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Mourning Dove

Population Status, 2002

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MOURNING DOVE BREEDING POPULATION STATUS, 2002

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Abstract: This report includes Mourning Dove Call-count Survey information gathered over the last 37years within the conterminous United States. Trends were calculated for the most recent 2- and 10-year intervals and for the entire 37-year period. Between 2001 and 2002, the average number of doves heard per route increased significantly in the Western Management Unit. No change was detected for the Eastern and Central Units. Over the most recent 10 and 37-year periods, significant declines were indicated for doves heard in the Central and Western Units. Additionally, in the Eastern Management Unit, a significant decline was detected over 37 years while there was no trend indicated over the most recent 10 years. In contrast, for doves seen over the 10-year period, a significant increase was found in the Eastern Unit while no trends were found in the Central and Western Units. Over the 37-year period, no trend was found for doves seen in the Eastern and Central Units while a decline was indicated for the Western Unit.

The mourning dove (*Zenaida macroura*) is a migratory bird, thus, authority and responsibility for its management is vested in the Secretary of the Interior. This responsibility is conferred by the Migratory Bird Treaty Act of 1918 which, as amended, implements migratory bird treaties between the United States and other countries. Mourning doves are included in the treaties with Great Britain (for Canada) and Mexico. These treaties recognize sport hunting as a legitimate use of a renewable migratory bird resource. As one of the most abundant species in both urban and rural areas of North America, it is familiar to millions of people. Maintenance of mourning dove populations in a healthy, productive state is a primary management goal. To this end, management of doves includes assessment of population status, regulation of harvest, and habitat management. Call-count surveys are conducted annually in the 48 conterminous states by state and federal biologists to monitor mourning dove populations. The resulting information on status and trends is used by wildlife administrators in setting annual hunting regulations.

The primary purpose of this report is to facilitate the prompt distribution of timely information. Results are preliminary and may change with the inclusion of additional data.

Artist, Joe Garcia and Wild Wings, Inc., Lake City, Minnesota, provided the cover art for this report.

DISTRIBUTION AND ABUNDANCE

Mourning doves breed from the southern portions of Canada throughout the United States into Mexico, Bermuda, the Bahamas and Greater Antilles, and scattered locations in Central America (Fig. 1). Although some mourning doves winter throughout most of the breeding range, except for central Canada and the north-central U.S., the majority migrate south, wintering in the southern United States and south throughout most of Mexico and Central America to western Panama (Aldrich 1993, Mirarchi and Baskett 1994).

The mourning dove is one of the most widely distributed and abundant birds in North America (Peterjohn et al. 1994, Fig. 1). Although not known precisely, the fall population has been estimated to be about 475 million (Dunks et al. 1982, Tomlinson et al. 1988). However, as there is evidence of population decreases since this estimate was made from data collected in the 1970's, we believe that the mourning dove population has declined to slightly more than 400 million in the United States.

POPULATION MONITORING

The Mourning Dove Call-count Survey was developed to provide an annual index to population size (Dolton 1993). This survey is based on work by McClure (1939) in Iowa. Field studies demonstrated the feasibility of the survey as a method for detecting annual changes in mourning dove breeding populations (Foote and Peters

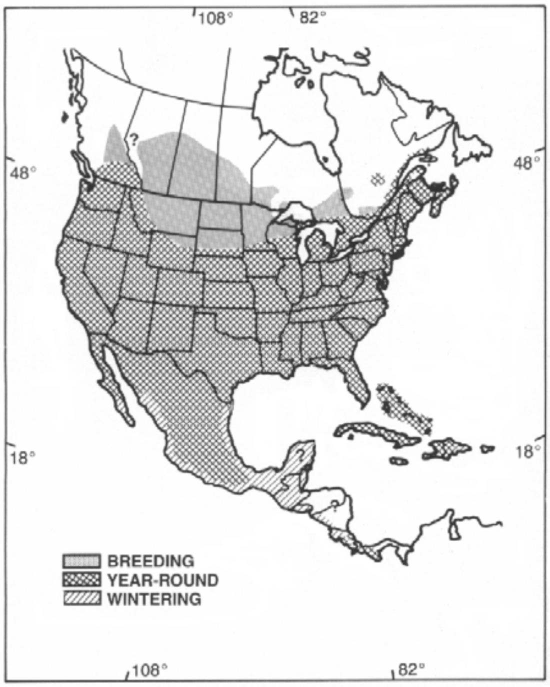

Fig. 1. Breeding and wintering ranges of the mourning dove (adapted from Mirarchi and Baskett 1994).

1952). In the United States, the survey currently includes more than 1,000 randomly selected routes, stratified by physiographic region. The total number of doves heard on each route is used to determine trends in populations and provides the basis for determining an index to population size during the breeding season. Indices for doves seen are also presented in this report, but only as supplemental information for comparison with indices of doves heard. Even though both the numbers of doves heard and seen are counted during the survey, they are recorded separately.

Within the United States, there are 3 zones that contain mourning dove populations that are largely independent of each other (Kiel 1959). These zones encompass the principal breeding, migration, and U.S. wintering areas for each population. As suggested by Kiel (1959), these 3 areas were established as separate management units in 1960 (Kiel 1961). Since that time, management decisions have been made within the boundaries of the Eastern (EMU), Central (CMU), and Western (WMU) Management Units (Fig. 2).

The EMU was further divided into 2 groups of states for analyses. States permitting dove hunting were combined into one group and those prohibiting dove hunting into another. Additionally, some states were grouped to increase sample sizes. Maryland and Delaware were combined; Vermont, New Hampshire, Maine, Massachusetts, Connecticut, and Rhode Island were combined to form a New England group. Due to its small size, Rhode Island, which is a hunting state, was included in this nonhunting group of states for analysis.

METHODS

The Call-count Survey

Each call-count route is usually located on secondary roads and has 20 listening stations spaced at 1-mile intervals. At each stop, the number of doves heard calling, the number seen, and the level of disturbance (noise) that impairs the observer's ability to hear doves are recorded. The number of doves seen while driving between stops is also noted.

Counts begin one-half hour before sunrise and continue for about 2 hours. Routes are run once between 20 May and 5 June. Intensive studies in the eastern United States (Foote and Peters 1952) indicated that dove calling is relatively stable during this period. Surveys are not made when wind velocities exceed 12 miles per hour or when it is raining.

Estimation of Population Trends

A population trend is defined as the ratio of the dove population in an area in one year to the population in the preceding year. For more than 2 years of data, the trend is expressed as an average annual rate of change. A trend was first estimated for each route by numerically solving a set of estimating equations (Link and Sauer 1994). Observer data were used as covariables to adjust for differences in observers' ability to hear or see doves. The reported sample sizes are the number of routes on which a given trend estimate is based. This number may be less than the actual number of routes surveyed for several reasons. The estimating equations approach requires at least 2 non-zero counts by at least one observer for a route to be used. Routes that did not meet this requirement during the interval of interest were not included in the sample size. State and management unit trends were obtained by calculating a mean of all route trends weighted by land area, within-route variance in counts, and density (mean numbers of doves counted on

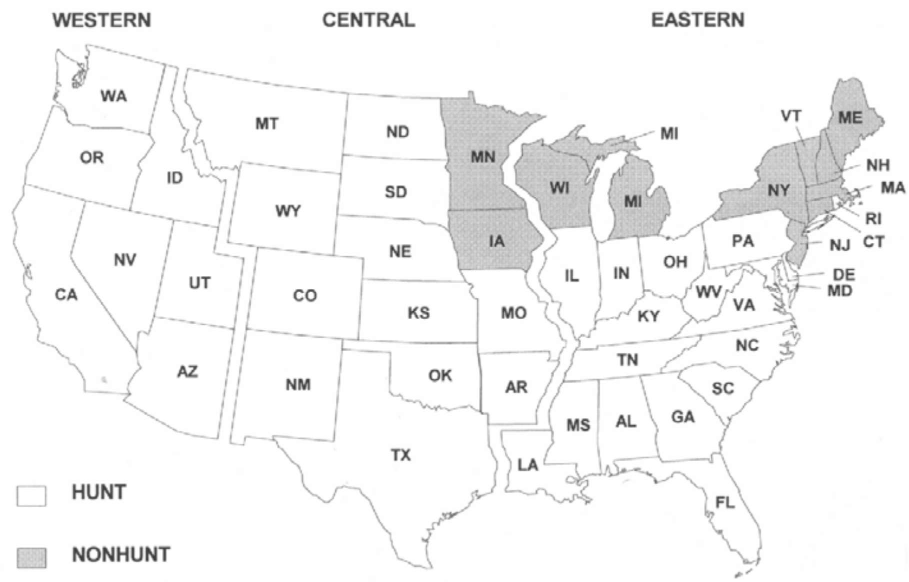

Fig. 2. Mourning dove management units with 2002 hunting and nonhunting states

each route). Variances of state and management unit trends were estimated by using route trends and a statistical procedure known as bootstrapping (Geissler and Sauer 1990).

The annual change, or trend, for each area in doves heard over the most recent 2- and 10-year intervals and for the entire 37-year period were estimated. Additionally, trends in doves seen were estimated over the 10- and 37-year periods as supplemental information for comparison.

For purposes of this report, statistical significance was defined as $P<0.05$, except for the 2-year comparison where $P<0.10$ was used because of the low power of the test. Significance levels are approximate for states with less than 10 routes.

Estimation of Annual Indices

Annual indices show population fluctuations about fitted trends (Sauer and Geissler 1990). The estimated indices were determined for an area (state or management unit) by finding the deviation between observed counts on a route and those predicted on the route from the area trend estimate. These residuals were averaged by year for all routes in the area of interest. To adjust for variation in sampling intensity, residuals were weighted by the land area of the physiographic regions within each state. These weighted average residuals were then added to the fitted trend for the area to produce the annual index of abundance. This method of determining indices superimposes yearly variation in counts on the long-term fitted trend. These indices should provide an accurate representation of the fitted trend for regions that are adequately sampled by survey routes. Additionally, only data from within an area are incorporated into the area's index. Since the indices are adjusted for observer differences and trend, the index for an area may be quite different from the actual count. In order to estimate the percent change from 2001 to 2002, a short-term trend (2 years) was calculated. The percent change estimated from this short-term trend analysis is the best estimator of annual change. Attempts to estimate short-term trends from the breeding population
indices (which were derived from residuals of the long-term trends) will yield less precise results. The annual index value incorporates data from a large number of routes that are not comparable between the two years 2001 and 2002, i.e., routes not run by the same observers. Therefore, the index is much more variable than the trend estimate.

In a separate analysis, the mean number of doves heard calling per route in 2002 was calculated for each state or groups of states. In contrast to the estimated annual indices presented in Table 2 (which illustrate population changes over time based on the regression line), the

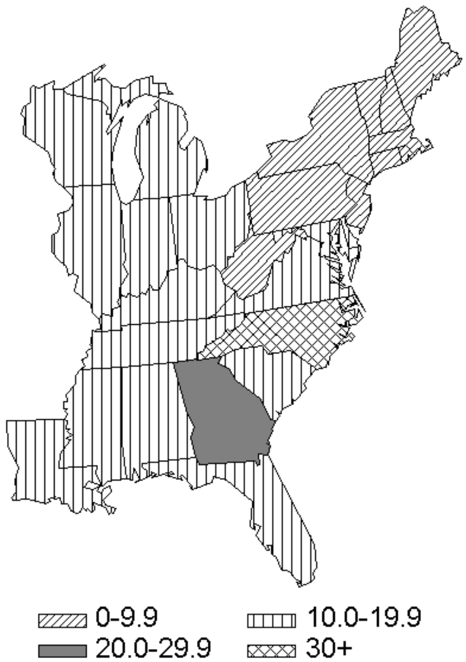

Fig. 3. Mean number of mourning doves heard per route by state in the Eastern Management Unit, 2001-2002.

estimated densities shown in Figs. 3, 7, and 11 illustrate the average *actual* numbers of doves counted in 2001 and 2002.

RESULTS

Eastern Management Unit

The Eastern Management Unit includes 27 states comprising 30% of the land area of the United States. Dove hunting is permitted in 18 states, representing 74% of the land area of the unit (Fig. 2).

2001-2002 Population Distribution.--North Carolina had one of the highest counts in the Nation with 40 actual doves heard per route over the 2 years (Fig. 3). Pennsylvania, West Virginia, New Jersey, New York, and the New England states averaged < 10 per route. Georgia had 23 doves heard per route while all other states had mean counts in the range of 10-20.

2001 to 2002 Population Changes.–No significant change was detected for the Unit although the average number of doves heard per route increased 2.1% (Table

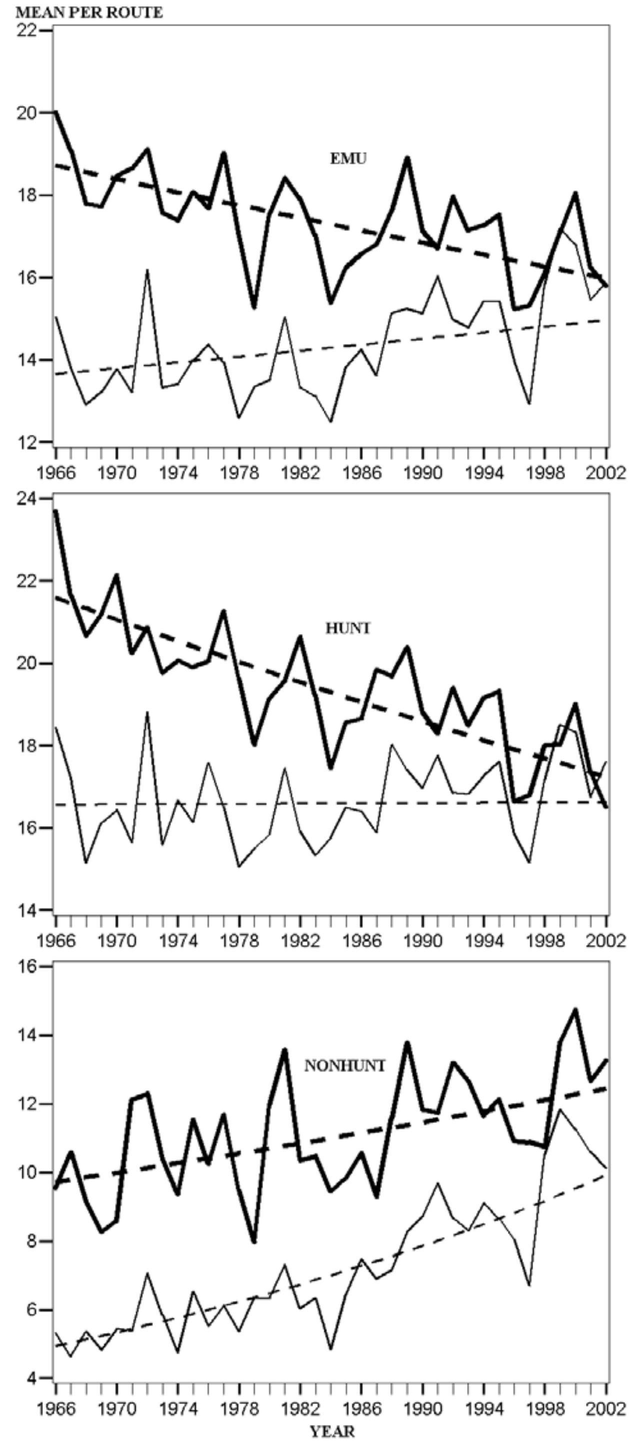

Fig. 4. Population indices and trends of breeding mourning doves in the Eastern Management Unit (EMU), combined EMU hunting states (HUNT), and combined EMU nonhunting states (NONHUNT), 1966-2002. Heavy solid line = doves heard; light solid line = doves seen. Light and heavy dashed lines = predicted trends.

