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A Description and Analysis of a Chimney Swift Roost Network in Urban Southern Appalachia

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Abstract

Chimney Swifts (*Chaetura pelagica*) are a unique species of bird, gaining their common name from their tendency to swarm and roost in chimneys as they migrate southward for the winter. They are a well-documented and extensively studied species of bird, with a summer range consisting of the entire eastern half of North America, yet they have found themselves on a steady decline for decades, largely due to human actions. Previous studies have been focused in New England, Canada, and Texas, leaving swift migration in the southern Appalachian region virtually undocumented. This project was the first of its kind in this region, cataloging a network of roost sites in and around the Asheville area in order to observe their interconnectedness and better understand the roosting ecology of this species as they travel through this area. Each site was chosen based on both current and historical data, and a number of characteristics were measured that could potentially attract migrating swifts. From a compilation of data spanning nearly two full decades, trends were analyzed between chimney height, volume, tree density, distance to water, consistency of usage, and peak roost size for the season. Some trends had historical foundation from other parts of the country and some were new and unique. The culmination of this study was a better understanding of each chimney's overall significance, whether it was a consistently used core roost site, or a sporadic and selectively chosen satellite site within the network. This project forms the basis for further study in Asheville and the southern Appalachians.

1. Introduction

The Chimney Swift (*Chaetura pelagica*), is a migratory bird that, during the breeding season, has historically ranged across the entire eastern half of the North American continent, from southern Ontario to Florida and from Texas to the Atlantic Ocean. Each autumn, *C. pelagica* begin their descent southward through the continental United States, Central America, and the Caribbean towards their wintering range in the rainforests of South America. It is during this season when the unique mass roosting behavior which earned *C. pelagica* its common name can be observed.

During autumn migration, *C. pelagica* forms large communal roosts each night, with dozens to thousands of individuals amassing together in a single chimney. Prior to European colonization, *C. pelagica* would roost in the hollowed-out carapaces of dead trees as they migrated south.[1] This roosting behavior is characterized by the large, spiraling patterns made by swarms of birds above the roost site at dusk. As the sun sets further, the individuals dive down into the column and remain there overnight, emerging again at dawn.[2] However, as settlers from Britain and other European nations colonized the continent, the chimneys they erected became necessary substitutes for the birds as their traditional trees were cleared away.[1] This is where *C. pelagica* earns its common name, the Chimney Swift.

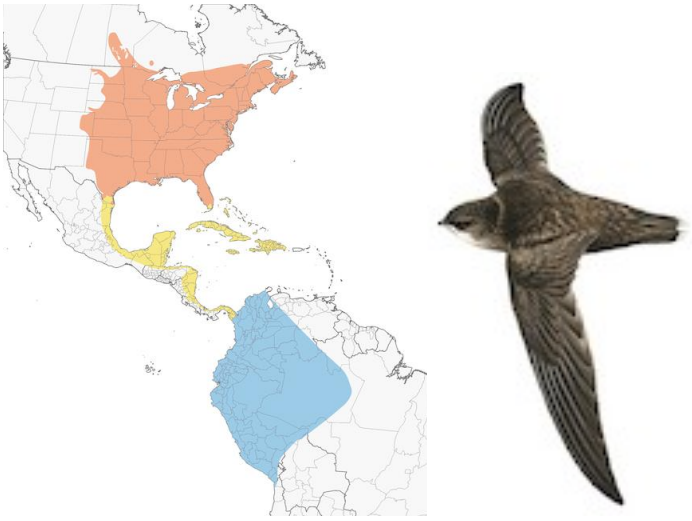

Figure 1. (a) Range of *C. pelagica* throughout year; summer/breeding season displayed in orange, migratory paths in yellow, and wintering range in blue.[1] (b) Illustration of *C. pelagica* by Ian Lewington.[3]

This style of roosting has afforded *C. Pelagica* some unique physiological adaptations. They have relatively short legs and small feet that have an pamprodactyl toe arrangement. This type of foot, along with stiff spines at the tips of their tail feathers, aid the bird's ability to attach to a vertical surface along the interior of trees and chimneys while it roosts for the night with its flock.[4]

Unfortunately, this shift from trees to chimneys has not been equitable for the birds. They have been in decline, becoming increasingly vulnerable as humans encroach further into their habitat. This has led to this species becoming more adapted to urban environments. Chimney swifts tend to roost in the same set of chimneys in urban areas each year, and roost size can vary from a few dozen birds to thousands of birds roosting together. Collectively, the chimneys of Asheville, and many other urban areas, constitute a large network utilized by thousands of birds throughout their migratory season. Understanding what makes certain chimneys more or less appealing may help to form a clearer picture of their overall significance in the area. An emerging method of value assessment for key ecological sites using social network analysis has gained traction in recent years, with *C. pelagica* being a model species for this concept.[5]

