University of North Carolina Asheville
Journal of Undergraduate Research
Asheville, North Carolina
December 2020

Environmental Influences on the Timing and Duration of Entry into a Chimney Swift Communal Roost

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Abstract

Communal roosting, in which individuals gather together at night to spend the resting period together, is common in many species of birds. There are several widely accepted reasons birds roost communally: to conserve heat and energy in non-feeding or extremely cold periods, to share information about where resources are in proximity to the group, and to reduce the effects of predation. Chimney Swifts (Chaetura pelagica) are small aerial insectivorous birds that roost communally at night. Not much is known about the roosting dynamics and what effects weather patterns have on the timing and duration of entry to the Chimney Swift roosts. To get a better understanding of these effects a roost was monitored at the Sherwin Williams Paint store on Merrimon avenue in Asheville, North Carolina. Data on cloud cover, wind speed, temperature, and total number of birds entering the roost was collected from August 30th, 2020 through October 13th, 2020, over 23 survey periods. These were then used to discern what impacts they may have on the time between sunset and first entry as well as the total time it took the flock of Chimney Swifts to enter the roost. In multivariate regressions analysis, temperature and total number of swifts entering the roost had a significant impact on the difference between time of sunset and first entry of swifts into the chimney. Cloud cover and wind speed did not significantly impact the timing between sunset and first entry. This study shows that temperature and total number of swifts affect the timing of Chimney Swift roost entry. None of the climate variables or the total number of birds at the roost explained any variation in the total duration of roost entry.

1. Introduction

Communal roosting, in which individuals gather together at night to spend the resting period together, is common in many species of birds. European Starlings (*Sturnus vulgaris*), Common Grackles (*Quiscalus quiscula*), American Robins (*Turdus migratorious*), and many species of swallows, have all been known to roost communally[1]. There are many benefits to this behavior. Roosting communally can increase survival by decreasing energy demands when outside temperatures decrease at night[2]. This was shown in a study done on communal roosting in Sociable Weavers (*Philetairus socius*) where the researchers also found the energy stored by communal roosting seemed to increase reproductive rates during the breeding season due to the extra amounts of stored energy from communal roosting prior to the breeding season. Another advantage of communal roosting is that it can increase the efficiency of food procurement, and in turn increase individual survivability[3]. One study explored this relationship in Turkey Vultures (*Cathartes aura*) and Black Vultures (*Corygyps atratus*) and found that communal roosting can be a way of sharing information about closely available resources in East Texas. Predation may also be reduced when species gather in communal roosts[4]. Reports from the island of Guam suggest that Mariana Crows (*Corvus kubaryi*) have recently started roosting communally possibly due to the introduction and prevalence of brown tree snakes (*Boigair regularis*).

Chimney Swifts (*Chaetura pelagica*) are migratory birds that breed across eastern North America and spend the winter in northern South America. In East Texas, spring arrival starts in mid-April and departure occurs in late

October[6]. These small insectivorous birds aggregate in communal roosts during autumn migration and are commonly seen congregating over chimneys at dusk across their range[5]. The flock of swifts usually travels around in a group within sight of the roost prior to entry. This flocking behavior eventually forms a vortex directly over the chimney when the birds are close to entering the roost[8]. Once the first birds in the vortex start entering the chimney the rest follow in quick succession. However, this behavior is not well understood and remains to be explored further.

There have been many studies done on Chimney Swifts analyzing population dynamics[7], and even communication while entering their nightly roosts[8]. However, research on Chimney Swift migration to and from the Asheville area is lacking and needs more exploration. Also, not much is known about environmental effects and the role of weather patterns on Chimney Swift entry into the roost. A study in Texas explored roost entry in relation to time of sunset and hypothesized there would be a negative correlation between light intensities and time of first entry after sunset. They found that entry times in the breeding season, July and August, were earlier by 3.3-7.8 minutes than in the spring and fall, indicating that entry behavior into the roost might be different during summer breeding and autumn communal roosting. Another study in Illinois explored how precipitation, cloud cover, wind speed, and temperature effected Chimney Swift entry and exit from roosts[9]. Precipitation was found to induce early entry to the roosts by an average of 4.6 minutes. They found no significant effect on entry time based on their data from cloud cover or haziness. The swifts were observed to enter the roost later on days with stronger winds which the researchers attributed to higher food availability on windier days. The Illinois study also found that with decreasing temperature the Chimney Swifts entered the roost significantly earlier on colder days. Research on the timing of arrival and departure of the swifts in Asheville is lacking but since there have been accounts from casual observers, I was confident the swifts would be in the area for the duration of my study.

