Biological Evaluation of the Call-count Survey

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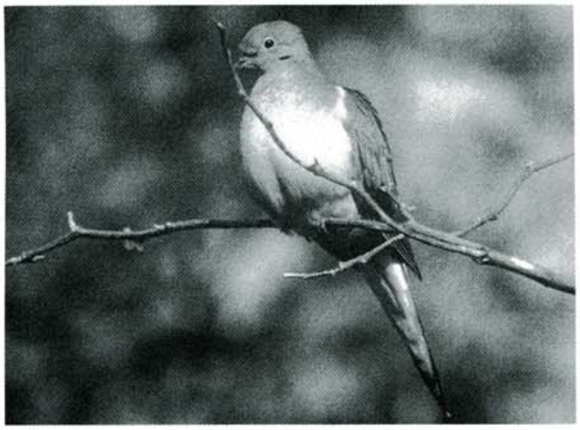
In his presentation "Counting Birds for a Relative Measure (Index) of Density," Dawson (1981: 12) provided an excellent perspective for many bird surveys: "Counts of birds from points of transect lines give an index of population density, even when distances have not been accurately estimated. Factors which influence the counts include the species, age, sex or reproductive group of each bird, the season, habitat, time of day, weather, environmental noise, the observer, the number of other birds being recorded and details of the counting technique. If valid deductions about bird densities are to be made, such influences must be standardized, or their effects removed."

Here, attention is focused on a single species, the mourning dove, and primarily with audio, not visual, counts. The preceding chapter dealt with details of the counting technique, including improvements in statistical design and analyses of data, and the consistency of observer performance. In the national Call-count Survey, the season, time of day, allowable limits for weather and habitat all have been standardized. This chapter emphasizes biological considerations of the Call-counts and attempts to answer (1) what a cooing mourning dove is and (2) what influences its cooing rates in ways that might affect the audio counts. Some of these factors pose problems that can be solved through standardization of counting methods, but some problems cannot.

The "perch coo" is the only vocalization recorded on Call-count Surveys (see chapters 10 and 14). It consists of "five to seven notes; one note, then a higher one and finally three to five lower notes held at a greater length" (McClure 1939: 323). It is the mourning dove's song (Craig 1911). It is uttered chiefly by the male, although the female sometimes sings a faint version (Frankel and Baskett 1961). Perch cooing serves to announce the presence of a male and to attract and court the female. Since perch cooing decreases soon after pair bond formation, mate attraction may be the most important function of dove song (Stone 1966).

Mourning doves of both sexes have another vocalization, which Craig (1911) termed the "nest call" (see also chapter 10). It resembles the first three notes of the perch coo but usually is fainter and variable in volume, length and inflection. It differs in function from the perch coo, for it usually is employed as communication between mates, particularly during courting and nest site selection (Jackson and Baskett 1964). Nest calls and accompanying behavior similar to those of the mourning dove probably are universal among the world's doves and pigeons (Craig 1911, Murton and Isaacson 1962). The nest call is not tallied in the North American Call-count Survey, so observers (listeners) must be able to distinguish it.



The perch coo is the song – the *only* song – of the mourning dove. When singing (perch cooing), the male arches his neck, puffs out his throat, stiffens his body and bobs his tail with each of the five to seven notes. *Photo by Mike Blair; courtesy of the Kansas Department of Wildlife and Parks.*

FACTORS AFFECTING PERCH-COOING RATES

Pairing Status

By far the most important factor affecting perch-cooing activity of male mourning doves is whether they are mated. Frankel and Baskett (1961) noted tenfold increases in perch-cooing frequency among males confined in small pens when their mates were removed. When the females were returned, cooing dropped to previous levels if pair bonds were restored. These findings were substantiated by several field studies of free-flying birds, most of them marked *(Table 38)*. Three-minute perch-cooing rates of unmated males ranged from 6.2 to 20.7 times higher than those of mated males. Cooing rates were computed as total coos divided by total numbers of three-minute periods each dove was observed. Data reported by Sayre et al. (1980) are the most appropriate for these comparisons because they were provided by radio-tagged doves monitored during the entire two-hour study periods, beginning half an hour before sunrise. In other studies *(Table 38)*, marked mated birds usually were silent and inconspicuous when away from their territories. At such times, they usually would not be included in the database because they were not observed.

For interpretation of Call-count Survey results, the relative probability that mated and unmated males will utter the perch coo during a three-minute period is a more useful figure than is the frequency of cooing. The probability figures *(Table 38)* were derived by dividing numbers of three-minute periods in which each dove perch cooed by the number of periods during which it was observed. Even this more conservative approach (comparing probability instead of frequency of cooing) shows that an unmated dove is 6.3 times more likely to be heard in a given three-minute period than is a mated bird (Sayre et al. 1980).

The combined sample sizes in the four field studies summarized in Table 38 were substantial. At least 65 marked individual doves were involved, and several of them provided data for both the unmated and mated status. Other known but unmarked birds brought the total known individuals to 91. Data were gathered during thousands of three-minute periods during hundreds of hours of observation. The conclusions about the cooing rates of unmated versus mated males were further supported by findings of Stone (1963) in a field study in Colorado.

Table 38. Cooing rates and probabilities of cooing per three-minute period by mated and unmated male mourning doves in four field studies (data for courting unmated males excluded).

Status (N)	Mean coos per three minutes	Ratio of cooing rates unmated/mated	Probability of cooing during three-minute periods	Number of three-minute periods	Location	Source
Unmated (8)	8.40	13.3	0.93	820	Missouri	Jackson and Baskett (1964)
Mated (6)	0.63		0.23	820		
Unmated (12)[a]	8.19	6.8	0.94	[b]	Arizona	Irby (1964)
Mated (25)	1.21		0.31	[b]		
Unmated (20)	8.88	6.2	0.95	3,543	South Carolina	Sayre et al. (1978)
Mated (6)	1.44		0.42	321		
Unmated (5)	8.68	20.7	0.94	952	Missouri	Sayre et al. (1980)
Mated (14)	0.42		0.15	2,546		

[a] Includes 5 males studied both as unmated and mated.

[b] Numerical bases for means not given; 488 total hours of observation.

Results of several studies of confined doves also have confirmed the lower perch-cooing rates for mated than for unmated males. However, overall rates for both groups generally are lower in pens than in the wild because doves in pens are silent for longer periods (Armbruster 1983).

During courtship, males (some of which never establish pair bonds) perch coo at rates intermediate between those of unmated and mated males (Irby 1964, Sayre et al. 1980). Despite this complication, the decrease in perch-cooing rates of males as they become mated is sufficiently dramatic and consistent to be used as a measure of mating status in various experiments with penned doves (Frankel and Baskett 1963, Goforth and Baskett 1965, Sayre et al. 1981, Armbruster 1983).

The potential impact of cooing by unmated male doves on the outcome of Call-count Surveys still has not been considered sufficiently. The problem extends to many other avian species, reviewed by Thorpe (1961), who noted that it is very unusual for a mated male to sing (perch coo) more frequently than any unmated bird, which is a considerable understatement. Species in which singing is at least partially suspended after mating include bobwhite quail (Stoddard 1931), song sparrow (Nice 1943), English robin (Lack 1946), pied flycatcher (von Haartman 1956), chaffinch (Thorpe 1961), field sparrow (Best 1975), Cassin's finch (Samson 1978), house wren (Wilson and Bart 1985) and others.

