Does Amount of Urban Area Around Predominantly Rural Banding Sites for Mourning Doves Affect Harvest in the Carolinas?

Michael F. Small, *South Carolina Department of Natural Resources, 1000 Assembly Street, Columbia, SC 29202, USA*

Joseph C. Fuller, *North Carolina Wildlife Resources Commission, 132 Marine Drive, Edenton, NC 27932, USA*

Michael W. Hook, *South Carolina Department of Natural Resources, 1000 Assembly Street, Columbia, SC 29202, USA*

William F. Dukes, Jr., *South Carolina Department of Natural Resources, 1000 Assembly Street, Columbia, SC 29202, USA*

Abstract: Mourning doves (*Zenaida macroura*) are among the most abundant and harvested game birds in North America. As such, their population abundance and vital rates are annually monitored by the U.S. Fish and Wildlife Service in cooperation with state agencies. Current monitoring indicates a decline in absolute abundance across a large portion of its range in the United States, raising concerns. One theory for this apparent decline is problems with the data used to estimate these vital rates: specifically, biases in the data collection methods (including banding programs) not being representative of the overall population and harvest rates. Therefore, to assess one potential bias in our banding programs, we investigated whether band recoveries of mourning doves in North Carolina and South Carolina are affected by the proportion of urban landscape around banding sites. We hypothesized that there would be a negative linear association between proportions of urban area (i.e., developed areas as defined by the National Land Cover Database) around banding sites and proportion of dove band recoveries in the Carolinas. We used geographic information systems and land cover classifications from the National Land Cover Database to extract 5-km extents around banding sites and determined proportions of urban landscape within each 5-km extent. We used simple linear regression of the proportion of urban landscape associated with each site and the proportion of banded doves harvested per site. The regression lines did not differ significantly from horizontal and the relationships between variables were weak. From an urban vs. rural harvest perspective, banding as currently implemented in North Carolina and South Carolina likely provide an unbiased sample based on level of urbanization (on a limited continuum) at these sites.

Key words: Columbidae, harvest rate, band recovery

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Mourning doves (*Zenaida macroura*) are migratory members of the Columbidae family occurring from southern Canada south to Panama and on some Caribbean islands and Bermuda (Aldrich 1993). Because mourning doves are a game bird with a long tradition of hunting, monitoring of mourning doves began, to some extent, in the late 1930s when McClure (1939) developed a method which estimated abundance of individuals based on calling rates. This methodology, however, was never tested for accuracy (Sadler 1993). Later, an annual dove call-count survey (CCS) began in 1966 and continued until 2013 (Seamans 2019). Based in part on the results of the CCS, it was evident that mourning dove populations showed a downward trend in a large portion of its range (USFWS 2003). Recognizing this decline, in 1998 the USFWS, in collaboration with state managers, determined that harvest reductions would be enacted if downward trends continued to a critical level (USFWS 2003). In response, a National Mourning Dove Planning Committee was formed in 2001 to facilitate development of guidelines for the preparation of management plans which would include harvest strategies to keep mourning dove populations stable without having to modify harvest frameworks (USFWS 2003).

To determine and define crucial vital rates of mourning dove populations and effects of harvest, several data collection programs were initiated in 2003, including a national banding program (Seamans et al. 2013). In 2013, a harvest strategy was adopted by the USFWS for implementation during the 2014-15 hunting season (USFWS 2013). This strategy uses band-recovery and harvest data to model and estimate absolute abundance. Estimates of absolute abundance began in 2003 (Lincoln 1930, Geis 1972, Otis 2006).

As part of the National Mourning Dove Banding Program, each state is provided a quota of doves to band. Each state's quota (further stratified by Bird Conservation Region) is weighted proportionately and excess banding above the quota results in a lowered "weight" given to each band. However, this sampling scheme assumes that doves banded are reasonably representative of the population and if differences exist, then adjustments to trapping and banding efforts can be made to adjust for any disparity. For example, if individuals occupying urban areas were less likely than their rural counterparts to be harvested (e.g., Scott et al. 2004), and a proportion of individuals banded were not from urban landscapes, then the sample may not represent the overall population and could bias estimates. Thus, managers would need to critically evaluate the locations of banding stations to ensure representative sampling was achieved.