Beyond these findings not much is known about environmental effects on Chimney Swift roost entry, or if behaviors are consistent across their range. Research on these birds in southern Appalachia is lacking. This study explored how environmental variables and the roost size influenced both the timing and duration of roost entry into the chimney. I hypothesized that there would be a positive relationship between ambient air temperature and both the timing and duration of roost entry. Chimney Swifts would take longer to roost with higher ambient air temperatures. Likewise, there would be a greater time gap between sunset and first entry associated with higher air temperatures. Further, heavy cloud cover (75-100%) would induce the swifts to roost earlier, possibly before sunset occurred due to premature darkening of the sky[9]. Lastly, I hypothesized that the swifts would start entering the roost longer after sunset during evenings with high wind.

2. Materials and Methods

2.1 Study Site

To study Chimney Swift roosting patterns and behavior, I visited a well-known roost site at the Sherwin Williams paint store on Merrimon Avenue in north Asheville, North Carolina. I viewed the Chimney Swift entry into the roost from the opposite side of the road from the paint store to get a better angle at which to view the roosting swifts, and to get more accurate bird counts. Observations took place from August 30th, 2020 through October 13th, 2020 for a total of 23 surveys. The surveys were performed at random so as not to skew results on my independent variables.

2.2 Dusk Viewing Procedure and Data Collection

I arrived at the viewing location in front of CVS 5-10 minutes before sunset for each survey. Between the time I arrived at the survey location and the time the swifts started to enter the roost, I took note of temperature, precipitation, cloud cover, and wind speed. To measure temperature, I used the weather application on an iPhone 7 and recorded the temperature within 10 minutes before sunset. I reported precipitation on a scale of 0-2, where 0 = none, 1 = trace rainfall, and 2 = moderate to heavy rainfall. Precipitation was only recorded if rainfall occurred during the observation period, it was not measured quantitatively. I defined cloud cover in this study on a scale from 1-4, with 1 = 0-25% cloud cover, 2 = 25-50% cover, 3 = 50-75% cover, and 4 = 75-100% cover. I measured wind speed using the Beaufort scale, in which the categories are as follows: a reading of 0 = calm, smoke rises vertically; 1 = light air movement, smoke drifts; 2 = slight breeze, wind felt on face; 3 = gentle breeze, small twigs move; 4 = moderate breeze, small branches move; 5 = fresh breeze, small trees sway; and 6 = strong breeze, large branches in motion. Several trees in sight of the viewing location were used as reference for predicting wind speed using the Beaufort scale. All the data were entered into a unique data entry form each night after observation.

We also explored how the total number of birds on a given night effected both the time after sunset that the first swifts entered as well as the total time it took the flock to enter the roost. When counting swifts entering the chimney, the fifth bird to enter was counted as the first. This was to try to eliminate bias caused by 'early birds' several minutes before the main flock. However, all birds were counted in the total tallies. At the end of the survey, after the last bird went into the roost, I waited 2 minutes to make sure I counted any late-comers. If birds were seen in the sky above the roost within 2 minutes of when the last bird had entered but did not go into the roost until after the two minutes was up viewing would continue. So, even if stragglers waited until 3-4 minutes after the rest of the flock entered the roost, as long as they were present in the sky above the roost within the 2 minutes after the main flock entered, they were counted.

2.3 Data Analysis

The roosting data were compiled through the use of a Google Form and were stored this way for the duration of the study. After compilation, I downloaded a spreadsheet of the data into Microsoft Excel for further analysis.

