The Call-count Survey: Historic Development and Current Procedures

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Estimation of size of animal populations is an integral part of wildlife conservation. Management goals for a migratory bird species can be expressed in terms of a desired numerical abundance and, for game species, a desired level of harvest (Martin et al. 1979). With respect to abundance, management may be directed at: (1) reducing population size in areas experiencing undesirable economic problems, such as crop depredation; (2) increasing numbers in areas where a species is declining or persisting at low levels; and (3) maintaining sizes of populations judged to be at desirable levels. For a game species, these abundance-oriented goals must be considered in the context of creating or maintaining a harvest level consistent with recreational interests.

Considerable progress has been made since the early 1900s in the methodologies for measuring wildlife abundance. Since Kendeigh (1944b) reviewed the historical development of surveys for bird populations and evaluated methods in use at the time, many new techniques have been developed (Ralph and Scott 1981).

In the context of mourning dove populations, a survey is employed to determine relative abundance as opposed to a census aimed at ascertaining absolute abundance. The Call-count Survey is an investigation designed specifically for the species.

EVOLUTION OF PROCEDURES

Development of Survey Technique

Development of a survey technique to detect and measure mourning dove population changes was a major objective of a Cooperative Dove Investigation initiated in the southeastern states in 1948 (Southeastern Association of Game and Fish Commissioners 1957). Leonard E. Foote, of the Wildlife Management Institute, was instrumental in originating and providing assistance throughout this study. Key personnel from the U.S. Fish and Wildlife Service included George C. Moore, who coordinated the project, and Harold S. Peters, who assisted in developing and testing field techniques. State project leaders included James Keeler (Alabama), David Donaldson (Arkansas), Frank Winston (Florida), Dan Nelson (Georgia), Dan Russell (Kentucky), John Newsom (Louisiana), St. Clair Thompson (Mississippi), Henry Bobbs (Mississippi), Don Allison (North Carolina), Harold Poole (South Carolina) and Jay Hammond (Tennessee).

Much was known about the mourning dove's life history prior to the project, but additional biological information was needed, including a technique suitable for monitoring breeding populations. Since it was deemed impossible to make a complete count of all doves, a method to develop an index to the population was sought. A variety of approaches was tried for the purpose of formulating an indexing technique that was economical, practical, statistically appropriate (e.g., estimating the same fraction of the population from year to year), permitted area-to-area and time-to-time comparisons, and was of sufficient sensitivity to detect differences within both high and low populations.

Initially, evaluations were made of different methods to provide an index to the level of the posthunting season dove population for comparison with indices at other seasons of the year. Roadside counts were conducted during winter by rural mail carriers, biologists and wardens. Records indicated large numbers of observations of a few birds and a small number of observations of large numbers of birds. This variation necessitated a large sample for desired reliability. Additionally, other deficiencies precluded use of winter road counts as a national survey method. Winter plot counts also were tried, but were disregarded due to variability and time requirements for extensive application.

Year-round random and controlled road counts were found to provide valuable indices for determining average dates of population peaks for hunting regulations if the sample was large and if the data were gathered on a comparable basis from year to year. Breeding season random road counts yielded an index with a fair degree of precision if the sample was large enough and data were collected by trained observers with approximately the same geographic coverage annually.

Ultimately, a Call-count Survey—in which numbers of individual doves heard calling (cooing) are counted along preselected routes—was judged to provide the best index to the population. Data from doves heard were found to be less variable than data from doves seen. Credit for the original idea of adapting an auditory index to doves in the late 1940s is more or less equally shared by George C. Moore, Daniel J. Nelson, Harold S. Peters, Edward Wellein and Leonard E. Foote (Foote and Peters 1952). Foote and Wellein initiated the original discussions for the possible use of an auditory method based on research by McClure (1939), who studied mourning dove calling activity and suggested its use for surveying the birds. He found that cooing was greatest in early morning and least at midday, increasing again in the evening before sundown.

Fieldwork to investigate and develop procedures for using Call-counts began in March 1950, with a three-car, 0.5-mile (0.8 km) interval route (Foote and Peters 1952). Duvall and Robbins experimented with Call-counts at 1.0-mile (1.6 km) stops in Maryland, Pennsylvania and New York during May and June. Peters followed similar procedures in Ohio in June, July and August of that year. These early studies served to determine the practicality of certain procedures in the Call-count method, particularly the starting time (morning or afternoon), the number of stops (twenty) and the distance between them—1.0 mile (1.6 km) with a driving time of three minutes—and the length of time for counting at each stop (three minutes). Coordinated research was proposed in late 1950 and begun the following spring.

At various times between 1951 and 1954, intensive studies designed to permit biological and statistical evaluation of the Call-count technique were conducted in Wisconsin (Wagner 1952), Tennessee (Kerley 1952), Ohio (Peters 1952), New York, Pennsylvania, Maryland and Virginia (Duvall and Robbins 1952), and Georgia (McGowan 1952, 1953, Lowe 1956). The results of these studies and additional data are reviewed in Southeastern Association of Game and Fish Commissioners (1957).

Similarities were seen in results of these investigations that led to the establishment of additional survey standards for large-scale surveys. In several of these studies, both morning and afternoon surveys were conducted to ascertain the best time of day to run the survey. Early morning counts were found to be consistently higher and less variable than afternoon counts. Mourning dove calling reaches a peak at sunrise and then diminishes gradually over the next hour and a half. To compare survey results from area to area, it was determined that counts should be standardized to start exactly one-half hour before sunrise. Throughout the range of the mourning dove, a plateau period of calling existed from mid-May to mid-June, during which calling levels were relatively stable. Breeding populations were spread more homogeneously throughout the range during this period than at any other season (Foote and Peters 1952). Analyses indicated that the three-minute listening period was the most efficient. Wind had a pronounced effect on one's ability to hear doves calling and, in high velocities, on the intensity of calling itself. Researchers suggested that no counts should be taken when wind velocity exceeded Beaufort 3 (8 to 12 miles per hour: 12.9 to 19.3 km/hr). Calling activity was depressed with light rains and practically ceased during heavy rains. McClure (1939) found that calling was very uniform between 41 and 77 degrees Fahrenheit (5 and 25° C). Doves did not coo as much when the temperature was below freezing or above 77° F (0 to 25° C).

Many intensive studies of cooing performance of penned or individually marked free-flying doves have provided new insights into the validity of mourning dove Call-count Survey procedures (see Baskett et al. 1978, see also chapter 15).

Inception of the Survey

After the initial studies in a few states were concluded in 1950, 133 routes in twenty-two states were established in 1951. Most of these routes were located in eight southeastern states (Alabama, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina and South Carolina), plus Ohio and Texas.

By 1952, 196 routes had been established in thirty-two states. During 1950 to 1952, the routes were surveyed three to ten times at four- to seven-day intervals annually to gather extensive basic data. Data analyses indicated that a more efficient sampling design would result from doubling the number of routes and surveying each route only once (Southeastern Association of Game and Fish Commissioners 1957).

Coverage expanded to a nationwide survey beginning in 1953, with 542 routes in forty-one states. The number was increased to 730 routes in forty-four states in 1954. These routes were surveyed only once each season. In 1959, all forty-eight conterminous states were represented by survey routes. During the past several years, the number of routes has varied between 1,000 and 1,065, as some states added routes for three- to five-year periods for special evaluations and then reduced the number of routes. In 1987, the number of routes was 1,062.

The U.S. Fish and Wildlife Service has coordinated the Call-count Survey from its inception and is responsible for analyzing the data and preparing reports. Personnel from state and federal agencies "run" the survey routes, as do a few specially selected volunteers.

Between 1966 and 1971, cooperators ran their routes from May 20 through June 10. From 1972 to 1976, the official survey period was designated as May 20 to 31. However, a grace period to June 10 was allowed for any person who was unable to complete the survey during the designated time frame. Beginning in 1977 and continuing to present, the official survey period still has an end date of May 31, but the extension has been shortened to June 5. This measure was adopted because of short time constraints between the time data are received and when reports have to be prepared for regulations purposes. Routes run June 5 to 10 were accepted, although the data were not used in the current year's analysis.

Selection of Route Locations

When Call-count Surveys were first initiated, route locations were personally selected, usually by the person making the counts, rather than on a statistically acceptable basis of randomization (Southeastern Association of Game and Fish Commissioners 1957). People may have tended to select routes in the better dove habitats, but this was unknown.

As part of the Cooperative Dove Investigation, Call-count samples for 1953 and 1954 were sorted into life zone, biotic province, soil province and soil association subgroups, and analyses of variance were made. Significant differences were found in dove populations in subgroups for each major classification. Consequently, suggestions were made for refinement of the sampling technique for Call-counts (Southeastern Association of Game and Fish Commissioners 1957). One recommendation was to select routes randomly within geographic sampling areas if tests indicated present sampling was biased.

A test to compare data from randomly located routes with those obtained from nonrandom routes was a high priority in the dove management program (Foote 1957). Subsequent to the Cooperative Dove Investigation, a study was conducted of the efficiency of existing dove Call-counts in seven southeastern states, with particular reference to tests of a random sampling design that would yield more reliable data (Foote et al. 1958). Appropriate sampling would permit area-to-area comparisons and proper weighting of Call-count data from geographic areas. Foote et al. (1958) found that the original route sampling was indeed positively biased, signifying that higher-than-average dove population areas had been sampled. Results also indicated that stratification by ecological zones was a more efficient sampling design than was either stratification by state or completely random sampling. Suggestions were made for revising the nationwide Call-count sampling scheme.

Foote (1959) devised a sampling system for mourning dove Call-counts based on an allocation of routes by geologic areas known as physiographic regions. The various regions were based on a map entitled "Physical Divisions of the United States," prepared by Fenneman (1931) *(Figure 34)*. The boundaries of some regions were modified based on an examination of the survey data and other geographical characteristics. Ruos (1971) made additional minor modifications after examination of more recent ecological studies.

Original, nonrandom routes gradually were replaced by randomly located routes stratified within

Figure 34. United States physiographic regions used in analyses of mourning dove population data, revised 1970. Based on Fenneman's (1931 [revised 1970]) map featuring physical divisions of the United States. Dark lines outline the three major mourning dove management units.

Laurentian Upland Division
010 Superior Upland Province
Atlantic Plain Division
Coastal Plain Province
031 Embayed section
032 Upper Coastal Plain
033 Floridian section
034 East Gulf Coastal Plain
035 Mississippi Alluvial Plain
036 West Gulf Coastal Plain
037 Lower Coastal Plain
Appalachian Highlands Division
Piedmont Province
041 Piedmont Uplands
042 Piedmont Lowlands
Blue Ridge Province
051 Northern section
052 Southern section
Valley and Ridge Province
061 Tennessee section
062 Middle and Hudson Valley section
St. Lawrence Valley Province
070 Champlain and Northern section
Appalachian Plateaus Province
081 Mohawk and Allegheny section
082 Catskill section
085 Kanawha section
086 Cumberland section
New England Province
091 Southern section
092 Northern section
093 Mountain section
095 Taconic section
100 Adirondack Province

Interior Plains Division
Interior Low Plateaus Province
111 Highland Rim section
112 Lexington Plain
113 Nashville Basin
Central Lowland Province
121 Eastern Lake section
122 Western Lake section
123 Wisconsin Driftless section
124 Till Plains
125 Dissected Till Plains
126 Osage Plains
Great Plains Province
130 Central Texas section
131 Missouri Plateau, glaciated
132 Missouri Plateau, unglaciated
133 Black Hills
134 High Plains
135 Plains Border
136 Colorado Piedmont
137 Raton section
138 Pecos Valley
139 Edwards Plateau
Interior Highlands Division
Ozark Plateaus Province
141 Springfield-Salem plateaus
142 Boston "Mountains"
Ouachita Province
151 Arkansas Valley
152 Ouachita Mountains
Rocky Mountain Division
160 Southern Rocky Mountains Province
170 Wyoming Basin Province
180 Middle Rocky Mountains Province
190 Northern Rocky Mountains Province

Intermontane Plateaus Division
Columbia Plateaus Province
201 Walla Walla Plateau
202 Blue Mountain section
203 Payette section
204 Snake River Plain
205 Harney section
Colorado Plateaus Province
211 High Plateaus of Utah
212 Uinta Basin
213 Canyon Lands
214 Navajo section
215 Grand Canyon section
216 Datil section
Basin and Range Province
221 Great Basin
222 Sonoran Desert
223 Salton Trough
224 Mexican Highland
225 Sacramento section
Pacific Mountain Division
Cascade Sierra Mountains Province
231 Northern Cascade Mountains
232 Middle Cascade Mountains
233 Southern Cascade Mountains
234 Sierra Nevada
Pacific Border Province
241 Puget Trough
242 Olympic Mountains
243 Oregon Coast Range
244 Klamath Mountains
245 California Trough
246 California Coast Ranges
247 Los Angeles Ranges
250 Lower Californian Province

(continued on back flap)

physiographic regions between 1957 and 1966 in forty-four states. Call-count data were analyzed for the first time by physiographic region in 1966 (Ruos and Tomlinson 1968). Selection of twelve random routes in the remaining four states—Maine, New Hampshire, Rhode Island and Vermont—was completed by 1970.

