WHITE WINGED DOVE MOVEMENTS AND REPRODUCTION IN A RECENTLY COLONIZED URBAN ENVIRONMENT

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 2004

ACKNOWLEDGMENTS

I would like to extend my heartfelt thanks to the Derrick family for taking me in and treating me as one of their own. I cannot imagine the past two years without them. I am indebted to many residents of Waco who volunteered their yards and their time to participate in this project. Several companies and groups in the Waco area provided me with assistance throughout this project. I thank Empire Seed, Equipment Depot and the Waco Audubon Society for their generosity. I also am grateful to Jose Cano, James Edwards, Nathan Rains, Mike Miller, John Davis, Mike Hernandez, and Frank Bumgarder for their time and banding efforts.

I thank Texas Parks and Wildlife Department, Gary Waggerman, Mike Frisbie, Jay Roberson, Roy Welch, Bobbye Ficke, and many others for their support and assistance. Through retirements, layoffs, and budget cuts this project was always well supported.

I would like to thank my thesis advisor, John Baccus, for being there without being overbearing, providing guidance while allowing me to work through problems on my own. I would also like to acknowledge my committee members, Butch Weckerly and Randy Simpson for their expertise. I am grateful to Michael Small for his assistance, availability and patience on this project. In addition, Emariana Taylor put in countless hours creating and recreating maps for this project. I appreciate all of her help, and wish her the best with her studies.

Finally, I would like to dedicate this paper to my husband who married into the project, and provided just enough distraction to keep me focused.

This manuscript was submitted on April 21, 2004.

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CHAPTER 1

EXECUTIVE SUMMARY

White-winged doves (*Zenaida asiatica*) have been steadily expanding their breeding range in Texas northward since the 1950's. The cause of this range expansion is not known but is most likely multifaceted and related to habitat loss and/or land use changes as a result of increased urbanization and agricultural production in the lower Rio Grande valley (LRGV). Interestingly the newly colonized areas are generally urban and a large proportion of the colonizing population becomes non-migratory.

My objective was to understand the process and selective pressures which prompted this recent change in white-winged dove biology. I collected contemporary baseline data regarding white-winged dove biology to better design community based studies from the ecological perspective of structure and function. This will provide a greater likelihood of determining the underlying causes of fundamental changes occurring in white-winged dove populations. Concurrent with this understanding, future research needs can subsequently be better identified and prioritized.

In 2002 and 2003, in Waco, Texas, 1,517 white-winged doves were banded and 79 were implanted with radio transmitters in order to document breeding ecology, nesting home range and movement of an urban population.

Capture and Recapture Rates

Overall capture rates of white-winged doves (0.1372 doves/trap-hour) was significantly correlated with overall recapture rate (0.0049 doves/trap-hour) ($P < 0.001$), although recapture rate was much lower than anticipated. Increased trap effort would be required to recapture sufficient winter residents during the breeding season for radio implantation and tracking with a population of this size.

Breeding Ecology

Twenty-six of 79 radio-marked white-winged doves were located to 36 nests during 2002 and 2003, including 1 nesting by a pair of radio-marked birds. Nest success rates, calculated using the Mayfield method, for first and single nest attempts were 0.52 and dropped to 0.28 for second nesting attempts. Four white-winged doves were documented nesting 3 times in a breeding season, while 1 male white-winged dove was documented nesting 4 times, the first and fourth were successful. Nests were located in 9 trees species with 48.5% of nests found in pecan trees (*Carya ıllinoensis*).

Movements

Of 1,517 white-winged doves banded, 35 (2.3%) were reported to the USGS Bird Banding Lab (BBL) as shot or found dead as of March 2004. Huntıng recovery rate alone in this study was 1.6%, although this is expected to rise as doves are exposed to future hunting seasons. The BBL reports band recovery rates for white-winged doves from 1914-2002 as 4.6%. While a longer study is necessary, it is possible that the lower recovery rate in Waco resulted from use of anthropogenic food sources instead of traditional feeding flights to grain fields, resulting in reduced hunting pressure.

Nesting Home Range

Mean nesting home range, calculated using Jennrich-Turner ellipses, was not significantly different between males and females. Radio-marked male and female white-winged doves were located to nest and to point with equal probability.

Recommendations

Some of the accepted natural history of white-winged doves in Texas has been based predominantly on dated anecdotal reports, and has been refuted in more recent studies. The length of breeding season and number of nesting attempts in a season are 2 aspects of white-winged dove breeding ecology that have recently contradicted historical information. In dynamic avian species, natural history information must be constantly reexamined to get a clearer picture of bird movements (e.g., migratory vs. resident), breeding ecology (e.g., nesting, monogamy, recruitment), and habitat use. With a clear picture of white-winged dove ecology, perhaps future range expansion and urbanization can be predicted. Finally, an accurate method of determining population size should be a high priority for future white-winged dove research as current methods are dated, subjective and unproven.

CHAPTER 2

TRAPPING AND RECAPTURE RATES FOR URBAN WHITE-WINGED DOVES IN WACO, TEXAS

The breeding range of white-winged doves (*Zenaida asiatica*) in Texas, until recently, was confined to the brush country and citrus groves of 4 southern counties (Cameron, Starr, Hidalgo and Willacy) in the lower Rio Grande Valley (LRGV) (Cottam and Trefethen 1968, George et al. 1994). In the 1950's, white-winged doves began expanding their breeding and wintering range northward, becoming less migratory, and more urban (Small and Waggerman 1999, West et al. 1993, George et al. 1994). By 1990, more white-winged doves occurred in upper south Texas (Zapata to Travis counties) than in the LRGV, with the majority of these birds in San Antonio, Bexar County (Waggerman 1990). Over 1.3 million white-winged doves inhabited San Antonio in 2001, while less than 400,000 occurred in the LRGV, a substantial change over a relatively short time (Waggerman 2001).

Current hypotheses suggest that loss of traditional white-winged dove breeding habitat to freezes, droughts and agricultural and urban development extirpated white-winged doves from historical environs into alternative urban habitats (West et al. 1993). Increases in white-winged dove density in urban areas prompted interest in exploring this phenomenon. I collected data from January 2002 to August 2003 on urban white-winged dove breeding ecology in Waco, Texas. I examined the trapping effort, trapping locations, and recapture rates.

Methods and Materials

Waco, Texas (McLennan County) has a human population of 202,983 (US Census 2001). Waco is located in north-central Texas near the confluence of the Bosque and Brazos rivers. Total land area included in the study area was 25,869 ha (Figure 2.1). The environs of Waco are characterized by gently sloping topography, dark colored clay soils, a mean daily maximum temperature of 35° C in summer, and a mean daily minimum temperature of 1.7° C in winter (Miller 2001). White-winged doves first appeared on the Waco Audubon Society's Christmas Bird Count in 1993 and call count surveys for 1999, 2001, 2002 and 2003 by Texas Parks and Wildlife Department show a steady population increase (Waggerman 2001).

Trap sites were primarily located through local Audubon society members and from residents in areas with high white-winged dove concentrations. Mean trap site area was less than 0.10 ha in size and usually had a home and garage or other small structure present. I placed traps on driveways or patios and occasionally in areas of low vegetation. About 50% of the trap sites had active bird feeders or birdbaths that attracted white-winged doves. When possible, I positioned traps near feeders, water, and protective perches.

Standard walk-in wire funnel traps (Reeves 1968) were constructed from 2.5 x 5cm galvanized welded wire. I baited traps with a 2:1 mixture of chicken scratch and black-oil sunflower seeds (Purina Corp, St. Louis, Missouri). Traps were baited continuously. Homeowners did not alter their normal activities and continued to fill bird feeders and bird baths.

I trapped from 16 January to 17 June 2002 and from 20 January to 11 July 2003. Individual traps were set no more than every other day, but effort varied based on homeowner activity, predator activity, and geographic area. I overturned traps and left them on site when not in use. I determined trapping effort by calculating the number of hours each trap was set between sunrise and sunset with 1 trap open 1 hour comprising 1 trap-hour. I checked traps every 2 to 3 hours and released non-target species. I banded white-winged doves with USFWS size 4a aluminum numbered leg bands. I determined gender of most adult white-winged doves using cloacal characteristics, with hatching year (HY) birds recorded as unknown (Swanson and Rappole 1992). I recorded primary wing feather molt of HY year birds.

Results

Between 16 January to 17 June 2002 and 20 January to 11 July 2003, I expended 11,235 trap-hours of effort at 36 locations. This effort resulted in trapping and banding 1,517 white-winged doves, of which 88.9% were adults and 11.1% were HY birds. Mean overall trap rate was 0.1372 doves/trap-hour and overall recapture rate was 0.0049 doves/trap-hour (Table 2.1). During the study, I recaptured 52 individuals once (none were recaptured ≥ 2 times), a 3.4% recapture rate based on 1,517 banded birds. A strong positive correlation between capture and recapture rates was present ($r = 0.95$, $P < 0.001$) (Fig. 2.1).

Discussion

Trap rate trends for urban white-winged dove populations were low in winter with a subsequent, steady increase as migrating birds arrived in the study area (mid-March), as expected. Recapture rates were much lower than anticipated, but urban banding studies are uncommon, so it was difficult to make predictions based on prior research. Low recapture rates can be explained by a population that is much larger than anticipated, too few doves banded, some or all wintering white-winged doves in the study area migrating elsewhere to breed, or a combination of these factors. Recapture rates were important because they allowed me to distinguish wintering white-winged doves from potential migrants for a concurrent study.

