P_{11} = proportion of successful nests in Fretwell's low density plot,
P_{12} = proportion of successful nests in Fretwell's high density plot,
P_{21} = proportion of successful nests in Gottfried's low density plot,
P_{22} = proportion of successful nests in Gottfried's high density plot,

$$\bar{P}_1 = \frac{P_{11} + P_{12}}{2},\ \bar{P}_2 = \frac{P_{21} + P_{22}}{2},\ P = \frac{\bar{P}_1 + \bar{P}_2}{2},\ q = 1 - P,$$

n_{11} = sample size in Fretwell's low density plot,
n_{12} = sample size in Fretwell's high density plot,
n_{21} = sample size in Gottfried's low density plot,
n_{22} = sample size in Gottfried's high density plot.

The value obtained is 0.33. If all the ratios in the numerator are normally distributed with variances as calculated beneath the square root bracket in the denominator, then the probability of the value calculated follows a z-distribution, since the sum of normally distributed variates is also normally distributed. These ratios are all calculated from means and should therefore be normally distributed. A z value of 0.33 is not large enough to reject the null hypothesis ($P < 0.37$).

Statistical significance is a statement about sample size, not about a biological phenomenon. The presence of statistical significance in some data simply means that one's sample is sufficiently large to detect the biological differences that are present. Absence of statistical significance means that one's data are insufficient to detect any measurable biological differences that are present. The inability to detect a difference does not justify the conclusion that no differences are present, however. Gottfried's data, which are invaluable and beyond any doubt deserve our attention, are yet too few (one breeding season, 136 nests) for us to know whether or not there is any biologically significant density dependence of nest predation in old fields. They are also too few for us to know whether or not there are any differences between old fields and marshes and successional woodlands.

If Gottfried replicated his study 4.5 times, he would have an 80% chance of detecting the presence of a density effect (Sokal and Rohlf, Biometry, W. H. Freeman and Co., San Francisco, California, 1968:609). To show differences between habitats, we would need many more replications in both woods and old field. Replicating both Gottfried's experiments and Fretwell's studies the same number of times, assuming all samples are the size of Gottfried's and correcting to equalize mean predation rates between old field and woods, it would take over 30 sets of results identical to Fretwell's and Gottfried's (or results showing a greater difference) to demonstrate significance.—STEPHEN D. FRETWELL AND FRANK S. SHIPLEY, *Div. Biology, Kansas State Univ., Manhattan, Kansas 66506.* *Accepted 18 Nov. 1980.*

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A comparison of nest-site and perch-site vegetation structure for seven species of warblers.—One aspect of the study of avian niche structure has involved habitat relationships of breeding birds. In general, birds seek a characteristic vegetation-structure type, their niche-gestalt (James, Wilson Bull. 83:215–236, 1971), in which to establish a territory (Hilden, Ann. Zool. Fenn. 2:53–75, 1965). This territory provides many breeding passerines with suitable areas for singing, feeding and nesting. Some previous descriptions of avian habitat relationships (James 1971; Whitmore, Wilson Bull. 87:65–74, 1975; Smith, Ecology 58:810–819, 1977) have been based on information collected from within a 0.04-ha circular

TABLE 1

BIRD SPECIES AND NUMBER OF CIRCULAR PLOTS USED IN THE ANALYSES

Species	Habitat[a]	Circles	Number of nests	Perches
Nashville Warbler (*Vermivora ruficapilla*)	edge	13	3	3[b]
Northern Parula (*Parula americana*)	forest	16	4	3
Yellow Warbler (*Dendroica petechia*)	open	14	4	4
Chestnut-sided Warbler (*D. pensylvanica*)	open	16	2	2
Palm Warbler (*D. palmarum*)	edge	4	2	2
Ovenbird (*Seiurus auricapillus*)	forest	18	4	3
Common Yellowthroat (*Geothlypis trichas*)	open	17	4	0
Total		98	23	17

[a] Collins et al. (Oikos, In press), based upon analysis of 211 plots for 16 species of warblers.
[b] Number of perch plots with corresponding nest-site samples.

plot centered on a song perch within the territory of a singing male. Various structural attributes of the vegetation are recorded in these plots (James and Shugart, Audubon Field Notes 24:727–736, 1970), and several circles are sampled to determine the general habitat structure of each species. In the past, these data have been presented as averages and thus do not permit analysis of subtle within-habitat structural differences. The purpose of my research was to determine if differences in vegetation structure occur within the territories of several species of Parulidae (Table 1). This study is part of a larger project analyzing the habitat relationships and geographic habitat variation of the warblers in Maine and Minnesota.

