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Mourning Dove: Breeding Population Status, 2000

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MOURNING DOVE BREEDING POPULATION STATUS, 2000

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Abstract: This report includes Mourning Dove Call-count Survey information gathered over the last 35 years within the conterminous United States. Trends were calculated for the most recent 2- and 10-year intervals and for the entire 35-year period. Between 1999 and 2000, the average number of doves heard per route did not change significantly in the Eastern and Western Management Units. A significant decrease was detected in the Central Unit. Additionally, significant declines were indicated for doves heard over the 10 and 35-year periods in all 3 Units. In contrast, for doves seen, no trends were indicated over the 10- and 35-year periods for the Eastern and Central Units. A decline was found for both time periods in the Western Management 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 federal and state 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.

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DISTRIBUTION AND ABUNDANCE

Mourning doves breed from the southern portions of Canada throughout the United States into Mexico, in Bermuda, the Bahamas and Greater Antilles, and in 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, 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 1952). In the United States, the survey currently

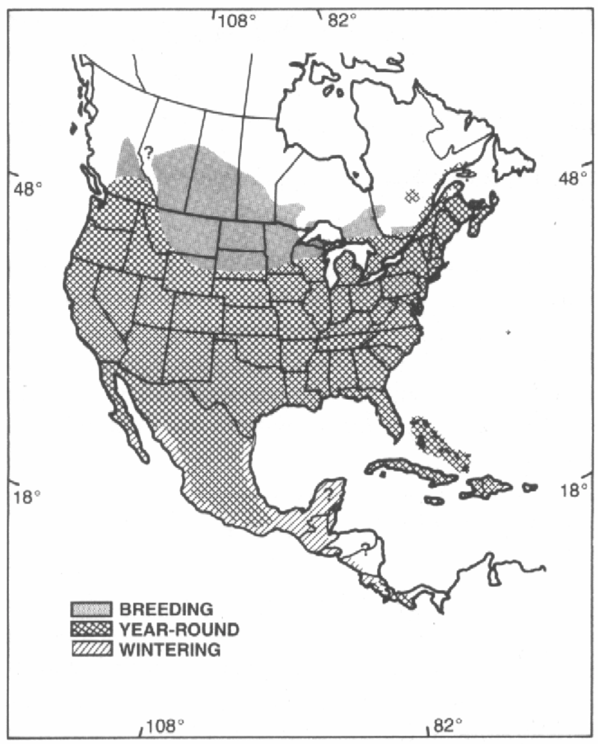

Fig. 1. Breeding and wintering ranges of the mourning dove (adapted from Mirarchi and Baskett 1994).

includes more than 1,000 randomly selected routes, stratified by physiographic region. In Canada, 20 randomly selected routes are located in parklands and prairie. 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 covariates to adjust for differences in observers' ability to hear or see doves. 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

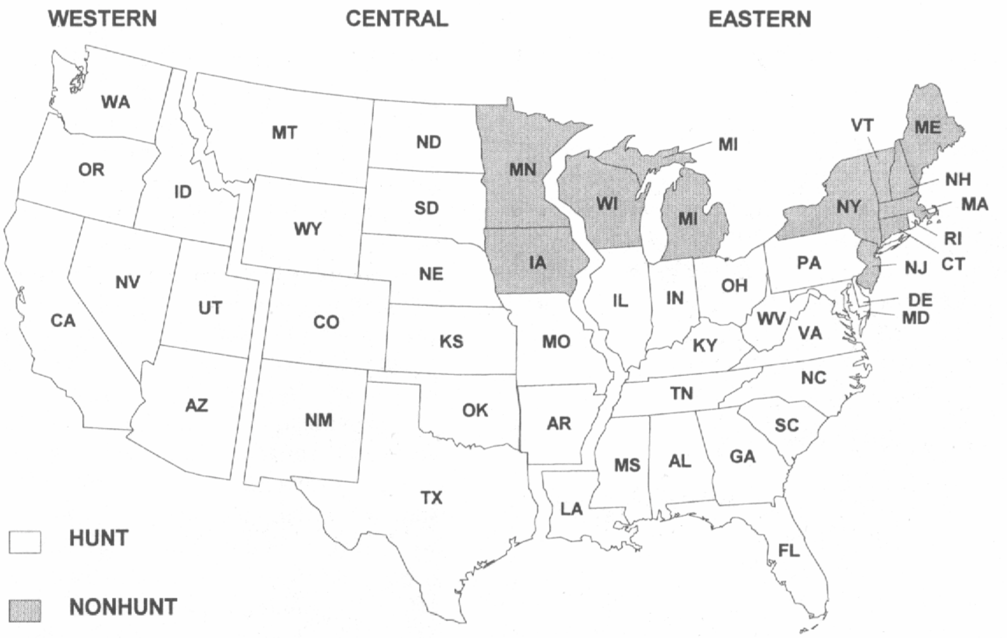

Fig. 2. Mourning dove management units with 1999 hunting and nonhunting states.

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 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 35-year period were estimated. Additionally, trends in doves seen were estimated over the 10- and 35-year periods for comparison.

For purposes of this report, statistical significance was defined as $P<0.05$, except for 2-year comparisons where $P<0.10$ was used due to 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). 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. 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 1999 to 2000, 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 1999 and 2000, 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 2000 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 estimated densities shown in Figs. 3, 7, and 11 illustrate the average *actual* numbers of doves counted in 1999 and 2000.

WEATHER SUMMARY

Weather prior to and during the survey period may influence survey results. A summary of May weather follows (U.S. Department of Commerce and U.S. Department of Agriculture 2000a,b): "Between 14-20 May, heavy rain soaked areas from southern Montana, Wyoming, and north-central Colorado to the Mid-Atlantic region. In the northern Corn Belt, rain significantly eased long-term drought. Dry weather persisted, however, across the southwestern Cord Belt. Mostly dry, often hot weather also intensified across the southern Atlantic and eastern Gulf Coast States. Farther west, however, widespread rainfall aided summer crop development from central and southern Texas eastward to the Delta. Excessive rainfall caused localized flooding, however, from the Arklatex region southward into eastern Texas. Showers briefly dampened portions of the drought-stricken southern High Plains. In the Southwest, cooler weather and subsiding winds aided fire containment efforts. Farther west, warm, dry weather returned to California. Record heat overspread the West Coast at week's end. Weekly temperatures averaged up to 6°F above normal in the Southeast and Northwest, but ranged from 1 to 7°F below normal in the Corn Belt and Northeast. High temperatures regularly exceeded 90°F in the southeast and briefly topped 100°F early in the week on the southern Plains. Early in the week, cool air settled in across most areas east of the Rockies, producing about a dozen daily-record lows. Cool weather lingered in California's Central Valley, where Redding's high of 60°F on Sunday was 20°F below normal. Dry air overspread California following early-week showers. Late in the week, record warmth reached the West Coast and also spread into the southeast. In contrast, temperatures fell slightly below the freezing mark along the Nation's

norther tier. A major storm system moved into the Great Basin on Tuesday, then churned across areas from Wyoming to the northern Mid-Atlantic region, reaching the East Coast on Friday. Thunderstorms erupted late in the week along the storm system's trailing cold front, soaking the Arklatex and adjacent areas.

During 21-27 May, heavy precipitation shifted southward from last week, resulting in beneficial, soaking rains in areas from the central Plains to the Mid-Atlantic region. Much-needed rain also dampened previously dry areas of the southwestern Corn Belt. Widespread showers aided pastures and summer crops across the interior Southeast, but largely bypassed drought-stricken areas from eastern Louisiana to the southern Atlantic Coast. Very warm, favorably dry weather prevailed in California's Central Valley, while occasional extreme heat partially offset the beneficial effects of scattered showers across the southern Plains. May-record high temperatures briefly exceeded 110°F in parts of western Texas and southwestern Oklahoma. Highs approached or reached 100°F in the southern Atlantic States and as far north as southern Kansas. Weekly temperatures averaged 4 to 12°F above normal in the South-Central States, as much as 10°F above normal in California's Central Valley, and up to 8°F above normal in the Southeast. In contrast, cool weather slowed crop development in the Northeast, where temperatures averaged as much as 6°F below normal. Near-normal temperatures prevailed in the Midwest. Iowa recorded above-normal precipitation during 2 consecutive weeks for the first time since February. Farther east, occasional rain continued to dampen the Northeast, pushing May and spring (March-May) precipitation totals toward record levels. During the week, very heavy rainfall (2 to 4 inches, with locally higher totals) affected areas from southeastern Kansas and northern Oklahoma to the northern Mid-Atlantic States. Some of the heaviest totals were observed in previously dry areas of the middle Mississippi Valley. Columbia, MO netted a daily-record rainfall (2.96 in) on

Friday. Weekly rainfall reached 3.24 inches in Columbia and 3.23 inches in Paducah, KY. Across the South, however, little or no rainfall accompanied record heat. During the week, more than 150 daily-record highs and at least 10 May-record highs were set or tied, mainly across the South. Farther west, record heat shifted from California early in the week to the southern Plains by midweek."

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).

1999-2000 Population Distribution.--North Carolina was the only state that had a mean count over the 2 years of > 20 actual doves heard per route (Fig. 3). Michigan, New Jersey, New York, Pennsylvania, West Virginia, and the New England states averaged < 10 per route. In all other states mean counts ranged between 10-20 doves heard per route.

1999 to 2000 Population Changes.--No significant change was detected for the Unit. The average number of doves heard per route increased 1.3% (Table 1). The population index did not change significantly between years in the combined hunting states (-0.6%) while it increased significantly (10.0%) in the combined nonhunting states..

The 2000 population index of 18.1 doves heard per route for the Unit, was higher than the long-term estimate of 17.0 (Fig. 4, Table 2). In the hunting states, the index of 19.1 was above the long-term estimate of 17.7, while in

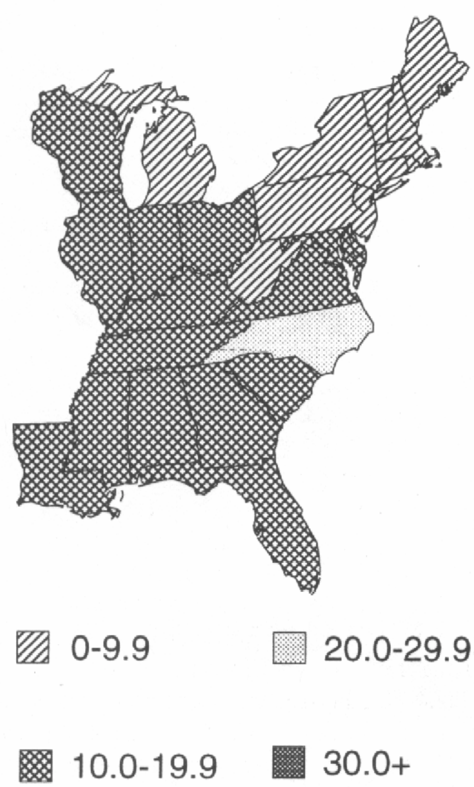

Fig. 3. Mean number of mourning doves heard per route by state in the Eastern Management Unit, 1999-2000.