I used linear regressions to understand the relationship between the two continuous dependent variables (the difference in minutes between sunset and the time of first entry into the roost, hereafter 'time', and total duration of roost entry, hereafter 'duration') and the independent variables (cloud cover, wind speed, temperature, and total number of birds at the roost). Since cloud cover and wind speed are ordinal categorical variables, we treated them as continuous variables for the linear regressions. I first used univariate linear regressions for each combination of dependent and independent variables, then combined the independent variables together and ran multiple linear regressions for each dependent variable.

3. Results

On average, swifts entered the roost starting approximately 8 minutes after sunset, but this varied from 8 minutes before sunset to more than 20 minutes after sunset. Likewise, swifts took on average approximately 12 minutes to enter the roost, but this varied from a minimum of 6 minutes to a maximum of 21 minutes. Roost size varied from a minimum of 43 swifts to a maximum of 600 swifts (Figure 1).

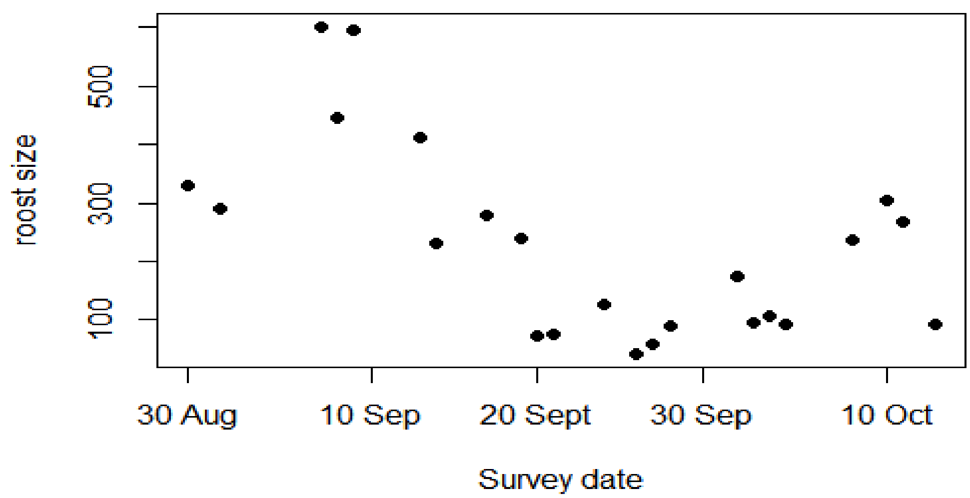

Figure 1. Roost sizes during the survey period.

Univariate linear regressions on the time of first entry and the independent variables yielded no significant relationships for cloud cover (P=0.0948), temperature (P=0.2280), wind speed (P=0.1995), and total birds (0.2618). Likewise, there were no significant relationships between total entry time and the independent variables for cloud cover (P=0.4259), temperature (P=0.3297), wind speed (P=0.8151), and total birds (0.1235). There was not enough variation in precipitation data to include this variable as 19 out of the 23 total surveys had no precipitation.

Multivariate regression analyses, however, yielded lower p-values on average which in the case of temperature and total number of swifts showed significant relationships when compared to time of first entry. Overall the independent variables in multivariate regression calculations significantly impacted time of first entry p-value = 0.024 and an adjusted R2 = 0.33. Cloud cover had a low p-value but was found to have no significance (P=0.0681) with a negative correlation (t-stat = -1.941, and R^2=0.113; Figure 2).

