USE OF FOOD RESOURCES BY WHITE-WINGED DOVES AND GREAT-TAILED GRACKLES AT URBAN BIRD FEEDERS IN CENTRAL TEXAS WITH OBESRVATIONS ON COLUMBID WING RAISING BEHAVIOR

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

Alayne B. Fronimos, B.S.

San Marcos, Texas

May 2011

USE OF FOOD RESOURCES BY WHITE-WINGED DOVES AND GREAT-TAILED GRACKLES AT URBAN BIRD FEEDERS IN CENTRAL TEXAS WITH OBESRVATIONS ON COLUMBID WING RAISING BEHAVIOR

Committee Members Approved:

____
John T. Baccus, Chair

____
Michael F. Small

____
Joseph A. Veech

Approved:

____
J. Michael Willoughby, Ph.D.
Dean of the Graduate College

FAIR USE AND AUTHOR'S PERMISSION STATEMENT

Fair Use

Duplication Permission

ACKNOWLEDGMENTS

I would like to thank all those who helped me complete my research. Dr. John Baccus, my committee chair, shared his knowledge and experience with me throughout this project and my work at Texas State University-San Marcos. Dr. Michael Small helped with the design and execution of the field work of my project. Dr. Joseph Veech guided the statistical analysis of the data from this project. Thank you all for your invaluable guidance and assistance throughout my time at Texas State University-San Marcos.

I could not have performed this study without the willingness of the landowners to permit me to observe the birds on their property.

I would like to thank my colleagues who lent their experience to this project. Dr. Butch Weckerly and Dr. Andrea Aspbury helped determine how to approach data collection. Chris Warren and Jeff Troy aided in bird identification. Their assistance and support helped make this project possible.

Support for my research was provided by the Texas Parks and Wildlife White-winged Dove Stamp Fund.

I would also like to thank my family and friends for their unwavering support, interest, and patience during this endeavor.

This Manuscript was submitted on April 9, 2011.

Table of Contents

LIST OF TABLES

Table **Page**

LIST OF FIGURES

ABSTRACT

INTERACTIVE USE OF FOOD RESOURCES BY WHITE-WINGED DOVES AND GREAT-TAILED GRACKLES AT URBAN BIRD FEEDERS IN CENTRAL TEXAS WITH OBSERVATIONS ON COLUMBID WING RAISING BEHAVIOR

By

Alayne Bernadette Fronimos

Texas State University-San Marcos

April 2011

SUPERVISING PROFESSOR: JOHN T. BACCUS

As White-winged Doves and Great-tailed Grackles have expanded their range northward, these species have shown an increased affinity for urban areas with a constant supply of anthropogenic food sources. I compared usage of bird feeders by both of these species with more-established avian species in urban central Texas. I set up 15 feeding stations in San Marcos and 15 in San Antonio. I digitally recorded interaction events for half-hour intervals in summer 2009 and winter 2010. I used recordings to calculate total time spent by each species at each feeding station, count the number of aggressive interactions, and determine participants in each interaction. I also recorded instances of

White-winged Doves raising their wings in a threat display, noting which wing was used to signal. In summer, both White-winged Doves and Great-tailed Grackles used feeding stations the most, with the exception of Mourning Doves. In winter, there was little difference between feeding station usage by White-winged Doves and Great-tailed Grackles; however House Sparrows used feeding stations more than either species. White-winged Doves were displaced by other species during summer, but became more aggressive in winter, perhaps to obtain more limited resources. Further studies are needed to determine if these range expansions are negatively affecting more-established avian species. White-winged Doves raised the wing opposite their opponent most of the time rather than the wing on the same side, as would be expected for wing-slapping. This is consistent with other dove species and appears to be an expression of conflicting choices to flee an aggressor or stay at the feeding station. The White-winged Doves' white wing-bars may play a role in signal amplification of this behavior, but further research is needed to confirm this.

CHAPTER I

INTRODUCTION

Historically, the range of Eastern White-winged Doves (*Zenaida asiatica asiatica*) in Texas only extended as far north as the Lower Rio Grande Valley (LRGV) (Cottam and Trefethen 1968, George et al. 1994). However, since the 1950s, range expansion has resulted in breeding populations as far north as Kansas (Cottam and Trefethen 1968, Moore 2001, Schwertner et al. 2002). This change in distribution has been attributed to loss and fragmentation of breeding habitat in the LRGV because of increased agricultural production, expanding municipalities, industrialization, and a series of damaging freezes to the citrus groves used as replacement habitat for diminishing brush habitat native to the LRGV (Cottam and Trefethen 1968, Curtis and Ripley 1975, Purdy and Tomlinson 1991, George et al. 1994, Hayslette et al. 1996, Brush and Cantu 1998).

Great-tailed Grackles (*Quiscalus mexicanus*) have undergone a similar range expansion into the United States. The original breeding range occurred only as far north as South Texas in the late 1800s; however, Great-tailed Grackles now breed in 20 states (Dinsmore and Dinsmore 1993, Wehtje 2003). Their expansion predated that of White-winged Doves by about 60 years with Great-tailed Grackles common in San Antonio, Texas by 1890 and Austin, Texas by 1902 (Attwater 1892, Schutze 1902). While habitat loss in the Lower Rio Grande Valley is likely the driving cause of Great-tailed Grackle expansion, it has also been speculated that they may have expanded their range to take advantage of increasing food resources becoming more prevalent from an increase of agricultural feedlots north of the LRGV (USDA-NASS 2000, Wehtje 2003).