The strong positive correlation between capture rates and recapture rates was not surprising. At observed recapture rates (assuming wintering birds do breed in the study area) about 5,000 trap-hours would have been required to secure the 40 winter resident white-winged doves needed for the complementary breeding ecology study. When relying on recaptured birds for a dataset, it is vital to have an *a priori* expectation of effort needed to secure the appropriate number of recaptures required to meet the objectives of the study.

Five trap sites yielded 55.7% of doves captured. These sites had a mean trap rate of 0.248, which was significantly higher than the overall trap rate of 0.137 ($t = -4.30$, df = 43, $P < 0.01$). Small sample sizes did not allow calculation of recapture rates per trap site. While I did not record specific site data, the 5 trap sites with the greatest number of captures had several common characteristics, thus allowing speculation as to the reason for their trap success. All 5 sites had bird feeders and water present before and during trapping. Residents at 4 of the 5 sites also fed doves prior to the study by throwing feed on the ground, usually daily. These sites had low levels of predators, relatively low levels of disturbance (dogs, children, very low traffic), and power lines and/or mature trees (which served as perch sites) in close proximity to traps. Future banding efforts in urban areas might benefit by using trap sites that possess some or all of these characteristics.

Another negative result of low recapture rate was an inability to calculate abundance using mark-recapture techniques (Jolly-Seber). I could not calculate a reliable estimate of abundance because of the small number of recaptures during the extended trapping period (Bibby et al. 2000). This information could be useful in planning future studies examining urban and migratory dove populations. More intensive trapping studies are recommended.

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Waggerman, G.L. 2001. White-winged dove and white-tipped dove density, distribution and harvest. Performance Report, Fed. Aid Project W-128-R-9, Job 2. Texas Parks and Wildlife Department, Austin, Texas.

Table 2.1. Number of white-winged doves banded, captured, recaptured by month and yield per unit effort (trap-hour) in 2002 and 2003 combined in Waco, Texas.

Month	Total Banded	Trap Rate (# Banded/trap hr)	Recap Rate (# recap/trap hr)
January	156	0.1256	0.0040
February	225	0.1024	0.0023
March	232	0.090	0.0027
April	342	0.127	0.0056
May	386	0.173	0.0063
June	170	0.205	0.0084

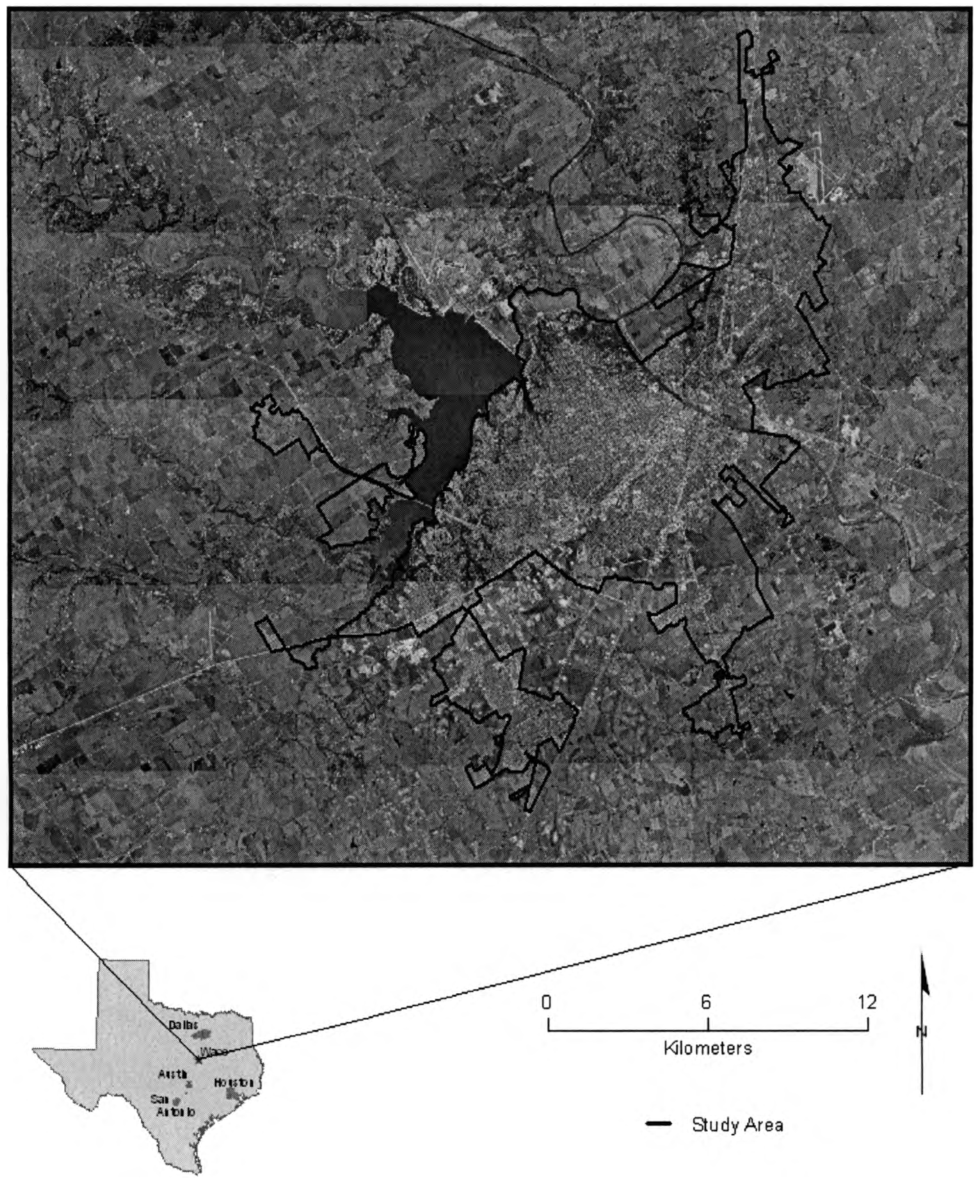

Figure 2.1. Map of the study area, Waco, Texas.

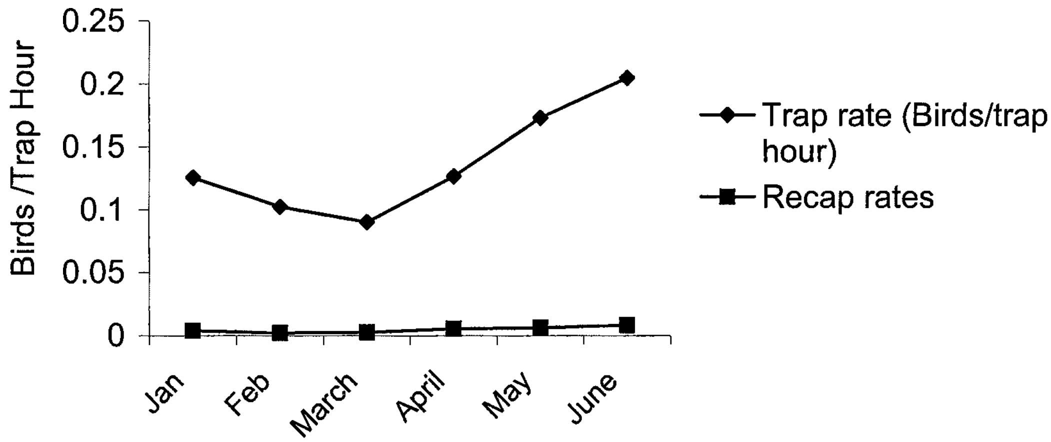

Figure 2.2. Capture and recapture rates for white-winged doves based on catch per unit effort (trap-hour) in Waco, Texas in 2002 and 2003 in Waco, TX.

CHAPTER 3

NESTING HOME RANGE AND MOVEMENT DATA FOR AN URBAN POPULATION OF WHITE-WINGED DOVES

White-winged doves (*Zenaida asiatica)* have been expanding their breeding range northward in Texas since the 1950's (Cottam and Trefethen 1968, George et al 1994). In the last 15 years, populations of white-winged doves in urban areas of Texas have grown exponentially, while populations in the lower Rio Grande valley (LRGV) show instability (Small and Waggerman 1999, Waggerman 2001). Habitat destruction, freezes, droughts, and availability of anthropogenic food sources are among the potential factors facilitating this change in white-winged dove distribution (Kiel and Harris 1956, Cottam and Trefethen 1968, West et al. 1993). Additionally, strong evidence of an extended breeding season and higher recruitment rate by urban, non-migratory white-wing doves (Small et al 1989, Hayslette and Hayslette 1998).

Because white-winged doves in Texas have demonstrated such a dramatic shift in life history over a relatively short period of time, quantifying movements and examining breeding ecology is essential to understanding potential reasons for the precursory changes. In this study I documented breeding home range and movements of white-winged doves from an urban population using radio telemetry and band return data.

Methods and Materials

Waco, Texas, population 202,983 (2001 US Census) was the study site for this research project. Waco was chosen because of its size, location and relatively recent colonization of white-winged doves. Total study area size was 25,868.9 ha (Fig. 3.1) and is one of the northernmost Texas cities with a sizeable population of winter resident white-winged doves. Waco is located in McLennan County in north-central Texas near the confluence of the Bosque and Brazos rivers.

