Surveys

A Comparison of White-Winged Dove *Zenaida asiatica* Densities Estimated During Morning and Evening Surveys

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Abstract

Surveying bird populations through visual observation is generally limited to morning. The focus on morning surveys is based on the reasonable assumption that detection is more likely when birds are most active. However, population surveys could become more time- and cost-efficient if both morning and evening sampling were equally effective, particularly for game birds, such as white-winged dove *Zenaida asiatica*. Texas Parks and Wildlife Department has recently implemented distance sampling to estimate population sizes and monitor an ongoing range expansion of this species. We compared morning vs. evening density estimates for white-winged doves sampled in Mason, Texas, on six separate occasions during summer 2006. Program DISTANCE (version 5.0) calculated similar detection probabilities and density estimates between paired morning and evening sampling periods. Probability of detection ranged from 0.27 to 0.46 for both morning and evening samples. Densities, in individuals/ha, ranged from 2.54 to 4.02 for morning sampling and 2.48 to 4.31 for evening sampling. In addition, variables (number of observations, cluster size, distance to cluster) used by DISTANCE did not vary substantially between morning and evening surveys. Our results suggest evening surveys are as effective as the conventional protocol of surveying white-winged doves only in the morning. Additional studies, using Program DISTANCE, should be conducted to similarly evaluate other species.

Keywords: distance sampling; survey times; white-winged dove

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Introduction

Understanding the distribution and abundance of avian species is critical to their management. This is particularly true in game bird populations, bird populations that have undergone range changes, and bird populations that have colonized habitats in which they previously were absent. Monitoring methods should maximize accurate results without sacrificing reliability, and often need to be tailored to the species being surveyed.

Previous studies of population-surveying protocols found that morning (the period when there is sufficient light to conduct surveys until 2 h post-official sunrise) is the most appropriate time for conducting surveys of birds (Smith and Twedt 1999; Conway et al. 2004). More species and individuals were detected during morning hours compared to other times of day in studies of the effect of diel period on detectability (Conway et al. 2004; Shields 1977), in part because morning tends to be cooler, birds are more active, and sound transmits farther (Skirvin 1981). This is particularly true during the breeding season when males of some species vigorously defend territories (Robbins 1981; Pagen et al. 2002; Buckland 2006; Fletcher et al. 2006).

Because species are typically more active and vocal in the morning than evening (period beginning 2 h presunset and extending until there is not sufficient light to conduct surveys), surveys of abundance and diversity have traditionally been conducted only in the morning. For example, survey protocol for the North American Breeding Bird Survey requires observers to

Figure 1. A white-winged dove *Zenaida asiatica* (photo by MFS).

start surveys 0.5 h before official sunrise and finish within 5 h (USGS 2001). However, for some species, detectability was greater during evening surveys than morning surveys (Kessler and Milne 1982; Krzys et al. 2002).

Distance sampling (Buckland et al. 2001) is a common and reliable method for surveying some bird species. In distance sampling, the probability of visually detecting a bird is modeled as a function of distance from the observer to the bird. In theory, a population can be surveyed at different times of day and abundance estimated reliably, if a minimum number of detections are obtained. Distance sampling may be particularly appropriate for nonterritorial, visually conspicuous, and flocking species (Buckland et al. 2001).

Within most of their range, white-winged doves *Zenaida asiatica* are easy to survey visually (Figure 1; Small 2007). In Texas, most breeding white-winged doves historically occurred in the lower Rio Grande Valley (LRGV) at the southern tip of the state (Smith 1910; Wetmore 1920; Marsh and Saunders 1942; Reference S1, *Supplemental Material*, http://dx.doi.org/10.3996/092011-JFWM-059.S1). Since about 1920, the breeding range of white-winged doves has expanded northward, and populations in urban environs north of the LRGV now substantially exceed historic numbers in the LRGV (George et al. 1994).

Harvested bird species, such as white-winged doves, are often monitored by state wildlife and natural resource agencies. Texas Parks and Wildlife Department (TPWD), has surveyed white-winged dove populations annually since about 1940, using several methods (Rappole and Waggerman 1986). Few, if any, of these methods are based on unbiased sampling protocols (George et al. 1994). However, following pilot studies in 2004 and 2005, TPWD began implementing morning distance sampling to estimate white-winged dove population size in Texas (Schwertner and Johnson 2005).