Because of the role banding has in monitoring mourning dove populations and because mourning doves have been increasingly occupying urban areas (Muñoz et al. 2008), we sought to evaluate whether the amount of urban area around banding sites differentially influenced harvest compared to those banded in more rural landscapes of North Carolina (NC), South Carolina (SC), and both states combined. Although Scott et al. (2004) showed that urban banded mourning doves were less likely to be harvested than rural banded mourning doves, they compared urban versus rural counties and not the local amount, or proportion, of urban landscape around each banding site. Therefore, our primary question of interest was whether proportion of urban area around banding sites at 5-km extents influenced harvest in NC and/or SC. Consequently, our objective was to evaluate if harvest of urban and rural banded mourning doves in the Carolinas across a continuum of urban landscape proportions around banding sites exhibited a negative linear relationship. In accordance with Scott et al. (2004), we hypothesized that there would be a negative linear association between proportions of urban area (i.e., developed areas as defined by the National Land Cover Database) around banding sites and proportion of dove band recoveries in the Carolinas.

Methods

Study Area and Dove Banding

Our study area consisted of the entirety of NC and SC. These states contain portions of three bird conservation regions: Appalachian Mountains, Piedmont, and Southeastern Coastal Plain (https://nabci-us.org/resources/bird-conservation-regions-map/) consisting of substantially different habitat characteristics which may affect mourning dove and urban area distribution. In general, sites were chosen to maximize capture rates based on agency employees' observations. We trapped mourning doves from 1 July through late August 2011–2015 using modified Kniffen walk-in traps (Reeves et al. 1968). Trap sites were pre-baited approximately 14 days prior using commercially purchased agricultural grains, including millet (*Panicum* spp.), sorghum (*Sorghum* spp.), sunflower (*Helianthus* spp.) seeds, and wild bird seed. As mourning doves were captured, they were removed from the trap and fitted with a uniquely numbered aluminum butt-end band with a 1-800 telephone number to report harvested individuals. Data recorded included date of capture, location of capture, age, gender (for adults), and primary feather molt. All individuals were released at their capture location.

Remote Sensing

We used geographic information systems software (ArcGIS v10.1, ESRI) to define landscape categories using the National Land Cover Database (NLCD version 2011; Homer et al. 2015) with mourning dove banding sites (delineated to 30-sec blocks) in NC and SC (Figure 1). We excluded sites with <50 individuals banded during our study to reduce concerns over the presence of outliers regarding return rates and because sampling effort was not necessarily consistent between sites potentially, leading to low banding numbers at these sites. We evaluated whether this was appropriate by using a *t*-test to determine if the proportion of urban area around the excluded sample sites differed from those included, as well as via descriptive statistics between reporting rates associated with each site.

We remotely sensed landscapes around banding sites by first buffering each site by 5 km and then clipping the NLCD raster by the buffer area. We chose 5 km because this extent encompassed a typical mourning dove home range during the July-August breeding season when banding was conducted (Sayre et al. 1980, Howe and Flake 1988, Losito and Mirarchi 1991). We summed the number of pixels of each land cover type (available at https://www.mrlc.gov/data/legends/national-land-cover-database-2011-nlcd2011-legend) contained within the 5-km buffer and calculated the total number of pixels from land cover classes indicative of four urban landscapes (developed-open space, developed-low intensity, developed-medium intensity, and developed-high intensity) following the protocol established in Collins et al. (2010). All other categories within the NLCD landscapes were deemed rural for the purposes of this study. The urban parameter was then divided by the total number of pixels in the 5-km buffer to determine the proportion of urban land cover around each banding site.

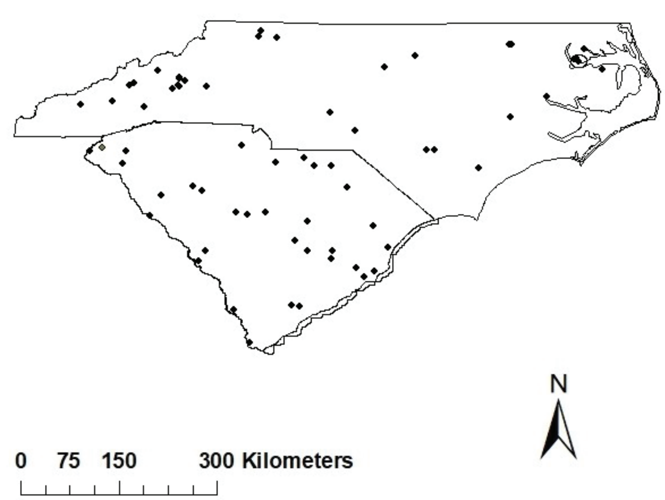

Figure 1. Banding sites used for our analysis to assess banding areas versus mourning dove band reporting rates in North Carolina and South Carolina, USA, 2011–2015.