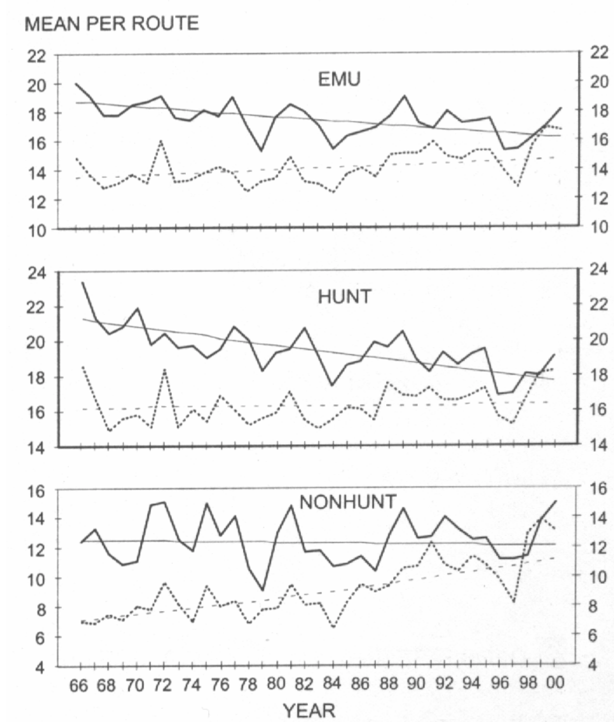

Fig. 4. Population indices and trends of breeding mourning doves in the Eastern Management Unit (EMU), combined EMU hunting states (HUNT), and combined EMU nonhunting states (NONHUNT), 1966-2000. Heavy solid line = doves heard; heavy dash line = doves seen; light solid and dash lines = predicted trends.

the nonhunting states, the index of 15.0 was higher than the long-term estimate of 12.1.

The population increased significantly in Michigan and New Jersey and decreased in Florida (Table 1). No significant changes were detected for other states.

Population Trends: 10 and 35-year.--Population indices declined significantly over the most recent 10 and 35-year periods for the Unit and combined hunting states (Table 1, Fig. 4). In contrast to doves heard, an analysis of doves seen indicated no significant trend over either time period for the unit or combined hunting states. There was no trend indicated with either analysis for the combined nonhunting states.

State population trends for doves heard are shown in Fig. 5 (10-year interval) and Fig. 6 (35-year interval) and Table 1. Delaware/Maryland, Georgia, Indiana, and West Virginia showed declines over 10 years. Between 1966 and 2000, there were increasing population trends in New England and decreasing trends 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).

1999-2000 Population.--Kansas, Nebraska, and North Dakota had the highest actual average number of doves heard per route over the 2 years (33, 37, and 36, respectively) in the nation (Fig. 7). Historically, Kansas often has the highest average counts in the nation (Table

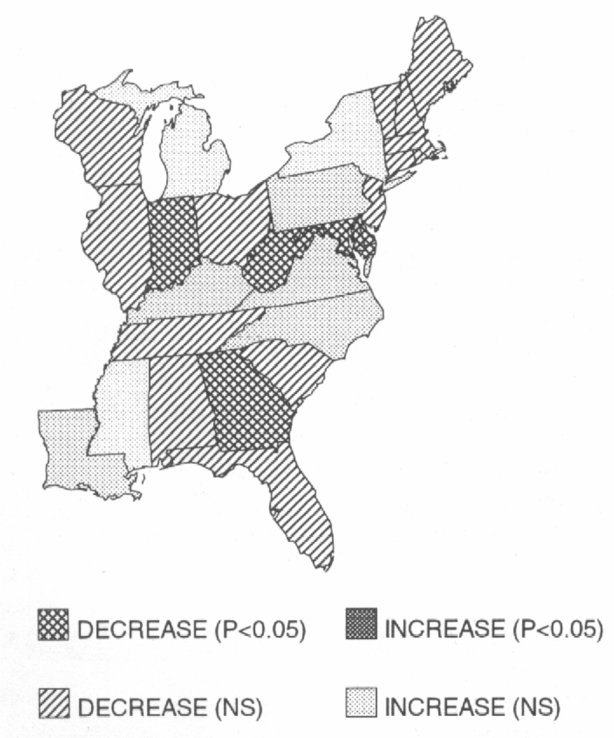

Fig. 5. Trends in number of mourning doves heard per route by state in the Eastern Management Unit, 1991-2000.

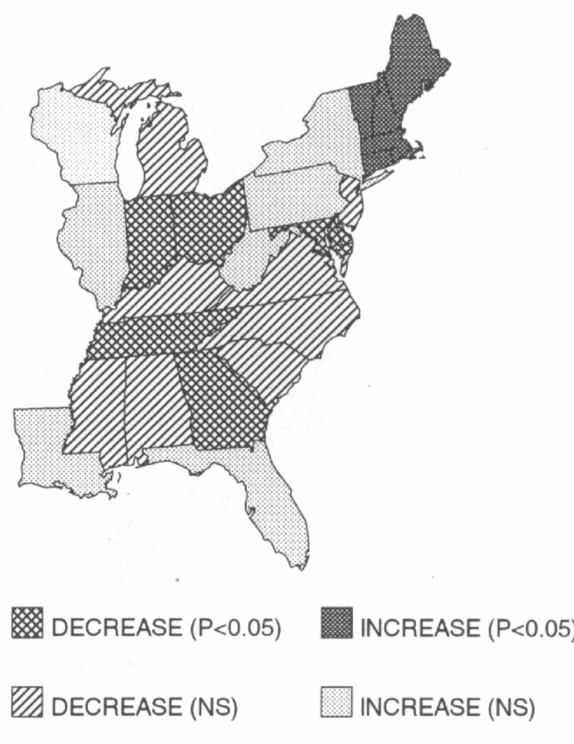

Fig. 6. Trends in the number of mourning doves heard per route by state in the Eastern Management Unit, 1966-2000.

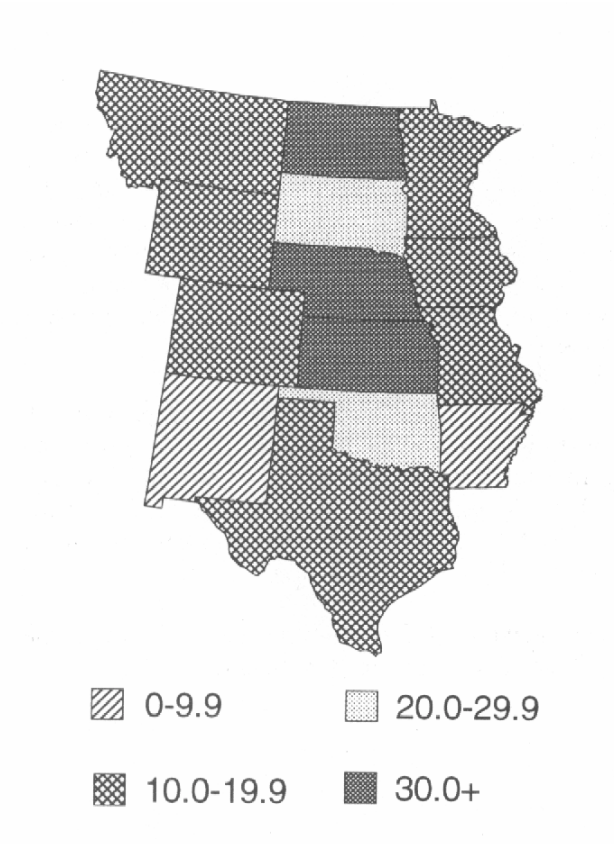

Fig. 7. Mean number of mourning doves heard per route by state in the Central Management Unit, 1999-2000.

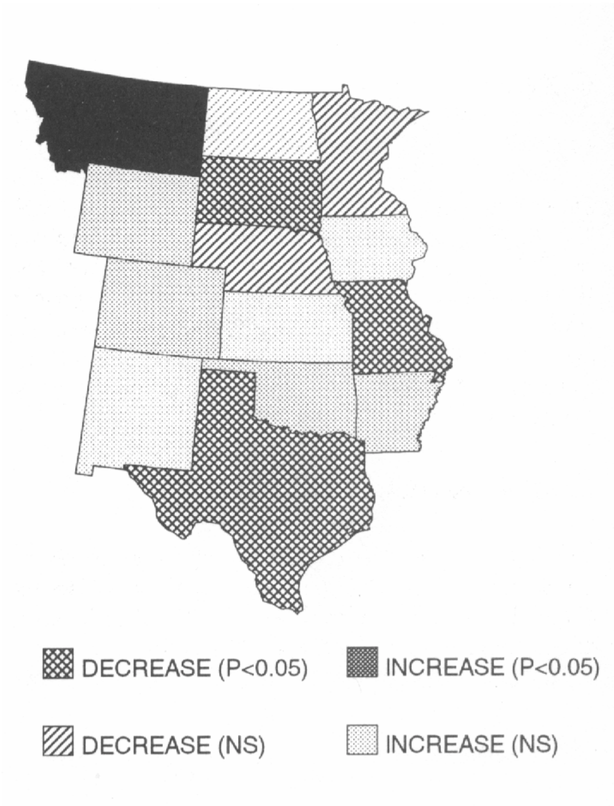

Fig. 9. Trends in number of mourning doves heard per route by state in the Central Management Unit, 1991-2000.

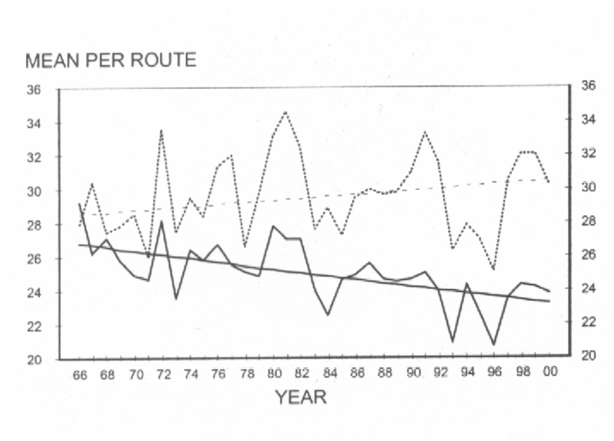

Fig 8. Population indices and trends of breeding mourning doves in the Central Management Unit, 1966-99. Heavy solid line = doves heard; heavy dash line = doves seen. Light solid and dash lines = predicted trends.

2). Arkansas and New Mexico were the only states with fewer than 10 doves per route. The remaining states had intermediate values.

1999 to 2000 Population Changes.--The average number of doves heard per route in the Unit decreased significantly between the 2 years (-5.1%; Table 1). The 2000 index for the Unit of 23.8 doves heard per route is only slightly above the predicted long-term trend estimate of 23.2 (Fig. 8, Table 2).

The population decreased significantly in Kansas (Table 1). No significant increases were found.

Population Trends: 10 and 35-year.--The index of doves heard for the Unit declined significantly over both time periods (Table 1). Trends for doves seen were not significant for either time period.

