ROOST SITE CHARACTERISTICS OF GREAT-TAILED GRACKLES

(*QUISCALUS MEXICANUS*) IN TEXAS

THESIS

Presented to the Graduate Council of
Texas State University-San Marcos
in Partial Fulfillment
of the Requirements

for the Degree

Master of SCIENCE

by

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San Marcos, Texas
May 2012

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ACKNOWLEDGMENTS

First I would like to thank Dr. Simpson for all of his help over the years in both my graduate and undergraduate degrees. You have been a great inspiration and guide throughout this entire process and I really appreciate your guidance. Also, I would like to thank my other committee members Dr. Green and Dr. Small for all of your help and advice throughout this project. Thank you to Dr. Bonner and Dr. Weckerly for helping me out with all of the stats related questions and issues I ran into. I also want to thank Dr. Hegde for letting me borrow some equipment I needed. Last but not least I want to thank all of my friends and family who helped me through this process. Many of my friends helped me with my data collection and stats analysis and I am so grateful to all you for putting aside your time to help me out. And to my family, I love you all so much for the help and support, also for encouraging me to continue with my degree even when all felt lost. I couldn't have completed any of this without all of you.

This manuscript was submitted on January 3rd, 2012

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ABSTRACT

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Great-tailed Grackles (*Quiscalus mexicanus*) are black birds (Family Icteridae) that form large roosts in urban areas during winter. Roosts are generally not maintained during the remainder of the year. Little information is available regarding Great-tailed

Grackle roost site selection during the winter. I investigated habitat components characteristic of 15 Great-tailed Grackle roosts compared with 15 non-roost sites. I conducted a Principal Components Analysis (PCA) on habitat characteristics to assess potential differences between roost and non-roost sites. Principal Components Analysis revealed that Great-tailed Grackles select sites with taller trees and wider canopies. I used a student's *t*-test to compare the PCA values of the x-axis for Great-tailed Grackle roost sites versus non-roost sites, confirming that tree heights and canopy widths are greater at Great-tailed Grackle roost sites. Other factors (available light, number of food sources, and number of trees per 100 m^2) did not directly influence selection of roost sites.

INTRODUCTION

Great-tailed Grackles (*Quiscalus mexicanus*) are sexually dimorphic blackbirds (Family Icteridae). Prior to the late 1800s, Great-tailed Grackles occurred only in parts of Central America, Mexico and extreme south Texas (Wehjte 2003). However, from the late 1800s to present, they have expanded their range northward and westward at a mean rate of 3.4% per year (Wehtje 2003). Great-tailed Grackles now occur throughout Texas, New Mexico, Arizona, California and parts of southern Nevada, Utah, and Colorado (Arnold 1977, Johnson and Peer 2001, Wehtje 2003). They have also been recorded in Oklahoma, southwestern Louisiana, Arkansas, and Kansas (Johnson and Peer 2001, Pratt 1977, Wehtje 2003). During winter, northern populations of Great-tailed Grackles migrate to southern portions of their range; the states of California, Arizona, New Mexico, Oklahoma, and Texas as well as throughout Mexico and Central America (Johnson and Peer 2001, Rappole et al. 1989).

Great-tailed Grackles occupy a variety of habitats, generally with access to water and with open areas for foraging, including agricultural lands, open areas with scattered trees, urban parks, and building complexes. They also occur in citrus groves, fresh and salt water marshes, and chaparral (Johnson and Peer 2001, Rappole et al. 1989) and avoid dense forests, prairies, and desert locations removed from water sources (Selander and Giller 1961). Nesting sites vary depending on available habitat (Rappole et al. 1989, Selander and Giller 1961).

Great-tailed Grackles are food generalists, consuming mostly insects and other invertebrates as well as grass seeds, vertebrates such as fish and tadpoles, and dropped or discarded human food or refuse when available (Johnson and Peer 2001, Davis and Arnold 1972). Great-tailed Grackles are commonly seen foraging in areas ranging from agricultural land to parking lots; because of their affinity for using anthropogenic food sources they are often considered a nuisance species (Johnson and Peer 2001, Pratt 1977). In urban locales, Great-tailed Grackles often roost in trees near malls, grocery stores, and gas stations (Hall and Harvey 2007, Johnson and Peer 2001). Female Great-tailed Grackles generally roost lower in tree crowns with males competing for the highest portions of roost trees (Hall and Harvey 2007). While Common Grackles (*Quiscalus quiscula*) roost communally with other species, Great-tailed Grackle roosts are composed of conspecifics (Caccamise and Finch 1985, Caccamise et al. 1983, Morrison and Caccamise 1990, Stewart 1975).

