*The Condor* 87:217–221


# NEST-SITE SELECTION BY SAGE SPARROWS

KENNETH L. PETERSEN

AND

LOUIS B. BEST

ABSTRACT.—In 1980, 1981, and 1982, we studied nest-site selection by Sage Sparrows (*Amphispiza belli*) in a sagebrush community in Idaho to provide a thorough description of nest-site characteristics and preferences. Sage Sparrows nested in areas where sagebrush coverage was sparse but shrubs were clumped. All nests were situated in big sagebrush (*Artemisia tridentata*) plants; large, living shrubs were strongly preferred. Nest placement relative to the ground and shrub perimeter seemed quite specific. Sage Sparrows avoided positioning nests on the southwest side of shrubs.

The Sage Sparrow (*Amphispiza belli*) is a common species breeding throughout much of the Great Basin region of the western U.S. (Wiens and Rotenberry 1981). Some investigators have considered Sage Sparrows to be sagebrush (*Artemisia* spp.) obligates (Braun et al. 1976), although Hill (1980) and Green (1981) recorded them nesting in low densities in fields with little or no sagebrush. Rich (1980) and Reynolds (1981) reported limited information on Sage Sparrow nest placement, but some questions were not addressed: Do Sage Sparrows show preferences in the nest sites they choose as well as in the manner in which they position their nests within the nesting substrate? Are habitat characteristics in the immediate vicinities of nests important in Sage Sparrow nest-site selection? Our objective was to comprehensively measure nest-site selection by Sage Sparrows occupying a sagebrush community in order to provide a more complete description of nest-site characteristics of this species and to identify nest-site preferences. Because Sage Sparrows are closely associated with sagebrush habitat and because sagebrush rangeland often is altered (Braun et al. 1976), thorough documentation of Sage Sparrow nesting habitat requirements is needed.

## STUDY AREA AND METHODS

### STUDY AREA

The Idaho National Engineering Laboratory (INEL) site lies at an elevation of about 1,500 m on the upper Snake River plain. The study area was located within the western boundary of the INEL site, approximately 11 km south of Howe, Butte County, Idaho. Average annual precipitation on the site is about 20 cm (Anderson and Holte 1981), and prevailing southwesterly winds frequently exceed 35 kph. Summer temperatures may reach 38°C near mid-day but can drop below 10°C at night. In conjunction with a fire ecology study (Petersen and Best 1983), four 6.25-ha plots were established on the area and gridded at 25-m intervals. Two plots occupied a prescribed burn area and two an adjacent area of similar (preburn) vegetational composition. Plots were approximately 200 m apart.

Vegetation on the study area was dominated by big sagebrush (*Artemisia tridentata*). Grasses typically occurred in small bunches, and dominant species included bluebunch wheatgrass (*Agropyron spicatum*) and Indian rice grass (*Oryzopsis hymenoides*). Forbs were a relatively minor component of the flora. The litter "layer" was composed primarily of scattered pieces of wood from dead sagebrush plants; much of the ground was bare.

### NEST SEARCHING

Sampling occurred in 1980, 1981, and 1982. Because two plots were burned in the fall of 1981, data reported for 1982 are only those collected from the two unburned plots. We searched all study plots for nests at 2-week intervals throughout May and June each year. Weighted, plastic streamers, attached to a 12-m rope, were systematically dragged through the vegetation to flush birds from their nests. Some nests were found by observing adults building nests or feeding young. We also discovered nests incidental to other activities; some after they had been abandoned. Abandoned nests believed to have been built before 1980 were excluded from the analysis.