Since expanding northward, both White-winged Doves and Great-tailed Grackles have shown an affinity for urban centers as breeding sites (Small et al. 1989, West et al. 1993, Johnson and Peer 2001, Wehtje 2003). For White-winged Doves, this selection may stem from urban designs resembling riparian habitat used by White-winged Doves in the LRGV (M. F. Small, pers. comm.). Both species may also benefit from a reduction in predation risks in urban areas, as well as a constant source of food from bird feeders (Wehtje 2003). Urban populations of nesting White-winged Doves also exhibit a reduction in migratory behavior, with a proportion of the population becoming year-round residents, likely taking advantage of a reliable food supply (George 1991, West et al. 1993, Hayslette and Hayslette 1999, Small et al. 2005). Great-tailed Grackles, being omnivorous, also forage in refuse dumpsters and parking lots (Johnson and Peer 2001); however, White-winged Doves are strict granivores (Lack 1968).

Because White-winged Doves and Great-tailed Grackles are relatively recent residents of urban areas, I compared their usage of anthropogenic food sources to usage by established urban species. In addition, I compared usage of feeding stations by White-winged Doves with usage by Great-tailed Grackles. No studies have compared usage of bird feeders between urban White-winged Doves and Great-tailed Grackles. A study of interactions between penned Mourning Doves (*Zenaida macroura*), a sympatric congener of White-winged Doves, and Eurasian Collared Doves (*Streptopelia decaocto*), an invasive exotic species expanding across the United States, found both species exhibited aggression toward each other at feeders, but neither displaced the other (Poling and

Hayslette 2006). Zenaida Doves (*Zenaida aurita*) in Barbados engaged in both territorial defense and communal feeding depending on food availability (Dolman et al. 1996, Lefebvre et al. 2006, Lefebvre et al. 2007). Since aggression is often heightened when food is clustered in a small area and appearance is predictable (Dubois and Giraldeau 2003), frequent bouts of aggression may be expected at feeders.

Also, subsequent to starting this study, I observed a wing-raising behavior and analyzed it as a side study (Fig. 1). White-winged Doves have a white wing bar on the upper wing surface, the significance of which has never been conclusively determined. As White-winged Doves are sexually monomorphic, it is likely not used for sexual display. However, similar wing-raising displays have been observed in Inca Doves, *Columbina inca* (Johnston 1960), Scaly Doves, *Scardafella squammata* (Harrison 1961), Ground Doves, *Columbina passerina* (Johnston 1964), and Zenaida Doves, *Zenaida aurita* (Lefebvre 1996, Sol et al. 2005), but never quantified for White-winged Doves previous to this study.

My objective was to compare the usage of anthropogenic feeding stations by White-winged Doves and Great-tailed Grackles in urban areas with other, more-established native species. I also analyzed how White-winged Doves use wing-raising displays while at feeding stations. My hypothesis was White-winged Doves and Great-tailed Grackles use bird feeding stations (feeders) more than established native species.

Figure 1. Wing-raising behavior by White-winged Dove.

CHAPTER II

MATERIALS AND METHODS

Study Area

I conducted my study at 30 locations in the Edward's Plateau ecoregion of Texas (Gould 1960): 15 each in northeastern San Antonio and San Marcos. The Edward's Plateau is dominated primarily by live oak (*Quercus fusiformis*)/Ashe juniper (*Juniperus asheii*) woodlands with aspects of this community forming a portion of the plant communities in San Antonio and San Marcos. While San Antonio (including the smaller cities of Live Oak, Selma, Universal City, and Converse) is more urbanized than San Marcos, both contain neighborhoods of varying ages, commercial development, and city parks containing old growth and sapling trees, a woody understory, and short grasses. Rivers run through both San Marcos and San Antonio. Every site chosen was composed of savannah-like habitat common to residential yards and parks and locations inhabited by White-winged Doves and Great-tailed Grackles. I attempted to select sites with vegetative and structural features as similar as possible.

Data Collection

Feeding stations were placed in yards at residential homes, parks, or businesses at least 0.5km apart to limit visitation of the same bird at more than one station within a day. Each feeding station (simulating a commercial bird feeder) consisted of a metal tray (38.8 x 25.9 cm) filled with 2 cups (454g) of commercial wild bird seed mix (including millet, milo, sunflower seeds, and wheat) corresponding with a combination of seeds likely used in residential bird feeders. Trays were placed on the ground, allowing access to all avian species (Losito et al. 1990) and reducing complication in defining presence of bird species at a feeding station. Trays were placed near a tree at each site, but outside of the canopy to maximize visibility. Feeding stations were baited on the day (Sunday) before observations began to allow birds to discover and acclimatize to the food source and replenished daily during an observation period.

Five stations were set and observed each week (one tray per location), such that by the end of the study, six sets of five stations were observed. I alternated sites between San Marcos and San Antonio weekly to prevent habitation by birds to feeders for a total of six weeks (three weeks in each city). Observations started 30 min after sunrise each morning (Monday-Friday). The order for station visits was rotated temporally so no station was observed at the same time twice (i.e., a site observed at 0900 h Monday was observed at 0800 h on Tuesday, and so on).