Great-tailed Grackles leave roost sites at dawn to forage, returning at dusk (Carlson 1983, Hanson 1976, Jones 1897). Birds arrive at roost sites in groups of varying size and congregate on perches until about an hour post-sunset when they settle in trees (Carlson 1983, Jones 1897). Great-tailed Grackles are considered a nuisance species in most urban areas because of their incessant vocalizations and large amounts of fecal material associated with roost sites (Campbell 2004, Rather 2003). Attempts to discourage roost formation include the use of laser beams, grape-scented fog, noisemakers, spotlights, and even trained Harris' Hawks which harass the birds (Tinsley 2007, Tinsley 2008). These methods have shown little success.

Current literature on Great-tailed Grackles focuses on range expansion, food habits, habitat preferences, and their nuisance reputation (Johnson and Peer 2001). Studies on urban roosting species such as European Starlings, House Sparrows, Common Grackles, and corvids are prevalent, yet little information is available on Great-tailed Grackle roost sites (Caccamise et al. 1983, Geir et al. 2002, Stewart 1973); how or why Great-tailed Grackles select sites for communal winter roosts is largely unknown.

Great-tailed Grackles begin arriving at winter roost sites in mid August and begin to disperse in late March. Certain corvid species have been shown to exhibit a positive correlation with human populations (Jokimaki and Suhonen 1997). These species, like Great-tailed Grackles, are omnivorous and able to use a variety of resources in urban areas (Jokimaki and Suhonen 1997). This may explain, in part, why some omnivorous birds are positively associated with urban areas, but not why a preference is given for one location over another. Studies suggest that birds roost to transfer information about spatial locations of food sources or reduce the risk of nocturnal predation (Caccamise and Morrison 1986, Gier et al. 2002). Some individuals actually change roost sites from one night to another (Caccamise and Morrison 1986). Energy allocation models show that Great-tailed Grackles are attracted to sites with ample food and multiple perches and which afford protection from wind and extreme temperatures (Carlson 1983).

My objectives were to collect habitat data from sites with and sites without Great-tailed Grackle roosts and to assess which factors contribute to Great-tailed Grackles roost selection. My research results may allow for management strategies to influence roost site selection by Great-tailed Grackles in urban areas.

METHODS

Study Area

I selected 15 Great-tailed Grackle roosts and 15 sites without roosts in the following Texas cities; Austin, Buda, Kyle, San Marcos, New Braunfels, Schertz, Seguin, Luling and Houston. Each non-roost site was selected to be within a 1.5 km radius of one of the Great-tailed Grackle roosts. This provided 15-paired sites for comparison. Non-roost sites were selected using geographic information systems (GIS) software (ArcGIS 9.0; Environmental Systems Research Institute, Inc., Redlands, CA, USA) and the National Land Cover Database (NLCD). I used GIS to randomly generate five points within a 1.5 km buffer around each roost site. I chose one of those points as a non-roost site based on the following criteria: 1) the site must be > 0.5 km from the Great-tailed Grackle roost and 2) the site must be within an area of high or medium intensity development as designated by the 2006 NLCD (these criteria were used because all occupied roost sites occurred in high or medium intensity development categories of the NLCD). I used a 1.5 km radius around roost sites because this distance minimized buffer zone overlap while still providing reasonable spacing between roost and non-roost sites. I chose 0.5 km as a minimum distance to ensure adequate spacing so that non-roost areas would not overlap with Great-tailed Grackle roosts. If more than one random point met these criteria, I generated five new points. I repeated this process until only one of the points occurred in a high to medium developed area within the buffer zone. All Great-tailed Grackles roosts were located in areas with similar levels of urban development (Table 1). The 15 non-roost sites were also located at similar levels of urban development (Table 2).