Study area and methods.—This study was conducted in Itasca State Park located in Clearwater, Hubbard and Becker counties, in north-central Minnesota. The park contains 12,500 ha, of which 941 ha (7%) are lakes and ponds (Hansen et al., Univ. Minnesota Agric. Exper. Stat. Bull. 298, 1974). The area is located in the hemlock (*Tsuga*)-white pine (*Pinus strobus*)-northern hardwoods forest region (Braun, Deciduous Forests of Eastern North America, Blakeston Press, Philadelphia, Pennsylvania, 1950). Both logging and fires have created a diversity of vegetation types in the region, ranging from aspen coppice to mature upland spruce (*Picea*)-fir (*Abies*) forests, hardwood stands and pine stands. Parmelee (Loon 49:81–95, 1977) reported 27 species of warblers in the park, of which 13 are considered common nesting species.

Additional habitat data were obtained for Nashville and Palm warblers from the Red Lake Peatlands Natural Area, northern Beltrami Co., Minnesota. The vegetation in this region consists of forested "islands" of small black spruce (*Picea mariana*) and tamarack (*Larix laricina*), dense, low ericacious shrubs and a continuous ground cover of sedges and *Sphagnum* spp.

To determine if within-habitat variability occurs, two 0.04-ha circular plots, one at the nest-site and one at a perch-site, were sampled within the territory of a breeding male bird. Thirteen structural characteristics of the vegetation were measured in each circle (Table 2). Supplemental perch-site data were obtained from another data set in which nest-sites were not located. A total of 23 nest-sites and 75 perch-sites were sampled (Table 1).

Statistical differences between the vegetation structure of the nest-sites and perch-sites were measured by the Wilcoxon matched-pairs signed-ranks test. This test determines the

TABLE 2
VEGETATION STRUCTURE VARIABLES CONSIDERED IN THE ANALYSIS OF 0.04-HA NEST- AND PERCH-SITE SAMPLES[a]

GC	Percent ground cover—no. of sightings of ground cover vegetation at 20 evenly spaced points across a transect dividing the circle
CC	Percent canopy cover—no. of sightings of canopy vegetation at 20 evenly spaced points across a transect dividing the circle
SC	No. of contacts of shrub vegetation by the outstretched arms at 20 evenly spaced points across a transect dividing the circle
CO	Percent coniferous vegetation in the canopy at 20 evenly spaced points across a transect dividing the circle
CH	Canopy height
SPT	No. of species of trees
T1	No. of trees 7.5–15 cm dbh
T2	No. of trees 15.1–23 cm dbh
T3	No. of trees 23.1–30 cm dbh
T4	No. of trees 30.1–38 cm dbh
T5	No. of trees 38.1–53 cm dbh
T6	No. of trees 53.1–68.5 cm dbh
T7	No. of trees greater than 68.5 cm dbh

[a] After James and Shugart (1970).

direction and magnitude of differences (Siegel, Nonparametric Statistics for the Behavioral Sciences, McGraw-Hill, New York, New York, 1956) between the structural characteristics of nest- and perch-sites. Comparisons for each species were made at two levels: (1) individual nests with corresponding perch-sites, and (2) average nest-site structure vs average perch-site structure.

Typically, 0.04-ha-plot data are analyzed by multivariate ordination techniques. These methods elicit habitat patterns and indicate the most important vegetation variables which produce these patterns. In this case, discriminant function analysis (DFA) was applied to each species habitat structure matrix to determine if vegetation structure variables can discriminate between nest- and perch-sites. DFA combines the habitat variables in a stepwise fashion into the linear discriminant function which can best segregate nest-sites from perch-sites. The advantage of the multivariate DFA over the univariate Wilcoxon tests is that the former method incorporates the variability inherent in any habitat structure data set. For a description of DFA see Morrison (Multivariate Statistical Methods, 2nd ed., McGraw-Hill, New York, New York, 1979). The DFA was performed with BMDP (Dixon, Biomedical Computer Programs, Univ. California Press, Los Angeles, California, 1977) on the University of Oklahoma IBM 360/50 computer.

Results and discussion.—The general habitat structure of the seven species of warblers ranged from open-country to forest and forest-edge nesting species (Table 1). In spite of the small sample size, some patterns and differences in nest-site and perch-site structure can be extracted.

