites, or type S. The remaining four contained three hummingbird feeders and were classified as triple-feeder sites, or type T. Each feeding site was randomly placed at one of the eight sites and randomly assigned as a single or triple site by the flip of a coin. The site assignments are outlined in Figure 1. To maintain consistency, each feeder was placed on a white pine branch, approximately 1.5 m above the ground. Once the sites were plotted, the feeders were staked to the ground with fishing line to prevent them from swinging in the wind. The feeders were filled with a sugar solution composed of one cup of granulated sugar and approximately two drops of red dye per four cups of water. Red dye was added to make each feeder look similar in color because ruby-throated hummingbirds are attracted to the color red (Pickens 1944). To create the nectar, sugar and water were mixed together and boiled for two

minutes, after which the red dye was added. The solution was then cooled to room temperature before it was poured into the feeders.

Observing Feeding Behaviors

We observed each feeding site at four different times, two days a week, on Wednesdays and Saturdays at 6:30 AM, 11:00 AM, 3:30 PM, and 8:00 PM. Each observation period lasted 30 minutes where one person was stationed randomly at each site. We observed the hummingbirds for three days, making six hours of observation for each site. A total of nine students contributed to this study; each student observed one site per observation period. We had a trial day of observations to get accustomed to watching the hummingbirds and the interactions within the feeding sites. After our trial day, we created a data sheet suitable for the three days of observation. The data collected on the trial day were not included in our analyzed data.

During each observation time, we recorded the interactions seen between the hummingbirds at the feeding sites. On a data sheet, we tallied the number of times we observed a hummingbird of a particular sex initiate guarding, chasing, and/or vocalization behaviors. Sex was determined through morphological differences between the males and females. The males are characterized by having a black head and a vibrant red throat, whereas the females do not have these two features. The interactions observed during each period were described as follows: guarding behavior was characterized by watching over the feeders, chasing was characterized by a hummingbird chasing another hummingbird away from the site, and vocalization was characterized by any sound made by a hummingbird during the time of observation. We also recorded observational notes on each data sheet.

Statistical Analysis

We analyzed our data to identify differences between interactions at type S sites and type T sites, as well as differences in territorial behavior between males and females. We tested whether vocalization and chasing behaviors were more common in males, on average, at type T sites than at type S sites. With this in mind, we performed two independent samples t-tests to compare the average frequencies of the two territorial behaviors exhibited in males at both types of sites. We also tested to see whether females exhibited vocalization and chasing behaviors more frequently at type S sites than at type T sites. Accordingly, we performed two additional independent sample t-tests to compare the female behaviors initiated at both types of sites. We then compared males to females to see whether the sex influenced the difference in behaviors at each type of site. We did not include guarding in our statistical analysis because of its ambiguity. Hummingbirds may have appeared to be guarding, but may have just been perched near the feeding site.

We also performed two Chi-square tests comparing male hummingbird behavior at type S sites and type T sites based on the four observation times. We examined chasing and vocalization behaviors separately. We wanted to determine whether there was a significant difference between the two types of feeding sites regarding the male behaviors that we were observing.

Results

Male hummingbirds exhibited significantly more vocalization and chasing behaviors per observation period, on average, at type T sites than at type S sites. Accordingly, the mean frequencies of vocalized behaviors were 1.17 at type S sites and 5.69 at type T sites (p -value <0.01). The mean frequencies of chasing behaviors were 5.58 at type S sites and 12.20 at type T sites (p -value <0.01). On the contrary, females exhibited significantly higher frequencies,

on average, of vocalization and chasing behaviors per observation period at type S sites than at type T sites. The mean frequency of vocalized behaviors were 7.87 at type S sites and 2.14 at type T sites (p -value <0.01). The frequency of chasing behaviors were 12.45 at the type S sites and 2.05 at the type T sites (p -value <0.01).