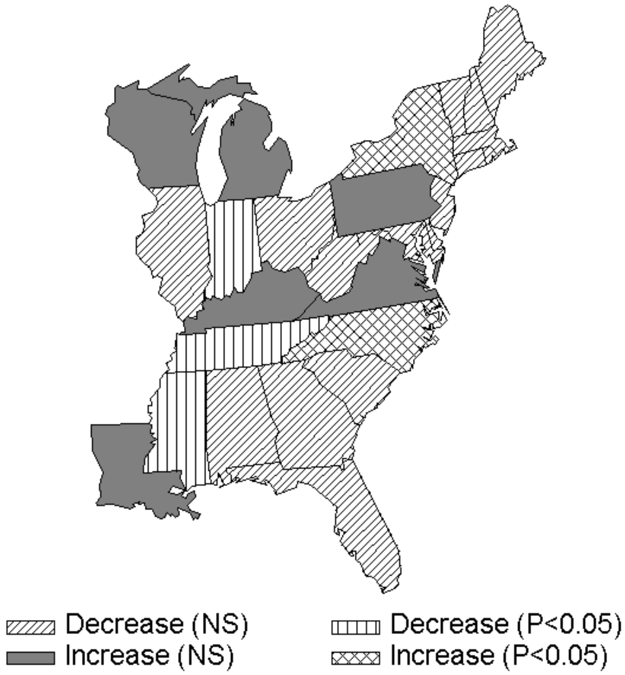

Fig. 5. Trends in number of mourning doves heard per route by state in the Eastern Management Unit, 1993-2002.

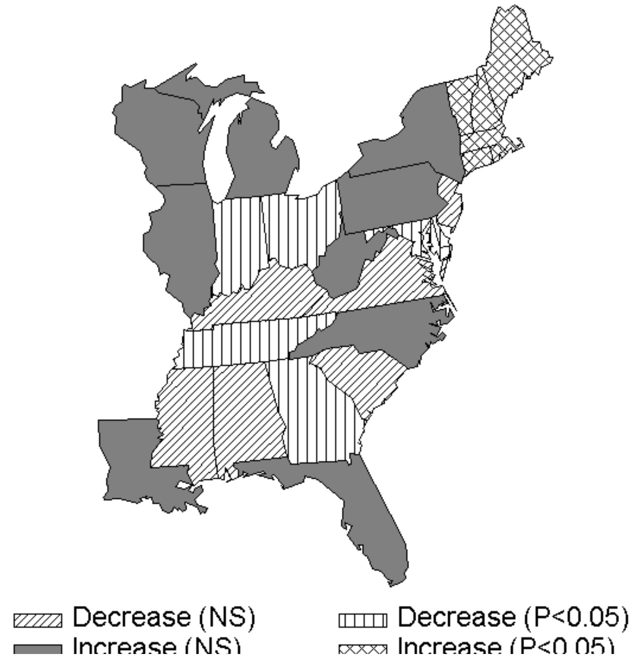

Fig. 6. Trends in the number of mourning doves heard per route by state in the Eastern Management Unit, 1966-2002.

1). The population did not change significantly between years in the combined hunting states (-2.6%). The index for the combined nonhunting states increased significantly (26.5%).

The 2002 population index of 15.8 doves heard per route for the Unit, was slightly below the predicted count based on the long-term estimate of 16.0 (Fig. 4, Table 2). In the hunting states, the index of 16.5 was below the predicted estimate of 17.3, while in the nonhunting states, the index of 13.3 is above the predicted estimate of 12.4.

The population increased significantly in Michigan and the New England states while it decreased in Delaware/Maryland and Mississippi (Table 1). No significant changes were detected for other states.

Population Trends: 10 and 37-year.--Analyses indicated significant declines over the most recent 10 and 37-year periods for the combined hunting states (Table 1). No significant trend was found over either time period for the combined nonhunting states. For the Unit, there was no trend indicated over 10 years, but a significant decline shown over the long term. Annual indices both for doves heard and seen are shown in Fig. 4. In contrast to doves heard, an analysis of doves seen indicated a significant increasing trend for the Unit and 2 groups over 10 years. No trend was detected over 37 years for the Unit or 2 combinations of states.

State population trends for doves heard are shown in Fig. 5 (10-year interval) and Fig. 6 (37-year interval) and Table 1). Over 10 years, increases were found for North Carolina and New York while Indiana, Mississippi, and Tennessee showed declines. Between 1966 and 2002, an increase was noted in New England, while a downward trend was noted in Delaware/Maryland, Georgia, Indiana, Ohio, and Tennessee.

Central Management Unit

The Central Management Unit consists of 14 states, containing 46% of the land area in the U.S. It has the highest population index of the 3 units. Within the unit, dove hunting is permitted in 12 states (Fig. 2).

2001-2002 Population.–Kansas, Nebraska, North Dakota, and South Dakota had the highest actual average number of doves heard per route over the 2 years (22, 27, 23, and 23 respectively) (Fig. 7). Historically, North Dakota and Kansas often have the highest average counts in the Nation (Table 2). Montana, New Mexico, and Wyoming were the only states with less than 10 doves per route. The remaining states had intermediate values.

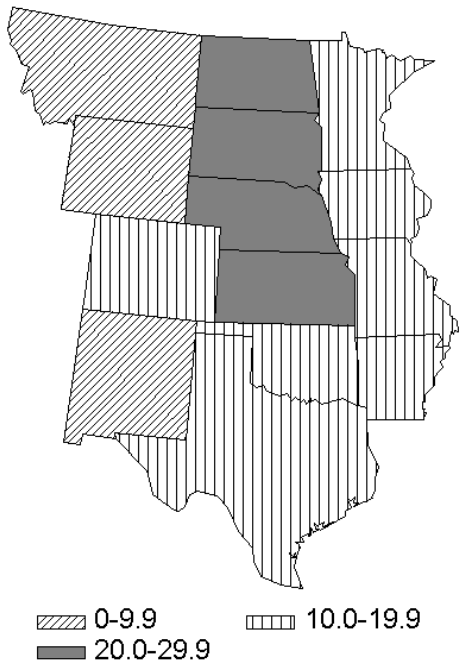

Fig. 7. Mean number of mourning doves heard per route by state in the Central Management Unit, 2001-2002.

2001 to 2002 Population Changes.--The average number of doves heard per route in the Unit did not change significantly between the 2 years (+3.7%; Table 1). The 2002 index for the Unit of 21.4 doves heard per route is only slightly below the predicted long-term trend estimate of 22.1 (Fig. 8, Table 2).

The population increased significantly in Minnesota and Wyoming (Table 1). No significant changes were found for the other states in the Unit.

Population Trends: 10 and 37-year.--A significant decline in doves heard was indicated for the Unit over both time periods (Table 1). Trends for doves seen were not significant for either time period.

State trends over 10 years are illustrated in Fig. 9 and Table 1. Montana showed an increase while Arkansas, Missouri, Nebraska, and Texas had declines during this time. Fig. 10 portrays trends over 37 years. No significant upward trend was found in doves heard for any state, but a significant downward trend was found in Missouri and Wyoming (Table 1).

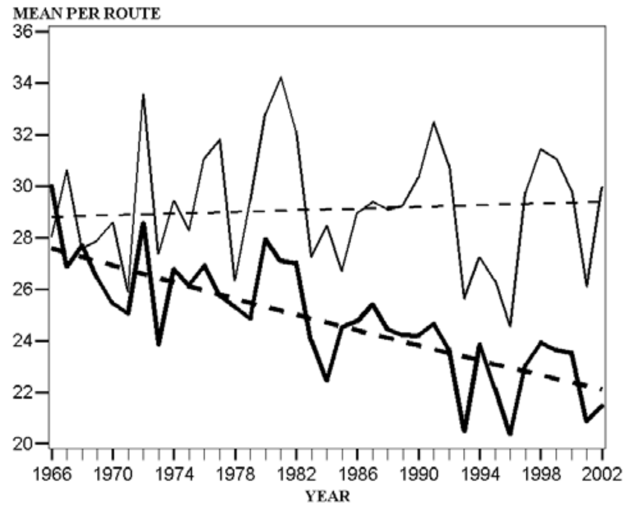

Fig. 8. Population indices and trends of breeding mourning doves in the Central Management Unit, 1966-2002. Heavy solid line = doves heard; light solid line = doves seen. Heavy and light dashed lines = predicted trends.

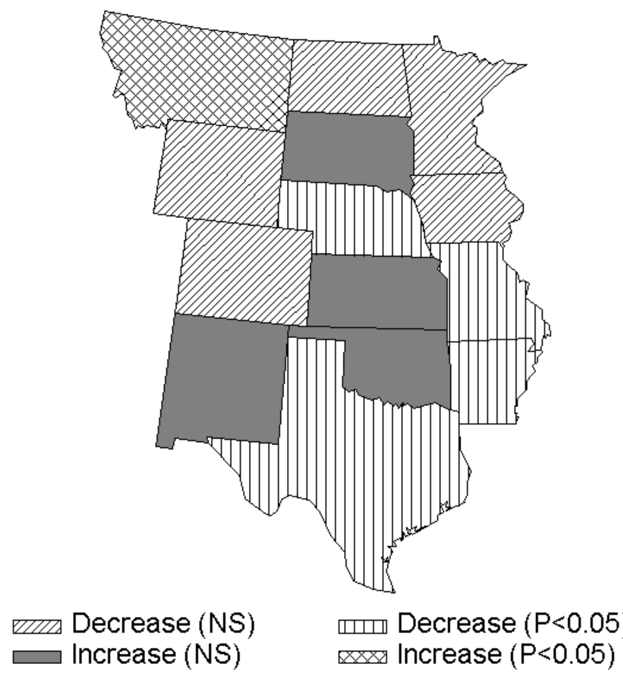

Fig. 9. Trends in number of mournig doves heard per route by state in the Central Management Unit, 1993-2002.

Western Management Unit

Seven states comprise the Western Management Unit and represent 24% of the land area in the United States. All states within the unit permit mourning dove hunting.

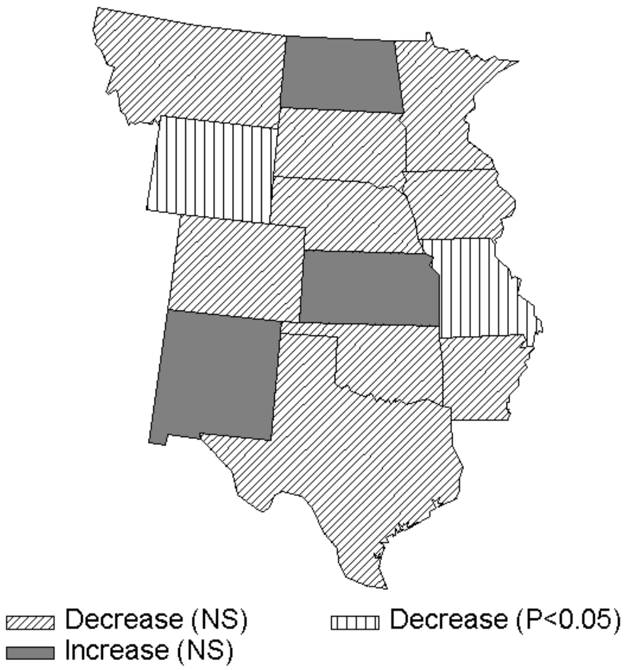

Fig. 10. Trends in mourning doves heard per route by state in the Central Management Unit, 1966-2002.

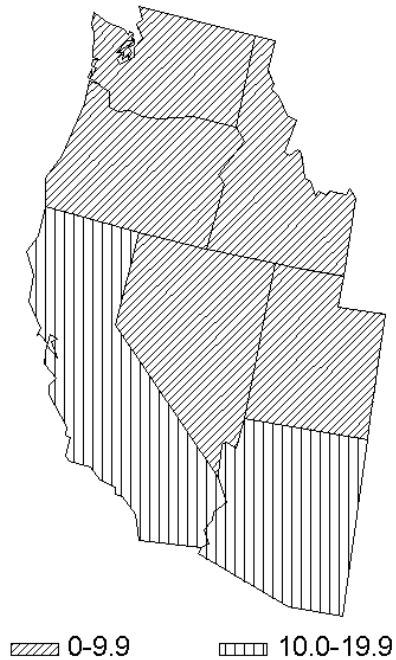

Fig. 11. Mean number of mourning doves heard per route by state in the Western Management Unit, 2001-2002.

2001-2002 Population Distribution.–Arizona and California averaged 13 and 11 actual doves heard per route, respectively (Fig. 11). The other states in the Unit averaged < 10 birds per route.

2001 to 2002 Population Changes.--The average number of doves heard per route increased significantly between years with the index increasing by 14.0% (Table 1). The 2002 population index of 10.3 doves heard per route is above the predicted count of 8.3 based on the long-term estimate (Fig. 12, Table 2).

The number of doves heard per route increased significantly in California (Table 1). No significant differences were found in other states.

Population Trends: 10 and 37-year.--A significant decline in numbers of doves heard was indicated for both time periods (Table 1). Analyses of doves seen also indicated a significant decline for the long-term periods, but no trend over 10 years.