From 16 January to 17 June 2002 and from 20 January to 11 July 2003, 1,517 white-winged doves were banded at 30 sites in the study area. Standard walk-in funnel traps (Reeves 1968) were baited with a 2:1 ratio of cracked corn and black-oil sunflower seeds (Purina Corporation, St. Louis, Missouri). Captured white-winged doves were banded with USFWS size 4A butt-end aluminum leg bands prior to release and age, trap location, and gender were recorded. Gender of adults was determined based on cloacal characters (Miller and Waggner 1955, Swanson and Rappole 1992).

An effort was made through the local media and presentations to local hunter groups to increase awareness of my project and importance of reporting banded birds. Band recovery data was provided in the coarse 10 minute scale by the USGS Patuxent Wildlife Research Center Bird Banding Laboratory (BBL).

In addition, 79 banded white-winged doves were surgically implanted in the field with radio-transmitters (Advanced Telemetry Systems, Isanti, Minnesota) using a portable anesthesia machine (Small et al. 2004). Surgeries were performed in the field at the trap-site and birds were released upon reaching a lucid state (no more than 20 minutes post-surgery). This was of particular importance because both sexes participate in incubation and care of young (Schwertner et al. 2002).

Transmitters had a mean weight of 3.65 g and were equipped with 16 cm external antennae. In 2002, 39 white-winged doves (16 males, 23 females) were implanted between 13 and 17 June, and in 2003, 40 (17 males, 17 females, 6 unknown) were implanted between 19 February and 11 March. Battery life of transmitters was estimated at 150 days; subsequently surgeries in 2002 were scheduled so as to monitor the middle to latter part of the breeding season, and in 2003 to cover the early to middle portion of the breeding season.

White-winged doves were tracked to site using a vehicle-mounted omni-directional antenna and hand held 4-element yagi style antenna. Attempts were made to locate each radioed bird to site at least once every 7 days. Radio-marked white-winged doves were placed randomly into 5 groups, with one group being tracked each day. Daily start times were rotated so that all birds were searched for during different periods throughout the day.

Nesting home range, defined as all movement by white-winged doves during the breeding season excluding feeding flights, was the measure of record rather than a complete survey of white-winged dove movements because of the limited range of the radio transmitters. It was logistically unrealistic to locate radio-marked white-winged doves feeding in agricultural fields surrounding the study site. Fifty percent and 95% Jennrich-Turner ellipses (Biotas 1.2b, Ecological Software Solutions, Urnasch, Switzerland) were used to calculate nesting ranges for radio-marked doves with a minimum of 10 location points.

Results

Mean nesting home range (95% Jennrich-Turner elipse areas) for males with > 10 location points (n = 11) was 31,936 m^2 (Fig. 3.2). Mean nesting home range (95% Jennrich-Turner ellipse areas) for females with > 10 location points (n = 17) was 75,657 m^2 (Fig. 3.3). Nesting home range between males and females was not significantly different. The probability of locating males and females to point and to nest was not significantly different (Table 3.1).

Of the 1,517 birds banded in 2002 and 2003, 36 (2.4%) were recovered as of March 2004 (Table 3.2). Twenty-six were shot and reported by hunters, while 10 were found dead, dead by striking stationary objects, or listed as unknown. Nineteen were recovered within 24 km from where they were banded, while 6 were found within 40 km from the banding site. One banded bird was recovered 495 km away in Lubbock, Texas.

Discussion

Nesting home range was measured rather than traditional home range measures with complete surveys of movements because of limited radio transmitter range. Also, white-winged doves are known to feed up to 100 km from their nesting areas (Cottam and Trefethen 1968, Schwertner at al. 2002) making tracking of individuals outside of their nesting area unrealistic. There was no correlation between number of unique locations found per bird and the size of the nesting home range ellipse. While no significant difference was found between male and female nesting home range areas, determining a baseline area may prove useful in determining nesting densities, or even predicting future colonization.

Because male and female white-winged doves were located to point and to nest with equal probability, future studies on this species utilizing telemetry will not benefit by radio-marking one gender more than another, as is common practice in other bird species (Rotella et al. 1993). This result was not surprising because although both males and females share in nest building, incubation, and care of young, there is a distinct diel difference by gender, with males being the primary diurnal nest attendant (Cottam and Trefethen 1968).

Between 1914 and 2002, the recovery rate of white-winged doves reported to the USGS Bird Banding Lab was 4.6%. This is nearly double the recovery rate reported in my study, a substantial difference even though birds in my study have only been exposed to a maximum of 2 hunting seasons. I suggest that urban white-winged doves spend less time moving in and through areas where they are subjected to hunting pressure as a possible explanation for below expected recovery rates. The hunting recovery rate alone in my study was 1.65%. A long-term intensive banding effort in multiple urban areas would shed additional light on movements and availability of urban white-winged doves to hunters. In addition, a larger scale study would provide information on what proportion of the population is migratory, addressing another major life history change for the species.

Problems were encountered in association with radio tracking white-winged doves in Waco, Texas. These difficulties included electromagnetic interference from power lines, physical interference from structures, and radio interference from cordless and cellular telephones, vhf radios and other sources. To reduce radio interference, transmitter frequencies were chosen specifically not to coincide with the frequencies used by civil emergency personnel. Physical interference reduced the range of some radio transmitters down to < 1 city block (about 200 m). In an attempt to overcome the problem, aerial surveys were conducted by helicopter on 4 occasions. Grids were flown over the study area, at both 76 m and 152 m elevation, with minimal success.

I was able to identify and report new and useful information from radio-marked white-winged doves in this study. This was accomplished despite locating less than 50% of the radio-marked birds 60 days after implantation. In comparison, a similar study in Kingsville, Texas, a much less populated area, using identical transmitters, had 81% of the radio-marked birds locatable after 60 days. It is apparent that some level of human development exists at which radio telemetry become a hindrance rather than a functional tool. Gaps exist in natural history information for white-winged doves, specifically in their newly expanded range. Specifically, nesting success rates, length of breeding season, and recruitment are all issues that can be addressed by carefully designed studies utilizing radio-transmitters.

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Table 3.1. Statistical comparison of the likelihood of locating white-winged doves with radio transmitters to at least 1 point as a function of gender for 2002 and 2003 combined in Waco, Texas.

Category	t	df	$\bar{u}_1 - \bar{u}_2$	P
Total points for all located individuals	0.84	62	1.21	0.41
Total unique points for all located individuals	0.59	62	0.40	0.56
Total nest points for all located individuals	-0.12	62	-0.07	0.91
Total nest points for all individuals located to nests	1.16	24	1.24	0.26
Total points for located individuals with >10 points	0.52	26	0.52	0.61
Total unique points for located individuals with >10 points	-0.75	26	-0.51	0.46
Total nest points for located individuals with >10 points	-0.36	26	-0.43	0.72
Total nest points for individuals located to nests with >10 points	0.60	16	0.89	0.56

Table 3.2. 2002 and 2003 Waco, Texas white-winged dove band recoveries by distance and method.

Number of recoveries	Distance (km)	Shot	Found dead	Other
19	0-24	13	4	2
6	24-48	6	0	0
1	48-96	1	0	0
3	96-120	3	0	0
1	120-144	1	0	0
2	144-168	0	1	1
3	192-240	2	0	1
1	475	0	0	1