Over a 10-year period population trends in Montana increased but declined in Missouri, South Dakota, and

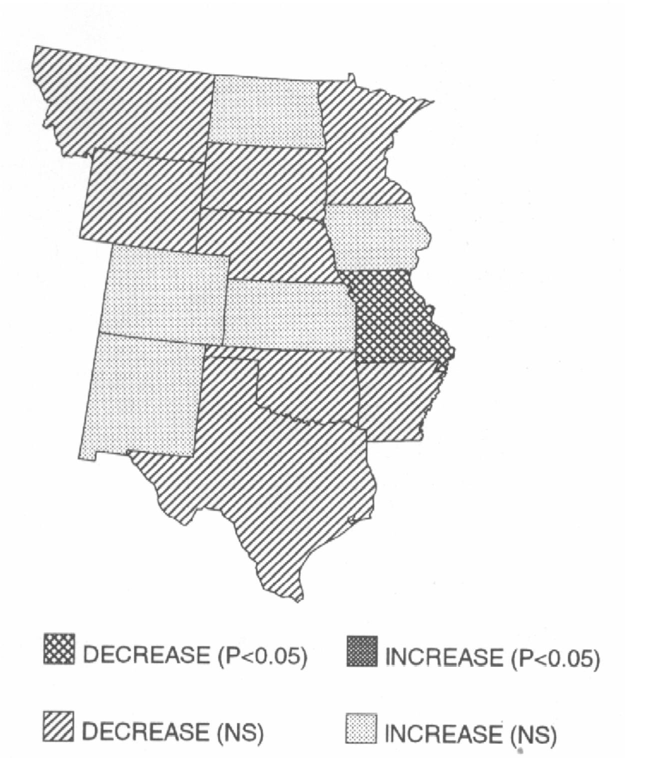

Fig. 10. Trends in mourning doves heard per route by state in the Central Management Unit, 1966-2000.

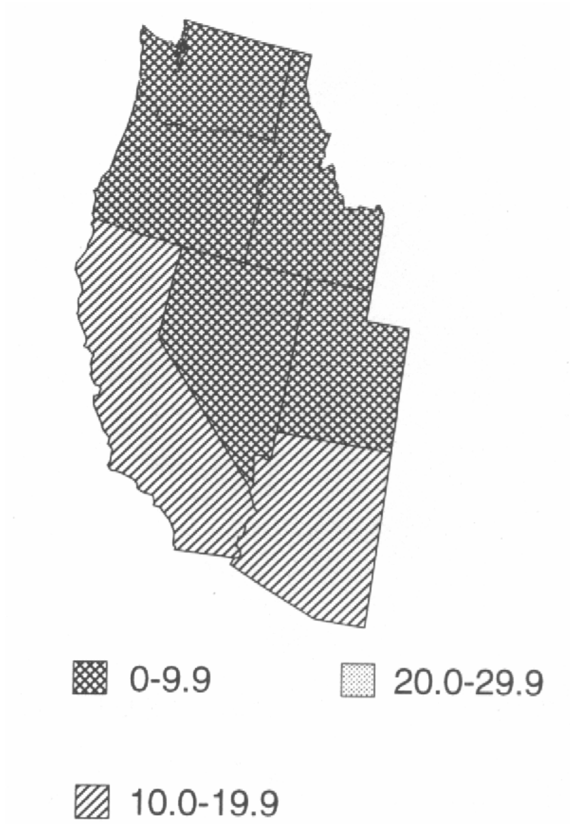

Fig 11. Mean number of mourning doves heard per route by state in the Western Management Unit, 1999-2000.

Texas (Fig. 9, Table 1). Over a 35-year period dove population indices declined in Missouri, but no significant trends were found in any other state (Fig. 10, Table 1).

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.

1999-2000 Population Distribution.–Arizona and California averaged between 10 and 20 actual doves heard per route (Fig. 11). The other states in the unit averaged < 10 birds per route.

1999 to 2000 Population Changes.--The average number of doves heard per route did not change significantly between years, although the index decreased by 3.6% (Table 1). The 2000 population index of 10.3 doves heard per route is above the predicted count of 8.6 based

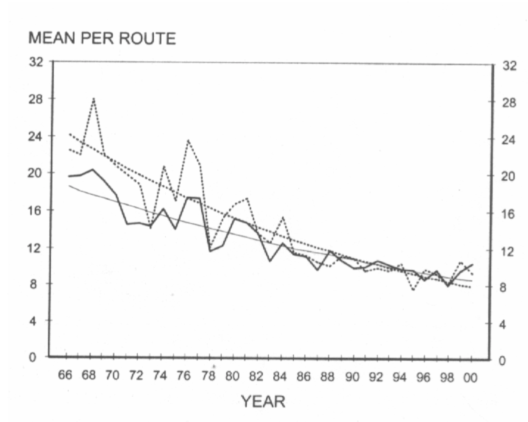

Fig. 12. Population indices and trends of breeding mourning doves in the Western Management Unit, 1966-2000. Heavy solid line = doves heard; heavy dash line = doves seen; light solid and dash lines = predicted trends.

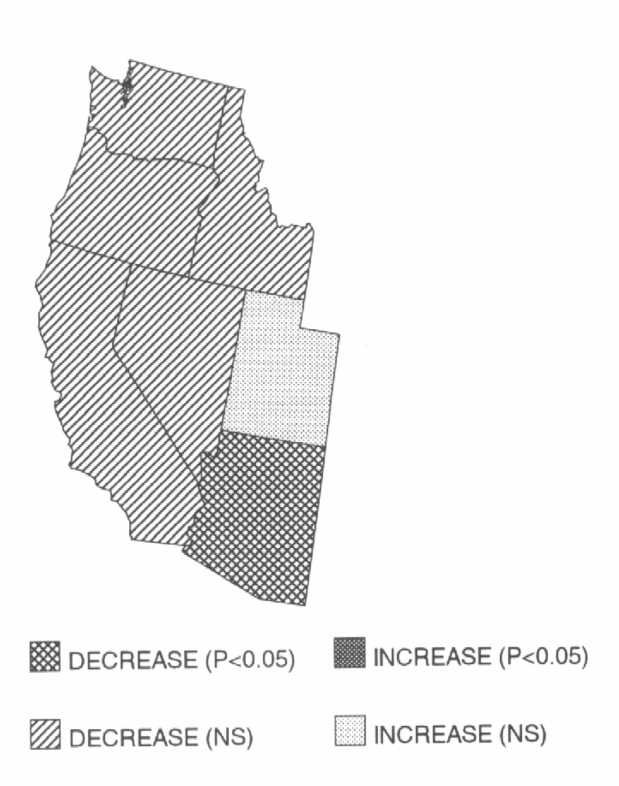

Fig. 13. Trends in number of mourning doves heard per route by state in the Western Management Unit, 1991-2000.

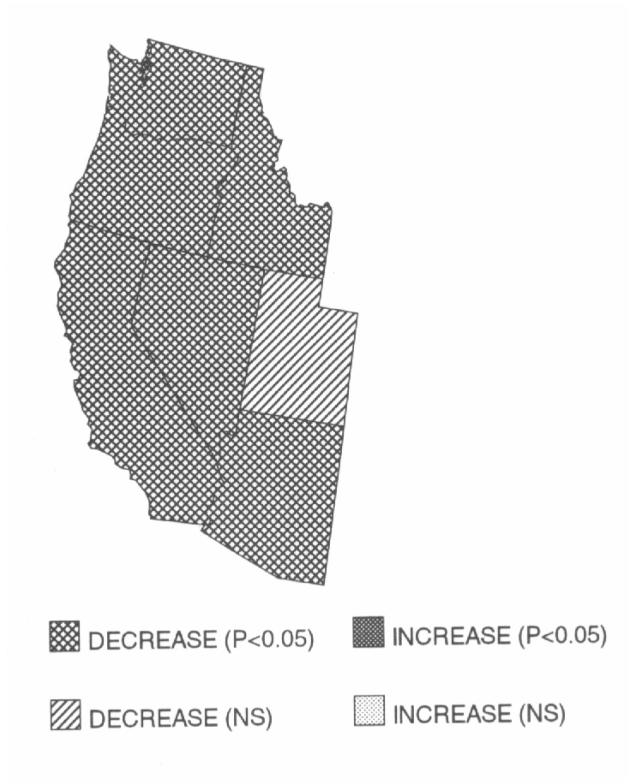

Fig. 14. Trends in number of mourning doves heard per route by state in the Western Management Unit, 1966-2000

on the long-term estimate (Fig. 12, Table 2).

The number of doves heard per route increased significantly in Utah (Table 1). No significant decreases were found in any state.

Population Trends: 10 and 35-year.--Numbers of doves heard declined significantly during both time periods (Table 1). Doves seen also declined significantly over both time periods.

By state, only Arizona dove trends declined over 10-year period (Figs. 13, 14, Table 1). All states in the Unit except Utah show a decline between 1966 and 2000.

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, we included 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 and Smith 1999). 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 (1990-99) and over 34 years (1966-99) are presented in Table 3.

In general, trends indicated by both surveys are similar. 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, the CCS indicated a significant decline (*P*<0.01) in doves heard for the combined hunting states in the EMU while the BBS showed no trend. For the nonhunting states, the CCS showed a tendency toward a decline (*P*<0.10) while the BBS trend was not significant. For the EMU as a whole, there was a significant decline (*P*<0.01) with the CCS while the BBS showed no trend (*P*=0.3429). For the CMU, the CCS showed a significant decline (*P*<0.05) while the

BBS showed a tendency toward a decline (*P*=2076). In the WMU, the CCS indicated a significant decline (*P*<0.01) while the BBS showed no trend (*P*=0.9863).

Over the last 34 years, results were similar with both surveys for the Central and Western Management Units. However, in the Eastern Unit, CCS analyses indicated a significant decline (*P*<0.05) while the BBS showed an increase (*P*<0.05) over the period. The combined hunting states in the EMU showed a tendency toward a decline (*P*<0.10) in the CCS, while there was no trend indicated in the BBS. The nonhunting states of the EMU were also different. The CCS showed no trend, but BBS data indicated a significant increase (*P*<0.01).

HARVEST ESTIMATES

State Surveys

In past years, a compilation of non-uniform, 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, approximately 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 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. In 1991, doves provided approximately 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, and 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 methodologies 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 migratory upland 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.

Although the results of the 1999-2000 Harvest Information Program surveys were not compiled in time to be included in this report, results of mourning dove harvest surveys conducted for the 1998-99 hunting season are presented in Table 4. The reliability of those 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. Estimates for Georgia, Kentucky, Montana, West Virginia, and Wyoming were not available due to data processing problems.

The Harvest Surveys Section is continuing to work with states to improve the accuracy and precision of the harvest estimates. Data for the 1999-2000 survey are improved and will be available soon. In the future, results will be presented by state within dove management unit.

ACKNOWLEDGMENTS

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Table 1. Trends (% change[a] per year as determined by linear regression) in number of mourning doves heard along call-count survey routes, 1966-2000.

