We thank the Audubon Society of Corvallis and the Oregon Department of Fish and Wildlife for their support of the Corvallis Bluebird Trail, and A. Ansell, M. S. Eltzroth, and J. Krabbe for their help with observing bluebird nests.—ELSIE K. ELTZROTH, *3595 NW Roosevelt Dr., Corvallis, Oregon 97330,* and SCOTT R. ROBINSON, *685 NW Linden, Corvallis, Oregon 97330.* Received 31 Aug. 1983; accepted 14 Feb. 1984.

Passerine Bird Densities in Shrubsteppe Vegetation.—In 1979 and 1980 we surveyed nesting passerine bird densities within the Bureau of Land Management's (BLM) Snake River Birds of Prey Study Area in southwestern Idaho. The BLM wished to estimate bird densities so that they could evaluate the importance of individual vegetation types to the production and maintenance of bird populations. We derived bird densities using line transect survey techniques (Burnham et al. 1981). Line transect sampling uses statistically sound procedures and unlike the numerous ad hoc survey techniques (see Ralph and Scott 1981 for an extensive review of available methods) in the ornithological literature, allows estimation of sampling variance. Without some measure of variance it is impossible to judge the precision of the density estimates and compare densities between times and areas.

Study site.—The Snake River Birds of Prey Study Area is located in southwestern Idaho along 110 km of the Snake River. The area is in an upper Sonoran life zone with an annual precipitation that ranges from 18 to 25 cm. Summers are hot and dry, and winters are mild. Vegetation within the Birds of Prey Study Area consisted of big sagebrush, *Artemisia tridentata,* and salt-desert shrub communities. A general description of the plant communities is given in Sharp and Sanders (1978). Birds were surveyed within 4 major vegetation types:

(1) **Big sagebrush** was nearly pure stands of big sagebrush with an understory of exotic forbs and grasses (primarily cheatgrass, *Bromus tectorum*).

(2) **Big sagebrush-winterfat mosaics** included a mosaic of big sagebrush and of winterfat (*Ceratoides lanata*) stands. Understory vegetation consisted primarily of cheatgrass, Sandberg bluegrass (*Poa sandbergii*) and exotic mustard species.

(3) **Salt-desert shrubs** occurred as nearly pure stands of a single species or as mixed stands including several shrub species. Shadscale (*Atriplex conferifolia*); bud sagebrush (*Artemisia spinescens*); winterfat; greasewood (*Sarcobatus vermiculatus*); Nuttall saltbush (*Atriplex falcata*); four-wing saltbush (*Atriplex canescens*); and horsebrush (*Tetradymia glabrata*) were shrubs occurring in this vegetation type. This vegetation type is a grouping of several vegetation types that was necessary to obtain adequate sample sizes for analysis (see below).

(4) **Grasses and forbs** were the result of fires in big sagebrush, winterfat, and salt-desert shrub stands. Immediately after a fire, exotic forbs such as Russian thistle (*Salsola kali*), tumble and tansy mustards (*Sisymbrium altissimum, Sophia pinnata*) colonize the area. Dense stands of cheatgrass follow within a few years.

Methods.—We located 23 transects in big sagebrush, 4 in big sagebrush-winterfat mosaics, 14 in salt-desert shrubs, and 13 in grass. Each transect was 4 km in length, and was located within a homogeneous stand of vegetation. Transect routes were measured and flagged prior to the actual survey (see Burnham et al. 1981 for a discussion of survey procedures). During the 4-week period of mid-April to mid-May of 1979 and 1980, each transect was walked once from first light until 0900. The survey was conducted during egg-laying and incubation and transects were walked only on days without inclement weather. Bird species were grouped into 4 categories: Horned Larks (*Eremophila alpestris*), Western Meadowlarks (*Sturnella neglecta*), sparrows, and other birds. Birds were grouped into these categories rather than analysis by individual species because of sample size considerations. A minimum of 40 and preferably 60 to 80 birds is needed for line transect analysis (Burnham et al. 1981). Lateral distances from the transect line were recorded in 5 m groupings to 30 m, then in two 30 m groupings to 90 m. Data from all transects within each vegetation type were combined and analyzed using the Fourier series estimator by program TRANSECT (Burnham et al. 1980).

