# MOURNING DOVE HARVEST CHARACTERISTICS, SURVIVAL, AND POPULATION TREND IN NORTH AND SOUTH CAROLINA

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*Abstract*: Within a study area comprising 6 South Carolina counties and 4 North Carolina counties, mourning dove (*Zenaida macroura*) harvest characteristics, survival, and population trend were studied. High survival and productivity are the factors responsible for the high mourning dove population on the study area. From 1968 through 1975, the study area had a stable breeding population trend, and productivity equaled or exceeded the productivity necessary to achieve population stability. Adult doves survived at a rate of 43.0%, immatures at a rate of 26.3%. Increasing the bag limit for 2 hunting seasons had no adverse effect on breeding population, productivity, or survival, but it did increase the shooting pressure on immatures. Age specific vulnerability to hunting was found only in September and October. There was no evidence of sex-specific vulnerability to hunting among adults. Approximately 86% of the harvest of doves banded on the study area occurred during September and October. At no time were more than 20% of the doves banded on the study area harvested off the study area. Adult doves leaving the study area moved to other portions of South Carolina, immatures leaving moved to Georgia, Florida, North Carolina, South Carolina, and Virginia. Adult doves from South Carolina and Virginia contributed to the study area's harvest, and immature doves from Massachusetts, New Jersey, New York, North Carolina, Ohio, Pennsylvania, South Carolina, and Tennessee contributed to the study area's harvest.

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From the standpoint of numbers harvested, the mourning dove is the most important game bird within North America (Amend 1969). Research on this popular game bird has not kept pace with increased hunter interest (Sandfort 1977). However, since 1967 an accelerated research program for migratory upland game birds, of which this study is part, has increased upland game birds, of which this study is part, has increased the amount of mourning dove research (MacDonald and Evans 1970).

The purpose of this study were to examine harvest characteristics, survival, and population trend of mourning doves in a portion of North and South Carolina. These elements have been studied for the Eastern Management Unit as a whole (Hayne 1975; Southeastern Association of Game and Fish Commissioners 1957). The smaller area chosen for this study contains one of the highest mourning dove populations in the Eastern Management Unit (Ruos 1974:9).

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## METHODS

This study was conducted in the north-central South Carolina counties of Chesterfield, Darlington, Kershaw, Lancaster, Lee and Marlboro, and the south-central North Carolina counties of Anson, Richmond, Scotland, and Union. The study area includes Piedmont, upper coastal plain, and lower coastal plain physiographic regions (Colquhoun and Pierce 1971). The Piedmont and upper coastal plain are approximately three-fourths forested with gently rolling or hilly topography; the lower coastal plain is between one-half and three-fourths forested, with gently sloping topography (Nelson and Zillgitt 1969). Much of the area within each physiographic region is farmed. Loblolly-shortleaf pine forests (*Pinus taeda* and *P. echinata*) dominate most of the study area except the upper coastal plain where pine-oak forests (*P. palustris, Quercus laevis*, and Q. *marilandica*) predominate.

Mourning doves were trapped and banded from June through August 1968-74. Doves were aged by primary covert coloration (Pearson and Moore 1940) or by wear of unmolted primaries (Wight et al. 1967). When time permitted, sex was determined by cloacal characters (Miller and Wagner 1955), otherwise by plumage coloration (Petrides 1950).

First hunting season band recoveries (direct recoveries) were used to estimate age- and sex-specific vulnerability to hunting, to determine the distribution of harvest from the study area, to determine the origins of harvest on the study area, and to estimate mortality due to hunting on the study area. Weighted direct recoveries (Kiel 1959) were used to study the origins of harvest on the study area. Also the origins of harvest study was limited to the 1968-69 through 1971-72 hunting seasons, because only then were doves banded both throughout the Eastern Managment Unit (Hayne 1975) and on the study area.

It was useful to examine the movements of doves to and from the study area through time, although problems arose from hunting season differences between North and South Carolina. From 1968-74, North Carolina dove seasons were split into 2 periods, whereas during the same years, South Carolina dove hunting was generally split into 3 periods. Because of these differences, I divided the hunting season into 2 parts: September through October and November through January. This division combined South Carolina's first hunting period with North Carolina's first hunting period, and South Carolina's second and third hunting periods with North Carolina's second hunting period.