Only 29% (5/17) of the nest-sites had vegetation structures that were significantly different from the corresponding perch-sites within a territory (Table 3). Four of the five differences were in open-country nesting species. The differences in the structurally simple open habitats

TABLE 3
COMPARISON OF NEST-SITE VS PERCH-SITE VEGETATION STRUCTURE[a]

Species	Nest-perch comparison	T[b]	*P*	N
Northern Parula	N2-P2	4.0	0.01	11
Yellow Warbler	N1-P1	3.5	0.05	9
Yellow Warbler	N3-P3	0.0	0.05	7
Chestnut-sided Warbler	N1-P1	4.0	0.05	8
Chestnut-sided Warbler	N2-P2	0.0	0.01	9

[a] Based on the Wilcoxon matched-pairs signed-ranks test (Siegel 1956); 5 of 17 comparisons were significantly different.
[b] T = sum of ranks, *P* = probability level, N = number of variables in comparison.

of the Yellow and Chestnut-sided warblers were due to the greater number of trees at perch-sites which increased canopy cover, tree height and percent conifer in the canopy. The perch-site of the Northern Parula had higher ground and shrub cover, and percent conifer in the canopy than at the nest location.

If the nest-site and perch-site data for each species are averaged and again compared by the Wilcoxon test, the within-territory structure of the Northern Parula is no longer statistically different (N = 12, T = 21). However, both the Yellow and Chestnut-sided warblers still showed significant differences (N = 12; T = 1 and T = 9, respectively). Average perch-site variables of these species again contained greater tree component structure than average nest-sites corroborating the results of the within-territory comparisons.

The F-values for the six discriminant functions were significant for only two species—Common Yellowthroat and Northern Parula (Table 4). Percent conifer and canopy height significantly separate Common Yellowthroat nest- and perch-sites. However, the DFA reclassified one perch-site as a nest-site, and vice versa. Thus, within this data set, some structural overlap occurs between the two types of sites.

Eight variables entered into the Northern Parula discriminant function, most of which were tree size-class variables. The nests of this species were located in forest to forest-edge habitat

TABLE 4
DISCRIMINANT FUNCTION ANALYSIS OF SPECIES NEST-SITE VS PERCH-SITE STRUCTURE

Species	Variables entered[a]	F-value (df)	*P*	Number reclassified
Nashville Warbler	T2, CO	3.49 (2, 10)	0.10	1
Northern Parula	T3, T2, T6, CH, T5, SPT, GC, T4	5.69 (8, 7)	0.02	0
Yellow Warbler	CH, SPT, SC, T1	1.79 (4, 9)	NS	2
Chestnut-sided Warbler	CC	3.83 (1, 14)	0.10	2
Ovenbird	T3, T5	2.36 (2, 15)	NS	5
Common Yellowthroat	CO, CH	4.50 (2, 14)	0.05	2

[a] Variables are listed in order of entry into the discriminant function; see Table 2 for definition of variables.

with variable numbers of large deciduous and coniferous trees, and a relatively open canopy. Perch-sites were also variable yet they were most often located in the forest rather than at the forest edge. No nest- or perch-sites were reclassified, so complete discrimination between these sites is possible.

In summary, it appears that for the ground nesting Palm Warblers, Nashville Warblers and Ovenbirds, minimal differences exist between nest-site and perch-site structure. The Yellow and Chestnut-sided warblers showed significant differences in individual and average nest-site/perch-site comparisons, yet these nonconformities did not appear in the DFA. The Common Yellowthroat showed a difference only in the multivariate analysis. Lastly, both uni- and multivariate comparisons of the Northern Parula nest- and perch-site variables imply locally different within-habitat vegetation structure.

Several factors may cause the differences observed in these tests, one of which is the inherent variability of the vegetation. Curtis (The Vegetation of Wisconsin, Univ. Wisconsin Press, Madison, Wisconsin, 1959) stressed the compositional variation of vegetation and concluded that the same plant communities in a region resemble each other only to the extent of 50–70%. Many territories of forest nesting species are greater than 0.5 ha (Bent, Life Histories of North American Wood Warblers, U.S. Natl. Mus. Bull. 203, 1953) thus incorporating the natural variability of the vegetation. Secondly, the male selects and defends the territory, whereas the female chooses the nest-site. Different criteria are selected at each site: conspicuousness for male displays vs sheltered nest location. Thirdly, previous ecological studies of warblers have shown that males and females use different parts of the territory (Morse, Ecology 49:779–784, 1968; Ecology 54:346–355, 1973; Busby and Sealy, Can. J. Zool. 57:1670–1681, 1979). In particular, males foraged farther from the nest and higher in the canopy than did females. Finally, the selection of a perch-site as the center of a circular plot implies some degree of vegetation structure. Therefore, the wide ranging foraging behavior of males, large territories and differential territory use combine to introduce within-habitat variability.