Table 1 Physical Locations and Descriptions of the Great-tailed Grackle Roost Sites in Texas

Site	Location, TX	Latitude	Longitude	Description
1	Austin	30°11'22.88"N	97°46'10.00"W	Grocery store by other businesses
2	Austin	30°12'44.55"N	97°45'10.20"W	Gas station and hotel
3	Austin	30°14'05.30"N	97°43'19.68"W	Two gas stations by a grocery store
4	Austin	30°14'01.77"N	97°44'23.47"W	Gas station with a carwash
5	Buda	30°05'16.27"N	97°49'15.51"W	Grocery store by other businesses
6	Kyle	30°00'54.54"N	97°51'43.86"W	Grocery store by other businesses
7	San Marcos	29°53'13.44"N	97°55'34.66"W	Grocery store by other businesses
8	San Marcos	29°49'35.65"N	97°59'08.89"W	Two fast food restaurants
9	New Braunfels	29°44'54.95"N	98°03'28.64"W	Truck stop gas station
10	Schertz	29°35'54.86"N	98°16'33.80"W	Grocery store by other businesses
11	Seguin	29°34'57.31"N	97°59'36.13"W	Gas station and fast food restaurant
12	Seguin	29°36'04.72"N	97°57'05.29"W	Restaurant
13	Luling	29°39'04.03"N	97°35'32.56"W	Truck stop gas station
14	Houston	29°52'37.93"N	95°38'23.37"W	Apartment complex
15	Houston	29°38'40.89"N	95°34'36.00"W	Gas station and car dealership

Table 2. Physical Locations and Descriptions of the Non-roost Sites in Texas

Site	Location, TX	Latitude	Longitude	Description
16	Austin	30°11'32.81"N	97°46'47.24"W	Small collection of shops
17	Austin	30°12'22.72"N	97°45'32.27"W	Car dealership
18	Austin	30°13'48.34"N	97°43'57.17"W	Small collection of shops
19	Austin	30°13'37.99"N	97°44'37.95"W	Eye doctor clinic
20	Buda	30°05'40.89"N	97°48'58.69"W	Gas station
21	Kyle	30°00'08.88"N	97°51'38.37"W	Elementary school
22	San Marcos	29°52'50.30"N	97°55'06.70"W	Apartment complex
23	San Marcos	29°50'37.06"N	97°58'07.95"W	Two fast food restaurants
24	New Braunfels	29°44'10.22"N	98°03'53.64"W	Large warehouse
25	Schertz	29°36'17.57"N	98°16'42.88"W	Small collection of shops
26	Seguin	29°35'41.79"N	98°00'01.78"W	Small warehouse
27	Seguin	29°35'53.61"N	97°57'31.98"W	Mobile home center
28	Luling	29°40'49.75"N	97°39'08.37"W	Grocery store
29	Houston	29°52'44.20"N	95°37'41.64"W	Convenience store
30	Houston	29°38'24.97"N	95°33'52.84"W	Restaurant nearby other businesses

Data Collection

I visited all 15 occupied roost sites about 30 minutes before sunset during March 2011. I digitally photographed multiple sections of each roost site simultaneously, with help from assistants, and then counted Great-tailed Grackles in each photograph to establish a minimum population size of Great-tailed Grackles at each site.

I measured and recorded data from each of the 30 sites during June and July 2011. Data recorded included tree species, tree height, tree canopy width, and number and type of potential food sources. I used an Opti-Logic LH-series Laser Hypsometer (Opti-Logic Corporation Tullahoma, TN) to measure tree heights. I used a 50 m tape measure to determine tree canopy width by averaging maximum crown width with the width at 90º from maximum width. Anthropogenic food sources included gas station convenience stores and fast food restaurants. These categories were selected because they have high human traffic and large amounts of dropped and discarded food on which Great-tailed Grackles routinely forage.

I also used an FX-200 Illuminometer to measure the amount of incident light in foot-candles (fc) in the evening (7-9pm CST) during September and October 2011 at the 30 sites. I calculated mean incident light from readings taken at five randomly chosen locations at each site. Area measurements were calculated for each site using GIS, and then the number of Great-tailed Grackles and the number of trees per 100 m^2 were calculated for each site.

Data were analyzed using PCA to test multiple variables at each site. This allowed me to determine if there were differences in measured variables between roost sites and non-roost sites and to identify which variables contribute to these differences.

RESULTS

I collected data from 15 Great-tailed Grackle roosts and 15 non-roost sites. Area of Great-tailed Grackle roost sites ranged from 4,013 m^2 – 101,196 m^2 and area measurements of non-roost sites ranged from 4,101 m^2 – 368,512 m^2 (Table 3). Minimum number of Great-tailed Grackles for each roost site ranged from 322-3,809 individuals.