Stoachastic models were used to estimate mourning dove survival instead of deterministic models (Anderson 1972). Adult mourning dove survival rates were calculated by modifications of the stoachastic models of Seber (1970) and Robson and Youngs (1971) for a tag-recapture experiment on an exploited animal population (Brownie et al. 1978). Immature mourning dove survival rates were calculated via models developed by Brownie (1973), Brownie and Robson (1974, 1976).

Use of these models for immature doves gave age-specific recovery and survival rates for the first year after banding, given that both adult and immature doves had been banded in the same area over a span of years. Mean life span and its variance were estimated via a modification of Cormack's (1964) method (Anderson 1975:5). Brownie et al. (1978) contains discussions of survival rate estimation by the above techniques.

Each May through June, 24 call-count routes were censused (1968-75) using nationwide call-count survey procedures (Ruos 1974). The data from these 24 routes were used to determine year-to-year changes in the breeding population on the study area. The 20 stations of each of these routes were permanently marked to assure that the same areas were censused each year. One observer censused the routes from 1968 through 1971, and a different observer censused the routes from 1972 through 1975. When this observer change occurred in 1972, 3 routes were run by both observers to compare observer ability to hear doves; no statistically significant difference was found.

From 1968 through 1973, 774 dove hunters were contacted at the end of their hunts. The same aging methods described above were used, except that when primary molt was complete, age was determined by methods described in Haas and Amend (1978). Age ratios corrected for age-specific vulnerability to hunting were used to determine year-to-year changes in productivity on the study area.

## RESULTS AND DISCUSSION

### Banding and Recoveries

From 1968 through 1974, 26,412 mourning doves were banded on the study area: 20,760 immatures and 5,652 adults. Of the 5,652 adult doves, 3,265 were male, 2,338 were female, and 49 were of unknown sex. From 1968 through 1975, 1,125 recoveries were made of the 1968 through 1974 banded doves (4.3% of the banded population). Of these

1,125 recoveries, 931 came from doves banded as immature (4.5% of the banded population), and 194 came from doves banded as adults (3.4% of teh banded population).

Eastern Management Unit direct recovery rates declined from 1965 through 1970, making doubtful any assumption of independence among yearly recovery rate values (Hayne 1975:25). Upon examination of direct recovery rates from adult and immature doves banded for this study, no such trend was found (Table 1).

Table 1. First hunting season recovery rates (direct recovery rates) of adult and immature mourning doves, 1968-74.

| | *Adults* | *Immatures* |
|---|---|---|
| 1968 | 0.021 | 0.029 |
| 1969 | 0.0222 | 0.054 |
| 1970 | 0.018 | 0.035 |
| 1971 | 0.013 | 0.032 |
| 1972 | 0.022 | 0.037 |
| 1973 | 0.022 | 0.030 |
| 1974 | 0.020 | 0.038 |
| Mean | 0.020 | 0.036 |

Age- and Sex-Specific Vulnerability to Hunting

The direct recovery rate of immatures was significantly higher ($P < 0.001$) than the direct recovery rate of adults in North and South Carolina (Table 2), meaning that immatures were 1.8 times more likely to be shot than were adults. Age-specific vulnerability for mourning doves has also been found in several other studies (Hayne 1975; Henry 1970; Rice and Lovrien 1974).

Table 2. Age-specific vulnerability to hunting among mourning doves, 1968-74.

| | *September - October* | | *November - January* | | *September - January* | |
|---|---|---|---|---|---|---|
| | *No. direct recoveries* | *Direct recovery rate* | *No. direct recoveries* | *Direct recovery rate* | *No. Direct recoveries* | *Direct recovery rate* |
| Immatures | 656 | 0.032 | 97 | 0.005 | 753 | 0.036 |
| Adults | 94 | 0.017 | 21 | 0.004 | 115 | 0.020 |

The data were further examined to determine whether immature doves become less vulnerable to shooting as the hunting season progressed. Immatures were significantly ($P < 0.001$) more vulnerable than adults to shooting in the September-October hunting period; however, during the November-January hunting period, no evidence was found of age-specific vulnerability to hunting. During the September-October hunting period, immatures are 1.9 times more likely to be shot than are adults.