The procedure for randomly selecting routes was to draw a grid of squares or cells, twenty miles (32.2 km) on a side, on a large map of the United States. Physiographic region boundaries were superimposed on the map. Cells then were numbered by region, excluding those that were substantially covered with open water and those, such as urban areas, that could not be surveyed (Foote et al. 1958, Foote 1959). Routes were allocated to regions proportional to presumed dove populations (mean counts from either 1954–56 or 1956–57 routes, depending on state and weighted by land area).

Mourning dove Call-count surveys were run in Canada between 1961 and 1965. Standard procedures for conducting the survey were followed. However, the routes had been nonrandomly located, as was done initially in the United States. When routes were relocated in the U.S., Canadian authorities decided to discontinue the survey rather than relocate routes in their country. Before terminating the survey, there were seventy-nine routes in Ontario, two each in British Columbia and Manitoba, and one in Alberta. Wight et al. (1964) reported results for 1963–64; Tomlinson (1965) summarized results for 1964–65.

A suggestion was made for a new stratification of routes based on potential natural vegetation (Blankenship et al. 1971). The U.S. Fish and Wildlife Service decided, however, not to change physiographic region boundaries because of discouraging statistical problems in adapting a new stratification to the current one based on regions. (D. MacDonald personal communication: 1988, D. W. Hayne personal communication: 1988). In addition, a considerable amount of historical data would be lost, since the data from earlier years would not be comparable.

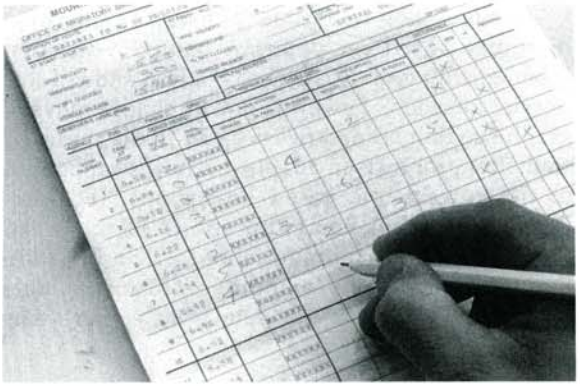
Current Procedures

Each Call-count route usually is located on lightly traveled secondary roads and run between May 20 and May 31, with a grace period to June 5. Counts begin one-half hour before sunrise and continue for two hours.

On each route, twenty listening stations are spaced at 1.0-mile (1.6 km) intervals. During a three-minute period 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. Also noted is the number of doves seen during a three-minute drive between stops.

Surveys are not made when wind velocities exceed 12 miles per hour (19.3 km) or when it is raining, as noted earlier.

A U.S. Fish and Wildlife Service biologist conducts a Call-count Survey on a secondary road in central Maryland. Separate records are made of doves heard and seen during a three-minute period at each of twenty listening/observation stations (stops) of 1.0-mile (1.6 km) intervals. Binoculars serve to verify dove observations. *Photo by David Dolton.*



As Call-count Surveys are being conducted, observers record a variety of information on a special form prepared by the U.S. Fish and Wildlife Service's Office of Migratory Bird Management. At the start and conclusion of each survey, wind velocity, temperature and percentage cloud cover are logged. At each stop, the number of individual mourning doves heard calling (cooing), the number of doves seen (singles or in pairs or flocks) and the disturbance level are documented. The number of doves seen during three-minute drives between stops also are recorded. *Photo by David Dolton.*

DATA ANALYSIS

Presentation

Methods of presenting or analyzing the data have changed periodically over the years. Results were mimeographed and distributed in "Mourning Dove Newsletters" from 1949 to 1960 (files of the U.S. Fish and Wildlife Service, Laurel, Maryland). Thereafter, results were presented in mimeographed administrative reports or published as Special Scientific Reports (e.g., Dolton 1977).

Data for doves heard and seen were summarized according to several different types of state groupings over the years. For example, the United States was divided into seven regions based on recoveries of banded doves. These regions also were combined into three larger regions, roughly dividing the U.S. into eastern, central and western units. Other summaries combined the regions into two units, with the Mississippi River as the dividing line between the eastern and western units. This division also roughly separated the eastern and western subspecies of the mourning dove (see chapter 2).

Counts of doves seen were determined to be more variable than counts from doves heard (Southeastern Association of Game and Fish Commissioners 1957). Consequently, data on doves seen were not analyzed between 1958 and 1984. Beginning in 1985, however, results from doves seen were deemed to be useful with long-term, sophisticated analyses and again were reported solely as supplemental information to doves heard (Dolton 1985).

Analyses of banding data led to the establishment of mourning dove management units in 1960 (see chapter 4) (Kiel 1961). These areas encompass the principal breeding, migration and U.S. wintering areas for largely independent populations. Since that time, management decisions have been made within the boundaries of the Western (WMU), Central (CMU) and Eastern (EMU) management units.

For many years, the EMU and CMU were divided into two groups of states— those permitting dove hunting and those prohibiting hunting—for analysis comparisons. However, hunting status among states, particularly in the CMU, has changed considerably. For example, in 1966, seven of the fourteen CMU states allowed hunting and seven did not. By 1987, twelve CMU states allowed hunting. The situation was further complicated by the fact that both South Dakota and Nebraska allowed hunting in some years but not in others during that overall period. Thus, comparisons between hunting and nonhunting states of the CMU now are impractical.

In different treatments, both the CMU and WMU were divided into separate geographic reference areas adopted by Dunks et al. (1982) and Tomlinson et al. (1988) *(Figure 35)*. These north/south-oriented tiers contain dove populations with

Figure 35. Geographic reference areas in the Western and Central management units.

similar migration patterns. The EMU was not similarly segmented, since a proper division of states has not been determined at this time (however, see chapter 4 for possible subdivisions to be considered). The reference areas are herein referred to as Coastal WMU, Interior WMU, West CMU, Mid-CMU and East CMU. In this analysis, Nevada was grouped with the interior states of the WMU rather than the coastal states as done in the aforementioned publications because of a greater similarity in dove populations with the interior states (Tomlinson et al. 1988).

Analyses

Analytical methods also have changed or evolved over the years to enable better interpretation of Call-count results.

Stratification. Call-count data initially (1956) were stratified by state and weighted by the estimated number of square miles of productive dove habitat in each state to arrive at average Call-count indices for a management unit (see Table 43 for an explanation of weighting). It was recognized, however, that statistically more precise estimates could be obtained with the same effort by collecting and analyzing survey data by ecological stratum rather than by political unit. Foote et al. (1958) suggested a sampling design using physiographic regions as the basis for stratification, and it eventually was adopted. Beginning in 1966, after establishment of randomly located routes, the population index for each state was determined as the mean number of doves heard calling per route, weighted by the land area of each physiographic region (stratum) within the state (Ruos and Tomlinson 1968). Management unit indices were calculated from state indices weighted by the land area of states within the unit.

Variables associated with counts. Since time of day is one of the most important factors affecting dove calling behavior, and therefore the Call-count Survey, Dolton et al. (in preparation) investigated whether an analysis based on doves heard at ten stops (starting at the normal thirty minutes before sunrise) would be as efficient as one using the standard twenty stops. They found that trend estimates on all twenty stops appeared to have about the same precision as the estimates based on the first ten stops but that the twenty-stop analysis was preferred since more doves are counted and little extra effort is required. Accordingly, the twenty-stop standard has been retained.

It was recognized early that observers do not have uniform ability to hear birds (see Bart and Schoultz 1984). When observer changes are made for Call-count routes, differences in hearing acuity could affect comparisons of data among years. Beginning in 1966, the ability to hear dove calls by different observers was considered in data analysis (Ruos and Tomlinson 1968). Each observer change was evaluated for unexpected differences in count results. Criteria were developed for acceptance or rejection of data following observer changes (Ruos 1974) and retroactively employed for all data from 1966 to 1971. Dolton et al. (in preparation) later evaluated various aspects of data analysis associated with route conditions, including observer change. Models with covariables for wind, temperature, percent cloud cover, disturbance (noise), observer change and different combinations of these covariables were tested to determine the best model. An adjustment for observers was the only factor found to affect Call-count results. The negative findings of the other variables probably resulted from the practice of limiting the counts to times when weather and noise covariables are within narrow bounds, thus effectively removing much of the variability associated with those factors. Baskett et al. (1978) also reported that weather has little effect on Call-counts except at the extremes.

Population trends. The issue of comparability has played a central role in data analyses to determine if a trend in the population is present. For example, if one or more routes from a state were not run in a specific year or they were run by different observers in successive years, the data from those routes were not considered comparable with data for the preceding and succeeding years. Using earlier methods of analysis, the data for those routes were omitted for the two years in question, resulting in the loss of a considerable amount of information throughout the survey. Through 1958, data were summarized by pairs of years. The percentage change for a state or management unit from one year to the next was calculated from comparable routes only. However, data for a series of years could not be compared, since all routes were not necessarily run in all years. To overcome this deficiency, a "base-year" system of analysis was adopted in 1959 and used through 1984. This method employed selection of a specific year (e.g., 1961) as the base year. During the period 1959–66, the average number of mourning doves heard calling on *all* routes for a state or management unit in that specific year (without regard to comparability) was used as the base index. Once the base year was established, percentage changes for preceding and succeeding years were calculated using data from *comparable* routes and applied to the base index. The resulting annual indices then were presented in tabular form for the period of years of data collection. The reader could visually scan these figures and determine if the resulting line was increasing or decreasing.

To obtain a more representative index than had been possible earlier, Ruos and Dolton (1977) selected a new base year (1971) for data analyzed in 1975 and thereafter. As their base index, however, they elected to use an average of comparable route results for a six-year period (1968–73). Since each year consisted of two comparable data sets (1968, for example, had one set to compare with 1967 and one to compare with 1969), a total of twelve data sets were used to obtain the average. This was done to reduce "the influence of a possible atypical year and . . . provide more reliable population indices used in calculation of both long- and short-term trends" (Ruos and Dolton 1977: 3). Trends were estimated by fitting a regression line through indices for a state or management unit. In retrospect, averaging over the six-year period probably served to mask actual low or high counts that occurred in 1971. Percentage changes were thus calculated in many cases from an erroneous starting index (the base year) and trends may have been biased. This factor is thought to have delayed detection of a declining trend in WMU dove populations for several years.