White-winged doves begin leaving their nest or roost sites during the period between sunrise and 2 h postsunrise (Cottam and Trefethen 1968) and forage in surrounding rural areas before returning to roost sites in the evening, 2 h presunset. The TPWD survey protocol intentionally targets counting birds at roost sites in the morning. However, because birds return to roost sites in the evening, we postulated that protocol restricting point counts to morning might exclude other legitimate survey periods and a less restrictive protocol allowing evening surveys could be used to estimate population densities. Here we compare morning and evening density estimates of white-winged doves derived by distance sampling.

Methods

Surveys

We conducted our study in Mason, Texas (30.750N, 99.230W), within the Edwards Plateau ecoregion (Gould et al. 1960). Mason encompasses 958.3 ha with a human population of about 2,211 (City-data.com 2006). We delimited urban land in Mason using the 1992 National Land Cover Data Set and GIS and defined a 500-m buffer around this area (ArcGIS 9.0; Environmental Systems Research Institute, Inc., Redlands, CA). We applied a buffer to encompass most of the known white-winged dove population; approximately 95% of all white-winged doves occurred within the urban area and 500-m buffer (Schwertner and Johnson 2005). We used the 1992 National Land Cover Data Set, as opposed to a more recent National Land Cover Data Set, because these data sets do not match completely, and a previous study that established the sample area for our study site used the 1992 National Land Cover Data Set (Schwertner and Johnson 2005).

We use the term transect to define a set of 100 points sampled over a 5-d period. We used GIS to randomly select 100 sampling points within the urban area and buffer and moved each point to the nearest road to ensure observer access. Thus, each point represented an independent location. We followed TPWD dove-monitoring-program survey protocols (Schwertner and Johnson 2005) to survey the white-winged dove population in Mason on six separate, week-long sampling occasions between 26 June 2006 and 11 August 2006. Each occasion consisted of a transect of the same 100 points; however, the order in which transect points were sampled differed for each of the six sampling occasions.

We randomly divided each transect into five sets of 20 points each and sampled each set on 5 consecutive d, which we define as a transect, because an entire transect of 100 points could not be completely sampled within a morning or evening period of a few hours. Morning sampling was conducted as soon after official sunrise as visibility allowed positive identification of birds, with some variation because of weather conditions (i.e., overcast days required a slightly later starting time for adequate visibility). We conducted evening counts with the same methodology, except start times commenced which allowed for sampling completion before official sunset. Mean morning starting and completion times were 19.7 min postsunrise (range = 15–40 min postsunrise) and 110.0 min postsunrise (range = 99–131 min postsunrise), respectively. Mean evening starting and completion times were 99.2 min presunset (range = 182–86 min presunset) and 18.7 min presunset (range = 41–3 min presunset), respectively. On a given survey day, the same set of 20 points was sampled in the morning and evening in the same order (Table S1, *Supplemental Material*, http://dx.doi.org/10.3996/092011-JFWM-059.S2).

We adhered to TPWD distance-sampling guidelines by visually surveying for white-winged doves at each point for 2 min, recording both flying and stationary birds (Schwertner and Johnson 2005). We did not include auditory counts because of potential bias in estimating distance to a source of sound (Nichols et al. 2000; Penteriani et al. 2002; Alldredge et al. 2007) and visual counts allow the use of cluster size (Buckland et al. 2001). White-winged dove clusters were treated as a single observation if detection of individuals was deemed dependent on conspecifics. Specifically, clusters included flocks or group roosts. Distances to individual birds or centers of clusters were determined to the nearest meter (±1 m) using a Bushnell™ Yardage Pro Legend laser range-finder (Bushnell, Inc., Overland Park, KS). Therefore, we recorded number of clusters (observations), cluster size (number of birds), and distance to each cluster for each sampling point.

As we approached each sampling point during surveys, we visually scanned from the point outward. Consequently, we were certain individuals on the point did not go undetected. When a dove was located on the point, but moved in response to the approach of the observer, the detection distance was recorded as zero.

Data analysis

We used Program DISTANCE version 5.0 (Thomas et al. 2006) with data stratified by time of day and sampling occasion to calculate expected cluster sizes, encounter rates, detection probabilities, and densities. We first used a global model to determine the best truncation distance and model for the detection function (Buckland et al. 2001). Truncation distance is a cutoff distance beyond which recorded observations are discarded because birds or clusters located beyond the truncation distance are not used in subsequent density estimates. Once truncation distance was determined, we used a model with time of day and occasion stratified to obtain estimates of expected cluster size, encounter rate, and density. This resulted in 12 sets of estimates representing a combination of two sampling periods (morning or evening) and six sampling occasions, which were compared for differences using 95% confidence intervals (Sokal and Rohlf 1994).