For the mourning dove, evidence is overwhelming that unmated males have higher rates and probabilities of perch cooing than do mated males. The effect of pairing status on cooing is so great that it must be considered in any analysis of other factors influencing cooing rates. The most important question is how differential cooing performance of unmated and mated males affects results of the mourning dove Call-count Survey (discussed later).

Position in the Nesting Cycle

Cooing performance of mated male doves also is affected by the stage of the nesting cycle, as suggested by Craig (1911) and Webb (1949). Quantitative studies of the relationships between perch cooing and nesting status have produced some contrary results (see Stone 1966, Baskett et al. 1978). Possible reasons for the apparent contradictions include differences in categorizing nesting cycle stages, sample sizes, penning effects and different subspecies of doves.

Frankel and Baskett (1961) noted small numerical differences in perch-cooing rates of three penned mourning doves according to nesting stages. These differences were not consistent among individuals nor statistically significant ($P > 0.05$). Frankel and Baskett concluded that any small differences in cooing rates at different nesting stages were overshadowed by the high rates of cooing of unmated males. In a study of six marked, mated, free-flying doves, Jackson (1963) and Jackson and Baskett (1964) reached the same conclusion, but Jackson's (1963) data showed numerical (not statistically significant) differences in cooing rates related to nesting stages that agreed with results of later, more complete data sets *(Table 39)*. Mackey's (1965) observations of one mated, unconfined male during parts of five nesting cycles produced similar results *(Table 39)*. Yet another study produced somewhat analogous numerical results, but cooing rates did not differ significantly according to stage of nesting (LaPerriere and Haugen 1972b).

Irby's (1964) two-year study involving 32 individually marked male mourning doves and numerous unmarked males provided data that clearly showed patterns of perch cooing that differed statistically according to stage of the nesting cycle. Irby's study, conducted in Arizona, also provided a framework for the three-year field study by Sayre et

Table 39. Mean perch-cooing rates per three-minute period for male mourning doves, related to phase in the nesting cycle, as determined in four studies of marked, free-flying, mated males.

	Nesting cycle phase								
Source	Selecting nest site	Building nest		Laying eggs	Incubating	Brooding young	After successful nesting		After nest disrupted
Jackson (1963)	[a]		0.59		0.65	0.52		0.75[c]	
Irby (1964)	0.19	0.21		1.41	1.53	0.37	2.11		2.64
Mackey (1965)[b]					1.32	0.26		3.56[c]	
Sayre et al. (1980)	0.42	0.48		0.85	0.70	0.24	1.12		0.47

[a]No data.
[b]Rates computed from Mackey's Table 2.
[c]From listings as "between nestings" by both Jackson (1963) and Mackey (1965).

al. (1980) in Missouri, in which 19 male doves were monitored by radio telemetry.

In both of these studies, perch-cooing rates and probability of cooing were low during nest site selection and nest building *(Table 39 and Figure 41)*, requiring one to three days and two to four days, respectively. Cooing increased during laying (two to three days) and during the fourteen-day incubation period, then dropped markedly during the ten to fourteen days when the adults brooded the young. Both Irby (1964) and Sayre et al. (1980) showed cooing rates and probabilities rising between nestings. In Irby's study, cooing rates did not differ significantly ($P>0.05$) when the doves were singing after successful and unsuccessful nestings. In the Sayre et al. study, however, singing (perch-cooing) rates were dramatically and significantly ($P<0.05$) higher following successful nestings than were those following unsuccessful nestings *(Table 39 and Figure 41)*.

Perch-cooing rates of mated males in different phases of the nesting cycle are related in complex ways to other behavioral traits, particularly the apportionment of the birds' time in different locations. Mated males coo principally when within their nesting territories (Jackson and Baskett 1964, Irby 1964, Sayre et al. 1980) but often perch coo briefly before leaving the roost. Other off-territory cooing is minimal *(Table 40)*.

The amount of time the male spends in the nesting territory generally decreases as each cycle progresses (Sayre et al. 1980). During the early phases (nest site selection, building and laying) nesting males spent much of the observation period in the vicinity of the nest. During the laying period the perch-cooing rate is quite high, reflecting a particularly active cooing period as well as prolonged presence near the nest.

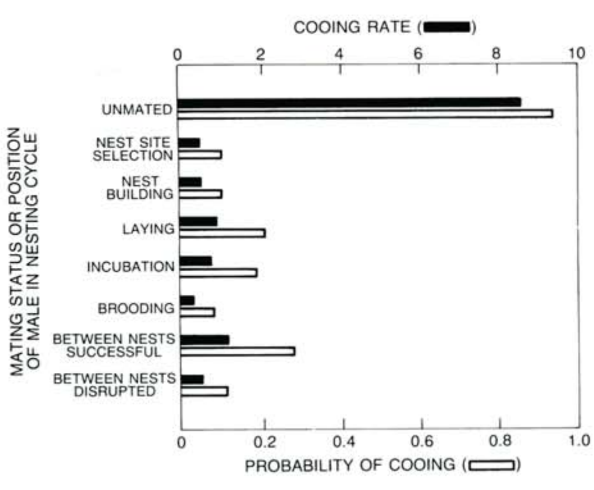


Figure 41. Mean perch-cooing rates and probabilities of cooing in three-minute intervals by radio-tagged, unconfined male mourning doves in Missouri, related to position in the nesting cycle (based on data from Sayre et al. 1980).

Table 40. Mean perch-cooing rates per three-minute period, in relation to location, by mated male mourning doves observed from 30 minutes before to 90 minutes after sunrise (from Sayre et al. 1980).

Location	Cooing rate (mean ± 1 SE)	Number of three-minute periods
On territory	1.02 ± 0.06	1,242
Off territory	0.01 ± 0.00	1,046
Roost	0.41 ± 0.08	258

During incubation and brooding, males spent considerable portions of the morning observation period away from nests. During incubation, perch-cooing rates remained high regardless of this fact, but then fell to a minimum during brooding *(Figure 41)*. Also during this stage, audibility of perch coos may be greatly reduced through interference from the crop when engorged with crop milk and seeds (M. J. Armbruster personal communication: 1987). Moreover, brooding males often do not come to nesting territories each morning until after the two-hour observation period (Sayre et al. 1980). When off territory, these males, mostly silent, may be as far as 5 miles (8 km) from nesting territories. (Many of the birds, even though marked, could not have been included properly in the database for cooing performance without having been found and located periodically through radio tracking.)

The considerable differences in perch-cooing rates according to stage in the nesting cycle, particularly the disparity between cooing rates of brooding males and males between nestings, were the basis for Irby's (1964) concern about the validity of Call-count data under certain circumstances. He thought that storms might disrupt large numbers of nests, which would be followed by synchronous renesting. Resulting waves of high then low cooing rates related to position of mated males in the nesting cycle, depending on timing of the Call-count Survey, might produce misleading indices. It seems unlikely, however, that such a high degree of nesting synchronization would occur over the large areas sampled in the Call-count Survey. Even on a local basis, T. S. Baskett and R. P. Breitenbach (unpublished data) found no evidence of synchronous renesting following a severe thunderstorm that destroyed known nests in two islands of nesting habitat in central Missouri.