When I arrived at a feeding station, I allowed 15 min of settle time after a tray was filled with food at a station before a 30 min observation began. Observations were made at a distance sufficient to avoid my presence affecting or disturbing bird activities while still allowing an adequate line of sight (4 m average). When possible, observations were made from inside a blind (car or house).

I conducted observations from 20 July to 22 August 2009 to correspond with the peak White-winged Dove population size. I conducted winter observations from 25 January to 5 March when only residential, non-migratory birds present.

I used a digital video camera (Sanyo Model Xacti HD, SANYO North America Corporation, San Diego, California) to record the 30-min observation periods. I transferred all recordings to DVDs for analysis. From these recordings I determined the time (sec) each species spent at a feeding station, as defined by a bird being physically on the feeder or within a 1m radius of the feeder. I documented and counted each instance of intraspecific and interspecific displacement during interactions (with displacement defined as an individual moving as a result of the behavior or arrival of another individual) and noted the aggressor species and displaced species in each interaction. I also documented each instance of wing-raising behavior by White-winged Doves and noted which wing they raised.

Statistical Analysis

Studies involving presence-absence of animals are generally predisposed to produce data sets containing large numbers of zeros, limiting the types of analysis possible. Consequently, if a species did not appear at a particular feeding station during the five observation periods, those zeros were designated null measurements and excluded from analyses because I could not determine with certainty whether the species was actually in the area. I included data from all stations where White-winged Doves or Great-tailed Grackles were present at least one day of the observation week, thus assuming the species was in the area but intermittently visited a feeding station.

I used one-tailed paired *t*-tests with Bonferronni adjustments, to compensate for inflated Type I error due to performing multiple *t*-tests for each season to compare the time White-winged Doves spent at a feeding station with time spent by other species. For another species to be used for comparison, there had to be at least 10 observation periods where both White-winged Doves and the other species were present during an observation week. I then repeated this analysis with Great-tailed Grackles as the focal species. These *t*-tests were performed for both summer and winter data. I also calculated percentage of the 30 min observation periods that each species was present at a feeding station, so comparisons could be made between paired species, despite different numbers of observation periods where each species was present.

To get a clearer assessment of direct aggressive interaction, a count was taken of every instance an individual displaced another. I defined displacement as an individual moving from its location as a result of the action of another individual. The displacing species and the displaced species were recorded. These counts were summed for each season. For each species in each season, the percentage of conspecific interactions was calculated out of total displacer events. For example, if a White-winged Dove exhibited aggressive behavior to another White-winged Dove in 192 out of 237 displacement events, it had a conspecific displacement percentage of 81%. An aggression ratio was also determined for each species in each season. The ratio was calculated by dividing the number of times a species was the displacer by the number of times the species was displaced by another individual of any species. Therefore, a ratio >1 suggested the species had a greater probability of being the aggressor, while a ratio <1 indicated the species had a greater probability of being displaced. For example, if a species was the displacer in 20 interactions and was displaced 100 times, its aggression ratio would be 0.2. This ratio was then calculated again counting only the times that a species was displacing an individual of a different species (interspecific interactions only).

Because the doves in my study were not banded or marked in any way, it was impossible to identify if wing-raising behaviors were performed by the same individuals repeatedly. This potential pseudoreplication made statistical analysis of the wing-raising data unfeasible. Instead, the counts of each type of wing-raise were simply plotted as a site total, since it is unlikely the same individuals were counted at different sites, with the acknowledgment that the data is very preliminary and requires a more thorough study to accurately discern trends.

All activities were conducted in accordance with Texas State University-San Marcos IACUC approval #06-05CC59736D and Texas permit #SPR-0890-234.

CHAPTER III

RESULTS

Relative Presence and Aggression

In summer, White-winged Doves spent more time at feeding stations than Inca Doves (t_1 = 3.5313, P< 0.001), Northern Cardinals, *Cardinalis cardinalis* (t_1 = 4.1571, P = 5.68x10^{-7}), Blue Jays, *Cyanocitta cristata* (t_1 = 3.8353, P< 0.001), and Brown-headed Cowbirds, *Molothrus ater* (t_1 = 4.00, P = 0.001) (Table 1). The Bonferroni adjustment was calculated by dividing α = 0.05 by 8 comparisons performed, resulting in α = 0.0063.

I performed the same analysis with Great-tailed Grackles as the reference species. Great-tailed Grackles spent significantly more time at the feeding stations than Northern Cardinals (t_1 = 2.8759, P = 0.0036), and Blue Jays (t_1 = 5.1464, P = 5.99x10^{-8}) and were not significantly different than any other species (Table 2). The Bonferroni adjustment was calculated by dividing α = 0.05 by 6 comparisons performed, resulting in α = 0.0071.

In winter, White-winged Doves did not use feeding stations more often than other species (Table 3). However, in winter, House Sparrows (*Passer domesticus*) used feeding stations significantly more than White-winged Doves (t_1 = -2.958, P = 0.001) (Table 3). The Bonferroni adjustment was calculated by dividing α = 0.05 by 5 comparisons performed, resulting in α = 0.01.

