A TECHNIQUE FOR SAMPLING MOURNING DOVE PRODUCTION[1]

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With an increased interest within the state of Iowa on the status of the mourning dove, *Zenaidura macroura* (Linn.), it was deemed advisable to obtain some comparative production figures for Lewis, Iowa, and some surrounding farm areas, where McClure (1943) had worked from 1938 through 1940.

One of the obstacles to be surmounted was the increase in the number of trees within the town of Lewis. In 1938, a survey showed 1,658 trees over 2 inches in diameter on the 160 acres that comprised Lewis, Iowa; whereas, in 1955, there were 3,363 trees. Therefore, it was evident that a complete survey of all trees by one man, the method used by McClure, would not be feasible along with other assignments on mourning dove ecology. Some type of sampling plan was needed.

Field Methods

With McClure's data on 2,886 nests for 1938-1940 revealing that more than 98 per cent of the nests were found in trees, the problem became one of sampling the 3,363 trees for the presence of dove nests. Since no recent information was available on the distribution of dove nests within the town of Lewis, it was decided to stratify the town into 14 strata with each stratum containing about the same number of trees. Further, each stratum was divided into six blocks with each block containing about the same number (40) of trees. The general shape of both blocks and strata was that of a square, depending on the distribution of trees.

Another problem revolved around the difference in tree size; diameter at breast height ranged from 2 to over 40 inches. Some of the smaller trees, depending on species, were easily examined from the ground, whereas others were thought to necessitate climbing for accurate nest counts. A ground count of mourning dove nests was made for all the trees comprising the sampling unit, 40 trees. In addition, a record was made of any tree within the sampling unit when there was any doubt of the accuracy of the ground counts. Then, a random sample of two trees was drawn from the group with doubtful ground counts, and these two trees were climbed. Hence a sample check was made on all trees with doubtful ground counts. No mourning dove nests were found on the ground in Lewis, Iowa, in 1955.

The sampling rate was two blocks a day, and each block necessitated two to three hour's work. With 14 strata in the town, a sample survey of Lewis was made twice every month. The order in which the six blocks in each strata were visited was on a restricted random basis after the first semimonthly period. This order was repeated after the first cycle, May 1 to August 1.

In order to check on the establishment of new nests within any semimonthly period, one set of blocks was retained and a new set was added, one in each stratum. The order in which each of the 14 strata was visited during the semimonthly period was on a restricted random basis.

All observed dove nests were checked with the aid of an offset mirror on a series of 6-foot sections of aluminum pipe. With this instrument it was possible to check nests as high as 40 feet above the ground. Also, it was a simple procedure to obtain the height of the nest above the ground and the distance from the trunk of a tree. A history of all nests was maintained by visiting active nests at least once every three days. Nests that were not successful in producing juvenile doves were deleted from computations on

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mourning dove production; however, their history was used in computing other biological data, such as causes and the amount of nest and nestling destruction, number of eggs, infertility, etc.

The sampling scheme was inaugurated on May 1 and continued to October 1, 1955. No active nests were found between September 15 and October 1. Between April 1 and May 1, 1955, all of the trees in Lewis were checked, but with the advent of leaf foliage, the task became too time consuming for one man.

Although the scheme of checking two trees with doubtful ground counts for mourning dove nests was continued through the sampling period, only once was an additional nest found by climbing. Consequently, the accuracy of the ground counts was beyond expectations and permitted the development of a simpler estimator of dove production and associated variance. However, with different observers and/or species of trees, considerable variation might be found between ground counts of dove nests and counts obtained by climbing the trees.

TABLE 1. – SAMPLING OF MOURNING DOVE PRODUCTION, LEWIS, IOWA, 1955

Semimonthly Period	Blocks	Observed Production[1]	Previous Observed Production[2]	Production
Prior to May 1	All	–	–	24
May 1-15	6	9	2	7
	4	14	4	10
May 16-31	4	17	11	6
	3	11	–	–
June 1-15	3	36	11	25
	5	9	–	–
June 16-30	5	18	4	14
	1	20	–	–
July 1-15	1	12	6	6
	2	11	–	–
July 16-31	2	16	7	9
	6	14	–	–
August 1-15	6	16	6	10
	4	22	–	–
August 16-31	4	14	8	6
	3	2	–	–
September 1-15	3	4	2	2
	5	15	–	–

[1] Observed Production=young produced from eggs in nests started during the period.