Clearly, stage of the nesting cycle does affect perch-cooing rates, but the mated male is never a match in cooing performance for his unmated counterpart, as shown dramatically in *Figure 41*. We doubt that varying rates of cooing by mated males in different positions of the nesting cycle could affect Call-count Survey results seriously on more than a very local basis.

Age

Armbruster (1983) was the first researcher to investigate possible effects of age on perch-cooing performance of confined male mourning doves. He compared cooing rates and probabilities of cooing within three-minute intervals by confined yearling and older (at least two years old) males. Samples were 25 unmated and 25 mated males observed during 501 periods between thirty minutes before and ninety minutes after sunrise, the period used in Call-count Surveys.

Older unmated males cooed about 1.4 times more frequently per three-minute interval during the entire two-hour periods than did unmated yearling males. Probability of cooing by unmated males in a three-minute interval was about 1.3 times that of mated males.

However, no significant age-related differences in perch-cooing rates or probabilities of cooing were found among mated males of the two age groups. Thus, changes in age composition of the population do not seem likely to affect seriously the interpretation of Call-count Survey results.

Time of Day

Most early studies (Duvall and Robbins 1952, McGowan 1952, Peters 1952, Cohen et al. 1960) showed that perch cooing by male mourning doves is more frequent during early portions than during late portions of the two-hour morning observation period formally adopted in 1953 in the national Call-count Survey. However, Robbins (1981) found little difference in mourning doves detected by sound and sight in the first and second hours of the nationwide Breeding Bird Survey, 1965–79. McGowan (1952) noted that fewer were heard at the end of the route than at the beginning, even if the population at the end equaled that at the beginning.

Later, Frankel and Baskett (1961) and Jackson and Baskett (1964) showed that daily time patterns of cooing by mated and unmated males differ markedly. These findings were confirmed and elaborated with substantial data in field studies of individually marked birds in Arizona (Irby 1964) and South Carolina (Sayre et al. 1978) and with radio-tagged doves in Missouri (Sayre et al. 1980). The same general tendencies were evident in results of all three studies. Unmated males cooed at high rates throughout the entire two-hour period. Rates of mated males were much lower and patterned very differently in time than those of unmated birds. Mated males cooed at their highest rates just before sunrise, then the rates dropped and steadied at a low level by about forty-five to fifty minutes after sunrise.

Data from Sayre et al. (1980) offered the most complete picture of cooing patterns related to time (*Figure 42*) because, as explained earlier, the males in that study were monitored by radio telemetry even when they were off territory. Mean cooing rates of unmated males computed for the first and second hours (8.6 versus 8.5 coos per three-minute interval) were not significantly different ($P>0.05$, t-test). In contrast, mated males cooed about three times as much per three-minute interval during the first hour as during the second (0.76 versus 0.25 coos per three-minute interval, $P<0.05$, t-test). Mean cooing rates and probabilities for mated males were highest in the fifteen minutes preceding sunrise. Rates dropped gradually during the remainder of the first hour, then dropped markedly during the last forty-five minutes of the observation period (*Figure 42*). Time-related trends (cooing patterns) were similar for mated males regardless of position in the nesting cycle (Sayre et al. 1980).

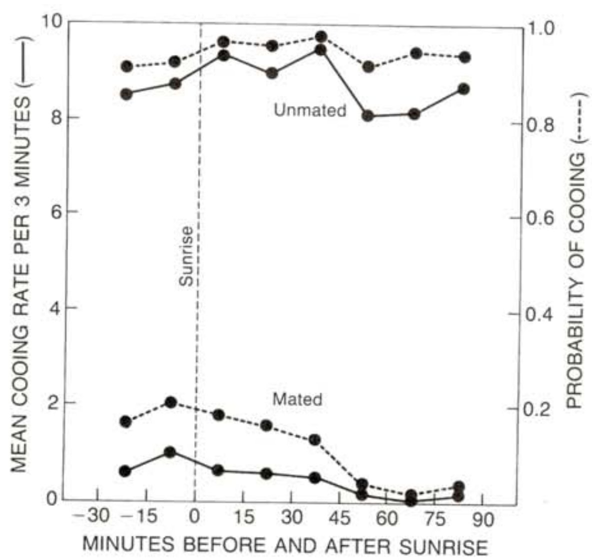


Figure 42. Mean perch-cooing rates and probabilities of cooing by mated and unmated male mourning doves during three-minute intervals within fifteen-minute segments of the morning survey period (after Sayre et al. 1980).

Radio tagging and telemetry have helped to show that unmated male mourning doves perch coo at a much greater rate than do mated males. Since the perch coo is the vocalization basis of the Call-count Survey and unmated males do most perch cooing, the Call-counts can serve as a measure of relative dove abundance in large areas and from one time to another, where ratios of mated to unmated males are relatively stable. Call-count data do not serve well as indicators of numbers of nesting doves on small, intensively studied areas. *Photo courtesy of the Missouri Cooperative Fish and Wildlife Research Unit.*

The probabilities of cooing within three-minute periods, which actually determine the numbers of doves tallied on Call-count routes, showed time patterns similar to those of calling rates *(Figure 42)*. Thus, the cooing of mated males that sing mostly before and soon after sunrise "is superimposed upon the cooing of unmated males which coo at a high rate throughout the morning period" (Frankel and Baskett 1961: 379). The early cooing activity of mated birds probably accounts for the greater numbers of doves tallied during the first hour of the survey than during the second hour. As noted by Baskett et al. (1978), differences in daily cooing patterns doubtless produce a very different mix of mated and unmated males in the tallies made during the first and second hours of the survey.

In many types of avian surveys, effects of daily time differences must be recognized (Shields 1977). A study in Ontario by Weber and Theberge (1977) well illustrates the potential problem. They used standard Breeding Bird Survey procedures (see Robbins and Van Velzen 1969) requiring more stops, longer routes and more time than the mourning dove Call-count Survey. Habitat for mourning doves was much better near the eastern end than the western end of one route. When Weber and Theberge ran this route from east to west, they tallied nearly three times as many singing male doves (mean = 12.4 doves per one hundred stops) as when they ran the route from west to east (4.3 per hundred stops). This finding emphasizes the necessity to run mourning dove Call-count routes in the same compass direction in consecutive years, as is customary.

If the mourning dove Call-count Survey could be restricted to the first hour, with other routes added to compensate for the reduced sample, the following advantages might be realized, as spelled out by Baskett et al. (1978: 169):

"1. More doves per stop would be tallied, and the sampling would be more representative for an entire route.
2. The statistical frame would probably be better, according to the findings of Gates et al. (1975) whose paper showed that for the Texas call-count survey, more routes with fewer stops would reduce the variance of the overall mean.
3. The number of mated males tallied per stop would be higher, as would their ratio to unmated males."

Population Density

Information about effects of population density on cooing is contradictory. Duvall and Robbins (1952), Southeastern Association of Game and Fish Commissioners (1957) and Cohen et al. (1960) all found that doves coo more frequently when their densities are high than when they are low. (The breeding status of the doves was not taken into account.

Irby (1964) reported cooing rates of mated males about 1.5 times higher in dense populations (three pairs of breeding doves per acre: 7.4/ha) than in sparse populations (one pair per acre: 2.5/ha). He had additional evidence from cooing rates of individual doves reinforcing his belief that mated birds coo more frequently when in sight or sound contact with other doves. Irby noted, however, that cooing by unmated males was unaffected by density—they cooed at high rates whether or not they were in sight or sound contact with other males.