Trees were taller and had wider canopies at Great-tailed Grackle roost sites than at non-roost sites (Table 3). Mean tree heights at Great-tailed Grackle roost sites ranged from 4.57m – 8.30 m compared to 3.49m – 9.00m (excluding locations with no trees) at non-roost sites. Mean canopy width ranged from 4.62m – 9.38m at roost and 2.05 – 9.65m (excluding locations with no trees) at non-roost sites (Table 3). Tree heights were closely associated with canopy width (Figure 1). I identified 12 tree species at Great-tailed Grackle roost sites and 14 tree species at non-roost sites. The most abundant tree species was live oak at both roost and non-roost sites (*Quercis virginiana*; 60.10% and 43.82%, respectively). The second most common tree species was cedar elm (*Ulmus crassifolia*) at roost sites and crape myrtle (*Lagerstroemia* sp.) at non-roost sites (Appendix 3). Each Great-tailed Grackle roost had at least one live oak and 11 of 15 non-roost sites had live oaks (Table 4).

Incident light levels ranged from 1.12 fc – 5.62fc (mean 2.75) at Great-tailed Grackle roosts and from 0.14fc – 14.16fc (mean 2.54) at non-roosts (Table 3). Six of 15 non-roost incident light means fell outside the range of readings at Great-tailed Grackles roosts. However, the results did not differ between roosts and non-roosts ($t_{28} = 0.42$, $P = 0.34$).

Number of food sources at each site did not appear to influence Great-tailed Grackles roost site selection. Mean number of food sources was lower at non-roost sites (0.4) than at roost sites (1.4) (Table 3). However, roost sites and non-roost sites both had locations with 0, 1, or 2 food sources (Appendix 2).

Table 3 Range, Mean, and Variance for Measured Characteristics of Great-tailed Grackle Roost Sites and Non-roost Sites.

Characteristic	Range	Mean	Variance
Site Area (m^2)			
Roost sites	4,013 – 101,196	26,743	163.87
Non-roost sites	4,101 – 368,512	39,304	302.80
Tree canopy width (m)			
Roost sites	4.62 – 9.38	6.67	1.22
Non-roost sites*	0.00 – 9.65	4.79	1.75
Tree height (m)			
Roost sites	4.57 – 8.30	6.16	1.11
Non-roost sites	0.00 – 9.00	5.12	1.67
Food Sources			
Roost sites	0 – 3	1.4	1.03
Non-roost sites	0 – 2	0.4	0.86
Incident light (fc)			
Roost sites	1.12 – 5.62	2.75	1.14
Non-roost sites	0.14 – 14.16	2.54	1.84
Trees (#/100 m^2)			
Roost sites	0.04 – 0.35	0.15	0.32
Non-roost sites	0.00 – 0.30	0.10	0.32

*Sites with a value of 0 for tree height and width indicates that some sites had no trees

Table 4 Live Oak Count Data Comparing Great-tailed Grackle Roosts to Non-roosts

	% Live Oak trees	# of sites with Live Oak
Roost sites	60.10%	15
Non-roost sites	43.82%	11

Data Analysis (Appendix 4)

Principal components I - II (PC I and PC II) cumulatively account for 61.9% of the variation in the measured variables (Table 5). The first principal component (41.9% of total variation) exhibits relatively high positive loading values for tree height (0.64) and canopy width (0.56) and a relatively low negative loading value for light (-0.04). The second principal component (20.0% of the total variation) exhibits a very high positive loading value for incident light (0.99) and a relatively small negative loading value for the number of trees/m^2 (-0.09). Great-tailed Grackle roost sites have higher overall positive values for PC I, however there is a slight overlap between the two groups (Figure 1). The ordination plot reveals that trees are generally taller with wider canopies at Great-tailed Grackle roosts. To confirm these findings, I used a *t*-test to compare PC values of Great-tailed Grackle roosts to the non-roost sites. Results show that PC I values are different between Great-tailed Grackle roosts and non-roosts ($t_{28} = 2.55$, $P < 0.01$). As tree height and canopy width are the two factors with the highest loading values for PC I this further confirms that the Great-tailed Grackle roosts have taller trees with wider canopies (6.16 m and 6.67 m) than non-roost sites (5.12 m and 4.79 m). The *t*-test comparing the PC II values of roost sites to non-roost sites revealed that the PC II data are not significantly different between sites ($t_{28} = 0.42$, $P = 0.34$). Incident light has the highest loading values for PC II, so the *t*-test confirms that incident light does not affect Great-tailed Grackle roost site selection. The other factors that I included in the PCA (food sources and number of trees/100m^2) did not have high positive or negative loading values. This indicates that these characteristics are not significantly different between sites.

