ACCURACY OF POPULATION ESTIMATES OF MOURNING DOVES USING RECAPTURE DATA[1]

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Abstract: The accuracy of Lincoln Index estimates for a wild population of mourning doves *(Zenaida macroura)* of known size was examined. Data indicated there was a tendency to overestimate population size regardless of the percentage of the population that was marked. Learned trap-escape behavior apparently caused the observed overestimations. A similar bias probably exists for other studies on birds.

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Usual methods of estimating wild populations utilizing capture-recapture methods tend to seriously underestimate population density (Eberhardt 1969). Silvy et al. (1977) developed a technique to check the accuracy of population estimates (Lincoln Index) based upon sub-sampling only the marked population of Key deer *(Ococoileus virginianus clavium)* in Florida to determine how large a sample is needed to achieve close agreement between the estimated number and the number of marked animals known to be present. We have applied this technique to check the accuracy of our Lincoln Index estimates for mourning doves. Silvy et al. (1977) worked with a semi-mobile, island population (Key deer), whereas our data were from the highly mobile, migratory mourning dove.

The purpose of this paper is to discuss the problems of estimating the size of wild mobile populations using illustrations from a mourning dove population of known size. Such a situation existed in our work with mourning doves on the Texas A&M University (TAMU) Campus.

There has been a substantial resident population of mourning doves on the TAMU Campus for many years. This population was intensively researched during the early 1950's (Swank 1952) and Bivings (1980) has completed a follow-up study.

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METHODS

Research was conducted on the TAMU Campus at College Station, Texas. The main campus is approximately 325 ha of park-like lawns surrounded by trees, predominantly live oak *(Quercus virginiana)* (Swank 1952), and has more than 120

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buildings of various shapes, dimensions, and construction. Most of these buildings receive at least some use by mourning doves during the year (Bivings 1980).

Mourning doves were live-trapped from February 1978 through May 1980 on 3 building roofs (Bivings and Silvy 1979) using modified funnel traps baited with a combination of milo and cracked corn (Reeves et al. 1968). Doves were banded using a combination of 1, size 3A Federal aluminum leg band and 1 or more colored plastic rings (Gey Band & Tag Co., Inc., Norristown, PA).

Application of the Lincoln Index to monthly trapping results provided estimates of population size. Doves were considered recaptured if they had been marked previously and were recaptured at least once during a monthly period. If an individual dove was recaptured only once or a dozen times during a given month, it was treated the same (i.e. considered recaptured for the month) for these estimates. Twenty-six months of trapping data from February 1978 through May 1980 were used to provide the numbers of banded doves recaptured (2,239 monthly recaptures of 981 banded doves). An average of 173 $\pm$ 12 doves was marked during any 1 month. Sex and age ratios of doves varied slightly throughout the study as more individuals were trapped. Originally, data were analyzed by sex and age and were found to be nonsignificant ($P > 0.05$); for this paper all sex and age classes were pooled for the population estimates.

To evaluate the accuracy of Lincoln Index estimates, determination of a "known" population was accomplished using all marked doves as the "total" population (after Silvy et al. 1977). During each month, the "known" population was calculated by including only those marked doves that were to be recaptured later in the study. By using this technique, we knew that individual members of our "known" population were alive and had not lost bands or died during the monthly calculations. The marked population was subsampled at 10, 25, 50, 75, and 90% for a given month. These subsamples of the marked population were considered the only "marked" animals; other banded doves were considered "non-marked." Selection of the "marked" doves to use in each subsample was by date of capture. First doves trapped were considered "marked" until the needed percentage was filled; this simulated actual field conditions where first doves trapped are the only ones used to estimate population numbers. The ratio of "marked" banded doves to "non-marked" banded doves then served as the basis for Lincoln Index estimates of the known marked population.

RESULTS AND DISCUSSION

Our data (Fig. 1) indicated that the probability of overestimation increased until after 75% of the population was marked, then it began to decrease. Most underestimates occurred when 10% or 90% of the doves were "marked." However, underestimates based on 90% marked were usually not as great (average 7% less than actual) as those that occurred when only 10% of the doves were "marked" (average 17% less than actual). Similarily, overestimations were not as great when 90% of the doves were "marked" (averaging 16% greater than actual) as they were when only 10% of the population was "marked" (averaging 68% greater than actual). When the number of doves "marked" comprised either 10% or 90% of the population, probabilities of underestimating and overestimating the population were nearly equal (31 and 53 and 31 and 67, respectively). No completely accurate

estimates were made. Population estimates could not be made 15% of the time when 10% of the population was "marked," 8% of the time when 25% of the population was "marked," and 4% of the time when 50% or 75% of the population was "marked" because trapped samples were so small that "marked" components were not represented. Only when 90% of the population was "marked" were we able to make estimates during all months.

