

Articles

Immigration and Recruitment in an Urban White-Winged Dove Breeding Colony

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Abstract

Dove population management necessitates estimates of vital rates for use in mechanistic models used to evaluate and predict population responses to environmental variation and/or alternative harvest scenarios. Estimating recruitment (number of juveniles per adult) is complicated because a compendium of factors drives production in doves. White-winged doves *Zenaida asiatica* exhibit a fairly unique breeding strategy wherein they commonly return to the same breeding area and reproduce in large breeding aggregations (i.e., colonies). We used an open-population capture–recapture model to estimate annual immigration and in situ recruitment of white-winged doves breeding in an urban colony during 2009 and 2010. We captured 5,101 unique white-winged doves in 2009 (2,894 after hatch year, 2,207 hatch year) and 3,502 unique white-winged doves in 2010 (3,106 after hatch year, 486 hatch year). Immigration of adults into the breeding colony peaked during late April and early May, with in situ recruitment occurring during a 6-wk period from 19 June to 30 July. Our results predicted that >90% of all hatch-year individuals had entered the local population by 1 August. The Jolly–Seber model used allows white-winged dove recruitment values to be estimated directly (rather than as a conglomerate of multiple parameters), separates immigration from in situ recruitment within a season, and can be useful for monitoring recruitment and evaluating alternative recruitment indices for future use in harvest management–planning actions.

Keywords: capture–recapture; Jolly–Seber; recruitment; white-winged dove

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Introduction

Doves *Zenaida* spp. represent some of the most widespread species in the United States, with population estimates exceeding 300 million individuals and harvest exceeding 20 million birds annually (Otis et al. 2008; Raftovich et al. 2010). Doves grant substantive benefits to state and local economies, and often provide a gateway for introducing individuals to hunting (Hayslette

et al. 2000); therefore, state and federal regulatory agencies have emphasized garnering survival and recruitment data for dove populations (Williams and Johnson 1995; Anonymous 2005). Moreover, population management necessitates estimates of vital rates for use in the mechanistic models used to evaluate and predict population responses to alternative harvest scenarios (Williams and Johnson 1995; Runge et al. 2004; Otis 2006). Ideally, vital rate data across age and sex would be



available for modeling population trajectories (Johnson and Kendall 1997); however, this is rarely the case for doves or most other migratory birds (Nichols et al. 2007).

The white-winged dove *Z. asiatica* is less ubiquitous than the mourning dove *Zenaidura macroura*, with a historical continental range restricted to the southwestern United States and Mexico, and an introduced population in Florida (Cottam and Trefethen 1968; George et al. 1994). White-winged doves exhibit a fairly unique breeding strategy wherein they commonly return to the same breeding area annually and reproduce in breeding aggregations (i.e., colonies), which sometimes exceed 1,000 nests/ha (Cottam and Trefethen 1968; Nichols et al. 1986; George et al. 1994). Historically, breeding colonies of white-winged doves occurred in native brushland and citrus orchards in the Lower Rio Grande Valley (Marsh and Saunders 1942; Cottam and Trefethen 1968; Martinez et al. 2005). Although it has been suggested that white-winged doves in this region suffered from poor reproduction since at least 1969 due to changes in native habitat conditions (Hayslette et al. 1996), white-winged doves have rapidly expanded their range northward and established new breeding colonies in urban environments across Texas and the southwestern United States during the past few decades (George et al. 1994; Schwertner and Johnson 2005; Veech et al. 2011).

Annual recruitment (new juveniles per adult) is one of the three most critical components (including survival and abundance estimates) underlying population modeling and harvest management planning for migratory game birds (Munro and Kimball 1982); however, the process of estimating recruitment for doves is difficult due to long breeding seasons, nonstandardized sampling methods, and the typically short time frames of most monitoring programs (Geissler et al. 1987; Otis 2003). Estimating recruitment is additionally complicated because a compendium of factors (i.e., nesting chronology, laying rate, egg hatchability, nest survival, fledgling survival) underlies recruitment estimation in doves (Geissler et al. 1987; Sayre and Silvy 1993; Otis 2003). For most harvested migratory species, the U.S. Fish and Wildlife Service (USFWS) relies on a Parts Collection Survey, where hunters provide wings from harvested individuals that are aged and used to index annual reproduction after correction for differential harvest rates (Nichols and Tomlinson 1993; Miller and Otis 2010; Zimmerman et al. 2010).