Table 5 Summary of Principle Component Analysis

Axes	1	2	3	4
Eigenvalues	00.419	00.200	00.186	00.167
Cumulative percent variance	41.9	61.9	80.5	97.2

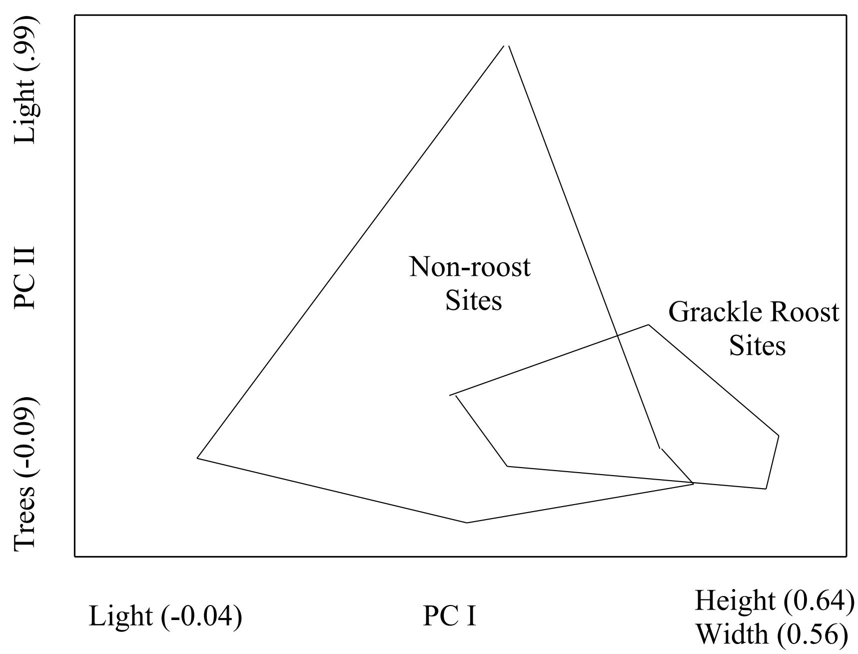

Figure 1. Ordination Plot of Principle Component Analysis Comparing Great-tailed Grackle Roost Sites to Non-roost Sites. PC I shows relatively high positive loadings for height (0.64) and width (0.56) of trees and relatively low negative loadings for the amount of incident light (-0.04). PC II shows very high positive loadings for incident light (0.99) and relatively low negative loadings for # trees/m^2 (-0.09).

DISCUSSION

Tree height and canopy width are the most important factors for Great-tailed Grackle roost site selection. Sites with higher numbers of trees or a greater canopy width attracted larger congregations of Great-tailed Grackles; most likely because of a greater number of roost perches (Lyon and Caccamise 1981). The three sites with the most trees (Site 6 n=67, Site 7 n=56, Site 10 n=75) also yielded the highest minimum number of Great-tailed Grackles (Appendix 3). All other sites had less than 3,000 Great-tailed Grackles, minimum, and less than 50 roost trees (Appendix 1, Appendix 3). Live oak trees were present at each Great-tailed Grackle roost, and in many cases it was the most abundant tree species at each site. In the few roosts that were not dominated by live oaks, the most abundant tree was cedar elm. Based on this observation, I suspect that live oak and cedar elm trees may provide a preferable structure for Great-tailed Grackles; however, this may simply be an artifact of these species being the most prevalent species in the area as a whole.

Incident light may be another factor influencing Great-tailed Grackle roost site selection. Six of the non-roost sites had incident light readings that fell either below or above the range found at Great-tailed Grackle roosts (1.12 fc – 5.62fc), contributing to greater variance at non-roost sites (s = 1.84) compared to the roost sites (s = 1.14). These outlier sites had mean values close to the overall incident light means at roost and non-roost sites (2.75fc and 2.54fc, respectively). However, the mean of outlier sites is similar to overall means. This likely is part of the reason why incident light did not differ between site types. Three roosts from the winter of 2010-2011 relocated to new sites. Roost site selection may depend on regional Great-tailed Grackle population differences as well as differences in available roost sites at the landscape level.