LaPerriere and Haugen (1972b) compared mean cooing rates per bird during three-minute intervals according to numbers of other male doves heard; pairing status of the birds was not determined. Cooing rates were significantly ($P<0.001$) higher when two doves were cooing than when only one was heard. No significantly elevated rates were found in means of the small samples when more than two birds were heard *(Table 41)*.

Table 41. Mean perch-cooing rates in relation to the number of cooing mourning doves present, as reported by LaPerriere and Haugen (1972b) and Sayre et al. (1978).

	LaPerriere and Haugen		Sayre et al.	
Number of cooing doves	Mean coos per three minutes[a]	Number of three-minute periods	Mean coos per minute[b]	Number of one-minute periods
1	5.08	376	2.68	2,614
2	7.36	61	2.99	3,417
3	9.07	9	2.99	2,375
4	8.13	2	2.95	1,142
5+			2.89	374

[a] Pairing status of males not specified.
[b] Coos issued by unmated males.

Sayre et al. (1978) studied the effects of density on perch cooing of marked unmated and mated males separately. For unmated males, the mean rate of perch cooing per one-minute interval was significantly ($P<0.05$) higher when two or more were cooing than when only one was heard *(Table 41)*. There were no significant ($P>0.05$) increases in mean cooing rates if more than two were cooing.

Data of this type for mated doves did not suffice for analysis in the study by Sayre et al. (1978). Infrequency of calling periods for mated males argues against any direct relationship between densities and calling rates on a short-term (one-minute) basis. However, on numerous occasions during the study, mated males were observed issuing a brief series of perch coos following territorial disputes (Sayre 1976). Thus, density might be a contributing factor in the total amount of cooing of a mated male over an extended period.

Sayre et al. (1978) also separately analyzed cooing rates of mated and unmated doves on two study areas with vastly different densities of cooing doves, based on local Call-count Survey data. Nearly 2.5 times as many males were tallied on one area as on the other. Cooing rates of neither mated nor unmated doves differed significantly by area. In fact, raw data for mated males on the high-density area defied the expected trend, for the birds cooed somewhat less frequently than did their low-density counterparts *(Table 42)*.

Disagreements regarding effects of density on cooing rate in the literature may arise from the researchers' failure to distinguish between mated and unmated males in their data collection and analyses. Pairing status influences perch-cooing performance so powerfully that it cannot be overlooked in collection or analysis of data used to evaluate other factors influencing cooing performance.

In conclusion, perch cooing of individual mated males over an extended period may be affected somewhat by density (Irby 1964, Sayre 1976). Density can affect cooing rates of unmated males by a factor of about 1.1 (Sayre et al. 1978, see also *Table 41*). These small differences probably would have little effect on reliability of the Call-count Survey. Moreover, the findings of Sayre et al. (1978)—that area differences in population density did not markedly change calling rates or probabilities of calling within three-minute periods for either mated or unmated males—reinforces the belief that population density is not a serious problem in interpreting Call-count Survey data.

Weather

Well before the preliminary nationwide Call-count procedures were established in 1953, and continuing thereafter, numerous investigators

Table 42. Comparison of mean cooing rates per three-minute period for mated and unmated mourning doves in two areas of South Carolina with differing dove densities (from Sayre et al. 1978).

	Low density		High density	
Pairing status	Cooing rate (mean ± SD)	Number of observations[a]	Cooing rate (mean ± SD)	Number of observations[a]
Unmated	8.88 ± 2.16	138	8.75 ± 1.31	29
Mated	1.64 ± 1.01	13	0.82 ± 0.40	4

[a] Observations of individual birds lasting 30 minutes or more.

studied the influence of temperature, humidity, barometric pressure, cloud cover and wind velocity on mourning dove cooing activity (McClure 1939, Duvall and Robbins 1952, McGowan 1952, Davey 1953, Wimmer 1953, Mackey 1954, Southeastern Association of Game and Fish Commissioners 1957, Frankel 1961, Frankel and Baskett 1961, Irby 1964). The broad objective of most of these studies was to develop and evaluate methods of determining the abundance of breeding doves (Duvall and Robbins 1952). One facet of special interest concerned establishing or testing limits on weather conditions under which standardized Call-count procedures would give useful and consistent results. Studies of weather factors related to cooing activity made before the mid-1960s were reviewed and analyzed by Stone (1966).

Some early observations were anecdotal. Even when quantitative results were obtained, they were not always treated statistically, and "analyses involving the interaction of two or more influents were seldom made" (Stone 1966: 16). And it was not always clear that only the perch coo was tallied or considered, and changing audibility as well as changing cooing rates may have influenced readings obtained under certain weather conditions.

Nevertheless, reasonable boundaries for weather seem to have been set as a result of the early studies. Call-counts are not recorded during rainfall or if winds exceed Beaufort scale number 3, 12 miles per hour (19.5 km/hr) (see chapter 14). These boundaries conform with the Southeastern Association of Game and Fish Commissioners' (1957) finding that cooing rates are depressed during light rains and with Mackey's (1954) observation that cooing ceases during heavy rains. Mackey also noted that cooing did not diminish as wind velocities rose until winds reached 10 to 12 miles per hour (16.1 to 19.3 km/hr).

Studies made after the mid-1960s dealt with combined effects of many weather variables on cooing and employed multivariate analyses. Gates (1969) studied the effects of temperature, cloud cover, and wind direction and velocity on the number of doves heard on Call-count routes in Texas. The data base was impressive—there were ninety-one routes, each run four times per year for three years. Analyses of covariance indicated that, within the limits of the investigation, weather factors had little or no consistent influence on numbers of cooing doves heard along the routes.

Working in Iowa, LaPerriere and Haugen (1972b) examined the relationship between dove cooing activity (both perch cooing and nest cooing) and climatic factors by employing a principal components factor analysis of twenty-eight variables associated with Call-count data. Results indicated that four synoptic weather situations (conditions occurring simultaneously over broad areas) might influence cooing activity sufficiently to affect Call-count Survey results. These synoptic conditions were linked to position or movement of weather fronts; each of the four had characteristic complex interactions of wind speed and direction, cloud cover, fog, etc.

Finally, Sayre et al. (1978) used a multiple regression model to evaluate relationships between weather and cooing performance of marked, free-flying, unmated male doves in South Carolina. The number of perch coos per minute per day per bird was the dependent variable; independent variables included temperature, increasing and decreasing temperature, barometric pressure, rising or falling pressure, wind speed and direction, cloud cover, two visibility categories of fog, humidity, and frontal passage occurring during the twenty-four-hour period preceding or following an observation. Analyses indicated that, within limits of standard Call-count procedures, weather factors did not significantly affect cooing activities of unmated males.

In a prior review of effects of weather on cooing activity, Baskett et al. (1978) noted that Gates (1969) and Sayre et al. (1978) came to similar conclusions, even though one study was based on analysis of actual field survey data and the other on cooing performance of individual wild birds. Considering their results, and the similar findings of Frankel and Baskett (1961) for penned birds and of Irby (1964) for large numbers of free-flying birds in Arizona, Baskett et al. (1978) concluded that effects of weather on Call-count Survey results were unlikely if survey instructions were followed carefully. That conclusion still seems valid; cooing performance seems profoundly affected by weather only beyond extremes that are excluded from standard Call-count tallies.