There are clear differences between male and female territorial behaviors. The average frequencies of vocalization and chasing behaviors per observation period in males is higher than in females at type T sites than at type S sites (Figure 2, Figure 3). Conversely, females exhibited higher frequencies of vocalization and chasing behaviors per observation period than males at type S sites than at type T sites (Figure 2, Figure 3).

The results from the Chi-square test indicate that there is a difference in the distribution of male behaviors between type S sites and type T sites. The Chi-square value we calculated for male chasing was 21.47 (p -value <0.01). This shows that there was a significant difference between male chasing at the two types of feeding sites. Similarly, the Chi-square value we calculated for male vocalization was 11.7 (p -value <0.01). Again we can conclude that there was a significant difference between male vocalizations at type S and type T sites. From our Chi-square tables, we also noticed that that there was not a big difference between the frequency of these two behaviors and the time of day.

We observed more female territorial behavior at the type S sites compared to those observed at the type T sites. Male visits to the type S sites were not very common. In total, there were 394 vocalizations by females at the type S sites compared to only 56 vocalizations by males at type S sites. Similarly, there were 589 observations of female chasing at type S sites and only 91 instances of males chasing at type S sites. We also observed that females worked together and displayed more cooperative behaviors. Females often let other females feed and/or would take

turns guarding the site. This behavior was not common among male hummingbirds at any of the feeding sites.

Discussion

Our data supported our hypothesis that male ruby-throated hummingbird aggression and territorial behavior will occur at a greater intensity near the triple-feeder sites than the single-feeder sites. There was a significant difference in the amount of aggressive behavior between the two types of feeding sites. Our data also supported our hypothesis that we expect to see more female interaction near single-feeder sites than triple-feeder sites. With the male hummingbirds primarily occupying triple-feeder sites, the single-feeders seem to exhibit less male competitive aggression, which led to more female activity in these areas. We also noticed that as the season progressed, there were fewer observations of territorial behavior. This was likely due to the fact that flowers began to bloom later in the spring season, attracting hummingbirds away from our feeders.

The results that we found are relevant because learning and understanding hummingbird behaviors has potential implications for future hummingbird studies. The interactions and territorial behaviors that we observed can also be used to examine polygynous bird behavior in general. The data and results from this study could be used to help answer new questions including: why are there more females behaving territorially at the type S sites than males? Why do some females get chased by males at type T sites? How does the mating season affect male and female hummingbird behaviors near the feeding sites?

In addition, throughout our observations, we observed differences between early morning behaviors, daytime behaviors, and evening behaviors. Males appeared to be more territorial in the morning and in the evening than during the day, which may be expected because

hummingbirds emerge from torpor in the mornings and prepare for torpor in the evenings; thus, feeding behavior may be most intense during these times. However, after running several Chi-squared tests to determine whether there was a significant difference in territorial behavior between the times, we discovered that territorial behaviors occurred significantly more frequently during the daytime than in the morning and evening, which did not support this additional hypothesis. Further studies are needed to determine whether time of day influences the frequency of territorial behavior in male hummingbirds.

Finally, there were several potential sources of error that could have affected the outcome of our experiment. For example, red dye had to be added to the solution to make all of the feeders approximately the same color because they were not standardized. There may have been a preference for the store-bought red feeders and this could have altered our results. To prevent this possibility, identical feeders could have been bought online and shipped to the station. Additionally, the feeders often leaked and were not filled as regularly as they should have been, which resulted in some empty feeders during observation times. This could have changed the number of visits we had at each feeder during observation times, and may have slightly skewed our data. We could have improved this by making sure the feeders were sufficiently filled before every observation. Another potential issue was that the feeders were located along a shoreline instead of within the woods, which could have changed our results because some of the observation days were very windy and possibly made it difficult for the hummingbirds to feed. For future experiments, it may be beneficial to have more observation days, observe for longer periods of time and for an entire breeding season. This would allow us to have a larger sample size and observe even more patterns that may not have seemed significant within our experiment.