Great-tailed Grackles' use of feeding stations changed in winter as well, with no remarkable difference in time spent at the feeding stations than other species. However, House Sparrows also used feeding stations significantly more than Great-tailed Grackles

(t_1 = -5.003, $P = 9.15 \times 10^{-8}$) (Table 4). The Bonferroni adjustment was calculated by dividing α = 0.05 by 5 comparisons performed, resulting in α = 0.0125.

Displacement Interactions

In summer, two-thirds (67.9%) of White-winged Dove interactions were conspecific (Table 5), with individuals being displaced more often than being the displacer (aggression ratio = 0.81) (Table 6). This pattern was reversed in winter with White-winged Doves the aggressor (aggression ratio = 1.24) (Table 5) and conspecific displacement decreased to 43.9% (Table 6). The only other species with a comparable degree of conspecific displacements were House Sparrows (67.6% in summer, 65% in winter) and Great-tailed Grackles (73.8% in summer, 62.4% in winter) (Table 5). House Sparrows, however, had very low aggression ratios (0.28 in summer, 0.11 in winter), while Great-tailed Grackles had very high ones (1.23 in summer, 1.28 in winter) (Table 6). Several other species had higher conspecific displacement rates, but they also had very small sample sizes (Table 5). Mourning Doves showed a reversal in aggression ratio patterns as White-winged Doves, being more aggressive in summer (aggression ratio = 2.10) and more likely to be displaced in winter (aggression ratio = 0.76) (Table 6).

Wing-raising Behavior

In summer, White-winged Doves raised the wing on the opposite side of their opponent more often than the wing on the same side at the majority of sites. They also raised both wings occasionally (Fig.2).

In winter, this trend remained consistent. The total number of wing raises observed was much smaller in winter than in summer, and same-side wing raises were very rare (Fig.3).

CHAPTER IV

DISCUSSION

Relative Presence and Aggression

As the distribution of White-winged Doves and Great-tailed Grackles spread northward, the consistent food supply provided by bird feeders in urban areas may have performed an important function in survival. Even with other species present, White-winged Doves and Great-tailed Grackles typically spent more time at feeding stations than other species. House Sparrows also spent significant amounts of time at feeding stations, probably because they are smaller and quicker than other species. All three of these species feed in large flocks, which allowed them to dominate bird feeders; thus, limiting access to bird feeders by other species.

Poling and Hayslette (2006) reported penned Mourning Doves coexisted with exotic Eurasian Collared Doves. In my study, Mourning Doves spent equivalent times at feeding stations as both White-winged Doves and Great-tailed Grackles. However, Mourning Doves spent more time as satellites waiting at edges of feeding trays, while larger size species fed, regardless of season.

There was a seasonal effect on aggression for White-winged Doves. Despite a large number of aggressive interactions involving White-winged Doves, the species had a low aggression ratio during summer. However, the ratio changed in winter and White-winged Doves became more aggressive. This may relate to an increased need for energy in winter because of larger body size and more mass to nutritionally support.

Supplemental feeding has increased winter survivorship of other avian species (Brittingham and Temple 1988, 1992), providing an energy source when natural food abundance and availability has decreased. Non-migratory doves much farther north than the historical distribution must contend with established, native species to secure these limited food resources. Thus, non-migratory doves may be at a disadvantage in interactions for food and compensate with increased aggression. This may also be reflected by White-winged Doves and Great-tailed Grackles spending similar amounts of time at feeding stations as other species, and House Sparrows were present more often, perhaps because their population did not migrate south (Lowther and Cink 2006).

As White-winged Doves and Great-tailed Grackles expand north, they are competing for resources with established species. My study suggests White-winged Doves and Great-tailed Grackles are capable of using urban food resources at the potential expense of other avian species. The only comparable species in time spent and numbers present at feeding stations were House Sparrows, also an exotic, invasive species. White-winged Doves and Great-tailed Grackles can physically intimidate or dominate attempts by most other species to approach bird feeders. Further research is required to determine whether range expansions by White-winged Doves, Great-tailed Grackles, and House Sparrows, are limiting food resources sufficiently to adversely affect native species.

Wing-raising Behavior

White-winged Doves signaled most often with the wing on the opposite side of their opponent (Fig. 4). This contralateral wing-raising has been documented for several dove species including Inca Doves (Johnston 1960), Scaly Doves (Harrison 1961), Ground Doves (Johnston 1964), and Zenaida Doves (Lefebvre 1996, Sol et al. 2005). They also occasionally raised both wings, which sometimes seemed to indicate escalating aggression, as suggested by Harrison (1961) for Scaly Doves and Johnston (1964) for Ground Doves. However, the two-wing raise was mainly used in cases where their opponent was in front of, behind, or above the individual signaling. This corresponds with an account from Whitaker (1957) where a flushed White-winged Dove walked away with its back to him, stretching both wings vertically. While these displays have previously been reported mainly in cases of territory defense, Inca Doves have been seen using wing-raising on foraging grounds to displace a Black Phoebe (*Savornis nigricans*) and House Sparrows (Johnston 1960).