Because this project is the first of its kind in this region, it is valuable for comparison with past studies in other areas of the swifts' range. The Chimney Swift is a very well-documented species and similar studies about *C. pelagica* have taken place in regions as far north as Ontario[6], and as far south/west as Texas.[7] Michael et al. (1973) noted that the swifts seemed to prefer chimneys that extend far further above the roof of the building, have greater internal volume, and are associated with non-residential buildings. In contrast, studies of this nature are scant in the southern Appalachians, an area much further south and much later in the migration cycle for many birds. Assessing any discrepancies between the findings of past projects in other regions versus Asheville could provide valuable information on the roosting ecology of this declining species.

In this study, I compiled all the known chimney swift roost surveys conducted in the Asheville area to develop a list of known roost sites, and measured physical and environmental characteristics of these sites in order to relate them to roost size and roost consistency. By developing a catalog of the roost network around the Asheville area, it is possible to test how various roosts might relate to one another, and which ones may be more or less significant to swifts as they journey through this region on their southward migration.

This is the first formal description of the Chimney Swift roost network in Asheville, North Carolina, taking into account environmental variables to distinguish which roost sites are most significant. Here, I also use historical data to develop the hypothesis that chimneys serve different roles throughout the migration season, with some chimneys acting as "core" roost sites that persist throughout the entire season, and other chimneys acting as "satellite" roost sites that are only active during a portion of the season.

2. Methods

To catalog the local roost sites of *C. pelagica*, I compiled current and historical roost surveys conducted at various sites around Asheville, North Carolina. The most recent surveys were conducted in the Fall of 2020. Additional data was collected from historical surveys recorded by the local Blue Ridge Audubon Society, the North Carolina Audubon Society, and the Swift Night Out community science project organized by the Chimney Swift Conservation Association.[8] I compiled these current and historical surveys, documenting for each site the latitude and longitude, type of building (school, church, business, or private residence), maximum roost size, and earliest and latest survey dates as a proxy for roost site persistence.

Additionally, I measured physical and environmental characteristics of each site to later relate to roost size. I measured the height of each chimney with a hypsometer from ground level to the top of the chimney, and visually estimated the width of each chimney to later measure the volume. I used Google Earth to measure the distance to the nearest major body of water (either a lake or major river), and to estimate tree canopy cover in both a 20-m radius circle and 50-m radius circle surrounding the chimney.

I used linear regression to understand the relationship between roost size and these physical and environmental parameters for each roost site. I hypothesized that both chimney height and volume would be positively related to maximum roost size, and that tree cover would be negatively related to roost size.

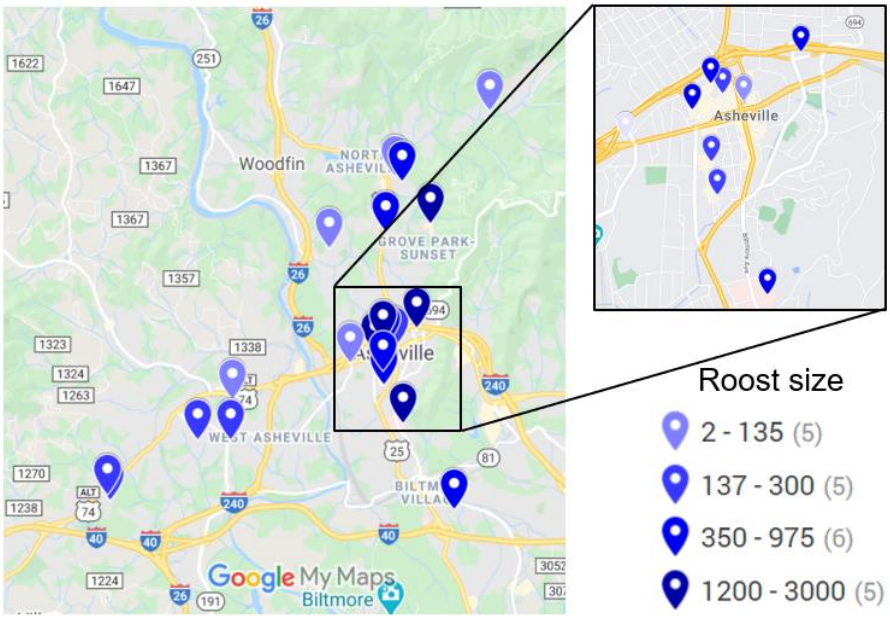

Figure 2. The locations of 21 roost sites in the Asheville, NC, Chimney Swift roost network (inset showing close-up view of downtown roost sites); darker icons indicate sites with more than 1000 swifts documented at peak use.