Resources

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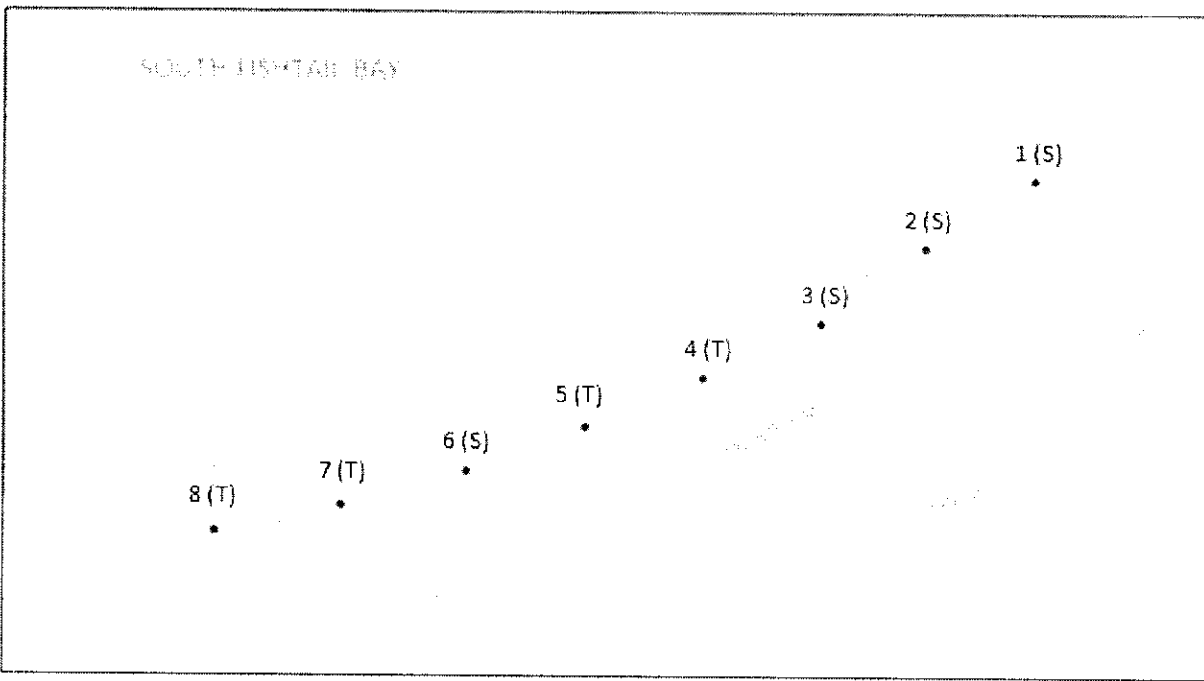


Figure 1. Map of the Eight Feeding Sites

Each site had a radius of 30 m, making the total distances between each site 60 m. All feeders are hung 1.5 meters off the ground in white pines along Douglas Lake's South Fishtail Bay.