During the late 1970s, it became apparent that the base-year method was not providing the level of precision desired. In addition to the problem noted above, it was discovered that random errors were accumulating over time as indices moved away from the base year, resulting in unreliable trend information (Geissler and Noon 1981). Dolton (1982) calculated new indices using 1977 as the new base year and demonstrated that this treatment more accurately reflected a state's relative dove density during current years than when 1971 was used as the base year. The discrepancy was especially apparent for data from the WMU. This procedure, however, did not solve the inherent problems with the base-year analytical technique. Clearly, an improved method of analysis was needed.

During the early 1980s, statisticians at the Patuxent Wildlife Research Center in Laurel, Maryland, were assigned the task of exploring alternative means of analysis. A route regression method was developed and tested by Geissler (1984) and eventually implemented in 1985. Random errors did not accumulate with this method, and its reliability was demonstrated with computer simulations. For route regression analysis, the trend still is defined as an average rate of change over time, i.e., the ratio of the dove population in an area in year t to the population in year $t-1$. To estimate a trend in a population for a specific area over a specified period of years, a trend is first estimated for each route through linear regression. The use of log-transformed counts estimates a proportional change per year. For each route, parallel lines are fitted through each observer's counts (i.e., the observer is included as a covariable). This method allows observers to count at different levels of efficiency but still estimates a common slope (trend) among all observers for the route *(Figure 36)*.

The trend for a physiographic region within a state is estimated as the average of the route trends weighted directly by the dove density and inversely by the relative variance of the individual route trends. The relative variance depends on the number of different observers and the number and distribution of years the route was run. For example, the program gives more weight to a route that has been run by a single observer for ten years than one that was run for only two years. More weight also is given to a route run twice, five years apart, than to a route run twice, two years apart. When estimating a trend for a state or management unit, trends for physiographic regions within states are combined in an average that is weighted by the land area of each physiographic region. Variances of state and management unit trends are estimated by a statistical procedure known as "bootstrapping" (Efron 1982).

The route regression method is currently the method employed by the U.S. Fish and Wildlife Service to provide trend information from the nationwide mourning dove Call-count Survey.

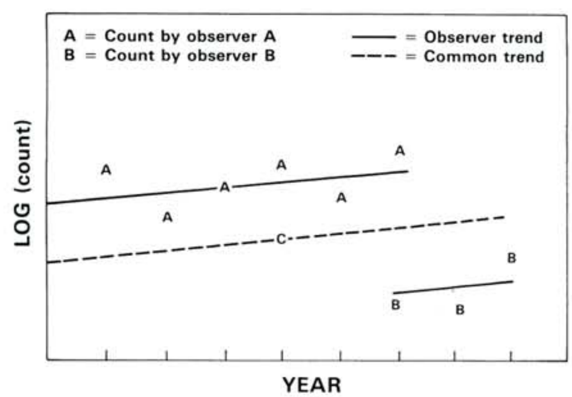


Figure 36. Illustration of a mourning dove population trend calculation for one Call-count route. Point C is an average of the counts and is used as the index of relative abundance of mourning doves on the route. The dash line indicates the common trend for all observers.

Annual indices. From 1959 through 1984, annual indices derived from the base-year analyses for states and management units were presented in annual reports and usually summarized by eleven-year periods. These indices were subject to the same problems as the base-year trends. Geissler (1984) and Sauer and Geissler (1990) developed two different annual index estimates, a linear model approach and a residual-based approach, to complement the trend estimates. Their methods give similar estimates of indices, but the residual indices are easier to compute.

Under this procedure, indices are calculated for the purpose of showing population fluctuations around a fitted line. Estimated indices are determined for an area by finding the average deviation between observed counts on all routes in the area and those predicted on the routes from the area trend estimate. These residuals are averaged on the log scale by year for all routes in an area and added to the fitted trend for the area to produce the annual index of abundance *(Figure 37)*. This method of finding indices superimposes yearly variation in counts on the long-term fitted trend. The indices provide an accurate representation of the fitted trend for areas that are adequately sampled by survey routes (ten or more). Additionally, only data from within an area are incorporated into the area's index. Since indices are adjusted for observer differences and trend, the index for an area may be quite different from actual count in individual years at the ends of a period. The index in midyear, however, is about equal to the average of all counts (raw data) for all years.

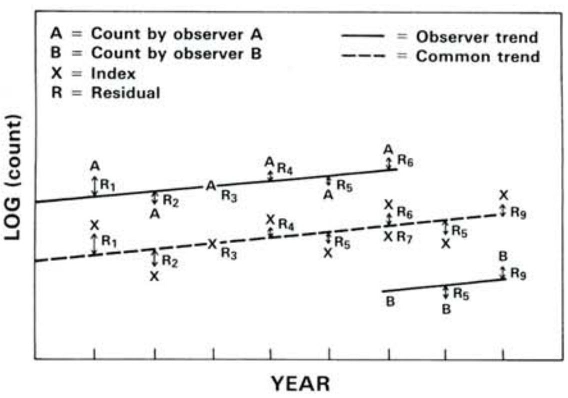


Figure 37. Illustration of mourning dove population index calculations for one Call-count route. The "residual" R_i represents the deviation of the yearly predicted count (based on trend) from the actual data. In this example, observer differences in ability to perceive birds are eliminated by placing the residuals on the predicted (common) trend line.

Annual indices are designed to show dispersion of actual data around a long-term trend. They are calculated from predicted counts over the entire period of years for which data are available. In contrast, trends are calculated using only data from specified sets of years. Consequently, the percentage change per year estimated from trend analysis may differ due to chance from the percentage change per year calculated directly from breeding population indices. The percentage change estimated from the trend analysis is the appropriate statistic to consider, as statistical significance is assessed from the trend analysis.

INTERPRETATION OF RESULTS

Trends

As a general rule for obtaining trend information, a minimum of ten routes in an area of consideration is required for reasonable confidence intervals. The number of routes used in the Call-count analysis for different time periods can vary as a result of mechanics of the analysis. Normally, there are more routes in the longer time periods, e.g., twenty-two years, since some routes may have been relocated (considered as a new route) and the old routes are included in the analysis. In addition, new routes may be initiated periodically within an area or areas.

The percentage change per year over all time periods may appear exaggerated for those areas with small numbers of routes that have large changes in counts over the years.

A two-year change obtained from the route regression trend analysis may differ from that calculated from index values. With Kansas as an example, the percentage change calculated by hand between 1986 and 1987 from the index values in Table 34 is 10.8 percent. However, the percentage change from the trend analysis in Table 35 for the same two-year period is 36.0 percent. In some instances (e.g., Indiana), the two-year trend *(Table 35)* and the indices for those years *(Table 34)* may appear to be in opposite directions. The trend indicates an increase, while the indices show a decrease. As discussed previously, indices were calculated over the entire twenty-two-year period and are designed to show year-to-year variation in the context of long-term trends. These index values tend to be somewhat smoothed and therefore may not exactly replicate results from the trend analysis over a shorter period, since the trend is calculated using only data from the shorter period. In the case of Indiana, one should note that the percentage

Table 34. Breeding population indices for mourning doves heard by management unit and state, 1966–87.[a]

Management unit/state	Year													
	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
EMU														
Alabama	23.5	21.2	19.5	19.9	20.0	16.6	23.8	21.2	16.8	21.2	21.1	23.2	25.7	25.0
Connecticut	2.5	4.0	4.2	2.0	8.4	6.4	6.1	5.2	5.6	10.2	10.9	11.3	14.9	16.1
Delaware	3.1	5.8	4.2	0.0	8.6	5.7	4.1	9.2	9.2	12.4	8.2	4.8	7.9	5.2
Florida	11.0	10.6	9.3	9.9	11.8	9.6	11.1	11.2	12.3	13.0	11.6	12.8	9.3	10.1
Georgia	26.8	21.6	20.5	20.8	26.9	23.4	21.3	22.7	24.5	29.7	24.7	26.0	29.5	26.0
Illinois	21.6	18.9	22.5	19.6	23.1	21.2	21.8	21.9	18.6	26.9	26.5	28.6	22.3	19.6
Indiana	46.9	41.7	41.9	38.4	36.3	47.6	40.4	35.6	33.2	33.7	32.7	36.7	20.3	20.7
Kentucky	28.4	22.6	22.9	23.7	28.8	26.7	22.6	24.6	28.5	21.4	23.0	21.7	25.5	18.6
Louisiana	12.1	12.3	11.5	13.1	9.0	11.9	12.8	10.0	11.4	12.3	12.1	9.9	12.1	9.8
Maine	1.5	1.5	2.8	2.5	1.7	2.2	−0.1	−0.6	0.9	0.9	0.9	7.9	6.8	4.2
Maryland	23.6	26.6	18.3	19.8	24.1	22.5	23.0	21.9	22.8	15.3	19.4	19.8	19.1	19.9
Massachusetts	9.6	18.8	5.8	5.0	12.3	8.1	12.1	14.0	10.8	11.3	7.2	11.2	13.2	8.0
Michigan	12.6	13.2	8.9	9.5	9.0	13.7	13.1	10.1	9.9	9.9	11.2	10.1	10.4	7.2
Mississippi	38.2	33.0	28.3	26.0	28.7	30.1	32.8	29.2	24.3	25.7	26.6	26.7	29.6	25.4
New Hampshire	3.7	2.3	2.4	2.1	3.2	3.4	3.5	5.0	3.8	2.8	3.2	3.5	4.2	3.6
New Jersey	21.4	17.7	23.4	21.2	27.8	25.0	26.7	23.9	20.6	15.5	18.3	20.0	16.1	17.0
New York	7.4	7.2	6.8	6.6	7.9	9.1	7.6	7.6	7.9	13.7	9.0	8.9	8.7	6.5
North Carolina	40.4	32.2	33.4	23.5	32.1	29.9	27.7	34.6	24.5	23.6	23.4	26.7	22.9	21.2
Ohio	25.8	23.2	21.3	23.5	25.1	23.1	24.2	18.8	22.7	29.5	23.5	22.4	11.3	11.2
Pennsylvania	11.9	12.7	12.0	11.4	7.2	7.4	10.7	7.1	10.2	7.1	7.3	6.4	6.8	7.2
Rhode Island	6.5	7.3	6.8	10.3	3.7	10.1	7.8	6.8	8.6	9.3	9.7	6.9	10.8	12.9
South Carolina	33.5	36.3	37.1	37.3	34.5	31.1	27.6	32.3	30.0	29.3	29.0	24.7	31.9	28.3
Tennessee	32.3	22.7	25.0	23.9	29.6	21.5	29.3	21.2	23.2	21.8	21.0	25.2	27.8	19.6
Vermont												4.5	2.8	7.0
Virginia	30.5	25.9	25.0	23.2	28.6	26.1	17.0	19.4	23.5	26.6	24.6	32.9	24.4	23.7
West Virginia	4.9	4.4	4.5	5.3	5.5	4.7	6.3	3.4	3.9	2.2	4.8	4.8	5.9	6.5
Wisconsin	13.1	17.9	16.1	13.1	12.7	16.4	17.9	14.3	13.0	15.1	16.1	17.2	11.3	11.2
Weighted average	21.0	19.4	18.2	17.6	18.8	18.5	19.3	17.8	17.3	18.2	18.2	18.8	16.8	15.0
East CMU														
Arkansas	30.0	28.6	28.2	26.3	25.9	26.3	29.8	27.5	23.0	20.7	24.7	20.2	15.1	12.6
Iowa	36.2	32.4	34.7	29.8	21.6	26.6	32.9	30.5	24.0	22.3	28.0	21.4	24.0	20.4
Minnesota	23.1	22.0	21.0	22.5	16.4	21.7	25.1	20.2	22.5	24.8	24.5	27.8	24.5	27.0
Missouri	46.0	43.2	52.8	31.0	42.7	35.0	47.1	35.7	29.9	33.0	29.0	32.8	21.6	20.5
Mid-CMU														
Nebraska	40.2	36.1	45.9	44.9	43.6	42.0	41.4	40.1	41.1	39.9	44.3	44.4	38.4	39.9
North Dakota	24.1	24.4	33.3	27.0	25.0	27.4	27.5	32.3	32.1	25.7	41.7	35.3	39.0	37.0
Oklahoma	26.7	32.1	39.5	39.8	26.9	24.8	33.5	29.8	30.3	26.4	30.5	39.5	28.5	29.0
South Dakota	49.4	31.4	41.4	37.4	45.6	38.8	39.1	41.7	50.8	43.6	46.9	40.4	44.8	42.5
Texas	25.3	20.1	22.1	19.1	20.3	19.2	25.9	21.3	22.2	20.0	19.9	18.9	19.5	23.6
West CMU														
Colorado	13.6	17.4	13.6	15.8	20.5	15.0	21.4	16.0	22.1	18.0	21.9	24.1	28.6	23.6
Kansas	48.2	47.1	52.6	49.9	46.2	48.2	54.8	47.4	47.0	45.4	50.2	48.3	37.6	52.6
Montana	24.5	21.9	19.1	19.7	16.1	22.6	17.1	12.8	14.5	19.6	15.3	18.6	17.6	18.0
New Mexico	12.5	9.1	13.3	11.1	10.7	10.3	12.8	9.4	11.1	14.7	14.6	13.8	14.3	10.5
Wyoming	18.3	18.7	9.2	16.9	18.5	9.3	12.6	13.7	17.6	15.3	15.1	11.1	14.0	11.2
Weighted average	28.0	25.4	28.3	25.7	25.3	24.8	28.5	24.9	26.0	24.6	26.0	25.1	24.1	24.4
Coastal WMU														
California	31.1	29.6	29.0	25.8	25.9	20.3	24.3	19.2	20.5	18.7	20.8	17.4	14.2	12.3
Oregon	23.7	16.4	17.6	18.6	13.1	11.3	9.8	11.7	15.6	11.8	11.3	12.6	6.2	6.3
Washington	13.0	16.1	15.6	12.3	13.5	14.0	10.9	8.6	9.8	10.1	9.9	10.9	6.7	9.0
Interior WMU														
Arizona	26.3	28.3	24.6	29.1	29.8	19.9	20.7	27.1	23.6	24.0	26.5	22.4	23.0	24.4
Idaho	17.1	17.9	16.2	16.8	16.0	12.7	12.2	13.9	12.0	9.8	15.4	19.0	10.1	10.1
Nevada	9.5	7.8	18.6	13.2	9.3	5.7	6.9	4.9	7.5	4.2	7.1	6.8	4.1	6.3
Utah	18.3	26.7	15.0	14.9	15.6	22.8	12.8	11.5	13.5	15.1	16.8	19.1	8.5	11.2
Weighted average	20.2	20.1	20.0	19.4	18.6	14.8	14.7	14.5	15.4	14.0	16.3	15.5	11.1	11.9
United States	24.1	22.6	22.7	21.6	22.0	20.6	22.0	20.3	20.7	20.3	21.4	21.2	18.7	18.2