### VEGETATION SAMPLING: STUDY AREA

We obtained a representative sample of vegetation coverage and structure from the study area in June each year. Canopy coverage and dispersion of sagebrush were estimated by line intercept (Canfield 1941). In 1980 and 1981, 100 regularly-spaced samples (25/plot) were

TABLE 1. Habitat characteristics in the vicinity of Sage Sparrow nests and on the study area in general ($\bar{x}$ ± SD). Sample sizes are in parentheses.

| Variable | Sage Sparrow | Representative sample |
|---|---|---|
| Sagebrush coverage (%) | 23 ± 9 (135)[a] | 26 ± 10 (220) |
| Shrub dispersion[b] | 86 ± 19 (135)[a] | 78 ± 19 (220) |
| Shrub height (cm) | 45 ± 19 (2,797)[a] | 43 ± 18 (3,053) |
| Herbaceous plant coverage (%) | 9 ± 12 (608) | 10 ± 12 (2,904)[c] |
| Litter coverage (%) | 6 ± 8 (608) | 6 ± 8 (2,904)[c] |
| Bare ground (%) | 51 ± 30 (608) | 53 ± 30 (2,904)[c] |

[a] Significantly different ($P \leq 0.05$) from representative sample ($t$-test).
[b] Coefficient of variation of inter-shrub distances (%).
[c] 1981 and 1982 data only.

taken near grid markers; an additional 20 samples (10/plot) were taken in 1982. Different grid markers were used each year. Line intercept and distance between adjacent shrubs were recorded along a tape extending 5 m from each sampling point in the four cardinal directions. For each sampling locus, the coefficient of variation of inter-shrub distances was used as an index of dispersion; the greater the index, the more clumped the shrubs.

Percentage coverage of herbaceous vegetation, litter, and bare ground was measured by using 20 × 50-cm sample quadrats (Daubenmire 1959). In 1980, two samples, and in 1981 and 1982, four samples were taken near each grid marker. We measured the height of all sagebrush plants occurring within quadrats. Additionally, the condition of each shrub was recorded as dead or 25, 50, 75, or 100% of the shrub living. For shrubs with foliage, we estimated foliage density as low (1), medium (2), or high (3). The continuity of the canopy (presence or absence of large gaps) of each shrub also was recorded.

### VEGETATION SAMPLING: NEST SITES

The same data were recorded for shrubs supporting a nest as for those occurring within quadrats. We estimated canopy coverage and dispersion of sagebrush in the vicinity of each nest by line intercept. A tape was extended from the nest 5 m in the four cardinal directions. We also recorded the height of each shrub intercepting the tape. In 1981 and 1982, we estimated coverage of herbaceous vegetation, bare ground, and litter in the vicinities of active nests (Daubenmire 1959). Samples were taken 2.5 and 5 m from each nest in the four cardinal directions.

All measures of nest placement within the nesting substrate were made in July after the breeding season. Height of the nest (ground to nest rim), distance from the nest rim to the top of the shrub, shortest horizontal distance from the center of the nest to the perimeter of the shrub, compass orientation of the nest relative to the center of the shrub, and number and diameter of supporting branches were recorded.

In 1980 and 1981, the vertical profile of the vegetation at each nest site was measured at 10-cm intervals along transects extending 50 cm outward from the center of the nest in the four cardinal directions. At each sampling point, a thin steel rod was passed vertically through the vegetation to the ground, and presence or absence of woody vegetation within 10-cm height intervals along the rod was recorded.

### ANALYSIS

Chi-square analyses, $t$-tests, and discriminant analyses were used to compare nest sites with the representative sample of vegetation from the study plot in general. Statistically significant, between-year differences in the data were rare; accordingly, and unless stated otherwise, we pooled the data from all years. All means are reported plus or minus one standard deviation; statistical significance was set at $P \leq 0.05$.