(S)=a site with one hummingbird feeder

(T)=a site with three hummingbird feeders

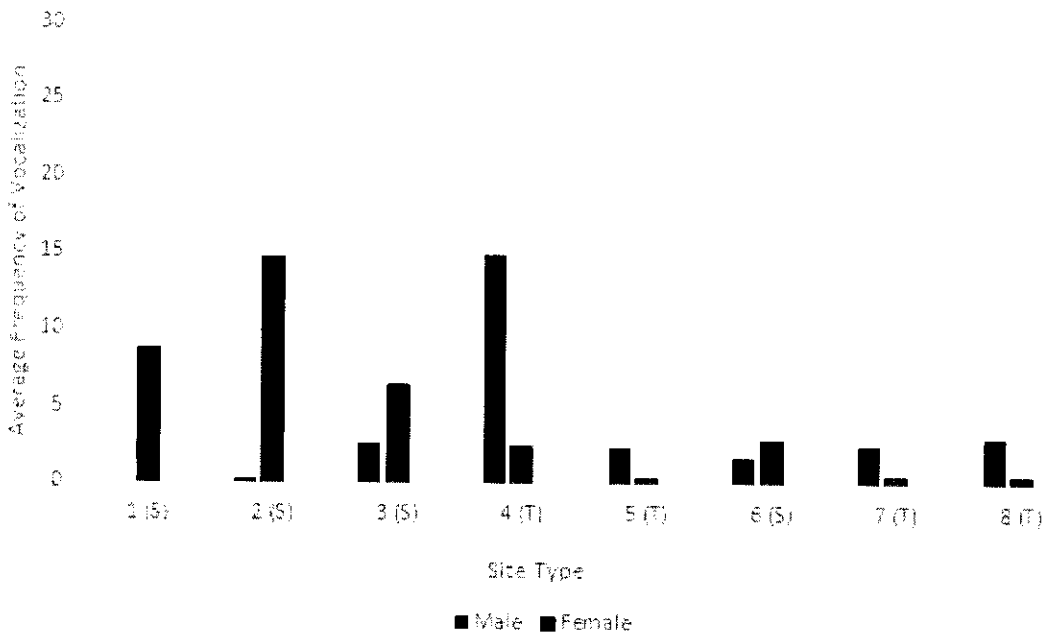


Figure 2. Average Frequency of Vocalization in Males vs. Females

Males exhibited a higher average frequency of vocalization at type T sites. Females exhibited a higher average frequency of vocalization at type S sites.

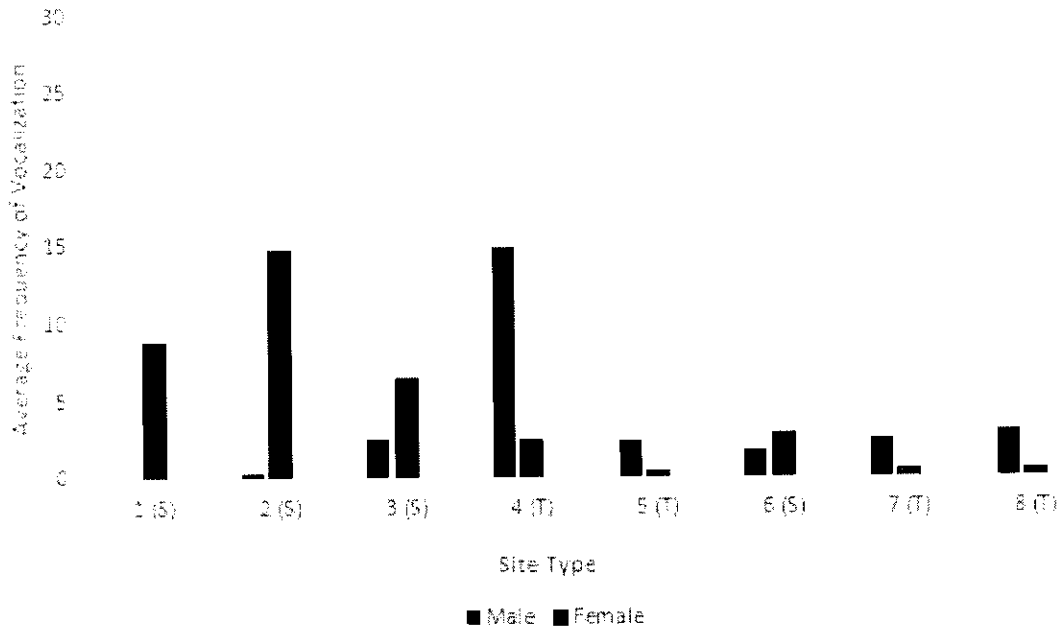


Figure 3. Average Frequency of Chasing in Males vs. Females

Males exhibited a higher average frequency of chasing at type T sites. Females exhibited a higher average frequency of chasing at type S sites.