TABLE 1. Passerine bird densities (number/ha) within major vegetation types within the Snake River Birds of Prey Study Area.

	Density	SE	% CV	95% CI
Big sagebrush				
Horned Lark				
1979	0.75	0.052	7.0	0.65–0.85
1980	0.65	0.038	5.8	0.58–0.73
Meadowlark				
1979	0.19	0.020	10.5	0.15–0.23
1980	0.12	0.016	13.1	0.08–0.14
Sparrow				
1979	0.44	0.064	14.7	0.31–0.56
1980	0.99	0.048	4.9	0.91–1.15
Other birds				
1979	0.29	0.040	14.0	0.21–0.37
1980	0.07	0.012	16.7	0.05–0.10
Total				
1979	1.63	0.110	6.7	1.42–1.84
1980	1.53	0.083	5.4	1.37–1.70
Big sagebrush—Winterfat Mosaics				
Horned Lark				
1979	0.61	0.094	15.4	0.43–0.80
1980	0.66	0.072	10.8	0.52–0.81
Meadowlark				
1979	0.18	0.041	22.2	0.10–0.27
1980	—[a]			
Sparrow				
1979	1.05	0.129	12.3	0.80–1.31
1980	1.27	0.101	8.0	1.07–1.47
Other birds				
1979	—[a]			
1980	0.06	0.024	37.4	0.02–0.11
Total				
1979	3.65	0.230	6.4	3.19–4.10
1980	2.01	0.130	6.5	1.75–2.26
Salt-desert Shrubs				
Horned Lark				
1979	0.63	0.087	13.6	0.47–0.80
1980	0.89	0.044	5.0	0.80–0.98
Meadowlark				
1979	0.06	0.016	25.7	0.03–0.09
1980	0.07	0.014	21.2	0.04–0.09
Sparrow				
1979	0.42	0.042	10.0	0.34–0.51
1980	0.38	0.074	19.5	0.23–0.53
Other birds				
1979	0.34	0.071	20.5	0.20–0.48
1980	0.06	0.012	18.7	0.04–0.08

TABLE 1. Continued.

	Density	SE	% CV	95% CI
Total				
1979	1.54	0.130	8.5	1.28–1.79
1980	1.54	0.059	3.8	1.43–1.66
Grass				
Horned Lark				
1979	0.59	0.054	9.1	0.48–0.69
1980	1.78	0.067	3.8	1.64–1.90
Meadowlark				
1979	0.08	0.016	20.3	0.05–0.11
1980	0.14	0.028	19.5	0.09–0.20
Sparrow				
1979	0.15	0.021	13.4	0.11–0.19
1980	0.06	0.013	20.1	0.04–0.09
Other birds				
1979	0.17	0.031	17.5	0.11–0.23
1980	0.02	0.007	39.1	0.00–0.03
Total				
1979	1.05	0.070	7.0	0.91–1.19
1980	1.93	0.070	3.7	1.79–2.07

[a] Insufficient sample size for analysis.

Results and discussion.—Passerine densities vary with habitat and species requirements (MacArthur and MacArthur 1961). Within the Birds of Prey Study Area the big sagebrush-winterfat mosaic type had the greatest number of birds (Table 1). Such vegetation offered nesting habitat for a variety of sagebrush and grassland species. Passerine densities for the big sagebrush and salt-desert vegetation types were similar for all groupings of birds. This probably was related to the fact that many bird species appear to select habitat on the basis of physiognomy rather than species composition (Rotenberry and Wiens 1980a). Many of the salt-desert vegetation types were comprised of shrubs similar to big sagebrush in stature.