Alternatively, several capture–recapture approaches are available that estimate annual recruitment directly (Burnham 1991; Schwarz et al. 1993; Pradel 1996; Nichols et al. 2000; Link and Barker 2005). These approaches, however, often necessitate an interannual cycle of data collection because estimates of recruitment, as defined by these approaches, represent both those individuals transitioning between juvenile and adult age classes and individuals entering via immigration (Pradel 1996; Nichols et al. 2000). Thus, recruitment is defined as the number of new individuals relative to the number of old individuals per sample occasion, rather than the definition of interest here, which relates recruitment to in situ

production (i.e., number of fledglings per adult within a breeding season) and that which a Parts Collection Survey attempt to measure on an annual basis (Nichols and Pollock 1990).

In an effort to further our understanding of white-winged dove immigration and recruitment rates as a basis for future management-planning actions, we used a capture–recapture study to evaluate in situ recruitment of white-winged doves in an urban breeding colony in Texas. We applied a Jolly–Seber open-population capture–recapture model (Schwarz and Arnason 1996) to identify peak arrival and breeding periods, estimate age-specific entrance via immigration and in situ recruitment over the course of the breeding season, and estimated age-specific period and season abundance and breeding population recruitment rate (juveniles per adult; Otis 2003) for white-winged doves during 2009 and 2010.

Methods

We captured white-winged doves in Alice, Texas (27°45'18.7"N, 98°4'11.7"W) during February–August, 2009–2010 using funnel-traps baited with standard bulk birdseed, black oil sunflower, and/or milo. All captured birds were aged (hatch year; after hatch year) based on gross morphological characteristics (Cottam and Trefethen 1968), and banded with U.S. Geological Survey size-4 metal bands using both toll-free (toll-free reporting number) and web-address (web reporting address) bands in an approximate 50:50 split concurrent with the U.S. Geological Survey shifting to a web-address return option (Collier et al. 2012a; Sanders and Otis 2012).

We used an open-population capture–recapture approach (i.e., Jolly–Seber; Schwarz et al. 1993; Schwarz and Arnason 1996) to model survival (Φ), hatch-year entry probability ($b_{\text{hatch year}}$), and after-hatch-year immigration probability ($b_{\text{after hatch year}}$); and to evaluate peak breeding period timing and period-specific population size (N_t^a) for $a = \text{hatch-year or after-hatch-year}$ white-winged doves in our urban breeding colony during 2009 and 2010. We categorized the reproductive season into 13 2-wk periods beginning 27 February and ending 31 August, and we aggregated multiple recaptures within a 2-wk period as a single capture for analysis. We used Program MARK (White and Burnham 1999) via RMark v. 2.1.1 (Laake 2012) and R v. 2.15.0 (R Development Core Team 2012) for analysis.

The JS-POPAN approach hypothesizes a superpopulation (N) for which occasion-specific estimates of abundance and of entry into the standing population were derived (Schwarz et al. 1993; Schwarz and Arnason 1996). We had no system-level covariates of interest applicable to all individuals, and application of individual covariates was limited because if individuals are not recaptured the value of the covariate is unknown for that sample period (but see Bonner and Schwarz 2006). Therefore, our candidate models relied on modeling age-specific and temporal variation in immigration, entry (fledging), and abundance because these parameters were the primary focus of our study. Our approach is similar to modeling detailed by Schwarz et al. (1993), wherein we were able

Table 1. Model selection table with number of estimable parameters (k), Akaike's Information Criterion adjusted for small sample sizes (AIC_c), change in AIC_c between models (ΔAIC_c), and model likelihood weights (w_i) for models fitted to 2009 and 2010 white-winged dove *Zenaida asiatica* capture–recapture data in Alice, Texas. Model parameters are denoted as follows: apparent survival (Φ), recapture probability (p), entry probability (pent), and abundance estimate (N) with model parameters conditions of group (g); age class, time (t), or constant (\cdot) effects.