Data Analysis

We limited our dataset to only include doves harvested in the first hunting season following banding (i.e., direct recoveries) because we did not know if site fidelity with the banding sites extended beyond the initial year. We then investigated the association between the proportion of urban landscape and the harvest proportions of banded doves for each state and both states combined using simple linear regressions (Sokal and Rolf 1995). For our analysis we pooled the data across the sample period of interest (i.e., 2011–2015) because landscape characteristics for the period (from the NLCD) encompassed that time frame and landscape changes around banding sites, if any, were likely minimal. We used Kolgomorov-Smirnov (K-S) tests to assess normality and skewness of the residuals and visual inspection of residual plots to assure that the assumptions of simple linear regressions were met. We assessed significance at $\alpha \leq 0.05$ and used coefficients of determination (r^2) to evaluate the degree of relationship between variables and P-values from ANOVAS (i.e., F statistic) to determine whether the slope of the best fit regression line differed significantly from horizontal. All analyses were performed using the Analysis ToolPack-VBA Add-in in Microsoft Excel and the K-S calculator found at https://www.socscistatistics.com/tests/kolmogorov/default.aspx.

Results

Collectively, we obtained dove banding records for 127 sites. After excluding sites with <50 individuals banded, we retained 33 sites each for SC and NC. We found no differences between urban proportions at sites we included and excluded in our study area (e.g., SC: $t = 0.49$, $P = 0.62$). However, there was a difference in band return rates between excluded and included banding sites in SC ($t = -2.17$, $P = 0.03$). Descriptive statistics of return rates for SC of the excluded and included sites, respectively, were: mean = 0.03, 0.06; median = 0.01, 0.05; mode = 0.00, 0.04; return rate range 0.00–0.14, 0.00–0.16, supporting that sites with <50 individuals banded biased our results by both zero inflating our data and yielding high harvest proportions compared to sites with greater banding success by banding more individuals. We considered this sufficient and did not repeat the analysis for NC because we were unable to obtain the necessary data; however, we had no reason to believe the results would differ.

Across our 66 included sites, we banded 15,580 mourning doves in NC ($n = 6{,}028$) and SC ($n = 9{,}552$). Of these individuals, 803 were reported as harvested direct recoveries to the Bird Banding Laboratory (NC = 356, SC = 447) for an overall return rate of 0.05. Proportions of urban land cover within 5-km extents of each banding site ranged from 0.01–0.52 (mean = 0.09, SE = 0.02). We calculated the amount of urban land cover to be 10.81% in NC and 9.30% in SC, and 10.22% combined (i.e., study area).

We found no differences between states for the proportion of doves reported to be harvested ($t = 1.72$, $P = 0.09$). Similarly, although mourning doves banded in landscapes with greater amounts of urban area in SC were more likely to be harvested than in NC based on regression line slope across the urban continuum, there was no significant relationship between proportion of urban landscape and proportion of harvested doves individually (NC, $r^2 = 0.0556$, $F = 1.83$, $P = 0.19$, $y = -0.1069x + 5.2858$; SC, $r^2 = 0.0105$, $F = 0.33$, $P = 0.57$, $y = -0.0325x + 5.9284$) or combined ($r^2 = 0.0372$, $F = 2.48$, $P = 0.12$, $y = -0.0019x + 0.2206$) (Figures 2, 3).