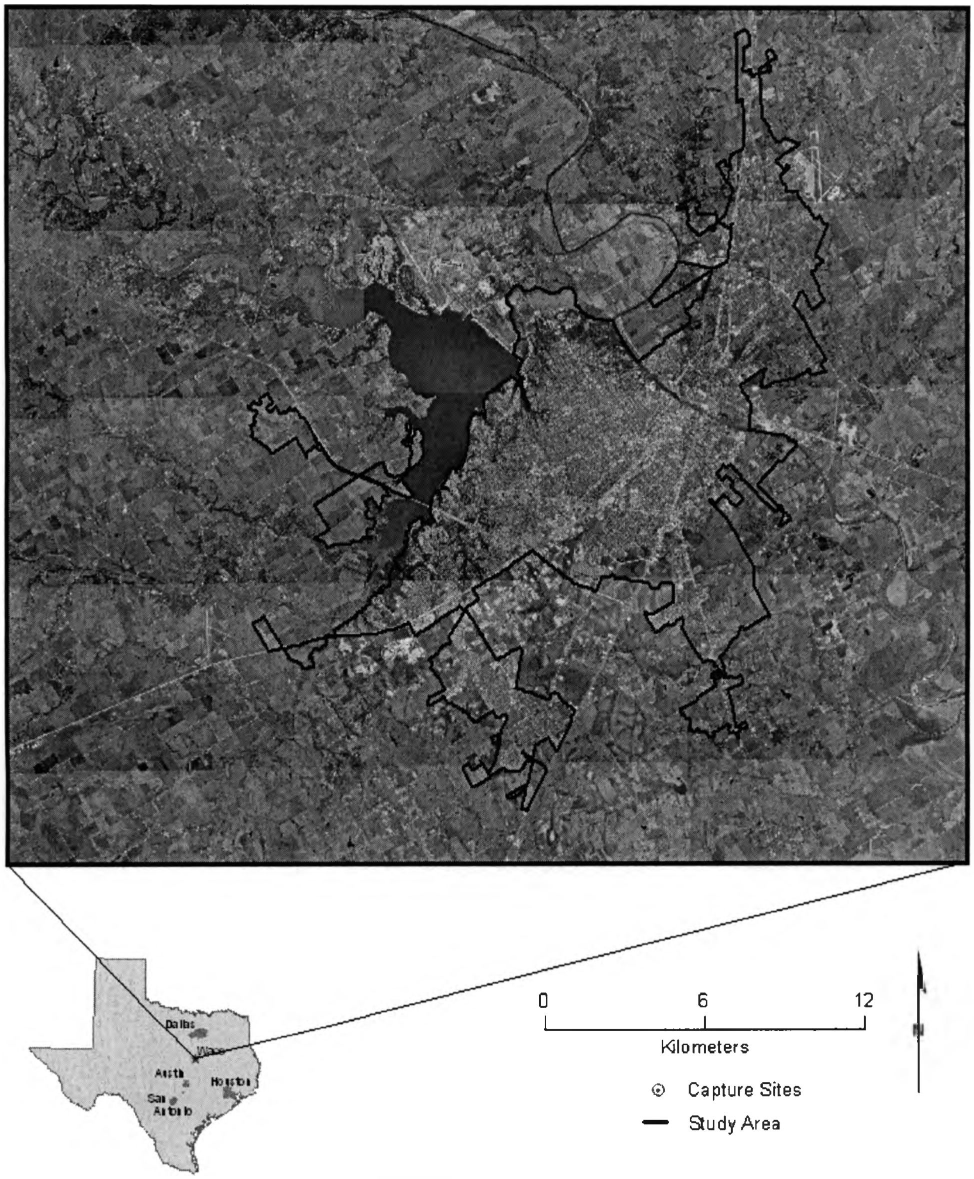

Figure 3.1 Map of the study area, Waco, Texas.

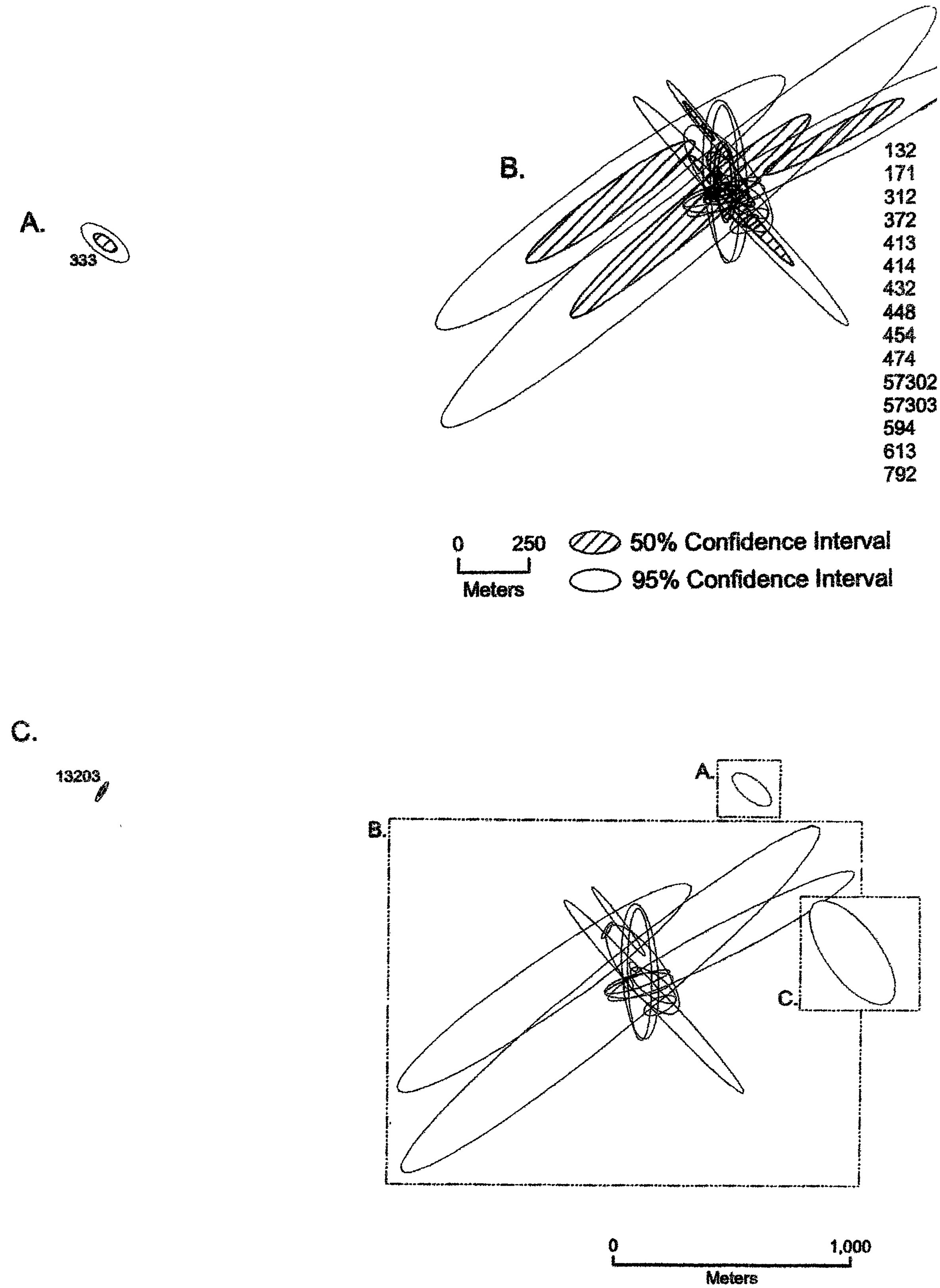

Figure 3.2. 95% and 50% Jennrich-Turner ellipses for radio-marked male white-winged doves with ≥ 10 locations at Waco, Texas in 2002 and 2003. Inset figure shows the spatial relationships between A, B and C.

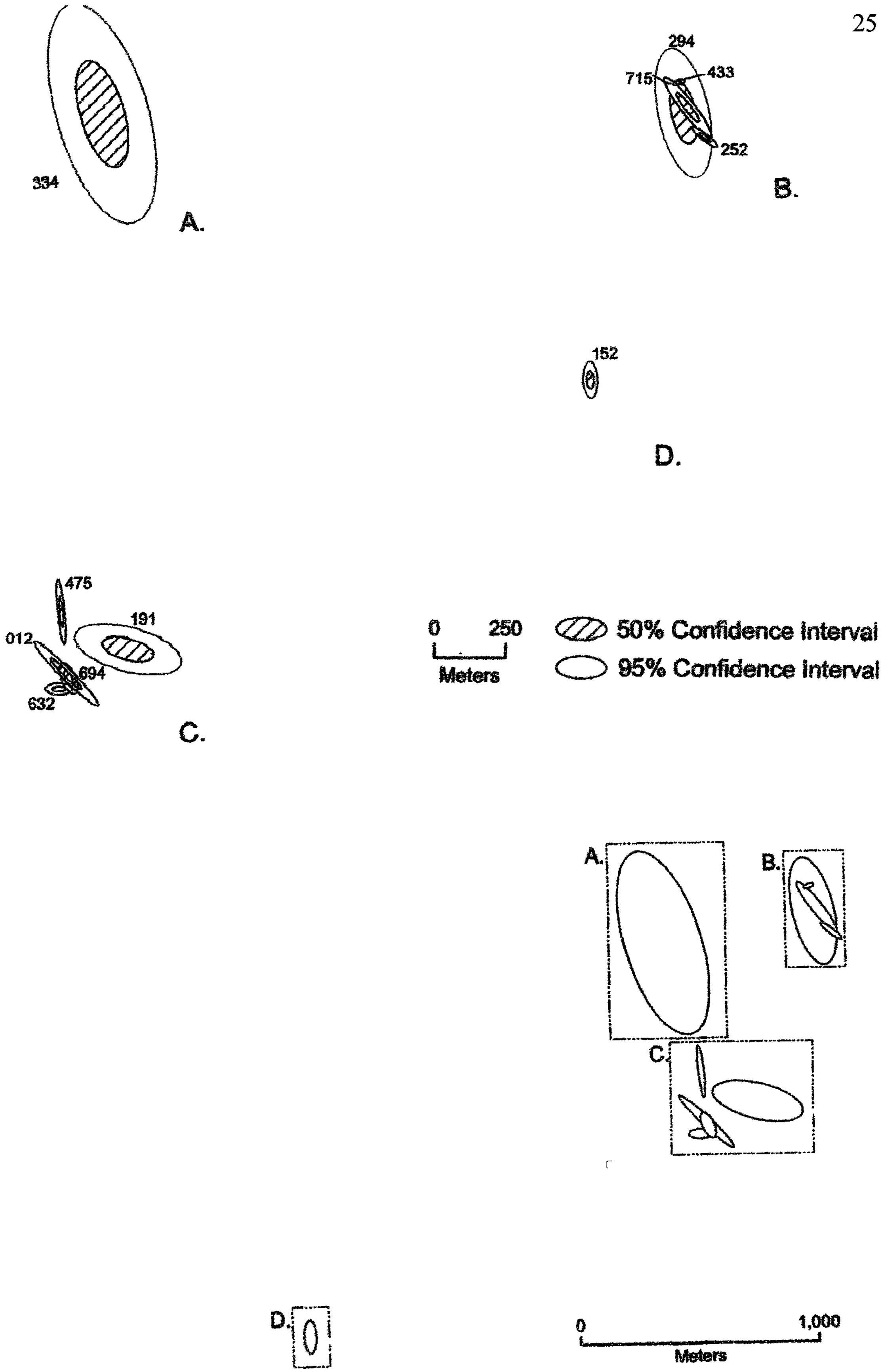

Figure 3.3. 95% and 50% Jennrich-Turner ellipses for radio-marked female white-winged doves with ≥ 10 locations at Waco, Texas in 2002 and 2003. Inset figure shows the spatial relationships between A, B, C, and D.