Trends by state are illustrated in Figs. 13 and 14, and Table 1. Arizona shows a decline over 10 years while all states in the Unit have a decline between 1966 and 2002.

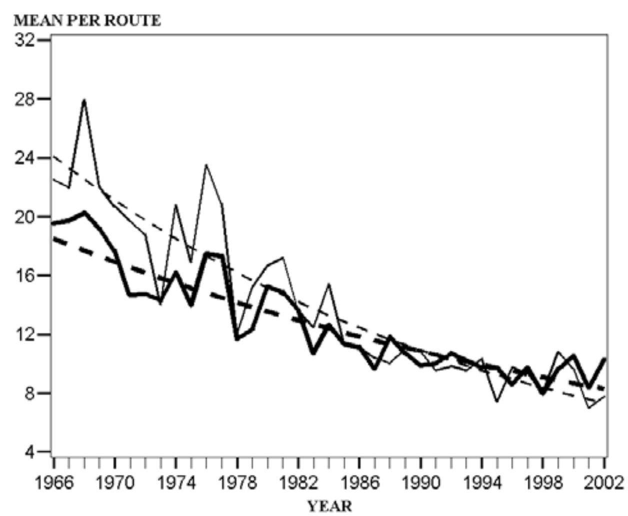

Fig. 12. Population idices and trends of breeding mourning doves in the Western Management Unit, 1966-2002. Heavy solid line = doves heard; light solid line = doves seen. Light and heavy dashed lines = predicted trends.

Breeding Bird Survey Results

There has been considerable discussion about utilizing the North American Breeding Bird Survey (BBS) as a measure of mourning dove abundance. Consequently,

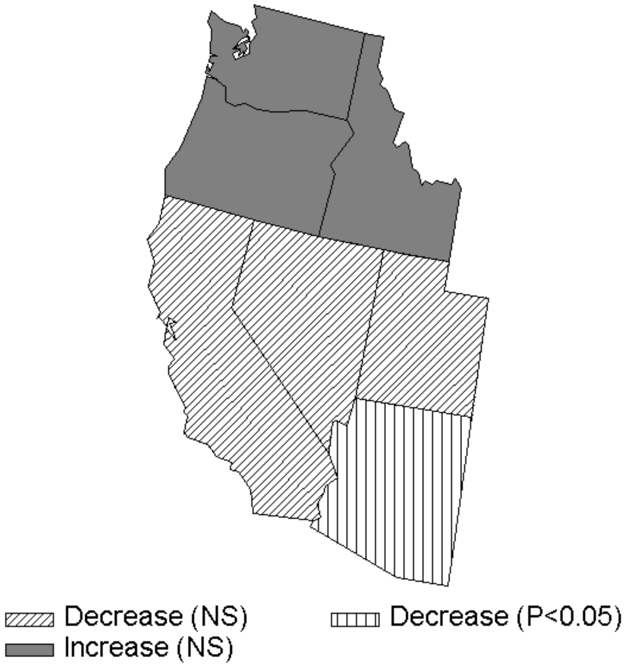

Fig. 13. Trends in number of mourning doves heard per route by state in the Western Management Unit, 1993-2002.

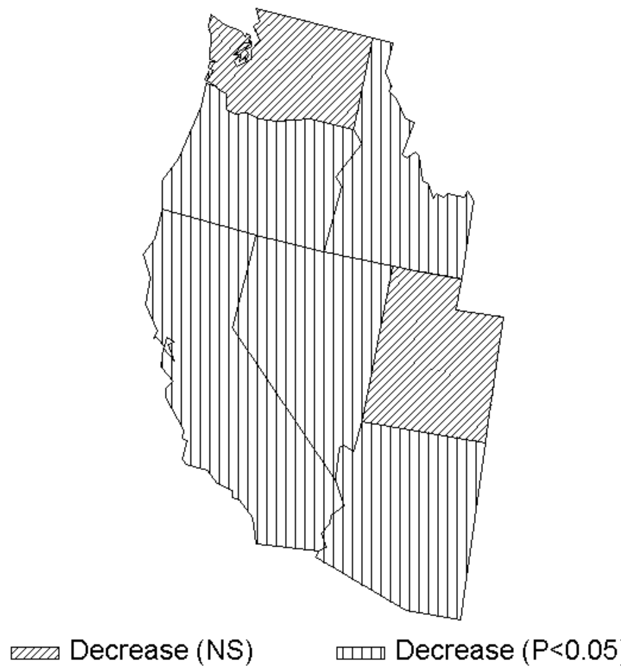

Fig. 14. Trends in number of mourning doves heard per route by state in the Western Management Unit, 1966-2002.

we are including trend information in this report to enable readers to compare BBS results with the Mourning Dove Call-count Survey (CCS) results from last year's mourning dove status report (Dolton et al. 2001). Sauer et al. (1994) discussed the differences in the methodology of the 2 surveys. The BBS is based on 50-stop routes that are surveyed in June. Also with the BBS, data for doves heard and seen are combined for analyses while those data are analyzed separately with the CCS. Unfortunately, BBS data are not available in time for use in regulations development during the year of the survey. Trends calculated from BBS data for the 10-year period (1992-2001) and over 36 years (1966-2001) are presented in Table 3.

In general, trends indicated by the BBS tend to indicate fewer declines. The major differences occur in the Eastern Unit. This is likely due to the larger sample size of BBS survey routes and greater consistency of coverage by BBS routes in the Unit (Sauer et al. 1994), although additional analyses are needed to clarify some differences in results between surveys within states.

For the 10-year period, 1992-01 the CCS indicated a significant decline (P<0.01) in doves heard for the combined hunting sates in the EMU while the BBS showed no trend (*P*<0.10). For the nonhunting states, the CCS showed no trend (P>0.10) while the BBS showed a significant decline (P<0.01). For the ENU as a whole, there was a significant decline (P<0.01) with the CCS while the BBS showed no trend (P>0.10). For the CMU, the CCS showed a significant decline (*P*<0.01) while the BBS showed no trend (*P*>0.10). In the WMU, the CCS indicated a significant decline (*P*<0.01) while the BBS showed no trend (*P*>0.10).

Over 36 years, results were very similar with both surveys for the Central and Western Management Units with both surveys indicating significant declines (BBS: *P*<0.01 for both Units; CCS: *P*<0.05 for CMU, *P*<0.01 for WMU). In the Eastern Unit, CCS analyses indicated a tendency toward a decline (*P*<0.10) over the period. In contrast, the BBS showed an increase (*P*<0.01). The combined hunting states in the EMU showed a decline (*P*<0.01) with the CCS, while there was no trend indicated with the BBS (*P*>0.10). The nonhunting states of the EMU were different also. The CCS showed no trend (*P*>0.10), but BBS data indicated a significant increase (*P*<0.01).

HARVEST ESTIMATES

State Surveys

In past years, a compilation of nonuniform, periodic state harvest surveys has been used to obtain rough estimates of the number of mourning doves killed and the number of dove hunters. These figures have been summarized by Sadler (1993). In general, mourning dove harvest in the EMU was relatively constant from 1966-87, with between 27.5 and 28.5 million birds taken. The latest estimate, a 1989 survey, indicated harvest had dropped to about 26.4 million birds shot by an estimated 1.3 million hunters. In the CMU, although hunting pressure and harvest varied widely among states, dove harvest in the Unit generally increased between 1966-87 to an annual average of about 13.5 million birds. In 1989, almost 11 million doves were taken by about 747,000 hunters. Dove harvest in the WMU has declined significantly over the years following a decline in the breeding population. In the early 1970's, about 7.3 million doves were taken by an estimated 450,000 hunters. By 1989, the harvest had dropped to about 4 million birds shot by approximately 285,000 hunters.

In summary, it appears that the dove harvest throughout the United States is on the decrease. However, the mourning dove remains an extremely important game bird, as more doves are harvested than all other migratory game birds combined. A 1991 survey indicated that doves provided about 9.5 million days of hunting recreation for 1.9 million people (U.S. Department of the Interior, Fish and Wildlife Service and U.S. Department of Commerce, Bureau of the Census 1993). A survey conducted in 1996 estimated that doves were hunted about 8.1 million days by 1.6 million people (U.S. Department of the Interior, Fish and Wildlife Service and U.S. Department of Commerce, Bureau of the Census 1997).

Harvest Information Program (HIP)

Wildlife professionals have long recognized that reliable harvest estimates are needed to monitor the impact of hunting. States have established harvest surveys to meet their individual needs for game species, and a federal waterfowl harvest survey has been conducted since 1952. However, there are serious problems with using either current state or federal harvest surveys to monitor the national or regional harvests of mourning doves and other non-waterfowl migratory game birds, especially on an annual basis. The federal waterfowl hunter survey system of obtaining names and addresses of duck stamp buyers is inadequate because non-waterfowl hunters are excluded. More than half the nation's migratory game bird hunters do not hunt waterfowl, thus, they cannot be sampled by that survey. Attempts to use state harvest surveys to obtain coordinated national and regional estimates have been unsuccessful because sample frames and survey methodogies vary widely among states.
To remedy these problems, state wildlife agencies and the U.S. Fish and Wildlife Service initiated the national, cooperative Harvest Information Program in 1992. This program is designed to enable the Service to conduct harvest surveys that will provide reliable annual estimates of the harvest of mourning doves and other migratort game bird species. Under the Harvest Information Program, states provide the Service with the names and addresses of all licensed migratory bird hunters each year, and the Service conducts surveys to estimate the harvest in each state.

California, Missouri, and South Dakota voluntarily participated in a 2-year pilot stage of the Harvest Information Program in 1992 and 1993, and each year since then more states have entered the program. In 1998, all states except Hawaii participated in the program.

Preliminary results of the total estimated harvest for the 2000-01 season by management unit and for the U.S. are as follows: Eastern: 10,292,200 " 8%; Central: 13,102,800 " 6%; Western: 2,024,500 " 9%; and, U.S.: 25,419,500 " 5%. It is important to note that these estimates do not necessary indicate that the harvest has declined. They cannot be compared directly with earlier estimates since they are based on a different sampling scheme. The reliability of these estimates depends primarily upon the quality of the sample frame provided by each participating state. If a state's sample frame does not include all migratory bird hunters in that state, the survey results underestimate hunter activity and harvest for the state. Beginning next year, we expect to have the past year's harvest survey results available in time for this report.

The Harvest Surveys Section is continuing to work with states to improve the accuracy and precision of the harvest estimates.. In the future, results will be presented by state within dove management unit.

ACKNOWLEDGMENTS

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LITERATURE CITED

Aldrich, J.W. 1993. Classification and distribution. Pages 47-54 *in* T.S. Baskett, M.W. Sayre, R.E. Tomlinson, and R.E. Mirarchi, eds., Ecology and management of the mourning dove. Stackpole Books, Harrisburg, PA.

Dolton, D.D. 1993. The call-count survey: historic development and current procedures. Pages 233-252 *in* T.S. Baskett, M.W. Sayre, R.E. Tomlinson, and R.E. Mirarchi, eds., Ecology and management of the mourning dove. Stackpole Books, Harrisburg, PA.

Dolton, D.D., R. D. Holmes, and G.W. Smith. 2001. Mourning dove breeding population status, 2001. U.S. Fish and Wildlife Service, Laurel, Maryland. 32pp.

Dunks, J.H., R.E. Tomlinson, H.M. Reeves, D.D. Dolton, C.E. Braun and T.P. Zapatka. 1982. Mourning dove banding analysis, Central Management Unit, 1967-77. Special Scientific Report--Wildl. No. 249. U.S. Fish and Wildlife Service, Washington, DC. 128 pp.

Sadler, K.C. 1993. Mourning dove harvest. Pages 449-458 *in* T.S.Baskett, M.W. Sayer, R.E. Tomlinson and R.E. Mirarchi, eds., Ecology and management of the mourning dove. Stackpole Books, Harrisburg, PA.

Sauer, J.R. and P.H. Geissler. 1990. Annual indices from route regression analyses. Pages 58-62 *in* J.R. Sauer and S. Droege, eds. Survey designs and statistical methods for the estimation of avian

Foote, L.E. and H.S. Peters. 1952. Pages 1-2 *in* Investigations of methods of appraising the abundance of mourning doves. U.S. Fish and Wildlife Service, Special Scientific Report--Wildlife 17.

Geissler, P.H. and J.R. Sauer. 1990. Topics in route regression analysis. Pages 54-57 *in* J.R. Sauer and S. Droege, eds. Survey designs and statistical methods for the estimation of avian population trends. U.S. Fish and Wildlife Service, Biological Reptort 90(1).

Kiel, W.H. 1959. Mourning dove management units, a progress report. U.S. Fish and Wildlife Service, Special Scientific Report--Wildlife 42.

____. 1961. The mourning dove program for the future. Transactions of the North American Wildlife and Natural Resources Conference 26:418-435.

Link, W.A. and J.R. Sauer. 1994. Estimating equations estimates of trends. Bird Populations 2:23-32.

McClure, H.E. 1939. Cooing activity and censusing of the mourning dove. Journal of Wildlife Management 3:323-328.

Mirarchi, R.E. and T.S. Baskett. 1994. Mourning dove (*Zenaida macroura*). *In* A. Poole and F. Gill, eds., The birds of North America, No. 117. The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, D.C. 32 pp.

Peterjohn, B.G., J.R. Sauer and W.A. Link. 1994. The 1992 and 1993 summary of the North American breeding bird survey. Bird Populations 2:46-61.

population trends. U.S. Fish and Wildlife Service, Biological Report. 90(1).

Sauer, J.R., D.D. Dolton, and S. Droege. 1994.Mourning dove population trend estimates from Call-count and North American Breeding Bird Surveys. Journal of Wildlife Management. 58(3):506-515.

Tomlinson, R.E., D.D. Dolton, H.M. Reeves, J.D.

Nichols and L.A. McKibben. 1988. Migration, harvest, and population characteristics of mourning doves banded in the Western Management Unit; 1964-1977. Fish and Wildlife Technical. Report 13, U.S. Fish and Wildlife Service, Washington, DC. 101pp.

U.S. Department of Commerce and U.S. Department of Agriculture. 2000a. Weekly weather and crop bulletin. Vol. 87, No. 21. NOAA/USDA Joint Agricultural Weather Facility, Washington, D.C.

U.S. Department of Commerce and U.S. Department of Agriculture. 2000b. Weekly weather and crop bulletin. Vol. 87, No. 22. NOAA/USDA Joint Agricultural Weather Facility, Washington, D.C.