Horned Lark and Meadowlark densities were comparable with little variation among vegetation types (Table 1). Densities of sparrows differed markedly among vegetation types. The sparrows included: Black-throated Sparrow (*Amphispiza bilineata*), Brewer's Sparrow (*Spizella breweri*), Chipping Sparrow (*Spizella passerina*), Lark Sparrow (*Chondestes grammacus*), Sage Sparrow (*Amphispiza belli*), Savannah Sparrow (*Passerculus sandwichensis*), Song Sparrow (*Melospiza melodia*), Vesper Sparrow (*Pooecetes gramineus*), and White-crowned Sparrow (*Zonotrichia leucophrys*). Some of these such as the Black-throated and Sage sparrows, were found only in specific vegetation types. This is in agreement with Wiens and Rotenberry (1981) who noted that some shrubsteppe species appear to be closely associated with shrub species composition. The "other bird" category included species ranging from Rock Wrens (*Salpinctes obsoletus*) and Barn Swallows (*Hirundo rustica*), to Ravens (*Corvus corax*) and Long-billed Curlews (*Numenius americanus*).

There was no significant difference in density between the survey years ($t = -.98$, df = 13). The 2 years were similar in precipitation and temperature patterns. Rotenberry and Wiens (1978, 1980b) pointed out that shrubsteppe birds respond to environmental conditions in a largely opportunistic fashion and densities vary from year to year.

Densities obtained during this study are similar to those reported from ad hoc survey techniques by other researchers in shrubsteppe vegetation (Frinzel 1964, Feist 1968, Best 1972, Wiens 1974, Rotenberry and Wiens 1980a). This lends support to the belief that many of the bird survey techniques probably have a sound biological basis although they lack sampling rigor.

Numerous wildfires have occurred within the Birds of Prey Study Area. These fires result in shrub vegetation being replaced by grasslands, consisting of either cheatgrass or BLM planted wheatgrass. Bird species composition changes with the vegetation. Shrub dependent species disappear to be replaced by those species using grasslands. Agricultural conversion results in the almost complete elimination of avian life from the fields. Fields are large, are without fence rows, are irrigated by overhead sprinkler systems, and are planted to crops such as potatoes and sugar beets which offer no nesting habitat.

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LITERATURE CITED

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

BURNHAM, K. P., D. R. ANDERSON, AND J. L. LAAKE. 1980. Estimation of density from line transect sampling of biological populations. Wildl. Monogr. 72.

———, ———, and ———. 1981. Line transect estimation of bird density using a Fourier series. Studies in Avian Biol. 6:466–482.

FEIST, F. G. 1968. Breeding bird populations on sagebrush-grassland habitat in central Montana. Audubon Field Notes. 22:691–695.

FRENZEL, J. E. 1964. Avian populations of four herbaceous communities in southwestern Wyoming. Condor 66:496–510.

MACARTHUR, R. H., AND J. W. MACARTHUR. 1961. On bird species diversity. Ecology 42:595–598.

RALPH, C. J., AND J. M. SCOTT (eds.). 1981. Estimating numbers of terrestrial birds. Studies in Avian Biol. 6.

ROTENBERRY, J. T., AND J. A. WIENS. 1978. Nongame bird communities in northwestern rangelands. Pp. 32–46 *in* R. M. DeGraff, coordinator. Proc. of the Workshop on Nongame Bird Habitat Management in the Coniferous Forest of the Western United States. Gen. Tech. Rep. PNW-64, Forest Service, U.S. Dep. Agric., Portland, Oregon.

———, and ———. 1980a. Habitat structure, patchiness and avian communities in North American steppe vegetation: a multivariate analysis. Ecology 61:1228–1250.

———, and ———. 1980b. Temporal variation in habitat structure and shrubsteppe bird dynamics. Oecologia 47:1–9.

WIENS, J. A. 1974. Habitat heterogeneity and avian community structure in North American grasslands. Am. Midl. Nat. 91:195–213.

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

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