CHAPTER 4

FIRST DEFINITIVE RECORD OF MORE THAN TWO NESTING ATTEMPTS BY WILD WHITE-WINGED DOVES IN A SINGLE BREEDING SEASON

The historical breeding range and recruitment of white-winged doves (*Zenaida asiatica*) in Texas was primarily restricted to a 4-county region in the lower Rio Grande Valley (LRGV) (Cottam and Trefethen 1968). Recruitment in peripheral populations in adjacent south Texas counties and the Trans-Pecos region have typically been considered negligible (Gray 2002). In recent years, white-winged dove nesting chronology data have shown a geographic shift in nesting to include urban areas (Small and Waggerman 2000). This shift in nesting range occurred concurrent with a substantial northward range expansion of breeding white-winged doves, colonization of urban areas, and establishment of non-migratory resident individuals over the last 3 decades (George et al. 1997, Schwertner et al. 2002).

As white-winged doves continue expanding their range, becoming non-migratory residents, and congregating in urban habitats, accurate measurements of annual recruitment are fundamental to understanding the ecology of this dynamic species. White-winged doves can nest twice in a single breeding season with speculation by some biologists of a greater number of nesting attempts (Cottam and Trefethen 1968, Alamia

1970, Swanson 1989). However, definitive records of more than 2 nesting attempts have not been documented prior to this account.

Methods and Materials

Studies of breeding white-winged doves using surgically implanted radio transmitters in 2000 and 2002-2003 were examined. In 2000, a study was conducted in Kingsville, Texas and in 2002-2003 I conducted a study in Waco, Texas. All white-winged doves were trapped locally in standard wire funnel traps (Reeves 1968) and implanted with subcutaneous radio transmitters in the field at trap sites (Small et al. 2004). In 2000, 40 doves (24 males, 16 females) were trapped between 19 May and 9 June. All doves were located to source once a week until onset of nesting. Nests were then monitored every 4 days using a mirror on an extendable pole.

In 2002, I trapped and implanted transmitters in 39 doves (16 males, 23 females) in June and in 2003, I trapped and implanted 40 doves (17 males, 16 females, 6 unknown) in February and March. I monitored all doves as in 2000, for the life of the transmitter, up to but not exceeding 90 days.

Results

During 2000, 3 male white-winged doves participated in 3 nesting attempts with unmarked females. Each attempt resulted in new nest construction. In each case, 2 nesting attempts proved successful with 1 failure. Young fledged on the first and second nestings but failed on the third for 2 nesting pairs. The other fledged young on the first and third attempts with the second failing. During 2002, 1 white-winged dove (sex unknown) made 3 nesting attempts. Two attempts fledged young, nestings 1 and 2, with nest 3 failing. During 2003, 1 female white-winged dove made 4 nesting attempts with the first and fourth attempts fledging young. The second attempt resulted in nest abandonment and the third nest failed.

In all multiple nesting attempts, none of the doves reused a nest. Doves built new nests either in the same tree or a nearby tree ≤ 100 m from the old nest. Because of its uniqueness, additional information for the individual with 4 nesting attempts is presented (Table 4.1).

DISCUSSION

Although some anecdotal evidence of > 2 nesting attempts by white-winged doves exists, radio telemetric methodology allowed us to report the first definitive occurrence of > 2 nesting attempts. Whether this is a unique occurrence or a fundamental aspect of white-winged dove natural history is unknown. Because of the dynamic range expansion, urbanization, and proportional residency shifts of white-winged doves over the last 30 – 50 years, frequency of > 2 nesting attempts in historic populations will probably never be known.

The availability of anthropogenic food and water resources and habitat associated with urbanization has the potential to extend the breeding season (Hayslette and Hayslette 1999) which could represent a shift in the reproductive strategy for white-winged doves. During 2002, one pair of doves with radio transmitters pair bonded, but both batteries failed after 1 successful nesting. Consequently, the issue of monogamy in wild populations of white-winged doves remains unanswered in this study. Further research is fundamental to understanding the dynamics of multiple nesting, monogamy and an extended breeding season on recruitment.

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Table 4.1. Nesting attempts of a female white-winged dove in the 2003 breedıng season in Waco, Texas.

	Date	Tree Species	Nest Height (m)	Tree Height (m)	Success
First attempt	4/08/03	Pecan	2.32	6.67	2 Fledglings
Second attempt	5/23/03	Pecan	2.9	6.67	Abandoned
Third attempt	6/11/03	Liveoak	8.06	16.64	Nest Failed
Fourth attempt	6/18/03	Pecan	2.33	6.67	2 Fledglings

CHAPTER 5

BREEDING ECOLOGY OF A RECENTLY COLONIZED URBAN WHITE-WINGED DOVE POPULATION

Over the last 40 years, information on the natural history of white-winged doves (*Zenaida asiatica)* has undergone substantial change (Schwertner et al. 2002). The breeding range for the species in Texas, until the 1980's, was predominantly limited to 4 counties (Cameron, Starr, Hidalgo and Willacy) in the lower Rio Grande Valley (LRGV) at the extreme southern tip of the state (Cottam and Trefethen 1968, George et al. 1994). Currently, that range is expanding northward with individual white-winged doves recorded in Canada and a breeding pair documented as far north as Kansas (Moore 2001). The Texas population of white-winged doves has the majority of breeding individuals in the United States, both currently and historically (George et al. 1994).

Large breeding populations of white-winged doves have subsequently become established in central Texas with numerous smaller populations occurring throughout the state. Additionally, concurrent with a northward range expansion, white-winged dove populations have become concentrated in urban areas (West et al. 1993). This represents a dramatic shift in habitat use away from thorn scrub and riparian woodlands of the

Tamualipan biotic province (Blair 1950) typical of the LRGV (West et al. 1993, Schwertner et al. 2002).

Losses of native habitat and extensive agricultural and industrial development in the LRGV have influenced changes in white-winged dove distribution in Texas (Hayslette et al. 2000). From 1900 to 1950, about 95% of the historic native white-winged dove breeding habitat has been converted for human uses, resulting in severe declines in old growth woodlands and water diversions from the Rio Grande and Arroyo Colorado (Kiel and Harris 1956, Cottam and Trefethen 1968). In addition, severe freezes in 1951, 1962, 1983 and 1989 decimated the orange groves where white-winged doves had been nesting in increasing numbers, most likely in response to native habitat loss (Cottam and Trefethen 1968, George et al. 1994).

Currently, white-winged doves continue to concentrate in urban areas and a substantial proportion of these populations have become non-migratory (George 1991, West et al. 1993, Hayslette and Hayslette 1999). Anecdotal evidence suggests that an extended breeding season in non-migrants in the expanded range could represent an increase in recruitment from these individuals as white-winged doves produce additional clutches before and after the traditional nesting period (Hayslette and Hayslette 1999). Consequently, white-winged dove populations have increased dramatically in size over the past 20 years, however, only 16% of the total Texas white-winged dove population now occurs in the LRGV (Gary Waggerman pers. com.). The objective of this study was to characterize various aspects of white-winged dove breeding ecology in a recently colonized urban environment using subcutaneously implanted radio transmitters.

Methods and Materials

This study was conducted in Waco, Texas (McLennan County), population 202,983 (U. S. Census 2001), because of its geographic location, relatively recent colonization by white-winged doves, and relatively large white-winged dove population. The study site included a mean land area of 25,869 ha at the confluence of the Brazos and Bosque rivers (Figure 5.1). The environs of Waco are characterized by dark-colored clay soils and gently rolling to flat topography. White-winged doves were first recorded in Waco on the Audubon Society's Christmas bird count in 1993 and first observed breeding in the area about 1990 (Whiteswift, personal communication). Texas Parks and Wildlife Department personnel in 1999, 2001, 2002 and 2003 used call-count surveys to derive a current white-winged dove population estimate of about 70,000 individuals with an increasing trend.

I trapped and surgically implanted subcutaneous transmitters in 39 white-winged doves (16 males, 23 females) in June 2002 and in 40 (17 males, 17 females, 6 unknown) in February and March 2003. I based gender assignment on cloacal characteristics (Miller and Wagner 1955, Swanson and Rappole 1992). I performed transmitter implant surgeries in the field using a portable anesthesia machine and mobile surgical lab (Small et al 2004). Implanted individuals were released immediately after regaining a coherent state. Transmitters used (Advanced Telemetry Systems, Isanti, Minnesota) weighed 3.65 g and were 25 mm x 14 mm x 7 mm with an external whip antenna 16 cm long.

I tracked individuals using a vehicle mounted omni-directional antenna and a handheld 4-element directional yagi antenna (White and Garrott 1990). I documented nesting behavior and attempts and, when possible, recorded habitat parameters. I monitored active nests visually with binoculars every third day, and when feasible, an extendable fiberglass pole mounted with a mirror was used for closer examination (Parker 1972). I calculated all nest success rates using the Mayfield method based on exposure (1961 and 1975), beginning when nests were located, and ending when young had fledged or the nest failed.