## RESULTS AND DISCUSSION

### NEST VICINITY

*Univariate analysis.* Mean canopy coverage of sagebrush was significantly less around Sage Sparrow nests than on the study area in general (Table 1). Shrub dispersion in the vicinities of nests also differed significantly from the representative sample; shrubs around nests were more clumped. Although not quantified in the present study, numerous observations in the field (Terrell Rich, pers. comm.; Winter 1984; pers. observ.) suggest that Sage Sparrows forage extensively on the ground and usually walk to and from their nests. Thus, Sage Sparrows may select nest sites having interspersions of shrubs and openings that afford favorable foraging sites and avenues for movement. Mean height of shrubs around Sage Sparrow nests was significantly (although slightly) greater than that of shrubs in the representative sample, but coverage of herbaceous vegetation, litter, and

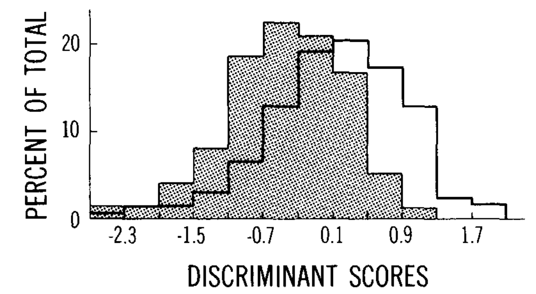


FIGURE 1. Distributions of standardized discriminant scores, comparing vicinities of Sage Sparrow nests (stippled histogram; $n = 76$) with the study area in general (open histogram; $n = 220$). Because some variables were not measured for nests in 1980, those nests were excluded from the analysis.

bare ground in the vicinity of nests did not differ significantly from that on the study area in general (Table 1).

*Multivariate analysis.* Discriminant analysis separated only weakly vicinities of nests from the study area in general (Fig. 1). Shrub dispersion was the most effective discriminator (standardized discriminant function: discriminant score = −0.646[shrub dispersion] + 0.304[herbaceous plant coverage] − 0.288[sagebrush coverage] − 0.279[shrub height] − 0.137[litter coverage] + 0.093[bare ground]). Despite the patterns observed in the univariate analysis, sagebrush coverage and shrub height seemingly contributed little to the discrimination. Thus, although nest vicinities differed significantly from the study area in general with respect to several characteristics of the sagebrush, spatial distribution of shrubs evidently was particularly important.

NEST SHRUB

*Univariate analysis.* All nests we found were in big sagebrush plants. Mean nest-shrub height (Fig. 2) was 1 cm less than that reported by Rich (1980) and identical to the value reported by Reynolds (1981). The distribution of nest-shrub heights was significantly different from that of the representative sample of shrub heights ($\chi^2 = 298.9$, df = 7). Sage Sparrows rarely nested in shrubs less than 40 cm and never in shrubs greater than 100 cm in height, but used shrubs 50–100 cm tall in greater proportions than their availabilities.

Large shrubs simply may offer more places for nests than small shrubs (see also Balda and Bateman 1972), but this probably does not explain the distribution we documented because shrubs 50–70 cm tall evidently were preferred over larger shrubs. As sagebrush plants grow beyond a certain point, they may become less suitable as nest sites because their branching structure becomes progressively more spreading and open. Also, very large shrubs are scarce and may be avoided as nest sites because they infrequently occur in combination with other nesting requirements. Shrubs below a certain size may not be used because the potential nest sites they offer are too close to the ground (near high soil surface temperatures and ground-dwelling predators) and do not afford sufficient cover above the nest (Best 1972).

TABLE 2. Condition of Sage Sparrow nest shrubs and a representative sample of shrubs. Values represent percent of the total sample.

| Condition | Sage Sparrow | Representative sample |
|---|---|---|
| Dead | 0 | 18 (535)[a] |
| 25% live | 1 (1) | 6 (182) |
| 50% live | 3 (4) | 13 (391) |
| 75% live | 27 (36) | 15 (443) |
| 100% live | 69 (94) | 48 (1,492) |

[a] Number of shrubs sampled.