Model parameters	k	AIC_c	ΔAIC_c	w_i
2009				
$\Phi(g \cdot t), p(g \cdot t), \text{pent}(t), N(g)$	58	17,552.17	0	0.99993
$\Phi(g \cdot t), p(\cdot), \text{pent}(t), N(g)$	36	17,571.07	18.89	0.00007
$\Phi(g \cdot t), p(t), \text{pent}(t), N(g)$	49	17,575.44	23.26	0
$\Phi(t), p(\cdot), \text{pent}(t), N(g)$	29	17,587.62	35.45	0
$\Phi(g), p(\cdot), \text{pent}(t), N(g)$	18	18,334.37	782.19	0
$\Phi(\cdot), p(\cdot), \text{pent}(t), N(g)$	17	18,646.13	>1093	0
2010				
$\Phi(g \cdot t), p(t), \text{pent}(t), N(g)$	49	18,915.38	0	0.8259
$\Phi(g \cdot t), p(t \cdot g), \text{pent}(t), N(g)$	58	18,918.49	3.11	0.1740
$\Phi(g \cdot t), p(\cdot), \text{pent}(t), N(g)$	36	18,953.76	38.38	0
$\Phi(t), p(\cdot), \text{pent}(t), N(g)$	29	18,994.22	78.85	0
$\Phi(g), p(\cdot), \text{pent}(t), N(g)$	18	19,241.80	326.42	0
$\Phi(\cdot), p(\cdot), \text{pent}(t), N(g)$	17	19,321.25	>405	0

to separate within-year immigration of after-hatch-year individuals from hatch-year individuals fledged (entry) within the colony. Because trapping was initiated well before immigration occurred, entry (b) parameters for after-hatch-year individuals represented recruitment of new after-hatch-year individuals into the breeding colony over the course of the breeding season (immigration). Based on our capture data, hatch-year individuals did not begin to appear until early June of each year, so we fixed both apparent survival ($\Phi_{\text{hatch year}}$) and entry ($b_{\text{hatch year}}$) parameters at zero for the first six sampling occasions (27 February–21 May) for hatch-year individuals. The formulation for the superpopulation approach estimated the number of individuals that had immigrated (arrived) before sampling began as a derived parameter with probability (b_0) equal to one minus the sum of the entrance probabilities for all sampling occasions. For our work, temporal dependence in entry probabilities was required for estimating immigration and recruitment rates in a biologically plausible manner (see Franklin 2001). However, there were a few individuals (either annual residents or early migrants) in our study area before trapping was initiated (Schwarz et al. 1993), and captures of these individuals caused a skew in the distribution of the time-specific predicted entry probabilities for the initial sampling occasion. The limited number of captures during sampling occasion 1 led to a very small capture probability value (0.0001) and, hence, minute estimated entry probabilities. When these probability values were used to derived abundance for that sampling period based on the number of individuals captured (<10 for example), they created abundance estimates that were highly inflated. Frequently the population estimated to be in residence prior to sampling was an order of magnitude larger than the estimated superpopulation for the entirety of our work

(10/0.0001 = 100,000). In response, rather than enforcing a constraint on the capture or entry probabilities that was biologically unwarranted, and to ensure the estimated capture probability would be zero for the first sampling occasion (e.g., no birds considered available prior to sampling, which created an inestimable parameter for that occasion), we used an artificial occasion for period $t - 1$ in our data matrix, during which there were no captures for either age class, and on which estimates of b_0 were then conditioned (E.G. Cooch, Cornell University, pers. comm.). This ensured that entry parameters (b_i) in our model summed to 1 for both hatch-year and after-hatch-year classes and forced the estimated number of individuals in the superpopulation before sampling to be negligible (Text S1, *Supplemental Material*).