RESULTS

I located 14 of 39 transmittered white-winged doves (8 male, 6 female) to 15 nests from 10 July to 4 September 2002. I located 12 of 40 white-winged doves (7 male, 3 female, 2 unknown) to 21 nests from 31 March to 14 July 2003 (Table 5.1), including 1 pair with both individuals radio-tagged.

Nests were located in 9 tree species with 48.5% (17) of nests in pecan trees (*Carya illinoensis*) and 17% (6) in sugarberry (*Celtis laevigata*) trees. The remaining 34.5% (12) of nests occurred in 7 additional tree species: live oak (*Quercus virginianus*), cedar elm (*Ulmus crassifolia*), chinaberry (*Melia azedarach)*, crepe myrtle (*Lagerstroemia indica*), pomegranite (*Punica granatum)*, Texas oak (*Quercus buckleyi),* and Privet (*Ligustrum lucidum)*. Nest height as a ratio of tree height was 0.55 in pecan trees, 0.41 in sugarberry trees, and 0.45 in the 7 remaining tree species (Table 5.2).

The probability of nesting success for white-winged doves for 2002 and 2003 was 0.65 and 0.43, respectively. Nesting success for both years combined was 0.52, as calculated using both single and multiple nesting attempts of all white-winged doves. Nesting success of first and single nesting attempts was 0.71 and 0.53 for 2002 and 2003, respectively. Second nesting attempt success was 0.28 in 2003 and was not calculated in 2002 because of low sample size (n = 1). Nesting success of single and first nesting attempts for both years was 0.62 with success of second nesting attempts dropping to 0.24. Third and fourth nesting attempt success rates were not calculated because of small sample size.

DISCUSSION

Monitoring of white-winged doves showed that individuals in Waco have an extended breeding season. May to mid-August is historically the period of greatest white-winged dove breeding activity, particularly in the LRGV (Cottam and Trefethen 1968, George et al 1994, Schwertner et al 2002). In 2002 in Waco, I located 9 separate nests in March and April. In 2002, one nest period extended into September. Additionally, I observed white-winged doves constructing nests in February and active white-winged dove nests as late as October. Further, I heard cooing white-winged doves in late January and into October, although cooing behavior peaked in May and June. To confirm that individual birds nest throughout the potential extended breeding season as opposed to shifting their breeding activity will require transmitters with battery duration greater than 150 days.

Twenty-three percent of nesting white-winged doves attempted > 1 nesting. This re-nesting rate was similar to the 39% found (Gray 2002, Small et al. in review) in Kingsville, Texas. In 2003, 1 radio-marked female nested 4 times, of which the first and fourth nests were successful (Schaefer et al. in review). Cottam and Trefethen (1968) stated that white-winged doves nested multiple times during the breeding season, while other publications listed the mean as 2 broods per season (Schwertner et al. 2002). The determination of the nesting rates and influence of multiple nesting on white-winged dove recruitment is an important aspect of natural history for understanding species ecology, particularly in urban areas with rapidly expanding populations.

The overall nesting success (0.52) was consistent with the 0.575 (Hayslette and Hayslette 1999) and 0.53 (Gray 2002, Small in review) success in studies in Kingsville, Texas, and the 0.39 to 0.73 success found in San Antonio, Texas (West et al. 1993). In 2002, when transmitters were implanted in June, it is possible that implanted birds had already nested 1 or more times. Similarly, when transmitters were implanted in late February and early March 2003, doves may have continued breeding after transmitters ceased operating. The only solution for determining nesting success for individual doves throughout this extended breeding season is to obtain transmitters with a longer battery life and signal range. Nest transect methods similar to West et al. (1993) would provide larger sample sizes for calculating overall nest success.

The majority of nesting in Waco occurred in deciduous tree species. Most of these species are similar in growth habit to woodland riparian species native to areas traditionally used by nesting white-winged doves in the LRGV (Cottam and Trefethen 1968, Schwertner et al. 2002) and in Kingsville, Texas (Gray 2002). In urban areas, shade trees such as pecan, live oak and hackberry are important white-winged dove nesting trees (Nillson 1943, Cottam and Trefethen 1968, West et al. 1993). Despite being displaced from the LRGV, most likely in part as a result of habitat loss (Purdy and Tomlinson 1991), white-winged doves seem to preferentially select nesting trees with specific characteristics. Also, nest height location, expressed as a proportion of tree height was consistent with other studies (Small et al. 1989, Small et al. in review) that showed mean nest height occurred in the middle one-third of the tree. Trees less than 3 m in height were rarely used for nesting.

In my study, I had difficulties with telemetry reception in urban settings, particularly when monitoring a highly mobile species. Radio and electromagnetic waves from power-lines, cellular phones, cordless telephones, handheld radios and other sources produced almost constant interference. The transmitter frequencies were in the 165 mHz range and did not overlap with frequencies used by civil emergency personnel. Radio interference was slightly lower in early morning and late evening hours. Electromagnetic interference from power lines did not vary by time of day. Physical interference was problematic in this study. Building density was high, and although few structures were > 2 stories, transmitter range was reduced by physical interference with the signal. This problem is inherent to urban telemetry and warrants further investigation to determine if improved technology or methodology could reduce or eliminate the problem. I flew aerial grids by helicopter over the study area at 76 m and 152 m using both omni-directional and directional antennae in an attempt to improve transmitter reception. I had minimal success and interference levels similar to ground surveys.

A consequence of these urban telemetry problems was small sample sizes (location points) in both years. Although nesting attempts are categorized as first, second, third, and fourth in this study, this does not preclude the possibility that radio-tagged white-winged doves nested prior to implantation with a transmitter, nor continued nesting following transmitter failure. Often, radio-marked white-winged doves tracked to nests were not located again for substantial periods of time.

Land access in Waco, Texas proved problematic. I had to secure property owner permission prior to accessing areas to search for birds. Although permission was obtained > 90% of the time, this was often time consuming, requiring multiple attempts at landowner contact, often at inconvenient times. In many instances, birds had left the area by the time permission was obtained. I publicized the project through the local newspaper to inform residents of activities taking place in their neighborhoods.

Improved telemetry equipment, including the use of satellite transmitters would eliminate many of the difficulties encountered on this project. Nesting transects similar to those used by West et al. (1993) in newly colonized urban areas would also yield more information on white-winged dove breeding ecology especially if used in conjunction with telemetry, albeit with increased time, effort, and expense. Enlisting the help of Master Naturalist groups, Audubon societies, or other birding groups to assist in urban surveys of breeding white-winged doves may prove prudent, as public awareness and participation can be crucial to success of urban studies.

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Table 5.1. Nesting attempts by radio-marked white-winged doves in Waco, Texas in 2002 and 2003.

		Nesting Attempts			
Year	Gender	1	2	3	4
2002	Male	7	1	0	0
	Female	6	0	0	0
2003	Male	5	2	0	0
	Female	2	0	0	1
	Unknown	0	1	1	0

Table 5.2 White-winged dove nest parameters by nest tree species in Waco, Texas in 2002 and 2003.

Tree Species	n	Nest Height (m)	SE	Tree Height (m)	SE	Nest Height/Tree Height
Pecan	17	9.50	2.09	17.21	3.60	0.55
Sugarberry	6	6.77	0.84	16.51	3.17	0.41
Cedar Elm	3	13.88	8.92	18.59	3.22	0.75
Chinaberry	2	5.05	1.99	11.56	2.05	0.44
Texas Oak	2	2.10	0.10	5.60	0.00	0.38
Live Oak	2	5.78	2.28	18.82	2.18	0.31
Crepe Myrtle	1	2.44	n/a	5.79	n/a	0.42
Privet	1	2.44	n/a	6.41	n/a	0.38
Pomegranite	1	2.13	n/a	4.57	n/a	0.47