Management Implications

Great-tailed Grackle roosts in urban areas can result in concerns regarding zoonosis and other nuisances (Lyon and Caccamise 1981). Attempts to deter Great-tailed Grackle roost establishment or to cause roost abandonment are generally ineffective. Techniques include use of trained falconers, noisemakers, and non-toxic smoke and gases (Tinsley 2007, Tinsley 2008).

Tree characteristics are a key factor in determining whether sites are favorable for Great-tailed Grackle roosts. Further research focusing on tree species, tree size, and tree density may indicate which characteristics are most important for roost site establishment. This information may elucidate ways to deter Great-tailed Grackle from one establishing roost sites.

APPENDIX 1

General Site Details.

Site	Location	Latitude ”N	Longitude ”W	Area (m^2)	Grackles
Roost sites					
1	Austin, TX	30°11'22.88	97°46'10.00	29,378	2,606
2	Austin, TX	30°12'44.55	97°45'10.20	9,414	1,451
3	Austin, TX	30°14'05.30	97°43'19.68	9,034	1,584
4	Austin, TX	30°14'01.77	97°44'23.47	4,013	476
5	Buda, TX	30°05'16.27	97°49'15.51	35,406	406
6	Kyle, TX	30°00'54.54	97°51'43.86	101,196	3,244
7	San Marcos, TX	29°53'13.44	97°55'34.66	46,138	3,809
8	San Marcos, TX	29°49'35.65	97°59'08.89	10,066	322
9	New Braunfels, TX	29°44'54.95	98°03'28.64	14,507	1,095
10	Schertz, TX	29°35'54.86	98°16'33.80	61,827	312
11	Seguin, TX	29°34'57.31	97°59'36.13	10,134	1,940
12	Seguin, TX	29°36'04.72	97°57'05.29	4,667	1,076
13	Luling, TX	29°39'04.03	95°34'36.00	16,015	648
14	Houston, TX	29°52'37.93	95°38'23.37	39,117	1,810
15	Houston, TX	29°38'40.89	95°34'36.00	10,236	2,202
Mean				(26,743)	
Variance				(163.86)	
Non-roost sites					
16	Austin, TX	30°11'32.81	97°46'47.24	12,639	-
17	Austin, TX	30°12'22.72	97°45'32.27	18,529	-
18	Austin, TX	30°13'48.34	97°43'57.17	9,721	-
19	Austin, TX	30°13'37.99	97°44'37.95	26,135	-
20	Buda, TX	30°05'40.89	97°48'58.69	7,216	-
21	Kyle, TX	30°00'08.88	97°51'38.37	31,631	-
22	San Marcos, TX	29°52'50.30	97°55'06.70	22,360	-
23	San Marcos, TX	29°50'37.06	97°58'07.95	6,830	-
24	New Braunfels, TX	29°44'10.22	98° 3'53.64	368,512	-
25	Schertz, TX	29°36'17.57	98°16'42.88	25,510	-
26	Seguin, TX	29°35'41.79"	98°00'01.78	4,101	-
27	Seguin, TX	29°35'53.61	97°57'31.98	15,784	-
28	Luling, TX	29°40'49.75	97°39'08.37	8,899	-
29	Houston, TX	29°52'44.20	95°37'41.64	6,624	-
30	Houston, TX	29°38'24.97	95°33'52.84	25,067	-
Mean				(39,304)	
Variance				(302.80)	

APPENDIX 2

Collection Data Used in Principle Component Analysis (before Z-transformation)