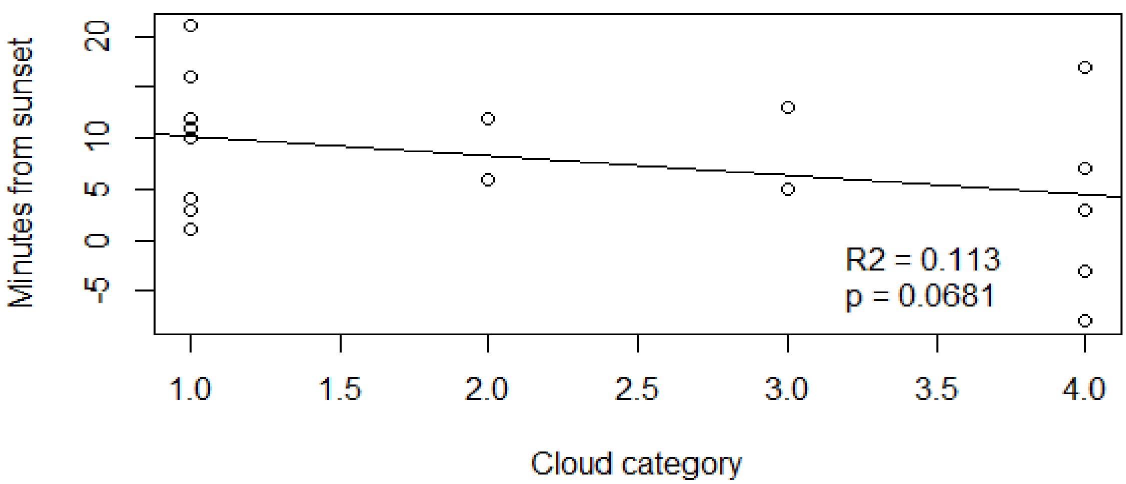

Figure 2. Relationship between time of entry and increasing cloud cover.

Temperature was found to have the largest effect on entry time (P=0.0134), showing a positive relationship between the variables (t-stat=2.741, R^2=0.005) (Figure 3).

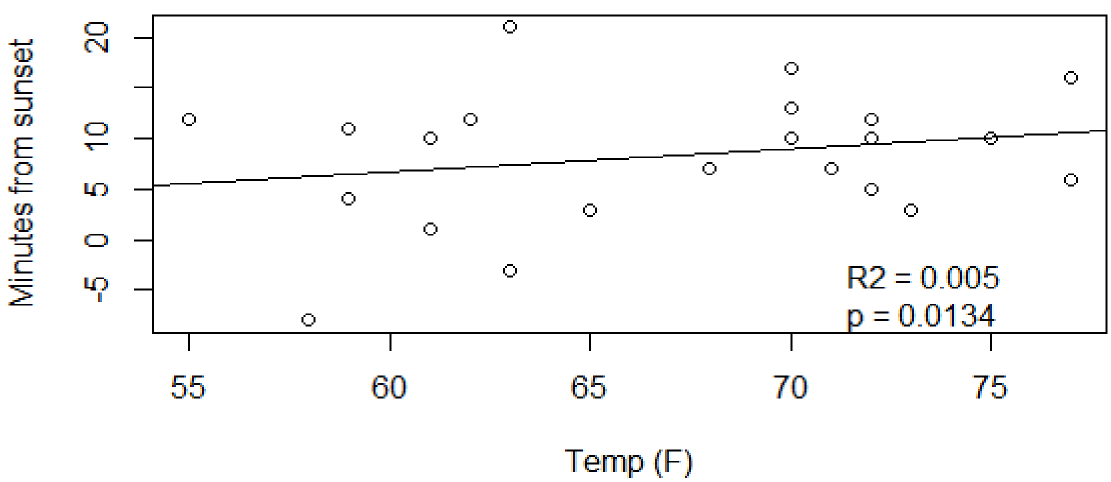

Figure 3. Relationship between time of entry and temperature.

Total number of swifts that entered the roost on a given night also had a significant effect on when the birds started to enter the roost (P=0.0230) with a negative correlation (t-stat= -2.486, R^2=0.0212) (Figure 4).