[a] Annual indices are defined as the predicted value from the trend analysis plus the deviation from the expected value in a year.

Table 34. (continued)

Year							
1980	1981	1982	1983	1984	1985	1986	1987
25.6	25.3	26.7	26.2	22.4	27.9	25.6	24.5
13.5	20.1	14.7	12.0	14.9	20.7	42.0	17.2
7.4	8.4	9.0	4.0	10.2	10.3	15.3	12.4
9.1	7.9	9.6	11.3	6.9	9.5	11.1	10.3
25.0	28.5	30.7	27.2	21.0	28.3	26.5	27.1
20.1	23.3	28.5	30.0	24.3	21.0	30.2	31.7
25.7	29.4	20.0	17.3	18.9	16.7	22.2	21.2
15.7	24.3	24.8	17.3	21.4	21.6	20.0	23.5
12.9	11.6	14.3	13.0	12.0	10.6	9.8	14.0
8.0	7.6	8.8	7.8	6.8	9.1	9.7	6.9
17.6	17.6	18.4	14.8	14.5	16.1	18.6	14.9
10.7	11.8	11.1	9.8	9.9	10.6	10.8	9.9
11.9	11.7	10.6	9.0	9.9	10.2	12.9	11.7
23.9	23.5	29.9	25.4	18.9	25.5	25.1	22.6
3.1	5.3	3.4	6.8	3.8	3.7	6.1	5.0
15.6	13.8	14.8	17.1	11.3	12.7	14.1	12.0
11.0	10.7	10.1	9.2	8.5	8.2	6.9	8.1
24.2	21.1	21.6	21.4	21.9	20.9	21.6	22.3
13.5	16.2	15.0	15.6	14.5	13.1	13.5	16.1
10.3	10.3	10.4	9.7	9.2	9.1	9.8	11.2
11.3	11.9	13.8	9.0	7.5	9.2	8.5	11.2
34.4	33.6	35.1	32.4	28.8	29.0	25.2	36.3
21.5	18.9	24.7	18.4	16.0	20.2	15.6	19.1
7.1	8.1	4.1	4.1	6.3	7.5	5.8	7.4
21.6	20.1	20.5	22.2	21.6	19.6	17.4	17.5
7.1	6.1	5.8	5.5	5.5	6.4	6.5	7.0
16.7	19.6	11.6	13.5	12.0	11.8	12.6	11.8
17.0	17.6	17.9	16.8	15.1	16.3	16.4	17.1
20.5	20.3	20.6	16.5	12.9	13.0	12.7	15.0
27.1	29.5	21.3	16.7	21.9	24.3	22.2	20.4
28.1	27.7	21.9	22.8	17.8	20.5	19.6	23.1
29.9	26.1	23.3	22.9	20.4	19.2	19.6	21.3
50.9	48.7	47.0	44.6	42.2	44.3	35.5	36.1
43.1	44.6	43.4	41.5	33.4	43.6	47.0	50.6
28.3	29.0	31.4	30.4	23.0	22.8	25.1	27.0
43.6	38.7	46.7	42.7	44.3	41.4	39.9	36.6
23.0	20.6	20.1	19.0	18.0	19.1	21.1	19.9
29.0	36.2	33.8	21.3	29.3	31.9	29.7	36.0
59.6	54.8	52.5	62.0	48.0	60.4	42.6	47.2
16.8	15.5	18.3	16.0	12.2	15.0	16.1	13.9
16.9	17.4	13.9	18.2	19.9	18.0	20.6	24.4
10.7	12.1	13.4	10.1	8.1	9.8	11.4	9.5
27.5	26.5	25.5	23.9	22.1	23.7	24.0	24.2
17.5	16.2	16.4	10.9	15.2	10.6	12.9	10.0
9.8	7.8	7.5	5.6	6.5	7.7	5.8	5.3
5.8	6.8	6.3	4.9	4.2	5.5	6.3	4.8
20.9	23.3	25.8	20.8	25.5	21.2	22.8	16.7
10.4	11.7	11.6	9.6	11.3	10.6	7.2	10.1
9.1	6.3	3.7	3.2	3.3	4.5	2.9	3.4
13.4	18.1	10.7	10.6	12.9	8.0	12.2	9.8
13.5	13.5	12.5	9.7	11.6	10.3	10.4	9.0
20.7	20.7	20.2	18.4	17.6	18.3	18.5	18.3

change is not significant, the confidence intervals are wide, and the actual trend could be either negative or positive. Additionally, in a population where the trend has been increasing but declines have occurred in counts of the last two years, the indices may not be sensitive to short-term fluctuations.

Confidence intervals about the trend estimates indicate the range of values in which 95 percent of the observations will occur. The smaller the interval, the more precise the point estimate. With wide intervals, little trust can be placed in the actual value (percentage change) presented. However, even in the presence of a wide confidence interval, if it does not overlap zero (meaning the trend is significant), one can conclude that the population is either increasing (positive percentage change) or decreasing (negative percentage change). The numbers are not as important as the direction.

Completed mourning dove Call-count Survey forms are received by the U.S. Fish and Wildlife Service's Office of Migratory Bird Management at Patuxent Wildlife Research Center in Laurel, Maryland. There a mourning dove specialist (biologist) quality checks each form for clarity (above) before having them keypunched for computer entry. After the forms are keypunched and entered in a computer, a biometrician performs the trend analysis and calculates indices by means of a minicomputer. *Photo by Mary Ann McKeough.*

Table 35. Trends (percentage change[a] per year as determined by linear regression) in number of mourning doves heard by management unit and state, 1966–87.

Management unit/state		2-year (1986–87)				5-year (1983–87)			
		N	Change[b]	CI		N	Change[b]	CI	
EMU	Alabama	24	-3.7	-19.3	11.8	30	-2.8	-7.7	2.0
	Connecticut	2	-60.6***	-97.4	-23.8	2	22.9	-20.3	66.1
	Delaware	2	-8.9	-53.1	35.4	2	44.9***	32.0	57.7
	Florida	21	-20.8*	-42.9	1.3	22	-3.4	-13.1	6.4
	Georgia	21	-0.7	-15.9	14.4	22	-2.0	-4.9	0.8
	Illinois	15	23.9	-16.0	63.9	20	3.8	-6.0	13.7
	Indiana	12	4.8	-16.4	26.0	15	6.0**	0.0	12.0
	Kentucky	14	14.0	-6.0	34.0	20	3.7	-2.2	9.6
	Louisiana	17	5.7	-11.3	22.6	18	-2.5	-10.0	5.0
	Maine	7	-32.4**	-57.6	-7.2	9	-12.6	-31.9	6.7
	Maryland	11	-31.7***	-55.3	-8.0	13	1.7	-6.5	9.9
	Massachusetts	7	-3.4	-35.2	28.4	16	-1.0	-10.8	8.8
	Michigan	19	-2.9	-25.7	20.0	20	9.0**	0.9	17.1
	Mississippi	22	-15.5**	-27.6	-3.4	22	3.0	-2.7	8.7
	New Hampshire	0	0.0	0.0	0.0	3	-6.2	-14.8	2.4
	New Jersey	11	-8.9	-22.9	5.1	18	-4.8	-11.9	2.2
	New York	9	-4.7	-49.6	40.2	12	-7.1**	-13.2	-1.1
	North Carolina	18	24.0*	-2.2	50.1	21	0.8	-3.0	4.6
	Ohio	16	7.6	-16.9	32.1	37	3.2	-3.0	9.4
	Pennsylvania	13	23.5	-13.2	60.2	15	4.5	-2.2	11.2
	Rhode Island	2	29.1**	2.1	56.1	2	4.9**	0.7	9.2
	South Carolina	17	17.4**	2.8	32.0	20	-1.1	-8.9	6.7
	Tennessee	21	28.1***	16.9	39.2	24	-2.3	-6.2	1.6
	Vermont	18	-3.3	-31.6	25.0	21	-3.3	-8.0	1.4
	Virginia	9	12.0	-31.0	54.9	11	-1.1	-7.0	4.8
	West Virginia	6	45.1	-19.0	109.2	7	9.5	-8.3	27.3
	Wisconsin	15	-27.5***	-47.3	-7.6	20	-0.9	-7.8	6.0
	Weighted average	323	1.6	-3.7	7.0	442	0.3	-1.1	1.7
East CMU	Arkansas	13	-10.4	-31.9	11.1	15	-2.0	-8.0	3.9
	Iowa	14	-16.8	-41.7	8.2	16	1.2	-3.3	5.7
	Minnesota	6	33.7	-25.3	92.8	11	-3.9	-15.6	7.8
	Missouri	20	-7.9	-31.2	15.4	20	-3.8	-10.6	3.0
Mid-CMU	Nebraska	21	3.2	-11.0	17.5	25	-6.1***	-9.3	-2.9
	North Dakota	15	7.1	-12.1	26.3	25	8.3	-2.6	19.3
	Oklahoma	14	26.2	-15.3	67.7	16	-2.9	-8.4	2.5
	South Dakota	15	-10.3	-36.5	15.9	21	-10.3***	-18.0	-2.6
	Texas	107	-11.3**	-20.9	-1.7	133	2.2	-1.0	5.4
West CMU	Colorado	14	25.2	-7.9	58.3	16	-1.5	-7.6	4.6
	Kansas	21	36.0*	-3.3	75.2	25	-5.9*	-12.0	0.1
	Montana	15	-6.4	-27.9	15.0	23	-3.2	-14.2	7.8
	New Mexico	20	25.2*	-5.0	55.4	26	18.5**	2.8	34.2
	Wyoming	14	3.7	-39.8	47.1	16	4.2**	0.6	7.8
	Weighted average	296	4.9	-2.4	12.2	388	-1.7*	-3.7	0.3
Coastal WMU	California	35	-14.4	-36.4	7.6	51	-4.4	-10.7	2.0
	Oregon	10	-23.8***	-34.9	-12.6	17	1.0	-10.9	12.8
	Washington	11	-14.9	-43.8	14.0	15	11.2*	-1.1	23.4
Interior WMU	Arizona	46	-21.8***	-31.5	-11.9	54	-8.1**	-15.9	-0.3
	Idaho	11	25.4	-15.1	66.0	21	0.9	-5.5	7.2
	Nevada	16	-9.4	-85.9	67.0	19	0.3	-13.1	13.6
	Utah	12	-30.0	-70.8	10.9	15	-1.4	-9.6	6.9
	Weighted average	131	-17.4***	-26.3	-8.5	192	-3.5**	-6.9	-0.1
United States		750	0.8	-3.9	5.5	1,022	-1.3*	-2.6	0.1

