On understanding quantitative surveys of vegetation

What those numbers mean and how to use them to envision a census area

Frances C. James

[This article was first published in *American Birds*, Vol. 32, No. 1, pp. 18-21, 1978, only two years ago. But because since then we have added several thousand new readers to whom the ecological studies that follow might be puzzling, we reprint herewith an updated version. Several photographs that accompanied the original article have been omitted for lack of space.—Ed.]

SEVERAL YEARS AGO A standardized quantitative method of describing the vegetation in census areas was proposed (James and Shugart, 1970), along with the suggestion that, if compilers of Breeding Bird Censuses and Winter Bird-Population Studies would adopt this method, the censuses could be compared and analyzed in various new ways. The method involves locating five to ten 0.1-acre randomly-distributed circular plots within the study area, making certain measurements on these plots, and then extrapolating to describe the vegetation per acre (or per hectare, which equals 2.471 acres). The radius of a 0.1-acre plot is 37 feet, 3 inches.

The method is only appropriate for areas with trees. All the common trees in a 0.1-acre circle that are larger than 3 inches "DBH" or "dbh" in *American Birds* (diameter breast height, assumed to be 4½ feet from the ground) are identified to species and their DBH is recorded. This permits a description of the trees by species and by size class in terms of their "density," "basal area" and "frequency." The density is simply the number of trees per unit area. The basal area, sometimes called "dominance," is the sum of the cross sectional areas of the trees at 4½ feet. It was originated by foresters as a way of estimating the marketable timber in a forest. Here it is useful as an estimate of the amount of woody vegetation present for each species of tree or each size class of trees. Frequency is a statistic that estimates the evenness of distribution. It is the percent of the 0.1-acre circles that has trees of the species in question. A sample summary sheet for this type of information is given in James and Shugart (*op. cit.*). But there is an error on that sheet in the instructions for estimating the number of shrubs (see below).

THE FOLLOWING EXAMPLE of a quantitative survey was one prepared by Anthony Erskine for a new site in a Black Cottonwood floodplain forest in British Columbia (Erskine, 1975a). It is in the recommended format (James and Shugart, *ibid.*; Van Velzen, 1972):

> A quantitative survey of the vegetation gave: Trees 3-inches diameter and over, 237 per acre; total basal area, 170.5 ft² per acre. Species comprising 90% of the total number of trees: Black Cottonwood, 100, 42, 72, 100; Quaking Aspen, 68, 28, 14, 45; Mountain Alder, 33, 14, 2, 82; White Spruce 12, 5, 6, 41; Beaked Willow (*S. bebbiana*), 12, 5, 1, 55. Trees by diameter size class: A (3-6 in.) 86, 36, 9.6, 6; B (6-9 in.) 61, 26, 18.9, 11; C (9-12 in.) 37, 15, 22.2, 13; D (12-15 in.) 23, 10, 23.1, 14; E (15-21 in.) 16, 7, 28.8, 17; F (21-27 in.) 7, 3, 21.4, 13; G (27-33 in.) 4, 2, 20.1, 12; H (33-46 in.) 3, 2, 26.3, 16. Shrub stems per acre, 7850 (est.); ground cover, 58%; canopy cover, 57%; mean canopy height, 73 ft. (range 35-90).

The sets of numbers after the names of the trees and the size classes are not explained in this example, but in many others there are two parenthetical explanations. The first comes just before the species of trees:

> [figures after each give number of trees /acre, relative density (%), relative dominance (%), frequency (%), in that sequence].

Before the size class information often comes the phrase:

> [figures after each size class give number of trees/acre, relative density (%), basal area (square feet/acre), relative dominance (%)].

By taking transects across the circle and checking the presence or absence of canopy cover, an estimate of percent canopy cover can be determined. Counts of the shrub stems intercepted about 4½ feet above the ground by crossing the circle with out-stretched arms will give an estimate of the shrub density of the area This statistic has not been very useful, partly because shrub stems are hard to define, but also because there is an error in the formula for estimating shrub stems per acre (James and Shugart, *ibid.*, p. 734). The instructions on pp 732 and 735 are correct, but the form on p. 734 should read,

> SHRUBS: Total shrub stems in all transects (2 per circle) × 100, divided by the number of transects,

making the estimate in that example 2360, not 23600. I apologize for this error Actually we need a new way to estimate shrubs, one that expresses how patchy or heterogeneous their distribution is. The final estimates are of the percent ground covered by green vegetation, and of the canopy height.

A COMPARISON BETWEEN Erskine's Black Cottonwood floodplain forest and a subalpine conifer forest (Erskine, 1975b) in the same general area can be made by comparing the quantitative vegetation surveys (Figs. 1 and 2).