	2 year (1999-2000)					10 year (1991-2000)					35 year (1966-2000)				
	N	% Change		90% CI		N	% Change		90% CI		N	% Change		90% CI	
EASTERN UNIT															
Hunt															
AL	26	6.5		-13.2	27.2	28	-0.63		-1.9	0.6	42	-0.34		-1.2	0.4
DE/MD	10	6.2		-10.7	24.7	14	-2.62	**	-4.82	-0.6	19	-1.7	**	-3.0	-0.5
FL	14	-28.5	***	-43.1	-13.2	23	-1.01		-3.1	1.1	28	0.60		-0.4	1.5
GA	18	-15.1		-31.4	3.1	21	-4.32	***	-6.4	-2.0	28	-0.90	**	-1.5	-0.3
IL	13	18.7		-1.7	42.2	20	-0.23		-3.5	3.8	22	0.81		-0.4	1.9
IN	12	-0.4		-18.0	18.6	15	-3.8	***	-4.7	-2.8	18	-1.54	**	-2.5	-0.4
KY	14	2.6		-12.4	18.8	20	1.32		-1.4	3.9	25	-0.5		-1.9	0.8
LA	13	-9.4		-29.9	14.1	19	0.7		-3.0	4.4	23	1.0	*	0.1	2.2
MS	13	-2.6		-20.3	16.9	23	0.1		-2.3	2.3	31	-1.82		-3.41	0.1
NC	16	10.3		-4.0	25.7	21	1.02		-0.4	2.3	24	-0.17		-1.31	0.9
OH[c]	32	1.6		-9.86	13.7	37	-1.9		-4.6	1.0	57	-1.2	***	-1.84	-0.5
PA	11	27.0		-4.8	61.0	17	0.7		-3.0	4.3	17	1.10		-1.12	3.1
SC	11	-9.0		-19.6	1.6	20	-1.64		-3.9	0.5	25	-1.1		-2.24	0.0
TN	18	-0.9		-15.5	12.8	24	-1.8		-4.4	0.8	32	-1.5	**	-2.54	-0.5
VA	27	-3.3		-16.6	10.5	33	0.52		-1.83	2.8	33	-2.8	*	-5.0	-0.2
WV	9	-7.0		-24.8	13.3	10	-4.00	**	-6.54	-1.3	11	1.81		-0.94	3.7
Subunit	257	-0.6		-5.7	5.0	345	-1.0	**	-1.71	-0.3	378	-0.53	**	-1.0	-0.1
Nonhunt															
MI	9	7.7	*	1.1	14.7	21	0.9		-2.4	3.9	22	-0.1		-1.71	1.5
N.England[d]	33	2.0		-12.3	18.5	43	-1.01		-3.0	1.0	76	2.14	***	1.07	3.1
NJ	5	68.3	*	0.1	155.	11	1.7		-4.9	7.4	20	-2.2		-5.14	1.3
NY	10	33.2		-22.3	98.5	17	1.21		-0.23	2.6	20	1.2		-0.9	3.6
WI	12	10.6		-10.2	32.3	22	-2.1		-5.5	1.0	23	0.1		-1.06	1.4
Subunit	69	10.0	**	1.9	18.3	114	-0.3		-2.01	1.5	218	-0.11		-0.76	0.5
Unit	326	1.3		-3.6	6.4	459	-0.83	**	-1.5	-0.2	596	-0.43	**	-0.8	-0.1
CENTRAL UNIT															
AR	9	-17.0		-34.0	2.6	15	0.3		-1.3	1.5	16	-0.9		-2.1	0.4
CO	8	-35.9		-77.3	27.1	17	5.00	*	0.33	10.6	21	2.3		-0.4	5.0
IA	13	2.0		-21.7	26.0	16	0.3		-2.6	2.8	17	0.2		-0.81	1.5
KS	19	-29.3	***	-46.1	-10.9	28	2.1		-1.2	5.7	33	0.20		-0.54	0.9
MN	8	8.0		-15.5	31.5	12	-3.04	*	-5.6	-0.2	13	-1.20		-2.81	0.6
MO	16	-4.3		-20.8	13.2	22	-3.6	**	-6.1	-0.9	28	-2.24	***	-3.6	-1.0
MT	9	3.0		-9.4	16.1	20	7.54	***	4.1	11.2	27	-1.7		-3.8	0.4
NE	21	-2.5		-11.5	7.0	24	-1.31		-3.3	0.6	27	-0.65		-1.4	0.1
NM	13	19.1		-6.1	43.8	28	0.84		-2.9	4.7	31	0.8		-0.42	2.0
ND	23	11.6		-0.3	23.0	26	-2.1		-4.7	0.4	29	0.62		-1.1	2.2
OK	13	-9.7		-23.9	5.9	17	1.64		-3.0	6.3	25	-0.9		-3.7	2.3
SD	14	9.6		-6.7	26.7	22	-3.04	**	-4.94	-0.9	28	-0.7		-2.02	0.7
TX	103	-7.0		-15.8	2.6	138	-2.20	***	-3.52	-0.9	196	-0.4		-1.01	0.3
WY	9	-7.2		-21.4	9.4	16	0.5		-4.3	4.7	21	-3.6	*	-6.1	-0.1
Unit	278	-5.1	*	-10.3	-0.1	401	-1.21	***	-2.0	-0.5	512	-0.42	**	-0.8	-0.1
WESTERN UNIT															
AZ	32	-11.1		-25.9	4.2	54	-2.63	**	-4.44	-0.8	68	-1.2	**	-2.1	-0.5
CA	38	0.8		-9.4	11.4	62	-0.9		-2.52	0.7	80	-2.5	***	-3.71	-1.4
ID	10	5.3		-27.4	48.0	22	-2.63		-7.12	2.7	26	-3.13	**	-5.52	-0.6
NV	8	-2.2		-56.0	75.8	26	-1.74		-7.81	4.6	31	-5.74	***	-8.0	-3.7
OR	7	10.5		-36.6	65.3	18	-2.31		-5.61	1.1	25	-3.02	***	-5.1	-1.2
UT	7	46.1	*	4.0	114.	18	1.0		-3.93	7.4	19	-3.62	*	-7.7	-0.2
WA	14	1.2		-15.1	20.4	21	-5.3		-10.3	0.8	26	-2.5	**	-4.62	-0.5
Unit	116	-3.6		-13.4	6.4	221	-2.1	***	-3.32	-0.8	275	-2.24	***	-2.92	-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., 35 years) may exaggerate the total change over the period.

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

[c] Ohio had hunting seasons in 1975-1976 and 1995-1999.

[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, 1966-2000.

Management unit/state	1966	1967	1968	1969	1970	1971	1972	1973	1974
EASTERN UNIT									
Hunt									
AL	25.6	22.9	20.7	21.0	21.2	17.4	25.0	21.9	16.7
DE/MD	16.7	20.4	14.3	15.1	18.7	15.8	17.3	17.1	18.1
FL	11.0	10.5	9.0	9.6	12.3	10.3	10.6	10.8	13.2
GA	30.1	28.6	24.6	26.3	33.2	26.2	25.0	27.5	28.5
IL	21.8	18.9	22.4	19.5	22.7	20.8	21.4	21.1	17.9
IN	37.2	34.2	33.6	32.6	31.5	42.5	37.2	33.2	31.6
KY	24.2	21.9	21.4	22.4	26.9	24.1	20.2	24.0	27.9
LA	10.5	10.7	10.0	11.7	8.0	10.5	11.6	9.0	10.5
MS	39.8	34.2	29.0	26.9	29.7	30.2	33.7	30.2	24.2
NC	34.5	27.9	29.4	41.7	48.1	28.0	22.7	43.2	24.6
PA	8.8	9.4	8.7	8.4	5.5	6.3	8.9	5.8	8.6
SC	31.0	33.9	34.6	33.4	31.4	27.5	24.5	27.9	26.0
TN	31.5	23.0	23.6	23.4	31.8	22.4	28.4	21.6	23.2
VA	28.0	22.8	26.2	23.0	29.6	23.5	14.2	16.6	22.4
WV	6.4	5.4	5.6	6.0	5.6	5.0	6.6	3.9	4.2
Subunit	23.4	21.3	20.4	20.8	21.9	19.8	20.4	19.6	19.7
Nonhunt									
MI	14.6	15.7	10.4	10.6	8.5	16.9	17.5	13.7	11.6
N.England[b]	5.5	6.0	5.5	4.8	5.6	5.9	6.6	7.8	5.0
NJ	19.5	16.7	20.7	19.0	25.7	24.3	25.5	22.5	21.6
NY	6.8	6.9	6.4	6.4	7.8	9.1	7.2	7.4	7.6
OH[c]	24.1	22.7	20.5	23.4	23.1	23.9	24.9	19.8	24.0
WI	10.9	14.0	14.0	10.8	11.5	16.7	17.5	11.4	12.1
Subunit	12.4	13.3	11.6	10.9	11.1	14.9	15.1	12.5	11.8
Unit	20.0	19.1	17.8	17.8	18.5	18.7	19.1	17.6	17.4
CENTRAL UNIT									
AR	22.6	23.6	22.7	21.8	23.5	23.6	22.1	24.9	23.0
CO	15.3	16.0	14.9	20.5	21.1	15.4	20.9	13.7	22.3
IA	29.7	26.7	28.7	26.1	18.9	23.3	31.3	29.6	23.2
KS	46.2	46.7	48.4	49.1	45.3	46.2	51.6	46.0	45.8
MN	28.8	23.3	25.1	18.6	15.0	21.5	24.8	18.8	25.8
MO	40.8	38.5	48.1	29.0	40.0	33.5	45.3	33.9	29.0
MT	27.1	25.1	19.7	21.8	17.4	24.8	19.7	14.2	16.5
NE	44.0	38.6	49.4	48.4	46.9	44.6	43.2	41.4	42.8
NM	15.1	11.2	15.7	12.0	11.7	11.0	12.7	9.1	11.1
ND	33.4	32.3	44.1	36.7	32.8	34.0	35.2	39.2	38.5
OK	23.4	28.9	33.9	32.7	25.6	18.6	29.8	28.0	29.2
SD	53.0	33.2	45.4	38.6	46.0	40.4	40.2	42.4	50.7
TX	26.2	21.7	21.4	19.4	20.6	19.9	26.6	21.3	22.8
WY	23.0	24.2	12.6	20.4	19.5	11.0	14.8	14.7	21.1
Unit	29.2	26.2	27.0	25.8	24.9	24.6	28.1	23.5	26.4
WESTERN UNIT									
AZ	29.1	29.2	26.6	31.0	31.0	20.9	23.4	28.2	24.3
CA	27.8	26.3	24.2	23.9	23.3	17.5	21.2	20.4	22.0
ID	18.7	19.2	17.2	17.8	16.7	13.0	12.5	15.2	12.6
NV	13.7	12.2	28.9	19.1	13.8	8.2	11.0	7.6	10.2
OR	16.8	11.2	13.3	12.0	9.1	7.9	7.7	7.6	13.2
UT	21.5	32.9	16.8	15.9	18.3	25.6	14.9	12.9	14.6
WA	11.1	16.3	15.2	12.2	12.3	14.6	10.4	9.4	11.8
Unit	19.6	19.7	20.4	19.2	17.7	14.6	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 35-year period.
[b] 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, 1966-2000.