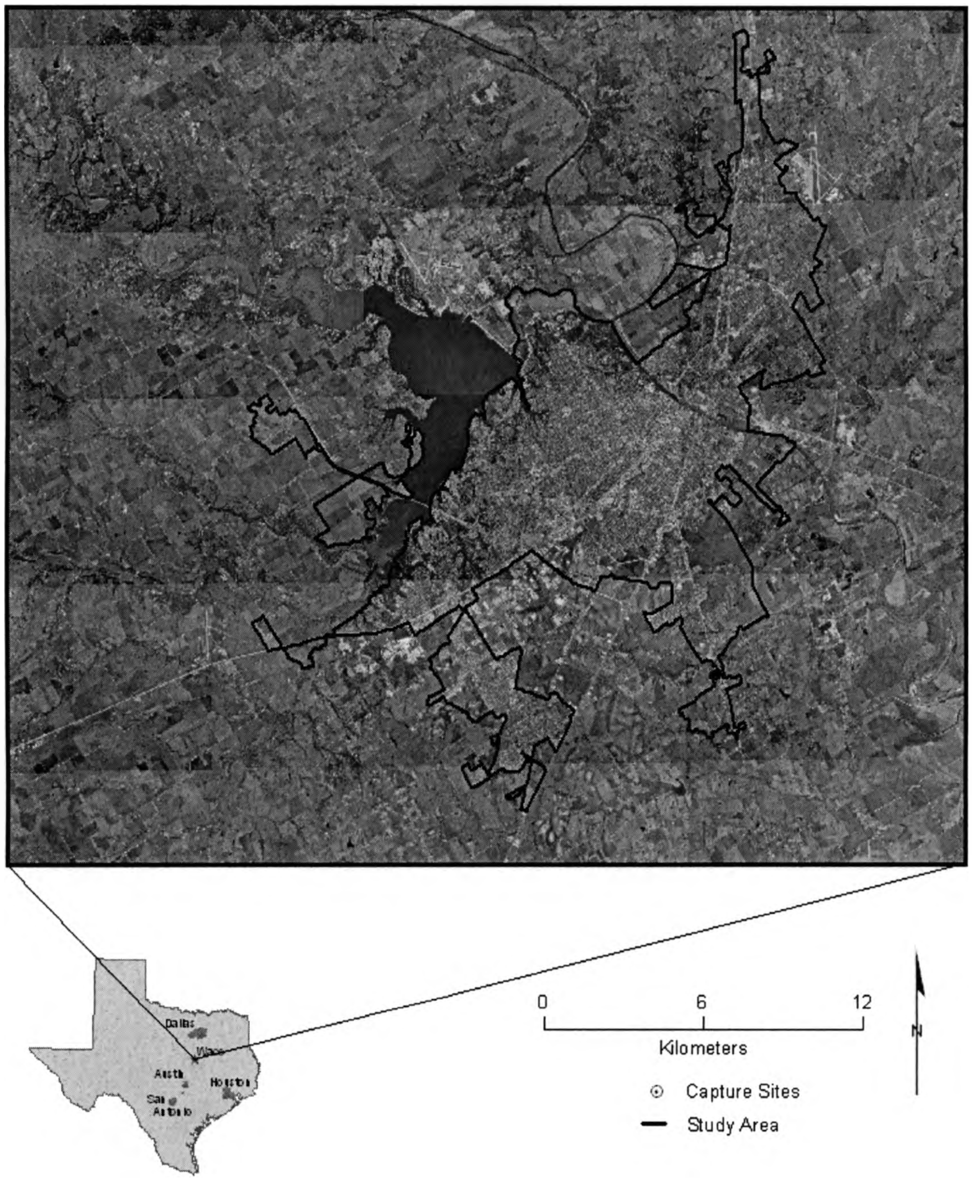

Figure 5.1.Map of the study area, Waco, Texas

APPENDICES

Site ID	Hours	Birds	Trap Rate
1	161 88	0	0.000
2	38 13	0	0 000
3	91 62	0	0.000
4	8.47	0	0 000
5	29 57	0	0 000
6	37 3	0	0.000
7	28.5	0	0 000
8	21.18	0	0 000
9	28 53	0	0.000
10	49 53	0	0 000
11	37.67	0	0.000
12	251 07	3	0 012
13	466 59	6	0 013
14	263	4	0 015
15	49 57	1	0 020
16	48.57	1	0 021
17	255.57	8	0.031
18	150 77	6	0 040
19	48.72	2	0.041
20	215 47	9	0 042
21	339 43	16	0.047
22	165.65	8	0 048
23	407 82	20	0 049
24	319.27	22	0 069
25	90.73	7	0.077
26	453.65	39	0 086
27	526 89	51	0.097
28	329.05	32	0.097
29	355.99	35	0.098
30	711.43	82	0.115
31	325 37	39	0.120
32	278.17	44	0.158
33	630.61	109	0 173
34	479.57	94	0 196
35	699 88	151	0 216
36	13.5	3	0 222
37	656 37	153	0 233
38	859 17	212	0 247
39	843 32	227	0 269
40	481.4	133	0 276

Appendix B Capture and Recapture Rates

Month	2002 trap hours	2003 trap hours	trap hours	banded 2002	banded 2003	2002 trap effort	2003 trap effort	total banded	Total up to x month 2003	Trap rate (Birds/trap hour)	recap 2002	recap 2003
Jan	472 05	770 22	1242 27	25	131	0 052960491	0 170081275	156	156	0.125576565	0	5
Feb	1666.15	530 82	2196 97	131	94	0 078624374	0 177084511	225	381	0 102413779	2	3
March	1914.03	655 43	2569 46	200	32	0.10449157	0 04882291	232	613	0 090291345	7	0
April	1913.87	781 07	2694 94	190	152	0 09927529	0 194604837	342	955	0 126904495	2	13
May	1223 42	1004 48	2227.9	192	194	0 156937111	0 193134756	386	1341	0.173257328	9	5
June	696 33	132 7	829 03	130	40	0 186693091	0.301431801	170	1511	0 205058924	7	0

Appendix B Capture and Recapture Rates

Recap totals	2002 recap/trap hour	2003 recap/trap hour	avg recap/trap hour	total recap/trap hours	2002 recap/total banded	2003 recap/total banded	average recap/total banded
5	0	0 006491652	0 003245826	0.00402489	0	0.038167939	0.019083969
5	0 001200372	0 005651633	0.003426003	0 002275862	0 012820513	0.008888889	0 010854701
7	0.003657205	0	0 001828602	0.002724308	0 019662921	0.027237354	0.023450138
15	0.001045003	0.016643835	0 008844419	0 005565987	0.003663004	0 004889976	0 00427649
14	0 007356427	0.0049777	0 006167063	0 006283945	0.012195122	0 014925373	0 013560248
7	0.010052705	0	0 005026352	0 008443603	0.008064516	0 01088647	0 009475493

Site ID	UTM-X	UTM-Y	Implant site
1	688678	3488984	n
2	678993	3491525	n
3	672718	3490355	y
4	671234	3479654	n
5	660405	3499710	n
6	669308	3487971	y
7	669460	3488449	n
8	680055	3501963	n
9	669965	3488053	n
10	675173	3495122	n
11	669449	3488550	n
12	674400	3491210	y
13	672174	3495207	n
14	672882	3481145	n
15	670921	3488993	n
16	672456	3492833	y
17	681121	3496495	n
18	674851	3492135	y
19	670722	3489219	n
20	669106	3488220	n
21	675449	3495044	n
22	670431	3490827	n
23	671966	3494333	y
24	675549	3491023	n
25	670850	3492515	y
26	680208	3483853	n
27	674594	3492310	n
28	667427	3485876	n
29	670162	3482512	n
30	670027	3490823	n
31	669886	3486755	n
32	671822	3494026	y
33	679825	3500057	n
34	679044	3483738	n
35	673023	3481323	n
36	669016	3487210	n

	recovery		recovery		Banded		Banded		Distance
BandNumber	lat	long	utm x	utm y	lat	long	utm x	utm y	(km)
84447101	31 50	97 00	689946	3486749	31 50	97 00	689946	3486749	0 00
84447641	31.50	97 00	689946	3486749	31.50	97 00	689946	3486749	0 00
84447659	31 50	97 00	689946	3486749	31.50	97 00	689946	3486749	0 00
84447778	31.50	97.00	689946	3486749	31.50	97 00	689946	3486749	0 00
84446677	31 50	97.17	674178	3486473	31.50	97.00	689946	3486749	0 28
84446906	31.50	97 17	674178	3486473	31.50	97.00	689946	3486749	0 28
76476628	31.50	97.00	689946	3486749	31.50	97 17	674178	3486473	0.28
84446606	31 50	97.00	689946	3486749	31.50	97.17	674178	3486473	0 28
84447130	31 50	97.00	689946	3486749	31 50	97 17	674178	3486473	0 28
84447217	31 50	97.00	689946	3486749	31 50	97.17	674178	3486473	0 28
84447293	31 50	97 00	689946	3486749	31.50	97 17	674178	3486473	0 28
84447298	31.50	97 00	689946	3486749	31.50	97.17	674178	3486473	0 28
84447527	31 50	97 00	689946	3486749	31.50	97 17	674178	3486473	0 28
84447731	31.50	97 00	689946	3486749	31.50	97 17	674178	3486473	0 28
84447797	31 50	97.00	689946	3486749	31 50	97.17	674178	3486473	0 28
84447829	31 33	97 17	674492	3467627	31.50	97 17	674178	3486473	18 85
84448286	31 33	97 17	674492	3467627	31 50	97.17	674178	3486473	18 85
84447381	31 33	97.00	690289	3467902	31 50	97 00	689946	3486749	18 85
84447135	31 66	97 00	689621	3504487	31 50	97 17	674178	3486473	18 01
84447957	31.33	97.00	690289	3467902	31 50	97.17	674178	3486473	18.57
84448251	31 33	97 17	674492	3467627	31 50	97.00	689946	3486749	19 12
84446612	31 50	97 00	689946	3486749	31 33	97 16	674492	3467627	19 12
84446971	31 50	97 00	689946	3486749	31 33	97 16	674492	3467627	19 12
84447809	31 50	97 00	689946	3486749	31.33	97 16	674492	3467627	19.12
84447903	31.00	97.33	659439	3430798	31.50	97.17	674178	3486473	55 68
84447625	32 33	97 33	657182	3578239	31 50	97 00	689946	3486749	91 49
84447353	32 50	97 33	656887	3597087	31 50	97.17	674178	3486473	110 61
84447133	30 50	97 33	660265	3375377	31 50	97.00	689946	3486749	111.37
84447122	32 00	98 17	578776	3540739	31 50	97.00	689946	3486749	53 99
84447608	30.17	97 67	628356	3337930	31.50	97.17	674178	3486473	148 54
84446928	30 17	97.67	628356	3337930	31.50	97.00	689946	3486749	148 82
84447905	29.33	98 33	565050	3244733	31 33	97 16	674492	3467627	222 89
84447528	29 33	98 33	565050	3244733	31 50	97.17	674178	3486473	241 74
84447844	29 33	98.33	565050	3244733	31 50	97.17	674178	3486473	241 74
84446838	33 50	101 67	252239	3709903	31 50	97.17	674178	3486473	223 43