U. S. Department of the Interior, Fish and Wildlife Service and U.S. Department of Commerce, Bureau of the Census. 1993. 1991 National survey of fishing, hunting, and wildlife-associated recreation. U.S. Government Printing Office, Washington, DC. 124 pp.

U. S. Department of the Interior, Fish and Wildlife Service and U.S. Department of Commerce, Bureau of the Census. 1997. 1996 National survey of fishing, hunting, and wildlife-associated recreation. U.S. Government Printing Office, Washington, DC. 115 pp.

Table 1.Trends (% change[a] per year as determined by linear regression) in number of mourning doves heard along call-count survey routes, 1966-2002.

	2 year (2001-2002)					10 year (1993-2002)					37 year (1966-2002)				
	N	% Change		90% CI		N	% Change		90% CI		N	% Change		90% CI	
EASTERN UNIT															
															Hunt
AL	25	1.7		-16.0	19.5	4	-1.5		-3.2	0.3	4	-0.5		-1.4	0.3
DE/MD	13	-25.6	**	-46.7	-4.5	4	-0.5		-3.0	1.9	4	-1.7	**	-2.9	-0.5
FL	19	18.2		-1.1	37.4	3	-1.3		-3.4	0.8	3	0.1		-0.8	1.0
GA	18	-2.9		-24.8	19.0	5	-2.7	*	-5.2	-0.2	5	-0.9	**	-1.6	-0.2
IL	16	-8.5		-19.9	2.8	2	-1.2		-4.2	1.7	2	0.4		-0.9	1.7
IN	11	-5.5		-17.7	6.6	3	-3.3	***	-5.3	-1.3	3	-1.6	***	-2.5	-0.7
KY	14	1.6		-21.1	24.4	5	1.2		-0.7	3.0	5	-0.5		-1.8	0.8
LA	19	-13.6		-32.6	5.4	3	2.0		-0.2	4.2	3	1.1	*	0.1	2.1
MS	18	-19.5	**	-34.7	-4.4	2	-4.4	**	-7.6	-1.1	2	-1.7		-3.5	0.0
NC	20	-4.2		-13.3	4.8	5	2.0	***	0.8	3.1	5	0.2		-0.8	1.2
OH[c]	36	16.5		-2.0	35.0	5	-0.7		-3.4	2.0	5	-1.0	***	-1.6	-0.5
PA	6	-0.9		-15.0	13.1	5	1.8		-1.2	4.8	5	1.1		-0.6	2.8
SC	16	-2.4		-16.6	11.9	4	-1.0		-2.8	0.8	4	-1.1	*	-2.2	-0.1
TN	16	-1.6		-9.9	6.7	7	-3.6	**	-5.9	-1.3	7	-1.7	***	-2.7	-0.6
VA	19	-2.1		-30.4	26.1	7	0.9		-0.9	2.7	7	-2.1		-4.3	0.1
WV	8	-13.4		-40.2	13.5	3	-0.6		-3.6	2.4	3	1.6		-0.2	3.5
Subunit	274	-2.6		-7.2	2.1	67	-1.2	**	-1.9	-0.4	67	-0.6	**	-1.1	-0.2
															Nonhunt
MI	14	49.1	***	29.1	69.2	2	2.0		-0.4	4.4	2	0.4		-0.9	1.8
N.England[d]	32	27.2	**	9.4	45.0	6	-0.9		-2.4	0.6	6	1.8	***	1.0	2.7
NJ	10	5.0		-14.9	24.9	4	-4.3		-12.3	3.8	4	-1.9		-5.0	1.13
NY	11	17.8		-13.5	49.0	6	5.2	***	2.8	7.6	6	1.7		-0.4	3.8
WI	15	-7.0		-17.7	3.6	4	1.7		-1.3	4.7	4	0.3		-0.9	1.5
Subunit	82	26.5	***	17.2	35.7	22	1.4	*	0.2	2.7	22	0.7		-0.1	1.4
Unit	356	2.1		-2.2	6.4	89	-0.7		-1.3	0.0	89	-0.4	**	-0.8	-0.1
CENTRAL UNIT															
AR	13	-6.4		-38.1	25.3	6	-3.5	***	-5.6	-1.4	6	-0.8		-2.1	0.4
CO	12	-4.0		-23.6	15.5	7	-0.6		-3.5	2.4	7	-0.6		-1.5	0.4
IA	9	-4.3		-30.5	21.9	2	-2.2		-5.4	1.0	2	-0.2		-0.8	0.4
KS	19	4.1		-15.8	23.9	4	1.9		-2.2	6.1	4	0.1		-0.6	0.8
MN	7	71.8	**	19.1	124.5	4	-3.5	*	-7.0	0.0	4	-1.3		-3.0	0.3
MO	13	2.2		-26.6	30.9	4	-5.7	***	-7.8	-3.6	4	-2.3	***	-3.5	-1.1
MT	12	44.6		-12.6	101.7	4	5.6	***	2.8	8.3	4	-1.7		-3.6	0.1
NE	18	-7.2		-21.6	7.2	4	-2.3	**	-3.9	-0.7	4	-0.9	*	-1.6	-0.1
NM	16	-16.4		-42.4	9.7	8	0.8		-2.0	3.5	8	0.7		-0.5	1.9
ND	15	-3.1		-20.2	14.0	3	-0.7		-2.5	1.1	3	0.3		-1.2	1.8
OK	16	-6.2		-29.4	17.0	5	0.2		-2.7	3.1	5	-1.1		-3.6	1.5
SD	11	5.7		-6.7	18.1	5	1.3		-2.4	5.0	5	-0.5		-2.0	0.9
TX	111	4.9		-4.8	14.6	8	-1.5	**	-2.7	-0.3	9	-0.4		-1.1	0.3
WY	9	33.4	*	2.4	64.5	5	-3.7		-8.0	0.7	5	-3.3	**	-5.9	-0.7
Unit	281	3.7		-2.3	9.7	69	-1.1	**	-1.9	-0.3	70	-0.6	***	-1.0	-0.3
WESTERN UNIT															
AZ	26	-14.2		-29.7	1.3	6	-3.4	***	-5.1	-1.7	6	-1.1	***	-1.8	-0.4
CA	47	24.1	***	9.2	39.1	9	-0.8		-2.1	0.5	9	-2.5	***	-3.6	-1.5
ID	13	55.9		-35.1	147.0	6	0.2		-4.5	5.0	6	-2.9	**	-5.1	-0.8
NV	15	50.0		-6.3	106.4	2	-0.1		-4.7	4.4	2	-4.9	***	-6.6	-3.2
OR	10	36.1		-5.3	77.5	8	0.7		-3.1	4.5	8	-2.6	**	-4.8	-0.5
UT	7	77.0		-43.0	196.9	5	-2.4		-5.9	1.1	5	-3.8	*	-7.0	-0.6
WA	18	6.7		-19.1	32.5	6	0.2		-4.4	4.7	6	-2.3	*	-4.2	-0.3
Unit	136	14.0	*	2.2	25.8	42	-1.8	***	-2.9	-0.8	42	-2.2	***	-2.8	-1.6

[a] Mean of route trends weighted by land area and population density. The estimated count in the next year is (%/100+1) times the count in the current year where % is the annual change. Note: Extrapolating the estimated trend statistic (% change per year) over time (e.g., 37 years) may exaggerate the total change over the period.

[b] *P<0.1; **P<0.05; ***P<0.01.

[c] Ohio became a hunting state in 1995.

[d] New England consists of CT, ME, MA, NH, RI, and VT.

Table 2. Breeding population indices[a] based on mourning doves heard along Call-count routes, 1966-2002.

Management unit/state	1966	1967	1968	1969	1970	1971	1972	1973	1974
EASTERN UNIT									
Hunt									
AL	26.1	23.3	21.0	21.3	21.6	17.7	25.4	22.2	16.9
DE/MD	16.8	20.5	14.4	15.2	18.8	16.0	17.4	17.2	18.2
FL	11.8	11.3	9.6	10.2	13.0	11.0	11.2	11.4	13.7
GA	29.8	27.9	24.0	25.7	32.4	25.6	24.4	26.8	27.8
IL	23.0	19.8	23.6	20.4	23.6	21.6	22.2	21.8	18.4
IN	37.8	34.8	34.2	33.1	31.9	43.0	37.6	33.6	32.0
KY	24.1	21.8	21.2	22.2	26.7	23.9	20.1	23.9	27.6
LA	10.5	10.7	10.0	11.7	7.9	10.5	11.6	9.0	10.5
MS	40.4	34.7	29.4	27.3	30.0	30.6	34.0	30.5	24.5
NC	33.7	27.3	28.8	41.3	47.7	27.8	22.5	42.9	24.5
OH[c]	24.3	22.9	20.7	23.5	23.3	24.1	25.1	20.0	24.3
PA	8.7	9.3	8.6	8.3	5.4	6.3	8.8	5.8	8.5
SC	31.7	34.7	35.3	34.1	32.1	28.1	25.0	28.5	26.5
TN	32.5	23.7	24.3	24.1	32.7	23.0	29.2	22.2	23.6
VA	26.5	22.0	25.0	22.1	28.3	22.7	13.6	16.0	21.8
WV	6.3	5.3	5.4	5.9	5.5	5.0	6.6	3.9	4.1
Subunit	23.7	21.7	20.7	21.2	22.1	20.3	20.9	19.8	20.1
Nonhunt									
MI	13.1	14.2	9.4	9.6	7.8	15.4	16.0	12.8	10.8
N.England[b]	5.7	6.1	5.6	4.8	5.7	6.0	6.7	7.8	5.0
NJ	19.5	16.6	20.6	19.0	25.6	24.2	25.5	22.5	22.0
NY	6.5	6.5	6.1	6.1	7.5	8.7	6.9	7.2	7.4
WI	10.7	13.8	13.8	10.6	11.4	16.5	17.3	11.3	12.0
Subunit	9.5	10.6	9.2	8.3	8.6	12.1	12.3	10.4	9.4
Unit	20.0	19.1	17.8	17.7	18.5	18.7	19.1	17.6	17.4
CENTRAL UNIT									
AR	22.4	23.4	22.5	21.6	23.4	23.5	22.0	24.8	22.8
CO	22.8	22.5	20.6	28.1	28.1	20.4	26.1	16.2	25.9
IA	32.4	29.1	31.2	28.1	20.3	25.0	33.0	31.1	24.7
KS	46.0	46.4	48.1	48.8	45.0	45.9	51.3	45.7	45.4
MN	29.5	23.8	25.6	19.0	15.2	21.9	25.2	19.1	26.3
MO	41.0	38.7	48.4	29.1	40.1	33.6	45.5	34.1	29.1
MT	27.9	25.9	20.3	22.5	18.0	25.5	20.4	14.6	17.0
NE	45.5	39.9	50.8	49.7	48.1	45.6	43.9	42.1	43.5
NM	15.0	11.1	15.5	11.9	11.6	10.9	12.6	9.0	11.0
ND	37.3	36.0	49.1	40.9	36.4	37.6	38.9	43.1	42.2
OK	24.2	29.9	35.2	35.4	26.6	19.2	30.6	28.7	29.8
SD	51.8	32.5	44.4	37.8	45.1	39.9	39.6	41.8	50.1
TX	26.5	21.9	21.6	19.6	20.8	20.1	26.9	21.6	23.1
WY	22.9	24.1	12.5	20.2	19.3	10.8	14.6	14.5	20.8
Unit	30.0	26.9	27.7	26.4	25.5	25.1	28.6	23.9	26.8
WESTERN UNIT									
AZ	29.6	29.8	26.3	31.6	31.6	21.4	23.9	28.9	24.9
CA	27.7	26.2	24.2	23.8	23.2	17.4	21.2	20.3	22.0
ID	18.1	18.6	16.7	17.4	16.2	12.7	12.2	14.8	12.4
NV	11.8	10.6	25.3	17.1	12.4	7.4	10.0	6.9	9.3
OR	16.1	10.7	12.7	11.5	8.7	7.6	7.5	7.4	12.9
UT	22.1	33.7	17.0	16.1	18.8	26.3	15.3	13.2	15.0
WA	11.0	16.2	15.2	12.1	12.3	14.5	10.3	9.5	11.9
Unit	19.5	19.7	20.3	19.2	17.7	14.7	14.7	14.3	16.2

[a]Annual indices are the predicted value from the trend analysis plus the deviation from the expected value in a year. Large but nonsignificant changes due to small sample sizes produce exaggerated indices over the 37-year period.
[b] New England consists of CT, ME, MA, NH, RI, and VT.
[c] Ohio became a hunting state in 1995.

Table 2. Breeding population indices[a] based on mourning doves heard along Call-count routes, 1966-2002.