Management unit/state	Year 1975	1976	1977	1978	1979	1980	1981	1982	1983
EASTERN UNIT									
Hunt									
AL	21.4	20.6	22.7	25.0	24.1	24.1	23.2	23.7	23.8
DE/MD	12.9	15.7	14.4	15.1	14.7	13.9	13.3	13.9	9.9
FL	14.0	12.8	14.1	11.1	12.1	9.7	9.0	10.6	12.3
GA	31.0	24.4	25.4	27.6	24.1	24.7	27.2	29.3	26.2
IL	25.3	24.9	26.7	20.6	18.0	18.4	20.8	25.4	26.2
IN	33.4	33.6	37.4	20.3	21.5	27.3	31.4	22.3	19.2
KY	19.6	24.6	23.0	24.6	16.9	16.4	27.9	24.0	13.3
LA	11.0	11.1	9.1	10.7	9.1	12.7	11.0	13.8	12.6
MS	25.7	26.2	27.0	30.5	26.1	24.5	24.5	30.8	25.8
NC	13.9	16.8	44.5	23.7	28.2	27.3	26.9	22.5	26.5
PA	5.9	6.0	4.9	6.1	6.8	8.0	9.5	9.0	9.0
SC	25.7	25.5	21.6	28.7	24.4	30.6	29.8	30.8	29.3
TN	22.2	22.0	24.2	29.8	20.4	22.2	18.7	25.0	19.4
VA	25.0	23.6	31.4	23.2	20.5	19.9	17.1	18.7	18.4
WV	2.4	5.8	5.4	6.8	7.3	8.4	6.8	6.4	6.1
Subunit	19.0	19.5	20.8	20.0	18.3	19.3	19.5	20.7	19.1
Nonhunt									
MI	12.9	13.1	11.0	12.6	7.4	13.4	15.3	11.1	9.8
N.England[b]	4.8	4.5	8.4	7.3	6.1	7.6	9.3	7.6	8.1
NJ	15.5	19.5	21.3	16.9	18.1	16.7	14.0	15.7	18.7
NY	13.4	7.9	7.8	9.5	6.4	11.2	9.6	10.2	9.4
OH[c]	36.7	26.8	25.6	13.5	13.1	15.8	19.3	18.4	19.4
WI	15.1	15.1	19.7	8.0	11.5	14.8	19.9	10.9	12.8
Subunit	15.0	12.8	14.0	10.6	9.0	13.0	14.8	11.6	11.8
Unit	18.1	17.7	19.0	17.0	15.3	17.6	18.5	18.0	17.0
CENTRAL UNIT									
AR	22.1	26.9	21.9	15.4	12.6	20.8	22.8	26.5	19.9
CO	16.8	23.7	22.9	25.9	22.8	27.3	32.0	31.2	17.7
IA	21.6	26.9	20.9	23.5	20.0	27.1	30.0	21.6	15.4
KS	44.0	48.5	46.2	35.9	53.0	57.6	55.0	52.4	59.1
MN	28.1	24.8	28.8	27.8	28.3	30.8	27.3	24.0	21.3
MO	33.9	29.9	34.6	22.1	21.0	32.6	27.4	24.1	23.3
MT	22.5	16.4	20.0	19.2	19.2	17.6	16.4	21.0	16.9
NE	40.3	45.5	46.2	38.2	41.1	52.3	49.7	48.8	44.5
NM	13.7	13.5	12.1	12.0	8.2	13.3	13.2	10.3	13.9
ND	28.3	45.7	38.0	40.9	38.5	43.7	44.0	41.4	40.0
OK	26.3	27.9	35.3	27.0	26.0	26.8	26.5	27.5	28.3
SD	42.6	46.2	40.4	43.4	42.5	42.6	38.3	45.5	39.3
TX	20.6	20.2	19.2	20.1	24.9	23.7	21.6	21.0	19.5
WY	18.6	17.2	10.9	17.2	13.1	11.8	12.9	16.7	11.2
Unit	25.8	26.6	25.5	25.1	24.8	27.8	27.0	27.0	24.0
WESTERN UNIT									
AZ	26.7	27.6	24.6	24.7	24.0	21.5	24.2	27.6	21.4
CA	18.6	22.3	17.1	15.4	11.8	20.1	16.6	20.6	12.7
ID	8.7	16.0	19.6	10.7	10.3	10.8	11.8	12.1	9.1
NV	6.1	9.8	10.1	6.0	8.7	12.0	8.6	4.6	4.1
OR	9.7	10.2	11.3	5.9	6.1	9.0	7.7	7.4	5.7
UT	15.7	18.4	21.4	9.4	11.6	13.9	18.4	11.1	10.9
WA	12.7	12.2	13.3	8.6	12.0	8.2	9.8	9.1	7.7
Unit	14.0	17.5	17.3	11.7	12.3	15.2	14.8	13.6	10.6

[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 35-year period.
[b] 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, 1966-2000.

Management unit/state	1984	1985	1986	1987	1988	1989	1990	1991	1992
EASTERN UNIT									
Hunt									
AL	19.9	25.5	23.2	20.7	22.9	19.7	18.5	17.3	19.9
DE/MD	11.2	12.3	14.5	12.5	11.6	15.9	7.6	11.8	15.1
FL	8.5	11.0	12.9	11.7	14.2	13.0	11.7	12.6	12.9
GA	21.2	27.3	24.7	25.5	25.6	26.1	26.8	21.8	30.7
IL	21.3	18.4	25.5	25.0	28.4	27.9	27.3	27.8	28.9
IN	20.8	18.3	24.3	24.5	29.4	24.9	27.1	27.4	24.2
KY	21.4	22.2	20.0	24.5	19.5	26.7	22.2	21.2	16.9
LA	11.9	10.7	9.8	14.1	10.5	16.5	11.8	12.0	16.0
MS	19.2	25.4	25.0	22.2	26.2	24.6	20.8	17.0	22.2
NC	29.7	20.6	28.9	28.0	25.6	30.7	28.5	24.3	23.5
PA	8.3	9.1	9.6	10.9	7.4	9.6	9.6	9.8	11.0
SC	26.6	26.7	22.8	33.1	26.2	25.1	27.2	22.1	21.7
TN	16.6	21.4	16.2	20.0	19.6	18.0	15.8	18.9	18.6
VA	17.8	16.3	13.3	13.7	14.9	14.5	12.3	13.0	11.3
WV	5.5	6.7	6.4	6.7	7.7	8.2	10.7	9.0	7.2
Subunit	17.4	18.6	18.8	19.9	19.6	20.5	18.9	18.2	19.3
Nonhunt									
MI	10.4	11.4	14.6	11.9	14.3	17.8	13.4	11.0	12.6
N.England[b]	7.0	7.8	8.6	8.2	7.7	8.1	9.0	9.9	10.6
NJ	11.8	12.3	14.5	13.2	12.8	15.7	12.6	14.9	9.6
NY	9.2	8.4	7.1	9.3	7.5	11.6	10.3	12.5	10.6
OH[c]	18.1	16.9	16.4	17.8	20.4	19.2	17.6	18.8	19.7
WI	10.0	10.3	11.1	7.3	17.2	17.2	13.8	12.7	19.3
Subunit	10.7	10.8	11.4	10.4	12.8	14.6	12.6	12.7	14.0
Unit	15.4	16.3	16.6	16.9	17.7	19.0	17.2	16.8	18.0
CENTRAL UNIT									
AR	14.2	14.1	15.3	14.3	15.8	22.2	17.3	15.5	18.8
CO	23.0	28.3	27.5	30.5	34.6	39.5	35.9	24.0	18.4
IA	22.6	24.9	22.6	21.7	29.2	27.4	31.6	23.6	31.9
KS	46.9	60.6	41.8	45.2	52.2	45.9	39.9	57.5	55.8
MN	18.2	19.8	18.3	23.4	23.8	19.1	15.8	19.6	22.8
MO	22.1	21.1	22.0	24.7	24.8	24.3	19.7	21.2	21.6
MT	12.8	17.6	18.4	17.7	14.6	18.6	20.3	13.4	14.4
NE	42.4	43.7	35.8	35.9	35.9	40.1	39.9	40.7	38.2
NM	15.0	12.8	15.3	18.5	13.9	15.4	16.9	15.8	10.3
ND	31.4	41.2	38.6	44.5	42.1	44.2	43.3	48.0	51.5
OK	21.2	20.6	22.9	25.0	22.1	16.4	21.5	21.6	23.5
SD	43.2	40.4	37.5	33.3	39.4	42.5	44.0	46.3	37.7
TX	19.1	19.8	21.4	21.1	21.7	16.6	17.7	24.6	22.4
WY	10.1	11.6	14.2	11.4	7.4	8.7	8.8	9.3	9.5
Unit	22.5	24.6	24.8	25.6	24.6	24.5	24.6	25.0	24.0
WESTERN UNIT									
AZ	26.3	21.1	25.0	16.8	18.8	23.0	17.7	22.3	23.9
CA	17.7	12.5	14.5	11.1	14.9	11.0	11.0	10.8	11.7
ID	10.6	9.8	6.9	7.0	8.9	9.0	9.8	9.0	8.1
NV	4.1	5.2	3.4	3.9	5.3	4.6	3.2	4.2	3.5
OR	7.1	7.8	6.1	5.6	7.0	5.7	6.3	4.0	6.2
UT	12.5	8.2	11.4	10.0	10.2	10.7	9.1	8.2	10.6
WA	6.7	8.4	10.1	8.0	8.0	6.9	7.2	9.0	8.0
Unit	12.6	11.3	11.1	9.6	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 35-year period.
[b] 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, 1966-2000.

Management	year							
unit/state	1993	1994	1995	1996	1997	1998	1999	2000
EASTERN UNIT								
Hunt								
AL	21.7	22.7	24.0	18.7	17.6	19.6	18.8	20.1
DE/MD	10.2	12.6	11.3	10.6	8.8	12.1	8.8	8.8
FL	11.5	10.9	12.2	11.9	10.7	13.5	14.5	13.3
GA	19.3	22.0	26.3	22.1	19.2	18.4	18.6	17.6
IL	25.4	28.4	29.4	23.2	23.8	24.0	22.1	29.0
IN	25.5	30.3	24.6	21.1	20.9	21.1	22.0	23.5
KY	21.7	20.9	20.6	18.1	17.1	21.5	21.6	23.5
LA	12.1	13.2	15.1	12.2	12.6	14.4	15.1	17.2
MS	24.3	20.5	18.8	17.7	16.6	16.8	20.2	17.0
NC	24.4	24.6	26.7	27.2	29.7	29.1	29.8	35.3
PA	12.0	11.4	11.0	10.6	9.7	11.8	9.5	11.2
SC	25.6	22.9	18.2	22.8	21.8	24.6	22.4	22.1
TN	16.3	19.9	18.4	15.7	16.8	16.5	16.4	18.4
VA	12.8	12.4	13.2	10.6	13.4	12.4	12.2	13.3
WV	8.5	9.2	9.5	4.7	9.4	7.8	9.1	8.7
Subunit	18.6	19.2	19.4	16.9	17.0	18.1	18.0	19.1
Nonhunt								
MI	11.6	11.0	12.3	12.5	12.1	13.7	12.9	16.8
N.England[b]	11.0	10.0	12.7	8.8	8.9	9.6	11.1	11.6
NJ	15.4	13.4	9.9	12.8	6.9	11.3	9.1	11.9
NY	9.5	9.8	10.6	9.9	10.8	9.4	12.3	13.7
OH[c]	16.6	18.5	17.0	13.8	13.8	16.4	16.7	18.0
WI	17.8	15.0	12.5	11.4	11.9	9.7	18.0	16.3
Subunit	13.2	12.5	12.6	11.2	11.2	11.4	13.8	15.0
Unit	17.2	17.3	17.5	15.3	15.4	16.2	17.0	18.1
CENTRAL UNIT								
AR	17.1	20.6	19.1	19.5	20.9	20.2	18.3	18.0
CO	18.1	31.8	27.4	20.9	28.8	32.3	39.7	35.4
IA	24.1	25.3	27.1	34.4	28.2	29.5	28.7	26.8
KS	37.2	51.3	59.8	32.7	59.4	53.9	65.5	50.0
MN	16.5	20.3	19.5	18.6	19.7	18.4	16.5	16.9
MO	21.0	25.0	21.6	21.2	20.5	18.1	16.7	17.5
MT	10.4	9.8	12.4	12.4	11.6	14.5	12.7	13.8
NE	40.0	37.2	40.8	34.2	32.1	40.7	36.9	37.3
NM	11.5	14.5	13.0	11.3	15.0	12.5	14.4	16.7
ND	44.6	38.5	40.7	42.1	38.1	34.2	46.9	45.5
OK	20.3	26.0	19.7	20.7	19.9	28.5	25.8	21.4
SD	34.0	37.1	39.3	38.5	33.0	35.8	36.8	37.6
TX	20.4	22.5	16.9	14.6	21.6	21.8	21.4	18.9
WY	7.0	8.9	6.5	7.6	7.3	7.5	5.6	7.9
Unit	20.9	24.2	22.6	20.7	23.5	24.3	24.2	23.8
WESTERN UNIT								
AZ	24.1	21.3	20.3	11.9	18.3	21.1	22.7	22.0
CA	14.2	11.9	11.8	11.7	10.3	10.4	11.0	10.1
ID	6.9	6.9	6.2	6.0	8.5	5.0	7.0	6.8
NV	2.8	2.5	4.1	3.8	3.3	2.8	3.4	3.0
OR	5.1	6.0	5.0	4.7	4.7	3.5	3.8	5.0
UT	8.8	9.2	6.0	7.0	8.8	5.1	8.0	12.6
WA	6.9	7.2	7.9	5.3	6.6	5.1	6.9	7.8
Unit	10.2	9.8	9.7	8.6	9.7	8.0	9.6	10.4

[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 35-year period.
[b] New England consists of CT, ME, MA, NH, RI, and VT.