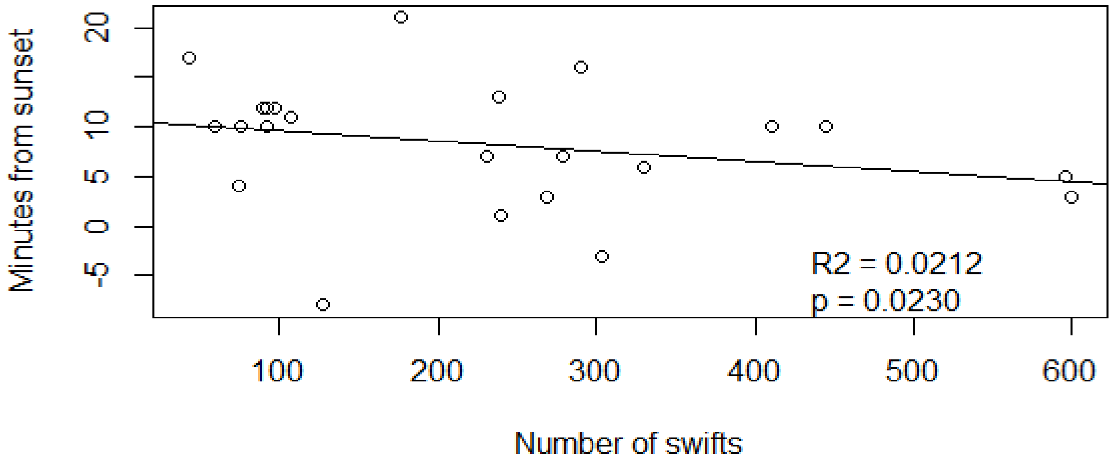

Figure 4. Relationship between time of entry and total number of swifts entering the roost on a given night.

We also ran wind speed in our multivariate analysis of difference in time between sunset and first entry but did not find any statistical significance (P=0.5064).

None of the independent variables explained any of the variation in total duration of entry: cloud cover (P=0.5529), temperature (P=0.8495), total swifts entered (P=0.2247), and wind speed (P=0.6273).

4. Discussion

While the independent variables we tested did not seem to explain the two dependent variables on their own, we did see some significant effects when exploring how the independent variables affect the dependent variables simultaneously. When calculating multivariate regressions, both the temperature (P=0.0134) and number of swifts (P=0.0230) were significant factors in predicting the difference in time between sunset and first entry. Decreasing nightly temperatures in the fall may lead the swifts to roost earlier for increased thermoregulation and energy storage demands[2]. However, energy storage is not imperative for swifts pre-migration like many birds, as they feed on insects during their diurnal migration[10]. One possibility is that higher temperatures mean more food availability, which might lead swifts to stay out feeding longer before roosting.

The number of roosting swifts had a significant impact on roosting time after sunset. Our findings suggest that with increasing numbers of birds on a given night, the birds entered their roost earlier relative to sunset. Higher numbers of swifts may encourage the birds to enter the roost sooner to acquire more prized roosting positions within the chimney. We also found the premature darkening effect from cloud cover was not found to significantly impact roosting behavior (P=0.0681). However, to get a more thorough understand of this relationship further study and more observations are needed. Wind speed also had no statistical significance on time of first entry even with multivariate analyses (P=0.5064). This was surprising as wind speed was expected to increase the time after sunset that first entry occured[9].

None of the independent variables in this study had a significant impact on total time of entry. And thus, my hypothesis that higher ambient air temperatures would increase the total time of swift entry was not supported by the linear regression model (P=0.3297) nor the multivariate analysis (P=0.8495). In the future, to get a better idea of how weather variables impact total time of entry it may be necessary to measure only how long it takes the main flock to go in rather than all the swifts in the area.

Clearly, weather plays a role in Chimney Swift entry to the communal roost[9]. More research is needed be able to piece apart exactly what all the effects are and how they impact swift entry. Increased observations are essential to better understanding timing of Chimney Swifts roost entry and the role of weather on this interplay.

5. Acknowledgments

I would like to thank my project advisor Dr. Andrew Laughlin for helping to construct and make this research come to fruition. He worked closely with me to ensure the smooth operation of the study and supported me throughout the duration. Also, I would like to thank the other faculty and staff in the environmental department at UNCA and the school for helping me on my academic journey.

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