Management	year								
unit/state	1975	1976	1977	1978	1979	1980	1981	1982	1983
EASTERN UNIT									
Hunt									
AL	21.6	20.8	22.9	25.2	24.2	24.2	23.3	23.7	23.9
DE/MD	13.0	15.8	14.5	15.2	14.7	14.0	13.4	14.0	9.9
FL	14.3	13.2	14.5	11.4	12.3	9.9	9.0	10.5	12.2
GA	30.2	23.8	24.8	27.3	23.8	24.3	26.9	28.9	25.8
IL	25.6	25.2	26.9	20.7	18.0	18.4	20.7	25.3	26.0
IN	33.7	33.8	37.6	20.4	21.6	27.4	31.5	22.2	19.1
KY	19.5	24.4	22.9	24.4	16.7	16.3	27.6	23.8	13.2
LA	11.0	11.1	9.1	10.7	9.1	12.7	10.8	13.6	12.5
MS	26.0	26.4	27.2	30.7	26.3	24.8	24.8	31.2	26.2
NC	13.8	16.7	45.4	24.3	28.8	27.9	27.5	23.1	27.3
OH[c]	37.2	27.1	25.9	13.8	13.4	16.0	19.4	18.5	19.7
PA	5.9	6.0	4.9	6.1	6.7	8.0	9.5	9.1	9.0
SC	26.3	26.0	22.1	29.2	24.8	31.2	30.3	31.3	29.8
TN	22.6	22.3	24.4	30.1	20.6	22.3	18.8	25.1	19.5
VA	24.4	23.3	31.1	23.0	20.3	19.7	17.0	18.7	18.5
WV	2.4	6.0	5.7	6.4	7.2	8.4	6.7	6.4	6.1
Subunit	19.9	20.1	21.3	19.6	18.0	19.2	19.6	20.6	19.2
Nonhunt									
MI	12.2	12.3	10.4	12.0	7.0	13.0	14.8	10.8	9.6
N.England[b]	4.8	4.5	8.4	7.2	6.1	7.5	9.1	7.5	8.0
NJ	15.8	19.9	21.7	17.2	18.4	17.1	14.1	16.0	19.1
NY	13.1	7.7	7.7	9.3	6.3	11.1	9.5	10.1	9.4
WI	15.1	15.1	19.7	8.0	11.6	15.0	20.2	11.1	13.1
Subunit	11.5	10.3	11.7	9.5	8.0	12.0	13.6	10.4	10.5
Unit	18.1	17.7	19.0	17.0	15.3	17.6	18.4	17.9	17.0
CENTRAL UNIT									
AR	21.9	26.7	21.7	15.3	12.5	20.7	22.6	26.2	19.7
CO	19.0	26.9	25.0	27.6	23.0	26.7	30.2	29.3	16.2
IA	22.9	28.2	21.9	24.6	20.9	28.3	31.1	22.5	16.0
KS	43.6	48.0	45.6	35.7	52.4	56.9	54.5	51.9	58.6
MN	29.0	25.2	29.2	28.1	28.6	31.1	27.4	24.1	21.3
MO	34.0	30.0	34.7	22.2	21.1	32.8	27.5	24.2	23.4
MT	23.2	16.9	20.6	19.8	19.8	18.1	16.9	21.7	17.4
NE	41.0	46.2	46.8	38.5	41.4	52.7	50.0	48.9	44.5
NM	13.6	13.3	11.9	11.9	8.1	13.1	13.0	10.2	13.7
ND	30.9	49.8	41.3	44.2	41.5	47.1	47.4	44.5	42.9
OK	26.8	28.5	35.9	27.4	26.4	27.1	26.8	27.8	28.6
SD	42.4	45.5	40.0	43.2	42.4	42.5	38.3	45.6	39.5
TX	20.9	20.4	19.5	20.3	25.1	24.0	21.8	21.1	19.6
WY	18.3	16.9	10.7	16.9	12.8	11.6	12.7	16.3	10.9
Unit	26.2	26.9	25.8	25.3	24.9	27.9	27.1	27.0	24.0
WESTERN UNIT									
AZ	27.4	28.3	25.3	25.4	24.8	22.1	24.9	28.5	22.1
CA	18.5	22.2	17.0	15.3	11.8	20.0	16.6	20.5	12.7
ID	8.5	15.7	19.2	10.5	10.1	10.6	11.6	11.9	9.1
NV	5.8	9.3	9.6	5.7	8.2	11.6	8.4	4.6	4.1
OR	9.6	10.1	11.3	6.0	6.1	9.2	7.8	7.6	5.8
UT	16.1	18.6	21.8	9.6	11.9	14.3	18.9	11.4	11.4
WA	12.8	12.4	13.4	8.7	12.2	8.3	10.0	9.3	7.9
Unit	14.0	17.5	17.4	11.7	12.4	15.3	14.9	13.7	10.7

[a]Annual indices are the predicted value from the trend analysis plus the deviation from the expected value in a year. Large but nonsignificant changes due to small sample sizes produce exaggerated indices over the 37-year period.
[b] New England consists of CT, ME, MA, NH, RI, and VT.
[c] Ohio became a hunting state in 1995.

Table 2. Breeding population indices[a] based on mourning doves heard along Call-count routes, 1966-2002.

Management unit/state	1984	1985	1986	1987	1988	1989	1990	1991	1992
EASTERN UNIT									
Hunt									
AL	20.0	25.5	23.2	20.7	22.8	19.5	18.4	17.2	19.7
DE/MD	11.3	12.4	14.8	12.8	11.9	16.4	7.9	12.1	15.5
FL	8.4	10.8	12.7	11.4	13.8	12.5	11.3	12.2	12.5
GA	20.9	26.9	24.0	25.1	25.3	25.7	26.5	22.0	30.9
IL	21.1	18.2	25.1	24.6	27.7	27.4	26.7	27.0	28.0
IN	20.8	18.3	24.2	24.4	29.3	24.8	27.0	27.3	24.1
KY	21.2	22.0	19.8	24.3	19.4	26.5	22.1	21.0	16.7
LA	12.0	10.8	9.9	14.0	10.5	16.3	11.6	11.9	15.8
MS	19.4	25.7	25.2	22.4	26.5	24.8	21.0	17.4	22.6
NC	30.7	21.3	29.9	29.1	26.9	31.8	29.3	24.9	24.2
OH[c]	18.3	17.1	16.7	18.2	20.9	19.6	18.0	19.3	20.3
PA	8.3	9.1	9.7	11.0	7.4	9.6	9.6	9.8	10.9
SC	27.0	27.1	22.8	33.6	26.6	25.5	27.6	22.4	22.0
TN	16.6	21.4	16.2	20.0	19.6	17.8	15.6	18.8	18.4
VA	18.1	16.8	13.6	14.3	15.6	15.2	13.0	13.7	12.1
WV	5.4	6.7	6.3	6.7	7.7	8.2	10.9	9.2	7.4
Subunit	17.5	18.6	18.7	19.8	19.7	20.4	18.8	18.3	19.4
Nonhunt									
MI	10.3	11.3	14.5	11.8	14.3	17.9	13.5	11.1	12.9
N.England[b]	6.9	7.6	8.3	7.9	7.4	7.8	8.8	9.6	10.2
NJ	12.0	12.4	14.6	13.4	13.0	15.9	12.7	15.3	9.9
NY	9.2	8.4	7.1	9.4	7.5	11.7	10.2	12.8	10.9
WI	10.2	10.5	11.4	7.5	17.6	17.7	14.1	12.8	19.5
Subunit	9.5	9.8	10.6	9.3	11.6	13.8	11.8	11.7	13.2
Unit	15.4	16.3	16.6	16.8	17.7	18.9	17.1	16.7	18.0
CENTRAL UNIT									
AR	14.0	13.9	15.0	14.0	15.5	21.8	17.0	15.3	18.5
CO	20.3	24.2	23.2	24.9	27.1	30.5	27.5	18.2	13.7
IA	23.4	25.9	23.4	22.5	30.3	27.2	31.3	23.1	30.9
KS	46.4	60.1	41.4	45.1	52.2	45.8	39.9	57.4	55.9
MN	18.2	19.8	18.2	23.4	23.8	18.8	15.5	19.2	22.3
MO	22.2	21.2	22.0	24.7	24.8	24.2	19.6	21.3	22.0
MT	13.2	18.2	19.0	18.2	15.0	19.1	20.8	13.8	14.7
NE	42.4	43.6	36.4	36.0	36.0	40.0	39.8	40.6	38.1
NM	14.7	12.6	15.1	18.2	13.6	15.2	16.6	15.3	10.1
ND	33.6	44.0	40.9	47.0	44.4	46.7	45.3	50.4	54.1
OK	21.2	20.7	22.9	24.7	22.0	16.3	21.4	21.4	22.8
SD	44.0	41.3	38.4	33.6	39.9	43.0	44.7	47.0	38.1
TX	19.2	19.9	21.5	21.2	21.8	16.7	17.7	24.6	22.5
WY	9.9	11.3	13.8	11.1	7.2	8.5	8.5	9.0	9.3
Unit	22.5	24.5	24.8	25.4	24.4	24.2	24.2	24.6	23.7
WESTERN UNIT									
AZ	27.1	21.9	25.9	17.4	19.5	23.7	18.4	23.1	24.8
CA	17.6	12.5	14.4	11.0	14.8	10.9	10.9	10.7	11.6
ID	10.6	9.7	6.9	7.0	9.1	9.0	9.7	8.9	8.2
NV	4.1	5.1	3.4	3.9	5.3	4.6	3.2	4.2	3.5
OR	7.3	8.0	6.4	5.8	7.3	5.9	6.7	4.2	6.6
UT	12.8	8.4	11.7	10.2	10.5	11.0	9.4	8.5	10.9
WA	6.9	8.7	10.4	8.2	8.3	7.1	7.4	9.3	8.2
Unit	12.6	11.4	11.2	9.7	11.8	10.7	9.9	10.0	10.7

[a]Annual indices are the predicted value from the trend analysis plus the deviation from the expected value in a year. Large but nonsignificant changes due to small sample sizes produce exaggerated indices over the 37-year period.
[b] New England consists of CT, ME, MA, NH, RI, and VT.
[c] Ohio became a hunting state in 1995.

Table 2. Breeding population indices[a] based on mourning doves heard along Call-count routes, 1966-2002.

Management unit/state	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
EASTERN UNIT										
Hunt										
AL	21.5	22.3	23.5	18.3	17.1	19.0	18.2	19.5	18.6	21.2
DE/MD	10.6	12.8	11.5	10.9	9.0	12.5	9.1	8.7	8.7	7.4
FL	11.1	10.4	12.1	11.3	10.4	13.0	13.8	13.2	10.3	11.0
GA	19.1	21.9	26.1	22.0	19.0	18.2	18.4	16.5	22.7	12.7
IL	24.6	27.5	28.3	22.3	22.6	22.7	20.9	27.4	22.9	24.2
IN	25.4	30.2	24.5	20.9	20.7	20.9	21.8	23.4	20.7	18.8
KY	21.5	20.7	20.3	17.5	16.4	21.2	21.5	22.8	18.5	22.1
LA	12.0	13.1	14.7	11.9	12.3	14.0	14.7	17.1	17.6	13.9
MS	24.7	20.9	19.0	17.9	17.1	17.4	20.9	18.1	16.5	13.3
NC	25.1	25.3	27.6	28.1	30.8	30.2	30.8	36.4	40.5	34.1
OH[c]	17.3	19.2	17.5	14.1	14.1	16.5	17.1	18.3	14.9	17.2
PA	12.0	11.6	11.1	10.8	9.9	11.8	9.7	11.4	10.6	10.1
SC	25.9	23.6	18.9	23.7	22.6	25.6	23.1	21.6	22.9	19.8
TN	16.1	19.8	18.3	15.6	16.7	16.1	16.3	18.1	14.2	14.5
VA	13.6	13.4	14.4	11.5	14.6	13.7	14.0	15.2	12.0	14.0
WV	8.6	9.4	9.6	4.8	10.1	8.5	9.9	9.4	6.5	9.2
Subunit	18.5	19.2	19.3	16.7	16.8	18.0	18.0	19.0	17.4	16.5
Nonhunt										
MI	11.9	11.3	12.6	12.9	12.5	14.3	14.3	17.0	14.2	13.6
N.England[b]	10.7	9.7	12.2	8.4	8.5	9.2	10.6	11.0	9.2	11.9
NJ	15.9	13.8	10.2	13.2	7.1	11.7	9.4	12.6	6.5	11.2
NY	9.7	9.8	10.9	10.2	11.1	9.6	12.8	14.4	12.2	13.2
WI	18.1	15.3	12.9	11.6	12.2	9.8	18.2	16.3	16.1	14.3
Subunit	12.7	11.7	12.1	10.9	10.9	10.8	13.8	14.7	12.7	13.3
Unit	17.2	17.3	17.5	15.3	15.3	16.1	17.1	18.1	16.2	15.8
CENTRAL UNIT										
AR	17.1	20.4	18.9	19.2	20.2	20.0	18.2	17.9	18.7	14.6
CO	13.3	23.0	19.3	14.5	19.6	21.2	22.2	22.4	18.9	19.1
IA	23.0	24.2	25.8	32.6	26.9	28.8	27.8	23.9	26.1	22.9
KS	37.1	51.2	58.7	32.2	59.1	53.5	65.3	50.3	42.5	46.2
MN	16.2	19.8	19.1	18.4	19.5	18.2	16.3	16.9	12.7	19.4
MO	21.3	25.4	22.0	21.6	21.0	18.8	17.3	18.0	15.3	16.5
MT	10.6	10.0	12.6	12.8	11.8	14.8	13.4	14.2	10.9	13.8
NE	40.1	37.2	40.7	34.1	31.5	40.0	36.5	36.8	30.9	30.8
NM	11.3	14.1	12.7	11.0	14.6	12.2	14.3	16.2	17.6	12.4
ND	47.0	40.6	42.8	44.4	39.7	35.2	47.7	47.3	45.3	39.9
OK	19.5	25.3	19.0	20.0	19.3	27.7	24.9	21.0	20.3	19.4
SD	34.4	37.6	39.3	39.5	33.5	36.1	37.9	39.8	35.6	37.5
TX	20.5	22.7	17.0	14.7	21.9	22.2	21.9	19.3	19.4	19.0
WY	6.8	8.7	6.3	7.3	7.1	7.5	5.6	7.9	4.8	6.4
Unit	20.5	23.8	22.1	20.4	23.1	23.9	23.6	23.5	20.9	21.5
WESTERN UNIT										
AZ	25.1	22.2	21.1	12.4	19.1	21.9	23.9	24.7	21.5	18.0
CA	14.2	11.8	11.6	11.6	10.2	10.2	10.9	10.0	9.7	12.1
ID	7.1	6.9	6.3	6.0	8.5	5.0	6.7	6.2	4.9	8.2
NV	2.9	2.6	4.3	3.9	3.5	3.0	3.6	2.9	2.8	3.1
OR	5.4	6.3	5.3	5.2	5.2	3.9	4.0	6.8	4.5	6.3
UT	9.1	9.4	6.1	7.1	8.9	5.2	8.3	13.6	5.6	8.3
WA	7.1	7.3	8.1	5.4	6.7	4.9	6.6	7.7	7.2	7.5
Unit	10.3	9.8	9.8	8.6	9.7	8.0	9.6	10.6	8.4	10.3

[a]Annual indices are the predicted value from the trend analysis plus the deviation from the expected value in a year.
Large but nonsignificant changes due to small sample sizes produce exaggerated indices over the 37-year period.
[b] New England consists of CT, ME, MA, NH, RI, and VT.
[c] Ohio became a hunting state in 1995.

Table 3. Trends (% change[a] per year as determined by linear regression) in number of mourning doves heard and seen along Breeding Bird Survey routes, 1966-2001.