Table 3. Trends (% change[a] per year as determined by linear regression) in number of mourning doves heard along Breeding Bird Survey routes, 1966-1999.

	10 year (1990-99)					34 year (1966-99)				
	N	% Change		90% CI		N	% Change		90% CI	
EASTERN UNIT										
Hunt										
AL	85	-1.0		-2.4	0.3	89	-1.032	**	-1.8	-0.3
DE/MD	69	-1.4	*	-2.6	-0.2	77	0.552		0.0	1.1
FL	66	-0.4		-2.4	1.7	79	2.918	***	2.0	3.8
GA	62	-2.4	**	-3.7	-1.1	67	-1.076	*	-2.0	-0.1
IL	81	1.0		-0.4	2.4	81	0.4		-0.5	1.3
IN	43	-1.9	***	-2.9	-0.9	44	-0.21		-0.9	0.4
KY	35	-1.8	*	-3.3	-0.2	48	0.336		-0.3	0.9
LA	46	2.9	**	1.0	4.8	59	1.418	*	0.13	2.7
MS	26	-1.6		-4.0	0.8	34	-1.327	**	-2.3	-0.4
NC	57	-0.5		-1.6	0.6	65	-0.303		-1.2	0.6
OH[c]	68	0.2		-1.0	1.4	75	0.657	*	0.03	1.3
PA	98	1.5		0.0	3.0	118	2.448	***	1.74	3.2
SC	23	3.22	***	1.8	4.7	29	-0.4		-1.2	0.5
TN	42	-1.5		-3.4	0.5	45	-0.8		-1.8	0.2
VA	49	-0.6		-2.3	1.2	55	-0.5		-1.1	0.2
WV	48	1.94		-0.4	4.3	53	6.0	***	5.01	7.0
Subunit	898	-0.4		-0.9	0.2	1018	1.0		-0.2	0.4
Nonhunt										
MI	65	0.0		-1.2	1.2	75	0.343		-0.2	0.9
N.England[d]	139	2.01	**	0.7	3.4	149	3.606	***	2.5	4.7
NJ	28	-0.6		-2.9	1.6	36	0.6		-0.5	1.7
NY	106	1.23	*	0.2	2.3	114	3.2	***	2.7	3.7
WI	86	-1.0		-2.0	0.0	88	1.013		-0.2	2.2
Subunit	424	0.23		-0.3	0.8	462	1.447	***	1.0	1.9
Unit	1322	-0.3		-0.7	0.2	1480	0.326	**	0.1	0.6
CENTRAL UNIT										
AR	31	5.1	***	3.2	7.0	33	-0.133		-1.3	1.1
CO	105	3.22	**	1.04	5.4	110	0.9		-0.3	2.0
IA	35	1.1		-0.3	2.5	37	-1.0		-1.9	0.0
KS	38	-1.9	**	-3.4	-0.4	39	-0.131		-1.0	0.7
MN	61	-2.6	*	-4.8	-0.5	66	-1.6	**	-2.7	-0.5
MO	52	-1.8	*	-3.4	-0.2	60	-2.6	***	-3.2	-1.9
MT	48	-1.7		-3.6	0.3	53	-0.901	**	-1.6	-0.2
NE	40	0.19		-1.6	2.0	44	-0.739		-1.5	0.0
NM	60	2.13		-0.9	5.2	68	-0.5		-2.3	1.4
ND	42	-3.7	***	-5.2	-2.2	45	1.62	***	1.05	2.2
OK	56	-1.5		-3.1	0.2	60	-2.0	***	-2.6	-1.3
SD	29	-3.4	**	-5.7	-1.1	44	0.534		-0.3	1.3
TX	164	0.62		-0.7	2.0	184	-1.6	***	-2.1	-1.0
WY	78	-1.6		-3.7	0.5	96	-0.523		-1.8	0.8
Unit	839	-0.4		-1.0	0.1	939	-0.7	***	-1.0	-0.4
WESTERN UNIT										
AZ	57	-1.3		-5.1	2.6	69	-1.44		-3.6	0.7
CA	164	-0.3		-2.1	1.4	203	-1.2	***	-1.9	-0.5
ID	39	-1.4		-5.2	2.4	43	-1.8	***	-2.7	-0.9
NV	22	6.3	**	1.7	11.0	31	5.1	**	1.1	9.1
OR	81	2.14		-0.4	4.7	93	-2.602	***	-3.8	-1.4
UT	77	-0.5		-3.3	2.2	79	-3.2	***	-4.9	-1.5
WA	56	-0.5		-2.8	1.8	61	-0.3		-1.9	1.4
Unit	496	0.0		-1.4	1.3	579	-1.449	***	-2.0	-0.9

[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., 35 years) may exaggerate the total change over the period.

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

[c] Ohio had hunting seasons in 1995-1999.

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

Table 4. The number of days afield, birds bagged, active hunters, the bag per active hunter and percent confidence intervals for each from the 1998-99 Harvest Information Program harvest surveys.

State	Days afield	95%CI	Birds bagged	95%CI	Active hunters	95%CI	Bag/Active hunter	95%CI
Alabama	248,300	87%	1,567,400	106%	53,100	33%	30	111%
Arkansas	138,700	104%	955,600	109%	54,600	124%	17	155%
Arizona	139,100	12%	897,700	15%	40,000	11%	22	18%
California	214,100	15%	1,107,500	15%	62,000	12%	18	19%
Colorado	25,700	64%	74,500	46%	5,700	37%	13	60%
Delaware	6,200	95%	34000	88%	1,700	96%	20	130%
Florida	122,400	49%	707,400	61%	23,200	32%	31	69%
Idaho	19,300	18%	70,000	20%	6,500	17%	11	27%
Illinois	84,700	10%	469,900	12%	26,300	9%	18	15%
Indiana	52,400	39%	270,300	50%	11,600	32%	23	59%
Kansas	156,600	12%	802,500	14%	36,000	8%	22	17%
Louisiana	79,900	53%	485,600	52%	41,200	56%	12	76%
Maryland	63,100	27%	377,500	34%	19,200	27%	20	43%
Mississippi	46,500	62%	209,400	49%	19,100	60%	11	78%
Missouri	94,800	24%	446,400	25%	25,800	14%	17	29%
North Carolina	208,000	17%	1,158,500	16%	69,200	11%	17	19%
North Dakota	18,600	36%	82,400	27%	5,200	25%	16	37%
Nebraska	29,800	75%	152,000	78%	6,300	76%	24	109%
New Mexico	11,200	46%	58,900	46%	4,200	62%	14	77%
Nevada	10,300	53%	46,000	71%	4,100	51%	11	87%
Ohio	24,100	46%	88,200	49%	7,000	47%	13	68%
Oklahoma	71,200	55%	351,400	68%	25,700	41%	14	79%
Oregon	26,300	39%	92,900	39%	7,500	29%	12	49%
Pennsylvania	123,900	23%	397,900	23%	29,900	15%	13	27%
Rhode Island	900	91%	2,900	167%	300	80%	8	185%
South Carolina	140,800	19%	915,500	18%	44,800	15%	20	23%
South Dakota	38,600	26%	194,100	30%	10,500	24%	18	39%
Tennessee	42,700	37%	354,500	27%	17,700	38%	20	47%
Texas	1,280,100	7%	8,474,500	8%	325,600	5%	26	10%
Utah	14,100	18%	47,800	19%	4,900	8%	10	20%
Virginia	65,600	37%	315,400	58%	21,900	25%	14	64%
Washington	32,900	34%	137,000	35%	14,500	26%	9	44%

CURRENT RESEARCH ACTIVITIES (PROGRESS TO DATE)

Eastern Management Unit

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 1990-99 (Smith and Dolton 1999). Although reasons for this negative trend are not known, survivorship appears to have decreased in South Carolina between the 1970's and 1990's (Haas 1978, McGowan and Otis 1998). Currently, annual survivorship of juveniles is thought to be particularly low (McGowan and Otis 1998).

Because the role of hunting in this population decline is unknown, we initiated a study to examine population parameters on 3 sites in the Upper Coastal Plain of South Carolina with different levels of hunting pressure. The objectives of this study are to: (1) estimate cause-specific mortality rates from July-November, (2) determine whether site-, year-, and age-specific differences in survivorship exist, (3) compare harvest rate estimates of derived from banding and telemetry data, (4) estimate the crippling rate of doves, and (5) examine the influence of various abiotic factors on indices of annual production, (6) assess the impact of subcutaneously implanted radiotransmitters on the health and survivorship of doves.

We are using telemetry and banding data to estimate period and annual survival rates, respectively. Telemetry data are also being used to estimate the magnitude and timing of various sources of mortality, and to estimate crippling rates. We are also collecting harvest age ratio data at organized dove hunts within 5 km of the 3 study sites. This 5 km buffer zone surrounding the core study sites defines the boundaries of a study site.

Because traditional methods of radiomarking doves have been generally unsuccessful, we elected to attach radiotransmitters to birds using the subcutaneous implantation method (Schulz et al. 1998). During Fall 1997, we began meeting with Clemson University (CU) veterinarians to acquire their assistance in the surgical implantation of transmitters during the 1998 field season. Because the veterinarians were unfamiliar with this marking technique and unsure of the health effects on the birds, the University Animal Research Committee (ARC) required us to conduct a pilot study to determine whether the radiomarked birds developed any negative health effects. Upon the successful completion of this pilot study, the ARC permitted us to begin field research.

Although the subcutaneous implantation of transmitters has been generally successful, it has been necessary to modify the protocol for the release of radiomarked birds back into the wild. In 1998, we released birds at the exact points of capture throughout the diurnal period. Unfortunately, 6 birds were predated within 2 days of release. All predation events occurred at the non-hunted site. Suspected predators were hawks, owls, and red foxes. Consequently, we began releasing radiomarked birds at sites near the point of capture where we believed predators would have more difficulty foraging. We also provided concentrations of preferred foods at the capture site. Further, we released birds in the early morning before buteo hawks could hunt on thermal air currents and when owls were not active. We have subsequently reduced the number of radiotagged birds predated within 7 days of release to 2 in 1999.