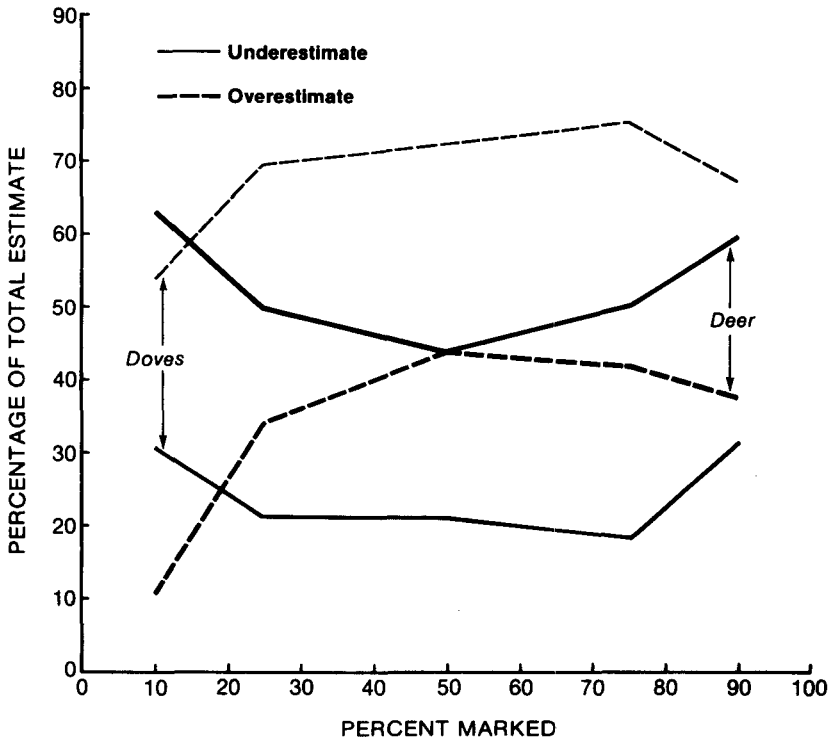

Fig. 1. Relationship of the number of Key deer (after Silvy et al. 1977) and mourning dove marked in a population on the TAMU Campus to the percentage overestimates and underestimates as determined by Lincoln Index estimates.

When monthly population estimates were averaged for the entire study, estimates for all percentages of doves "marked" were overestimates. An estimate of 181 doves when 90% of the population was "marked" came closest to the actual mean monthly population size (173 ± 13 doves). All population estimates except when 90% of the popuation was "marked" differed significantly ($P < 0.05$) from the actual mean monthly estimate (Table 1).

According to Eberhardt (1969), the usual capture-recapture methods seriously underestimate population numbers. Silvy et al. (1977) observed a greater tendency for Lincoln Index estimates of Key deer to be underestimates rather than overestimates of the population numbers.

Table 1. Mean monthly Lincoln Index estimates and number of monthly underestimates, overestimates, accurate estimates, and non-estimates of mourning doves as determined by difference in the total number of marked doves in the population during February 1978 through May 1980, Texas A&M University Campus, College Station.

% marked	Mean monthly estimate	Number of monthly underestimates	Number of monthly overestimates	Number of monthly accurate estimates	Number of monthly non-estimates
10	248±34[a]	8	14	0	4
25	217±21	6	18	0	2
50	241±29	6	19	0	1
75	202±18	5	20	0	1
90	181±14	8	18	0	0
100	173±12	0	0	26	0

[a] Standard error

The tendency to underestimate population numbers has been shown by Robson and Regier (1964) to be a natural bias of small sample sizes. They also noted, as did Silvy et al. (1977), that the proportion of animals marked can affect population estimates. Silvy et al. 1977) pointed out that all individuals in the population should be equally likely to be recaptured. If marked individuals are "trap-happy," then there will be a greater chance for underestimation, whereas if they are "trap-shy," there is a greater chance for an overestimation.

Sample size was similar throughout our study ($\bar{X} = 167 \pm 16$) and was considered to have a similar effect at all levels of subsampling (Silvy et al. 1977). To test the assumption that animals captured 1st in the study did not differ in behavior from those caught later, the probability of recapturing individual doves in walk-in traps was determined. Comparisons were made of the probabilities of recapturing in the walk-in traps those doves "marked" in the population with those "non-marked" (Table 2). These data indicated that there were significantly ($P < 0.05$) greater probabilities of recapturing "non-marked" doves at all sampling levels (10, 25, 50, 75, and 90%) than there were for recapturing the "marked" subsample of the population.

