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A D-Vac Calibration Technique

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A D-Vac Calibration Technique[1]

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Abstract

Removal samples from an irrigated pasture were used as a calibration technique for the D-Vac. Plots 4 m^2 were enclosed with a frame, and 1 initial and 3 removal samples were taken. Equations are given for computing the population and probability of collecting an insect. For leafhopper adults, leafhopper nymphs, *Orius insidiosus* (Say), and corn flea beetle, *Chaetocnema pulicaria* Melsheimer, calibrations (m^2/linear m) were 0.405, 0.328, 0.272, and 0.490, respectively.

A suction sampler, the D-Vac, is widely used for sampling insect populations. It is now generally recognized that samples thus obtained are not directly quantitative but must be calibrated against actual populations determined by other methods. The techniques of removal trapping (Moran 1951) provide a means for making a calibration using the D-Vac as the only sampling device.

Methods

Areas, 4^2 (2×2 m), in an irrigated meadow bromegrass pasture were enclosed with a frame 0.3 m in height. Height of grass varied from 120 to 300 cm, but each 4 m^2 area was chosen for relatively homogeneous grass cover. The D-Vac was fitted with a 0.0462 m^2 (diam = 0.2425 m) collecting head and operated at maximum rpm. The head, oriented at 45° to and ca. 2 cm above ground level, was advanced at ca. 0.3 m/sec.

Airflow was determined in the laboratory with a hot-wire anemometer with the D-Vac mounted in this position. Maximum airflow, ca. 600 m/min, was at the point of nearest contact with the ground, diminishing to 100 m/min at 0.2 m either side and in front of this point with measurable airflow at much greater distances. Thus, the effective width of a transect is not the same as the diam of the collecting head but varies with the suction required to remove a given species.

Since our normal sampling procedure was to take linear transects, we took 2 equally spaced transects in the 1st plot (4 linear m total). After these initial transects, 3 additional removal samples, each of 6 equally spaced transects (12 linear m total) were taken in the same manner and identified as to sequence. This procedure was repeated in other plots for initial samples of 3, 4, 5, or 6 transects (2 replicates of each).

The total population of each plot was computed from the removal samples to which was added the number collected in the initial sample. Let: N = population of plot, p = probability of collecting an insect, k = number of removal sample, C_1 = number of insects caught in *i*th sample, and R_1 = number of insects removed through the *i*th sample.

Then, from Moran (1951),

$$p = \frac{R_k}{k-1} \qquad kN - \sum R_1 \tag{1}$$

$$\log(1 - R_k/N) = k\log(1-p) \tag{2}$$

Guessing an initial value for N, we find a value of p which satisfies (1), substitute this value in (2) and solve for N, continuing iteration in this manner until both equations are satisfied. If only 3 removal samples are taken, a simple algebraic solution is given by Seber and Whale (1970). Correcting a typographical error in their paper, $X = 2C_1 + C_2$, $Y = C_1 + C_2 + C_3 = R_k$;

$$N = \frac{6X^2 - 3XY - Y^2 + Y(Y^2 + 6XY - 3X^2)^{1/2}}{18(X-Y)} \tag{3}$$

$$p = \frac{3X - Y - (Y^2 + 6XY - 3X^2)^{1/2}}{2X} \tag{4}$$

As an example, in 1 plot, 2 transects collected 62 adult leafhoppers, and the 3 removal samples resulted in collection of 72, 15, and 15 leafhoppers:

i	C_1	R_1
1	72	72
2	15	87
3	15	102

From either method of solution, we find N = 108.028, p = 0.6179. The total plot population is thus estimated as 108 + 62 = 170 leafhoppers or 42.5/m². Since 2 transects = 4m, 1 linear meter is found to equal the population of

$$\frac{62}{4(42.5)} = 0.365 \text{ m}^2$$

Calibrations were determined from each plot in this manner for total leafhopper adults, leafhopper nymphs, *Orius insidiosus* (Say), and the corn flea beetle, *Chaetocnema pulicaria* Melsheimer.

This approach requires the assumption the p remains constant in successive samples. This assumption can be tested using Zippin's (1956) χ^2. In this study, all χ^2 values were nonsignificant, and we accepted the hypothesis that p was constant.

If the variance of our estimate of N is desired, this can be found from equations (11) and (17) of Zippin (]956). The variance-covariance matrix of Moran (1951) is not satisfactory in cases where p is high as is often true of D-Vac samples. In our example, the 95% confidence interval for the estimate of N is ±9 leafhoppers; however the variance may be slightly underestimated (Zippin 1956).

Results

For calibration purposes, we used only those plots in which the percent of total estimated plot population collected in the initial transects was directly proportional to the number of transects (i.e., without overlap in collection between transects). Since proportions of leafhopper species (44% *Endria inimica* (Say)) were the same for removal samples 1–3, in this study the same calibration seemed applicable for all species and data were pooled for species. Stages (adults vs. nymphs) differed in susceptibility to capture, and different calibrations were required.

Maximum number of initial transects/plot taken without apparent overlap were 3, 4, 4, and 6 for corn flea beetle, leafhopper adults, leafhopper nymphs, and *O. insidiosus*, respectively, and based on 6, 8, 8, and 10 samples, calibrations (m²/linear m) were 0.490 ± 0.094, 0.405 ± 0.052, 0.328 ± 0.065, and 0.272 ± 0.042. These values are equivalent to the effective widths of transects and, based on laboratory studies of the airflow generated, suggest that 75 (corn flea beetle) to 180 m/min (*O. insidiosus*) is required for removal of different species.

These calibrations agreed closely with those made by comparing collections in linear transects with adjacent enclosed areas sampled by prolonged suction. Variation in the population of small plots is often great, but calibrations made by the removal method are usually not much influenced by this variation. The greatest advantage of the removal method is that populations of individual plots can be estimated with considerable confidence. The mean CV of plot population estimates ranged from 2% (leafhopper adults) to 4% (*Orius*) with a maximum CV for any plot of 8%. Achievement of this precision requires nearly complete removal of the insects from a plot, but this seems easily accomplished with the D-Vac. Conventional techniques often lead to erroneous calibrations because of errors in population estimation by the comparative technique. The removal method also permits simultaneous calibrations for all species present, and the plots used for calibration can be used to supplement other population estimates.

The removal method appears especially advantageous when sampling high, but nonuniformly distributed, populations. For maximum reliability, the initial sample should not remove more than 50% of the plot population. This assures that there is no overlap between transects. Removal samples must also be sufficient, either in number or intensity, to remove most of the remaining plot population. The initial sample can be used directly in calculating the plot population only if it involves the same number of transects as the removal samples. If only plot populations are desired, this is the preferred technique. For calibration, only a few transects can be taken without overlap and a much larger number of removal samples would be required for good plot estimates if this reduced intensity of removal were used.

The removal method would be equally suitable for calibrating the D-Vac when used for individual sucks. While great precision can be obtained in calibrations made for a specific situation, these calibrations cannot be assumed to hold under other conditions. However D-Vac collections seem less subject to differences in height of vegetation, weather, etc. than sweep samples.

Note

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References Cited

Moran, P. A. P. 1951. A mathematical theory of animal trapping. Biometrika 38: 307–11.

Seber, G. A. F., and J. F. Whale. 1970. The removal method for two and three samples. Biometrics 26: 393–400.

Zippin, C. 1956. An evaluation of the removal method of estimating animal populations. Ibid. 12: 163–89.