assisted in the field. The study was supported by the Northeastern Forest Experiment Station of the USDA Forest Service through the Northeast Consortium for Environmental Forestry. This paper is authorized as Journal Series No. 6741 of the Pennsylvania Agricultural Experiment Station.—ANN P. GAVETT AND JAMES S. WAKELEY, *School of Forest Resources, The Pennsylvania State Univ., University Park, Pennsylvania 16802.* *Received 15 Aug. 1983, accepted 30 Mar. 1985.*

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Vegetation structure and Vesper Sparrow territory location.—Vegetation structure can affect avian habitat selection (e.g., Whitmore, Wilson Bull. 91:592–598, 1979; Meents et al., Auk 98:818–827). As it also affects reproductive success in some species (Wray and Whitmore, Auk 96:802–805, 1979; Redmond et al., Can. J. Zool. 60:670–675, 1982), it should therefore affect territory location. Wray and Whitmore (1979) found that Vesper Sparrow (*Pooecetes gramineus*) reproductive success was positively correlated with percent litter cover and vertical vegetation density, and negatively correlated with percent bare ground around the nest. I tested the hypothesis that vegetation structure also affects where Vesper Sparrows locate their territories.

The study site was located on an upland grassy ridge in central west Montana, 1.4 km north of Missoula, Missoula County (114°W, 47°48'N; elevation 980 m). The vegetation was mostly mixed grasses and forbs of variable height and density.

In the first three weeks of April 1983, I established four plots, each of which was a 175 ×

TABLE 1

MEAN VALUES (STANDARD DEVIATION) OF CONTINUOUS VARIABLES USED IN THE DISCRIMINATION OF GRID POINTS FROM USED AND UNUSED AREAS

Variable	Used (N = 52)	Unused (N = 88)
Vegetation height (cm)		
Mean at the grid point	20.23 (13.1)	22.67 (18.5)
Mean at 1 m	24.01 (10.9)	31.26 (18.5)
Mean at 5 m	28.97 (9.5)	34.47 (10.8)
% ground cover[a]	351.26 (29.1)	343.25 (36.7)
% grass cover[a]	144.96 (94.9)	125.82 (76.8)
% forb cover[a]	206.30 (95.6)	217.96 (76.7)
Vertical vegetation density[b]	3.54 (1.8)	3.49 (1.9)
Horizontal vegetation density[c]		
At 1 m	505.63 (275.7)	633.27 (333.7)
At 5 m	1710.45 (758.2)	2163.85 (984.5)
Height of nearest perch (cm)	90.00 (39.0)	93.7 (24.0)
Distance from grid point to nearest perch (m)	9.32 (6.4)	8.06 (5.5)

[a] Cumulative percent cover (max = 400).
[b] Mean number of contacts with vegetation.
[c] Cumulative percent cover (max = 4000).

TABLE 2

THE STANDARDIZED CANONICAL DISCRIMINANT FUNCTION COEFFICIENTS FOR THE STEP-WISE DISCRIMINANT FUNCTION ANALYSIS (DFA) BETWEEN "USED" AND "UNUSED" HABITAT, AND FOR THE DIRECT DFA BETWEEN "USED" AND RANDOM GRID POINTS

Variable	Used vs unused	Used vs random
Vegetation height (1 m)	0.64	0.63
Vertical vegetation density	−0.24	−0.15
% ground cover	−0.77	−0.93
Horizontal vegetation density	0.70	0.66

125-m grid made up of 7 × 5 sample points spaced at 25-m intervals (average territory size on my study area in 1982 was 1.65 ha, N = 60). Grids were set up within a 3-week period. I assumed that early vegetation structure was important in determining territory location and that the vegetation structure changed minimally during the early nesting period. Grids were established along a previously marked census route that included territories of Vesper Sparrows during the previous year and that showed activity early in the study. Territories were mapped using the flush method (Wiens, Ornithol. Monogr. 8, 1969). Flight paths that overlapped a neighbor's territory were excluded. Territories were considered nonoverlapping, abutting at a boundary determined by observing interactions between neighbors. Fifty-two grid points occurred in six territories and were considered to represent "used" areas; 88 grid points occurred outside territories and were considered to represent "unused" areas. Plots within a territory were not considered to differ with regards to data analysis, so that an unused area within a territory was still considered "used."