[a] Mean of route weighted by land area and population density. The estimated count in the next year is (percentage ÷ 100 + 1) times the count in the current year where percentage is the annual change. Note: extrapolating the estimated trend statistic (percentage change per year) over time (e.g., 22 years) may exaggerate the total change over the period.
[b] *$P<0.1$, **$P<0.05$, ***$P<0.01$.

Table 35. (continued)

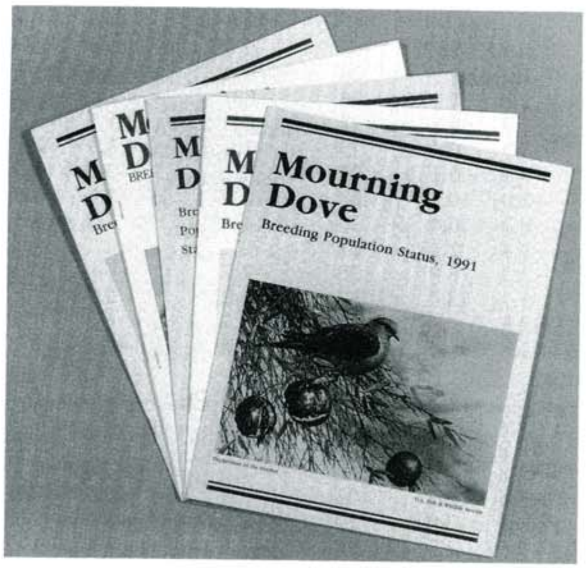
10-year (1978–87)				15-year (1973–87)				22-year (1966–87)			
N	Change[b]	CI		N	Change[b]	CI		N	Change[b]	CI	
33	-2.4	-5.3	0.5	37	1.8	-0.7	4.3	39	1.4**	0.3	2.5
2	-6.0	-45.8	33.8	2	5.5	-21.5	32.6	2	11.3	-14.0	36.5
3	12.6	-9.7	35.0	3	-0.9	-26.4	24.6	3	3.8	-16.1	23.6
24	-1.4	-6.6	3.9	24	-1.6	-4.2	1.1	27	-0.7	-2.6	1.2
22	0.0	-2.1	2.1	25	0.0	-2.1	2.1	26	1.1	-0.6	2.8
22	4.2**	0.6	7.8	22	1.7	-1.5	5.0	22	1.4	-1.5	4.4
15	-0.8	-2.5	0.9	15	-5.3***	-7.0	-3.6	17	-4.6***	-5.6	-3.5
21	-1.8	-9.8	6.1	23	-2.2	-6.8	2.4	25	-1.5	-4.8	1.8
19	-1.5	-5.3	2.3	19	-1.1	-4.0	1.8	22	-0.1	-2.7	2.5
9	0.5	-6.2	7.3	9	7.5*	-1.2	16.3	11	10.3	-15.4	36.1
14	-2.4	-7.9	3.1	15	-2.6**	-5.3	-0.0	15	-1.7*	-3.7	0.2
18	-0.1	-4.6	4.4	18	0.9	-4.1	5.9	19	-0.2	-4.3	3.8
20	3.0	-1.1	7.2	20	0.2	-4.2	4.7	20	-0.1	-4.7	4.5
23	-1.9**	-3.6	-0.3	24	-0.7	-3.6	2.3	25	-1.9	-5.3	1.5
3	2.1***	2.1	2.1	4	-1.1	-6.1	3.9	8	3.1***	0.9	5.4
18	-2.5	-7.5	2.5	18	-4.0*	-8.9	0.8	19	-3.3	-7.6	1.1
15	-1.7**	-3.0	-0.4	17	-0.4	-2.5	1.6	19	0.3	-1.9	2.4
21	0.8	-0.6	2.3	21	-1.0	-2.9	1.0	21	-2.8***	-4.2	-1.4
52	6.5**	1.4	11.5	52	-3.8**	-6.9	-0.8	54	-3.4***	-5.5	-1.3
15	4.1**	0.6	7.5	16	4.0**	0.3	7.6	16	-0.6	-3.6	2.3
2	-3.0*	-6.0	0.0	2	1.0**	0.2	1.8	5	1.9	-16.3	20.2
23	-1.7	-4.0	0.7	23	-0.4	-4.0	3.1	23	-0.8	-3.3	1.7
24	-3.1**	-5.7	-0.5	27	-1.8	-4.0	0.5	30	-1.8*	-3.6	0.0
21	0.4	-10.4	11.2	21	3.3	-9.3	15.9	23	8.9	-7.9	25.7
11	-2.9*	-6.3	0.5	11	-2.3*	-4.9	0.3	11	-1.6*	-3.5	0.3
8	2.5	-1.4	6.4	10	3.5	-1.8	8.8	11	2.3	-3.2	7.9
21	-1.6	-6.1	3.0	21	-2.6*	-5.4	0.3	21	-1.1	-3.1	0.8
479	-0.5	-1.3	0.3	499	-0.8**	-1.6	-0.1	534	-0.9***	-1.7	-0.2
15	-2.1	-5.7	1.5	15	-4.7***	-8.0	-1.4	16	-3.6***	-5.9	-1.3
17	-2.5***	-3.9	-1.2	17	-1.4***	-2.1	-0.6	17	-2.0***	-2.4	-1.6
12	-5.1*	-10.8	0.6	12	-2.0	-7.5	3.6	13	-0.1	-3.4	3.1
22	-2.6***	-4.3	-0.8	24	-3.4***	-5.0	-1.9	26	-4.0***	-5.8	-2.1
25	-3.1**	-5.6	-0.7	25	-0.3	-1.8	1.1	26	-0.0	-1.1	1.1
26	-0.9	-4.7	2.8	26	1.6	-1.3	4.5	27	3.2***	1.1	5.4
16	-3.7	-9.8	2.5	17	-2.7*	-5.9	0.4	19	-1.0	-3.9	2.0
23	-5.5***	-8.3	-2.8	23	-2.8**	-5.4	-0.1	26	0.1	-2.0	2.2
144	-1.9**	-3.4	-0.3	154	-0.6	-2.0	0.9	183	-0.5	-1.9	0.9
18	-2.9***	-4.8	-1.1	18	3.0*	-0.3	6.4	19	4.4***	2.0	6.9
28	-2.7*	-5.4	0.1	30	0.5	-1.4	2.4	31	0.1	-1.1	1.3
24	-2.9	-11.5	5.7	26	2.4	-2.2	6.9	28	-1.7	-5.9	2.5
28	7.4***	2.5	12.4	30	8.1***	3.1	13.0	30	4.2**	0.8	7.5
18	-1.3	-6.8	4.2	19	-4.2	-12.9	4.4	19	-2.9	-6.5	0.8
416	-2.6***	-3.5	-1.6	436	-0.7*	-1.6	0.1	480	-0.5*	-1.1	0.1
59	-6.5***	-9.8	-3.3	61	-5.3***	-7.9	-2.7	70	-4.9***	-7.3	-2.5
21	-0.5	-3.6	2.6	21	-3.3**	-5.9	-0.6	22	-6.0***	-8.3	-3.7
18	-2.8	-7.5	1.9	19	-6.0***	-10.2	-1.7	20	-6.0***	-9.8	-2.3
55	-2.8**	-5.5	-0.1	58	-1.5	-5.8	2.7	63	-1.1	-4.2	2.0
22	-0.5	-4.4	3.3	22	-2.2	-6.6	2.2	23	-2.3	-5.3	0.8
20	-8.6*	-18.8	1.6	22	-3.1	-9.2	3.0	27	-5.2***	-8.2	-2.1
16	-0.2	-3.1	2.6	16	-4.0	-9.5	1.5	16	-2.8	-6.6	1.0
211	-3.9***	-5.5	-2.2	219	-3.8***	-5.8	-1.9	241	-3.4***	-4.9	-1.9
1,106	-2.1***	-2.7	-1.5	1,154	-1.2***	-1.8	-0.6	1,255	-1.1***	-1.5	-0.6

Indices

The main value of indices is to identify *patterns* of counts that may deviate from the fitted line in some years. They allow the reader to evaluate the consistency of the trend over a selected time interval and to provide a relative measure of the variability of year-to-year changes.

Since indices are meant to represent fluctuations, they may not agree exactly with the magnitude of fluctuations of raw data that are biased by observer differences (Geissler and Noon 1981). The indices are adjusted for periodic variation associated with routes that were not run, changes in observers, disturbance and other factors. Consequently, these adjustments may cause the indices to be different from the mean of actual counts of doves heard or seen (raw data). However, it is important to note that, in some cases, the actual counts may be more misleading because they have not been adjusted.

Any area with a small number of routes and a large but nonsignificant trend may have exaggerated indices. Although indices are computed so that the adjusted value in the middle year of the interval equals the midyear raw data average value, variances associated with the trend line may cause the indices to be greater than the actual numbers of doves present. This exaggeration increases as the index gets farther away from the midyear.



After mourning dove Call-count Survey data are compiled, consolidated by computer program and analyzed, the results are summarized in an annual report completed and distributed prior to a Washington, D.C. public hearing held each June on early hunting season regulations. *Photo courtesy of the U.S. Fish and Wildlife Service, Office of Migratory Bird Management.*

The reader should use indices as a means of examining deviations from long-term trends. However, patterns that are identified by indices should be verified by estimating trends over the selected interval of years. Comparisons of dove density may be made among areas, if done cautiously. Indices are affected by the same biases that raw data are, such as differences in observer ability to hear or see doves among areas. Also, as explained above, indices from one area may be exaggerated while those from another area may not. These problems generally occur only at the state or physiographic region level, rather than for management units that have large sample sizes.