[2] Previous Observed Production=young produced from eggs in nests observed during the previous semimonthly period.

RESULTS AND ANALYSIS

The production of mourning doves is estimated by the number of juvenile doves produced from nests observed during the semimonthly sampling periods, regardless of the date that the doves left the nest (Table 1). The normal term of egg laying, incubation, and rearing of young is about 30 days (McClure, 1943).

Prior to May 1 a complete count of dove nests for Lewis was available. Therefore, during the first two weeks of sampling (May 1-15), the number of active nests in blocks 6 and 4 (Table 1) for all 14 strata that started prior to May 1 was known. After the first two weeks, that is, from May 15th onwards, the information for the two blocks differed. One of the two blocks in each stratum, blocks 4 for the period May 15 through May 30, was retained from the previous period and it was possible to record for each of these blocks 4: (1) young produced from eggs in nests started before the beginning of the period, called "Previous Observed Production" in Table 1 (11 young for all blocks 4 combined); (2) young produced from eggs in nests started before the end of the period, called "Observed Production" in Table 1 (17 young for blocks 4); and (3) young produced from eggs in nests started during the period called "Production" in Table 1 (6 young for blocks 4). This is the difference between items (2) and (1). Inasmuch as no information was available on nests started during the previous semimonthly period, May 1 through May 15, for blocks 3, only item (2) "Observed Production" was available for these blocks. If we now assume that the ratio of "Production," item (3), to "Observed Production," item (2), is approximately the same for the two sets of blocks, then an estimate of the "Production" in blocks 3 is given by the ratio estimator:

$$\left(\frac{\text{Production in blocks 4}}{\text{Observed Production in block 4}}\right) \cdot \text{Observed Production in blocks 3}$$

Therefore, substituting from Table 1 (May 16-31):

$$\frac{6}{17} \cdot 11 = 3.9 \text{ young}$$

The mathematical formulation for this ratio estimator is as follows:

y'_s = Actual production from eggs in nests started during the s^{th} semimonthly

period in blocks retained from the $(s-1)^{st}$ semimonthly period

x'_S = Total "observed production" from all eggs in the above blocks during the s^{th} semimonthly period

x''_S = Total "observed production" from all eggs in the blocks newly introduced during the s^{th} semimonthly period.

Then, the ratio estimate for the total production during the s^{th} period is given by

$$3\left[y'_S+\left(\frac{y'_S}{x'_S}\right)x''_S\right] = 3\left[6+\frac{6}{17}\cdot 11\right] = 30 \quad \ldots (1)$$

where the factor 3 allows for the fact that the total area is 3 times as large as the sets of blocks sampled in the 14 strata during a semimonthly period.

The ratio estimator (1) for any semimonthly period after May 15 can be written as follows:

$$\hat{y}_S = 3\,\frac{y'_S}{x'_S}\,(x'_S+x''_S) \quad \ldots (2)$$

The estimator for production for the last eight semimonthly periods after May 15 is therefore given by:

$$\hat{y}_{(S=2,\ldots,9)} = 3\sum_{S=2}^{9}\frac{y'_S}{x'_S}(x'_S+x''_S) = \sum_{S=2}^{9}\hat{y}_S \quad \ldots (3)$$

The above estimate is technically known as a ratio estimator in double sampling. The sampling scheme consists of two samples of blocks; that is, the first sample, two blocks from each of the 14 strata, for which the x values are recorded and a second sample (subsample of the first), one block from each of the 14 strata, for which the y value is also recorded.

To this estimate of production (3) will have to be added the estimate of the production prior to the end of the first period (Table 1), i.e. prior to May 15, which we may designate as $\hat{y}_1$:

$$\hat{y}_1 = 3(y_1+y'_1)+24 = 3(7+10)+24 = 75 \quad \ldots (4)$$

Where $3(y_1 + y'_1)$ equals the estimate of mourning dove production between May 1-15 in blocks 6 and 4, respectively, and 24 is the complete enumeration of all young produced from nests in the town of Lewis prior to May 1 (Table 1).

Therefore, the estimate of mourning dove production for Lewis, Iowa, in 1955 may be written:

$$\hat{y} = \hat{y}_1+\hat{y}_{(S=2,\ldots,9)}$$

Substituting from Table 2:

$$\hat{y} = 75+420 = 495$$

In order to estimate the variance of such an estimator, we find that only one y value is available for each of the 14 strata. Therefore, it is necessary to follow the customary device of "collapsing" neighboring strata into 7 strata pairs ($L = 7$) containing 12 blocks each ($N = 12$). Now within each stratum we find a "first sample" of $n' = 4$ blocks was drawn for which x values are recorded, and a second sample (subsample) of $n = 2$ blocks selected from these four blocks for which y values have been recorded as well.