Site	Location	Width (Mean (m))	Height (Mean (m))	Food	Light (fc)	Trees (#/100 m^2)
Roost sites						
1	Austin	7.06	7.38	1	4.84	0.12
2	Austin	7.48	6.87	2	1.66	0.10
3	Austin	8.25	8.14	2	2.34	0.29
4	Austin	7.65	8.30	1	1.12	0.35
5	Buda	6.00	5.19	1	2.32	0.05
6	Kyle	4.62	4.73	0	3.62	0.07
7	San Marcos	5.17	5.44	3	3.58	0.12
8	San Marcos	9.38	6.76	2	2.94	0.14
9	New Braunfels	5.13	4.70	1	1.64	0.19
10	Schertz	5.10	4.57	3	3.42	0.12
11	Seguin	9.01	6.66	3	1.70	0.07
12	Seguin	5.79	5.15	0	1.86	0.34
13	Luling	6.22	5.60	1	3.14	0.12
14	Houston	5.77	5.97	0	1.42	0.04
15	Houston	7.43	7.00	1	5.62	0.18
Mean		(6.67)	(6.16)	(1.4)	(2.75)	(0.15)
Variance		(1.22)	(1.11)	(1.03)	(1.14)	(0.32)
Non-roost sites						
16	Austin	6.40	6.06	2	1.88	0.13
17	Austin	5.97	5.79	0	14.16	0.09
18	Austin	8.20	6.65	0	0.82	0.12
19	Austin	8.92	5.22	0	0.52	0.04
20	Buda	3.56	4.34	1	2.82	0.07
21	Kyle	2.05	3.43	0	1.02	0.01
22	San Marcos	4.81	9.48	0	1.48	0.30
23	San Marcos	2.09	4.03	2	2.00	0.22
24	New Braunfels	0.00	0.00	0	2.40	0.00
25	Schertz	3.82	3.97	0	4.32	0.07
26	Seguin	4.34	4.32	0	0.14	0.12
27	Seguin	8.05	6.40	0	0.90	0.01
28	Luling	0.00	0.00	0	2.16	0.00
29	Houston	4.05	8.16	1	2.30	0.29
30	Houston	9.68	9.00	0	1.26	0.01
Mean		(4.79)	(5.12)	(0.4)	(2.54)	(0.10)
Variance		(1.75)	(1.67)	(0.86)	(1.84)	(0.32)

APPENDIX 3

Tree Species Data

Site	Dominant Tree	# of species	# of trees	Live oak*	Cedar elm	Crape myrtle
Roosts						
1	Cedar elm	2	36	1	1	0
2	Cedar elm	2	9	1	1	0
3	Live oak	2	26	1	1	0
4	Live oak	1	14	1	0	0
5	Cedar elm	3	16	1	1	0
6	Live oak	2	67	1	1	0
7	Cedar elm	5	56	1	1	0
8	Live oak	3	14	1	0	1
9	Live oak	2	27	1	0	0
10	Live oak	5	75	1	0	1
11	Live oak	2	7	1	0	0
12	Chinkapin oak	4	16	1	1	0
13	Live oak	3	21	1	0	0
14	Live oak	3	15	1	0	0
15	Live oak	2	18	1	0	0
Sum:				15	7	2
Non-roosts						
16	Live oak	3	17	1	0	1
17	Live oak	1	17	1	0	0
18	Live oak	1	12	1	0	0
19	Live oak	4	10	1	0	0
20	Spanish oak	2	5	1	0	0
21	Crape myrtle	1	3	0	0	1
22	Crape myrtle	4	68	1	0	1
23	Live oak	8	15	1	1	0
24	No trees	0	0	0	0	0
25	Crape myrtle	4	18	1	1	1
26	Live oak	2	5	1	0	1
27	Live oak	1	1	1	0	0
28	Crape myrtle**	1	9	0	0	1
29	Loblolly pine	1	19	0	0	0
30	Live oak	1	2	1	0	0
Sum:				11	2	6

*1 means there is at least 1 of that species at the site 0 means there aren't any

** Very small (<3m tall) so I didn't measure them or include them in my analysis

APPENDIX 4

Basic Data Analysis Information

Principal Components Analysis (PCA) presents data on multiple axes and assigns different loading values to each measured characteristic. These data are represented on an ordination plot that usually displays the data from the principal components I and II unless otherwise designated.

Each component accounts for a certain amount of variation in the measured variables. In this case PC I (41.9%) and PC II (20%) cumulatively account for 61.9% of the variation in the data. These are the only two components I reference in this paper. On the ordination plot (Figure 1) the data from PC I are displayed on the x-axis and the data from PC II I displayed on the y-axis.

Loadings on a given PC represent to how much positive or negative influence each measured variable has on the PC. The loading values range from -1 to 1. The closer the loading value is to -1 or 1 the more negative or positive influence that characteristic has on the PC. The closer the loading value is to 0 the weaker the influence that characteristic has on the PC.

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VITA

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