Southern Pine Beetle
Dendroctonus frontalis Zimmermann
Coleoptera: Scolytidae

Objective: To optimize sampling effort required for estimating within-tree populations of *D. frontalis*.

Abstract: The southern pine beetle, *Dendroctonus frontalis* Zimmermann, is the most damaging bark beetle in the southeastern USA. All species of indigenous pines are susceptible to attack except longleaf pine, *Pinus palustris* Mill., presumably due to its high resin flow. Mature, over-stocked stands of loblolly, *P. taeda* L., and shortleaf, *P. echinata* Mill, pines on poorly drained sites are most susceptible to infestation. During beetle epidemics, groups of host trees are typically killed, and termed "spots" to delineate from other infestations in close proximity.

Areas in southern Arkansas were surveyed to determine optimum sample sizes as a function of attack density, egg gallery length, and total brood size. A series of permanent 2,000-cm^2 X-ray maps were made. They depicted *D. frontalis* life stages occurring at varying heights in trees of different sizes. The map data were stored as addressable grid cell values in a computer, and programs were written for randomly selecting a series of defined experimental units. From these observations, the relationship of sample number to sample unit size was determined, and a procedure was outlined for estimating *D. frontalis* density.

Sampling Procedure: Select 10 trees in each spot in either the pupal or callow (teneral) adult stage. Cut three logs containing approximately 2,000 cm^2 of bark surface area from each tree (n=30), taking one log each from the upper, middle and lower bole. Count and record the number of pupae and callow adults.

Measure each log to determine bark area, and identify sections to be placed on X-ray film for radiography. Count the number of attacks and any brood (live larvae, pupae or callow adults). Mark their locations with colored china markers to produce a map. Identify *D. frontalis* galleries on the original bark samples, and by cross-comparison between the samples and map, draw the galleries on the map. Measure the gallery lengths. Following identification and marking, a transparent grid with 2.5 cm squares on each side is placed over the entire map and all variables and their locations are measured and recorded.

The values for each variable are stored on a computer by coordinates of each unit grid square (6.25 cm^2) on the maps. The computer program represents the map as a cylinder and then generates the random samples to be taken.

Procedure:

1. Depending on the variables to be measured, use equations in Table 2 of the original publication to calculate desired sample sizes.

2. Survey the infested area where population measurements are desired in order to estimate the number of infested spots.

3. Depending on the number of samples determined from Step 1, allocate a proportionate number to each spot depending on the number of infested trees in suitable stages of brood development.

4. Samples should be collected from a minimum of three heights, which are divided evenly along the infested portion of the tree bole.

Example: The average number of samples required to estimate attacking density was 107 100-cm^2 samples, 20 500-cm^2 samples or 10 1,000-cm^2 samples (Table 3). Assume that 100-cm^2 samples are used, there are three infested spots, and that the number of trees suitable for sampling in each spot is 10, 20 and 2. Therefore, the 107 samples would be divided according to the proportion 5:10:1 (i.e., 33, 67 and 7 samples, respectively).

Table:

Table 3.—Calculated number of samples needed to estimate density of the given variables within 10% of the mean for 100 cm², 500 cm², and 1,000 cm² sample unit areas. Number of samples needed at the lower and upper 90% confidence intervals are also given.

Sample unit area	Variable	No. of samples		
		Lower	Average	Upper
100 cm²	Attacks	72	107	158
	Gallery length	11	17	25
	Total Brood	49	95	178
	Parasites	212	385	675
	Predators	429	650	971
500 cm²	Attacks	13	20	32
	Gallery length	4	6	9
	Total Brood	12	26	56
	Parasites	55	112	220
	Predators	104	170	276
1000 cm²	Attacks	6	10	16
	Gallery Length	2	4	6
	Total Brood	7	15	34
	Parasites	31	66	136
	Predators	56	96	160