It has been speculated that wing-raising indicates intent to attack (Johnston 1960, 1964), but raising the distal wing does not position individuals for a wing slap (Harrison 1961). Goodwin (1956) suggested the wing might be extended to help the dove balance while striking out with its other wing, but I observed this behavior. Harrison (1961) suggested the wing-raise is used when doves want to flee an aggressor, but are either physically unable or have conflicting desires. The White-winged Doves at my feeding stations had no barriers to escape, but may have experienced conflicting drives to flee and remain at the food source. Wing-raises in my study were only performed in response to aggression or arrival of other birds. Some have proposed that wing-raising is used to make the individual appear taller (Harrison 1961) or indicate they have greater reach in a confrontation (Sol et al. 2005). However, as this posture displays the upper surface of the wing to the aggressor and White-winged Doves raised both wings so opponents in front of, above, or behind them would see the upper surfaces, it may also be used to show colored patches on the wings (Fig. 5). White-winged Doves have a very pronounced white wing-bar contrasted by the dark primaries beside it. Zenaida Doves have a similar white patch on the upper surface of their wings (Lefebvre 1996). Scaly Doves have a white zone on their secondary coverts that becomes more visible when their wings are extended, which Inca Doves also have to a lesser degree (Harrison 1961). If this display is frequent in doves, it is possible the white markings on White-winged Doves and Zenaida Doves are used as signal amplification given they are the most communal of the dove species in which this behavior has been recorded. All previous accounts of wing-raising by doves are anecdotal, however, further studies are required to quantify and elucidate exactly what these displays signify and how doves use them.

Table 1. Paired interactions showing relative time spent by White-winged Doves and other species where both species were present at feeding stations at 15 sites in San Marcos, Texas and 15 sites in San Antonio, Texas during summer 2009.

Other Species	Percentage Time Spent by White-winged Dove	Percentage Time Spent by Other Species	SD	t_1	*P*	Species Present Most
Great-tailed Grackle	21.3	21.6	655.7	-0.0476	0.4811	No Difference
Mourning Dove	19.3	18.2	554.7	0.1250	0.4515	No Difference
Inca Dove	31.1	6.20	621.2	3.5313	0.0009	White-winged Dove
Northern Cardinal	22.4	6.41	518.8	4.1571	5.6800×10^{-5}	White-winged Dove
Blue Jay	15.3	3.57	296.4	3.8353	0.0003	White-winged Dove
House Sparrow	17.9	18.7	527.5	-0.1761	0.4305	No Difference
House Finch	14.8	5.02	361.2	1.8200	0.0480	No Difference
Brown-headed Cowbird	23.9	1.72	346.5	3.9992	0.00010	White-winged Dove

Table 2. Paired interactions showing relative time spent by Great-tailed Grackles and other species where both species were present at feeding stations at 15 sites in San Marcos, Texas and 15 sites in San Antonio, Texas during summer 2009.

Other Species	Percentage Time Spent by Great-tailed Grackle	Percentage Time Spent by Other Species	SD	t_1	*P*	Species Present Most
Mourning Dove	29.4	13.3	500.3	2.2454	0.0207	No Difference
Inca Dove	7.41	12.1	302.9	-0.6930	0.2520	No Difference
Northern Cardinal	17.5	6.64	390.2	2.8759	0.0036	Great-tailed Grackle
Blue Jay	24.5	2.53	395.1	5.1464	5.9907×10^{-6}	Great-tailed Grackle
House Sparrow	25.4	13.9	567.6	2.3769	0.0111	No Difference
Painted Bunting	21.3	5.24	347.5	2.6356	0.01355	No Difference

Table 3. Paired interactions showing relative time spent by White-winged Doves and other species where both species were present at feeding stations at 15 sites in San Marcos, Texas and 15 sites in San Antonio, Texas during winter 2010.

Other Species	Percentage Time Spent by White-winged Dove	Percentage Time Spent by Other Species	SD	t_1	*P*	Species Present Most
Great-tailed Grackle	15.7	10.8	471.7	0.9658	0.1715	No Difference
Mourning Dove	15.5	19.2	466.8	-0.5116	0.3091	No Difference
Inca Dove	18.0	6.9	379.1	1.8976	0.0410	No Difference
Northern Cardinal	15.8	5.9	396.4	2.1831	0.01975	No Difference
House Sparrow	13.0	21.0	273.6	-2.9575	0.0029	House Sparrow

Table 4. Paired interactions showing relative time spent by Great-tailed Grackles and other species where both species were present at feeding stations at 15 sites in San Marcos, Texas and 15 sites in San Antonio, Texas during winter 2010.

Other Species	Percentage Time Spent by White-winged Doves	Percentage Time Spent by Other Species	SD	t_1	P	Species Present Most
Mourning Dove	9.56	14.6	434.2	-0.6540	0.2647	No Difference
Inca Dove	9.65	6.81	285.8	0.6202	0.2739	No Difference
North Cardinal	4.76	4.26	184.8	0.2149	0.4161	No Difference
House Sparrow	6.58	20.5	292.9	-5.0026	9.1523×10^{-6}	House Sparrow

Table 5. Percentage of time aggressive behavior directed at a conspecific for each species.

Species	Sample Size		Percentage of Conspecific Displacements	
	Summer	Winter	Summer	Winter
White-winged Dove	237	269	67.9	43.9
Mourning Dove	21	34	23.8	23.5
Inca Dove	0	12	0	50.0
Northern Cardinal	58	30	5.17	23.3
Blue Jay	14	5	7.14	80.0
House Sparrow	37	20	67.6	65.0
Great-tailed Grackle	305	141	73.8	62.4
House Finch	1	2	100	100
Brown-headed Cowbird	0	0	0	0
Painted Bunting	2	0	100	0

Table 6. Aggression ratio (number of times a species was the aggressor divided by number of times displaced, both including conspecifics and only interspecific interactions) for each species.