Seasonal and Short-term Variability in Cooing

Seasonal patterns of cooing by mourning doves were studied by McGowan (1952, 1953), Duvall and Robbins (1952), Wagner (1952) and Lowe (1956). They described a "plateau" period of cooing, principally in May and June, in localities ranging from Georgia to Tennessee, Ohio and Wisconsin. In some cases, these plateaus coincided with nesting peaks (McGowan 1953, Lowe 1956). Information about the cooing plateau, particularly as related to location or year, was reviewed by the Southeastern Association of Fish and Game Commissioners (1957) and Stone (1966).

Other studies did not substantiate the existence of a seasonal plateau period of cooing (Irby 1964, Clark 1968, Armbruster et al. 1978) or a relationship between doves calling and doves nesting (Armbruster et al. 1978, Olson et al. 1983, Armbruster and Baskett 1985). Call-counts fluctuated throughout the summer months in these studies.

Stone (1966) and Baskett et al. (1978) reexamined earlier data concerning seasonal trends of cooing and agreed that, for considerable periods in late spring and summer, marked fluctuations in cooing activity were apparent but without identifiable trends. Data did not show smooth, steady levels of cooing implied by the word "plateau." A clear example of the jagged pattern was furnished by Olson et al. (1983) in their Colorado study *(Figure 43)*: from late May until mid-July, high but fluctuating numbers of doves were heard on three routes censused every other week.

Causes of these fluctuations in numbers of doves heard on the same routes over short periods probably are complex but must depend on a summation of cooing performance of individual birds. Sayre (1976) found mean cooing rates of marked mated and unmated doves to be quite variable (coefficients of variability were 71.0 and 24.3, respectively). Differences in cooing rates related to position in the nesting cycle, superimposed on individual variation, undoubtedly accounted for the greater overall variability of cooing by mated males. This latter phenomenon was noted earlier by Frankel (1961), whose penned mated males all reached a peak in cooing at a different time. Unmated males, on the other hand, had a steady, high calling rate as long as they were unmated or until the seasonal decline in calling in September. A similar pattern in cooing of marked, unmated, unconfined males was recorded by Sayre (1976). It should be remembered that both the Frankel (1961) and Sayre (1976) data were based on calling frequencies of individual birds, not on total number of doves heard calling along routes, as in the case of other studies discussed (e.g., Olson et al. 1983).

Early cooing peaks (in April or early May), documented in several studies reviewed by Stone (1966) and more recently demonstrated by Best (1981), may be attributable to the presence of numerous unmated males that either migrate onward or remain and later become mated and less vocal as breeding populations stabilize.

Even though there is little evidence of a "plateau" in cooing, debating its existence is largely an academic exercise, because the survey is adequately timed to include periods of fairly high cooing activity when nesting is in full swing and breeding populations should be stabilized (Wight 1962).

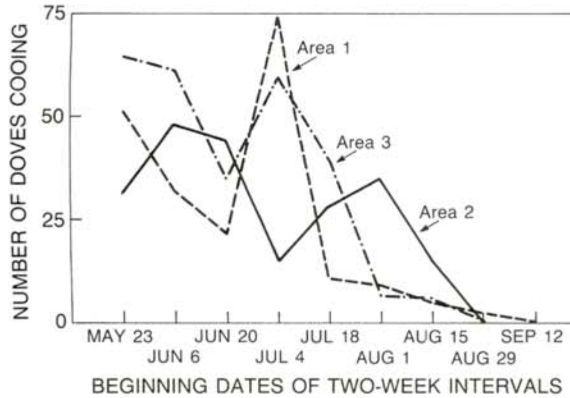


Figure 43. Seasonal perch-cooing patterns of mourning doves in northern Colorado, 1978 (adapted from Olson et al. 1983).

SUITABILITY OF CALL-COUNT DATA FOR INTENSIVE STUDY OF LOCAL BREEDING POPULATIONS

Data collected annually in the Call-count Survey are used primarily as an index to relative densities and long-term population trends in the three management units (groupings of eastern, central and western states) and in the states comprising them (Keeler 1977, Dolton 1987, see also chapter 14).

Modifications of Call-count Survey procedures or related audio-census programs have also been used in intensive studies of mourning dove breeding populations on small areas, e.g., 151 acres (61 ha) as in Lowe (1956). This intensive approach—often with implications of great precision in estimating numbers of breeding doves and nesting densities or even in predicting production of young on the small study areas—has been confused from the beginning (McClure 1939) with the use of Call-count data as indices to population trends and for other broad-scale purposes wherein great accuracy is neither expected nor probably needed.

Prominent among early studies employing coo counts, at least in part to assess breeding parameters on areas of 99 to 284 acres (40 to 115 ha), were those of Kerley (1952), Hopkins and Odum (1953), McGowan (1953) and Lowe (1956). When these studies were made, little was known about differences in cooing behavior of unmated and mated male doves. Hopkins and Odum (1953: 134) wrote that "A bird or pair consistently perched, calling or otherwise associated with a potential nesting site was considered to represent a breeding pair, to be verified by location of an actual nest when possible." These "potential" nests were used in computation of total nesting and production. Many of the males observed may have been unmated, and nesting density probably was overestimated. Only twenty-three of fifty-eight "nests" used by Lowe (1956) to quantify breeding density and nesting effort were actually known nests.

In several of the studies listed above, spot mapping (modified from Williams 1936) was used rather than the Call-count procedures soon to be standardized. Spot mapping to determine breeding bird populations is subject to serious interpretational errors, even when used for highly territorial passerines (Best 1975).

Other workers have not found tallies of cooing male doves to be consistently related to breeding densities, nests or production on small, intensively studied areas (Webb 1949, Caldwell 1955, Jackson 1963, Stone 1963).

Three other studies examined in detail the relationship between calling doves and nesting in areas surrounding listening stops of survey routes. Olson et al. (1983), in Colorado, provided data on cooing activity and nesting along one Call-count Survey and two Breeding Bird Survey routes from late March through October in two years. Numbers of nests found varied from 135 in 1978 to 46 in 1979, despite similar nest-searching effort. There was little evidence that the number of dove nests could be estimated from Call-count data, as is evident in Figure 43. This lack of clear connection was confirmed with regression analyses.

In the other two investigations, both in Missouri, cooing and nesting data were collected for two stops on a Call-count route and the 151-acre (61 ha) area surrounding each. The first of these studies was based on seventy-nine Call-count runs, each followed by intensive nest searches, during two years (Armbruster et al. 1978). As in the Colorado study (Olson et al. 1983), there was great variability in calling birds counted—as much as 50 percent along the entire route on consecutive days (Armbruster 1973). There were no consistent relationships between number of calling males tallied at the two stops and number of nests in each surrounding 151-acre (61 ha) area.

The second Missouri study added five years to the data base on the same study areas (Armbruster and Baskett 1985). During the entire seven years, mean numbers of calling males at one stop were not significantly correlated ($r=0.06$, $P>0.10$) with the numbers of active nests found in the circular plot surrounding it. At the other stop, numbers of calling doves and nests were significantly correlated ($r=0.857$, $P<0.03$), but only one nest was found during the last four of seven years. Results from the entire seven years reinforced the earlier conclusions by Armbruster et al. (1978) and Olson et al. (1983: 335) that there "is little evidence that the number of mourning dove nests in a local area can be estimated from Call-count data."

