TESTS OF ASSOCIATION BETWEEN BIRD SPECIES AND TREE SPECIES
(Query by J. M. Speirs)

BU-379-M D. S. Robson July, 1971

Abstract

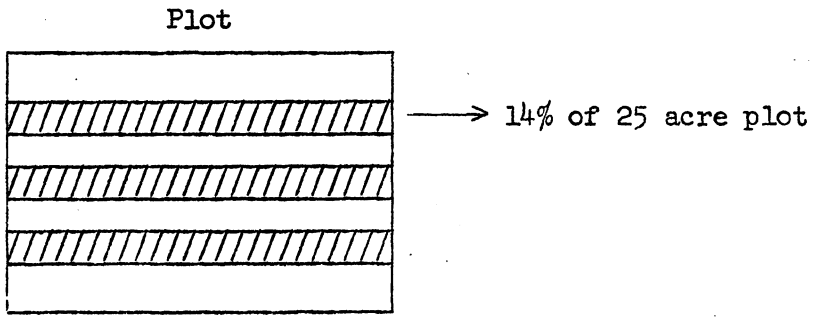
In order to study the association between bird species and tree species, a number of forest plots were surveyed to map out bird territories (by individual species) and the spatial distribution of plants (by individual species). Association between bird species B and tree species T can then be tested by comparing the density of T within B territories with the density of T in the entire forest plot. Partitioning the total plot into subplots which are roughly the size of a B territory and then identifying each B territory with a subplot allows the use of a randomization test to compare the average T per B-subplot with the average T per subplot.

Paper No. BU-379-M in the Biometrics Unit Mimeograph Series, Department of Plant Breeding and Biometry, Cornell University, Ithaca, New York 14850.

TESTS OF ASSOCIATION BETWEEN BIRD SPECIES AND TREE SPECIES
(Query by J. M. Speirs)

BU-379-M D. S. Robson July, 1971

The tree species composition of a series of woodland plots was measured by enumerating, identifying, and measuring DBH of trees in systematically located transects (swath of fixed width) through the plots:



Subtotals were recorded for each 25 ft. (.05 acre) interval along a transect; these intervals thus represent the smallest unit for which tree data are available.

During the nesting season the plots were repeatedly cruised in search of birds, and the location of each sighting (or hearing) was located on the plot map and identified as to bird species. Territories of the individual birds (or nesting pairs) were then roughly plotted out on the basis of these sightings. The problem then is to utilize these data on tree species and bird species to measure and test tree preferences on the part of the several different bird species. A somewhat similar investigation, restricted to two upland game bird species — spruce grouse and ruffed grouse — was reported on in the January, 1969 issue of the Journal of Wildlife Management.

Paper No. BU-379-M in the Biometrics Unit Mimeograph Series, Department of Plant Breeding and Biometry, Cornell University, Ithaca, New York 14850.

The general idea presented in the grouse study appears to offer a reasonable approach to the problem; that is, to compare the tree species composition within the territories selected by a given bird species with the tree composition outside of these territories. A "territory" in the present study is defined by a collection of sighting locations which, on the basis of simultaneous sightings of distinct birds, have been grouped together on the presumption that they represent a single bird (or nesting pair). The validity of such territories, fortunately, is not crucial in the analysis of tree preferences. The device of grouping the sightings together into territories may be regarded as an attempt to eliminate duplication of individual birds in the combined sightings made over several days of cruising, and thereby permit a single analysis of the combined data. One could, however, fall back on the alternative of analyzing the sightings of each cruise separately, accepting the fact that the separate analyses are not statistically independent. Alternatively, one could regard the "territories" of a species simply as a disjoint collection of places which are frequented by birds of this species, without insisting that the indicated territories satisfy some specified definition of a territory — the question of tree preference would still arise.

Preference for a given tree species T by a given bird species B can be measured by comparing the average amount of T within B-territories with the average amount of T outside B-territories — or, equivalently, comparing T within B with the average T for the whole 25 acre plot. The implementation of this approach would require first that the 70 twentieth-acre subplots be partitioned into blocks of subplots of equal area and of roughly the size of a B-territory, and second that each B-territory then be uniquely identified with that block containing the largest share of the territory — or nearest to the center of the territory — or identified by some other well defined rule of association. If blocks so identified with B are called B-blocks then the comparison of interest becomes the average amount

of T per B-block versus the average amount of T per block in the entire 25 acre area. Let $N = 70/k$ denote the total number of blocks and n denote the number of B-territories in the 25 acre plot; if $T_1, T_2, \cdots, T_N$ denotes the amount of T in each of the N blocks then under the null hypothesis that B selects territories independently of T the deviation of the B-block mean $\overline{T}_B$ from the grand mean $\overline{T}_N$ is approximately normally distributed with mean zero and variance

$$\mathrm{Var}(\overline{T}_B - \overline{T}_N) = \frac{N - n}{Nn} \sigma_T^2$$

where

$$\sigma_T^2 = \frac{\sum_1^N (T_i - \overline{T}_N)^2}{N - 1} = \frac{1}{N - 1}\left[\sum_1^N T_i^2 - \frac{(\sum_1^N T_i)^2}{N}\right].$$

Equivalently, the test-statistic

$$Z_{T,B} = \frac{\overline{T}_B - \overline{T}_N}{\sqrt{\frac{N - n}{Nn} \sigma_T^2}}$$

has approximately the "unit" normal distribution. If n is very small then the $\binom{N}{n}$ possible samples of n blocks can be enumerated and the exact frequency distribution of $\overline{T}_B - \overline{T}_N$ tabulated to determine critical values of the test-statistic. Test-statistics calculated separately for each 25 acre plot can be combined into a single test-statistic:

$$\text{combined } Z_{T,B} = \frac{\Sigma(\overline{T}_B - \overline{T}_N)}{\sqrt{\Sigma \frac{N - n}{Nn} \sigma_T^2}}$$

where the sum extends over all plots containing both T and B. The combined $Z_{T,B}$ must be very nearly normally distributed with mean zero and variance unity under the null hypothesis.

This same approach can be applied to any vegetative characteristic of the B-blocks. For example, if tree-size rather than tree species is a matter of preference then the comparison can be made with respect to average DBH of all trees in a block. Insight into bird behavior is required for the judicious selection of vegetative characteristics to be used in such comparisons.

Because of the number of different comparisons to be made the approach outlined above is feasible only with the aid of a computer. The definition of blocks of subplots and their identification with bird species must be done manually, but once this is accomplished the computer can take over.