Appendix E Nesting Home Range

year	bird id	sex	95% area	95%circ	50% area	50% circ.	date radio	# unique points	# total points	# total points are nest
2003	333	f	13231 25	464 52	3061 41	223 44	3/5/2003	3	16	0
2003	093	u	3741 10	228 25	865 61	109 79	2/19/2003	4	18	8
2002	694	m	4549.46	270 86	1052 64	130 29	6/17/2002	4	12	2
2002	012	m	9755 56	649.57	2257.22	312.45	2/19/2003	4	11	2
2002	792	f	59880 89	1038.83	13855 1	499 7	6/14/2002	4	11	4
2002	414	f	21584 60	646 02	4994 2	310 75	6/16/2002	5	13	2
2002	132	f	86871 11	1204 4	20100 03	579 34	6/15/2002	5	10	0
2002	474	f	10760 98	588 06	2489 85	282.87	6/16/2002	6	13	3
2003	191	m	46104 06	885 95	10667 45	426 16	3/4/2003	6	14	0
2003	171	f	265768 94	3104 29	61493	1493 22	3/4/2003	6	16	0
2003	433	m	598 38	98 4	138 45	47.33	3/7/2003	7	13	7
2003	454	f	995 63	115 91	230 37	55.76	3/7/2003	7	15	0
2003	372	f	1547 82	145 99	358 13	70 22	3/5/2003	7	16	2
2003	252	m	1941 50	233 05	449.22	112 1	3/4/2003	7	14	7
2003	475	m	4330 52	459.7	1001 98	221.12	3/7/2003	7	12	0
2002	152	m	5293 71	303 48	1224 85	145.98	6/15/2002	7	21	2
2003	413	f	9181 80	738 61	2124 46	355 29	3/5/2003	7	18	10
2002	312	f	44204 11	1166 03	10227 84	560 88	6/14/2002	7	12	0
2002	432	f	70642 21	2241 79	16345 03	1078 34	6/17/2002	7	16	0
2003	132	f	1150 35	171 85	266 16	82 66	2/27/2003	8	16	11
2002	632	m	3078 70	224 84	712 34	108 15	6/14/2002	8	12	1
2002	448	f	15868 45	526 18	3671 61	253 1	6/14/2002	8	18	0
2002	573	f	128250 15	2383 82	29674 22	1146 66	6/14/2002	8	11	1
2002	613	f	480359 10	4652 1	111144 4	2237 74	6/17/2002	8	16	2
2002	715	m	9851 52	551 89	2279 42	265 47	6/15/2002	9	15	2
2002	294	m	64166 84	1054 63	14846 77	507 3	6/16/2002	9	17	3
2002	594	f	68443 26	1239 59	15836 24	596.26	6/14/2002	9	14	0
2003	112	u	3072 60	209 76	710 93	100 9	2/19/2003	10	18	3
2003	573	f	7437.89	341 89	1720 96	164 45	3/7/2003	10	16	1
2002	334	m	201629 33	1846 16	46652 52	888 03	6/13/2002	10	13	2

Appendix F Nesting Data

year	Bird	Sex	Attempt #	Date Discovered	utm x	utm y	Tree Sp.	Tree Height (m)	Nest Height (m)	Nest height as % of tree height	Date Fledged/failed	Result	HY	Reason for Failure	successful (y/n)	incubating nest-days
2002	193-2002	f	1	7/22/2002	672704	3490312	pecan	16 00	12 40	77 50	8/13/2002	fledged	1	n/a	y	1
2002	414-2002	f	1	7/10/2002	674359	3491177	cedar elm	24 00	22 80	95 00	7/17/2002	failed	0	abandoned	y	14
2002	432-2002	f	1	7/24/2002	674375	3491156	pecan	17 40	9 50	54 60	8/11/2002	fledged	2	n/a	y	18
2002	474-2002	f	1	7/31/2002	674381	3491225	pecan	20 10	9 30	46 27	8/30/2002	fledged	1	n/a	y	30
2002	573-2002	f	1	7/16/2002	674867	3491477	hackberry	18 40	6 40	34 78	7/30/2002	fledged	1	n/a	y	14
2002	792-2002	f	1	7/18/2002	674400	3491323	chinaberry	13 60	7 04	51 76	8/13/2002	fledged	1	n/a	n	26
2002	012-2002	m	1	7/12/2002	674345	3491233	pecan	15 00	8 55	57 00	7/31/2002	failed	0	abandoned	n	4
2002	152-2002	m	1	7/22/2002	672704	3490312	pecan	16 00	12 40	77 50	8/13/2002	fledged	1	n/a	y	22
2002	294-2002	m	1	7/10/2002	674898	3492061	pecan	19 60	8 40	42 86	7/26/2002	fledged	2	n/a	y	16
2002	294-2002	m	2	8/1/2002	674899	3492058	pecan	19 60	13 72	70 00	8/20/2002	failed	0	abandoned	y	19
2002	334-2002	m	1	8/5/2002	674263	3491859	hackberry	5 49	3 66	66 67	9/4/2002	fledged	2	n/a	n	1
2002	632-2002	m	1	8/1/2002	674820	3492154	cedar elm	18 90	unknown	unknown	8/1/2002	fledged	2	n/a	y	0
2002	694-2002	m	1	8/11/2002	674411	3491147	pecan	17 25	8 25	47 83	9/1/2002	failed	0	unknown	n	21
2002	715-2002	m	1	8/4/2002	674895	3492114	hackberry	8 00	5 28	66 00	8/20/2002	fledged	1	n/a	y	16
2002	754-2002	m	1	7/22/2002	672995	3490730	cedar elm	12 87	4 95	38 46	7/30/2002	fledged	2	n/a	n	8
2003	372-2003	f	1	5/22/2003	674338	3491200	pecan	12 42	10 08	81 16	5/28/2003	failed	0	abandoned	y	6
2003	413-2003	f	1	4/8/2003	674277	3491490	pecan	6 67	2 32	34 78	4/28/2003	fledged	2	n/a	y	20
2003	413-2003	f	2	5/23/2003	674278	3491492	pecan	6 67	2 90	43 48	5/28/2003	failed	0	abandoned	n	5
2003	413-2003	f	3	6/11/2003	674282	3491495	liveoak	16 64	8 06	48 44	6/12/2003	failed	0	nest failed	n	1
2003	413-2003	f	4	6/18/2003	674278	3491492	pecan	6 67	2 33	34 93	7/14/2003	fledged	2	n/a	y	26
2003	573-2003	f	1	5/14/2003	674474	3491074	pecan	21 95	12 19	55 55	6/3/2003	fledged	2	n/a	y	20
2003	034-2003	m	1	4/7/2003	674285	3491193	pomegranıt	4 57	2 13	46 67	4/8/2003	failed	0	abandoned	y	15
2003	252-2003	m	1	4/8/2003	674926	3492023	chinaberry	9 51	3 05	32 05	5/13/2003	fledged	1	n/a	n	35
2003	252-2003	m	2	6/18/2003	674977	3492015	pecan	9 75	4 68	48 00	6/24/2003	fledged	1	n/a	n	16
2003	272-2003	m	1	4/1/2003	674856	3492107	liveoak	21 00	3 50	16 67	4/29/2003	fledged	2	n/a	y	28
2003	292-2003	m	1	4/8/2003	675059	3491797	pecan	15 36	7 36	47 92	4/29/2003	failed	0	nest failed	n	21
2003	313-2003	m	1	4/1/2003	674915	3492124	crepe myrtl	5 79	2 44	42 11	4/2/2003	failed	0	nest failed	y	1
2003	433-2003	m	1	4/8/2003	674833	3492214	tx oak	5 60	2 20	39 29	5/7/2003	fledged	2	n/a	y	29
2003	433-2003	m	2	5/27/2003	674833	3492216	tx oak	5 60	2 00	35 71	5/28/2003	failed	0	abandoned	n	1
2003	693-2003	m	1	5/15/2003	674186	3491376	privet	6 41	2 44	38 05	5/23/2003	failed	0	nest failed	n	8
2003	093-2003	u	1	3/31/2003	674334	3491214	pecan	11 07	4 86	43 90	4/29/2003	fledged	2	n/a	n	15
2003	093-2003	u	2	5/22/2003	674335	3491221	pecan	11 07	4 49	40 56	6/2/2003	fledged	2	n/a	y	11
2003	132-2003	u	1	3/31/2003	674246	3491418	hackberry	22 40	8 64	38 57	4/28/2003	fledged	2	n/a	y	28
2003	132-2003	u	2	5/12/2003	674239	3491421	hackberry	22 40	7 68	34 29	6/3/2003	fledged	2	n/a	y	22
2003	132-2003	u	3	6/18/2003	674242	3491419	hackberry	22 40	8 96	40 00	6/24/2003	failed	0	abandoned	y	6

VITA

Cynthia Lauren Schaefer was born in Houston, Texas, on September 8, 1975 to parents Richard James and Janet Elizabeth Ross. In 1994 she enrolled in The University of Texas at Austin to study Biology. Summers were spent working on wildlife crews, wilderness crews and wildland firefighting crews for the US Forest Service in Montana and Oregon. After graduating in December 1998, Cynthia spent 9 months doing wildlife and habitat surveys in Oregon before returning to Texas to work for Texas Parks and Wildlife Department. In August 2001 she entered the Graduate College of Texas State University-San Marcos.

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