Similar conclusions were reached by Rappole and Waggerman (1986) in a study of white-winged doves in the Lower Rio Grande Valley of Texas. For nine of ten sites, the number of breeding pairs per hectare estimated by coo counts exceeded nest count estimates by as much as fifteen times.

Possible reasons for the uncertain relationship between calling and nesting are many and include the greater calling rates of unmated compared with those of mated males and differences in calling rates of mated males according to position in the nesting cycle. The considerable mobility of the mourning dove during the breeding season (Hegdal and Gatz 1977, Sayre et al. 1980) also may be a factor. Problems in estimating numbers of breeding birds through counts of singing males are by no means confined to mourning doves, as elucidated by Mayfield (1981). However, his counts of calling doves were only 33 percent "efficient"—i.e., doves were tallied only ten of thirty possible times on an intensively studied area.

Armbruster and Baskett (1985) suggested that numbers of active nests found by direct search are the best available estimators of numbers of breeding pairs of doves on small study areas. Precise linkages, however, among numbers of active nests, breeding pairs and ultimate production of young are unknown. A large-scale effort, similar in scope to the one intended to assess seasonal patterns of nesting and effects of September hunting (U.S. Fish and Wildlife Service 1982), probably would be needed to settle, once and for all, the validity of using Call-count data to assess breeding populations on limited areas and for purposes other than approximating relative densities and trends.

The weak or variable relationships demonstrated between mourning dove Call-counts and nesting or production on small study areas offer little comfort to those using the Call-count Survey for broader purposes. However, the results of these intensive studies are not entirely relevant to and do not disprove the usefulness of the mourning dove Call-count Survey as an index to relative densities of doves or their population trends on a broad scale, such as the mourning dove management units. Nor do they invalidate the approach to dove habitat assessment described by Grue et al. (1976, 1981, 1983). Grue et al. related dove Call-count data to habitat types on 133 15-mile (24 km) transects in ten ecological areas in Texas. Questions remain, however, as to how well their audio data reflect population densities; Grue et al. (1983) considered this problem carefully.

CALL-COUNT SURVEY RESULTS AS INDICES TO DOVE POPULATIONS AND TRENDS

The great importance of the mourning dove as an ecological and recreational resource makes it imperative that attempts continue to be made to refine and improve the only coordinated wide-scale inventory for this species: the Call-count Survey.

In a review of information then available, Baskett et al. (1978) concluded that several factors could influence Call-counts somewhat but posed no major problems within limits of then-current Call-count Survey procedures. These factors were position in the nesting cycle, population density and weather. To this list, age of the males (yearling or older) now can be added. Survey procedures probably would be more sound biologically (tallying higher numbers of doves and higher proportions of mated males), and statistically as well, if the number of three-minute stops were halved and the number of routes increased.

Importance of Pairing Status

As emphasized throughout this chapter, the principal factor influencing cooing rates of male doves and the probability that they will issue the perch coo in any three-minute period is whether they are mated. The effect of this factor on Call-count Survey results remains unknown, but it has the potential to affect survey results from area to area and year to year. Unfortunately, mated and unmated males cannot be distinguished by cooing rates at such short periods as the three-minute stop in Call-count Surveys, because mated males may coo as frequently as their unmated counterparts during bursts of singing, then fall silent for long periods.

To evaluate the effects of unmated males on survey results, it must be determined (1) whether those males exist in substantial numbers, and (2) more importantly, whether ratios of unmated to mated males change substantially from place to place or year to year.

When a pair bond is attained by an adult male and adult female, the male's perch cooing dramatically declines. This indicates that the primary purpose of this distinctive vocalization is mate attraction. Perch cooing by mated males likely serves as a territory advertisement. *Photo by Jim Rathert; courtesy of the Missouri Department of Conservation.*

Presence of Unmated Males in Breeding Populations

In four field studies, 45 of 91 male doves, whose pairing status was known over long periods, were unmated, as discussed earlier. The proportion of unmated birds (49 percent) does not reflect the true condition in the field because of the much greater ease in finding and observing unmated males, and perhaps greater ease in trapping them for marking. However, the numbers of unmated males observed in the studies mentioned show that unmated males in the wild are readily available for study (see also Stone 1963).

The presence of highly vocal, unmated, male passerine birds during the breeding season has been well documented (e.g., Kendeigh 1944b, Enemar et al. 1976). The potential for tallying unmated males in audio surveys of "breeding" birds is attested to by Best's (1975) finding that 67 percent of the singing observations of field sparrows were of marked males known to be unmated at the time. "Floating populations" of both males and females (surplus nonbreeders that can breed if resources become available) for many other species have been reported by other authors (see Stutchberry and Robertson 1985).

Variation in Ratios of Unmated and Mated Males

Ratios of mated to unmated male mourning doves still have not been accurately determined. Therefore, the crucial information about changes in these ratios from large area to area or year to year is not available. The potential for varying sex ratios certainly is present, based on differential wintering tendencies of the sexes; males winter farther northward than do females (Quay 1951a, Chambers et al. 1962, see also chapter 3). Thus, severe winter conditions over parts of the wintering range might cause disproportionate losses of birds of either sex, with resultant changes in adult sex ratios during the subsequent breeding season.

Using hypothetical models, Wight (1964) asserted that changes in ratios of unmated to mated males will not significantly affect results of the Call-count Survey in which sex ratios of adults approach equality. Preliminary calculations suggested that the adult sex ratio should stabilize at about 110 males per 100 females. Wight claimed that, within this range, changes would have little influence on survey results.

From a later perspective, one weakness in Wight's computations was that he used figures provided by Jackson (1963) and Jackson and Baskett (1964) for probabilities of hearing mated (0.23) and unmated (0.93) doves perch coo during survey hours. If more accurate probabilities provided later by Sayre et al. (1980)—0.15 for mated and 0.94 for unmated doves—had been used, Wight's model would have shown the contributions of unmated birds to be of greater importance than he judged them to be.

Another problem with Wight's approach is the lack of unbiased data on adult sex ratios (unmated males presumably being the excess left after all females are mated). Much evidence suggests an excess of males in most dove populations. Hanson and Kossack (1963) found a great preponderance of males among nestling doves in Illinois—158:100, based on sixty broods. However, Hanson and Kossack quoted unpublished data supplied by Wight reporting seasonal changes in nestling sex ratios, and the ratio was only 105 males to 100 females, based on 265 nestlings (see also chapter 8.)

Summer trapping data often show a heavy preponderance of male doves, ranging from 161:100, 178:100 (Tomlinson et al. 1960) and 176:100 (Rice and Lovrien 1974) to 241:100 overall (Henry et al. 1976). Many of these data were not available to Wight in 1964. Such ratios are assumed to be greatly biased; the traditional explanation is that daily incubation schedules cause males to feed in hurried and unwary fashion, thus they are vulnerable to trapping. These ratios may indeed reflect bias, but unpublished observations by both M. J. Armbruster and M. W. Sayre show very leisurely feeding by mated males, with frequent preening and loafing. Moreover, radio telemetry data confirmed that incubating or brooding males devoted about as much or more time in early morning or late evening to activities other than feeding (e.g., loafing) as to feeding (Sayre et al. 1980).

Sex ratios derived from shot samples also frequently show a predominance of males, but they may be biased because of different migration and wintering habits of males and females (original data presented and literature reviewed by Chambers et al. [1962] and Hanson and Kossack [1963]). Although there were notable exceptions (cf. Pearson and Moore 1941, for example), most studies reviewed in the papers cited above showed great preponderance of males in shot samples in both autumn and winter. Many ratios based on sizable samples ranged over 150 males to 100 females. In their Illinois data, Hanson and Kossack (1963) noted greater preponderance of males among adults than among immatures.