The Black Cottonwood floodplain forest had 33 species of birds, 278 territorial

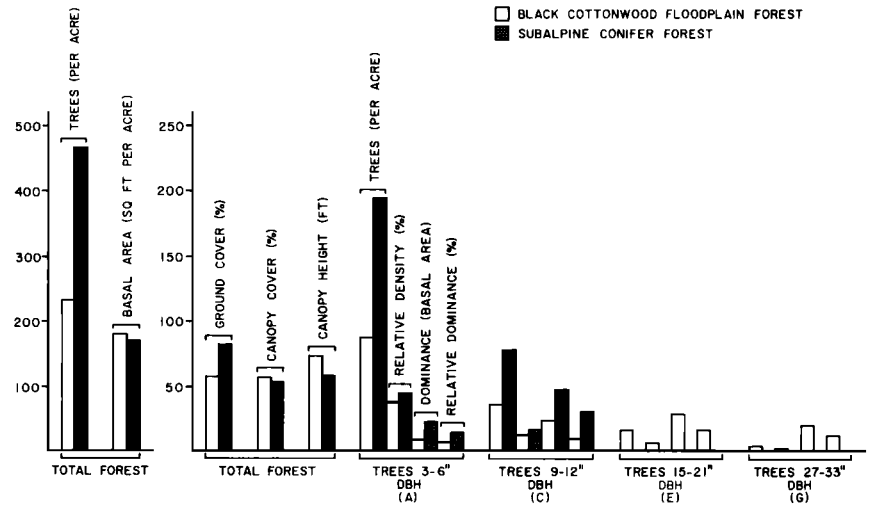

Figure 1. A comparison between the structure of the vegetation in two Breeding Bird Census areas studied in British Columbia: A Black Cottonwood floodplain forest (open bars) and a subalpine conifer forest (darkened bars). Data from Erskine (1975a, b).

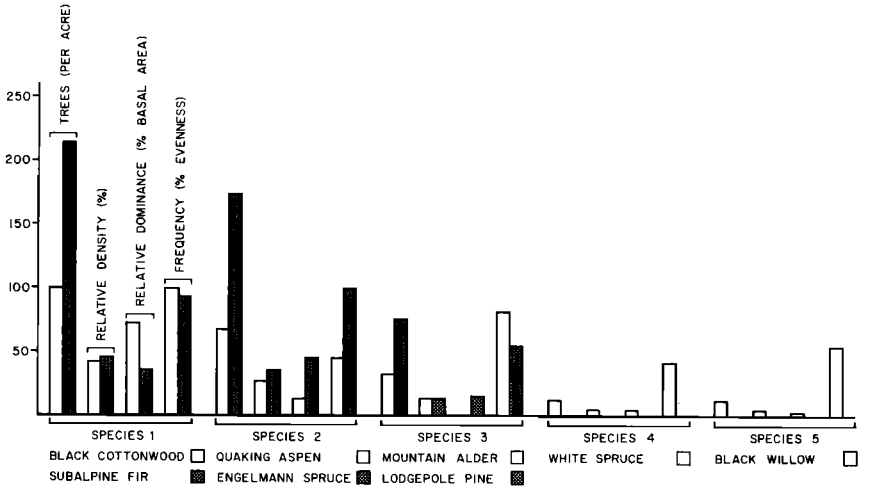

Figure 2. A comparison of the major species of trees for the same areas as in Figure 1, a Black Cottonwood floodplain forest (open bars) and a subalpine conifer forest (darkened bars).

males per 100 acres. The most common species were American Redstarts, Warbling Vireos and Swainson's Thrushes. The site is a mature floodplain forest in which five species of trees comprise 90% of the trees larger than 3 inches DBH. The Black Cottonwoods dominate the entire site, being the most numerous trees (highest density), having the most biomass (greatest basal area), and occurring in all sections (highest frequency). The Quaking Aspen are clumped in certain areas (lower frequency), and have considerably less biomass. The Mountain Alder is less common but more evenly distributed than the aspen. The White Spruce comprises only 5% of the trees but was found in 40% of the circles.

THE SUBALPINE CONIFER FOREST had only 14 species of birds, 54 territorial males per 100 acres. The most common species were Townsend's Warblers, Ruby-crowned and Golden-crowned Kinglets. Three species of trees accounted for 90% of the vegetation. The amount of woody biomass (total basal area) and the canopy cover were about the same as in the cottonwood forest, but there were more than twice as many trees in the conifer forest, and the average canopy height was lower. Subalpine Fir and Engelmann Spruce were common and widely distributed. Lodgepole Pines occurred on about half of the plots sampled. The number of small trees per acre (3-6" DBH) was more than twice that in the deciduous floodplain forest.

From1971-1976 compilers of approximately 110 census areas in the U.S. and Canada have submitted vegetation surveys of this type to *American Birds* These are being stored on magnetic tape in the computing center at Florida State University. Within the next year we should be able to provide them on request to persons interested in specific types of habitat analysis. We are optimistic about the potential usefulness of this information for studies of habitat selection, avian community organization, ecological succession, and forest management. I would like to thank Noel Warner for assistance with this effort at F.S.U.

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—Department of Biological Science, Florida State University, Tallahassee, Florida 32306.