3. Results

I compiled all current (Fall 2020) and historical (2003 - 2019) Chimney Swift roost surveys in the Asheville, NC, area, for a total of 121 unique surveys. Over the course of these migration seasons, twenty different chimneys were identified as *C. pelagica* roosts sites (Figure 2, Table 1). The sites with the largest number of birds recorded in one roost were Mission Hospital and the Grove Arcade, both with an estimated roost size of 3000 swifts at their peak. These peaks were recorded September 15th and October 3rd, respectively. The Grove Arcade survey was taken in 2003, and the peak at Mission Hospital was recorded during the Fall 2020 season. UNC Asheville's Vance Hall had the smallest roost, with only 30 individuals.

Roost size was positively and significantly related to chimney height ($P < 0.01$, $R^2 = 0.29$; Figure 3), but not chimney volume ($P = 0.1$, $R^2 = 0.1$). The distance to a large body of water did not explain much variation in roost size ($P =$

0.06, $R^2 = 0.13$), but there is an apparent negative – and perhaps nonlinear – relationship between roost size and canopy cover within 50m of the roost site (Figure 4), although the linear regression was not significant ($P = 0.08$, $R^2 = 0.12$).

Table 1. Roost sites and locations with physical and environmental characteristics.

Roost site	Type	Lat	Lon	Roost size (# birds)	Height	Volume	% cover at 50m
Grove Arcade	satellite	35.595	-82.557	3000	19.8	30.888	0
Mission Hospital	satellite	35.581	-82.549	3000	15.7	28.26	0
Thomas Wolfe Auditorium	satellite	35.598	-82.555	1785	26.4	79.2	0
Grove Park Inn	satellite	35.621	-82.543	1560	24.8	214.272	0.1
Park Place	satellite	35.600	-82.546	1200	18.2	54.6	0.1
Rankin Ave (Noble)	satellite	35.597	-82.554	975	12.4	12.4	0
Buncombe County Tax Dept	satellite	35.591	-82.555	950	10.4	8.736	0
Lofts at South Slope	core	35.589	-82.554	600	13.4	0	0
Sherwin Williams	core	35.620	-82.554	600	9.8	6.86	0
Forestry Camp	satellite	35.563	-82.537	500	14.8	25.012	0.15
Jones Elementary	core	35.630	-82.550	350	12.5	14	0.2
Ananda Hair Studio	satellite	35.596	-82.552	300	9.5	4.655	0
Asheville School	core	35.565	-82.623	300	19.4	29.1	0.25
Herring Elementary	satellite	35.577	-82.601	250	8	3.92	0.01
Provisions Furniture	core	35.577	-82.593	170	8.8	5.28	0
Asheville School II (Lawrence)	core	35.566	-82.624	137	17.4	26.1	0.25
Army Reserve Center	core	35.586	-82.593	135	14.3	25.74	0.15
Asheville Catholic School	satellite	35.631	-82.552	100	9.8	6.272	0.05
Haywood St. Congregation	core	35.593	-82.563	60	10.2	2.55	0.05
UNCA Vance Hall	satellite	35.616	-82.568	30	4.6	3.22	0.2

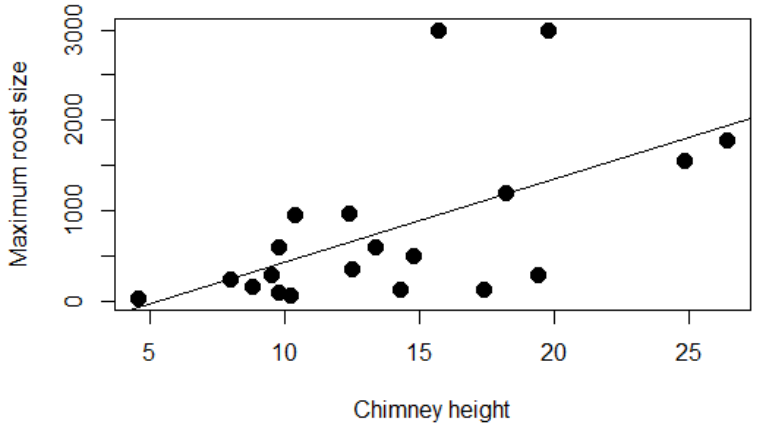

Figure 3. Chimney height in comparison to peak roost size.