In some studies, survival rates of females banded as adults are significantly ($P<0.05$) lower than those of males. Such a condition was found for doves in the Eastern Management Unit (Hayne 1975) and for adults banded in Missouri, where survival rates of males were 46.7 versus 31.2 percent for females (Atkinson et al. 1982). However, for the entire Central Management Unit, survival rates of adult females (51.0 percent) did not differ from those for males (51.7 percent) (Dunks et al. 1982). In a recent analysis of data from mourning doves banded in the Western Management Unit from 1967 to 1977, there likewise was no significant difference in survival rates by sex (Tomlinson et al. 1988). These analyses, taken together, offer little indication that differential survival by sex might produce the unbalanced sex ratios (favoring males) that are often reported.

It is not known how to interpret the sex ratio data presently available. Variations in trapping methodology obviously can result in biased samples (Henry et al. 1976), and season and geographic location can similarly affect sex (and age) composition of shot samples (Chambers et al. 1962). Nevertheless, most sizable, carefully analyzed samples of adults, both in summer and autumn, show sex ratios unbalanced in favor of males. It is concluded that most breeding populations contain surplus males.

At least some unmated males may be present in populations for long periods before, during and after the Call-count survey period. Irby (1964) observed two marked unmated males for more than a month. Both became mated early in April, well before the Call-count period. Sayre (1976) followed one marked unmated male from April 24 to June 27 (forty-one observations) and another from May 8 to July 30 (twenty-four observations)—thus, both were unmated throughout the Call-count period. M. W. Sayre (personal communication: 1980) followed another male fitted with a radio transmitter; it remained unmated from July 13 to August 22. Sayre et al. (1980) had radio telemetry contact with five unmated males for about one month each before, during and after the Call-count Survey period. The length of time the doves were known to be unmated was limited by transmitter life, not by known change in their pairing status.

Sex ratios may not wholly reflect ratios of unmated to mated male doves. R. E. Mirarchi (personal communication: 1977) estimated that 15 to 20 percent of about 160 female doves force-paired with males in quail breeder batteries failed to breed with the first males presented to them, even when they were kept together from February until June. After June, birds were shuffled and many of them mated. Armbruster (1983), working with doves in large aviaries, also found it necessary to reshuffle birds to ensure their pairing. A few males formed and retained homosexual bonds even though unmated females were present. These failures to pair may be attributable to penning, but there is fragmentary evidence of a "floating" population of unmated female mourning doves in the wild (Taber 1926). Jackson and Baskett (1964) observed remating of a marked nesting male mourning dove within ten days after his mate was destroyed. Irby (1964) documented eight cases in which males found new mates when their females were destroyed or pair bonds were otherwise disrupted. (Some of these "new" females may have become available because their own mates were lost.) The presence of unmated females could be important to Call-count Surveys only if their proportions changed from year to year or place to place, but this information is lacking. In several other avian species, presence of unmated females has been demonstrated or surmised (Brown 1969, Best 1977, Stutchberry and Robertson 1985), but their existence has not been studied as carefully as that of surplus males.

In a review paper, Baskett et al. (1978) noted that an important and still unresolved question about pairing status is whether ratios of unmated to mated males present during the Call-count Survey period vary markedly by year and by locality. There are many gaps in knowledge needed to evaluate survey results with respect to these ratios. Because of these gaps, opinions differ widely as to the validity of Call-count Survey results. Wight (1964) was comfortable with the survey, but information not available to him might have altered his view somewhat. Gates and Smith (1972: 357) wrote: "Differential calling rates of mated and unmated doves may present no particular difficulty as long as the other assumptions are met if their rates do not differ substantially. Should their rates change relative to one another during the survey season the problem could be more severe. It would appear to be fruitless to approach this difficulty analytically unless means are found for distinguishing the calls of mated and unmated males." As with Wight (1964), Gates and Smith did not know then that rates of calling of unmated males may exceed those of mated birds by a factor of twenty or more.

A different view was expressed by Wilson and Bart (1985). They pointed out that applying the three-minute cooing probabilities provided by Sayre et al. (1980) for mated (0.15) and unmated (0.94) males would produce a survey result for a population containing 50 percent mated birds that would be 37 percent higher than for one containing 75 percent mated birds. The difference would be due solely to the difference in average detectability. Wilson and Bart (1985: 69) concluded: "Thus, for Mourning Doves, changes in reproductive status may cause substantial changes in survey results. This finding raises doubts about the effectiveness of these surveys in detecting changes in density."

The conclusions of Wight (1964) and Gates and Smith (1972) concerning probable effects of pairing on Call-count results can reasonably be questioned. If, for example, a population of 100 males, all mated, is distributed along a Call-count route, it can be expected that only 15 of them, on average, will be detected when a Call-count Survey is run. If 45 unmated males are added to the population, it can be expected that 42 new birds (0.92 x 45), plus the 15 mated birds, will be detected, for a total of 57 *(Figure 44)*. Thus, increasing the real population by 45 percent would increase the number detected by 280 percent; the resultant sex ratio would be 145 males to 100 females. This degree of disparity is commonplace in summer samples of adults, as discussed earlier. Even with considerably lesser disparities in true sex ratios, the consequences to Call-counts of adding unmated males are quite dramatic.

Admittedly, changes in dove sex ratios of the magnitudes proposed above are quite unlikely to occur over large areas, and the examples probably put Call-count Survey results in an unrealistically poor scenario. The examples, however, emphasize the need for better sex ratio information and for adequate backup to the Call-count Survey. In this context, Wight (1964) wrote that methods to measure ratios of unmated to mated dove males do not exist, so indirect methods must be used for estimations. Regrettably, little progress has been made in solidifying these indirect methods since 1964.

CONCLUSIONS

Changes in proportions of mated and unmated mourning dove males of the magnitudes suggested in models by Wilson and Bart (1985) and in the reckoning above could occur in local populations, and such changes may lie behind the observed shortcomings of Call-count data when used to predict nesting effort and other breeding parameters of mourning doves in small, intensively studied areas (e.g., Olson et al. 1983, Armbruster and Baskett 1985).