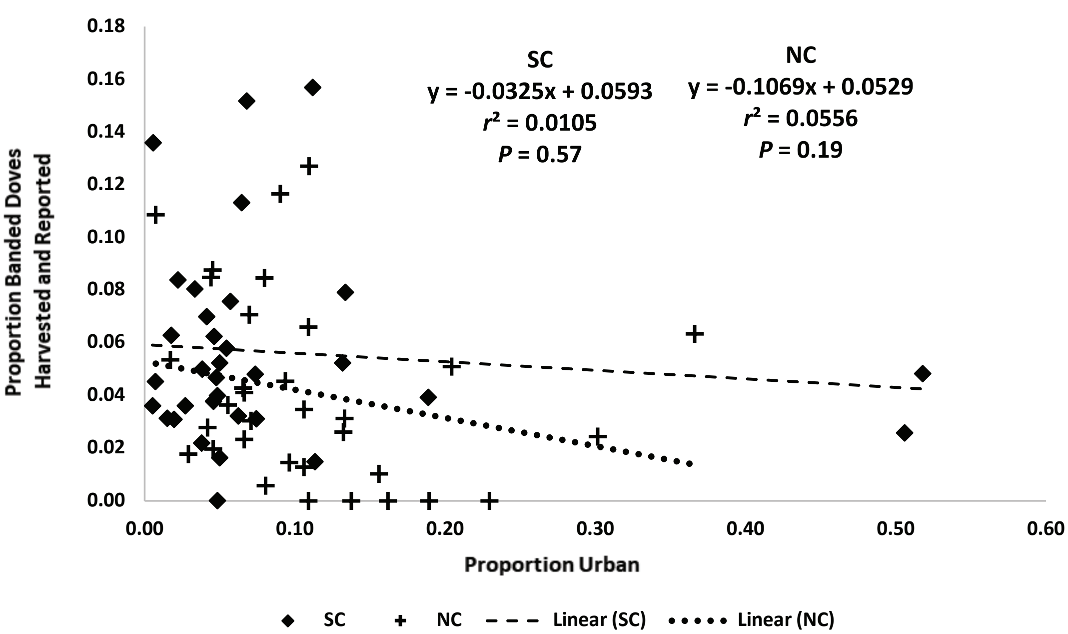

Figure 2. Simple linear regression of proportions of harvest on proportions of urban landscape within a 5-km extent of each banding site in North Carolina and South Carolina, USA, 2011–2015.

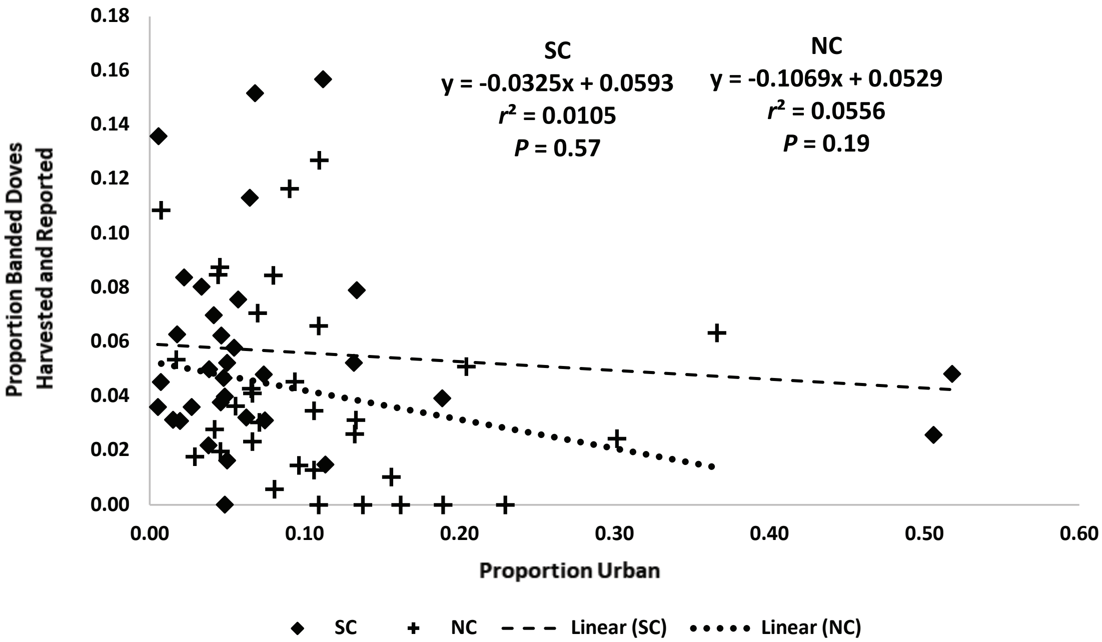

Figure 3. Simple linear regression of combined proportions of harvest of banded mourning doves on proportions of urban landscape within a 5-km extent of each banding site in North Carolina and South Carolina, USA, 2011–2015, combined.