To compare territory and nonterritory vegetation, I set up four, 5-m transects at each grid point. The transects followed each of the four cardinal directions. Vegetation variables included (1) Percent cover of grass, forb, and ground; (2) Vegetation height at the grid point, and at 1 and 5 m from the grid point along the transect; (3) Vertical vegetation density, determined by lowering a thin rod vertically through the vegetation at the grid point and counting the number of contacts with vegetation (Wray and Whitmore 1979); (4) Horizontal vegetation density, determined by using a 40 × 100-cm board painted in a checkerboard of 0.1 m^2 that was placed narrow end down at 1 and 5 m from the grid point. The percent of each square covered by vegetation was estimated and then summed for total board cover. These measurements were made with the observer at the grid point looking from 75 cm above the ground (to simulate the view from a Vesper Sparrow perch); (5) The height of the nearest structure I considered a potential perch, and its distance to the grid point. This was determined subjectively, based on relative heights of a given structure and the surrounding vegetation. Measurements along the four transects were summed to make a composite value for each variable at each grid point.

Vegetation structure data at grid points in used and unused areas (Table 1) were compared using step-wise discriminant function analysis (DFA). To test the significance of the DFA results I used the linear function in a classification analysis, where grid-point-variable values for each grid point are entered in the linear equation, and then each point is classified as "used" or "unused" based on which group mean each was nearest. The classification results were then compared with an "expected" value based on chance sorting of grid points. Chance sorting into two categories results in 50% correct classification, and this was tested using a χ^2 test. Used and unused grid points were also compared with 52 randomly selected grid points.

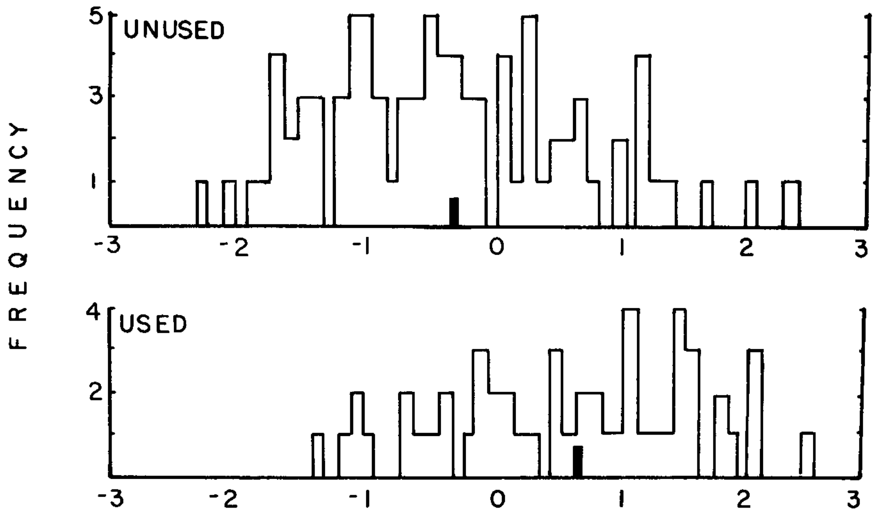

FIG. 1. Canonical discrimination function axis showing the distribution of grid points from used and unused areas. The continuum can be interpreted as going from short, dense vegetation with a high percent of ground cover (+3) to patchy tall vegetation (−3). Group means are marked with a thick vertical bar.

Maximum discrimination of vegetation structure between used and unused grid points was attained with four variables (Wilks' Lambda = 0.82, $P < 0.001$): vegetation height at 1 m, horizontal vegetation density at 1 m, percent bare ground, and vertical vegetation density (standardized canonical description function coefficients (SCDFC) are in Table 2). The distribution of points from unused to used areas along the discriminant function axis (Fig. 1) can be interpreted as a continuum from tall, patchy vegetation in unused areas (−3, group mean = −0.359), to short, dense vegetation with a relatively high percent ground cover in used areas (+3, group mean = 0.608). The height of vegetation 1 m from the grid point and horizontal vegetation density 1 m from the grid point varied inversely with percent bare ground and vertical vegetation density.