	10 year (1992-01)					36 year (1966-01)				
	N	% Change		90% CI		N	%			90%CI
EASTERN UNIT										
Hunt										
AL	90	-0.6		-2.1	0.8	95	-1.2	***	-1.9	-0.5
DE/MD	70	-0.5		-1.8	0.9	79	0.5		0.0	1.1
FL	70	-0.1		-1.5	1.2	82	2.6	***	1.8	3.4
GA	61	-2.5	***	-3.6	-1.4	68	-1.3	**	-2.2	-0.3
IL	82	0.2		-1.0	1.4	82	0.5		-0.4	1.3
IN	55	-1.1		-2.4	0.3	58	-0.2		-0.8	0.3
KY	38	1.8	**	0.4	3.2	50	0.4		-0.2	1.1
LA	50	3.8	**	0.8	6.7	66	1.8	**	0.6	3.0
MS	27	-5.2	**	-8.6	-1.8	35	-1.6	***	-2.4	-0.8
NC	60	-0.6		-2.1	0.9	69	-0.3		-1.2	0.5
OH[c]	64	1.3		-0.1	2.6	75	0.7	*	0.1	1.3
PA	98	2.7	***	1.5	3.8	118	2.4	***	1.7	3.1
SC	30	3.2	**	0.8	5.7	36	-0.2		-1.1	0.7
TN	42	-0.3		-2.2	1.7	47	-0.8		-1.8	0.2
VA	50	-0.2		-2.0	1.6	56	-0.6		-1.1	0.0
WV	51	4.5	***	1.7	7.3	56	5.8	***	4.9	6.8
Subunit	938	-0.1		-0.5	0.4	1072	0.1		-0.2	0.4
Nonhunt										
MI	66	2.3	***	1.1	3.6	78	0.4		-0.2	1.0
N.England[d]	140	1.0		-0.2	2.2	154	3.7	***	2.8	4.5
NJ	27	0.0		-1.8	1.7	36	0.6		-0.6	1.7
NY	105	2.4	***	1.2	3.7	115	3.0	***	2.5	3.5
WI	89	1.7	**	0.6	2.7	91	1.1	*	0.1	2.0
Subunit	427	1.7	***	1.1	2.3	474	1.8	***	1.3	2.2
Unit	1365	0.3		-0.1	0.7	1546	0.4	***	0.2	0.7
CENTRAL UNIT										
AR	31	2.0	***	0.8	3.3	34	0.1		-1.1	1.3
CO	117	3.2	***	1.5	5.0	123	1.2	*	0.1	2.4
IA	35	-0.1		-2.1	2.0	37	-0.9	*	-1.8	-0.1
KS	38	-1.6		-3.9	0.8	39	-0.1		-1.0	0.7
MN	60	-1.4		-3.9	1.2	68	-1.3	**	-2.3	-0.2
MO	53	-2.7	***	-3.7	-1.6	62	-2.4	***	-3.1	-1.8
MT	49	-0.4		-3.1	2.3	53	-0.9	*	-1.6	-0.1
NE	40	-1.2		-2.8	0.5	46	-0.8	**	-1.5	-0.2
NM	63	0.9		-1.3	3.1	70	-0.6		-2.3	1.0
ND	44	-3.3	***	-5.0	-1.5	46	1.2	***	0.6	1.8
OK	56	0.1		-1.8	2.0	61	-1.6	***	-2.3	-0.9
SD	34	0.4		-1.7	2.5	46	0.7		-0.2	1.5
TX	168	-0.7		-1.9	0.6	190	-1.6	***	-2.1	-1.1
WY	77	-2.2		-4.5	0.1	98	-0.6		-1.7	0.6
Unit	865	-0.3		-0.9	0.3	973	-0.6	***	-0.9	-0.4
WESTERN UNIT										
AZ	56	-2.1		-4.4	0.3	72	-1.3		-3.1	0.5
CA	167	0.7		-0.6	2.1	213	-1.1	***	-1.8	-0.5
ID	40	1.2		-1.2	3.5	43	-1.6	***	-2.5	-0.7
NV	22	5.2	***	3.0	7.4	32	3.8	***	1.5	6.0
OR	82	1.9		-1.5	5.3	96	-2.3	**	-3.8	-0.7
UT	81	0.2		-1.6	1.9	83	-2.2	***	-3.3	-1.1
WA	58	0.7		-1.6	2.9	64	0.2		-1.5	1.8
Unit	506	0.3		-0.7	1.2	603	-1.3	***	-1.8	-0.7

[a]Mean of route trends weighted by land area and population density. The estimated count in the next year is (%/100+1) times the count in the current year where % is the annual change. Note: Extrapolating the estimated trend statistic (% change per year) over time (e.g., 36 years) may exaggerate the total change over the period.
[b] **P*<0.1; ***P*<0.05; ****P*<0.01.
[c] Ohio became a hunting state in 1995.
[d]New England consists of CT, ME, MA, NH, RI, and VT.

CURRENT RESEARCH ACTIVITIES (PROGRESS TO DATE)

Harvest Dynamics of Mourning Doves in South Carolina

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Call-count surveys indicate the mourning dove (*Zenaida macroura*) population in South Carolina and the Eastern Management Unit (EMU) declined from 1966-2001 (Smith et al. 2001). Although reasons for this negative trend are not known, annual survival, particularly that of juveniles, appears to have decreased in South Carolina between the 1970's and 1990's (Haas 1978, McGowan and Otis 1998). Thus, there is a need to investigate patterns of mortality during periods within the annual cycle when the mortality rate is thought to be particularly high.

The role that various sources of direct mortality and their interactions have played in the population dynamics of mourning doves is sometimes unclear (Braun et al. 1993). Because South Carolina is thought to have had a high harvest rate historically (Shipes et al. 1983) and the role of hunting in this decline is unknown, we initiated a study to examine population parameters on 3 Upper Coastal Plain sites thought to have different levels of hunting pressure. The objectives of this study are to: (1) assess the impact of subcutaneously implanted radiotransmitters on the health and survival of doves, (2) compare harvest rate estimates derived from banding and telemetry data, (3) determine whether site-, year-, and age-specific differences in period survival rates (PSR) exist, (4) estimate cause-specific mortality rates from July-November, (5) estimate the crippling rate of doves, and (6) examine the influence of various factors on indices of annual production.

We used telemetry and banding data to estimate period and annual survival rates, respectively. Telemetry was also used to estimate crippling rates and the magnitude and timing of various sources of mortality. We collected harvest age ratio data at organized dove hunts within 5 km of the 3 study sites as an index to site- and year-specific reproductive success. This 5 km buffer zone surrounding the core study sites defined the boundaries of each study site.

We elected to attach radiotransmitters to birds using the subcutaneous implantation method of Schulz et al. (1998) because, in general, traditional methods of radiomarking doves have been unsuccessful. We acquired the assistance of Clemson University veterinarians for both the surgical implantation of transmitters during the 1998 field season and training of the surgeon (JBB) and surgical assistants during the 1999 and 2000 field seasons. Initially, the veterinarians were unfamiliar with this marking technique and unsure of the health effects on the birds. Consequently, the University Animal Research Committee (ARC) required us to conduct a pilot study to determine whether the radiomarked birds displayed any negative health effects. The ARC permitted us to begin field research upon the successful completion of this pilot study.

We captured doves in modified Kniffin traps baited with corn, wheat, sorghum, browntop millet, and/or proso millet. We classified the age and gender of captured birds selected randomly for radiomarking (Table 1) based on external feather characteristics (Cannell 1984, Schulz et al. 1995), and held the birds in sheltered outdoor cages for up to 4 days before they were transported to a veterinary facility to be implanted with a transmitter. Implantation surgeries were performed at an animal research facility at Clemson University in 1998, and at a veterinary clinic near our study sites in 1999 and 2000. Birds were held in captivity for approximately 36 hours after surgery, then released near the point of capture at microhabitats in which we thought predators would have difficulty foraging. We monitored these birds from the day of release until the day of death,

Table 1. Sample sizes of site-, year-, and age-gender cohorts of radiomarked mourning doves in the Coastal Plain of South Carolina, 1998 - 2000.

		Age-gender cohort				
Site / hunting	Year	Adult	Adult	Adult unidentified	Juvenile unidentified	Unidentified age and
Heavy	1998	11	1	0	15	4
	1999	15	2	0	14	5
	2000	6	2	3	12	4
Moderate	1998	6	6	2	5	2
	1999	12	2	1	10	2
	2000	10	3	1	11	2
Light	1998	11	4	0	12	6
	1999	8	2	2	11	3
	2000	5	9	1	13	4
Total		84	31	10	103	32

or the end of the study period. We used evidence remaining on and near the carcass and transmitter to classify cause of death of radiomarked birds. Because subcutaneous transmitter implants have not been used in previous field investigations of mourning dove ecology, we examined the effects of this marking method on dove mortality. We graphically displayed the number of dove deaths per day throughout the field season after radiomarking and release to examine temporal mortality patterns. We observed that 16.9 % of all postrelease mortalities occurred during the first 3 days after release (Table 2), with the number of mortalities per day decreasing abruptly after that time. We conclude that researchers implanting transmitters in the subcutaneous layer of doves can enter these birds into the population at-risk on the fourth day after release.

Next, we calculated the 21 July - 1 September PSRs of our radiomarked juveniles and adults with the Kaplan-Meier product limit estimator method (Kaplan and Meier 1958, Pollock et al. 1989). To facilitate comparisons between our summer survival rates and those of a northcentral Missouri study which attached transmitters with body-loop harnesses (Schulz et al. 1996), we converted all PSR estimates and associated confidence intervals to mean daily survival rates (MDSR) estimates. The adult and juvenile doves in which we implanted transmitters had MDSR estimates of 0.999 (0.9969 - 1.0005, 95% CI) and 0.998 (0.9962 - 1.0005), respectively. Doves in northcentral Missouri had an estimated MDSR of 0.997 (0.9967 - 0.9981) during April - August. The slightly higher MDSR of doves with subcutaneously implanted transmitters suggests that this attachment method may be preferable to body-loop harnesses.

We examined the influence of various sources of mortality on doves with subcutaneously implanted transmitters (Table 2). After 3 days postrelease, the sources of mortality for radiomarked birds during the study period in which they were released was hunting (65.3 %), avian predators (16.3 %), unretrieved hunter kills (10.2 %), unidentified predators (4.0 %), mammalian predators (2.0 %), and unknown causes of death (2.0 %). To determine whether doves telemetered during the prehunting season were more susceptible to hunter harvest than were birds leg-banded, we fit our marking and recovery data to a series of models in Program MARK (White and Burnham 1999, Brownie et al. 1985). We allowed recovery and annual survival rates to vary by age (adult or juvenile) and marking method (radiomarked or leg-banded), and used information-theoretic methods to assess the value of each model (Burnham and Anderson 1998). Our preliminary results suggest that the best model was that in which recovery rates varied by age but not marking method, and survival was constant over age and marking method. Under this model, recovery rates of adults and juveniles were 0.093 (0.0561 - 0.1501, 95% CI) and 0.175 (0.1119 - 0.2637), respectively. The annual survival rate of all birds was 0.283 (0.1323 - 0.5061). Our best model suggests that no significant difference exists between the recovery rate of radiomarked and

Table 2. Sources of mortality for different age-gender cohorts of radiomarked mourning doves in the Coastal Plain of South Carolina during 21 July - 29 November, 1998-2000.

		# Days post-release	
Age-gender cohort	Source of mortality	<4 days	≥4 days
Adult male	Hunter		10
	Unretrieved hunter kill		2
	Avian predator	1	2
	Mammalian predator	1	
Adult female	Hunter		1
	Avian predator	3	
	Mammalian predator	1	
	Unidentified predator		1
Adult unknown gender	Hunter		3
	Avian predator		1
Juvenile unknown gender	Hunter		15
	Unretrieved hunter kill		2
	Avian predator	1	4
	Mammalian predator	2	1
	Unidentified predator		1
	Weather	1	
	Unknown		1
Unknown age and gender	Hunter		3
	Unretrieved hunter kill		1
	Avian predator		1
Total		10	49

leg-banded birds. Thus, marking method appears to not have any influence on the susceptibility of doves to hunter harvest. Preliminary estimates of the 21 July - 29 November PSR (all years pooled) were 0.653 (0.5261 - 0.7729, 95% CI), 0.399 (0.2461 - 0.5529), and 0.779 (0.5867 - 0.9711) for adults, juveniles, and birds of unknown age, respectively. The PSR of birds of unknown age may have been deceptively high because most of the birds in this cohort were entered into the population at-risk after a period of high mortality (i.e., the first split of hunting season). Site-specific PSR were 0.272 (0.1244 - 0.4204), 0.617 (0.4539 - 0.7792), and 0.638 (0.4464 - 0.8295) for the sites with heavy, moderate, and light hunting pressure, respectively. The overall PSR estimate was 0.496 (0.3942 - 0.5976). The uncorrected age ratios (juveniles:adult) of harvested birds were 2.35:1, 1.88:1, and 2.46 in 1998, 1999, and 2000, respectively. The observed site-specific variation in harvest age ratios was modest in most cases. These ratios are well below most previous estimates from the Carolinas (Haas 1978, McGowan and Otis 1998). We will investigate how abiotic factors influence variation in corrected harvest age ratios from 4 studies conducted in the Carolinas (Hayne 1975, Haas 1978, McGowan and Otis 1998, this study) in future analyses.

We presented 2 papers from these findings at the 8th Annual Conference of The Wildlife Society: *Population Dynamics of Mourning Doves in the Coastal Plain of South Carolina* and *The Influence of Subcutaneous*

Transmitter Implants on the Health, Survival, and Fate of Wild Mourning Doves. Funding for this study was provided by the 1996 and 2000 Migratory Game Bird Research Program, South Carolina Department of Natural Resources, South Carolina Public Service Authority (Santee-Cooper), Safari Club International, Clemson University, and the South Carolina Cooperative Fish and Wildlife Research Unit.