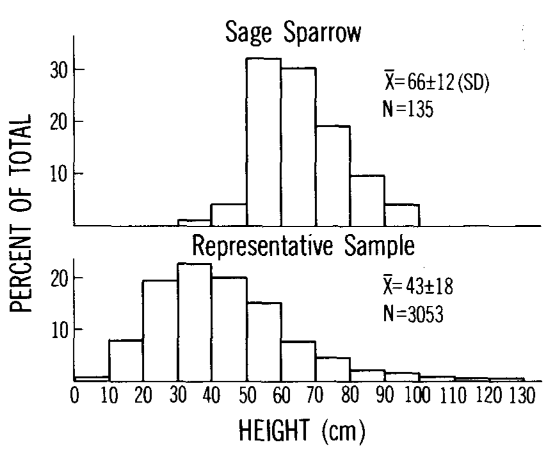


FIGURE 2. Size distributions of Sage Sparrow nest shrubs and a representative sample of shrubs.

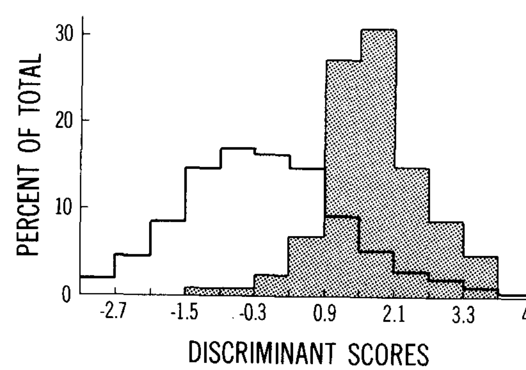


FIGURE 3. Distributions of standardized discriminant scores, comparing Sage Sparrow nest shrubs (stippled histogram; $n = 135$) with a representative sample of shrubs (open histogram; $n = 3,053$).

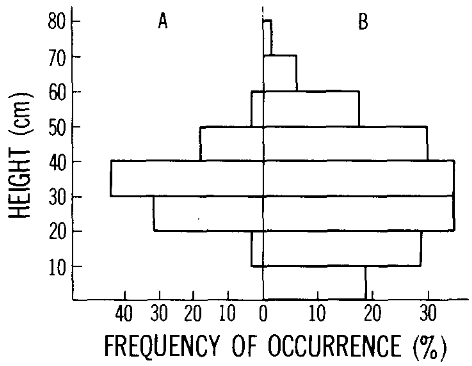


FIGURE 4. Frequency distribution of nest heights (A) and nest-site vegetation profile (B). Includes 1980 and 1981 data only ($n$ = 104).

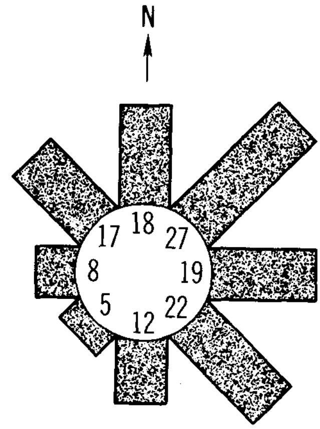


FIGURE 5. Orientation of Sage Sparrow nests relative to the center of the support shrubs. Values represent numbers of nests.

The distribution of Sage Sparrow nest shrubs among the condition classes (Table 2) was significantly different from the distribution of the representative sample of shrubs ($\chi^2 = 64.9$, df = 4). Sage Sparrows preferred nesting in living or mostly living shrubs; 96% of all nests were located in shrubs that were 75% or more living. Although some partly dead shrubs were used, nests never were placed in the dead portion of the shrub. Living shrubs probably were preferred as nest sites because they provided cover from the elements and concealment from predators.

Foliage density and continuity of the shrub canopy did not seem to be important factors influencing nest-site selection. Foliage density averaged 2.0 ± 0.5 for nest shrubs ($n$ = 135) and 2.0 ± 0.6 for the representative sample of shrubs bearing foliage ($n$ = 2,510). Because canopy continuity is related to shrub size, we considered shrubs only within the size range used for nest sites. This included 1,852 shrubs from the representative sample; 867 (47%) had gaps within their canopies, while the remainder had continuous crowns. Sixty-seven (50%) of the 135 nest shrubs had gaps in their canopies. Thus, with respect to canopy continuity, Sage Sparrows used shrubs for nest sites in proportions similar to their availabilities ($\chi^2$ = 0.38, df = 1).