In 1998, we radiomarked and released 31 doves (15 juveniles, 11 adult males, 1 adult female, and 4 birds of unknown age and gender) at the heavily hunted site, 22 birds (5 juveniles, 7 adult males, 6 adult females, 2 adults of unknown gender, and 2 birds of unknown age and gender) at the lightly hunted site, and 30 birds (12 juveniles, 9 adult males, 4 adult females, and 5 birds of

unknown age and gender) on the non-hunted site. During the 1999 field season, we radiomarked and released 36 doves (14 juveniles, 15 adult males, 2 adult females, and 5 birds of undetermined age and gender) at the heavily hunted site, 27 birds (10 juveniles, 12 adult males, 2 adult females, 1 adult of undetermined gender, and 2 birds undetermined age and gender) at the lightly hunted site, and 26 birds (11 juveniles, 8 adult males, 2 adult females, 2 adults of undetermined gender, and 3 birds of undetermined age and gender) at the non-hunted site.

In 1998, 8 birds (4 juveniles, 3 adult males, and 1 individual of unknown age and gender) were harvested by hunters on the heavily hunted site. On the lightly hunted site, 1 juvenile was taken by a raptor and 5 birds (2 juveniles, 1 adult male, 1 adult female, and 1 adult of unknown gender) were taken by hunters. On the non-hunted site, 1 juvenile was predated by a raptor, 1 bird of unknown age or gender was predated by a mammal, 2 birds (1 juvenile and 1 bird of unknown age and gender) were harvested by hunters, and 1 adult male was thought to be scavenged by a mammal after being shot but not retrieved. As of mid-November 1999, 1 juvenile has been predated by a raptor and 6 birds (3 juveniles and 3 adult males) have been harvested by hunters on the heavily hunted site. One adult male has been predated by a raptor on the lightly hunted site. One adult male has been predated by a raptor and another adult male was shot but not retrieved near the non-hunted site.
Preliminary analyses indicate that the July - November period survival rates of adults was 0.70 $\pm$ 0.09 (1 SE) in 1998 and 0.70 $\pm$ 0.10 in 1999. Juveniles had period survival rates of 0.49 $\pm$ 0.13 and 0.76 $\pm$ 0.12 during 1998 and 1999, respectively. We observed a crippling rate of 6.3% in 1998 and 14.3% in 1999; well below the 27 - 41% crippling rate previously observed in the Carolinas (Haas 1977). We did not know the fate of 36% of the doves at the end of the 1998 field season, and expect to right-censor a similar proportion of our radiomarked population at the end of the 1999 field season. Possible explanations for the loss of these birds include migration from the study area, transmitter failure, and hunters not reporting telemetered birds.

We found that the uncorrected age ratios (juveniles:adult) of harvested birds were 2.34:1 in 1998 and 1.88:1 in 1999. These age ratios are well below those previously observed in the Carolinas (Haas 1978, McGowan and Otis 1998). We will use corrected age ratios of harvested doves from 4 studies conducted in the Carolinas (Hayne 1975, Haas 1978, McGowan and Otis 1998, this study) as an indices to annual production in this area, and explore how weather variables impact these indices.

Funding for this study was provided by the 1996 Migratory Game Bird Research Program (U.S. Fish and Wildlife Service and U.S. Geological Survey, Biological Resources Division) South Carolina Department of Natural Resources, South Carolina Public Service Authority (Santee-Cooper), Clemson University, and the South Carolina Cooperative Fish and Wildlife Research Unit.

Lead Exposure in Mourning Doves

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Expected Completion: December 2000

In recent years, mortality of birds due to lead exposure has resulted in legislation restricting the use of lead shot, particularly in North America and Europe. In the United States, lead shot was banned for use in waterfowl hunting in 1991, but there is increasing concern that upland birds are also being exposed to lead shot. In fact, lead exposure from the ingestion of spent lead shot has been identified in several species of North American upland game birds, including the mourning dove (*Zenaida macroura*). Over 40 million mourning doves are harvested annually in the United States in selectively managed fields, where up to five to eight shotshells are expended per bird taken. Lead shot densities of greater than 860,000 pellets per hectare have been reported from heavily hunted dove fields. 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. However, data on lead shot ingestion and liver lead concentrations in tissues of mourning doves are limited. Although studies have been conducted in several states, sample sizes varied widely and study designs have differed. 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.

During September 1998, carcasses of 1,660 hunter-killed doves were collected in five states: Arizona, Missouri, Pennsylvania, South Carolina, and Tennessee. All carcasses were aged and sexed, and gizzards, livers, and wing bones were removed. The gizzards were radiographed and examined visually for the presence of shot. 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 1,660 doves collected in 1998, we found ingested shot in 0.84% of the gizzards, while 1.5% of the gizzards contained shot-in shot. As of November, 1999, livers from 549 of the dove carcasses collected in 1998 have been analyzed for lead. Preliminary results indicate that 2.8% 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. Our study continued during the 1999 hunting season, when carcasses of about 2,800 hunter-killed doves were collected in six states: Arizona, Georgia, Missouri, Oklahoma, South Carolina, and Tennessee. These carcasses will be processed as described above, resulting in a total sample size of more than 4,400 doves over the two field seasons covered by the study. 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 second year of a 3-year study funded by the 1998 Webless Migratory Game Bird Research Program (U.S. Fish and Wildlife Service), 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 the year 2000, we will finish the gizzard and tissue analyses and prepare the final report, which we expect to be completed by December, 2000.

Morphometric Discrimination of Age and Sex in Mourning Doves

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Current techniques for determination of age (aging) and sex (sexing) of live mourning doves (*Zenaida macroura*) subjectively evaluate plumage characteristics, head shapes, and progression of molt of primary remiges. These techniques are subject to substantial error and more objective techniques are needed to improve accuracy and precision. Our objective was to develop aging and sexing techniques using morphological measurements in conjunction with linear discriminate function analysis.

We measured length and width of the fifth and tenth primary remiges and central rectrices of wild and captive mourning doves in east-central Alabama. Differences ($P<0.0001$) occurred among age-plumage-sex classes of wild doves, and between sexes and between plumages of captive doves. Feather widths did not differ ($P<0.05$) in wild or captive mourning doves. We developed linear discriminate-function equations to sex wild mourning doves using feather length data, head height and length, body weight, and the number of tail feathers with white tips. These equations correctly classified sex in 90.5% of male and 94.4% of female hatching-year (HY) mourning doves with molt primary 5, 93.9% of male and 94.6% of female HY mourning doves with molt between primaries 6 and 10, 92.3% of male and 92.2% of female HY mourning doves that had completed molt, and all after-hatching-year (AHY) doves. Equations were not developed to age mourning doves due to overlap in mean feather lengths between age classes.

These equations are the best technique currently available for sexing HY mourning doves with primary molt 5.

Combination of these equations with basic subjective techniques also would allow biologists to make better decisions in assigning sex to AHY doves, HY doves with molt > primary 5, and all doves with completed primary molt. Implementation of these methods would eliminate concerns about disparate sex ratios being due to inaccurate determination of sex.

These are final results from this study which is funded by the Alabama Agricultural Experiment Station.

Factors Affecting Food Selection of Mourning Doves in Alabama

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Food habits of mourning doves (*Zenaida macroura*) have been described at locations throughout their distribution, including the southeastern U.S., but information regarding food preferences of mourning doves in this region remains incomplete. Available data suggest that cultivated seeds deteriorate more rapidly than wild seeds, which may influence food selection of mourning doves. Likewise, food preferences may vary with short- or long-term (seasonal) weather changes. The influence of food nutritional quality on food selection in granivorous birds generally is poorly understood. Our objectives were to determine preferences of mourning doves for various cultivated and uncultivated foods in Alabama, examine effects of weather and season on these preferences, test the relationship between dove food selection and food nutritional characteristics, and document deterioration rates of selected mourning dove foods and their effect(s) on food selection. Mourning doves in our study foraged selectively; captive mourning doves consistently selected white proso millet over all other foods offered. Free-flying doves foraged less selectively, and trends were not as clear, although preference for white proso millet was clear in many instances. Food preferences did not change with weather conditions or seasons. Food selection by doves appeared unrelated to nutritional characteristics of foods. Cultivated foods deteriorated at a faster rate than did wild foods; white proso millet deteriorated at the fastest rate, and broadleaf signalgrass (*Brachiaria platyphylla*) at the slowest. Dove preferences among deteriorated foods shifted in favor of the least-deteriorated food. Initially selecting the most rapidly-deteriorating foods may maximize food availability for mourning doves during winter. Funding was provided by the Alabama Department of Conservation and Natural Resources (Division of Game and Fish) and Auburn University.

Mourning Doves and Salt: Is There an Attraction?

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Baiting with salt to attract mourning doves (*Zenaida macroura*) for hunting has been illegal since 1931, yet there has been no comprehensive experimental study of the attraction of wild mourning doves to salt. We completed the first of a 2-year study of various aspects of the relationship between mourning doves and salt during April-September 1998. We documented uptake of rock salt by captive mourning doves, and we investigated the role of salt as grit in the diet of mourning doves by comparing salt consumption among doves with and without access to additional grit. We tested the role of salt in mourning dove reproduction by

comparing salt consumption among breeding and non-breeding birds. We tested the general prediction that salt attracts mourning doves by comparing dove use of foraging patches containing salt bait to use of patches without salt. To date, 1998 data have been compiled and analyzed. Females without access to an additional grit source consumed more salt than did females with access to additional grit, although males did not. Mourning doves feeding crop milk consumed more salt/day than those not feeding young. Mourning dove use was similar between patches containing both food and salt baits and patches with food bait alone, and between salt bait patches and control (no bait) patches. Results of our first year of study confirm that mourning doves will consume salt in their environment. Salt consumption seems to increase in the absence of other grit sources and/or during brooding, when crop milk production increases nutritive requirements. Addition of salt bait does not seem to increase use of foraging areas by mourning doves, however. We began our second (final) year of data collection in April 1999. Field work will be completed in January 2000, with data analysis and manuscript preparation to follow. This study is funded by the Alabama Department of Conservation and Natural Resources (Division of Game and Fish), U.S. Fish and Wildlife Service, and Auburn University.

Management of Selected Food Plantings for Mourning Doves in Alabama

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Changes in laws regarding acceptable planting methods in prepared mourning dove (*Zenaida macroura*) fields have created a need for improved information regarding costs and benefits of various management options. Goals of research to date have been to document benefits of wheat plantings for mourning doves in light of prohibition on hunting over top-sown fields, 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. These results suggest that wheat plantings provide most benefits to mourning doves early in the breeding season, and that little unshattered wheat remains by early August. If prohibition on hunting over top-sown fields continues, wheat may be of limited use in attracting mourning doves for hunting in Alabama. We also 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*) at these 3 sites during June-September 1998. Seed yield varied widely among foods, and was highest for browntop millet and lowest for dove proso millet at all 3 sites. Yields of white proso millet and broadleaf signalgrass varied widely among 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*), and the effects of row spacing and planting rate on seed yield of white proso millet, dove proso millet, and browntop millet. Analysis of these data is underway. Funding is provided by the Alabama Department of Conservation and Natural Resources (Division of Game and Fish) and Auburn University.