Age-specific vulnerability to hunting has also been found to decline for black ducks (*Anas rubripes*) (Geis et al. 1971). This decline was thought to be caused by either a learning process which makes immatures as wary as adults during the passage of the hunting season, or elimination of the more vulnerable immatures by shooting, or a

combination of these 2 other possibilities. I feel that the apparent decline in mourning dove age-specific vulnerability as the hunting season progressed was primarily due to a learning process, since the kill rate for immature doves was low (see "Mortality Due to Hunting").

Sex-specific vulnerability to hunting was examined only for adults. No difference was found between male and female direct recovery rates, indicating no differential vulnerability to hunting. This was also found to be true in the Eastern Management Unit as a whole (Hayne 1975).

Timing of Harvest

Two sources of data for examination of dove harvest timing were available: unweighted direct recoveries of doves banded on the study area, and weighted direct recoveries (Kiel 1959) of doves harvested on the study area. For doves banded on the study area, the proportions of adult males and females harvested during the September-October period and during the November-January hunting period were not significant, nor were the proportions of adults and immatures harvested during the two different periods significant. For doves banded on the study area, 86.4% were harvested during the September-October hunting period, and 13.6% were harvested during the November-January hunting period (Table 3).

Table 3. Distribution of band recoveries (direct recoveries) from mourning doves banded on the study area, 1968-74.

| | *Adults* | | | | *Immatures* | | | |
|---|---|---|---|---|---|---|---|---|
| | *September - October* | | *November - January* | | *September - October* | | *November - January* | |
| | *Number of recoveries* | *Percent* | *Number of recoveries* | *Percent* | *Number of recoveries* | *Percent* | *Number of recoveries* | *Percent* |
| Study area | 92 | 97.9 | 17 | 81.0 | 612 | 93.3 | 80 | 82.5 |
| Remainder of -- | | | | | | | | |
| South Carolina | 2 | 2.1 | 4 | 19.0 | 25 | 3.8 | 12 | 12.4 |
| North Carolina | | | | | 15 | 2.3 | 2 | 2.0 |
| Florida | | | | | 1 | tr[1] | | |
| Georgia | | | | | 2 | tr | 3 | 3.1 |
| Virginia | | | | | 1 | tr | | |
| Percent harvest | | 81.7 | | 18.3 | | 87.1 | | 12.9 |

[1]less than 1%.

For mourning doves harvested on the study area, the proportion of adult males and females harvested during the September-October and November-January hunting periods was not significant, and the proportion of adults and immatures harvested during the September-October and November-January hunting periods was not significant. For doves harvested on the study area, 83.1% were taken during the September-October hunting period, and 16.9% were taken during the November-January hunting period (Table 4). The timing of harvest is very similar for doves banded on the study area and doves harvested on the study area, because most of the doves harvested on the study area were banded on the study area (See "Source of Harvest on the Study Area").

Distribution of Harvest from the Study Area

Examination of adult direct recoveries show that no adult males and 5.9% of the adult females left the study area during the September-October hunting period, and that 15.4% of the adult males and 25% of the adult females left the study area during the

Table 4. Source of mourning dove harvest (percentage of harvest) within the study area based upon weighted direct recoveries, 1968-71.

| | *Adults* | | *Immature* | |
|---|---|---|---|---|
| | *Sept. - Oct.* | *Nov. - Jan.* | *Sept. - Oct.* | *Nov. - Jan.* |
| Study area | 74.8 | 64.5 | 80.4 | 68.1 |
| Remainder of -- | | | | |
| South Carolina | 25.2 | 22.7 | 12.6 | 10.9 |
| North Carolina | | | 2.7 | 16.1 |
| Massachusetts | | | tr[a] | tr |
| New Jersey | | | 1.0 | |
| New York | | | tr | |
| Ohio | | | 1.9 | |
| Pennsylvania | | | | 4.7 |
| Tennessee | | | 1.2 | |
| Virginia | | 12.8 | | |
| Harvest per period | 78.4 | 21.6 | 85.8 | 14.2 |

[a]less than 1%.