It can now be shown that the estimator $\hat{y}_S$ has the following approximate variance formula:

$$V(\hat{y}_S) = N^2L\left\{\frac{1}{n}\left(1-\frac{n}{n'}\right)S^2_{y-R_Sx}+\frac{1}{n'}\left(1-\frac{n'}{N}\right)S^2_y\right\} \quad \ldots (5)$$

where

S^2_y = the average within stratum variance of the y

$S^2_{y-R_Sx}$ = the average within stratum variance of the $y - R_Sx$ with

TABLE 2. — ESTIMATED PRODUCTION OF MOURNING DOVES, LEWIS, IOWA, 1955

Date	Blocks	Estimated Total Production	Standard Error of Estimate $\sqrt{V}$
Prior to May 1	All	24	
May 1-15	6-4	51	14.0
May 16-31	4-3	30	18.0
June 1-15	3-5	94	36.7
June 16-30	5-1	89	21.5
July 1-15	1-2	35	15.9
July 16-31	2-6	51	19.6
August 1-15	6-4	71	15.0
August 16-31	4-3	21	17.8
September 1-15	3-5	29	11.0
Estimated total production		495	
Standard error of estimated total production			60

R_S defined as the ratio of the populations means; i.e., $R_S = \bar{y}_S / \bar{x}_S$ . . . (6)

This formula agrees with that given by Cochran (1953, p. 282) for the special case of one stratum ($L = 1$) of infinitely large size ($N \to \infty$).

In order to estimate the above variance from the data, let us denote by

$\Delta y'_{si}$ = Difference between the two actual productions in the two blocks in the i^{th} stratum pair retained from the $(s-1)^{st}$ period, where i is the strata pair index.

$\Delta x'_{si}$ = Difference between the two corresponding values of the total production in the same two blocks.

$r_s = y'_s / x'_s$

Using these quantities in conjunction with (5) to obtain an estimate $v(\hat{y}_S)$ of $V(\hat{y}_S)$ or remember that for collapsed strata the variances S_y^2 and $S_y^2 - R_S x$ may be respectively estimated by $\frac{1}{2}(\Delta y'_{si})^2$ and $\frac{1}{2}(\Delta y'_{si} - r_s x'_{si})^2$ so that with $n = 2$, $n' = 4$ and $N = 12$ we obtain here

$$v(\hat{y}_S) = \sum_{i=1}^{7} 144 \left\{ \frac{1}{8}(\Delta y'_S - r_S x'_S)^2 + \frac{1}{12}(\Delta y'_S)^2 \right\}$$

This gives an estimate of the variance of y_S the estimated production during the s^{th} period (for $s = 2, 3, \ldots, 9$). During the first period, y values were observed for both blocks in each stratum and the variance estimation followed standard procedures here as no double sampling occurred; that is,

$$v(\hat{y}_1) = 6 \sum_{c=1}^{14} (\Delta y)^2$$

where Δy denotes the difference between the two values in each of the 14 strata.

The standard errors $\sqrt{v(\hat{y}_S)}$ of the estimates in the individual periods are given in Table 2. Now an estimate of the variance of production during all periods is $v(\hat{y}) = \sum_{S=1}^{9} v(\hat{y}_S)$; which is the sum of the variances of the individual estimates of semimonthly periods. In doing this we have neglected certain correlations in dove production between consecutive periods, but these correlations were estimated to be negligible.

McClure (1943) indicated that production of doves for Lewis, Iowa, 1938-40, averaged 1,108 juvenile doves; consequently, production in 1955, 488 juvenile doves, was only 44 per cent of the 1938-40 level. This drop in production for the town of Lewis may or may not be indicative of southwest Iowa. Mourning doves do shift their breeding populations as indicated by McClure for Lewis in 1938-40. Also, there may be more suitable nesting habitat at the present time throughout southwest Iowa than there was in 1938-40.

SUMMARY

A technique for estimating mourning dove production by making counts of doves fledged from nests located in sample blocks of trees is presented for Lewis, Iowa, for 1955. The semimonthly and annual estimates of dove production and the standard errors of the estimates are given. A comparison of annual dove production is made between the periods 1938-40 and 1955.

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