RESULTS: 1966 to 1987

For the purposes of this volume, the latest analyses for annual indices and trends were conducted in 1987 *(tables 34 to 37)*. The route regression method was used to estimate trends for doves *heard* and *seen* for several reference areas (e.g., management unit, submanagement unit and state). Trends were calculated for the most recent two-, five-, ten- and fifteen-year intervals and for the entire twenty-two-year period between 1966 and 1987. Statistical significance is defined as $P<0.05$, except for the two-year comparison where $P<0.10$ was used because of the low power of the test. Significance levels were approximate for areas with less than ten routes. Annual indices were calculated over the entire twenty-two-year period. A brief overview of the results is presented in the following discussion. Additional details are discussed in other chapters of this book dealing specifically with each management unit.

Doves Heard

Indices. Indices provide a means to compare breeding densities among areas of the United States *(Figure 38)*. For example, the CMU consistently registers higher population indices of doves heard than do the other two units *(Table 34)*. In 1987, the CMU index was 24.2 doves heard per route compared with 17.1 in the EMU and 9.0 in the WMU. Furthermore, the index from the Mid-CMU (the Great Plains states) registered an index of 31.7 (see Table 56). This high breeding density combined with the large area involved leads to the conclusion that the Mid-CMU is the most important mourning dove-producing area of the nation. In contrast, the Coastal WMU and northeastern sections of the EMU (with indices lower than ten) are

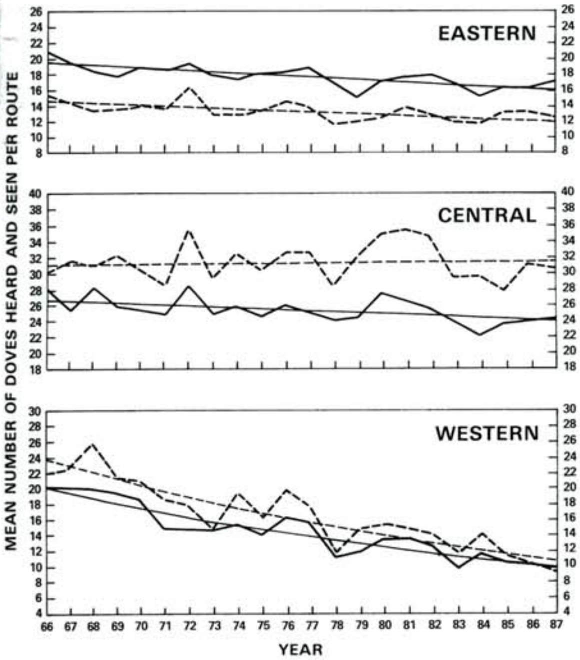


Figure 38. Population indices of breeding mourning doves for the Eastern, Central and Western management units, 1966–87. Heavy solid line = doves heard; heavy dash line = doves seen; light solid and dash lines = predicted trends.

relatively unimportant dove production areas. This aspect will be covered in greater detail in later chapters on the individual management units.

Trends. Lacking a standardized, nationwide harvest survey, breeding dove trend estimates are the primary sources of information in formulating annual hunting regulations and for other management considerations *(Figure 39 and Table 35)*. For the

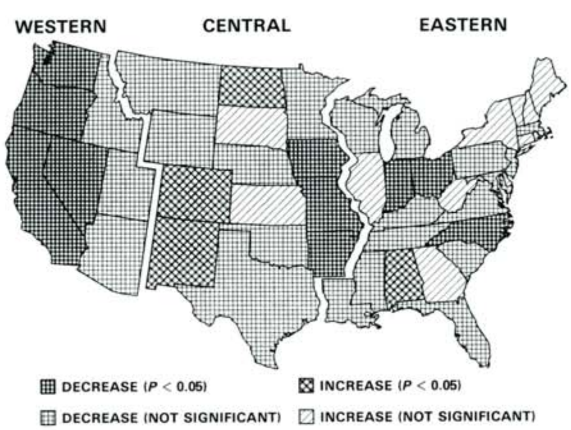


Figure 39. Twenty-two-year (1966–87) trends of mourning doves heard in the Western, Central and Eastern management units.

EMU, estimates indicate that small (less than 1 percent per year) but significant downward trends have occurred for the fifteen- and twenty-two-year periods. No trends are noticeable for the more recent time periods, indicating that populations may have stabilized at a lower level in recent years. For the CMU, a downward trend is indicated for the most recent ten years. Although no significant trends ($P<0.05$) were detected for other time periods, a tendency for a decline ($P<0.10$) is noted for each time frame. When the CMU is examined by subunit, highly significant downward trends are apparent for the East CMU during the ten-, fifteen- and twenty-two-year periods, whereas populations appear to have been stable for the Mid- and West CMU subunits. For the WMU, highly significant downward trends ($P<0.01$) are noted in all time periods except for the five-year period (and that at $P<0.05$). This decline in WMU dove populations was most apparent in the Coastal subunit, where highly significant downward trends are detected for the ten-, fifteen- and twenty-two-year periods.

Doves Seen

Indices. Information for *doves seen* on the nationwide Call-count Survey has been routinely summarized over the years *(Table 36)*, but it is used only as supporting data to *doves heard* because of higher variability in the estimates. Nevertheless, when plotted index points are examined by year for both parameters, a close similarity is seen for all three management units *(Figure 38)*. However, indices for doves seen in the CMU and WMU have been consistently higher than indices for doves heard in those units, whereas those in the EMU were lower, probably because doves are more visible in the open country of the West than in the more forested regions of the East. Thus, for comparisons among units, the doves-seen index data yield misleading conclusions as to the relative breeding population densities, particularly between the EMU and the other two units. For example, in 1987, the doves-seen index values were CMU 30.7, EMU 12.6 and WMU 9.2 *(Table 36)*. It is concluded that only doves-heard data should be used for relative density comparisons among geographical units.

Trends. Trends for doves seen by management unit generally agreed with those for doves heard, although there were some exceptions *(Figure 40 and Table 37)*. For the EMU, estimates indicated a downward trend for the entire twenty-two-year period (as for doves heard), but a few inconsistencies occurred within the other time periods (most were insignificant and therefore of no real import for

Table 36. Breeding population indices for mourning doves seen by management unit and state, 1966–87.[a]

Management unit/state	Year													
	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
EMU														
Alabama	16.9	18.9	15.5	16.2	16.0	14.1	25.4	22.3	14.1	15.3	18.4	16.4	15.9	20.4
Connecticut	3.3	2.9	1.9	2.0	2.7	3.5	10.5	2.7	4.9	5.3	13.1	8.3	11.8	12.1
Delaware	5.2	7.4	4.0	0.1	15.5	7.7	15.8	23.3	30.7	0.9	5.0	8.3	23.4	3.1
Florida	6.4	4.6	5.6	5.7	4.6	3.9	7.3	7.5	6.5	9.5	11.9	7.3	9.7	8.6
Georgia	17.0	14.1	11.7	13.3	15.1	13.0	15.2	12.9	14.5	12.1	12.5	15.0	15.3	17.0
Illinois	17.5	24.3	19.1	21.6	16.6	16.8	20.9	15.8	14.3	14.8	19.1	16.9	13.0	10.2
Indiana	36.1	32.4	30.8	36.0	34.5	28.6	27.4	26.6	33.8	30.8	30.9	25.8	8.7	11.7
Kentucky	21.1	19.5	17.0	18.2	17.9	13.6	17.0	13.4	16.7	14.2	21.2	16.7	14.0	13.7
Louisiana	14.5	12.9	11.2	12.6	10.1	14.0	15.3	11.9	11.5	10.8	9.3	15.3	12.9	11.9
Maine	1.4	1.4	1.6	0.9	1.8	1.6	−0.0	−0.1	1.0	1.0	3.0	4.9	2.9	1.4
Maryland	10.6	17.5	12.0	13.3	18.8	17.1	16.2	13.2	14.9	11.3	21.2	17.9	14.8	15.0
Massachusetts	6.9	8.2	13.3	10.9	19.2	9.7	9.2	10.4	7.2	15.4	5.0	9.8	17.3	8.4
Michigan	9.1	6.6	8.2	4.8	7.0	7.0	7.9	6.1	6.5	8.9	7.3	7.4	5.5	5.1
Mississippi	32.7	28.1	27.2	25.5	24.2	24.3	34.1	23.1	23.2	25.3	19.3	25.8	24.4	25.6
New Hampshire	1.7	1.0	1.1	2.5	3.0	2.4	2.4	3.6	2.6	1.1	1.5	1.5	0.9	2.5
New Jersey	1.6	23.0	19.1	20.4	11.5	23.6	29.5	19.5	8.5	14.8	27.2	21.7	30.3	22.4
New York	3.2	2.5	2.8	4.1	4.4	3.3	3.4	3.2	2.3	4.6	2.8	3.2	3.3	3.4
North Carolina	26.5	23.6	21.8	17.2	23.9	23.2	19.5	19.4	21.6	16.4	20.7	17.2	21.8	20.3
Ohio	13.1	19.1	18.2	22.6	24.1	21.9	22.2	20.1	22.2	26.0	24.0	20.0	10.3	10.7
Pennsylvania	15.0	12.7	11.5	14.2	10.3	10.4	10.7	11.4	14.9	14.0	13.2	6.7	7.5	9.1
Rhode Island	1.7	3.8	12.6	4.5	3.1	3.5	5.1	1.7	3.8	10.1	12.0	8.5	9.5	4.0
South Carolina	22.0	22.9	19.4	22.2	17.2	29.6	25.0	19.0	21.5	27.3	24.5	21.0	27.9	27.8
Tennessee	33.4	25.1	21.2	22.3	24.8	26.5	28.7	18.1	19.6	21.3	22.5	27.2	22.6	22.2
Vermont	2.2	0.5	1.1	1.3	1.3	2.6	0.9	0.9	1.8	0.8	5.3	1.5	2.7	4.3
Virginia	18.1	10.9	11.9	9.4	21.2	12.7	22.0	15.9	15.4	12.7	18.6	18.8	17.3	18.6
West Virginia	3.7	2.2	2.4	1.7	1.7	2.9	2.6	1.5	1.8	2.2	2.3	2.3	2.1	3.5
Wisconsin	3.8	3.7	4.0	3.6	4.6	4.0	7.0	4.2	4.5	5.1	5.3	5.6	3.0	6.2
Weighted average	15.4	14.2	13.3	13.4	13.9	13.5	16.3	12.8	12.7	13.4	14.6	13.7	11.5	12.1
East CMU														
Arkansas	21.0	35.2	25.4	27.7	24.1	20.3	30.1	24.9	23.9	19.3	29.3	19.6	19.9	22.0
Iowa	20.1	21.5	19.5	16.7	13.1	16.3	24.5	16.4	17.0	13.2	16.7	20.8	16.6	13.3
Minnesota	18.9	16.1	15.4	10.3	13.9	17.7	22.3	10.2	13.5	12.6	16.9	22.4	12.3	17.7
Missouri	56.5	53.0	44.0	52.4	43.6	41.0	53.0	39.9	36.3	33.1	27.8	30.6	22.4	25.8
Mid-CMU														
Nebraska	48.8	49.5	55.1	58.4	53.4	57.7	61.4	60.7	65.3	72.7	80.8	80.6	79.1	75.1
North Dakota	15.5	19.2	17.2	19.6	17.6	17.2	19.7	22.8	17.2	18.1	24.7	25.4	22.1	24.5
Oklahoma	50.3	69.4	87.6	81.8	57.3	65.7	85.9	58.5	83.4	75.3	73.1	61.8	102.1	93.3
South Dakota	39.8	31.9	38.5	41.6	43.9	36.6	38.9	42.0	46.4	37.2	48.7	46.9	41.8	45.0
Texas	37.5	29.3	36.4	32.9	34.5	28.4	36.9	29.4	35.2	33.1	32.1	31.7	29.4	39.7
West CMU														
Colorado	18.4	22.0	17.4	18.5	16.5	20.8	20.9	20.2	29.2	13.9	36.9	29.3	28.9	19.1
Kansas	65.5	75.8	53.0	71.8	74.2	67.1	80.0	69.9	70.2	69.1	69.9	75.0	63.3	73.0
Montana	7.4	14.6	10.1	11.9	13.3	9.4	12.2	13.1	13.6	11.9	12.7	18.0	11.6	14.5
New Mexico	13.9	9.9	13.9	12.0	14.0	10.0	21.0	9.7	15.9	17.4	16.2	13.1	10.8	10.8
Wyoming	19.5	18.9	19.2	25.4	16.2	16.9	15.3	17.4	17.0	24.2	17.4	24.1	12.6	15.9
Weighted average	30.1	31.6	31.0	32.3	30.5	28.4	35.5	29.4	32.4	30.3	32.6	32.6	28.3	31.9
Coastal WMU														
California	35.1	31.7	33.1	30.2	27.3	24.9	25.5	20.8	26.7	25.5	25.6	23.0	14.2	18.1
Oregon	12.4	10.7	13.0	11.7	9.7	9.8	11.5	7.6	11.3	8.7	9.5	12.3	7.2	6.8
Washington	14.9	11.8	10.8	10.7	10.9	9.8	13.7	8.5	6.7	7.3	11.1	9.1	5.3	5.8
Interior WMU														
Arizona	36.0	43.4	51.7	38.8	46.2	27.7	26.6	31.2	27.6	25.0	23.4	20.3	20.6	26.3
Idaho	24.6	31.8	20.8	17.7	12.5	18.9	20.6	13.5	16.1	14.8	18.3	17.9	12.3	12.1
Nevada	10.2	8.8	23.9	15.6	9.2	11.7	8.1	6.3	14.6	7.4	24.5	16.1	5.8	12.4
Utah	10.4	15.2	15.3	13.9	24.8	24.3	11.8	6.3	29.3	16.5	28.5	20.0	10.1	14.6
Weighted average	21.9	22.4	25.7	21.3	20.9	18.5	17.8	14.7	19.4	16.3	19.8	17.5	11.7	14.8
United States	23.9	23.6	23.7	23.2	23.1	21.8	25.3	20.7	22.8	22.0	24.5	23.4	19.2	21.5