Monitoring the Presence and Annual Variation of *Trichomonas gallinae* in Mourning Dove Populations

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Expected completion date: June 2002

Trichomonas gallinae is a pear-shaped flagellated protozoan which sometimes causes a fatal disease called trichomoniasis in mourning doves, other columbids, and some raptors. The disease is thought to be transmitted when infected adult doves feed nestlings, and/or contaminate drinking water and food sources (i.e., bird feeders or baths) used by other doves. Weather conditions may contribute to disease transmission; e.g., extended hot dry weather may force birds to use limited but contaminated food and water supplies. Trichomonads are usually found in the oral-nasal cavity, or anterior end of the digestive and respiratory tracts of infected birds. Symptoms include difficulty flying, listlessness, swollen necks, and cheesy yellowish lesions in the oral cavity. Death occurs when the lesions block the trachea and oral cavity making eating and respiration impossible. Our objectives are to determine the presence of *Trichomonas gallinae* in a local mourning dove population using hunter killed birds on the James A. Reed Memorial Wildlife Area (JARMWA), Missouri, 1998-2002, and to evaluate the practicality of a large scale *Trichomonas gallinae* monitoring program to monitor trends in the disease=s presence through time. Our goal is to attempt to sample 1,000 hunter killed birds annually using the InPouch7 TF (BioMed Diagnostics, San Jose, CA, USA) culture system for detecting trichomonads. Using 3 captive mourning doves from another study, which died from trichomoniasis, we tested how long trichomonads lived in the dead birds. Viable trichomonads were found >36 hrs after the birds died and were left at ambient temperature showing that hunter killed birds would prove useful in detecting the presence of the parasite.

During 1 September 1998, we tested 687 hunter killed doves from JARMWA; an additional 29 doves were sampled from Eagle Bluff Conservation Area during the first and third days of the hunting season to increase our sample size. Of the 716 birds sampled, none showed visible lesions but 39 (5.4%) tested positive for carrying the parasite. During 1 September 1999, we tested 541 hunter killed birds from JARMWA. Of the 541 birds sampled, no birds showed visible lesions but 30 (5.5%) tested positive for carrying the parasite. During 1 September 2000, we tested only 415 hunter killed doves from JARMWA; we sampled fewer birds because of extremely hot weather on opening day of the dove season and corresponding low hunter participation. None of the 415 birds showed visible lesions; however, 10.6% of the birds tested positive for carrying the parasite. On 4 September 2001, we tested 823 hunter killed mourning doves from JARMWA. None displayed visible lesions, and 4.4% of the birds tested positive for carrying the parasite. Given the relatively low cost of this study, we are considering continuing the monitoring of hunter killed doves beyond 2002. A longer term monitoring program would provide more insights into annual variation in the presence of the disease, and more certainty concerning factors that relate to causes of the annual variation.

These preliminary results represent the fourth year of a 4-year study. The final report for the first 4 years study

will be available by June 2002. Funding and assistance for this study was provided by 1998 Webless Migratory Game Bird Research Program (U.S. Fish and Wildlife Service and the U.S. Geological Survey-Biological Resources Division), Missouri Department of Conservation-Conservation Research Center (Federal Aid in Wildlife Restoration Project W-13-R-52), and BioMed Diagnostics (San Jose, CA).

Lead Exposure in Mourning Doves

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Expected Completion: February 2002

Lead shot was banned for use in waterfowl hunting in the United States in 1991. In recent years, concern has also been raised about the exposure of upland game birds, particularly the mourning dove (Zenaida macroura), to spent lead shot. Past surveys have shown that several shotshells are often expended for each mourning dove taken, thus heavily hunted dove fields can be expected to accumulate relatively high densities of lead shot. Ingestion of lead shot by mourning doves may result in lead poisoning and death, and lead exposure can cause sublethal physiological or behavioral effects leading to starvation, the inability to escape from predators, or perhaps an increased susceptibility to disease. Although the mourning dove is a species of special concern regarding lead exposure and information on lead poisoning has been identified as a research need for proper dove population management, data on lead shot ingestion and lead concentrations in tissues of mourning doves are limited. The objective of this study is to evaluate the prevalence of lead exposure in mourning doves, based on ingested lead shot and lead concentrations in liver and bone, in a sample of hunter-killed birds from the three primary management units. The prevalence of ingested lead shot in gizzards will provide an index to the frequency with which mourning doves are picking up lead shot, and lead residues in liver and bone will reflect recent and chronic lead exposure, respectively.

In September of 1998-2000, a total of 4,575 hunter-killed doves was collected in seven states: Arizona, Missouri, Pennsylvania, South Carolina, Tennessee, Georgia, and Oklahoma. Carcasses were aged and sexed, and the gizzard from each bird was removed and radiographed. Shot-in and ingested shot were differentiated by the presence or absence of entry wounds in the gizzard and physical characteristics of the shot. Of the 4,575 doves collected, we found ingested lead shot in 2.4% of the gizzards, while 2.3% of the gizzards contained shot-in shot. Livers and wing bones from a sub-sample of carcasses were analyzed for lead by atomic absorption spectrophotometry. As of November 2001, livers from 1,978 doves have been analyzed for lead. Our results indicate that 6.6% of these doves had been exposed to lead, using the commonly accepted criterion of $6.0 parts per million (dry weight) of lead in the liver as an indicator of exposure. To date, wing bones from nearly 700 mourning doves have been analyzed for lead and 28% had lead concentrations of $20 ppm (dry weight). Final results will include the frequency of lead shot ingestion in the mourning doves collected during the study and data summarizing lead residues in liver and bone from a sub-sample of carcasses.

These results are from the last year of a 4-year study funded by the 1998 Webless Migratory Game Bird Research Program (U.S. Fish and Wildlife Service), U.S. Geological Survey, Arizona Game and Fish Department, Georgia Department of Natural Resources, Oklahoma Department of Wildlife Conservation, Missouri Department of Conservation, Pennsylvania Game Commission, South Carolina Department of Natural Resources, and the Tennessee Wildlife Resources Agency. Additional cooperators include the South Carolina Cooperative Fish and Wildlife Research Unit. During autumn of 2001, we will finish the laboratory work and prepare the final report, which we expect to be available early in 2002.

Development and Evaluation of Mourning Dove Population Models for Optimizing Harvest Management Strategies in the Eastern Management Unit, Central Management Unit, and Western Management Unit

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Expected completion: June 2002

Introduction and Objectives

An informed harvest management process for mourning doves will require development of one or more population models that synthesize existing knowledge of basic life history parameters and how these parameters may be affected by intrinsic and extrinsic factors such as harvest rate, weather, and habitat conditions. Such models allow predictions of effects of different harvest prescriptions on long term population and harvest levels, and can ultimately be used to define decision criteria for implementing alternative harvest strategies. This modeling effort represents an initial step in a process to an improved decision making process for mourning doves, and strives to place mourning dove harvest management in an objective and quantitative framework.

Understanding the effects of harvest on mourning dove populations is a multi-faceted challenge, and this effort is only one of many steps in increasing our knowledge. Upon completion of the project, we expect to have advanced the process of developing an improved system of dove harvest management by 1) improving our understanding of dove population dynamics, 2) prioritizing population monitoring data needs within the context of a long term harvest management system, and 3) recommending surveys and studies to fill information gaps that constrain development of more useful and realistic population models.
Contemporary information about dove population demographics and the relationship of mortality and reproductive rates to extrinsic and intrinsic factors is clearly inadequate to support sophisticated modeling fitting or adaptive modeling efforts at this point in time. However, it is necessary to begin development and evaluation of rudimentary models that represent a first step toward a long term objective of improved dove harvest management strategies that are grounded in credible population models and that guide improved population monitoring programs that will be necessary to support management efforts.

Progress to Date

Re-analysis of the 1965 -1975 banding experiment on increased bag limits in the EMU has been completed and a manuscript accepted for publication. The analysis revealed that the increase in bag limits during experimental years did not result in increased harvest rates, and thus the study could not provide any rigorous insight into the relationship between harvest and annual survival. There was a high degree of association between annual survival rates from banding data and harvest rate estimates derived from mail survey data collected during the study. Dove populations from groups of non-hunting states in the Northeast and Upper Mideast had much higher annual survival rates. However, this phenomenon can also be at least partially explained by a hypothesis of an intrinsic latitudinal gradient in annual survival of mourning doves.

Re-analysis of the 1965-1975 banding studies in the CMU and WMU was completed, and a set of survival models for each management unit was constructed based primarily on these analyses. The models are distinguished by the functional form of the relationship between annual survival and harvest rate, which ranges from completely additive to totally compensatory. A manuscript based on this work has been submitted for publication.

Although much is known about the reproductive biology of the mourning dove, no long-term, large-scale monitoring programs or datasets are available to serve as the basis for development of quantitative models that predict annual production as a function of weather, habitat, and/or population density. Based on a review of the dove literature and a more general review of relevant ornithological literature, I derived a reasonable range of per capita reproductive rates for each of several large geographical subunits within each of the 3 dove management units. These estimates are based on 3 assumptions that provide the framework for determination of the range of per capita reproduction. First, doves are determinate layers with a clutch size of 2. Second, the nesting cycle is 30 days (Sayre and Silvy 1993). Third, on the average, 1 fledgling is produced per nesting cycle. This fledging rate was derived from several independent sources. Although doves belong to the Order Columbidae, it is interesting to note that Lack (1966) stated that about 50% of eggs laid in open nests of passerines produced flying young. This assumption applied to doves would lead to an estimate of 1 fledgling/nest attempt, since clutch size is 2. An average of 1.1 fledglings/nest attempt was documented by McClure (1943) in his extensive study in Iowa. The average number of fledglings/active nest was 0.8 in the large scale cooperative nesting study (Geissler et al. 1987).An estimate of production per pair per year can be now be obtained, given a value for the number of nesting cycles per year. This logic is consistent with Lack (1966), who stated that Athe number of broods raised by a bird each year depends mainly on the length of time for which conditions are suitable for feeding young, and it may vary between populations of the same species.@ Geissler et al. (1987) provided nesting chronology data for 5 geographic regions: EMU-North, EMU-South, CMU-North, CMU-South, and the WMU. They used the middle 80% of the distribution of active nest dates to define a normal breeding season length. I used this range as the lower bound, and the entire range of dates as the upper bound, for breeding season length. A range divided by 30 then represents an initial estimate of production per pair per year. I then discounted these ranges by a factor that represents survival from time of fledging to September 1. This adjustment was done to fit the framework of the post-breeding census population growth rate model. The calculations involved extracting the vector of proportional breeding by month (Geissler et al. 1987) in each of his subregions, calculating the average monthly survival rate of HY age class birds as estimated from my survival analyses, and then summing over the product of the respective monthly percentages and the estimated survival from that month to September 1. These discount factors average about 85%, i.e., there is a 15% loss in young of the year between fledging and the beginning of hunting season. These ranges seem to match well with published estimates from field studies (Sayre and Silvy 1993).

The sets of survival and reproductive models can be combined into a set of rudimentary population models of growth rate as a function of harvest rate. These models can make predictions of population trajectories, but contemporary estimates of survival, harvest, production, and population trend will be required to begin a process of evaluation of the relative weights of evidence for different models.

Because the harvest management process involves choice among different sets of harvest regulations, it is essential to have models of the relationship between regulation parameters and the realized harvest rate (Johnson et al 1997). Thus, we are compiling a database of historical dove regulations and of corresponding harvest rates (where available) for the U.S. These data will be used to develop predictive models for each management unit.

Future Work

Work in the next year will primarily focus on:

1) Further refinement of population models. Emphasis will be on the relationship between harvest age ratios and per capita reproduction.

2) Development of a reward banding project to estimate band reporting rate, harvest rate, and related population parameters in a sample of subregions in each management unit.

3) Complete analysis of harvest rate and harvest regulation data.

4) Communication of project status and direction to technical committees and working groups in each management unit.

Evaluation of Physiological and Pathological Effects of Subcutaneously Implanted Radiotransmitters on Captive Wild Mourning Doves

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Expected completion date: June 2004

The use of radiotelemetry as a wildlife research tool has broadened our understanding of many ecological processes. A critical assumption of telemetry studies, however, is that transmitters have no appreciable effects on animals, and provide unbiased estimates of the variables being studied. Despite the widespread application of radiotelemetry, the impacts of radiotransmitters on animals has been subjectively evaluated; e.g., the animal=s Abehavior appeared unaffected@ or Areproduction seemed normal.@ A common approach has been to assume that the radiotransmitter package has minimal effects if the animal successfully completes the biological or behavioral processes such as mating or producing offspring. Such reasoning is weak, however, indicating only that the transmitter packages are not overtly deleterious to the well-being of the animals in question.

Despite the success of previous mourning dove investigations using dorsally attached radiotransmitters with cyanoacrylate-based glues, the attachment of radiotransmitters is relatively short term; i.e., 2-12 weeks. In addition to short retention time, prolonged exposure of the skin to the glue could potentially cause pathological tissue damage of a physical nature. Other dove investigators have used either double body loop or double wing loop harnesses because these harness attachment methods securely held the transmitters to the sample of marked birds; it was not unusual for some bird
Before implanted transmitters can be recommended as a standard field technique for radiotelemetry, however, further evaluation has been recommended (Schulz et al. 1998, Schulz et al. 2001) to evaluate the efficacy of the subcutaneous implant technique in a wide range of situations and conditions. Also, these previous studies were conducted using relatively small cages which limited the movements of the birds, and possibly biasing the results in regards to effects on free flying birds.

to retain transmitters for $12 months. Although harnesses provide an effective long-term attachment method, numerous problems have been reported in other avian species (e.g., reduction in survival or sublethal effects on behavior, body mass, feathers, skin).

Because mourning dove transmitter glue attachment is a relatively short-term attachment technique, and transmitter harnesses have been shown to inflict deleterious injuries, other methods of attaching transmitters have been developed and tested. A study conducted in Missouri (Schulz et al. 1998) showed that subcutaneously implanted radiotransmitters had minor physiological or pathological effects on captive mourning doves compared to doves with intra-abdominal radiotransmitter implants. Based on the success of previous work, Schulz et al. (2001) conducted a second evaluation that used captive wild mourning doves to compare the physiological effects of subcutaneous transmitter implants to radiotransmitters attached with glues and harnesses. The data suggested that subcutaneous implants were superior to glue attachments based on retention time, and superior to harnesses based on pathological effects. Subcutaneous implants did not appear to affect doves physiologically in a captive setting, although long-term effects on wild free-flying doves were unknown.

Other questions concerning optimum post-surgical recovery times, post-surgical release protocols, surgical site complications, and post-treatment effects need to be evaluated in more Anatural@ conditions where captive wild birds are allowed to fly and conduct daily activities while still following experimental protocols. Therefore, the objectives of this project are to evaluate the efficacy of using fecal corticosterone levels as an independent measure of stress, and then evaluate the physiological stress and pathological effects related to captive wild mourning doves implanted with subcutaneous radiotransmitters using larger cages. In addition to fecal corticosterone, other measurement variables include heterophil:lymphocyte ratios, blood plasma chemistries, body weights during pretreatment and post-treatment sessions, body temperature of doves implanted with thermistor transmitters, and pathology/histopathology data from necropsies.