Curves showing the probability of overestimation or underestimation of the population number of Key deer (after Silvy et al. 1977) and of mourning doves had similar trends (Fig. 1). For both Key deer and mourning doves, the probability of an overestimation increased with proportion of animals marked until 50 - 75% of the populations were marked, then they decreased. With underestimations, the probabilities were greatest when either 10 or 90% of the population was marked. Although the trends were similar, the magnitudes of these trends were quite dissimilar. For Key deer there was either a greater or equal probability to underestimate the population, whereas for mourning doves there was always a greater probability to overestimate the population numbers.

It therefore appears that Key deer were "trap-happy," whereas mourning doves were "trap-shy." However, Silvy et al. (1977) noted that this difference in the probability to overestimate and underestimate also may be a function of the

Table 2. Average probability of retrapping individual "marked" and "non-marked" mourning doves when a different percentage of the population is marked using walk-in traps during February 1978 through May 1980, Texas A&M University, College Station.

% marked	Probability of retrapping[a] "marked" dove	Probability of retrapping "non-marked" dove
10	0.30	0.39[b]
25[c]	0.29	0.42[b]
50	0.31	0.53[b]
75	0.34	0.53[b]
90	0.37	0.73[b]

[a] Probability of always retrapping a dove each month equals 1.00.
[b] Differs significantly ($P < 0.05$) from probability of retrapping "marked" doves.
[c] Calculation of the probability of retrapping individual dove is cumulative, that is, the 25% marked includes doves in the 10% marked, etc.

proportion of animals marked in the population. First animals caught are the ones that are probably the easiest to trap and therefore are more "retrappable." This was observed by Silvy et al. (1977) for Key deer, as the probability of observing the 1st 10% of the animals was greater than the remaining 90%. They also noted a natural tendency to underestimate when most of the population was marked. At that time, any recaptured sample in which all animals observed are marked gives an estimate equal to the total marked in the population, which is an underestimation if the few remaining unmarked individuals are not captured.

With our mourning dove data, there was a tendency to overestimate (i.e. our doves appeared to be "trap-shy"). Doves trapped earlier in the study had a lower probability of being retrapped than did those trapped later in the study. The probability of retrapping an individual dove that comprised the 1st 10% of the marked population was less than for those comprising 25, 50, 75, or 90% of the marked population, and was less for the 1st 25% subsample than it was for the 50, 75, or 90% subsample, etc. (Table 2). Were those doves truly "trap-shy?" The probability of recapturing an individual dove in subsequent months after initial capture indicated the highest probability (50%) of being recaptured occurred during the month following initial capture. If these birds are not "trap shy," then there must be some other behavioral difference that causes a lower probability of recapture the longer the doves are marked. Because all the doves considered for this paper were known to be alive (and marked) during this study, loss of bands and/or death of birds could not have affected results. Our procedure assumes that all banded individuals that were later recaptured had an equal chance of being recaptured at any time (i.e. dove did not migrate from the area). Both Dunks (1977) and Bivings (1980), using band-return data, suggested that dove populations in our area of Texas probably did not migrate. Our overestimations of the dove population is due to the unequal probability of retrapping early marked doves as opposed to retrapping those trapped later in the study. The longer we had a dove marked, the less likely it was to be retrapped even though it was known to be in the area.

Our method of trapping doves in baited walk-in traps on roof tops gave us an opportunity to observe dove behavior at the trap sites. Two of the 3 buildings on which traps were set, had windows from which traps could be observed. Because doves were individually colored marked (Bivings 1980), behavior of individual doves could be followed. It was apparent that doves soon "learned" to enter traps, feed, and exit traps through the funnels (Bivings unpublished data). This escape "learning" also was observed for house sparrows *(Passer domesticus).* Marked doves also were observed feeding only in the funnels without entering the traps. When through feeding, they would back out of the funnels. On occasion, a marked bird would be forced into the trap by others trying to enter the funnels. During early spring, some females feeding within the funnels were forced into the traps by courting males. Doves forced into the traps may have accounted for the infrequent recapture of these earlier marked doves. The "learned" trap-escape behavior probably caused our overestimations of the dove population. This behavior would explain why doves caught early in the study were more difficult to trap later in the study.

It seems apparent that the Lincoln Index, when used to estimate dove numbers from mark-recapture results of walk-in funnel traps, may cause an overestimate of the true population number. This overestimation appears to be due to a "learned" trap-escape behavior. We do not know whether results from our study apply only to the TAMU Campus or for other similar dove studies. We suspect our data to be similar to those of other mark-recapture studies on birds.

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