[a] Annual indices are defined as the predicted value from the trend analysis plus the deviation from the expected value in a year.

Table 36. (continued)

Year							
1980	1981	1982	1983	1984	1985	1986	1987
19.1	14.5	19.4	17.6	14.5	18.3	20.5	11.4
10.1	14.6	8.9	9.3	9.8	14.4	20.7	19.0
17.2	14.9	8.5	3.9	17.6	33.3	14.3	7.9
9.2	16.0	11.5	9.2	15.1	16.1	14.8	12.9
13.3	16.2	10.9	8.8	12.4	17.4	13.0	13.2
11.1	14.4	11.0	11.6	8.1	13.0	12.9	13.3
15.4	23.6	16.4	15.7	15.2	14.3	16.7	23.0
12.0	19.9	20.9	17.3	13.5	20.8	15.0	21.2
13.7	14.1	13.7	18.2	17.1	10.4	15.2	13.7
2.9	2.1	2.5	2.1	2.2	1.7	2.2	2.4
18.5	16.7	7.8	14.7	20.6	14.8	20.7	17.8
7.7	6.8	7.2	5.2	6.2	11.3	7.6	5.5
6.4	8.5	5.2	5.8	5.2	7.8	8.7	7.6
22.7	20.9	25.7	29.2	20.7	20.9	23.2	18.0
6.1	1.5	3.1	5.9	2.6	3.3	2.9	2.9
14.2	18.0	20.4	16.9	17.2	13.0	19.5	11.3
3.9	4.2	5.0	3.6	2.1	3.6	4.7	4.6
17.6	20.1	15.7	13.9	18.8	18.3	21.2	20.8
12.4	18.7	19.1	16.4	15.7	16.5	18.6	22.0
11.5	9.1	8.9	11.1	8.6	10.0	12.5	9.6
5.1	2.1	9.0	3.7	1.7	6.6	5.1	6.2
24.7	28.3	38.6	23.5	27.4	25.8	23.6	27.6
21.2	22.0	22.4	16.3	19.3	19.4	18.2	21.3
4.3	2.9	2.7	2.8	3.2	5.8	4.6	3.8
17.8	13.3	13.2	14.7	11.5	12.8	8.2	10.7
2.5	3.9	3.6	2.6	5.1	4.8	3.4	3.7
6.5	8.9	5.7	6.7	5.3	4.7	6.9	7.6
12.4	13.8	12.9	11.8	11.6	13.2	13.3	12.6
24.7	23.1	21.0	27.9	15.6	16.5	18.3	17.4
23.5	16.5	18.6	14.8	17.2	15.2	13.4	17.3
15.3	16.0	11.6	14.2	12.3	13.2	11.0	9.0
26.5	32.4	28.3	32.5	21.0	15.3	21.6	24.0
73.8	79.1	81.2	62.5	65.9	66.7	59.8	69.8
25.1	25.7	23.1	20.2	18.9	20.2	22.3	25.4
104.8	82.4	100.6	81.7	70.6	77.8	89.9	81.0
40.4	44.4	42.0	40.0	46.3	39.2	31.0	36.7
35.7	40.7	41.5	34.0	31.7	30.2	37.6	37.4
35.0	35.5	36.8	24.1	34.3	28.9	39.9	34.0
89.1	68.3	75.4	70.7	72.1	62.4	65.7	65.0
15.7	18.6	13.4	10.8	13.7	18.0	14.7	14.5
18.5	17.4	14.9	13.5	24.6	16.7	18.9	14.9
16.2	12.8	17.4	9.7	9.7	9.5	15.0	11.3
34.7	35.5	34.5	29.4	29.7	27.8	31.1	30.7
20.5	21.0	21.8	17.5	17.6	15.6	14.4	13.7
9.3	13.4	9.6	7.1	7.2	6.3	6.8	8.1
5.1	5.9	5.6	3.8	6.8	3.8	4.0	3.3
19.6	13.5	20.2	14.3	14.7	15.1	13.0	8.1
11.7	13.7	15.3	12.2	15.4	9.5	10.1	10.3
17.2	11.7	5.7	8.5	12.5	8.3	5.7	7.9
19.1	27.2	10.5	12.2	28.5	13.4	15.9	13.9
15.3	14.8	13.9	11.5	14.1	11.2	10.4	9.2
22.8	23.9	22.8	20.0	20.7	20.4	21.2	20.2

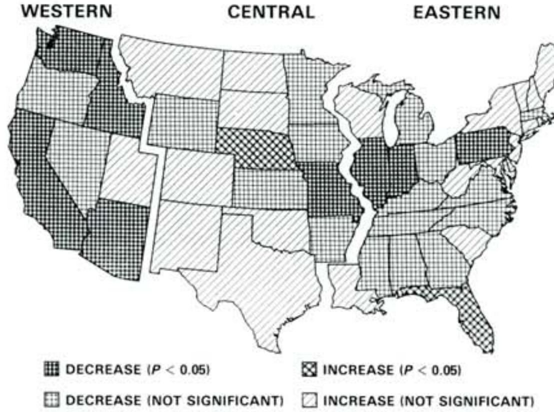


Figure 40. Twenty-two-year (1966–87) trends of mourning doves seen in the Western, Central and Eastern management units.

management decisions). For the CMU, downward trends were indicated in the five-, ten- and fifteen-year periods, whereas for doves heard, a downward trend was registered only for the ten-year period. No trend was noted for the twenty-two-year period for doves either seen or heard. For the WMU, highly significant downward trends were indicated for all but the two-year period. This result matched that for doves heard.

Comparison with the North American Breeding Bird Survey

The North American Breeding Bird Survey annually monitors all birds seen and heard, including the mourning dove, along more than two thousand routes in Canada and the United States (Robbins et al. 1986). Whereas this survey was designed to provide trend information for all species of birds encountered, the Call-count Survey was developed to yield annual comparisons and trend information specific to mourning dove populations. Nevertheless, the Breeding Bird Survey provides an independent measure of mourning dove population trends for comparison with the Call-count Survey, despite several differences in timing, methods and results of the two surveys.

Sauer et al. (in preparation) made a detailed comparison of mourning dove population trend estimates from the two surveys for the 1966–88 period. For the United States, both the Call-count Survey data (-0.66 percent per year) and Breeding Bird Survey data (0.05 percent per year) showed no trend (both surveys $= P > 0.10$). Both survey analyses indicated a population decline in the WMU but with differing magnitudes (Call-count Survey, -2.38 percent per year, $P < 0.05$; Breeding Bird

Table 37. Trends (percentage change[a] per year as determined by linear regression) in number of mourning doves seen by management unit and state, 1966–87.

Management unit	State	2-year (1986–87) N	Change[b]	CI		5-year (1983–87) N	Change[b]	CI	
EMU	Alabama	24	−29.9***	−49.2	−10.5	30	−1.6	−8.0	4.8
	Connecticut	2	0.0	0.0	0.0	2	25.7***	21.9	29.4
	Delaware	2	−66.6**	0.0	−10.7	2	30.8	−36.5	98.2
	Florida	21	0.1	−20.3	20.5	21	1.3	−7.7	10.3
	Georgia	21	13.2	−26.1	52.5	22	−4.2	−19.6	11.2
	Illinois	15	21.4	−14.8	57.6	20	16.0***	5.0	27.1
	Indiana	12	43.2***	20.4	66.0	15	9.6	−2.9	22.2
	Kentucky	14	5.1	−31.0	41.2	20	2.6	−11.0	16.1
	Louisiana	16	−19.6	−51.7	12.6	18	5.6*	−0.4	11.6
	Maine	6	−22.6	0.0	102.3	7	−14.5	−41.2	12.2
	Maryland	10	−20.9*	−43.7	1.8	13	15.7*	−1.9	33.2
	Massachusetts	6	−48.0**	−87.3	−8.6	16	10.5	−11.0	32.1
	Michigan	18	12.0	−28.7	52.8	20	17.8***	5.7	30.0
	Mississippi	22	−22.0**	−43.2	−0.7	22	−1.9	−13.1	9.3
	New Hampshire	0	0.0	0.0	0.0	3	−22.9***	−29.3	−16.3
	New Jersey	10	−43.7***	−60.9	−26.5	18	−5.8	−18.0	6.3
	New York	8	9.9	−45.8	65.5	10	19.1***	5.9	32.3
	North Carolina	18	−19.0	−58.2	20.3	21	5.5***	2.0	9.0
	Ohio	16	18.8	−22.9	60.5	38	15.7***	4.2	27.2
	Pennsylvania	13	11.2	−38.0	60.3	15	12.0	−6.1	30.0
	Rhode Island	2	25.6	−49.9	101.2	2	22.1***	20.8	23.3
	South Carolina	17	−8.8	−24.4	6.8	20	1.0	−5.6	7.6
	Tennessee	21	16.6	−5.5	38.8	24	6.0	−10.8	22.8
	Vermont	16	−28.8*	−58.3	0.7	23	10.3	−7.2	27.8
	Virginia	8	−16.2*	−35.8	3.3	11	−15.6***	−20.8	−10.4
	West Virginia	9	−10.6	−71.1	49.8	10	−7.5	−39.2	24.3
	Wisconsin	15	−12.5	−42.4	17.4	20	9.1***	3.7	14.5
	Weighted average	317	−4.3	−11.6	2.9	443	2.9*	−0.2	5.9
East CMU	Arkansas	13	−4.5	−52.8	43.8	15	−9.9***	−14.7	−5.0
	Iowa	14	2.5	−34.4	39.4	16	6.4*	−0.5	13.4
	Minnesota	6	47.4	−83.9	178.8	11	−12.5	−38.6	13.6
	Missouri	20	20.0	−4.7	44.8	20	1.2	−4.5	6.8
Mid-CMU	Nebraska	21	19.5**	2.0	37.1	25	0.1	−7.1	7.3
	North Dakota	15	11.9	−26.9	50.8	25	2.9	−3.9	9.6
	Oklahoma	14	−8.0	−58.1	42.1	16	−9.7**	−17.5	−1.8
	South Dakota	15	36.8	−12.2	85.8	21	−9.7*	−19.8	0.3
	Texas	107	−5.1	−19.7	9.6	133	1.6	−3.1	6.2
West CMU	Colorado	13	−22.9**	−42.1	−3.6	16	7.6	−4.4	19.7
	Kansas	21	0.0	−21.4	21.5	25	−8.5**	−15.9	−1.2
	Montana	16	2.2	−31.6	36.0	22	−6.4	−19.3	6.3
	New Mexico	20	−33.3**	−63.2	−3.4	26	0.5	−11.9	12.9
	Wyoming	10	1.7	−37.3	40.8	15	−3.9	−25.8	17.9
	Weighted average	292	1.5	−7.1	10.0	386	−3.1**	−6.1	−0.2
Coastal WMU	California	34	6.1	−13.5	25.7	48	−6.5	−14.8	1.7
	Oregon	8	−12.9	−47.3	21.5	15	13.2	−4.6	31.0
	Washington	11	7.4	−41.0	55.7	15	−6.3*	−13.2	0.7
Interior WMU	Arizona	40	−31.3**	−56.3	−6.3	52	−21.4***	−34.2	−8.7
	Idaho	10	91.5	−62.9	245.8	21	2.0	−6.3	10.3
	Nevada	15	71.8	−19.5	163.1	21	−14.5	−37.7	8.6
	Utah	10	−20.2***	−35.8	−4.7	14	0.1	−12.7	13.0
	Weighted average	116	1.5	−12.3	15.4	186	−6.9***	−11.6	−2.1
United States		725	0.2	−6.0	6.4	1,015	−2.2**	−4.4	−0.0