We used the same modeling approach for both years; however, during 2010, capture of hatch-year individuals was substantially lower (>80%) than during 2009. Subsequently, the number of recaptures available for the hatch-year class was low for 2010, precluding accurate parameter estimation using biologically sensible (e.g., time-dependent) capture–recapture models of in situ hatch-year recruitment and abundance (Table S1, *Supplemental Material*). Thus, for 2009, we provide estimates of apparent survival (mortality and emigration), immigration, and abundance for after-hatch-year individuals and in situ recruitment of hatch-year individuals, but for 2010, we report only apparent survival, immigration, and abundance for after-hatch-year individuals.

Results

We captured 5,101 unique white-winged doves in 2009 (2,894 after hatch year, 2,207 hatch year) and 3,502 unique white-winged doves in 2010 (3,106 after hatch year, 486 hatch year). Using our 2009 data, we used a full

Table 2. Sampling-occasion-specific estimates of entry via immigration ($b_{\text{after hatch year}}$ [SE]), entry via in situ recruitment ($b_{\text{hatch year}}$ [SE]), and age-specific abundance (95% CI) for white-winged doves *Zenaida asiatica* banded in Alice, Texas, during 2009 and 2010.

Occasion (first day)	2009				2010 ^a	
	$b_{\text{after hatch year}}$	$N_{\text{after hatch year}}$	$b_{\text{hatch year}}$	$N_{\text{hatch year}}$	$b_{\text{after hatch year}}$	$N_{\text{after hatch year}}$
27 February	0.003 (0.001)	29	0	0	0.01 (0.001)	153
13 March	0.05 (0.025)	456	0	0	0.14 (0.05)	2,065
27 March	0.03 (0.023)	289	0	0	0.07 (0.029)	1,041
10 April	0.54 (0.12)	4,742	0	0	0.157 (0.042)	2,244
24 April	0.16 (0.095)	1,390	0	0	0.138 (0.039)	1,976
8 May	0.074 (0.026)	652	0	0	0.152 (0.041)	2,169
22 May	0 ^b (0)	3	0.002 (0.0009)	27	0 ^b (0)	57
5 June	0.003 (0.001)	27	0.023 (0.012)	267	0.018 (0.005)	262
19 June	0.067 (0.017)	587	0.502 (0.185)	5,746	0.062 (0.031)	882
3 July	0.035 (0.012)	306	0.262 (0.122)	2,998	0.131 (0.063)	1,858
17 July	0.020 (0.008)	182	0.156 (0.077)	1,782	0.105 (0.078)	1,497
31 July	0.003 (0.0003)	32	0.027 (0.011)	313	0 ^b (0)	0
14 August	0.001 (0.005)	13	0.011 (0.039)	130	0 ^b (0)	0
Abundance	—	8,714 (6,835–11,489)	—	11,431 (6,263–23,184)	—	14,221 (11,398–17,993)

^a Due to limited recaptures, we were unable to estimate in situ recruitment during 2010.

^b Inestimable parameter due to limited recaptures during that occasion.

group (age class) \times time model for estimating both apparent survival ($\Phi[g \cdot t]$) and recapture probability ($p[g \cdot t]$) across the 2 age classes with abundance estimated for each age class ($N[g]$; Table 1). For the 2010 data, because so few hatch-year birds were recaptured post-initial marking (<10), the full group \times time model rendered multiple sample-period entry parameters inestimable for the hatch-year age class. Thus, we restricted our interpretation to the model that restricted the recapture ($p[t]$) and entry parameters ($\text{pent}[t]$) to time-specificity in 2010 (Model: $\Phi[g \cdot t]$, $p[t]$, $\text{pent}[t]$, $N[g]$; Table 1).