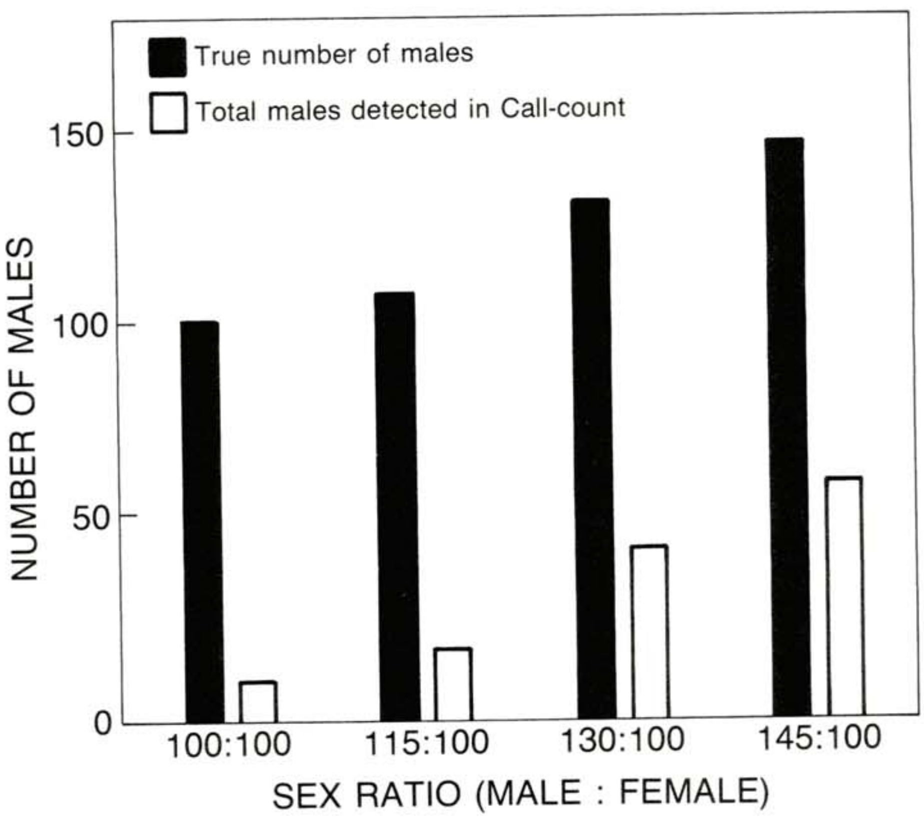


Figure 44. True numbers of male mourning doves versus numbers detected by Call-count procedures in a population of 100 mated males augmented in increments of 15 unmated males each (based on data of Sayre et al. 1980).

It is difficult to imagine, though, that differences in sex ratios (and consequent proportions of unmated males) could pose a comparable threat to the formal Call-count Survey results when only gross comparisons in space and time are needed. Data derived from large samples of Call-count routes (e.g., management units) likely provide reasonable estimates of long-term population trends because any local changes in proportions of unmated males may level out over the larger areas.

Several optimistic notes can be reported. Brown and Smith (1976) found a significant ($r=0.74$, $P<0.01$) correlation between Call-count data and hunting success (numbers of doves bagged per hunter per season) during ten seasons in Arizona. Their approach seems valid, because most direct recoveries of doves in that state are of birds banded within the state or in adjacent localities.

California data for 1966–85 showed significant correlations between Call-count data for that state and total harvest of mourning doves ($r=0.76$, 18 df, $P<0.01$) and mourning doves bagged per hunter ($r=0.52$, 18 df, $P<0.05$). Data for the entire Western Management Unit during 1966–83 also showed significant correlations between Call-counts and total harvest ($r=0.53$, 16 df, $P<0.05$) and between Call-counts and doves bagged per hunter ($r=0.49$, 16 df, $P<0.05$) (R. E. Tomlinson personal communication: 1987). These relationships lend considerable plausibility to Call-count procedures but need further verification on other statewide bases and in the Eastern and Central management units. The need is evident, because in preliminary analyses, some statewide data do not show the expected correlations (R. E. Tomlinson personal communication: 1987).

Visual counts also provide a means of checking Call-count results. In the mourning dove Call-count Survey, numbers of doves seen along the routes are tallied. Resulting data are analyzed as a supplement to Call-count data. Dolton (1987) showed that trends of counts of doves seen on Call-count routes of all three management units, 1966–87, were similar to trends of doves heard. However, in the 1966–90 counts, trends in doves seen and heard diverged with time in the Central Management Unit and converged in the Western Unit (see Dolton 1990).

Both Missouri and North Dakota have conducted long-term roadside counts of doves seen on 20-mile (32 km) routes during summer after Call-count Surveys have been made. For data collected during 1968–85 in Missouri, average numbers of birds seen per route along 111 routes were strongly correlated ($r=71$, 16 df, $P<0.01$) with average numbers of doves heard per route on Call-count Survey routes (R. E. Tomlinson personal communication: 1987). These Missouri counts were made in June and included a few early-hatched immatures. The North Dakota counts were made in July, when many immatures were present. However, immature doves tend to concentrate in fields, not along roads (Henry et al. 1976). The North Dakota data, collected 1966–85, showed even higher correlation ($r=0.82$, 18 df, $P<0.01$) between Call-count data and average numbers of doves seen per route on a total of 1,143 transects (R.E. Tomlinson personal communication: 1987). These findings also lend credibility to the Call-count Survey and its results.

As might be expected for any survey based on data whose validity is affected by many complex biological factors, the mourning dove Call-count Survey needs to be backed up with corroborative information, particularly uniformly gathered harvest figures. The need for a standardized nationwide harvest survey for doves has been discussed for years (e.g., Baskett et al. 1978) and is well advocated in chapters 23, 24 and 29. Both total harvest data and doves bagged per hunter are needed because the former may reflect trends in numbers of hunters, not just numbers of doves available. Such a survey would require an adequate sampling frame that could be provided by a "dove stamp" similar to the present federal duck stamp. Unfortunately, little progress has been made toward establishing uniform harvest surveys for mourning doves.

Another need is sex ratio data that will permit comparisons among years and large areas, such as states. Such data possibly could be gathered by extensive summer trapping programs in which dates, procedures and trapping effort are held in a rigorously similar manner from place to place and year to year. Efforts for uniform gathering of shot samples of doves in autumn would also be valuable. Sex ratio data of these sorts appear to be the only reasonable way to estimate percentages of surplus males in populations and thus permit intelligent surmises as to the effect of the high cooing rate of unmated males.

Although the formal Call-count Survey procedure mandates starting each run precisely one-half hour before sunrise (see chapter 14), there can be "slippage" on this point in operational counts. In those procedures, "close" timing may not be entirely adequate. At Columbia, Missouri, for example, sunrise changes from 4:53 to 4:44 CST between May 20 and June 5. Thus, a "clock time" prescription possibly could produce results at "hot" dove stops on the survey route early in the permissible survey period not comparable to those later in the period. At least, this point may deserve further investigation.

Another point that needs scrutiny and possibly further research is the procedure used in relocating Call-count Survey routes when the traditional routes become dangerous or unsuitable to run owing to highway changes or commercial and suburban developments.

In conclusion, the mourning dove Call-count Survey is a well-managed, well-coordinated and adequately statistically interpreted wildlife survey. Deserving special commendation are early researchers—particularly McClure (1939), who furnished the initial ideas and information—and investigators and administrators of the late 1940s and early 1950s who provided information used to establish ground rules for the survey. Over the years, the survey coordinators have been quick to seek improvements, particularly relating to statistical matters.

The national Call-count Survey clearly should be continued for long-range monitoring of mourning dove populations over large areas. As pointed out by Wilson and Bart (1985: 71), "Investigators using data from surveys such as the Mourning Dove coo-count . . . usually calculate trends on the basis of 10 or more years. It is difficult to see how chance factors could have much effect with so large a sample."

Nevertheless, the great necessity for accurate, reliable population monitoring of a species so important to both hunter and nonhunter demands corroboration of the principal monitoring system. Such corroboration could be provided if there were an adequate base for uniform harvest sampling throughout the hunted range of the mourning dove. This base could be available if a federal "dove stamp" were established to provide a sampling frame. This is a matter of paramount importance. Further comparisons of visual counts with Call-count results and provision of uniformly gathered sex ratio data would be useful adjuncts.