[a] Mean of route weighted by land area and population density. The estimated count in the next year is (percentage ÷ 100 + 1) times the count in the current year where percentage is the annual change. Note: extrapolating the estimated trend statistic (percentage change per year) over time (e.g., 22 years) may exaggerate the total change over the period.
[b] *$P<0.1$, **$P<0.05$, ***$P<0.01$.

Table 37. (continued)

10-year (1978–87)				15-year (1973–87)				22-year (1966–87)			
N	Change[b]	CI		N	Change[b]	CI		N	Change[b]	CI	
33	−3.0	−7.4	1.3	37	−0.2	−3.6	3.2	39	−0.5	−2.3	1.3
2	−7.6	−32.5	17.2	2	6.0	−2.7	14.6	2	10.6***	9.5	11.7
3	8.3	−33.5	50.1	3	4.9	−17.8	27.7	3	3.2	−21.8	28.3
21	2.6	−1.5	6.6	23	5.8***	3.0	8.5	26	6.4***	4.2	8.6
22	−2.4	−5.8	1.0	25	0.5	−1.3	2.3	26	−0.1	−3.3	3.1
22	2.8*	−0.0	5.7	22	−2.4**	−4.7	−0.1	22	−3.3***	−5.8	−0.9
15	8.0***	3.1	12.9	15	−4.0*	−8.5	0.4	17	−4.4**	−8.3	−0.4
21	4.8	−4.0	13.6	23	2.0**	0.2	3.8	24	−0.2	−3.1	2.8
18	1.8	−1.3	4.9	18	1.8	−1.5	5.1	22	0.9	−3.0	4.8
8	−0.3	−10.4	9.8	8	−0.1	−9.0	8.8	10	2.7	0.0	141.6
14	6.2***	2.8	9.7	15	3.5	−1.2	8.2	15	1.4	−1.3	4.2
18	−3.9	−9.5	1.6	18	−1.8	−6.1	2.4	19	−2.9*	−6.3	0.5
20	4.7	−1.7	11.2	20	1.1	−3.4	5.6	20	−0.4	−4.7	3.9
23	−1.9*	−3.9	0.1	24	0.4	−1.4	2.3	25	−1.4	−3.4	0.7
3	14.1***	9.3	18.9	3	7.5	−2.9	17.9	8	3.2	−9.1	15.4
18	−5.2	−12.0	1.6	18	−2.5	−6.6	1.5	19	0.3	−7.2	7.8
14	−6.0	−14.5	2.5	14	2.0	−3.0	6.9	16	1.6	−4.8	8.0
21	0.3	−1.6	2.3	21	1.5	−0.6	3.7	21	−1.1	−2.6	0.4
52	9.2***	2.8	15.7	52	−1.4	−4.3	1.4	54	−1.3	−3.5	0.8
15	7.2**	0.5	13.8	16	2.0*	−0.0	4.1	16	−3.0**	−5.9	−0.2
2	−4.2	−18.5	10.1	2	−1.6	−4.2	0.9	4	0.9	0.0	297.8
23	0.2	−4.9	5.3	23	1.2	−1.3	3.7	23	1.1	−2.4	4.6
24	−1.0	−6.7	4.6	27	1.5	−3.6	6.6	30	−1.2	−4.5	2.2
23	3.5	−11.4	18.5	23	9.2	−3.4	21.8	25	7.8	−7.1	22.7
11	−8.5***	−12.8	−4.2	11	−5.7***	−8.8	−2.6	11	−1.9	−4.4	0.6
10	5.2***	2.8	7.5	11	9.2***	6.4	12.1	11	3.0	−4.5	10.6
21	3.7	−1.1	8.5	21	2.4	−1.1	5.8	21	2.7*	−0.2	5.5
477	0.4	−0.7	1.6	495	0.2	−0.6	1.1	529	−0.9**	−1.7	−0.1
15	−3.5***	−5.9	−1.1	15	−5.0***	−7.6	−2.5	16	−1.7	−4.5	1.2
17	−0.6	−4.7	3.4	17	0.2	−2.1	2.4	17	−0.5	−2.5	1.5
12	−8.7*	−18.9	1.5	12	−4.7	−11.4	2.0	13	−2.1	−7.4	3.3
22	−2.5**	−4.7	−0.2	24	−3.1***	−4.9	−1.3	26	−4.8***	−7.4	−2.3
25	−3.7***	−5.9	−1.5	25	−1.5*	−3.1	0.1	26	1.5***	0.5	2.5
26	−7.3***	−11.1	−3.6	26	−2.2	−6.3	1.8	27	1.6	−0.6	3.9
16	−10.4***	−17.3	−3.6	17	0.2	−2.2	2.7	19	1.6	−0.8	4.0
23	−6.7***	−11.3	−2.1	23	−3.9**	−7.5	−0.3	26	0.0	−3.9	3.9
145	−1.2	−3.7	1.3	155	0.9	−0.8	2.6	183	0.5	−1.2	2.3
18	−0.3	−3.3	2.7	18	4.4***	1.6	7.2	19	3.9*	−0.1	7.9
28	−4.0***	−6.7	−1.3	30	−1.6	−3.6	0.4	31	−0.1	−2.2	2.0
25	−1.4	−9.7	6.8	26	−0.8	−7.1	5.6	28	2.0	−3.7	7.7
27	4.6	−4.9	14.2	30	6.0	−3.4	15.3	30	2.0	−0.8	4.8
17	−4.6	−14.8	5.6	18	−8.6*	−17.3	0.0	18	−2.5	−6.3	1.3
416	−4.7***	−6.6	−2.7	436	−1.0**	−1.8	−0.2	479	0.1	−0.7	0.9
58	−3.9*	−7.9	0.1	61	−5.4***	−8.3	−2.5	70	−4.0***	−5.6	−2.3
18	2.0	−1.4	5.3	19	−1.5*	−3.2	0.2	20	−2.4	−6.3	1.5
16	−3.6	−11.9	4.6	18	−7.6**	−13.5	−1.6	19	−6.1**	−11.2	−1.1
54	−12.0***	−18.8	−5.1	58	−7.8***	−13.4	−2.1	63	−6.7***	−10.4	−3.0
22	0.3	−6.6	7.3	22	0.5	−3.9	5.0	23	−3.3**	−6.4	−0.1
21	−6.0	−16.5	4.5	22	−0.2	−13.6	13.2	26	−0.8	−8.2	6.5
16	8.5***	2.0	14.9	16	1.2	−5.0	7.3	16	0.2	−3.4	3.7
205	−3.9***	−6.6	−1.2	216	−4.1***	−6.2	−2.0	237	−3.3***	−5.0	−2.5
1,098	−3.6***	−5.1	−2.1	1,147	−1.1***	−1.7	−0.4	1,245	−0.6*	−1.2	0.0

Survey, −2.35 percent per year, $P<0.01$). For the CMU, neither survey analysis detected a significant trend (Call-count Survey, −0.43 percent per year; Breeding Bird Survey, −0.4 percent per year; both = $P>0.10$). In the EMU, the point estimates of trend differed in magnitude: the Call-count Survey indicated a possible negative population change (−0.34 percent per year), whereas the Breeding Bird Survey data showed an increasing population trend (+0.58 percent per year). However, neither trend was significantly different from zero ($P>0.10$). Interpretation of results for the EMU are discussed in greater detail in chapter 17.

A comparison of results from the two surveys by state revealed significant differences in trend estimates for eleven (23 percent) of the forty-eight states sampled. Many of the discrepancies were associated with differences in strata used in each survey, as well as with large differences in the sample sizes (number of routes) associated with many states in each survey. Generally, the Breeding Bird Survey exhibited smaller variances than did the Call-count Survey among states in the EMU and WMU where the former's sample sizes were greater. Variances were especially greater for Call-count Survey estimates among northeastern and mid-Atlantic states where sampling was perceptibly lower. Sauer et al. (in preparation) concluded that the greater sample sizes associated with the Breeding Bird Survey appeared to provide more precise trend estimates than did those of the Call-count Survey in the EMU and WMU. On the other hand, the Call-count Survey appeared to yield estimates with about equal precision in the CMU.

The merits of maintaining two surveys that collect similar information on mourning doves recently were reviewed in 1989 by the U.S. Fish and Wildlife Service. It was decided to retain and rely on the Call-count Survey for management decisions because:

1. The Migratory Bird Treaty Act specifies that, when adopting hunting regulations, the Secretary of the Interior give *due regard* to, among other considerations, the distribution, abundance and flight lines of migratory birds. These considerations—especially abundance—can change from year to year, so it has been logical from the beginning to develop hunting regulations annually. The Call-count Survey is the *only* survey program designed to monitor mourning doves on a national scale and provide status information in time for consideration in the annual harvest regulations-setting process, which begins each June. A yearly assessment of populations helps assure that regulations are appropriate and commensurate with the status of the resource. The Call-count Survey provides timely information needed for regulations development; data from Breeding Bird Survey routes are not available to meet the June deadline.
2. Each survey has its own respective strengths and provides information on different aspects of mourning dove populations. For example, the Breeding Bird Survey presently provides more extensive coverage in the eastern U.S., while the Call-count Survey has better coverage in the western states. The Breeding Bird Survey collectively records doves heard and doves seen and, therefore, can be influenced by the greater variability of doves seen. The Call-count Survey records doves heard and doves seen separately, allowing a more detailed analysis of trends by considering two independent variables. At some locations, increased disturbance can be an important factor in census results. Trends, using disturbance as a covariable, can only be assessed with the Call-count Survey. Consequently, the Call-count Survey provides information that is unavailable from the Breeding Bird Survey.
3. The Call-count Survey was developed specifically as a survey technique for mourning doves, and various assumptions associated with the survey have been reviewed periodically to assure continued reliability of this program. Future use of both surveys' results in mourning dove management will be contingent on a more thorough comparison of survey methods and consideration of other issues, such as comparability to historical data sets and availability of information to meet current timetables for development of hunting regulations.