Trapping was initiated before we assumed doves had arrived; therefore, the small number of individuals from the total breeding population that the model predicted would be present before sampling began in 2009 (0.003) and 2010 (0.01) indicated that few, if any, doves were present en masse before sampling began. Immigration of after-hatch-year white-winged doves consisted of two distinct pulses over the breeding season (Table 2). The first pulse initiated in early March, peaked around mid-April, and declined through early June. The second pulse initiated during late June, peaked in mid to late July, and declined to the point where no new birds entered the population by late August (Table 2). During both years, there was a distinct period from 22 May to 4 June where entry probabilities for after-hatch-year birds were low, which occurred roughly 2–4 wk before the hatch-year individuals entered the population en masse (Table 2). In situ recruitment occurred during a 6-wk period from 19 June to 30 July, and our models predicted that $>90\%$ of all hatch-year individuals entered (i.e., fledged) into the local population before 1 August (Table 2). Occasion-specific apparent survival was fairly consistent across sampling periods; however, in 2010 we had

several inestimable parameters during the course of modeling due to sparse recapture data during those capture periods (Table 3).

Discussion

We estimated white-winged dove recruitment directly using captured individuals while separating immigration from in situ recruitment (Nichols and Pollock 1990; Schwarz and Arnason 1996). Based on our estimates for hatch-year and after-hatch-year population size in 2009, per capita recruitment ($N_{\text{hatch year}}/N_{\text{after hatch year}}$) was 1.31 hatch-year individuals per after-hatch-year bird. Assuming a 50:50 sex ratio, our data equate to a production estimate of 2.6 hatch-year birds per after-hatch-year pair; this falls within the range predicted by Otis (2003) for mourning doves within the south-central United States. During both years of our study, after-hatch-year capture probabilities were near zero during the period 22 May–4 June. Reduced captures within this period occurred several weeks before 50% of the hatch year individuals in 2009 were predicted to enter the population. White-winged doves have a 15–20-d incubation followed by 13–18 d in the nest before fledging (Schwertner et al. 2002), so this places the peak production of hatch-year individuals entering the population around 27 May, or roughly in the middle of the 22 May–4 June period. Thus, the low capture rate of after-hatch-year birds during this time was likely due to adults tending to incubation or nestlings. Our results also indicate a pulse of after-hatch-year individuals entering the local breeding population during the identified peak of hatch-year entry during both years (Table 2). Based on available knowledge of white-winged dove breeding biology, we suspect that these individuals were likely uncaptured breeders within

Table 3. Sampling-occasion-specific estimates of apparent survival for hatch-year ($\Phi_{\text{hatch year}}$ [SE]) and after-hatch-year ($\Phi_{\text{after hatch year}}$ [SE]) individuals for 2009 and 2010 based on white-winged doves *Zenaida asiatica* banded in Alice, Texas, during 2009 and 2010. Inestimable parameters are denoted (ne) and represent those parameters that were confounded (Schwarz et al. 1993). For periods where recapture data were too sparse for estimation (e.g., survival when no individuals were present), parameters are represented as a zero.

Occasion (first day)	2009		2010
	$\Phi_{\text{after hatch year}}$	$\Phi_{\text{hatch year}}$	$\Phi_{\text{after hatch year}}$
27 February	ne	0	ne
13 March	ne	0	0.76 (0.21)
27 March	0.51 (0.002)	0	0.30 (0.07)
10 April	0.53 (0.14)	0	0.48 (0.08)
24 April	0.34 (0.04)	0	0.34 (0.05)
8 May	0.45 (0.03)	0	ne
22 May	ne	0	0.85 (0.14)
5 June	0.68 (0.08)	0.29 (0.16)	0.60 (0.20)
19 June	0.42 (0.08)	0.52 (0.16)	ne
3 July	0.45 (0.10)	0.60 (0.16)	0.42 (0.24)
17 July	0.54 (0.18)	0.21 (0.06)	ne
31 July	0.08 (0.03)	0.05 (0.009)	ne
14 August	ne	ne	ne

our study colony, or were new individuals emigrating into our breeding populations before autumn migration began (Alamia 1970; Schwertner et al. 2002). However, further evaluation focused on estimating temporary and permanent emigration or immigration (e.g., open robust design; Kendall and Bjorkland 2001) to quantify the contribution of emigrating and immigrating individuals to the local population size, and within-season recruitment should be conducted to ensure that hatch-year and after-hatch-year entry and abundance estimates are accurate.