Species	Sample Size		Total Aggression Ratio		Interspecific Aggression Ratio	
	Summer	Winter	Summer	Winter	Summer	Winter
White-winged Dove	237	269	0.81	1.24	0.58	1.53
Mourning Dove	21	34	2.10	0.76	3.20	0.70
Inca Dove	0	12	0	0.57	0	0.40
Northern Cardinal	58	30	2.00	1.88	2.12	2.56
Blue Jay	14	5	0.78	1.00	0.76	1.00
House Sparrow	37	20	0.28	0.11	0.11	0.04
Great-tailed Grackle	305	141	1.23	1.28	3.48	2.41
House Finch	1	2	0.17	0.25	0	0
Brown-headed Cowbird	0	0	0	0	0	0
Painted Bunting	2	0	0.25	0	0	0

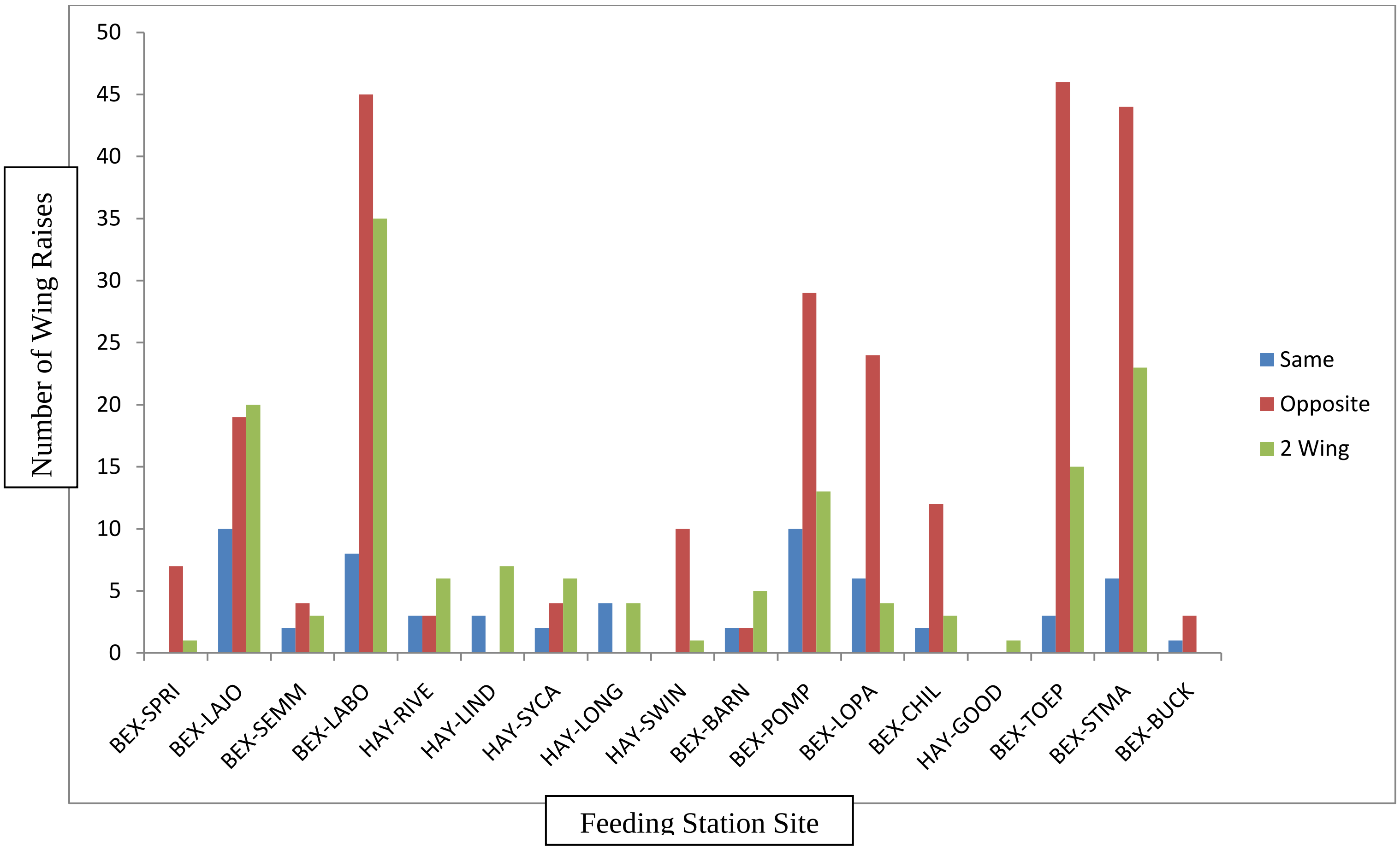

Figure 4. Number of wing-raises performed by White-winged Doves at feeding stations in San Marcos, Texas and San Antonio, Texas during summer 2009.