The residuals from all regressions were normally distributed and homoscedastic (SC: $D = 0.16$, $P = 0.30$, skewness = 1.34; NC: $D = 0.15$, $P = 0.39$, skewness = 0.90; both states: $D = 0.12$, $P = 0.31$, skewness = 1.07) indicating the simple linear regressions met the requisite assumptions and were appropriate.

Discussion

Because of the role banding has in monitoring mourning dove populations and because mourning doves are tolerant to land-use changes, including urbanization (Muñoz et al. 2008), we wanted to evaluate whether the amount of urban area around banding sites differentially influenced harvest compared to those banded in more rural landscapes, across a continuum. This is particularly of interest given the increase of urbanization worldwide (Giraudeau and McGraw 2014) which affects many species (e.g., Morgan and Cushman 2005). As such, urban landscapes are intuitively encroaching into mourning dove habitat. For our study, we found no effect and almost none of the variation on susceptibility to harvest mourning doves was attributed to the amount of urban landscape proportion. While mourning doves banded in NC and SC are not differentially harvested based on level of urbanization around banding sites, our data covered a limited portion of the continuum, tending substantially toward more rural composition around banding sites. This may be partially because these states have a relatively low amount of urban areas and thus less urban landscape around banding sites. For example, only four sites had >30% urban landscape composition for the combined NLCD landscape developed categories. Moreover, our sites were typical of where huntable public lands occur in the Carolinas. Therefore, although areas with greater levels of urban landscape have been shown to influence harvest rates elsewhere (e.g., Scott et al. 2004), such sites were not available for our study.

Inferences about avian populations derived from banding studies assume that the sample of banded individuals is representative of the overall population. However, there are many sources of potential bias including reporting rate differences (Sanders and Otis 2012), temporal variation (Arnold et al. 2016), and geographic variation (Seamans 2019). In particular, Scott et al. (2004) suggested a sensitivity to reporting rates which, for national mourning dove population estimates in the United States, are weighted based on reward band studies that assume a 100% return rate (Conroy and Williams 1981, Scott et al. 2004, Seamans 2019). Our results were similar to state-wide band return rates reported by Seamans (2015) for the Carolinas for adult and juvenile individuals, respectively (SC = 0.10, 0.06; NC = 0.11, 0.07 for 2015) and to rates reported by Scott et. al (2004) for rural mourning doves in Ohio. Although many factors may impact harvest, initial capture site (rural vs. urban) and subsequent harvest patterns would seemingly also have the potential to inject bias into banded samples.

Our analyses provide some reflection of how the national mourning dove banding program is implemented in both states, as managers have direct control over the location of banding sites. Further research for other states with overall differences in urban habitat coverage (e.g., we calculated that Florida and Ohio both have >14% total urban landscape) should be conducted. Additionally, the distribution of urban landscape around banding sites may influence harvest susceptibility within higher urban banding areas that have rural landscape at the banding sites proper. For example, if the urban portion of a 5-km extent around a banding site is clustered around the outer portion of the extent, the actual banding site in the center could be predominantly rural. Also, proximity of dove hunting sites to urban areas may have an effect. Both possibilities warrant further study.

Based on our regression analyses, we failed to accept our hypothesis that harvest rates of banded mourning doves would be negatively influenced by an increased proportion of urban landscape around a 5-km extent of banding sites for NC and SC during our study. Future studies could assess additional aspects of land use change, including whether distances between banding and harvest sites influence harvest rates relative to, or independent of, the amount of urban area near banding sites. This could be influential given many doves in our study area are often harvested in the same county (or nearby) where they were banded (J.C. Fuller, North Carolina Wildlife Resources Commission, and M.F. Small, South Carolina Department of Natural Resources, unpublished data). Similarly, other land uses (e.g., row crop agriculture, working forestry) may influence local populations and hunter harvest rates differentially from urbanization. Such findings should be incorporated into the national mourning dove monitoring program to minimize biases, and thus provide a more representative sample of the overall dove population.

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