We compared morning to evening samples with respect to six variables: observed cluster size, distance to cluster, expected cluster size (adjusted based on distance), encounter rate, detection probability, and density. The first two variables were determined directly from raw data and compared using Mann–Whitney *U*-tests instead of parametric tests because these variables were not normally distributed or homoscedastic; there were many values of 0 and 1. The remaining four variables, which were obtained from distance-sampling models (see below) were normally distributed and homoscedastic. For these variables, we used paired *t*-tests ($\alpha \leq 0.05$) to compare morning and evening samples.

Results

We recorded 2,271 observations (clusters) during evening sampling and 2,232 during morning sampling over all six sampling occasions. During evening sampling, maximum cluster size, number of clusters >10 birds, and number of clusters = 1 bird were 50, 44, and 1,613, respectively; for morning sampling these values were 65, 54, and 1,720, respectively. Minimum distance to a cluster, maximum distance, and number of distances >100 m were also similar between morning and evening sampling; 0 m, 527 m, and 622 for evening compared to 0 m, 590 m, and 650 for morning. Mean cluster size differed between morning and evening sampling for three instances and mean distance to cluster differed between morning and evening sampling once (Table 1).

The global model indicated a truncation distance of 155 m (which discarded the highest 11.93% of distances) best fit a detection function modeled as a half-normal key function with two simple polynomial (orders 4 and 6) adjustment terms ($D = 0.02$, $P = 0.17$, K–S test). Therefore, we used this model and truncation distance for the stratified global model (the model using covariates) that estimated expected cluster size, encoun-

Table 1. Summary statistics and results of the Mann–Whitney *U*-test[a] comparing mean cluster size and distance to cluster for morning and evening[b] sampling ($\bar{x}$ = mean; n = sample size, subscript m and e refer to morning and evening, respectively) of white-winged doves *Zenaida asiatica* in Mason, Texas from 26 June 2006 to 11 August 2006. Values in parentheses are standard errors.

Occasion	Variable	$\bar{x}_m$	$\bar{x}_e$	χ^2	P	n_m	n_e
1	cluster size	1.23 (0.10)	1.12 (0.05)	0.59	0.44	282	277
2	cluster size	1.57 (0.14)	2.20 (0.29)	1.24	0.27	352	341
3	cluster size	1.62 (0.16)	1.83 (0.15)	13.30	<0.01	314	321
4	cluster size	1.76 (0.13)	1.74 (0.10)	7.14	<0.01	423	432
5	cluster size	2.61 (0.26)	1.88 (0.12)	0.11	0.74	436	476
6	cluster size	1.61 (0.12)	2.33 (0.17)	28.88	<0.01	425	424
1	distance	66.54 (3.17)	65.89 (2.99)	0.05	0.83	255	253
2	distance	71.61 (2.88)	72.15 (2.75)	0.53	0.47	332	321
3	distance	85.15 (3.95)	92.66 (4.03)	1.72	0.19	296	313
4	distance	97.37 (3.88)	88.04 (3.61)	4.48	0.03	409	429
5	distance	77.69 (2.71)	82.53 (2.90)	2.02	0.16	428	463
6	distance	101.08 (4.33)	103.29 (4.05)	1.29	0.26	413	418

[a] Note that the Mann–Whitney test compares mean ranks; however, table presents mean values for the unranked data because these are more meaningful.
[b] Morning, period when there is sufficient light to conduct surveys until 2 h post-official sunrise; evening, period beginning 2 h presunset and extending until there is not sufficient light to conduct surveys.

ter rate, and detection probability. These three variables did not differ between morning and evening sampling periods (Table 2). In addition, density estimates were similar between morning and evening sampling within each sampling week, as indicated by overlapping 95% confidence intervals (Table 3).

Discussion

With distance sampling, conducting morning sampling is primarily an issue of efficiency. In theory, provided that probability of detection at distance 0 equals 1.0 (a fundamental assumption of distance sampling), sampling could take place at any time of day. Distance sampling also requires the population being sampled to remain closed (size of the population must not change) during the sampling period. In the context of evening and morning sampling, this means that, for a given location, the population in the evening must be the same as the morning. For example, urban-dwelling white-winged doves roost overnight and for several hours postsunrise. Individuals then venture into rural environs to forage. Several hours prior to sunset, individuals return to urban roost sites. Consequently, the entire (and the same) population is present in mornings and evenings.