Many stimuli, such as specific aspects of habitat structure, presence of other birds, food and previous breeding success, are proximate factors which can combine to elicit a territorial settling response in breeding birds (Hilden 1965). The measurement of vegetation structure is a reliable means of summarizing these stimuli since the physical habitat provides the background for the variables in the life cycle of a breeding bird. The suitability of the 0.04-ha-circle technique for summarizing and describing the 3-dimensional habitat structure of a species remains valid. Certain caveats, however, should be considered. James (1971) stated that centering a circular plot on a song perch "may give a biased view of habitat for species which occur in open areas and choose singing perches in places different from their foraging areas, but this objection is minimized in the forest." She later reiterated this statement noting that the 0.04-ha-circle method was only suitable for areas with trees (James, Am. Birds 32:18–21, 1978). However, my evidence for the Northern Parula suggests that within-habitat variability exists in forest nesting species. The technique is still very useful for describing the habitat of breeding birds, but locating circular samples around nest-sites or around female foraging areas is recommended whenever possible to incorporate within-habitat variation. Otherwise, caution should be used when interpreting habitat structure since perch-sites of forest and open-country nesting species may overestimate the tree component of the habitat.

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Foundation Summer Fellowship to the University of Minnesota Biological Station.—SCOTT L. COLLINS, *Dept. Botany and Microbiology, Univ. Oklahoma, Norman, Oklahoma 73019.* *Accepted 8 Nov. 1980.*

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Use of artificial perches on burned and unburned tallgrass prairie.—Kendeigh (Condor 43:165–175, 1941) stated that territorial male birds may lack sufficient perches in grasslands from which to conduct display activities. I investigated the importance of artificial perch availability to tallgrass prairie birds, from 7 June–31 July 1979, at the Konza Prairie Research Natural Area. This area of native bluestem (*Andropogon*) prairie is located in the extreme south-central portion of Riley and northern portion of Geary counties, Kansas.

Two areas on annually burned prairie and two on unburned prairie were selected for study. Artificial perches were added to one annually burned prairie (35 ha) and one unburned prairie (25 ha) with the other annually burned prairie (12 ha) and unburned prairie (39 ha) used as controls. The experimental sites were located adjacent to each other. Control sites were separated from experimental sites and from each other.

Perches were 2 × 2 cm wooden stakes, 1.5 and 2.0 m above ground level. Twenty-three perches were placed on the 35-ha annually burned prairie and 17 perches on the 25-ha unburned prairie, giving approximately equal perch density (0.67 perch/ha) in each area. The perches were placed in 15 m^2 subplots in each experimental area using randomly generated numbers. Use of perches in burned and unburned prairie and perch height preference were recorded during 36 spot check censuses. Spot check censuses were performed by approaching each perch within 100 m and noting the species and activity of each bird.

A vegetation density analysis on each plot was made using randomly selected 5 m^2 areas, for which standing height and percent cover by life form were recorded. For each area, 50% of the total area was analyzed.

Vegetation analyses indicated that the following plants were dominant. Grasses included: big bluestem (*Andropogon gerardi*), little bluestem (*A. scoparius*), windmillgrass (*Chloris verticillata*), switchgrass (*Panicum virgatum*) and side-oats grama (*Bouteloua curtipendula*). Dominant forbes were lead plant (*Amorpha canescens*), prairie wild indigo (*Baptisia leucophaea*), Baldwin ironweed (*Vernonia baldwini*), wild alfalfa (*Medicago lupulina*), fingeleaf ruellia (*Ruellia humilis*), tick-trefoil (*Desmodium illinoense*), butterfly milkweed (*Asclepias tubersoa*) and narrow-leaved milkweed (*A. stenophylla*). Woody vegetation consisted of the prairie rose (*Rosa arkansana*) and buckbrush (*Symphoricarpos abiculatus*). The mean standing height of vegetation for burned and unburned prairie was 27.66 cm and 45.50 cm, respectively.

Eleven of 23 perches (48%) were used on the burned area and 5 of 17 perches (29%) on the unburned area. This difference was not significant using the Chi-square test for equal proportions ($\chi^2 = 1.18$, df = 1, $P = 0.17$). Lack of significance may have been caused by small sample size and similarity in proportions of bird density/perch use in each area.

Species observed using perches in the burned area, in order of decreasing perch use were Dickcissel (*Spiza americana*), Eastern Meadowlark (*Sturnella magna*), Red-winged Blackbird (*Agelaius phoeniceus*), Brown-headed Cowbird (*Molothrus ater*), Common Nighthawk (*Chordeiles minor*), Grasshopper Sparrow (*Ammondramus savannarum*), Eastern Kingbird (*Tyrannus tyrannus*) and Upland Sandpiper (*Bartramia longicauda*). The following birds were found to use perches in the unburned area in order of decreasing perch use: Eastern Meadowlark, Grasshopper Sparrow, Dickcissel and Brown-headed Cowbird. Birds using