During 2010, hatch-year captures were limited to primarily one capture for each individual, whereas after-hatch-year captures remained similar to 2009 levels. No changes were made to our study location, trapping locations, trapping effort, or study timing between years. Our 2009 study period occurred during the final year of a significant drought in Texas, whereas above-normal precipitation occurred during the spring and summer of 2010. We suggest two plausible explanations for why hatch-year captures were drastically reduced during 2010: 1) production during 2010 actually was below average and subsequently there were lower numbers of hatch-year individuals available within our study area for capture; or 2) food sources were readily available to hatch-year individuals postfledging, which reduced trapping efficiency at our study site. Additionally, we note that our apparent survival estimates are a combination of both the survival and emigration process. Further works similar to ours should focus on open robust design models to address the impact of temporary emigration on parameter estimate accuracy.

A majority of modeling approaches for recruitment estimation have focused on the annual rate of net additions or subtractions to the population of interest. Our interest, however, was in estimating recruitment rate for both in situ recruits (newly fledged individuals) and adult immigrants into our breeding population. There are many capture–recapture approaches that can estimate annual recruitment directly (Burnham 1991; Schwarz et al. 1993; Pradel 1996; Nichols et al. 2000; Link and Barker 2005). However, these approaches focus on net additions and subtractions, defining recruitment as the number of new individuals relative to the number of old individuals. Thus, the JS-POPAN approach we used was required for separation of the recruitment of newly fledged ‘entrants’ and those entering via emigration, thus providing an estimate of annual juvenile recruitment relative to the standing crop of adults.

Recruitment estimation is complicated because it is inherently a function of several parameters (e.g., nesting rate, nest survival, fledgling survival), and rarely are resources available to measure all metrics on any single location or population over time. Thus, methods resulting in predictions of annual recruitment ($N_{\text{hatch year}}/N_{\text{after hatch year}}$; Nichols and Tomlinson 1993) into the harvestable population are necessary because harvest management planning and population monitoring actions are dependent on annual estimates of recruitment for all migratory game bird species (Munro and Kimball 1982). Although several authors have conducted research addressing breeding season ecology of white-winged doves (e.g., Alamia 1970; Swanson and Rappole 1993; Schacht et al. 1995; Hayslette et al. 1996; Hayslette and Hayslette 1999; Small et al. 2005), to our knowledge, we are the first to estimate in situ recruitment in white-winged doves, rather than relying on egg or fledgling density, nest success, or other values as proxies. As such, recruitment information on the ratio of immature birds per adult, when combined with data on age-specific harvest vulnerability reported from banding studies will be the data needed for estimating population-level recruitment of white-winged doves (Nichols and Tomlinson 1993; Otis 2003). Our recruitment estimates, as described, are equivalent to those required for nearly all harvest management models (Munro and Kimball 1982; Williams et al. 2002) and thus represent the baseline estimate, which is intended to be compared with current and future estimates from a national Parts Collection Survey (see Otis 2003).

Admittedly, although our intensive capture–recapture data were necessary for initial evaluation of immigration and breeding-season timing of white-winged doves, our approach is likely not tenable for long-term studies of white-winged dove recruitment. However, our results do provide a foundation for us to suggest an alternative monitoring protocol for white-winged dove recruitment in Texas. Previous work on timing of breeding activity indexed via coo counts (Sepulveda et al. 2006) indicated that peaks of calling occurred in early May, which from our data would be concordant with our estimates of reproductive timing. Managers in urban areas could conduct point-count sample surveys (Buckland 2006) of the breeding population during mid-May to estimate

after-hatch-year population size, and then repeat the survey in late July or early August to estimate abundance when a majority of hatch-year birds have entered the local population but before migration occurs. Then, straightforward application of a population growth estimator ($\lambda = N_{t+1}/N_t$) based on the point counts could be used to estimate a recruitment rate (λ ; population growth), which in theory should be concordant with in situ annual recruitment rates. Because white-winged doves have transitioned to urban environments (Schwertner and Johnson 2005; Collier et al. 2012a, 2012b), our information on the timing of adult immigration and in situ recruitment could make the estimation of recruitment via count statistics a plausible, logistically feasible option for supporting future conservation and harvest-management planning strategies. We acknowledge that like most intensive studies, our work is limited in both scope and scale, and thus any application for harvest management planning should be approached cautiously until further similar studies are conducted. However, the immigration timing and recruitment information we collected should provide a useful comparison with recruitment estimates garnered via the USFWS Parts Collection Survey currently under development for use in supporting better management of white-winged doves.