In classification analysis, 69% of the 140 grid points were classified correctly, significantly more than the 50% expected by chance sorting ($\chi^2 = 20.2$, df = 1, $P < 0.005$).

Using the four significant variables in the first DFA, grid points in used areas were successfully discriminated from random points using direct DFA (Wilks' Lambda = 0.89, $P < 0.02$) (Table 2), and more points were classified correctly (61%) than expected by chance sorting ($\chi^2 = 7.23$, df = 1, $P < 0.025$). Analysis did not discriminate between the vegetation structure of unused and random grid points (Wilks' Lambda = 0.93, $P > 0.10$), and no more grid points were classified correctly (54%) than expected by chance sorting ($\chi^2 = 0.90$, df = 1, $P > 0.05$).

A possible explanation for discrimination success between points in used and unused areas is that adjacent grid points may be more similar than nonadjacent points. Discrimination would then be an artifact of sampling. To look at variability between adjacent and nonadjacent points, I chose two sets of 36 grid points. One set was chosen at random from the four grids, and the second set consisted of the middle-most point and the eight surrounding points in each of the four grids. These represented random and clumped points

TABLE 3
STANDARD DEVIATIONS OF THE FOUR VARIABLES IMPORTANT IN THE DISCRIMINANT FUNCTION ANALYSIS (VALUES ARE FROM 36 RANSOM GRID POINTS AND 36 CLUMPED POINTS WITHIN FOUR GRIDS)

		Grid number			
	Random	1	2	3	4
Vegetation height (1 m)	11.2	8.0	9.9	12.8	10.7
Vertical vegetation density	2.2	1.2	0.7	1.5	2.0
% ground cover	28.4	29.7	16.5	46.8	29.0
Horizontal vegetation density	318.4	93.8	145.8	462.2	325.6

respectively. The variability of each of the four variables important in discrimination was similar (Table 3).

Vesper Sparrows were found in areas where the vegetation was short and dense, with a relatively high percentage of ground cover, and not in areas where the vegetation was tall and patchy. In this study vegetation structure in used areas was similar to that found in territories of Vesper Sparrows with high reproductive success as described by Wray and Whitmore (1979). Wray and Whitmore (1979) stated that the higher amount of ground cover may be needed to conceal nests from predators. During the breeding season Vesper Sparrows feed primarily on arthropods (Evans, Am. Midl. Nat. 72:57–75, 1964), and it may be easier for birds to forage in short dense vegetation. Although my results are consistent with previous research, they are based on a small sample size, and caution should be used in generalizing from them.

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Male and female parental care in Tree Swallows.—Often, it is assumed that to maximize their fitness, parental investment by males in raising altricial nestlings is substantial in monogamous species (e.g., Trivers, pp. 136–197 *in* Sexual Selection and the Descent of Man, 1871–1971, E. C. Campbell, ed., Aldine Press, Chicago, Illinois, 1972; Emlen and Oring, Science 197:215–233, 1977; Wittenberger, pp. 271–349 *in* Handbook of Behavioral Neurobiology, Vol. 3, Social Behavior and Communication, P. Marler and J. G. Vandenbergh, eds., Plenum Press, New York, New York, 1979). Although some Tree Swallows (*Tachycineta bicolor*) mate polygynously (Quinney, Auk 100:750–754, 1983), most are monogamous. They are relatively short-lived and almost exclusively single-brooded (but see Hussell, Wilson Bull. 95:470–471, 1983). Plumage characteristics distinguish first year females from males and other females, but the plumage of older birds is monomorphic. Nestlings are brooded by their mothers until they are about 5 days old (Dunn, Wilson Bull. 91:455–457, 1979), they are fed aerial insects, and the fecal sacs produced by the young are