To date we have completed construction of 60 outdoor pens at the Baskett Wildlife Research and Education Area, near Ashland, Missouri. The cages are constructed of CCA treated lumber covered with 1" H 2" welded wire. Individual pens are approximately 6'(L) H 6'(W) H 6' (H) with the cage bottoms about 2' off the ground. The bottom of the cages are covered with 2 layers of 1" H 2" welded wire spaced 3 2@ apart to discourage predation. Data collection for the first objective has been completed concerning the evaluation of fecal corticosterone as an independent measure of stress; laboratory analysis is on-going. We have also completed the first trial of 60 birds; 30 with subcutaneous implants, 30 control birds. Preliminary data shows that 28 of 30 (93%) subcutaneous implants were pathologically unremarkable, and in excellent body condition. The other two doves had complications that could have been easily avoided with surgical practice prior to the experiment. Preliminary body temperature data from the first experimental trial shows that 18 of the 30 implanted doves demonstrated a 24 hr body temperature cycle with lowest body temperature during the evening (39.0 ECelsius; 102.2 EFahrenheit), and highest body temperature during mid-day (43.0 ECelsius; 109.4 EFahrenheit) during 6-week post-treatment period. There was no apparent temperature increase related to infection associated with the subcutaneous implants. The second trial of 60 birds is scheduled to be completed by spring 2002. Laboratory analysis of fecal samples and manual reading of heterophil:lymphocyte ratios will require more time. The final report and associated manuscripts should be completed prior to June 2004.

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Management of Selected Food Plantings for Mourning Doves in Alabama

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Graduate student: Steven E. Hayslette (Ph.D.); **Final Report**

Recent controversy regarding acceptable planting methods in prepared mourning dove (*Zenaida macroura*) fields has created a need for improved information regarding costs and benefits of various management options. Goals of this project were to document benefits of wheat plantings for mourning doves, and measure and compare costs and benefits of planting strategies for highly-preferred warm-season mourning dove foods.

Field work during June-September 1998 measured and compare unshattered seed availability of experimental wheat plantings established at 3 sites in eastern Alabama during September 1997. Mean wheat seed availability in mid-June varied widely among sites. Wheat availability declined from mid-June through early August at all 3 sites, and by early August, unshattered wheat seed availability was #0.01 g/m^2 at 2 sites. By mid-September, wheat availability at the third site had declined to <20% of that in mid-June.

Field work at these 3 sites during June-August 1998 documented and compared seed yields of experimental plantings of white proso millet, dove proso millet, browntop millet, broadleaf signalgrass (*Brachiaria platyphylla*), and yellow bristlegrass (*Setaria lutescens*). Seed yield of browntop millet was much greater than yield of any other crop at all 3 sites. Seed yield of broadleaf signalgrass was greater than yield of yellow bristlegrass, white proso millet, and dove proso millet at one site, but was similar to yields of these other crops at other sites. Seed costs were much lower for cultivated crops than for wild species. Seed cost/ha and cost/kg of seed produced were lowest for browntop millet at all 3 sites.

Field work at the same sites during July-October 1999 tested the effects of fertilization rate on seed yield of white proso millet, dove proso millet, browntop millet, broadleaf signalgrass, yellow bristlegrass, and switchgrass (*Panicum virgatum*). We tested 4 fertilization rates, including no fertilizer; N, P, and K as recommended by soil test; twice recommended N, with P and K as recommended; and three times recommended N, with P and K as recommended. Surprisingly, fertilization rate did not significantly affect seed yield of any crop at any site. Seed yield of browntop millet was much greater than yield of any other crop at 2 sites, and was greater than yield of all but broadleaf signalgrass at the third site. As in 1998, seed costs were much lower for cultivated crops than for wild species. Seed cost/ha was equal among cultivated crops, but seed cost/kg of seed produced was much less for browntop millet than for any other crop at all 3 sites.

Additional field work at 2 sites during July-October 1999 tested the effects of row spacing and planting rate on seed yield of white proso millet, dove proso millet, and browntop millet. We tested 3 row spacings (18, 36, and 72 cm) and 4 planting rates (5.6, 11.2, 16.8, and 22.5 kg/ha). Yield of browntop millet seed varied among row spacing/seeding rate combinations at 1 of the 2 sites, and was highest at that site when planted in 18-cm rows at a rate of 16.8 kg/ha. Dove proso millet yield also varied among row spacing/seeding rate combinations at 1 of the 2 sites, and was highest at that site when planted in 36-cm rows at 16.8 kg/ha. Seed yield of white proso millet generally was low, and did not vary among row spacing/seeding rate combinations at either site.

Results indicate that browntop millet is by far the best choice for planting in warm-season dove fields in Alabama, if maximizing seed production and cost-efficiency on these fields is the desired management goal. Use of wild species in dove field plantings appears limited by high seed costs. However, if a more affordable source of seed was available, broadleaf signalgrass may be appropriate for dove field plantings, especially if annual regeneration of signalgrass following initial establishment eliminates the need to plant each year. Results also suggest that cool-season wheat plantings provide most benefits to mourning doves early in the breeding season, and that few benefits from wheat remain by late summer. Unless top-sown prior to, or during, the hunting season, wheat may be of limited use in attracting mourning doves for hunting in Alabama.

These are final results from this study; manuscript preparation currently is underway. Funding was provided by the Alabama Department of Conservation and Natural Resources (Division of Wildlife and Freshwater Fisheries) and Auburn University.

Studies of Native Columbiformes in Tucson, Arizona

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Expected Completion: December 2002

Studies of native columbids in suburban Tucson, Arizona initiated on 1 January 2000 continued through 2001. Species under study are: mourning dove (*Zenaida macroura*), white-winged dove (*Zenaida asiatica*), and Inca dove (*Columbina inca*). Objectives during the 2nd year of the 3-year study included trapping and banding all 3 species, obtaining body mass, molt, and measures of primary length, as well as recording timing of breeding activities. In 2001, 1000 mourning doves and 181 white-winged doves were newly banded bringing the 2000-01 totals to 2,300 mourning doves and 274 white-winged doves. Too few Inca doves (37) were banded for meaningful data analysis.

Two recoveries were reported of mourning doves, both found dead in the Tucson area, while no recoveries have been reported of white-winged doves. These few data indicate that populations of both species are either not exposed to hunting or that too few have been banded. One recapture of a mourning dove, in the Tucson area, has been reported away from the banding site. Significant numbers of mourning doves have been recaptured (repeats) at the banding site. In 2001, 133 different mourning doves banded in 2000 were recaptured at the site of banding. These individuals represented all 12 months of banding in 2000 with January, March, and June each having 15 different individuals being recaptured, followed by May (14), July (13), August and November (10 each), February and September (9 each), April and December (8 each), and October (7). These data indicate the population banded is resident, a finding supported by the lack of recoveries. Thus, the original hypotheses of both migratory and resident populations in the area of banding are not supported.

Mourning and Inca doves occur in the trap area throughout the year and are considered resident. Courtship activities (calling, display flights, active ground chases) of mourning doves are initiated in the 1st (2001) and 2nd (2000) week in January and continue into the 1st week of September. Hatching year mourning doves first appear in trap samples in late March (23rd in 2000) and early April (2nd in 2001). White-winged doves are migratory in the study area with first arrivals in early April (first captured on 12 April in 2001 and 14 April in 2000). Courtship activities (calling, display flights, active ground chases) of white-winged doves are initiated upon arrival in the study area and hatching year birds are first captured in late May (29th in 2000) and June (15th in 2001). White-winged doves depart the study area in late August and early September (last capture on 13August in 2000 and 7 September in 2001). Analyses of morphometric data have not been completed. This study is funded by Grouse, Inc.

Spent Shot Availability and Ingestion on Areas Managed for Mourning Doves

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Final Report

Mourning dove (*Zenaida macroura*) hunting is becoming increasingly popular, especially hunting over managed shooting fields. Given the possible increase in lead (Pb) shot availability on these areas, our objectives were to estimate availability and ingestion of spent shot at the Eagle Bluffs Conservation Area (EBCA; hunted with non-toxic shot) and the James A. Reed Memorial Wildlife Area (JARWA; hunted with Pb shot) in Missouri. During 1998, we collected soil samples one or 2 weeks prior to the hunting season (prehunt) and after 4 days of dove hunting (posthunt). We also collected information on number of doves harvested, number of shots fired, shotgun gauge, and shotshell size used. Dove carcasses were collected on both areas during 1998-99. At EBCA, 60 hunters deposited an estimated 64,775 pellets/ha of non-toxic shot on or around the managed field. At JARWA, approximately 1,086,275 pellets/ha of Pb shot were deposited by 728 hunters. Our posthunt estimates of spent shot availability from soil sampling were 0 pellets/ha for EBCA and 6,342 pellets/ha for JARWA. Our findings suggest that existing soil sampling protocols may not provide accurate estimates of spent shot availability in managed dove shooting fields. During 1998-99, 15 of 310 (4.8%) mourning doves collected from EBCA had ingested non-toxic shot. For doves that ingested shot, 6 (40.0%) contained 7 shot pellets. In comparison, only 2 of 574 (0.3%) doves collected from JARWA had ingested Pb shot. Because a greater proportion of doves ingested multiple steel pellets compared to Pb pellets, we suggest that doves feeding in fields hunted with Pb shot may succumb to acute Pb toxicosis and thus become unavailable to harvest, resulting in an underestimate of ingestion rates. Although further research is needed to test this hypothesis, our findings may partially explain why previous studies have shown few doves with ingested Pb shot despite feeding on areas with high Pb shot availability.

Funding and support for this study was provided by the Missouri Department of Conservation=s Conservation Research Center (Federal Aid in Wildlife Restoration Project W-13-R-52) and the University of Missouri, Department of Fisheries and Wildlife Sciences.

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Landscape and Habitat Analysis Along Mourning Dove Call-count Survey Routes in Mississippi

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Mourning dove (*Zenaida macroura*) call-count surveys show a decreasing trend in Mississippi. In an effort to examine relationships between long-term habitat changes throughout the state and mourning dove populations, we have utilized a Geographical Information System (GIS) approach.

Ten routes (two in each physiographic region of the state) were selected for analysis. Aerial photography was purchased for each of the selected routes for three time periods. Photos purchased were form the 1960's, 1980's, and 1990's for each route from the Aerial Photography Field Office of the Natural Resource Conservation Service. Aerial photos were scanned into a GIS, geocorrected (using digital quads), and mosaiced. Once this was completed, a 1.64 km. buffer was created around call-count routes. All habitats inside this buffer were then interpreted and digitized into polygons. Habitat types selected include; agriculture, pine forest, hardwood-pine forest, hardwood forest, regeneration stands, urban, wetland, and woodlot. ERDAS Imagine was used to create the data set, and the spatial analysis was accomplished with ArcView. The completed coverages were analyzed using the program FRAGSTATS to examine spatial patterns of landscape structure and relationships to variability in mourning dove relative abundance.

FRAGSTATS allows for analysis at three spatial scales: patch, class, and landscape. Patch level analysis was deemed too fine a scale for the purposes of this study and therefore was eliminated from consideration. At the class level, the percentage of each of the eight habitat types was included in further analysis. We condensed pine forest, hardwood forest, and pine-hardwood forest into one forest habitat type. The percent habitat types were included to give some measure of possible correlations between relative dove abundance and landscape composition. To examine possible correlations between relative dove abundance and landscape structure, we examined the landscape scale of metrics calculated by FRAGSTATS. Many metrics calculated by FRAGSTATS are redundant or cannot be adequately interpreted biologically. Therefore we a priori eliminated them from further consideration. The landscape level metrics included in further analysis were patch density, edge density, area-weighted mean shape index, total core area, Shannon's diversity index, patch richness density, and interspersion/juxtaposition index. A disturbance index taken from the call-count data was also included as a variable.

In an effort to reduce the number of predictor variables and to reduce the collinearity of the variables, we utilized a Principle Component Analysis approach. The individual loadings of variables were examined for each principle component. The first four principle components contained apx. 85% of the total variation contained in the data set. The first four principle components individually contained high loadings on variables that did not receive high loadings in the previous principle component [i.e. The fifth principle component contained high loadings on variables which were previously contained in a principle component (redundant information)]. A high loading is taken in context of its loading compared to other loadings within the same principle component with 0.3 (in either a positive or negative direction) generally used as the cut-off. Therefore the PC scores for the first four principle components were used in further analysis.

Call-count data obtained from the Migratory Bird Management Office was then broken into equal segments around the photo years, and the mean number of doves heard for each of the segments used in a multiple linear regression analysis as the dependent variable. The independent variables were principle components one-four. Akaike's Information Criteria was used as the model selection option in the regression model. AIC values were converted to AICc to account for small sample sizes. Delta AIC was then calculated (AICi-minAIC) and models ranked in ascending order based on delta AIC. Only models < 2 delta AIC units were deemed Agood@ candidate models. The only model that meet that criteria contained principal component one. Principle component one had high loadings for patch density, edge density, Shannon's diversity index, and percentage of forest in a negative correlation with relative dove abundance; and total core area and percentage of agriculture in a positive correlation with relative dove abundance.

We also conducted short-term modeling analyses to examine agreement with our long-term landscape analysis models. For it, only the most recent GIS coverages (1990's photos) were used in analysis. The call-count data from the MBMO was not used, instead two years of data collected by Mississippi Cooperative Wildlife and Fisheries Research Unit (with same protocol as MBMO call-count procedure) was used as the dependent variable. Methods were the same as stated above. In this modeling procedure only the first two principle components were put into the regression model (explaining 77% of the variation). Again only one model met the criteria. This model contained only principle component one, which had similar loadings as the long-term model except that patch richness density was not highly loaded but percentage of wetlands was (correlated in a positive direction with relative dove abundance).

Additionally, we conducted a short-term modeling analysis where dove density (both heard and seen) was collected for two years and used as the dependent variable. Again only the most recent GIS coverage was used, and methods were the same as stated above. In this modeling procedure only the first three principle components were put into the regression model (explaining 90% of the variation). Once again, only one model meet the criteria, and it contained principle component one. Loadings were the same as in the short-term model with relative abundance data. Interpretation of model results and preparation of the final report is in progress. This study was funded by the Mississippi Department of Wildlife, Fisheries, and Parks.

Reference: *Elmore, R. D. In preparation. Landscape and habitat analysis along mourning dove call-count routes in Mississippi. Mississippi State University, Mississippi State, MS. 116.*