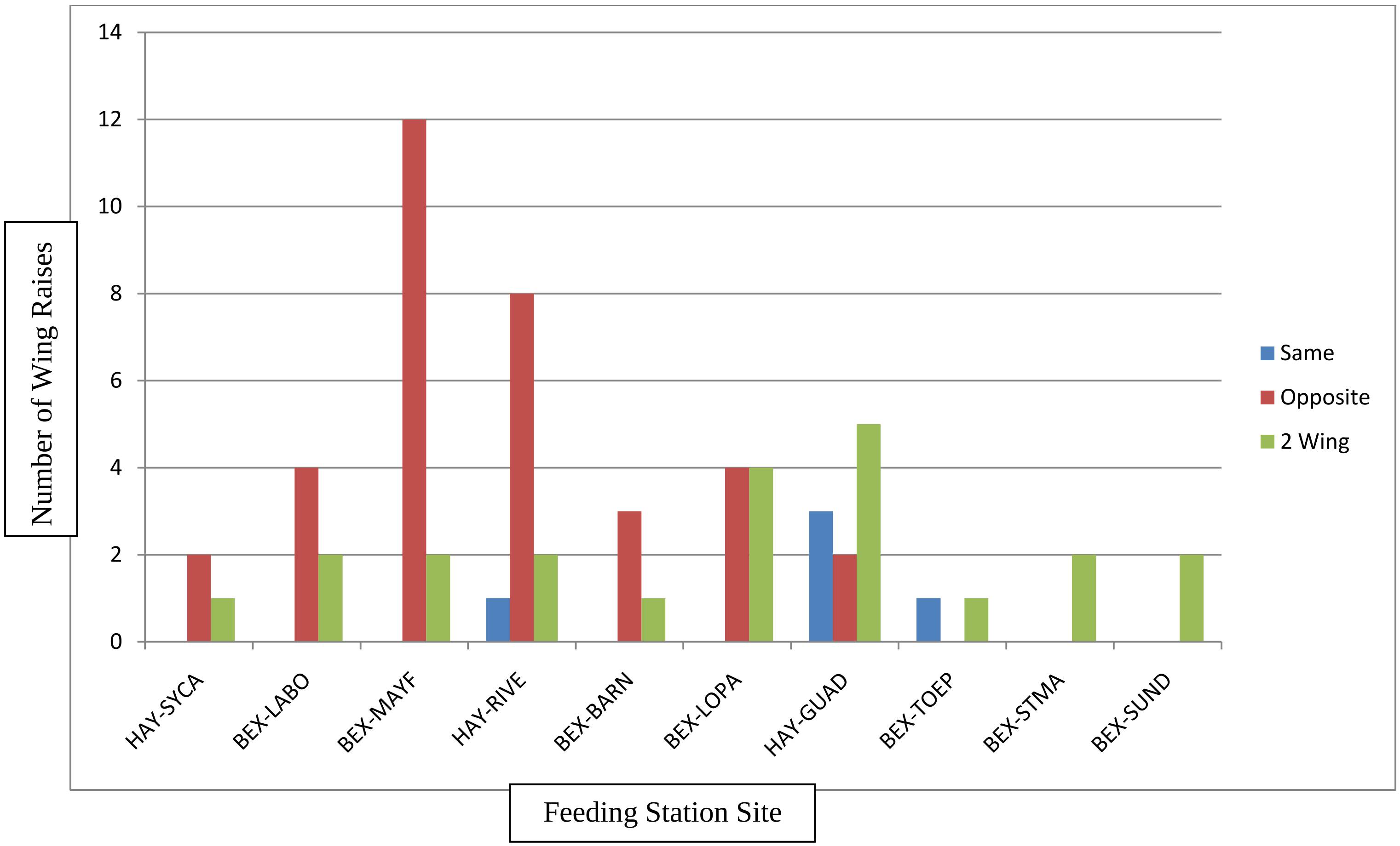

Figure 5. Number of wing-raises performed by White-winged Doves at feeding stations in San Marcos, Texas and San Antonio, Texas during winter 2010.

Figure 4. White-winged Dove opposite side wing-raising.

Figure 5. White-winged Dove raising both wings to fox squirrel.

LITERATURE CITED

Attwater, H. P. 1892. List of birds observed in the vicinity of San Antonio, Bexar County, Texas. Auk 9:229-238.

Brittingham, M. C. and S. A. Temple. 1988. Impacts of supplemental feeding on survival rates of Black-capped Chickadees. Ecology 69:581-589.

Brittingham, M. C. and S. A. Temple. 1992. Use of winter bird-feeders by Black-capped Chickadees. Journal of Wildlife Management 56:103-110.

Brush, T. and A. Cantu. 1998. Changes in the breeding bird community of subtropical evergreen forest in the lower Rio Grande Valley of Texas, 1970s-1990s. Texas Journal of Science 50:123-132.

Cottam, C. and J. B. Trefethen. 1968. White-wings: the life history, status, and management of the White-winged Dove. D. Van Nostrand Company, Princeton, New Jersey.

Dinsmore, J. J. and S. J. Dinsmore. 1993. Range expansion of the Great-tailed Grackle in the 1900s. Journal Iowa Academy of Science 100:54-59.

Dolman, C. S., J. Templeton, and L. Lefebrvre. 1996. Mode of foraging competition is related to tutor preference in *Zenaida aurita*. Journal of Comparative Psychology 110:45-54.