November-January hunting period. These adult doves that left the study area only moved to other portions of South Carolina. I feel that there were no differences between adult male and female harvest distributions, because the distributions during the September-October hunting period were very close, and the distributions during the November-January hunting period were not statistically significant.

Few adult doves left the study area until the November-January hunting period (Table 3). During the September-October hunting period, only 2.1% of the adult population moved from the study area to other portions of South Carolina, but during the November-January hunting periods, 19.0% of the adult population did so.

The proportions of adult and immature doves harvested on and off the study area were not significant between hunting periods; however, some of the immatures that left the study area also left the Carolinas (Table 3). During the September-October hunting season, 6.1% of the immature population left the study area (8.2% of these leaving the Carolinas), whereas during the November-January hunting season 17.5% of the immature population left the study area (17.7% of these leaving the Carolinas). An age-specific migratory tendency has also been found to be true for South Dakota (Rice and Lovrien 1974) and Louisiana doves (Watts 1969).

Source of Harvest on the Study Area

The majority of adult doves harvested on the study area were banded on the study area (Table 4). The same proportion of adult male and female doves came from on and off the study area during the September-October and November-January hunting periods. However, probably due to small sample size, the origins of off-area male (South Carolina) and female (Virginia) doves differed. I feel that the combined adult data best describe the origins of adults harvested on the study area. Therefore, adults from South Carolina contributed to the harvest during the September-October and November-January hunting periods, no adults from North Carolina were harvested on the study area, and adults from northern states (Virginia) contributed to the harvest during the November-January hunting period.

The majority of immature doves harvested on the study area were banded on the study area (Table 4). Immatures produced off the study aera, but within the Carolinas, also contributed to the harvest on the study area, the contribution increasing through time. Immatures produced north of the Carolinas contributed less than 5% of the harvest, with no significant difference between hunting periods for this contribution.

Some adult and immature doves banded outside the study area but within the Carolinas were harvested on the study area within the first week of September in some years. No adult mourning doves banded north of the Carolinas were harvested on the study area until the November-January hunting period, and immature doves banded north of the Carolinas were not harvested on the study area until the third week of September in some years. Therefore, the analysis of age ratios in this study was restricted to the first 2 weeks of September.

Survival Rates

Three models allow calculation of adult mourning dove survival. Model 1 assumes time-specific survival and recovery rates, Model 2 assumes constant survival but time-specific recovery rates, and Model 3 assumes constant survival and recovery rates (Brownie et al. 1978).

First, I examined the adult male data to see if recovery and survival rates were constant from year-to-year (Model 3), 1968-73, and found that this hypothesis could not be rejected. I then tested the hypothesis that first year recovery rates of adult males were constant, and found that this hypothesis also could not be rejected. I further tested Model 3 versus Model 1 and Model 3 versus Model 2, and concluded that Model 3 best described adult male survival. Therefore, adult males had a survival rate of 45.9% and a mean life span of 1.3 years (Table 5).

Using the above procedures, I found that Model 3 best described adult female survival. Adult females had a survival rate of 42.2% and a mean life span of 1.2 years (Table 5).

For the entire Eastern Management Unit, adult male survival averaged significantly ($P < 0.05$) higher than adult female survival (Hayne 1975:26). In this study, the survival rate of adult males was very close to the survival rate of adult females. In fact, it appears that adult male and female data should be combined to estimate adult survival, because no statistically significant difference was found when adult male and female survival and recovery rates were compared via a contingency chi-square test (Brownie et al. 1978).

Table 5. Percentage survival rates and mean life spans (years) of mourning doves on the study area, 1968-73.

| | *Survival* ± *S.E.* | *Mean life span* ± *S.E.* |
|---|---|---|
| Adult males | 45.9 ± 4.3 | 1.3 ± 0.2 |
| Adult females | 42.2 ± 6.3 | 1.2 ± 0.2 |
| Adults | 43.0 ± 3.4 | 1.2 ± 0.1 |
| Immatures | 26.3 ± 2.8 | 0.9 ± 0.1 |

As with adult male and female survival estimation, total adult survival was best described by Model 3. Adult doves had a survival rate of 43.0% and a mean life span of 1.2 years (Table 5).