Supplemental Material

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Table S1. White-winged dove *Zenaida asiatica* capture–recapture data collected during February–September, 2009 and 2010 in Alice, Texas, USA. Data were used in a Jolly–Seber POPAN model to identify peak arrival and breeding periods, estimate age-specific entrance via immigration and in situ recruitment over the course of the breeding season, and estimated age-specific period and season abundance and breeding population recruitment rate (juveniles per adult; Otis 2003) for white-winged doves during 2009 and 2010. Data consist of white-winged dove band number (Prefix and Suffix), encounter-history data for 14 sample occasions, and individual age at capture (hatch year = hatch year, after hatch year = after hatch year).

Found at DOI: <http://dx.doi.org/10.3996/052012-JFWM-043.S1> (1228 KB XLS).

Text S1. R code detailing the analysis of white-winged dove *Zenaida asiatica* capture–recapture data collected during February–September, 2009 and 2010 in Alice, Texas.

Found at DOI: <http://dx.doi.org/10.3996/052012-JFWM-043.S2> (4 KB TXT).

Reference S1. Alamia LA. 1970. Renesting activity and breeding biology of the white-winged dove (*Zenaida asiatica*) in the Lower Rio Grande Valley of Texas. Master's thesis. College Station: Texas A&M University.

Found at DOI: <http://dx.doi.org/10.3996/052012-JFWM-043.S3>; also available at <http://repository.tamu.edu/>

[handle/1969.1/ETD-TAMU-1970-THESIS-A318?show = full](http://dx.doi.org/10.3996/052012-JFWM-043.S4) (4.7 MB PDF).

Reference S2. Anonymous. 2005. Mourning dove national strategic harvest management plan. Washington, D.C.: U.S. Department of the Interior, Fish and Wildlife Service, Division of Migratory Bird Management.

Found at DOI: <http://dx.doi.org/10.3996/052012-JFWM-043.S4>; also available at <http://www.fws.gov/migratorybirds/NewReportsPublications/SpecialTopics/Mourning%20Dove%20National%20Strategic%20Harvest%20Management%20PlanSm.pdf> (3.4MB PDF).

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Found at DOI: <http://dx.doi.org/10.3996/052012-JFWM-043.S5>; also available at <http://pubs.er.usgs.gov/publication/5200093> (18.9 MB PDF).

Reference S4. Munro RE, Kimball CF. 1982. Population ecology of the mallard. VII. Distribution and derivation of the harvest. Washington, D.C.: U.S. Fish and Wildlife Service Resource Publication 147.

Found at DOI: <http://dx.doi.org/10.3996/052012-JFWM-043.S6> (5.7 MB PDF).

Reference S5. Otis DL, Schulz JH, Scott DP. 2008. Mourning dove (*Zenaida macroura*) harvest and population parameters derived from a national banding study. U.S. Washington, D.C.: U.S. Department of Interior, Fish and Wildlife Service, Biological Technical Publication FWS/BTP-R3010-2008.

Found at DOI: <http://dx.doi.org/10.3996/052012-JFWM-043.S7>; also available at <http://library.fws.gov/BTP/mourningdove08.pdf> (1.1 MB PDF).

Reference S6. Raftovich RV, Wilkins KA, Richkus KD, Williams SS, Sprigg HL. 2010. Migratory bird hunting activity and harvest during the 2008–2009 hunting seasons. Washington, D.C.: U.S. Department of the Interior, Fish and Wildlife Service, Division of Migratory Bird Management.

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