Mourning Dove Hunting in Alabama: Motivations, Satisfactions and Socio-cultural Influences

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Knowledge of factors affecting participation in, and satisfactions gained from hunting is important yet unstudied among mourning dove (*Zenaida macroura*) hunters. We investigated effects of 4 aspects of childhood socialization on dove hunting participation and attrition, and we tested 3 predictions based on the multiple-satisfactions model of hunting using a mail survey of hunters in Alabama in 1996. Childhood socialization clearly was important in developing hunting behavior among both dove and non-dove hunters. Dove hunters began hunting at a younger age and were more likely to be introduced to hunting by older family members than were hunters who did not hunt doves. Attrition rate from dove hunting was low (<20%), and was unrelated to age of initiation, person initiating hunting, or childhood residence, but was positively associated with whether or not one currently lived in an urban or urban metro area. Most dove hunters and non-dove hunters appeared motivated by multiple, primarily non-success-based satisfactions, although some hunters were motivated primarily by success. Because of the importance of early socialization and non-success-based motivations among dove hunters, we encourage programs providing childhood socialization toward dove hunting and management for multiple hunter satisfactions. Funding was provided by the Alabama Department of Conservation and Natural Resources (Division of Game and Fish) and Auburn University.

Mourning Dove Body Composition Relative to Reproduction

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Mourning doves (*Zenaida macroura*) form monogamous pair bonds and produce multiple broods throughout a breeding season that typically lasts from late February to early September. While breeding, mourning doves also undergo primary wing molt and begin body molt. Because body composition of mourning doves during the breeding season is poorly known, we plan to determine if changes occur in mourning dove body composition relative to crop gland activity and molt during that time. We collected 5 adult females and 5 adult males per crop gland activity phase (active, developing/regressing, and inactive) during 4 periods of the breeding season (early breeding, peak breeding, late breeding, and non-breeding). The lipid, protein, and ash components of each bird and of each crop gland were determined using a Soxhlet apparatus and muffle furnace. We will use analysis of variance and mean separation programs to do multiple comparisons for differences in body mass, carcass components, and crop gland activity throughout the breeding season. Data analysis is currently underway.

Landscape and Habitat Analysis Along Mourning Dove Call-count 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 are utilizing a 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. Photos purchased from the Aerial Photography Field Office of the Natural Resource Conservation Service for each route were from 1966, 1985, and 1996. 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 included: agriculture, pasture and grassland, pine forest, hardwood-pine forest, hardwood forest, regeneration stands, urban, wetland, and orchard. Once digitized, the percentage of each habitat type for each decade for each route was calculated. Call-count data obtained from the Office of Migratory Bird Management, U.S. Fish and Wildlife Service, was then broken into equal segments around the photo years, and the mean number of doves heard for each of the segments was used in a regression analysis as the dependent variable. The percent area of each habitat type was used as the independent variable in the regression analysis. This analysis will examine any possible habitat correlations that may exist with relative dove abundance as detected by the call-count survey. ERDAS Imaging is used to create the data set, and the spatial analysis is accomplished with ArcView. Additionally, the program FRAGSTATS will be used to examine spatial patterns of landscape structure and relationships in mourning dove abundance.

Ten selected call-count routes are being surveyed during 3 seasons (breeding, fall-migration, and wintering) during 2 years. This data will be used in regression analysis to examine this short-term variability in dove abundance and correlations that may exist with habitat composition. ANOVA will be used to determine if there are differences in dove abundance between seasons, between routes, and between physiographic regions.

Central Management Unit

Comparison of Radiotransmitter Attachment Techniques with Captive Mourning Doves, and Baseline Biochemical Reference Values

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Expected completion date: June 2000

Although subcutaneous radiotransmitter implants with external antennas have been shown to be a tractable transmitter attachment technique for mourning doves (*Zenaida macroura*; Journal of Wildlife Management

62:1451-1460), few experiments have been conducted comparing implants to conventional external attachment techniques. To determine if implants provide an improvement, we compared the physiological and pathological effects of subcutaneous implants with external antennas (SC1), subcutaneous surgeries without implants (SC2), transmitters attached with harnesses (HAR), transmitters with glue attachment (GLU), and a control group (CNT) without surgery or transmitter; we also compared differences in amount of time needed to attach transmitters and transmitter retention rates. A captive colony of 195 wild-trapped doves had equal numbers of males and females assigned to each treatment. Average time required to attach radiotransmitters was different among treatments ($P = 0.0001$), and highest for GLU (9.24 ± 0.22; ± SE) and lowest for HAR (2.49 ± 0.07). Transmitter retention rates were different among treatments (log-rank: $P = 0.0046$; Wilcoxon: $P = 0.0164$) with 100.0% of SC1 remaining attached during the 63-day posttreatment period and 38.5% of GLU. There were no differences among treatments in heterophil:lymphocyte ratios ($P = 0.3159$) or body masses ($P = 0.3051$). Our data suggest that subcutaneous implants are superior to glue attachment based on retention time, and superior to harnesses based on pathological effects. Implants do not appear to affect doves physiologically in a captive setting, though long-term effects on wild free-flying doves are unknown, and we recommend further evaluation. Despite the extensive amount of research conducted on mourning doves, no biochemical reference values exist for this species. Our other objective, therefore, was to establish base line clinical chemistry reference values for mourning doves to assist with establishing clinical diagnoses. Wild mourning doves were captured 19 March 1996 to 8 August 1996, and 6 February 1998 to 12 May 1998; blood samples were collected from 382 mourning doves. Plasma biochemical values were established for glucose, sodium, potassium, chloride, enzymatic CO_2, albumin, total protein, globulin, calcium, phosphorus, cholesterol, magnesium, aspartate aminotransferase (AST), gamma glutamyl transferase (GGT), lactate dehydrogenase (LDH), and uric acid. These reference values are invaluable for determining diagnosis of diseases of the gastrointestinal, hepatic, renal, cardiovascular, musculoskeletal, and endocrine systems.

The P-R final report has been completed, and 2 manuscripts have been submitted for publication to peer reviewed journals. Funding for this study was provided by 1997 Webless Migratory Game Bird Research Program (U.S. Fish and Wildlife Service and the U.S. Geological Survey-Biological Resources Division), the University of Missouri (Veterinary Medical Teaching Hospital, Veterinary Medicine Diagnostic Laboratory, Animal Sciences Research Center), and the Missouri Department of Conservation - Conservation Research Center (Federal Aid in Wildlife Restoration Project W-13-R-52).

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. The disease is transmitted when infected adults feed nestlings, and/or contaminate drinking water and food sources (i.e., bird feeders or baths). Weather conditions contribute to disease transmission; e.g., extended hot dry weather may force birds to use contaminated food and water supplies that may be limited. Trichomonads are usually found in the oral-nasal cavity, or anterior end of the digestive and

respiratory tracts. 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 sample 1,000 hunter killed birds annually using the InPouch® 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. This shows 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.

These results represent the second year of a 4-year study. The final report for this study will be available by June 2002. Funding 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), and the Missouri Department of Conservation-Conservation Research Center (Federal Aid in Wildlife Restoration Project W-13-R-52).

Western Management Unit

Relationships Between the Density of Mourning Doves and Long-term Habitat Change Along Call-count Routes in the Western Management Unit

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Expected completion: March 2000

Mourning doves have declined steadily along call-count routes in the Western Management Unit (WMU). Biologists have attributed this to many factors, including long-term habitat changes that have adversely affected dove nesting populations by eliminating nesting and foraging substrates. The objective of our study was to document changes in habitat types along a sample of call-count routes in the WMU using a GIS analysis of historical aerial photography obtained in the 1960s, 1970s, and 1980s, and correlate these habitat changes with changes in dove density on the routes. We selected routes with sharp increases in dove density over time (increasing routes: n = 2), those with marked declines (decreasing routes: n = 7), and those with no change since the 1960s (stable routes; n = 6). We used strict criteria to select routes in Arizona (n = 3), California (n = 4), Idaho (n = 2), Nevada (n = 1), Utah (n = 2), and Washington (n = 3). We have completed interpretation of photographs, digitization of habitat type polygons, and sorting of habitat extent by route for all routes, and have tried to relate these to dove trends.

Analysis and interpretation of our results is proving to be frustrating, because clear-cut trends in patterns of habitat relationships with dove density have so far eluded discovery. For example, we found that within decreasing, increasing, and stable routes in which we analyzed field size within ½ mile of listen points, mean field size point estimates of agricultural habitats increased from the 1960s to the 1980s (decreasing: 5.0, 5.7, 8.2 ha; increasing (n = 1 with agriculture): 13.8, 18.7, 22.7 ha; stable: 5.7, 9.1, 9.8 ha; respectively), a result predictable based on previous literature in which increases in field sizes have been associated with declines in dove abundance. However, in contrast to this, we found that mean field size point estimates were largest in the one increasing route with agriculture (13.8 - 22.7 ha) and smallest in decreasing routes (5.1 - 8.2 ha) (5.7 - 9.8 ha in stable routes), a counterintuitive result. Similar analyses on changes in road lengths per route demonstrated conflicting results, with increases and decreases in total road lengths varying unpredictably by route type. Agricultural lands increased in all three categories of routes (combining all routes), with the largest percentage increase in increasing trend routes; native vegetation decreased on all three route types, with the largest decline on increasing trend routes; urban areas increased 65-262% on decreasing and stable routes, respectively, but extent was small (15-16 ha) (no change in urban on increasing routes); urban vegetation increased markedly on all three route types, as did water areas, although the percentage increase was greatest (2000%) on increasing trend routes (but only 6 ha), and insignificant on stable routes (2 ha, 1%); however, we believe these results to be misleading, because the two increasing trend routes are both Arizona desert, and the other two route types include a wide array of habitat types. We looked at the proportion of each route's land area under investigation (within ½ mile of listening points) that had actually undergone change (changed status) since the 1960s. Results show that only two routes showed very large land status changes: 38% of the land changed status in Arizona 1550, an increasing dove route, and 35% changed status in Idaho 2580, a stable route. In the other increasing trend route, only 3% of the land changed status, in the decreasing trend routes, only 4-13% changed status, and in the stable routes, only 2-17% changed status. Thus, irrespective of the specific habitats that changed, with the exception of the two routes mentioned, not much of the land areas actually were effected by change over time. We question whether or not habitat changes of such small magnitude, in general, could exert a strong response by dove populations, at least on a scale that uses the entire call-count route as the experimental unit.

We reaffirm our conclusion that high variation within routes obscures statistical verification of real relationships between habitat change and dove density if they exist. We conclude that if definitive habitat-dove relationships have occurred since the 1960s, the best way to get at them will be to look at each listening point as the sample unit across years, rather than the entire route as a whole. This would provide 20 regressions per route (1 for each listening point) in which to assess trend slopes (positive, negative, or no change), instead of just 1 per route. This is intuitively attractive because *a priori* we suggest that route trends are probably not driven by changes in habitat occurring throughout the route, as our data show, but instead, to specific areas along each route. It would seem obvious that those areas that have changed, as opposed to the areas along listening points that have not changed, would be most associated with dove density trends reflected by route trends. Therefore, our primary conclusion is that these analyses need to be directed at an analysis of habitat change within ½ or 1 mile radii of each listening point along all study routes. Route regression trends should be estimated across years for each listening point for each route and correlated with the habitat change information. One need not, in such an analysis, be limited to just those routes in which doves are increasing or decreasing; but, rather the number of listening points with increasing and decreasing (and no change) trends would far exceed the number of routes that fall into those categories. This large increase in sample size will strengthen conclusions, yielding far more data in which to find real habitat-dove relationships. This 2-year project was funded by the Webless Migratory Game Bird Research Program (U.S. Fish and Wildlife Service) and the California Department of Fish and Game.