Before determining which model best described immature mourning dove survival, I tested the similarity of adult and immature survival and recovery rates via a contingency chi-square test (Brownie and Robson 1974). Immature survival and recovery rates were found to be significantly different from adult survival and recovery rates ($P < 0.001$).

First, I tested the goodness of fit of a model (H02) assuming that young and adults have different survival and recovery rates, that survival rates are otherwise constant from year-to-year, and that recovery rates are year-specific, and found that this model could not be rejected. I then tested Model H02 versus a more restrictive model (H01) assuming that young and adults have different survival and recovery rates, and that otherwise survival and recovery are constant from year-to-year. In this comparison, Model H01 was rejected ($P < 0.001$). Then I tested Model H02 versus a less restrictive model (H1) assuming that annual survival and recovery rates are year-specific, and that young birds have different survival and recovery rates from those of adults. In this comparison, Model H02 could not be rejected. I concluded that immature survival was best described by Model H02. Therefore, immature doves had a survival rate of 26.3% and a mean life span of 0.9 years (Table 5).

### Mortality Due to Hunting

To estimate the proportion of the population removed by hunting (kill rate), I adjusted the direct recovery rate for unreported bands and unretrieved kill (Geis 1972). Reeves (1978) found the reporting rate for direct recoveries in the Eastern Management Unit to be 31%, and I found that unretrieved loss on the South Carolina portion of the study area was between 27 and 41% of the retrieved kill (unable to directly estimate unretrieved kill because not all doves shot, but still capable of flight, die from their wounds) (Haas 1977). Therefore, the mortality due to hunting lies between 14 and 16% for adults and 20 and 22% for immatures.

### Population Trend and Productivity

For the 1968 through 1973 period I found the population trend (based on the call-count index) on the study area stationary with the exception of 1973 ($P < 0.01$) (Fig. 1). Data were also available for 1974 and 1975. When this additional information was considered, I again found the population trend on the study area to be stable with the exception of 1973 ($P < 0.01$). The 1973 survey period was characterized by daily thunderstorms, which could have influenced calling in the area.

The number of immatures produced per adult that must enter the population each hunting season to maintain a stationary population can be calculated by dividing the adult mortality rate by the immature survival rate (Hickey 1955). Because adult and immature survival did not vary from year-to-year on the study area, it appears that 2.2 immatures per adult must be produced to achieve population stability.

Age ratios from hunter bag checks during the first 2 weeks of the hunting season were adjusted for age-specific vulnerability to hunting (relative recovery rate of 1.9) (Table 6). During the 1969-73 period, productivity exceeded the amount necessary to keep the popoulation stationary, and in 1968 productivity was high enough to keep the population stable. At present, this lack of agreement between the breeding population trend index and the population productivity index is not understood.

### Comparison with Eastern Management Unit

The recently completed "Experimental Increase of Mourning Dove Bag Limit in Eastern Management Unit (Hayne 1975)" study provided data for comparison with this study. Mourning doves survived at a higher rate on the study area than they did within the larger area of the Eastern Management Unit hunting states as a whole. In this study, adults had a survival rate of 43.0%, and immatures had a survival rate of 26.3%. In the Eastern Management Unit hunting states, had a survival rate of 24.4%. Also productivity appeared to be higher in this study than in the Eastern Management Unit study; the age ratio for this study averaged 2.85 immatures per adult, and it averaged 2.54 immatures per adult for the Eastern Management Unit study.