*Multivariate analysis.* Discriminant analysis resulted in marked differentiation between shrubs used by Sage Sparrows and the representative sample of shrubs (Fig. 3; standardized discriminant function: discriminant score = 1.265[height] + 0.415[condition] + 0.141[foliage density]). Shrub height contributed strongly and shrub condition moderately to the discrimination. Moreover, most nest shrubs fell within a narrow range of discriminant scores, further emphasizing the specificity of nest-shrub selection by the sparrows. Sage Sparrows strongly preferred large, living shrubs.

NEST PLACEMENT

On the average, Sage Sparrows placed their nests ($n$ = 135) 34 ± 8 cm above the ground, 27 ± 7 cm from the top of the nest shrub and 21 ± 5 cm from the shrub perimeter. The mean number of branches supporting each nest was 6 ± 1 and supporting branches averaged 12 ± 5 mm in diameter. Mean nest height in our study was significantly greater than the values reported by Rich (1980) (20 cm; $t$ = 5.99, df = 147) and Reynolds (1981) (18 cm; $t$ = 8.64, df = 149). Nest heights could vary among localities owing to differences in nest-shrub heights, but the mean nest-shrub height we recorded was close to those reported by Rich and Reynolds. Differences in weather and types and intensity of predation among localities and years also may influence nest height. Reynolds (1979, 1981), for example, found that Loggerhead Shrikes (*Lanius ludovicianus*) preyed heavily on nestling Sage Sparrows. This may have caused the sparrows on his study area to nest lower (i.e., deeper within the shrubs where concealment likely would be greater) than they did on our study area, where shrikes did not breed. Figure 4 suggests that nest-site cover is indeed important to Sage Sparrows; most nests were placed in the densest portion of the nest-site vegetation profile.

Nest height, distance from the nest to the top of the shrub, and distance from the nest to the shrub perimeter varied relatively little. This suggests specific nest placement in relation to the ground and shrub perimeter, probably in response to a combination of nest-support requirements, microclimatic factors, and predation pressure. The relative constancy in nest placement may partly explain the seemingly stenotopic response by the sparrows to shrub size (Fig. 2). Preferences for placing the nest at a specific height and distance from the top and perimeter of the shrub limit the shrub size range that can provide suitable nest sites. Conversely, preferences for particular shrub sizes may restrict nest placement to a narrow range of heights and distances from the shrub perimeter.

The pattern of Sage Sparrow nest orientations was significantly different from uniform ($\chi^2 = 23.2$, df = 7); in general, the southwest side of shrubs was avoided (Fig. 5). This pattern may indicate a response to strong southwesterly winds that were frequent on our study area (see also Ricklefs and Hainsworth 1969; Austin 1974, 1976). Alternatively, intense, afternoon solar radiation may have been the primary factor causing Sage Sparrows to avoid southwest and to prefer northeast exposures for their nests (see also MacLean 1970, Balda and Bateman 1972).

## CONCLUSIONS

Sage Sparrows showed preferences in the habitat they chose near their nests, in the shrubs they selected as nest sites, and in the positioning of their nests within the shrubs. The vicinity of the nest site included proximate factors influencing nest-site selection. Documenting those factors reveals a more complete picture of Sage Sparrow nest-site and habitat requirements than that given by nest-substrate measurements alone. Given the association of Sage Sparrows with sagebrush, it is not surprising that the most important nest-vicinity variables were those characterizing the sagebrush and that Sage Sparrows have developed preferences for certain types of nest shrubs. Moreover, the close agreement between our nest-shrub size measurements and those of Rich (1980) and Reynolds (1981) suggests that the preferences we documented may not be peculiar to our study area. Further research should address the questions of **why** Sage Sparrows select the nest sites they do and **why** they position their nests as they do. If Sage Sparrows have evolved in sagebrush habitat, it seems likely that the patterns of nest-site selection we documented are adaptive and are ultimately determined by such factors as predators, foraging habits, and microclimate.