Table 2. Morning and evening[a] comparisons for expected cluster size, encounter rate, and detection probabilities for white-winged doves *Zenaida asiatica*, obtained using distance sampling in Mason, Texas, for each of six sampling occasions from 26 June 2006 to 11 August 2006 (subscript m = morning, subscript e = evening).

Variable	$\bar{x}_m(s^2)$	$\bar{x}_e(s^2)$	t_5	P
Expected cluster size	1.32 (0.02)	1.50 (0.06)	−1.73	0.14
Encounter rate	0.37 (0.01)	0.37 (0.01)	0.98	0.37
Detection probability	3.21 (0.30)	3.29 (0.48)	−1.18	0.29

[a] Morning, period when there is sufficient light to conduct surveys until 2 h post-official sunrise; evening, period beginning 2 h presunset and extending until there is not sufficient light to conduct surveys.

Studies comparing density estimates obtained from morning and evening sampling, for most species, are lacking. Studies on the effect of diel period on avian detectability are generally restricted to comparisons at different times of the morning (Shields 1977; Kessler and Milne 1982). Verner and Ritter (1986) quantified hourly variation in morning counts for 66 species of forest birds and discovered no single hour of the morning yielded greater counts than other hours. They concluded the best survey strategy was to not restrict sampling to certain hours of the day, so more sites could be sampled in a given ''season.'' However, the results of some studies suggest evenings are acceptable for surveying wetland birds and waterfowl (Hein and Haugen 1966; Nadeau et al. 2008).

Our study revealed similar density estimates between morning and evening sampling. This similarity may be influenced, in part, by bird behavior. Both male and female white-winged doves participate in egg incubation and hatchling care (Cottam and Trefethen 1968). Females incubate eggs and care for hatchlings at night, with males roosting nearby. Males tend the nest during the majority of daytime (Schwertner et al. 2002). However, during mornings and evenings, females relieve males, allowing them to forage (Cottam and Trefethen 1968; Schwertner et al. 2002; Small et al. 2006). These two periods may overlap our morning and evening sampling times, thus maximizing the number of observations recorded for each sex.

Results of our study suggest experimentation and development of more time-efficient protocols for surveying white-winged doves and other visually conspic-

Table 3. Morning and evening[a] density estimates (birds/ha) and 95% confidence intervals for white-winged doves *Zenaida asiatica*, obtained using distance sampling in Mason, Texas, for each of six sampling occasions from 26 June 2006 to 11 August 2006.

Occasion	Morning density	Evening density
1	2.54 (1.96–3.29)	2.48 (1.92–3.22)
2	3.15 (2.51–3.95)	3.14 (2.45–4.02)
3	2.73 (2.18–3.43)	2.69 (2.19–3.30)
4	3.55 (2.85–4.42)	3.83 (3.10–4.73)
5	4.02 (3.29–4.93)	4.31 (3.39–5.49)
6	3.44 (2.66–4.44)	3.55 (2.94–4.29)

[a] Morning, period when there is sufficient light to conduct surveys until 2 h post-official sunrise; evening, period beginning 2 h presunset and extending until there is not sufficient light to conduct surveys.

uous avian species is warranted. State natural-resource agencies monitor certain rare, threatened, and harvested species while relying on state personnel and volunteers with time limitations. Our findings may enhance the reliability and efficiency of white-winged dove monitoring without increasing the number of sample days. Conversely, a given sampling effort could be achieved in half the time (i.e., sample days) by conducting morning and evening sampling at different localities instead of just morning sampling at one locality.

Further research is needed to test our findings across ecoregions, urban habitats of varying human densities, and urban habitats of varying white-winged dove densities. In addition, more research is needed to determine whether evening sampling could be appropriate for other species. At the very least, our results suggest that, for many future small-scale autecological studies of single populations, it is worthwhile to do a pilot study to determine whether conducting surveys at different times of the day gives accurate results.

Supplemental Material

Please note: *The Journal of Fish and Wildlife Management* is not responsible for the content or functionality of any supplemental material. Queries should be directed to the corresponding author for the article.

Reference S1. Marsh EG, Saunders GB. 1942. The status of the white-winged dove in Texas. The Wilson Bulletin 54:145–146.

Found at DOI: http://dx.doi.org/10.3996/092011-JFWM-059.S1 (202 KB PDF).

Table S1. Data used to derive morning and evening densities for white-winged doves *Zenaida asiatica* in Mason, Texas during 2006, using Program DISTANCE.

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