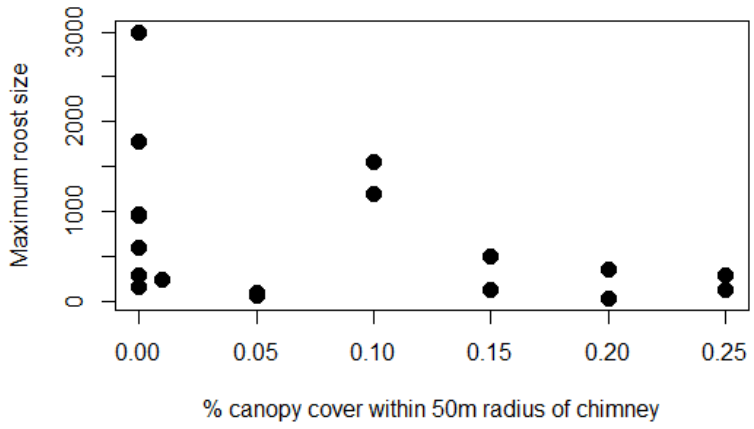

Figure 4. Percent of tree cover within a 50 meter radius of chimney.

4. Discussion

This study provides the first formal description of the Chimney Swift roost network in Asheville, North Carolina, USA. I compiled historical and current swift roost surveys, and documented 20 roost sites of varying sizes. There was a relatively strong positive correlation between roost size and chimney height, in agreement with other studies.[7] There was also a positive correlation between volume and roost size, as well as a negative correlation between roost size and tree cover at both a 20 and 50 meter radius, although these were not significant. Distance from water did not yield any significant findings.

Of all the variables compared, one of the most significant was the positive correlation between chimney height and roost size. There was also a positive correlation between volume and roost size, supporting findings of past studies in Texas[7], but interestingly it was weaker than the correlation with height. This suggests that the height of the chimney may be a more important factor for roosting swifts than the chimney volume. It should be mentioned however that the exact depth of each chimney into its respective building, as well as wall thickness, was unavailable, meaning volume measurements could be somewhat inaccurate. The same study also indicates a preference to chimneys of greater height but with further extension beyond the roof of its building.[7] While exact height from roof to chimney peak was not a variable in this study, the Thomas Wolfe Auditorium, with a chimney height of 24.6 meters and a maximum roost size of 1785 birds, had a roof and chimney of virtually equivalent height to each other. This would be an interesting metric to test further in the future.

Another interesting discovery was an apparent negative correlation between tree cover and roost size. I observed this pattern when analyzing at both a 20 meter radius and a 50 meter radius, although the trend was stronger at 50 meters. This could imply that swifts are slowly adapting to being a more urban species during their migration due to necessity and lack of usable trees. However, when the radius was widened from 20m - 50m, the greatest percentage of tree cover estimated was no more than 25% of the area. This suggests that swifts may still prefer wooded areas when available, but fewer trees immediately around the chimney could facilitate the birds' chances of finding it. More data focusing on this specific relationship is needed to confirm this hypothesis.

An analysis of roost site duration yielded an interesting trend: some roosts appear to persist throughout the eight-week season ("core" roosts), whereas other roosts do not last more than a few weeks ("satellite" roosts). Although more data is needed, this could indicate that different Chimney Swift populations that migrate through Asheville at different times of the season prefer different roost sites. It is difficult to definitively categorize core roosts and satellite roosts with the data available. Only six of the sites had multiple surveys recorded in a given year, which are used as an indicator of when the chimney began and suspended its seasonal activity. Of these six, the chimney most likely to be a core chimney was at the Sherwin Williams site on Merrimon Avenue. Although the Sherwin Williams site peaked with a maximum roost estimate of 600 birds, relatively average for the dataset, it remained in steady use throughout a 60-day period of the 2020 fall migration. The site from the dataset that seems most likely to be a satellite is the chimney

at the Grove Park Inn. While massive and having been observed to house at least 1500 birds at its peak, it was only recorded in use for a 10-day period. It is possible that this indicates a negative correlation between a chimney's roost size and seasonal duration, but more data is needed to make a more accurate conclusion. Hypotheses for additional core and satellite sites are listed in Table 1.

It should also be noted that two chimney sites included in the dataset were situated adjacent to each other on the campus of Asheville School. According to the surveyor of these sites, a teacher at the school, in years past swifts have almost exclusively used Anderson Hall, but suddenly have shifted to Lawrence Hall. Lawrence Hall has since been the site of every single survey recorded at Asheville School in the 2020 season. Not enough additional data was available to perform any meaningful multi-year analysis of whether some core roosts have developed into satellites or satellites into cores. The vast majority of the surveys collected were recorded from the fall 2020 migration (81 out of the 121 compiled).

5. Acknowledgments

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6. References

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