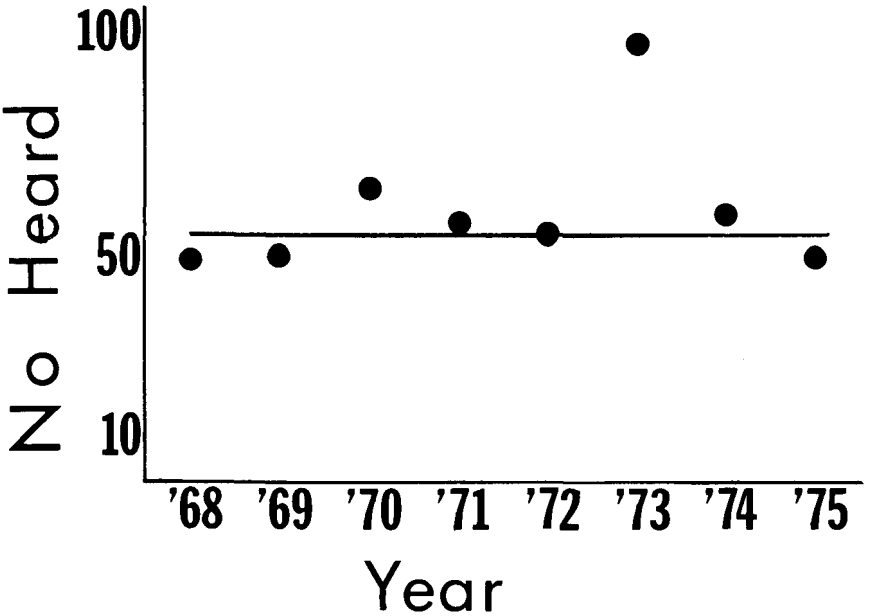


Fig. 1. Yearly trend in mourning dove breeding populations (mean number heard each year along 24 census routes) on study area, 1968-75.

The area chosen for this study contains one of the highest mourning dove populations in the Eastern Management Unit (Ruos 1974:9). It appears that high survival rates and productivity are responsible for this high population.

Effect of Hunting Regulation Changes

The major regulation change that occurred during the study period was an increase from 12 to 18 doves in the Eastern Management Unit bag limit during the 1969-70 and 1970-71 hunting seasons (Hayne 1975). I examined the effect of this 2-year bag limit change on direct recovery rates, survival rates, age ratios, and breeding density indices. Direct recovery rates and survival rates would be affected during the 1969-70 and 1970-71 hunting seasons; however, age ratios and breeding density indices would be affected during the year following the experimental change, 1970-71. For statistical analyses, the direct recovery rates, survival rates, and breeding density indices were not transformed, whereas the arcsin transformation (Snedecor and Cochran 1967) was used on the age ratios.

No statistically significant differences were found between experimental and control periods for adult mourning dove survival, adult direct recovery rates, immature survival rates, and breeding density indices; however, statistically significant differences ($P < 0.001$) were found between experimental and control periods for immature direct recovery rates and age ratios (Table 7). The age ratio change demonstrated no adverse effect on mourning dove production, because an increase occurred during the experimental period. The direct recovery rate change shows that shooting pressure on immatures increased during the experimental period. This shoting pressure increase for immatures can also be seen in relative recovery rates of the experimental and control periods. Immatures were 1.77 times more likely to be shot than adults during the control period, whereas they were 2.06 times more likely to be shot than adults during the experimental period.

Table 6. Mourning dove age ratios derived from 774 hunter bag checks during the first 2 weeks of September, and corrected for age-specific vulnerability to hunting.

| | *Sample size* | *Age ratios* |
|---|---|---|
| 1968 | 1289 | 2.2 |
| 1969 | 458 | 2.3 |
| 1970 | 688 | 3.9 |
| 1971 | 147 | 4.6 |
| 1972 | 696 | 2.4 |
| 1973 | 405 | 2.9 |
| Mean | | 2.9 |

Table 7. Evaluation of the effect of increasing the mourning dove daily bag limit from 12 (control period) to 18 (experimental period) doves on direct recovery rates, survival rates, age ratios, and breeding density index.

| | *Direct recovery rates* | | *Survival rates* | | | |
|---|---|---|---|---|---|---|
| | *Adults* | *Immatures* | *Adults* | *Immatures* | *Age ratios* | *Breeding density index* |
| Experimental period (2 years) | 0.020 | 0.044 | 0.457 | 0.271 | 4.2 | 60.9 |
| Control period (4 years) | 0.019 | 0.033 | 0.418 | 0.200 | 2.4 | 62.5 |

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