## ACKNOWLEDGMENTS

We thank Paul Sievert and Linda Erickson-Eastwood for assisting with field work; and Denise Hoffman, Julie Holmes and Ted LaGrange for helping with data compilation. James Dinsmore, Richard Johnson, Timothy Reynolds, Terrell Rich, Mark Ryan, and Robert Whitmore provided helpful comments on earlier drafts of the manuscript. This study was supported by the Office of Health and Environmental Research, U.S. Department of Energy, and by Sigma Xi, and is a contribution from the INEL Radioecology-Ecology Program. This is Journal Paper No. J-10609 of the Iowa Agriculture and Home Economics Experiment Station, Ames, Iowa, Project No. 2468.

## LITERATURE CITED

ANDERSON, J. E., AND K. E. HOLTE. 1981. Vegetation development over 25 years without grazing on sagebrush-dominated rangeland in southeastern Idaho. J. Range Manage. 34:25–29.

AUSTIN, G. T. 1974. Nesting success of the Cactus Wren in relation to nest orientation. Condor 76:216–217.

AUSTIN, G. T. 1976. Behavioral adaptations of the Verdin to the desert. Auk 93:245–262.

BALDA, R. P., AND G. C. BATEMAN. 1972. The breeding biology of the Pinon Jay. Living Bird 11:5–42.

BEST, L. B. 1972. First-year effects of sagebrush control on two sparrows. J. Wildl. Manage. 36:534–544.

BRAUN, C. E., M. F. BAKER, R. L. ENG, J. S. GASHWILER, AND M. H. SCHROEDER. 1976. Conservation committee report on effects of alteration of sagebrush communities on the associated avifauna. Wilson Bull. 88:165–171.

CANFIELD, R. H. 1941. Application of the line interception method in sampling range vegetation. J. For. 39: 388–394.

DAUBENMIRE, R. F. 1959. A canopy-coverage method of vegetational analysis. Northwest Sci. 33:43–64.

GREEN, B. H. 1981. Habitat selection and utilization by Sage Sparrows (*Amphispiza belli*) in a cold desert mixed shrub community. M.Sc. thesis, Brigham Young Univ., Provo, Utah.

HILL, H. O. 1980. Breeding birds in a desert scrub community in southern Nevada. Southwest. Nat. 25:173–180.

MACLEAN, G. L. 1970. The biology of the larks (Alaudidae) of the Kalahari sandveld. Zool. Afr. 5:7–39.

PETERSEN, K. L., AND L. B. BEST. 1983. Effects of prescribed burning on nongame birds breeding in sagebrush communities: pre-burn phase, p. 202–210. *In* O. D. Markham [ed.], Idaho National Engineering Laboratory radioecology and ecology programs: 1983 progress report. U.S. Dep. of Energy, Idaho Falls, ID.

REYNOLDS, T. D. 1979. The impact of Loggerhead Shrikes on nesting birds in a sagebrush environment. Auk 96: 798–800.

REYNOLDS, T. D. 1981. Nesting of the Sage Thrasher, Sage Sparrow, and Brewer's Sparrow in southeastern Idaho. Condor 83:61–64.

RICH, T. 1980. Nest placement in Sage Thrashers, Sage Sparrows, and Brewer's Sparrows. Wilson Bull. 92: 362–368.

RICKLEFS, R. E., AND F. R. HAINSWORTH. 1969. Temperature regulation in nestling Cactus Wrens: the nest environment. Condor 71:32–37.

WIENS, J. A., AND J. T. ROTENBERRY. 1981. Habitat associations and community structure of birds in shrubsteppe environments. Ecol. Monogr. 51:21–41.

WINTER, B. M. 1984. Effects of prescribed burning on avian foraging ecology and arthropod abundance in sagebrush-grassland. M.Sc. thesis, Iowa State Univ., Ames.

*Department of Animal Ecology, Iowa State University, Ames, Iowa 50011.* Received 30 January 1984. Final acceptance 13 November 1984.