Dubois, F., and L. Giraldeau. 2003. The forager’s dilemma: food sharing and food defense as risk-sensitive foraging options. American Naturalist 162:768-779.

George, R. R. 1991. The adaptable whitewing. Texas Parks and Wildlife 49:10-15.

George, R. R., E. Tomlinson, R. W. Engel-Wilson, G. L. Waggerman, and A. G. Spratt. 1994. White-winged Dove. Pages 29-50 *in* Migratory, shore and upland game bird management in North America. (T. C. Tacha and C. E. Braun, Eds). Allen Press, Lawrence, Kansas.

Goodwin, D. 1956. Observations on the voice and some displays of certain pigeons. Avic. Mag. 62:17-33, 62-70.

Harrison, C. J. O. 1961. Notes on the behavior of the Scaly Dove. The Condor 63:450-455.

Hayslette, S. E. and B. A. Hayslette. 1999. Late and early season reproduction of urban White-winged Doves in Southern Texas. Texas Journal of Science 51:173-180.

Hayslette, S. E., T. C. Tacha, and G. L. Waggerman. 1996. Changes in White-winged Dove reproduction in Southern Texas, 1954-1993. Journal of Wildlife Management 60:298-301.

Johnson, K. and B. D. Peer. 2001. Great-tailed Grackle (*Quiscalus mexicanus*). The birds of North America, No. 576.

Johnston, R. F. 1960. Behavior of the Inca Dove. The Condor 62:7-24.

Johnston, R. F. 1964. Remarks on the behavior of the Ground Dove. The Condor 66:65-69.

Lack, D. 1968. Ecological adaptations of breeding birds. Chapman and Hall, London, United Kingdom.

Lefebvre, L. 1996. Raging dove. Natural History 105:34-37.

Lefebvre, L., B. Palameta, and K. K. Hatch. 1996. Is group-living associated with social learning? A comparative test of a gregarious and a territorial columbid. Behaviour 133:241-261.

Lefebvre, L., J. Templeton, K. Brown, and M. Koelle. 1997. Carib Grackles imitate conspecific and Zenaida Dove tutors. Behaviour 134:1003-1017.

Losito, M. P., R. E. Mirarchi, and G. A. Baldassarre. 1990. Summertime activity budgets of hatching-year Mourning Doves. Auk 107:18-24.

Moore, L. 2001. Spring season roundup: March 1, 2001 through May 31, 2001. The Horned Lark 28(3):12.

Poling, T. D., and S. E. Hayslette. 2006. Dietary overlap and foraging competition between Mourning Doves and Eurasian Collared-Doves. Journal of Wildlife Management 70:998-1004.

Purdy, P. C. and R. E. Tomlinson. 1991. The Eastern White-winged Dove: factors influencing use and continuity of the resource. Pages 255-265 *in* Neotropical wildlife use and conservation. (J. G. Robinson and K. H. Redford, Eds). University of Chicago Press, Chicago, Illinois.

Schwertner, T. W., H. A. Matthewson, J. A. Roberson, M. Small, and G. L. Waggerman. 2002. White-winged Dove (*Zenaida asiatica*). The birds of North America online (ed. by A. Poole). Cornell Lab of Ornithology, Ithica, NY. Available at: http://bna.birds.cornell.edu/bna/species/710/articles/introduction (accessed 1/18/2011)

Small, M. F., R. A. Hilsenbeck, and J. F. Scudday. 1989. Resource utilization and nesting ecology of the White-winged Dove (*Zenaida asiatica*) in central Trans-Pecos, Texas. Texas Journal of Agriculture and Natural Resources 3:37-38.

Small, M. F., C. L. Schaefer, J. T. Baccus, and J. A. Roberson. 2005. Breeding ecology of White-winged Doves in a recently colonized urban environment. Wilson Bulletin 117 (2):172-176.

Sol, D., M. Marcoux, E. Chrostovsky, C. Porcher, and L. Lefebvre. 2005. Ecological mechanisms of a resource polymorphism in Zenaida Doves of Barbados. Ecology 86:2397-2407.

USDA-NASS. 2000. Quickstats. Cattle on Feed Report 1965-2000. http://www.usda.gov/NASS.

Wehtje, W. 2003. The range expansion of the Great-tailed Grackle (*Quiscalus mexicanus* Gmelin) in North America since 1880. Journal of Biogeography 30:1593-1607.

West, L. M., L. M. Smith, R. S. Lutz, and R. R. George. 1993. Ecology of urban White-winged Doves. Transactions of the North American Wildlife and Natural Resources Conference 58:70-77.

Whitaker, L. M. 1957. Comments on wing-flashing and its occurrence in Mimidae with uniformly colored wings. The Wilson Bulletin 69:361-363.

VITA

Alayne Bernadette Fronimos was born in Minot, North Dakota, on January 13, 1985, the daughter of Debra Jean Fronimos, Gregory Laurence Fronimos and stepmother Susan Hartman-Fronimos. After graduating from Judson High School, Converse, Texas in 2003, she entered the University of Texas at San Antonio. She received the degree of Bachelor of Science in Biology with a minor in Psychology from UTSA in May 2008. She then entered the Graduate College of Texas State University-San Marcos.

Permanent e-mail address: alaynefronimos@yahoo.com

This thesis was typed by Alayne B. Fronimos